FINAL REPORT

MAYFLOWER TAILING STORAGE FACILITY 5 DAM OPERATING CONDITION SEEPAGE AND STABILITY ANALYSES CLIMAX MINE CLIMAX, COLORADO

Prepared for
Climax Molybdenum Company
Highway 91 – Fremont Pass
Climax, CO 80429

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In 2012 Climax Molybdenum Company (Climax) reinitiated milling operations at Climax Mine and, with the approval of the Colorado Division of Reclamation, Mining and Safety (DRMS), began depositing tailing at the Tenmile Tailing Storage Facility (TSF). Climax currently plans to deposit tailing at the presently inactive Mayflower TSF during Summer 2014.

URS Corporation (URS) was requested by Climax to perform seepage and stability analyses for the Mayflower TSF's decant pond area and embankment to satisfy DRMS requirements prior to initiating deposition activities. This report presents a summary of our analysis and findings. For purposes of this report, the Mayflower TSF, including the decant pond area and embankment, will be referred to collectively as 5 Dam.

SITE DESCRIPTION

The Climax Mine is located in central Colorado at Fremont Pass at the confluence of the Arkansas, Eagle, and Tenmile drainages. Tailing produced from the milling process was stored in one of five tailing impoundments, numbered 1 through 5 for the order in which they were constructed. 1 Dam is a closed facility and has been inactive since the late 1970s. 3 Dam was reactivated in 2012 and is currently the active facility on site until deposition begins on 5 Dam (planned for 2014). This report is focused on resumed deposition at the currently inactive 5 Dam.

5 Dam was constructed at the lower end of the Tenmile Valley in the early 1970s. The dam was designed to contain tailing up to a crest elevation of 10,960 feet. Deposition began in the late 1970s and was ceased in 1985. The dam currently has an approximate overall downstream slope of about 4 Horizontal to 1 Vertical (4H:1V), a maximum height of approximately 190 feet, a crest elevation of 10,612 and a crest length of about 2,100 feet. The current estimated freeboard is 12 to 14 feet. Climax plans to raise 5 Dam about 210 feet to the current life of mine (LOM) crest elevation of 10,820 feet.

Deposition was initiated behind a starter dam that consists of compacted glacial till. Bottom drainage is provided through a subdrain system and a cycloned tailing sand blanket. The dam was built using the upstream method, utilizing header-and-spigot deposition in summer months and single-point discharge (leadoff) deposition in the winter.

The dam was partially reclaimed in the 1990s by flattening the downstream face and placing a vegetated soil cover on the dam face and impoundment surface. A deposition berm was constructed in 2012 to prepare for new deposition at 5 Dam.

PREVIOUS ANALYSES

URS completed a probabilistic seismic hazard analysis (PSHA) and stability analyses for the inactive Robinson, Tenmile and Mayflower TSF embankments (1 Dam, 3 Dam and 5 Dam, respectively) in 2007. Other reports and field investigations have been completed by URS, Woodward-Clyde (heritage firm to URS), and by others prior to 2007. These reports, although not specifically discussed within this report, were used to supplement data collected for the URS 2007 stability analysis report.

2007 Probabilistic Seismic Hazard Analysis

URS completed a PSHA in 2007 for the Climax Mine site. The results of the PSHA serve as the primary characterization of seismic sources in the area. The ground motions developed in the PSHA were used in the analyses completed in 2007 by URS and in the current work.

URS 2007 Analyses

URS completed geotechnical investigations of 1 Dam, 3 Dam and 5 Dam. The work scope included reviewing existing data, performing a geotechnical field investigation, and completing stability analyses of each tailing dam for existing elevations and the future design height elevations. This report was prepared to provide a preliminary assessment of the tailing dams for current conditions in 2006 and to assess the potential for raising 3 and 5 Dams. Seepage analyses were not conducted as part of the 2007 project.

The field investigation included test hole drilling, piezometer installation and advancing cone penetrometer testing with pore pressure measurement (CPT) soundings. Selected samples were tested for index and engineering properties. Results of the investigation were used to evaluate liquefaction potential and conduct slope stability analyses. CPT and laboratory test result data collected for the 2007 report are included as appendices to this report.

The 2007 liquefaction potential analysis showed the potential for liquefaction at 5 Dam during the 1,000-year event as low. Slope stability analyses included steady-state and post-earthquake loading conditions for the existing dam height and undrained and post-earthquake loading conditions for the future design elevation (elevation 10,960 feet). Results of the analyses show 5 Dam met or exceeded minimum recommended factors of safety of 1.5, 1.2 and 1.0 for steady-state, undrained and post-earthquake loading conditions, respectively.

2012 FIELD INVESTIGATIONS

A geotechnical investigation of 5 Dam was performed to evaluate the subsurface conditions and collect tailing samples for laboratory testing. The field investigation included performing 3 cone penetration test (CPT) soundings, and drilling and sampling 8 test holes. Five of the test holes were completed as open well piezometers and one test hole was completed as an inclinometer. The test holes completed with instrumentation were included as part of a program to increase the monitoring instrumentation on the dam.

All CPTs were collocated with or near a test hole to allow correlation between measured in-situ parameters (standard penetration tests [SPTs]) and laboratory test results. Additionally, the CPTs were collocated with or near 2006 CPTs to allow for direct comparison.

Results from this investigation were utilized to provide data for this report and associated analyses.

LABORATORY TESTING

Laboratory tests were performed on selected samples collected from the test holes. Laboratory tests were performed to provide index properties, classify materials according to the Unified Soil Classification System (USCS), and to measure engineering properties.

The index property tests included sieve analysis, hydrometer analysis, natural water content, dry unit weight, specific gravity, Atterberg limits and visual classifications. Engineering property testing included permeability tests, consolidation tests, and different types of shear strength testing. Shear strength testing included isotropically consolidated undrained triaxial compression tests with pore pressure measurement (CIŪ), direct simple shear tests (DSS), and cyclic triaxial shear tests.

Index test results and CIŪ test results were generally agreeable with previous data collected at the site. DSS and cyclic testing had not been completed in previous investigations. The cyclic testing generally showed the tailing is dilative. Soils that exhibit dilative behavior are generally less susceptive to liquefaction.

SUBSURFACE AND MATERIAL CHARACTERIZATION

The material characterizations within 5 Dam were evaluated based on the tip resistance, sleeve friction, friction ratio, and dynamic pore water pressures from the CPT soundings, visual observation of samples collected during test hole drilling, SPT blow counts collected during drilling, and laboratory test data. Historic information, including data collected for the previous URS 2007 report, was also used.

The test holes and CPT data show the embankment to be composed mostly of silty sand to sandy silt material, with lenses of finer tailing at depth, and to be relatively free-draining. Review of the data also found no discernible difference in the whole tailing and cycloned sands, other than their permeabilities. The CPT data was evaluated and identified the state condition of the whole and cycloned tailing as generally dilative.

Results of the cyclic triaxial tests show the whole and cycloned tailing did not lose strength after being cycled for motions much higher than the OBE event. Therefore, the post-earthquake (OBE) shear strength of the whole tailing and cycloned sands was identified as equivalent to the undrained shear strength of the materials.

New data was not collected in the fine tailing, foundation or bedrock, and therefore material properties established in the URS 2007 report were used for the current analyses. New SPT results were available for the starter dam, which agreed with the URS 2007 material properties and supported their continued use in the current analyses.

Results of the characterization were used in the seepage and stability analyses completed.

SEEPAGE ANALYSES

A two-dimensional seepage analysis was performed along the maximum dam section to evaluate the effects of deposition on the phreatic conditions of the existing 5 Dam. Material properties used in the analyses, including horizontal conductivity and anisotropy ratio, were based on historic data review, published correlations, and evaluation of new and existing laboratory data.

The model was calibrated to the existing decant pond location, measured phreatic surface and estimated seepage flows. Estimated future conditions were analyzed assuming the decant pond is located 800 feet from the crest. Three cases were analyzed for this report and include:

- Case 1: Calibration of Existing Conditions (Crest Elevation 10,612 feet)

- Case 2: Steady-State Model (Estimated Future Conditions, Crest Elevation 10,820 feet)
- Case 3: Transient Model (Deposition Conditions at Estimated Future Conditions, Crest Elevation 10,820 feet)

URS has recommended Climax maintain the decant pond at least 800 feet from the dam crest to facilitate development of a relatively free-draining shell of coarse sand, which was reflected in the seepage analyses.

The resulting phreatic surface from Case 1 (calibration model) closely aligns with the observed current phreatic conditions and matches observed seepage outflows. The resulting phreatic surface from Case 2 showed an increase in the phreatic surface mostly attributed to the reduced beach width. The resulting surface from Case 3, which is about 2 feet higher than the Case 2 surface and attributed to the effects of active deposition for 35 days, was used in the stability analyses completed for the raised dam case.

STABILITY ANALYSES AND RESULTS

Liquefaction triggering and slope stability analyses were completed to evaluate the current and future estimated conditions at 5 Dam while in active operation.

Design Criteria

Climax requested DRMS review the proposed seismic design criteria of both 3 Dam and 5 Dam in 2008. These design criteria were accepted by DRMS in a letter to Climax dated February 14, 2008.The design criteria proposed consists of the OBE for the operating period of the facility. The OBE was calculated using probabilistic methods considering a 7.0 magnitude earthquake with a 475-year return period. The calculated associated peak ground motions are 0.06g.

URS has recommended Climax maintain the decant pond at least 800 feet from the dam crest during normal operations to facilitate development of a relatively free-draining shell of coarse sand. Seepage analyses performed for the LOM dam crest (elevation 10,820 feet) located the beach 800 feet from the crest, as have the stability analyses.

DRMS does not have specific requirements for factor of safety (FS) values calculated as part of slope stability analyses. Recommended minimum FS values for the analyses, in accordance with generally accepted engineering practice, are:

- Slope Stability, Steady-State Loading Conditions: 1.5
- Slope Stability, Undrained Loading Conditions: 1.2
- Slope Stability, Post-Earthquake Loading Conditions: 1.0

Liquefaction Triggering

Liquefaction potential was evaluated using semi-empirical methods described by Idriss and Boulanger (2004) and Idriss and Boulanger (2008). SPT- and CPT-based triggering assessments, utilizing SPT and collocated CPT data, were used to evaluate the potential for liquefaction while conservatively assuming all subsurface soils were “sand-like” soils.

Results from the liquefaction triggering analyses show calculated factors of safety greater than1.0 for both approaches (generally above 2.0 and increasing with depth) for all test holes and CPTs from the 2012 investigation, which indicates low potential for liquefaction triggering for the OBE event.

Additionally, review of available CPT data, test hole blow counts, and laboratory test results indicates the coarse tailing is generally dilative during shearing. Results of the cyclic triaxial tests show the whole and cycloned tailing did not lose strength after being cycled for motions much higher than the OBE event. Based on the simplified cyclic stress approach and the equations presented by Idriss and Boulanger (2008), OBE cyclic stress ratios (CSRs) are expected to range between about 0.04 and 0.07 within the tailing and produce 5 to 15 equivalent uniform cycles. When tested at CSRs of 0.19 and 0.30, pore pressure ratios in tailing samples reached values of about 28% and 95% after 1,000 and 248 cycles, respectively. The OBE parameters and the cyclic triaxial test results indicate that the OBE event is very unlikely to induce widespread liquefaction in the tailing.

Slope Stability Analyses

Stability analyses for operating conditions at 5 Dam was completed for steady-state, undrained, and post-earthquake loading conditions for the existing dam and the raised dam. The OBE event has low ground motions that are not anticipated to liquefy nor cause the coarse tailing to undergo significant shear strength loss during shaking (as evident by the cyclic triaxial test results). However, the OBE event may induce excess pore pressures, essentially creating an undrained loading condition in the saturated materials; therefore the post-earthquake loading condition was analyzed as similar to the undrained loading condition.

Stability was evaluated at the study section representing the maximum dam section. Material properties used in the analyses were based on historic data review, published correlations, and evaluation of new and existing laboratory data.

Results of our stability analyses show 5 Dam meets or exceeds minimum recommended FS values for each loading condition, as summarized in Table ES-1.

Table ES-1
CALCULATED THEORETICAL FACTORS OF SAFETY FOR STABILITY ANALYSES

Loading Condition	Design Section	Failure Surface	Calculated Minimum FS (Global Failure)	Minimum Recommended FS
Steady-State (Static Drained)	Existing Conditions (Elevation 10,612)	Circular	2.6	1.5
		Noncircular	3.0	
	Future Design Elevation (Elevation 10,820)	Circular	2.7	
		Noncircular	2.7	
Undrained/ Post-Earthquake (OBE Event)	Existing Conditions (Elevation 10,612)	Circular	2.5	1.2/1.0
		Noncircular	2.4	
	Future Design Elevation (Elevation 10,820)	Circular	2.1	
		Noncircular	2.0	

RECOMMENDATIONS

We recommend performing the following activities associated with deposition on 5 Dam:

- Perform beach profile sampling to evaluate newly deposited tailing to verify the material properties are consistent with those envisioned in the design. This will include evaluating the new whole tailing gradation as it compares to past whole tailing gradations. Profile sampling should be performed near the end of the first spigot season (estimated early fall 2014). The sampling should include collection of relatively undisturbed samples along 2 to 3 profile lines from the crest extending into the impoundment. Selected samples will be tested to measure index properties of the tailing.
- Evaluate the tailing beach and beach topography to verify the beach slope is consistent with that envisioned in the original design. The beach area should be surveyed near the end of the first spigot season. Evaluation of the differences with prior surveys should be performed on an annual basis.

- Maintain the decant pond at least 800 feet from the crest under normal operating conditions.
- Implement weekly review of the data from currently installed piezometers during start-up. Piezometric data review may be decreased to a monthly basis as deemed appropriate by the Engineer-of-Record (EOR) after review of the weekly readings.
- Install additional piezometers, as deemed necessary by the EOR, along the crest and face of the dam to evaluate the phreatic surface and material changes resulting from tailing deposition and to continue to support the observational approach. Frequency and location of piezometer installation will be established during regularly scheduled inspections and piezometric data review. Laboratory testing on selected materials should also be completed during piezometer installation to confirm design assumptions. Initial piezometric data generated at start-up will be reviewed with consideration to whether additional piezometers are required.

Implementation of the recommendations will be addressed in the Mayflower TSF Operations and Maintenance Manual.

Climax resumed milling operations at the Climax Mine in 2012 and will resume tailing placement on the presently inactive Mayflower TSF in 2014. URS was requested by Climax to perform seepage and stability analyses for the Mayflower TSF pond area and embankment to satisfy DRMS requirements prior to initiating deposition activities. This report presents a summary of our analyses and findings. For purposes of this report, the decant pond area and embankment of the Mayflower TSF will be referred to as 5 Dam. Presented below is a brief project background, followed by our scope of work and a summary of the report organization.

Tailing deposition began at the Tenmile TSF in 2012 and will continue through Summer 2014, at which time Climax currently plans to transition to the Mayflower TSF for the remaining mine life.

1.1 SCOPE OF WORK

Climax requested URS perform geotechnical analyses considering the current geometry of 5 Dam and the planned upstream raise to elevation 10,820 feet. This is an estimated elevation based on mine production forecasts and existing dam and pond geometry for the project mine life.

Our work included reviewing previous analyses and data; performing CPT soundings and test hole drilling field program; conducting laboratory testing on selected field samples; developing characterizations of the subsurface materials based on the results of the field work and laboratory testing; preparing a seepage analysis that was calibrated to current conditions and used to estimate future phreatic levels during deposition; and using the seepage analysis results to complete a slope stability evaluation under operating conditions for existing and future design elevation of 5 Dam.

The results of our analyses are summarized in this report along with recommendations for operating the dam based on our analyses and experience with this and similar facilities.

Additionally, the field investigations, historic data review, and analyses completed for this report are an important part of the overall successful operation of 5 Dam and are part of the "observational approach." The observational approach consists of evaluating the in-place tailing properties with those modeled in previous analyses. It is an iterative process that occurs throughout the life of the tailing dam, which Climax is proactively pursuing.

1.2 SITE DESCRIPTION

The Climax Mine is located in central Colorado at Fremont Pass at the confluence of the Arkansas, Eagle, and Tenmile drainages. Tailing produced from the milling process was stored in one of five tailing impoundments, numbered 1 through 5 for the order in which they were constructed. 1 Dam is a closed facility and has been inactive since the late 1970s. 3 Dam was reactivated in 2012 and is currently the active facility on site until deposition begins on 5 Dam (planned for 2014). This report is focused on resumed deposition at the currently inactive 5 Dam. A plan view showing the Climax tailing dams is presented on Figure 1-1.

5 Dam was constructed at the lower end of the Tenmile Valley in the early 1970s. The dam was originally designed to contain tailing up to a crest elevation of 10,960 feet. Deposition began in the late 1970s and was ceased in 1985. The dam currently has an approximate overall downstream slope of about 4H:1V, a maximum height of approximately 190 feet, a crest

elevation of 10,612 and a crest length of about 2,100 feet. The current estimated freeboard is 12 to 14 feet. Climax plans to raise 5 Dam about 210 feet to the current LOM crest elevation of 10,820 feet, which is approximately 140 feet below the original design elevation.

The dam is designed to be raised using the upstream construction method. The tailing dam incorporates a starter dam composed of compacted glacial till. Initial tailing deposition consisted of placing cycloned underflow upstream of the starter dam to establish drainage. Cycloned overflow was deposited in the decant pond. This was later followed by header-and-spigot deposition in the warmer months and lead-off deposition in the winter months.

Historic water treatment activities at Climax have produced “process sludge.” Some of this sludge has precipitated and settled in the 5 Dam decant pond. The sludge layer is reportedly 1 to 3 feet thick near the upstream end of the current pond (the sludge is estimated to be about 1,200 feet from the crest) and increases to approximately 30 feet at the back of the decant pond. Additional discussion about the sludge is included in Appendix C.

5 Dam has a series of foundation drains (subdrains) and drain trenches that, in conjunction with the foundation drain blanket of cycloned underflow tailing, provide bottom drainage. Subdrains were excavated parallel to the valley floor with fingers extending perpendicularly outward from the main line. This drain system is composed of 8- and 12-inch diameter perforated corrugated steel pipes surrounded by gravels and sands. The main subdrain lines are about 1,600 feet in length.

The historic decant system in the dam consists of 2 separate, adjacent pipelines. These pipelines are used to dewater the decant pool and as an emergency/flood spillway. Each pipeline consists of a 42-inch diameter steel pipe encased in blocks of reinforced concrete, founded on prepared subgrade. Climax is currently constructing a new dewatering system that will consist of a barge and tunnel. The barge will be used to dewater the decant pool and the tunnel will be used as a flood spillway. The barge and tunnel will be operational before deposition begins at 5 Dam, currently planned for 2014. The historic decant system will be closed with grout in the future, currently anticipated in 2015.

The Mayflower Dam was partially reclaimed in the early 1990s. The downstream face was regraded to a uniform benched slope and a soil cover was placed on the downstream face and over the tailing beach to the decant pond. The soil cover is about 2 feet thick and vegetated with grasses and forbs. This cover will be removed from the impoundment surface prior to initiating future deposition.

A deposition berm, also referred to as a raise berm, was constructed in 2012 to begin preparation for active deposition. The cover was removed in the footprint of the berm, and the underlying tailing was scarified prior to initiating borrow placement activities. The berm was mechanically constructed of compacted tailing sands and was stepped back 25 feet from the crest (at the downstream toe) to create a new bench on the face of 5 Dam. The berm is about 20 feet tall with a crest elevation of about 10,630 feet. Two leadoffs, also constructed of tailing and placed on the scarified tailing surface, extend 800 feet (from the upstream edge of the raise berm crest) into the impoundment at a 0.5% slope. A third leadoff, consisting of leadoff piping placed on natural ground at the left abutment, extends into the impoundment similar to the other leadoffs.

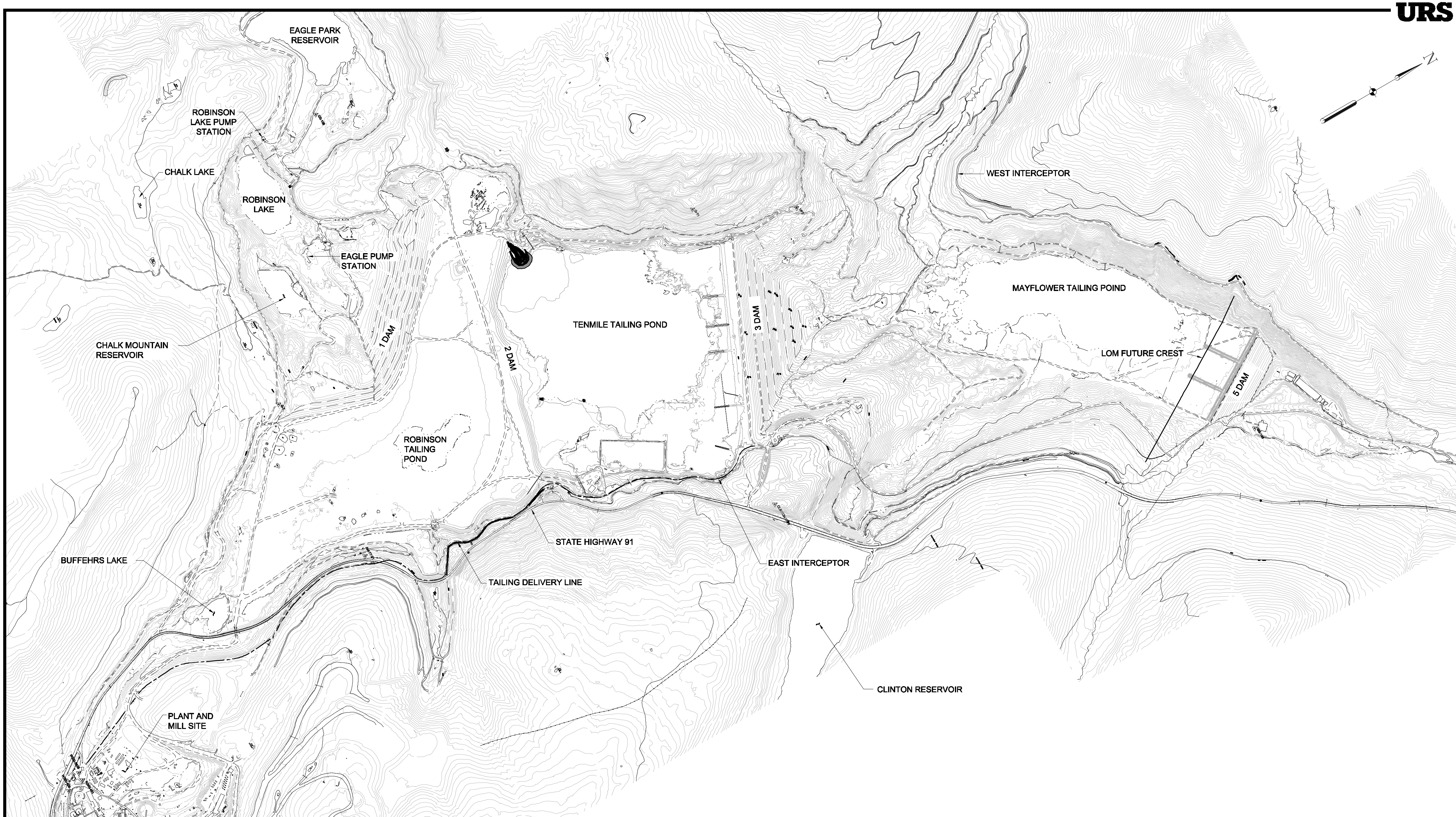
1.3 REPORT ORGANIZATION

This report presents a summary of previous analyses and our current geotechnical analyses completed for 5 Dam. The report is organized into the following sections:

- Executive Summary
- Section 1 – Introduction
- Section 2 – Previous Analyses
- Section 3 – 2012 Field Investigations
- Section 4 – Laboratory Testing
- Section 5 – Subsurface and Material Characterization
- Section 6 – Seepage Analyses
- Section 7 – Stability Analyses
- Section 8 – Conclusions and Recommendations
- Section 9 – General Information
- Section 10 – References

This report also includes tables, figures and appendices with supporting data. The appendices are as follows:

- Appendix A – CPT Data (includes 2006 and 2012 investigation data)
- Appendix B – Laboratory Test Results (includes 2006 and 2013 investigation results)
- Appendix C – Sludge Sensitivity Analysis (includes a discussion about sludge that has been placed in the Mayflower Tailing Pond)



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NOTE:

1. THE BASE TOPOGRAPHY FROM A 2006 AERIAL SURVEY WITH 2012 AS-BUILT SURVEY OF DEPOSITION BERM AND SURVEYED EXISTING PIEZOMETER LOCATIONS WERE PROVIDED BY CLIMAX.

Job No. : 22243088	CLIMAX MINE SITE PLAN
Prepared By : JSE	
Date : SEPTEMBER 2013	

FIG. 1-1

URS completed a PSHA and stability analyses for the inactive Robinson, Tenmile and Mayflower TSF embankments (1 Dam, 3 Dam and 5 Dam, respectively) in 2007.

Other reports and field investigations have been completed by URS, Woodward-Clyde Consultants (heritage firm to URS), and others prior to 2007, including a seepage analyses completed by URS in 2003. These other historic reports, although not specifically discussed within this Section, were used to supplement data collected in the URS 2007 report and are listed in the References (Section 10.0).

2.1 2007 PROBABILISTIC SEISMIC HAZARD ANALYSIS

A PSHA was completed in 2007 for the Climax Mine site. The PSHA included a review of historic seismicity, identification of potential earthquake sources, a site-specific paleoseismic evaluation, and a probabilistic analysis generating ground motions and associated return periods. A number of faults have been mapped within 100 kilometers of the area, with the Mosquito Fault being the most active fault, located approximately 3 kilometers from the site.

The available geological and seismological data, including information obtained directly from site reconnaissance completed part of the PSHA study, was used to characterize potential seismic sources, the likelihood of earthquake occurrence on or within those sources, the likely magnitude of potential earthquakes occurring, and the likelihood of the earthquakes producing ground motions over a specific level within a given period of time. The analysis allowed for explicit inclusion of the range of potential interpretations in the various components of the seismic hazard model. Uncertainties in model parameters were directly incorporated into the hazard analysis. Parameters input into the calculations included fault distance from the dam location, fault rupture model characteristics including length and dip, maximum magnitude achievable during rupture, and fault slip rate. Weighted values of each key fault parameter as well as the estimated probability of activity were input in to the calculations.

Probabilistic ground motions were calculated as a function of annual exceedance probability or return period. The results of the PSHA serve as the primary characterization of seismic sources in the area. Peak horizontal accelerations for various return periods at 5 Dam are presented in Table 2-1.

Table 2-1
SUMMARY OF PEAK HORIZONTAL ACCELERATIONS FOR 5 DAM (URS 2007)

Return Period (years)	Peak Horizontal Accelerations
475	0.06g
2,500	0.14g
5,000	0.20g
10,000	0.27g

2.2 2007 URS ANALYSES

URS completed geotechnical investigations of 1 Dam, 3 Dam and 5 Dam (URS 2007). The work scope included reviewing existing data, performing a geotechnical field investigation, and completing stability analyses of each tailing dam for existing elevations and facility design future elevations.

This report was prepared to provide a preliminary assessment of the tailing dams for current conditions in 2006 and to assess the potential for raising 3 and 5 Dams. Seepage analyses were not conducted as part of the 2007 work.

Field Investigation

Field investigations for each dam, performed in late summer 2006, included cone penetration test (CPT) soundings and geotechnical test holes at each dam, including 5 Dam, the focus of this current report.

Seven CPT soundings were advanced into 5 Dam (4 at the crest, 3 within the impoundment) and two geotechnical test holes were drilled (1 at the crest, the other within the impoundment) as shown in Figure 3-1. Select CPT soundings were collocated with test holes to allow correlation with measured in situ parameters such as SPTs and laboratory tests performed on selected tailing samples. The information collected from CPT soundings and drilled test holes was used to develop an understanding of the internal dam characteristics, the dam construction methods used, as well as historic tailing deposition patterns and practices. Soundings located at the crest were advanced between 55 and 203 feet to the natural ground contact. The variation in depth is due to the soundings' proximity to the abutments. Soundings advanced further upstream within the impoundment had total depths ranging from 35 to 125 feet.

Laboratory Investigation

The geotechnical evaluation found that the tailing material contained within 5 Dam generally classified as silty sands (SM), with isolated samples of poorly-graded sand with silt (SP-SM) and a non-plastic silt (ML). Laboratory testing was performed on selected samples collected during the field investigation. The laboratory tests measured the physical and index properties of the tailing including gradation analyses, dry densities and water contents, Atterberg limits, and specific gravity measurements. Laboratory tests were also conducted to measure the engineering properties of the tailing and included permeability, consolidation, and shear strength. Laboratory test results are provided in Appendix B.

Geotechnical Analyses

Geotechnical analyses performed included liquefaction analyses and slope stability analyses. Liquefaction analyses were completed and the results show that the potential for liquefaction for the 1,000-year event (magnitude 7.0) was low.

Slope stability analyses for 5 Dam were performed at the maximum dam cross-section for the following conditions:

- Steady-state seepage loading conditions for existing height (elevation 10,612)
- Post-earthquake loading conditions for existing height (elevation 10,612)

- Steady-state seepage loading conditions for future height (elevation 10,960)
- Undrained loading conditions for future height (elevation 10,960)
- Post-earthquake loading conditions for future height (elevation 10,960)

Internal geometry of the section and material properties were based on the data collected during the 2006 field and laboratory investigations, previous investigations, and previous stability analyses. Table 2-2 presents the material properties used in the 2007 stability analyses.

Table 2-2
SUMMARY OF URS 2007 STABILITY ANALYSES
MATERIAL PROPERTIES FOR 5 DAM

Material	Unit Weight (pcf)	Steady-State Analyses		Undrained Analyses		Post-Earthquake Analyses	
		Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)
Unsaturated Tailing Sands	110	35	0	35	0	35	0
Saturated Tailing Sands	115	35	0	$S_u/p' = 0.45$		$S_u/p' = 0.36$	
Slimes	110	25	500	$S_u/p' = 0.40$		$S_u/p' = 0.32$	
Saturated Cycloned Sands	110	35	0	$S_u/p' = 0.45$		$S_u/p' = 0.36$	
Unsaturated Cycloned Sands	110	35	0	35	0	35	0
Sludge	73	0	1,200	0	0	0	0
Starter Dam	135	35	0	35	0	35	0
Foundation	145	35	0	35	0	35	0

A seepage analysis was not completed for the 2007 URS report. Future phreatic conditions were estimated based on then-current piezometric ranges, and our understanding of how the dam and similar tailing dams behave.

The results of the 2007 stability analyses are presented in Table 2-3.

Table 2-3
SUMMARY OF URS 2007 STABILITY ANALYSES
RESULTS FOR 5 DAM

Dam Configuration	Steady-State FS	Undrained FS	Post-Earthquake FS
Existing Height (El. 10,612)	2.9	--	2.4
Future Design Elevation (El. 10,960)*	1.9	1.4	1.1
Minimum Recommended FS	***1.5***	***1.2***	***1.0***

*El. 10,960 represents the design elevation for the facility; the current LOM crest that was analyzed for the current report is 10,820 feet.

A geotechnical investigation of 5 Dam was performed to evaluate the subsurface conditions and collect tailing samples for laboratory testing. The field investigation included performing CPT soundings, drilling and sampling test holes. Five test holes were completed as piezometers and one as an inclinometer.

The locations of the soundings and test holes are shown on Figure 3-1. Profile views of the maximum section and a second study section are presented on Figures 3-3 and 3-4, respectively, and include tip resistance plots from CPT soundings. A legend for the section views is presented on Figure 3-2. Full CPT sounding data is included on Figures 3-5 through 3-7.

The results of the investigations were used to supplement existing geotechnical information, refine the internal dam geometry for our analyses, and assist in evaluating engineering properties of the subsurface materials. Presented below is a brief summary of our field investigation completed for this project.

3.1 CONE PENETROMETER TESTING INVESTIGATION

Three CPT soundings were advanced at 5 Dam from October 2 through 4, 2012, utilizing a track-mounted rig by ConeTec, Inc. of Salt Lake City, Utah, under subcontract to URS. The subcontractor activities were observed on a full-time basis by a URS representative. The locations of the CPT soundings (CPT 2012-5-1, CPT 2012-5-2, and CPT 2013-5-3) are shown on Figure 3-1. The CPTs were located along the maximum section. All CPTs were collocated with or near a test hole to allow correlation between measured in-situ parameters, SPTs and laboratory test results. Additionally, the current CPTs were collocated with or near 2006 CPTs to allow for direct comparison to review changes in phreatic conditions and to review for any indication of cementation since 2006.

CPT soundings provide a continuous record of the encountered subsurface materials. The resulting information provides insight into the microstratigraphy of the subsurface tailing and is well-suited for fine grained, hydraulically-deposited materials. The information obtained from CPT soundings was used to supplement our understanding of the internal dam characteristics, construction methods used, and historic tailing deposition patterns and practices.

A CPT sounding is advanced by hydraulically pushing an electric piezocone with a series of one-meter long steel rods. As the piezocone is advanced through the tailing, built-in sensors provide a continuous record of the subsurface tailing. The CPT sensors provide data traces that help identify the stratigraphy of the different materials and are well suited for characterizing fine-grained hydraulically deposited materials, such as tailing.

Sounding depths ranged between approximately 133 and 204 feet below existing grade and were generally terminated when the probe encountered foundation soils. The tip resistance (q_c), sleeve friction (f_s), and dynamically induced pore water pressure measured behind the cone tip (u_2) were recorded every 2 centimeters. The q_c, f_s, and u_2 values were recorded and plotted as a function of depth as shown on Figures 3-5 through 3-7. Correlations for effective friction angle (Kulhawy and Mayne 1990) and predicted SPT blow counts (Idriss and Boulanger 2008) are presented on the CPT figures. As anticipated, the CPT correlations for SPT blow counts are conservative when compared to field measured values. CPT data collected and presented by ConeTec are provided in Appendix A.1.

Dynamic pore pressures are measured as the piezocone is advanced and shears the soils. The measured dynamic pore pressure values do not reflect actual in-situ pore pressures, therefore the piezocone was stopped at selected intervals to allow dissipation of the dynamic pore pressures and to record the static pore pressure. This process is known as a pore pressure dissipation (PPD) test. The locations for dissipation tests are typically selected to occur in sand layers. The PPD test data, provided in Appendix A.2, gives an estimate of percent hydrostatic pore pressures. The locations of the PPD tests are shown on Figures 3-5 through 3-7.

Table 3-1
CPT SOUNDING SUMMARY

Sounding	Total Depth (feet)	Remarks
CPT 2012-5-1	204	Collocated with INC 5-1, CPT 2006-5-2, TH 2006-5-1
CPT 2012-5-2	133	Collocated with TH5-2
CPT 2012-5-3	168	Collocated near TH5-3, CPT 2006-5-6

A discussion of the CPT data collected and its relation to the properties of the subsurface materials is presented in Section 5.

3.2 TEST HOLE DRILLING INVESTIGATION

Eight test holes were drilled at 5 Dam in October 2012. The drilling was performed by Boart Longyear of Fife, Washington, under subcontract to URS. A URS representative observed test hole drilling, logged the test holes, collected samples for laboratory testing, and visually classified the samples in the field.

Five of the test holes were completed as open well piezometers (P-1N, P-9, P-10, P-11, and P-12) and one test hole was completed as an inclinometer (INC 5-1). The test holes completed with instrumentation were included as part of a program to increase the monitoring instrumentation on the dam (P-1N was installed to confirm readings in the starter dam). This investigation was utilized and supplemented with 2 additional test holes (TH5-2 and TH5-3) to provide data for this report and associated analyses.

A majority of the dam's instrumentation is located at or near the maximum section, identified as Section A – A' on Figure 3-1 (in plan view) and shown in section on Figure 3-3. A second study section, B – B', is shown in plan view on Figure 3-1 and in section on Figure 3-4. A legend supporting the section views is presented on Figure 3-2.

Drilling Summary

The test holes were drilled using mud rotary methods powered by a truck-mounted CME 75 drill rig. A URS engineer observed the drilling, visually classified samples collected, and logged the test holes. Test holes were sampled using a 2-inch outside diameter standard split-spoon sampler and 3-inch nominal diameter Shelby tubes. The drilling program generally called for collection of samples at 5 to 10-foot intervals using the split-spoon sampler. Two to 3 Shelby tube samples were collected from the test holes.

The split-spoon samplers were driven by a 140-pound automatically-operated hammer falling 30 inches. Penetration resistance was recorded as blows per 6 inches of sampler penetration, with a total of 18 inches of penetration. The SPT resistance (or blow count, N) is the total number of blows required to drive the sample between 6 inches and 18 inches of penetration. Soil samples were classified in the field as they were obtained and stored for transportation, and returned to the URS Denver office for review and laboratory testing assignment.

Penetration test results are presented on the summary logs, which are located on the profile views presented on Figures 3-3 and 3-4. The blow counts shown are the field measured blow counts (uncorrected).

Piezometer Installation

Five of the test holes were completed as open well piezometers as shown in Table 3-2. The piezometers consist of 2-inch diameter, flush-threaded, 0.010-inch machine-slotted, Schedule 40 polyvinyl chloride (PVC) pipe installed to the bottom of the test hole. The annular space between the slotted pipe and test hole wall was backfilled to about 8 feet below the existing ground surface with sand pack consisting of No. 10 – 20 silica sand. A 5-foot thick bentonite seal was placed above the sand pack, followed by a 3-foot concrete surface seal. Steel surface casing was installed and all piezometers were fitted with end caps.

Table 3-2
PIEZOMETER INSTALLATION SUMMARY

Piezometer No.	Type	Total Drilled Depth (feet)	Screen Interval (feet)	Northing	Easting	Ground Surface Elevation (feet)
P-1N	Open Well	30	10-20	30,909.2	8,104.6	10,485.2
P-9	Open Well	35	10-30	30,419.8	8,431.5	10,481.3
P-10	Open Well	85	10-80	29,668.6	8,238.0	10,614.4
P-11	Open Well	136	10-136	30,098.6	7,975.5	10,613.2
P-12	Open Well	135	10-130	30,769.1	7,574.6	10,612.8

Inclinometer Installation

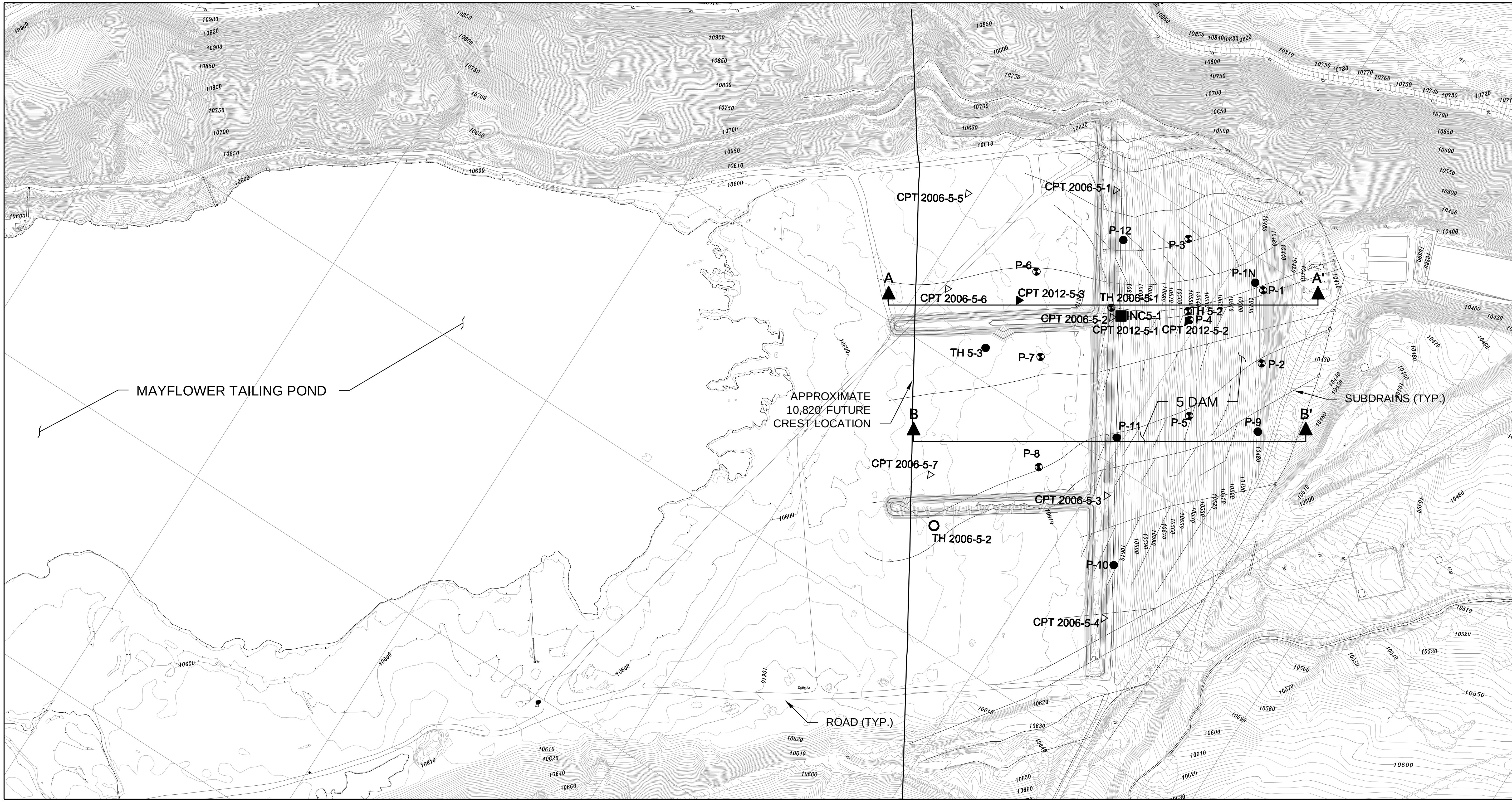
One of the test holes was completed as an inclinometer, designated as INC 5-1. Table 3-3 presents a summary of the inclinometer installation details, including that the inclinometer was drilled about 32 feet into the foundation for a total depth of 228 feet. The completed inclinometer consists of 2.75-inch *Slope Indicator* inclinometer casing for the entire depth which was backfilled with cementitious grout.

Table 3-3
INCLINOMETER INSTALLATION SUMMARY

Inclinometer No.	Total Depth (feet)	Depth into Foundation (feet)	Northing	Easting	Ground Surface Elevation (feet)
INC 5-1	228	32	30,511.6	7,729.9	10,612.4

A discussion of the test hole data collected and its relation to the properties of the subsurface materials is presented in Section 5.

URS



LEGEND

CPT 2012-5-1	▶	CPT (2012)
P-10	●	PIEZOMETER (INSTALLED 2012)
INC5-1	■	INCLINOMETER (INSTALLED 2012)
P-5	◐	PIEZOMETER (INSTALLED 2006 OR EARLIER)
TH 2006-5-2	○	TEST HOLE (2006)
CPT 2006-5-1	▷	CPT (2006)

NOTES:

1. THE BASE TOPOGRAPHY FROM A 2006 AERIAL SURVEY WITH 2012 AS-BUILT SURVEY OF DEPOSITION BERM AND SURVEYED EXISTING PIEZOMETER LOCATIONS WERE PROVIDED BY CLIMAX.
2. TEST HOLE AND CPT SOUNDING LOCATIONS (2012) WERE SURVEYED BY CLIMAX WITH THE EXCEPTION OF TH 5-2 AND TH 5-3 WHICH ARE APPROXIMATE.
3. PIEZOMETERS P-6, P-7, AND P-8 ABANDONED IN 2012.
4. SEE FIGURES 3-3 AND 3-4 FOR SECTION VIEWS.

0 200 400 800
SCALE IN FEET

Job No. :	22243088
Prepared By :	JSE
Date :	SEPTEMBER 2013

TEST HOLE AND CPT LOCATIONS
5 DAM

FIG. 3-1

URS

LEGEND

	SAND TO SAND WITH SILT TO SILTY SAND, VERY LOOSE TO VERY DENSE, SLIGHTLY MOIST TO WET, YELLOW TO TAN TO GRAY (SM, SP-SM, SP) (TAILING)
	SILT WITH SAND TO SANDY SILT WITH TRACES OF CLAY, DENSE TO VERY DENSE, SLIGHTLY MOIST TO WET, YELLOW TO TAN TO GRAY (ML) (TAILING)
	SAND WITH SILT AND GRAVEL TO SILTY SAND WITH GRAVEL, MEDIUM DENSE TO VERY DENSE, WET, BROWN TO RED TO GREY (SM, SP-SM) (NATURAL FOUNDATION AND FILL)
	GRAVEL WITH SILT AND SAND TO SILTY GRAVEL WITH SAND, MEDIUM DENSE TO VERY DENSE, MOIST TO WET, BROWN TO GRAY (GM, GP-GM) (NATURAL FOUNDATION, COVER, STARTER DAM)
q_C (tsf)	CPT TIP RESISTANCE IN TONS PER SQUARE FOOT
	INDICATES 2-INCH DIAMETER FLUSH-THREADED (0.010-INCH MACHINE SLOTTED BELOW SOLID RISER) SCHEDULE 40 PVC PIPE PIEZOMETER INSTALLED IN TEST HOLE
	INDICATES 2.75-INCH DIAMETER SLOPE INDICATOR INCLINOMETER PIPE CASING INSTALLED IN TEST HOLE
10/12	INDICATES 20 BLOWS OF A 140-LB. HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2-INCH O.D. SPLIT SPOON SAMPLER 12 INCHES
16.0%, 15.8%	INDICATES 16.0% WATER CONTENT , 15.8% FINES CONTENT (<200 SIEVE) FROM LABORATORY TESTS
ST	INDICATES A 3-INCH DIAMETER THIN WALLED SHELBY TUBE SAMPLE WAS OBTAINED
	APPROXIMATE RECENT PIEZOMETRIC ELEVATION

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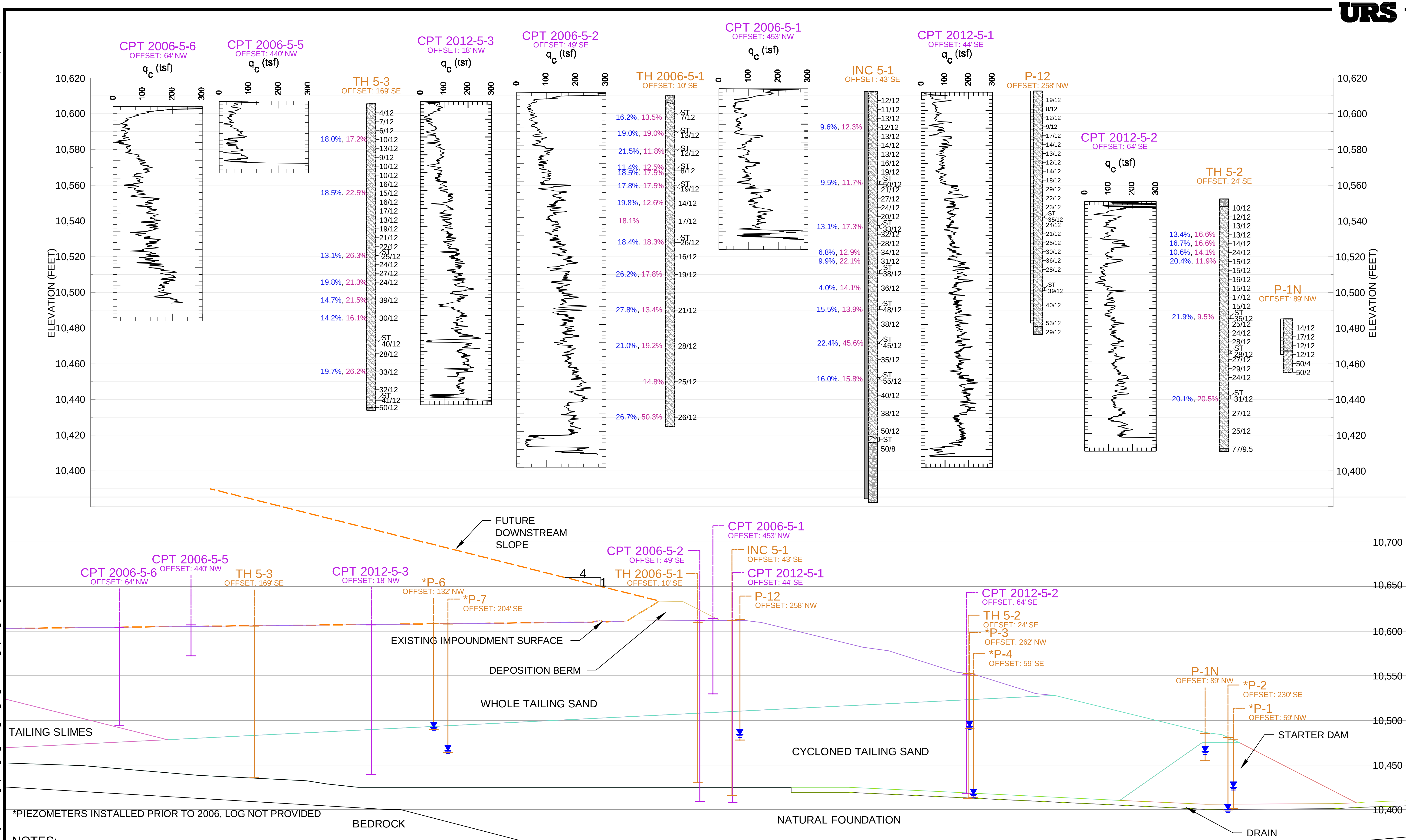
Job No. :	22243088	SECTION VIEW LEGEND 5 DAM
Prepared by :	JSE	
Date :	SEPTEMBER 2013	

FIG. 3-2



*PIEZOMETERS INSTALLED PRIOR TO 2006, LOG NOT PROVIDED

NOTES:

1. LEGEND INCLUDED ON FIGURE 3-2.
2. PLAN VIEW INCLUDED ON FIGURE 3-1.
3. NATURAL FOUNDATION ESTIMATED FROM PRE-DAM TOPOGRAPHIC MAPS FROM 1978 WOODWARD-CLYDE CONSULTANTS REPORT.

0 50 100 200
SCALE IN FEET

Job No. : 22243088	SECTION A-A' 5 DAM
Prepared By : JSE	
Date : SEPTEMBER 2013	

FIG. 3-3

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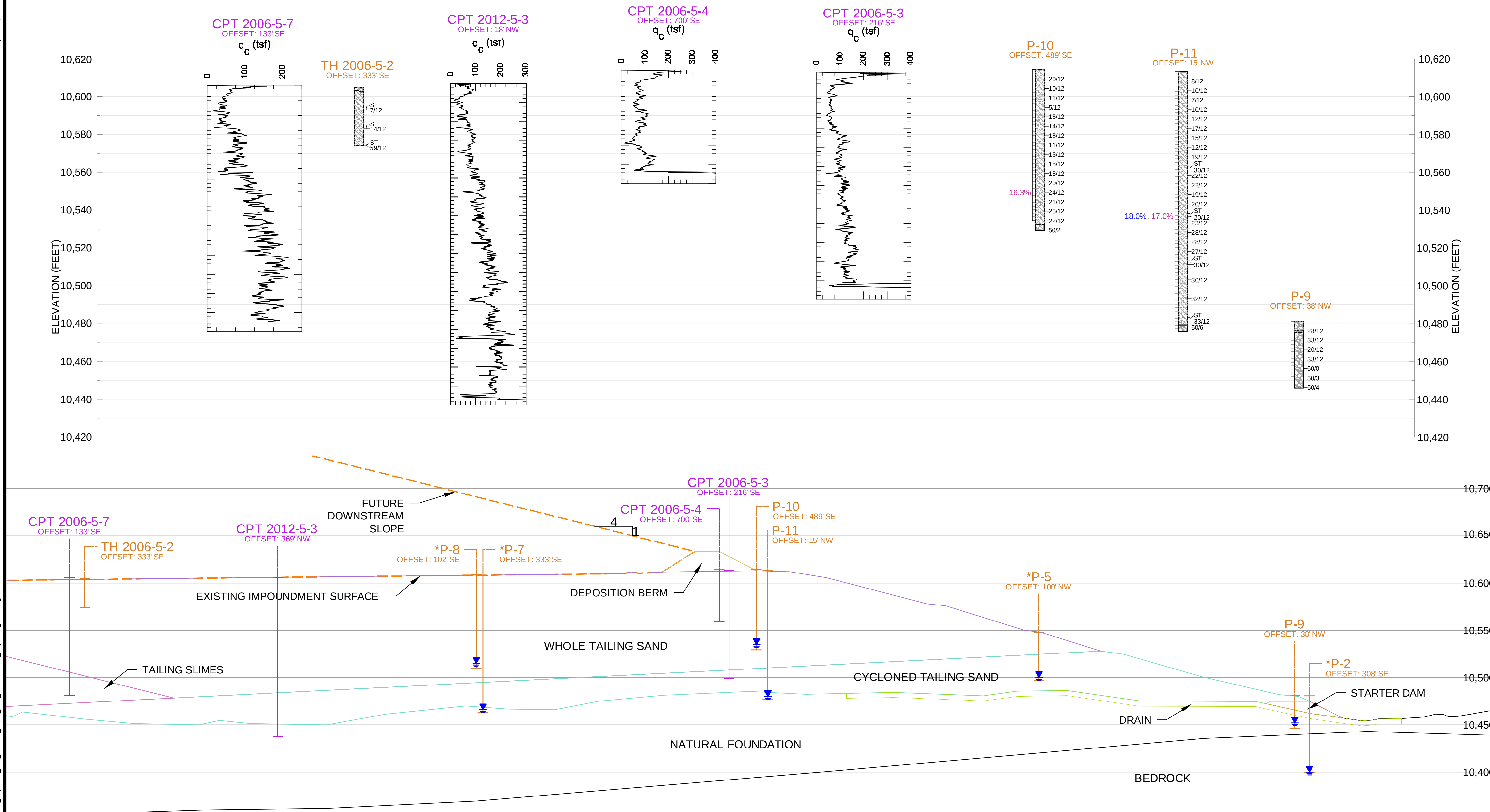

*PIEZOMETERS INSTALLED PRIOR TO 2006, LOG NOT PROVIDED

NOTES:

1. LEGEND INCLUDED ON FIGURE 3-2.
2. PLAN VIEW INCLUDED ON FIGURE 3-1.
3. NATURAL FOUNDATION ESTIMATED FROM PRE-DAM TOPOGRAPHIC MAPS FROM 1978 WOODWARD-CLYDE CONSULTANTS REPORT.

0 50 100 200

SCALE IN FEET

DRAWING PATH: N:\Projects\22243088_Mayflower_Eval_Des\Sub_0017.0_CAD_GIS\22243088_Mayflower_JSE2.dwg

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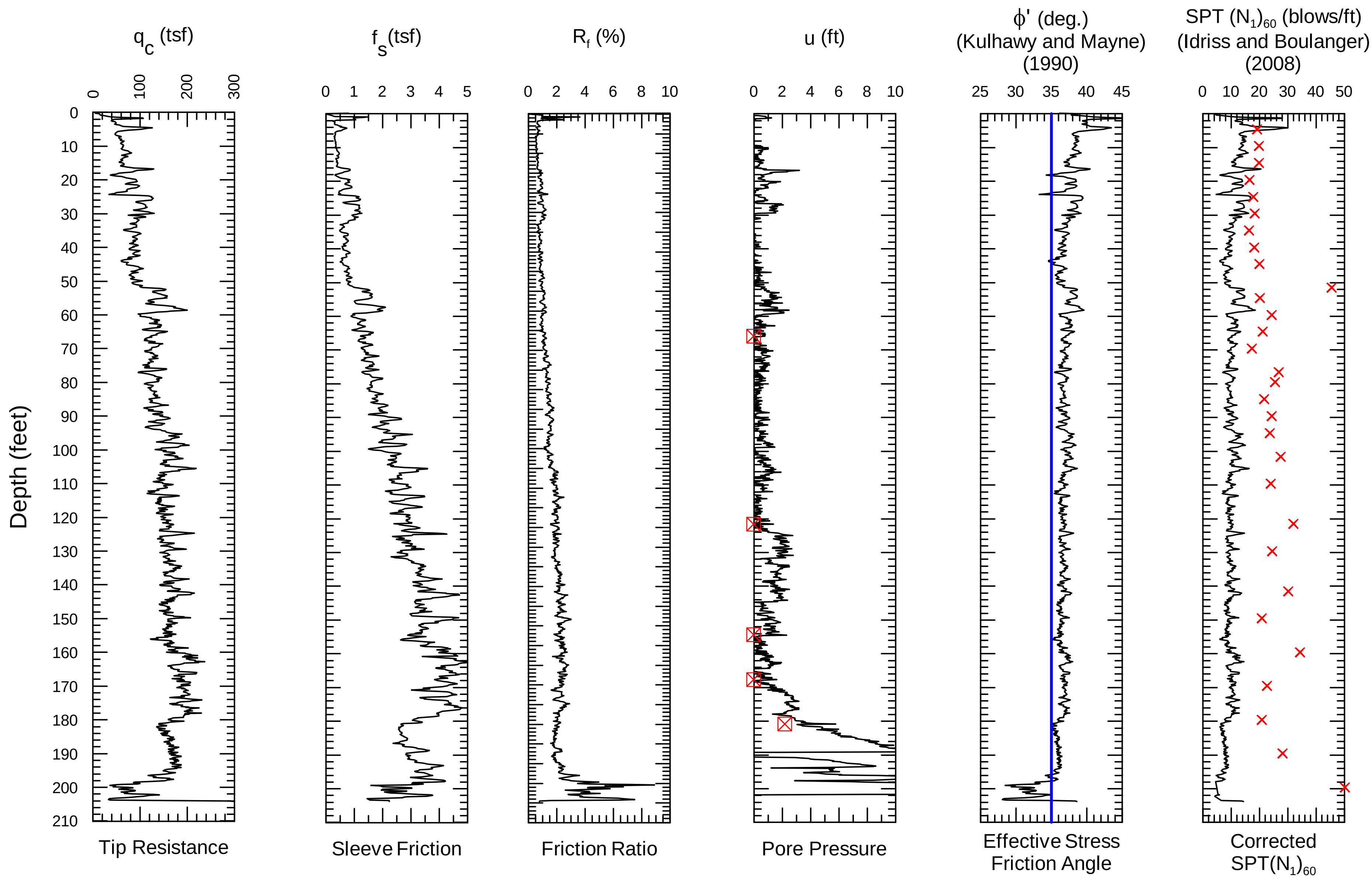
Job No. :	22243088
Prepared By :	JSE
Date :	SEPTEMBER 2013

SECTION B-B'
5 DAM

FIG. 3-4



CPT 2012-5-1 advanced October 4, 2012 by ConeTec, Inc.

⊠ Pore pressure dissipation test
| Effective stress friction angle used in analysis
× Corrected $(N_1)_{60}$ field measured blow counts from test hole INC5-1

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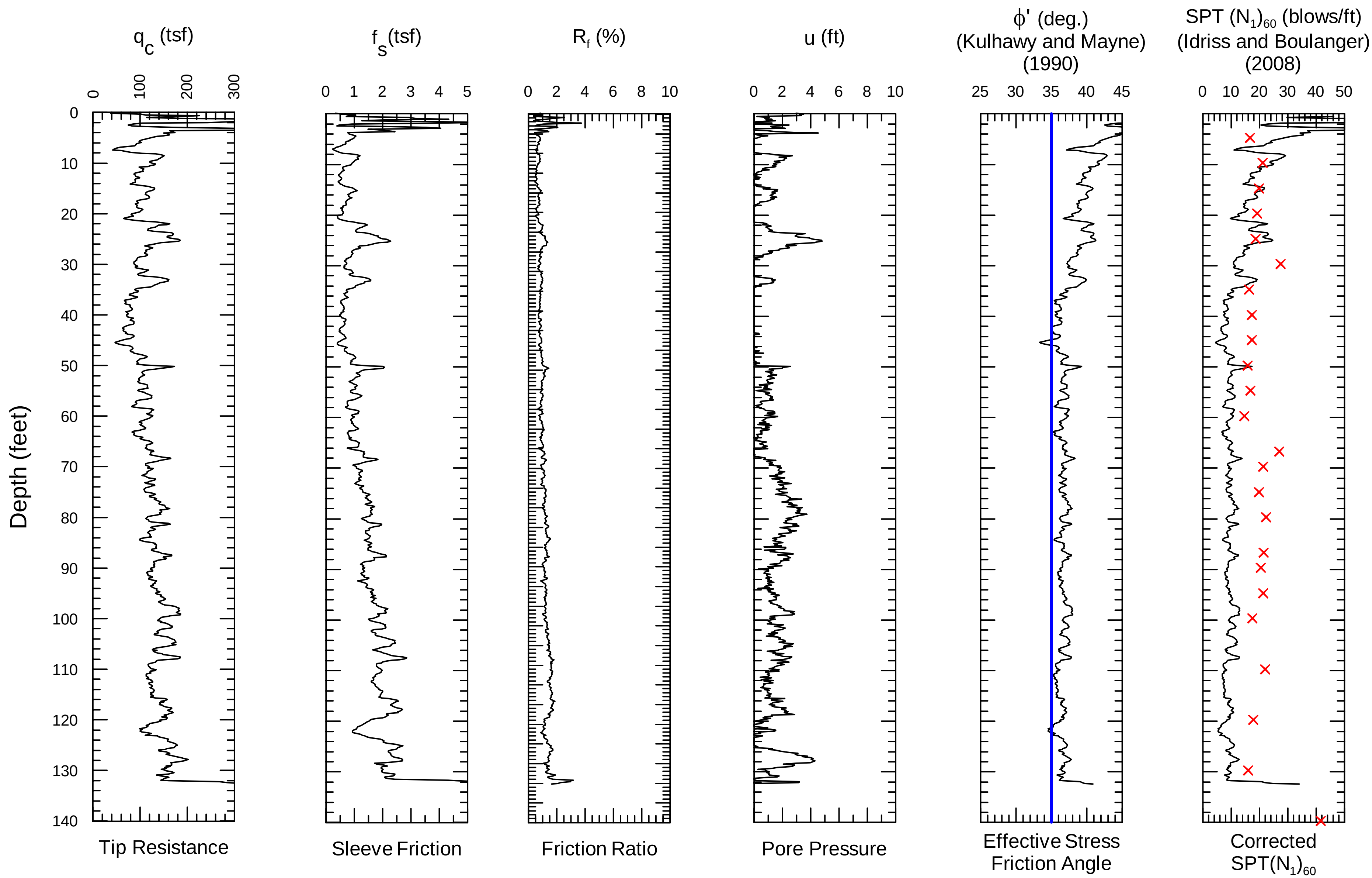
URS	Climax Mine Climax, CO	**CPT-2012-5-1** **5 Dam**	Figure 3-5
September 2013	Project No. 22243088		



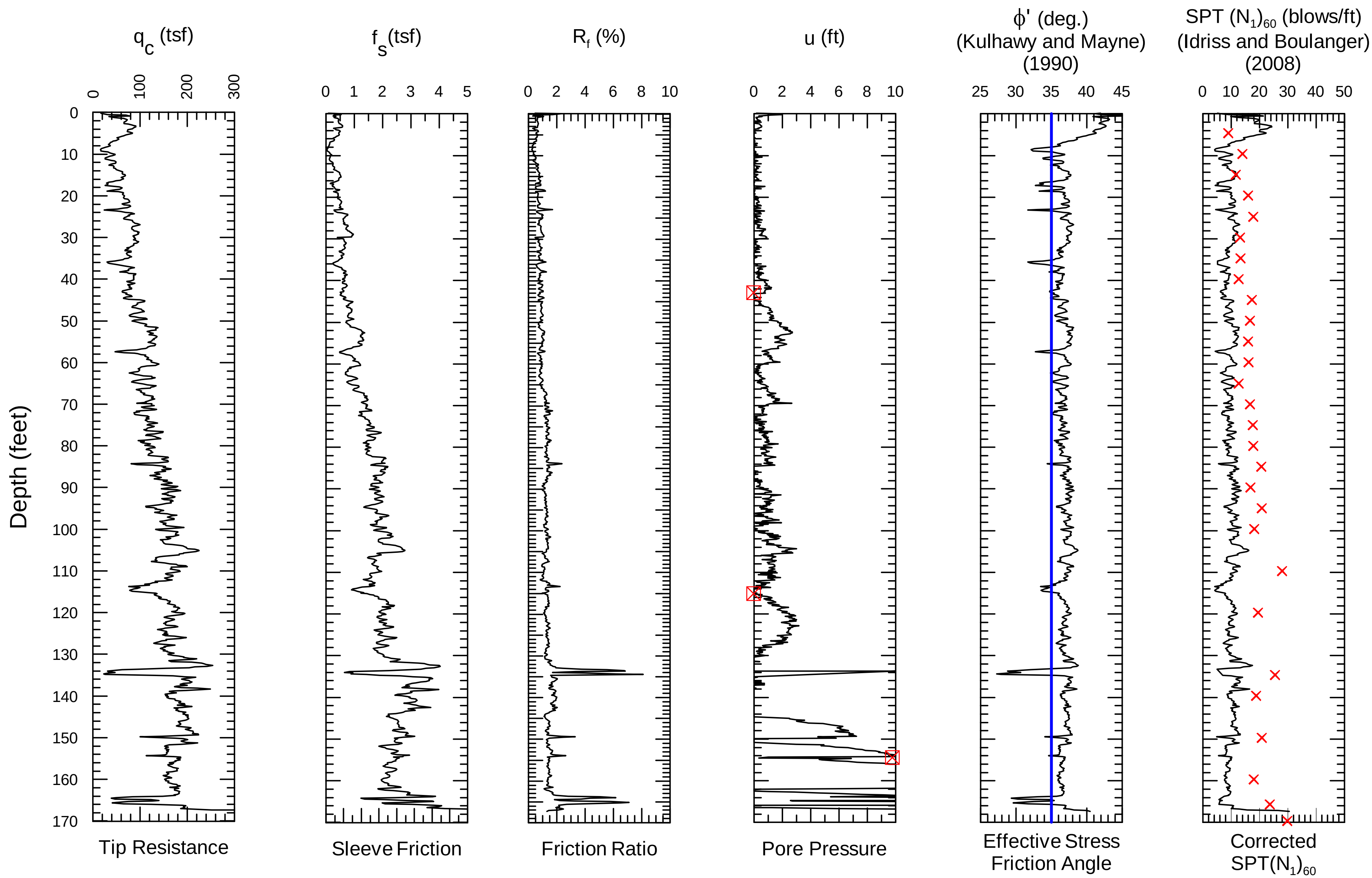
CPT 2012-5-2 advanced October 3, 2012 by ConeTec, Inc.

⊠ Pore pressure dissipation test

| Effective stress friction angle used in analysis

× Corrected $(N_1)_{60}$ field measured blow counts from test hole TH5-2

URS	Climax Mine Climax, CO	CPT-2012-5-2 5 Dam	Figure 3-6
September 2013	Project No. 22243088		



CPT 2012-5-3 advanced October 3, 2012 by ConeTec, Inc.

N:Projects\22243088_Mayflower_Eval_Des\Sub_00\10.0_Calculations_Analysis_Data\Strength_Characterization\CPT-02012-5-1.grf

- Pore pressure dissipation test
- Effective stress friction angle used in analysis
- Corrected $(N_1)_{60}$ field measured blow counts from test hole TH5-3

URS	Climax Mine Climax, CO	CPT-2012-5-3 5 Dam	Figure 3-7
September 2013	Project No. 22243088		

Laboratory tests were performed on selected samples collected from the 2012 test holes. Laboratory tests were performed to provide index properties, classify materials according to the Unified Soil Classification System (USCS), and to measure engineering properties. The soil samples were sent to TerraSense, LLC in Totowa, New Jersey, to perform the laboratory testing under subcontract to URS.

Presented below is a summary of the laboratory testing completed for this report. The laboratory test results are summarized in Tables 4-1 and 4-2. Laboratory test data are provided in Appendix B.

4.1 INDEX PROPERTIES TESTING

The index property tests included sieve analysis, hydrometer analysis, natural water content, dry unit weight, specific gravity, Atterberg limits and visual classifications. Index test results are provided in Appendix B.1

Particle Size Analysis

Sieve analyses were performed on 24 whole and cycloned tailing samples. All but 1 sample classified as silty sand (SM); the single sample from test hole TH 5-2 at about 66 feet of depth classified as poorly-graded sand with silt (SP-SM). A summary plot of the gradations from 2012 and 2006 laboratory investigations (URS 2007) are shown on Figure 4-1. Fines content (percent passing the No. 200 sieve) ranged between 9.5 and 26.3, with one sample from INC5-1 at 140.2 feet having 45.6 percent. A plot of percent fines versus depth is presented on Figure 4-2. Data from the 2006 investigation is included on the plot for information purposes.

A hydrometer test classifies the fraction of material passing the No. 200 sieve and indicates the silt and clay-sized fraction of the tailing. The five hydrometer results are shown along with the gradations on Figure 4-1. Data from the 2006 investigation is included on the plot for information purposes. Each tested sample had more silty fines than clayey fines.

Moisture Content and Unit Weight

Moisture contents measured from Shelby tube samples ranged between 4.0 and 23.9 percent with an average moisture content of 14.6 percent. A plot showing the distribution of moisture contents with depth is presented on Figure 4-3. Data from the 2006 investigation is included on the plot for information purposes.

Dry unit weights ranged between 87.2 and 105.0 pounds per cubic foot (pcf). The average total unit weight calculated from the moisture contents and dry unit weights was 98.8 pcf. A plot of dry unit weights versus depth is presented on Figure 4-4. Data from the 2006 investigation is included on the plot for information purposes.

Atterberg Limits

Atterberg limits testing was performed on 7 selected laboratory samples. The tested samples were non-plastic (NP).

4.2 ENGINEERING PROPERTIES TESTING

Engineering property testing included permeability tests, consolidation tests, and different types of shear strength testing. Testing was performed on relatively undisturbed samples collected using thin-walled Shelby tubes. Engineering test results are provided in Appendix B.2.

Permeability Testing

Five permeability tests were performed on selected tailing samples, including four constant head triaxial tests and one falling head U-tube test. The constant head tests were on samples collected from test holes INC-5-1 at 14.6 and 50.5 feet (both whole tailing); P-1N at 75.9 feet (whole tailing); and TH-5-2 at 65.9 feet (cycloned sand). The falling head test was performed on a sample from TH-5-3 at 84.4 feet (whole tailing). The constant head test samples were saturated and consolidated at 3.1 to 22.8 kips per square foot (ksf) net cell pressure. The results indicate the tailing permeability varies from 2.0E-5 to 7.6E-4 centimeters per second (cm/sec), with an average permeability of 3.0E-4 cm/sec.

Consolidation Testing

One consolidation test was performed on a cycloned sand sample collected from test hole TH5-2 at 110 feet. The sample was initially saturated and loaded incrementally up to 0.76 tons per square foot (tsf). The sample was then incrementally unloaded to 0.09 tsf before incrementally reloading to 96.0 tsf. The sample was then incrementally unloaded to 0.05 tsf.

The sample had an estimated pre-consolidation pressure of 5.0 tsf. The calculated compression index was 0.096 and the calculated recompression index was 0.017.

Shear Strength Testing

Shear strength tests included isotropically consolidated undrained triaxial compression tests with pore pressure measurement (CIŪ), direct simple shear tests, and cyclic triaxial shear tests. A summary of the shear strength testing is described by type below.

<u>CIŪ Triaxial Tests</u>

Isotropically-consolidated undrained (CIŪ) triaxial compression (TXC) shear strength tests were performed to measure the effective stress friction angles and undrained strength ratios of the selected whole and cycloned tailing sand samples. Two failure envelopes (3 tests per envelope) were developed from relatively undisturbed Shelby tube samples. The cycloned sand sample was collected from INC-5-1 at 140 feet below ground surface (bgs) and the whole tailing sand sample from P-11 at 75 feet bgs. Plots of effective stresses at failure and undrained friction ratios are presented as Figures 4-5 and 4-6, respectively. Data from the 2006 investigation is included for information purposes. The following is a summary of the current CIŪ test parameters and results:

- P-11 @ 75 feet (whole tailing)
  - Nominal Consolidation Pressures: 10, 25, 50 ksf
  - In-Situ Dry Unit Weights: 101.2, 96.6, 101.0 pcf
  - Fines Content: 17%
  - USCS: SM
  - Peak obliquity effective friction angle: 37.4^{o}

  - Peak deviator stress effective friction angle: 36.2°
  - Peak obliquity C_u/σ'_c: 0.86, 0.54, 0.45

- INC-5-1 @ 140 feet (cycloned sand)
  - Nominal Consolidation Pressures: 15, 30, 50 ksf
  - In-Situ Dry Unit Weights: 104.4, 87.2, 96.1 pcf
  - Fines Content: 46%
  - USCS: SM
  - Peak obliquity effective friction angle: 38.1°
  - Peak deviator stress effective friction angle: 37.4°
  - Peak obliquity C_u/σ'_c: 0.43, 0.42, 0.41

Undrained CIŪ strength ratios (C_u/σ'_c) ranged from 0.41 to 0.86, with an average of 0.52 and a standard deviation of 0.17.

<u>Direct Simple Shear Tests</u>

Direct simple shear (DSS) tests were performed to identify strength characteristics of the samples when loaded horizontally. Two failure envelopes were developed for whole tailing and cycloned sand tailing samples from relatively undisturbed thin-walled Shelby tubes. The samples were collected from INC-5-1 at 160 feet bgs (cycloned sand) and 50 feet bgs (whole tailing). The sample from INC-5-1 at 50 feet is whole tailing sand. The sample from INC-5-1 at 160 feet is cycloned sand. A plot of the undrained DSS friction ratios is presented on Figure 4-7. The following is a summary of the DSS test parameters and results:

- INC-5-1 @ 50 feet (whole tailing)
  - Nominal Consolidation Pressures: 6, 12, 25 ksf
  - In-Situ Dry Unit Weights: 98.5, 88.1, 99.7 pcf
  - 10% Strain C_u/σ'_c: 0.51, 0.35, 0.41
  - Fines Content: 12%;
  - USCS: SM

- INC-5-1 @ 160 feet (cyclone sand)
  - Nominal Consolidation Pressures: 17.5, 21.5, 25 ksf
  - In-Situ Dry Unit Weights: 105.0, 88.6, 95.6 pcf
  - 10% Strain C_u/σ'_c: 0.29, 0.32, 0.46
  - Fines Content: 16%
  - USCS: SM

Undrained DSS strength ratios (C_u/σ'_c) ranged from 0.29 to 0.51, with an average of 0.39 and a standard deviation of 0.09.

<u>Cyclic Triaxial Tests</u>

Two post-cyclic triaxial compression shear strength tests were performed on samples of tailing sand to identify whether liquefaction would occur under simulated ground motions. The cyclic load forms were sinusoidal at a frequency of 0.5 Hz. The tested whole tailing samples were from INC-5-1 at 76 feet bgs and 122 feet bgs and were tested at cyclic stress ratios (CSRs) of 0.19 and 0.3, respectively. Pore pressure ratios developed during the cyclic portion of the tests are shown on Figure 4-8. The following is a summary of the cyclic triaxial test parameters and results:

- INC-5-1 @ 76 feet (whole tailing)
  - Nominal Consolidation Pressures: 15 ksf
  - In-Situ Dry Unit Weight: 100.4 pcf
  - CSR: 0.19
  - Cycles applied: 1,000
  - Peak pore pressure ratio: 0.28
  - Ratio of peak shear strength to consolidation stress: 1.22

- INC-5-1 @ 122 feet (whole tailing)
  - Nominal Consolidation Pressures: 25 ksf
  - In-Situ Dry Unit Weight: 95.5 pcf
  - CSR: 0.30
  - Cycles applied: 248
  - Peak pore pressure ratio: 0.95
  - Ratio of peak shear strength to consolidation stress: 0.62

After 1,000 cycles, the sample tested at a CSR of 0.2 reached a pore water pressure ratio (r_u) of about 28% and the sample was sheared. Results indicate the peak effective friction angle was 39.5 degrees. After 248 cycles, the sample tested at a CSR of 0.3 reached a pore water pressure ratio (r_u) of about 95% and the sample was sheared. Results indicate a peak effective friction angle of 38.5 degrees.

Table 4-1
SUMMARY OF LABORATORY INDEX TEST RESULTS

Piezometer No.	Depth (feet)	Moisture Content (%)	Unit Weight		Atterberg Limits			Gradations		USCS Symbol
			Dry Unit Weight (pcf)	Total Unit Weight (pcf)	Liquid Limit[1] (%)	Plastic Limit (%)	Plasticity Index	Sand (%)	Fines (%)	
INC-5-1	20	9.6	-	-	-	-	-	87.7	12.3	SM
INC-5-1	51	-	-	113.2	-	-	-	-	-	
INC-5-1	50.2	6.8	-	-	-	-	-	-	-	
INC-5-1	50.5	9.5	101.4	111.0	-	-	-	88.3	11.7	SM
INC-5-1	50.8	8.8	-	-	-	-	-	-	-	
INC-5-1	50.9	10.3	98.4	108.6	-	-	-	-	-	
INC-5-1	51.2	12.1	-	-	-	-	-	-	-	
INC-5-1	51.3	12.1	88.1	98.8	-	-	-	-	-	
INC-5-1	51.5	15.0	-	-	-	-	-	-	-	
INC-5-1	51.7	19.2	99.7	118.9	-	-	-	-	-	
INC-5-1	76	-	-	-	-	-	-	-	-	
INC-5-1	76	11.3	-	-	-	-	-	-	-	
INC-5-1	76.3	13.1	100.4	113.5	-	-	-	82.7	17.3	SM
INC-5-1	90	6.8	-	-	-	-	-	87.1	12.9	SM
INC-5-1	95	9.9	-	-	-	-	-	77.9	22.1	SM
INC-5-1	100	-	-	-	-	-	-	-	-	
INC-5-1	110	4.0	-	-	-	-	-	85.9	14.1	SM
INC-5-1	121	-	-	-	-	-	-	-	-	
INC-5-1	121.7	10.1	-	-	-	-	-	-	-	
INC-5-1	121.9	15.5	95.5	110.3	-	-	-	86.1	13.9	SM
INC-5-1	141	-	-	114.6	-	-	-	-	-	
INC-5-1	140.2	22.4	104.4	127.8	NP	NP	NP	54.4	45.6	SM
INC-5-1	140.5	21.0	-	-	-	-	-	-	-	
INC-5-1	140.6	15.5	87.2	100.7	-	-	-	-	-	
INC-5-1	141	18.3	96.1	113.7	-	-	-	-	-	
INC-5-1	161	-	-	112.8	-	-	-	-	-	

Piezometer No.	Depth (feet)	Moisture Content (%)	Unit Weight		Atterberg Limits			Gradations		USCS Symbol
			Dry Unit Weight (pcf)	Total Unit Weight (pcf)	Liquid Limit[1] (%)	Plastic Limit (%)	Plasticity Index	Sand (%)	Fines (%)	
INC-5-1	160.2	21.1	105	127.2	-	-	-	-	-	
INC-5-1	160.5	16.0	88.6	102.8	NP	NP	NP	84.2	15.8	SM
INC-5-1	160.8	23.9	95.6	118.5	-	-	-	-	-	
INC-5-1	193.5	-	-	-	-	-	-	-	-	
P-10	65	-	-	-	NP	NP	NP	83.7	16.3	
P-11	76	-	-	107.9	-	-	-	-	-	
P-11	75.7	6.1	-	-	-	-	-	-	-	
P-11	75.9	15.5	101.2	116.8	-	-	-	-	-	
P-11	76.2	21.1	-	-	-	-	-	-	-	
P-11	76.5	18.0	96.6	113.9	-	-	-	83	17.0	SM
P-11	77	18.2	101	119.3	-	-	-	-	-	
TH-5-2	20	13.4	-	-	NP	NP	NP	82.4	16.6	SM
TH-5-2	25	16.7	-	-	-	-	-	83.4	16.6	SM
TH-5-2	30	10.6	-	-	-	-	-	85.9	14.1	SM
TH-5-2	35	20.4	-	-	-	-	-	88.1	11.9	SM
TH-5-2	66	-	-	102.2	-	-	-	-	-	
TH-5-2	65.7	12.5	-	-	-	-	-	-	-	
TH-5-2	65.9	21.9	94	114.5	-	-	-	90.5	9.5	SP-SM
TH-5-2	85	-	-	-	-	-	-	-	-	
TH-5-2	111	-	-	104	-	-	-	-	-	
TH-5-2	110.6	11.5	-	-	-	-	-	-	-	
TH-5-2	110.8	20.1	96.3	115.6	NP	NP	NP	79.5	20.5	SM
TH-5-3	20	18.0	-	-	-	-	-	-	-	
TH-5-3	50	18.5	-	-	NP	NP	NP	-	-	
TH-5-3	84	-	-	109.7	-	-	-	-	-	
TH-5-3	84.2	8.5	-	-	-	-	-	-	-	
TH-5-3	84.4	13.1	93.4	105.7	-	-	-	73.7	26.3	SM
TH-5-3	100	19.8	-	-	-	-	-	78.7	21.3	SM
TH-5-3	110	14.7	-	-	-	-	-	78.5	21.5	SM

Piezometer No.	Depth (feet)	Moisture Content (%)	Unit Weight		Atterberg Limits			Gradations		USCS Symbol
			Dry Unit Weight (pcf)	Total Unit Weight (pcf)	Liquid Limit[1] (%)	Plastic Limit (%)	Plasticity Index	Sand (%)	Fines (%)	
TH-5-3	120.0	14.2	-	-	-	-	-	83.9	16.1	SM
TH-5-3	132.5		-	-	-	-	-	-	-	
TH-5-3	150	19.7	-	-	NP	NP	NP	73.8	26.2	SM

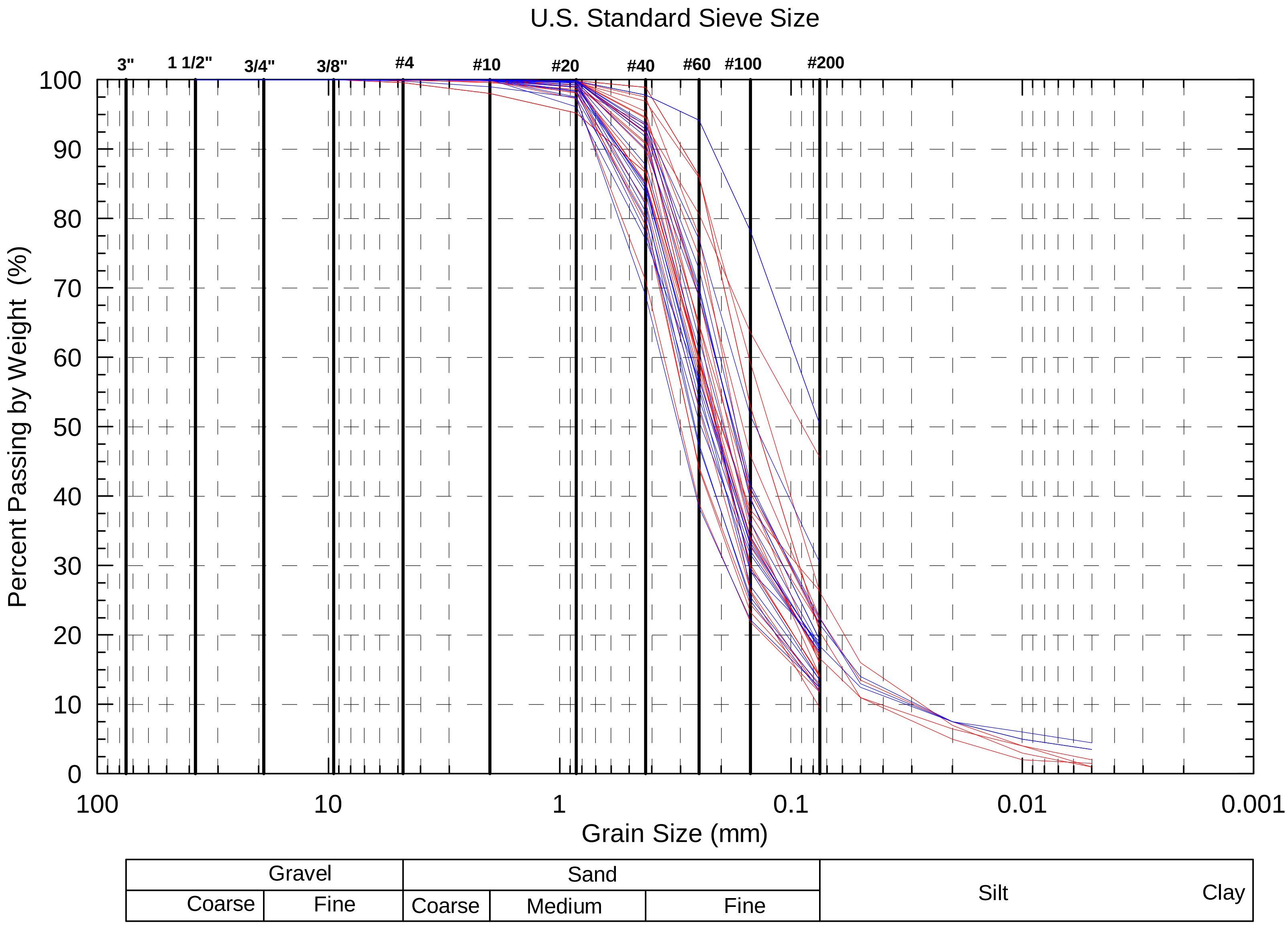
1: NP = non-plastic

Table 4-2
SUMMARY OF LABORATORY ENGINEERING TEST RESULTS

Piezometer No.	Depth (feet)	Hydraulic Conductivity (cm/sec)	Consolidation Testing	CIŪ Testing		DSS Testing	Cyclic Triaxial Testing			Remarks
				Peak Obliquity Effective Friction Angle (degrees)	Undrained Shear Stress at Peak Obliquity (ksf)	Shear Strength Ratio at 10% Strain	Applied Cycles	Peak Pore Pressure Ratio	Post-Cyclic Triaxial Compression Peak Effective Friction Angle (degrees)	
INC5-1	50.9					0.51				
INC-5-1	51.3					0.35				
INC-5-1	51.7					0.41				
INC-5-1	50.5	2.5E-04								CP[1]: 3.1 ksf
INC-5-1	76.3						1,000	0.28	39.5	CSR[2]: 0.19
INC-5-1	121.9						248	0.95	38.5	CSR: 0.30
INC-5-1	140.2			34.8	7.9					CP: 15.0 ksf

Piezometer No.	Depth (feet)	Hydraulic Conductivity (cm/sec)	Consolidation Testing	CIŪ Testing		DSS Testing	Cyclic Triaxial Testing			Remarks
				Peak Obliquity Effective Friction Angle (degrees)	Undrained Shear Stress at Peak Obliquity (ksf)	Shear Strength Ratio at 10% Strain	Applied Cycles	Peak Pore Pressure Ratio	Post-Cyclic Triaxial Compression Peak Effective Friction Angle (degrees)	
INC-5-1	140.6	7.6E-04		39.3	16.4					Hydraulic conductivity CP: 22.8 ksf; CIU CP: 30.0 ksf
INC-5-1	141.0			38.0	25.7					CP: 50.0 ksf
INC-5-1	160.2					0.29				CP: 17.5 ksf
INC-5-1	160.5					0.32				CP: 21.5 ksf
INC-5-1	160.8					0.46				CP: 24.73 ksf
P-11	75.9	2.1E-04		35.7	10.6					Hydraulic conductivity CP: 7.1 ksf; CIU CP: 9.99 ksf
P-11	76.5			36.9	16.8					CP: 25.0 ksf
P-11	77.0			37.9	28.3					CP: 50.0 ksf
TH-5-2	65.9	2.7E-04								CP: 7.1 ksf
TH-5-2	110.8		σ'_p = 5.0 tsf C_c = 0.096 C_r = 0.017							
TH-5-3	84.4	2.0E-05								CP: 18.0 ksf

1: CP = Cell Pressure
2: CSR = Cyclic Stress Ratio



Legend

2012 Gradations

2006 Gradations

Project No. 22243088	Climax Mine Climax, CO	Tailing Gradation Summary 5 Dam	Figure 4-1
	URS		

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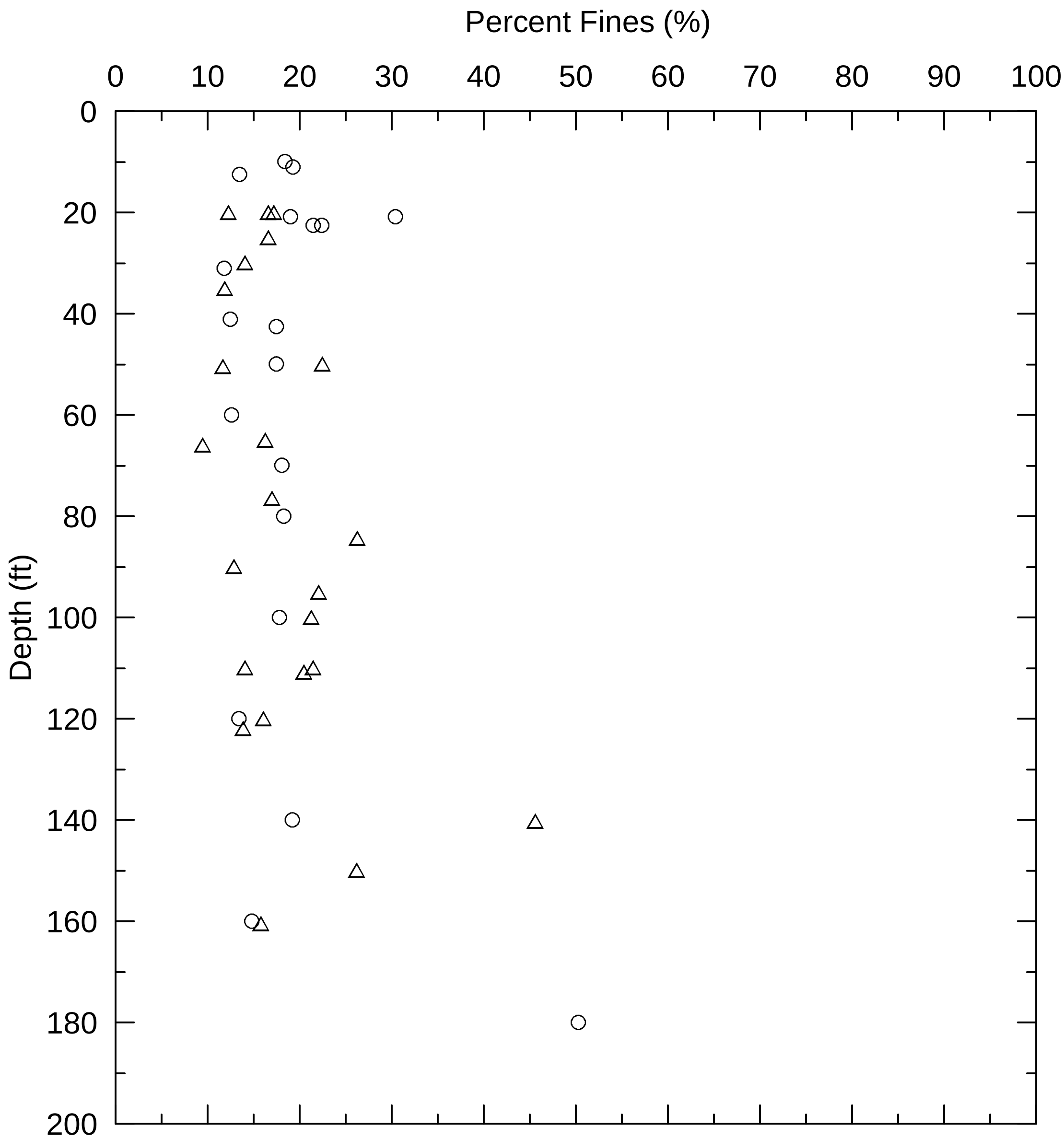

LEGEND:

○ 2006 Laboratory Test Result

△ 2012 Laboratory Test Result

NOTE:
Percent fines refers to the percent passing the No. 200 sieve.

Project No.: 22243088	**Fines Content with Depth 5 Dam**	Figure 4-2
Climax Mine Climax, CO		
URS		

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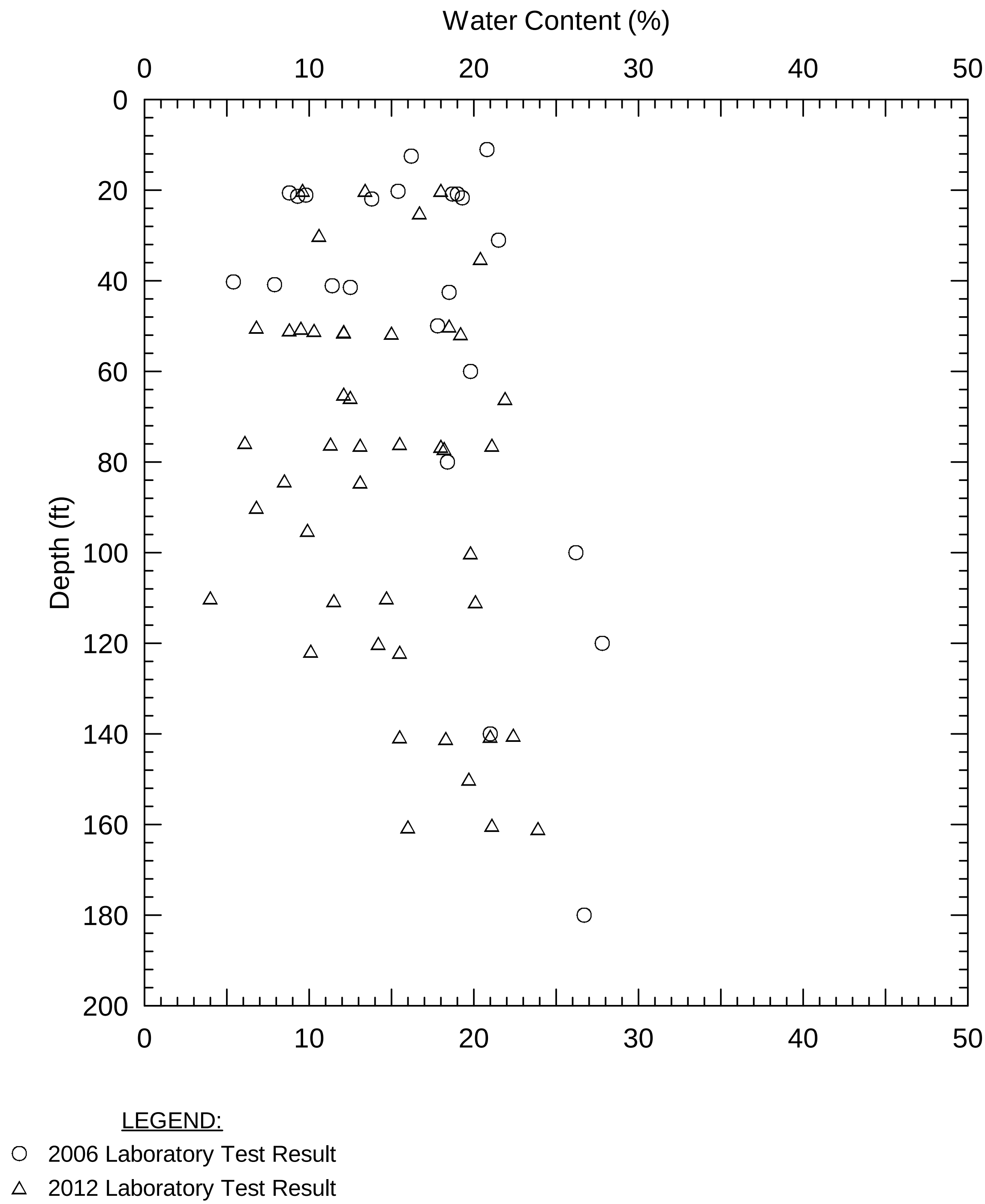

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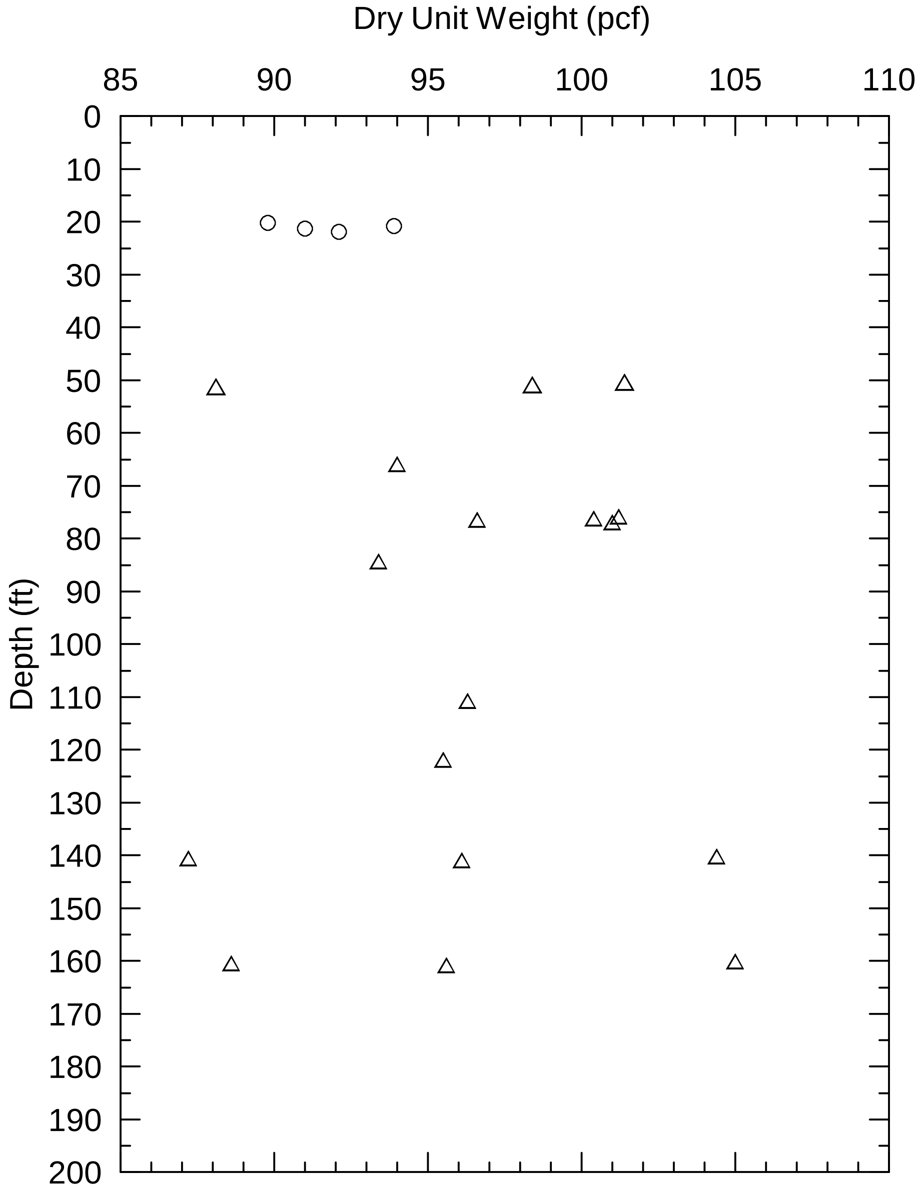
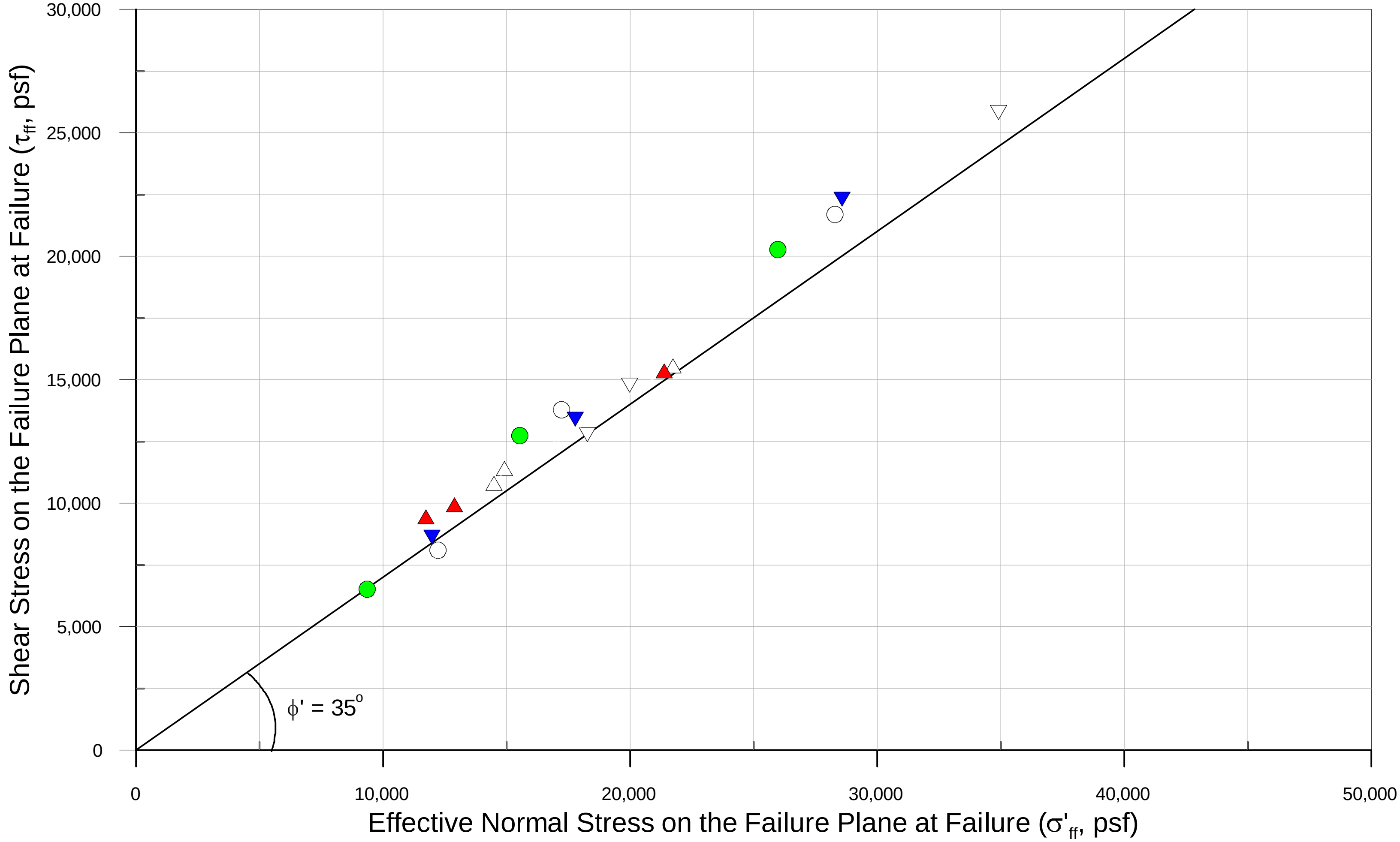
Project No.: 22243088 Climax Mine Climax, CO URS	**Water Content with Depth** **5 Dam**	Figure 4-3



LEGEND:
○ 2006 Laboratory Test Result
△ 2012 Laboratory Test Result

Dry Unit Weight vs. Depth.GRF w/Climax Material Plots (bd).XLS

Project No.: 22243088	Dry Unit Weight with Depth 5 Dam	Figure 4-4
Climax Mine Climax, CO		
URS		



Legend

- ▲ TH-5-1 at 20 feet (URS 2007, peak obliquity)
- △ TH-5-1 at 20 feet (URS 2007, peak deviator stress)
- ▼ P-11 at 75 feet (peak obliquity)
- ▽ P-11 at 75 feet (peak deviator stress)
- ● INC-5-1 at 140 feet (peak obliquity)
- ○ INC-5-1 at 140 feet (peak deviator stress)

Project No. 22243088	Climax Mine Climax, CO	**CIU Triaxial Test Results 5 Dam**	Figure 4-5
URS			

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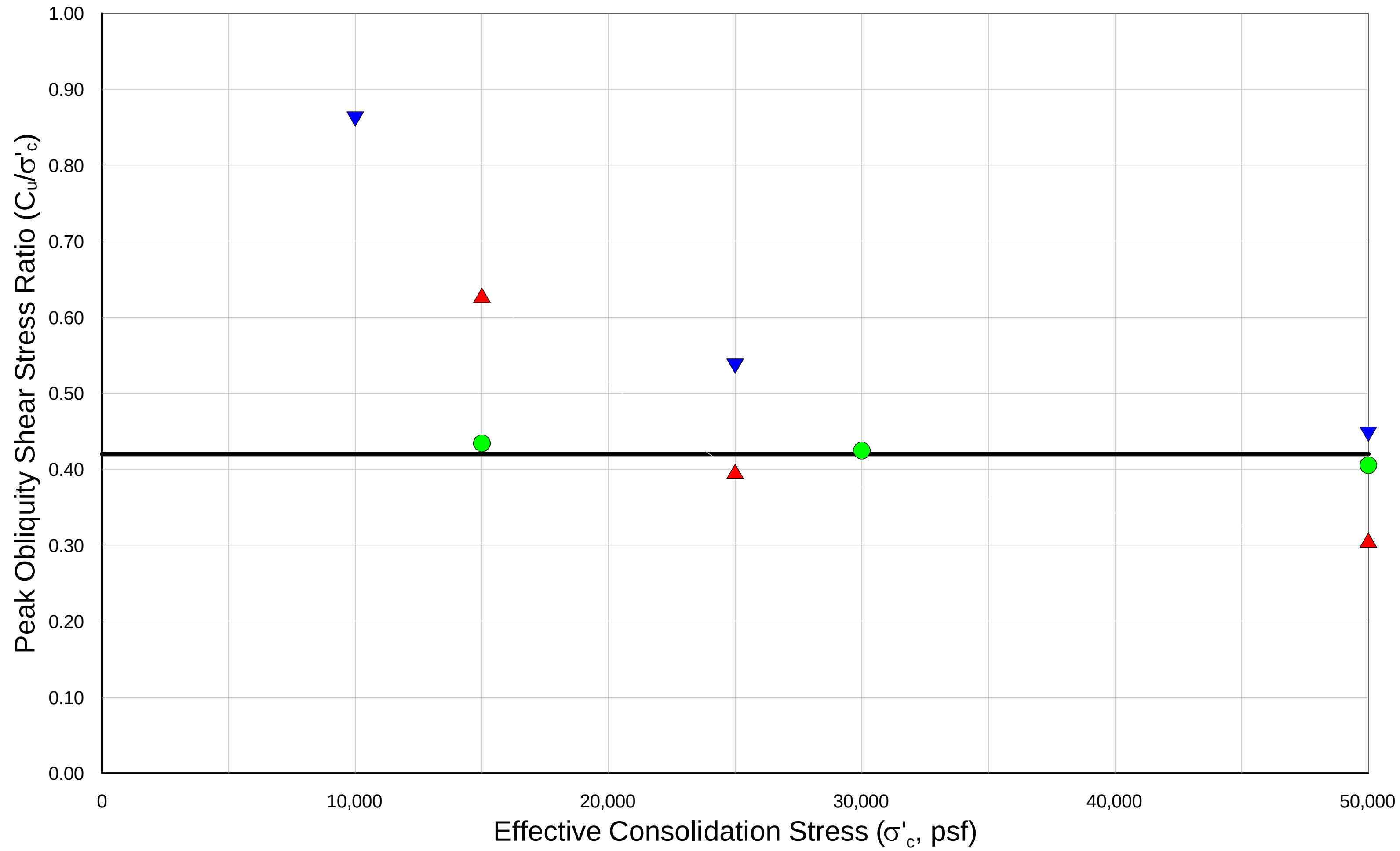

Legend

- ▲ TH-5-1 at 20 feet (URS 2007)
- ▼ P-11 at 75 feet
- ● INC-5-1 at 140 feet
- ▬ $C_u/\sigma'_c = 0.42$

Project No. 22243088	Climax Mine Climax, CO	**CIŪ Undrained Shear Strength Ratio 5 Dam**	Figure 4-6
	URS		

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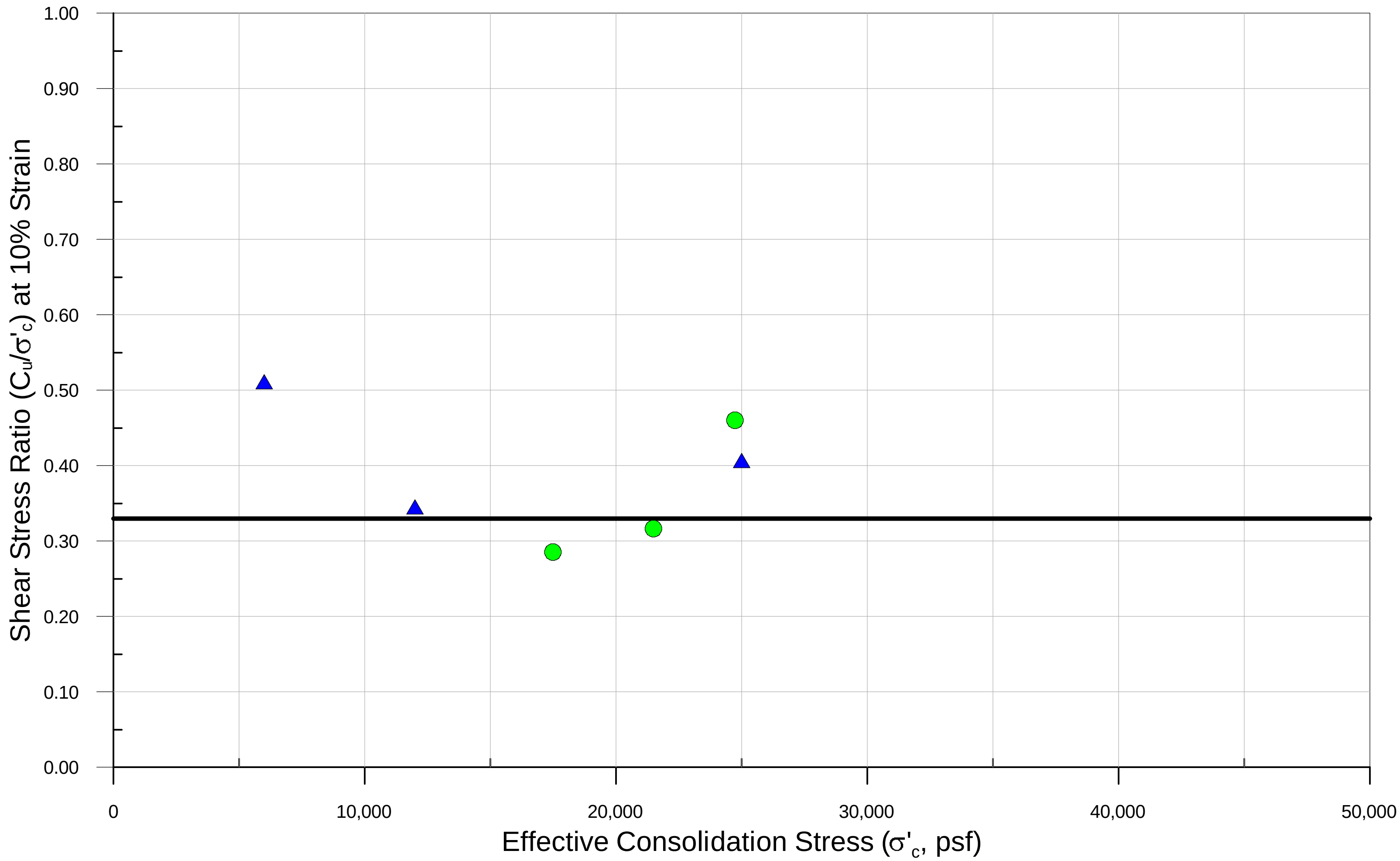
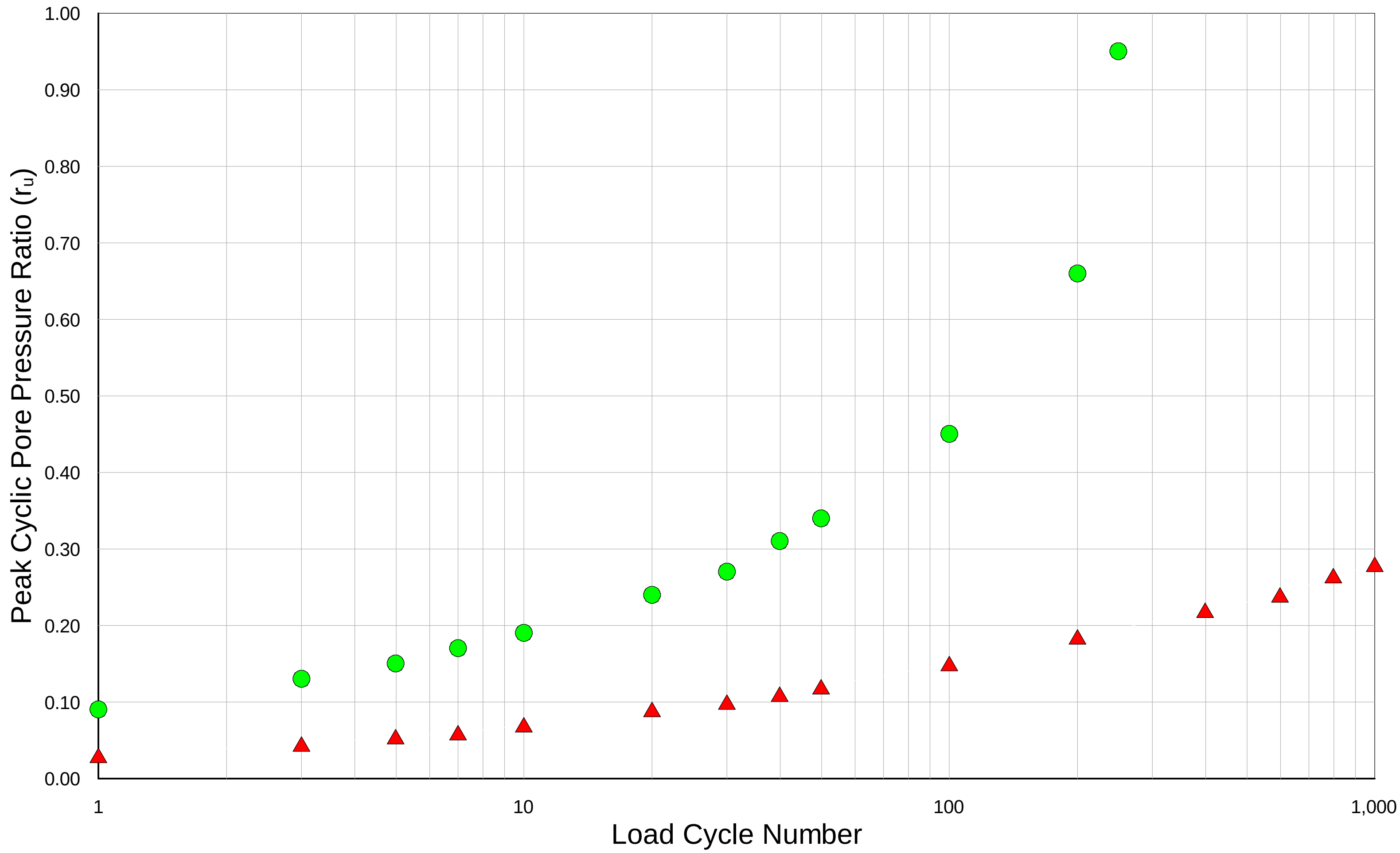


Project No. 22243088	Climax Mine Climax, CO	**DSS Undrained Shear Strength Ratio 5 Dam**	Figure 4-7
URS			

N:22243088/10.0/Stability Analysis/Report Figures/Undrained DSS.grf



Legend

- INC-5-1 at 76 feet (CSR = 0.19)
- INC-5-1 at 122 feet (CSR = 0.30)

Project No. 22243088	Climax Mine Climax, CO	Cyclic Triaxial Pore Pressure Ratio 5 Dam	Figure 4-8
URS			

N:22243088/10.0/Stability Analysis/Report Figures/Cyclic Triaxial.grf

The results from the recent field and laboratory investigations, as well as data from previous investigations and analyses were used to develop the subsurface and material characterization of tailing within 5 Dam.

5.1 TAILING

Three types of tailing exist within the 5 Dam impoundment – cycloned tailing that was used to create a drainage blanket at the base of the impoundment; coarse tailing (also referred to as whole tailing), which was hydraulically deposited utilizing spigots, that form the drainage shell; and fine tailing (also referred to as slimes), also hydraulically deposited, that generally forms the interior of impoundment.

The tailing materials were characterized using empirical data and established correlations from the CPT soundings; the SPTs, or blow count data, obtained during test hole drilling; and laboratory test data, both current and from previous investigations.

During our analyses, we found the coarse and cycloned tailing sand visual classification, CPT sounding data, and engineering strength properties were highly similar and not distinguishable, and therefore they have been grouped together below. While most of the material characterization of the whole tailing and cycloned sands are the same, the permeability properties of the whole tailing sands and cycloned sands will differ. A discussion of how the CPT data was used followed by a detailed description of tailing characterizations is presented below.

5.1.1 Normalized CPT Data

Soil types can be identified using a combination of tip resistance, sleeve friction, friction ratio, and pore pressure measurements obtained during advancement of CPT soundings. Typically sandy soils exhibit low friction ratios, low dynamic pore pressures, and high to moderately high tip resistance, depending on their density and shear strength. Fine-grained soils (silty and clayey soils) typically exhibit higher friction ratios, higher dynamic pore pressures (if normally consolidated or lightly overconsolidated) and lower tip resistance than sandy soils.

Normalized CPT data were evaluated to identify the behavior type of the tailing material. The normalized data, when plotted using a procedure described by Robertson (2010), provides an indication of soil behavior type (SBT). The fine-grained and coarse-grained nature of the material can be interpreted, as well as expected dilative and contractive behavior during shearing. Soils that exhibit contractive behavior, particularly silts and sands, may be susceptive to liquefaction under earthquake loading conditions. Soils that exhibit dilative behavior are generally much less susceptive to liquefaction.

Normalized CPT soil behavior type charts (SBT_n charts) were created following the approach of Robertson (2010); these “SBT_n” charts include the approximate boundary between dilative and contractive material responses suitable for a preliminary or comparative assessment of soil state. Three figures for each CPT from 2012 and 2006 have been prepared to illustrate the soil behavior and state condition of the tailing (see Figures 5-1 through 5-30).

The boundary included in this evaluation is $\Psi = -0.05$, defined by Robertson (2010). The boundary presented and defined by $\Psi = -0.05$ will be referred to as a state parameter line as it indicates different behaviors (contractive or dilative). Contractive behavior is typically observed in loose granular materials when sheared as the particles move into a denser configuration generating positive excess pore pressures. Dilative materials are either too dense to move closer together or may be partially saturated, thereby reducing excess pore pressures. Generally, the whole tailing and cyclone sands plot on the dilative side of the SBTn chart.

The CPT data plots are normalized based on the assumed phreatic surface at the time of advancing the sounding. Most of the CPTs evaluated from 2006 and 2012 did not exhibit a phreatic surface. The normalized CPT data were plotted as normalized tip resistance (Q_{tn}) versus normalized friction ratio (F_r) to evaluate tailing that plot as contractive (potentially liquefiable) or dilative (have a higher resistance to liquefaction). The CPT parameters are normalized according to Robertson (2010) by effective overburden stress to produce the dimensionless parameters, Q_t and F_r, where:

$$Q_t = \frac{q_t - \sigma_{v0}}{\sigma'_{v0}}$$

$$F_r = \left(\frac{f_s}{q_t - \sigma_{v0}}\right) \times 100\%$$

Where:

σ_{v0} is the in-situ total vertical stress

σ'_{v0} is the in-situ effective vertical effective stress.

The normalized cone parameter using normalization with a variable stress exponent, n, was used as follows:

$$Q_{tn} = \left(\frac{q_t - \sigma_z}{p_a}\right)\left(\frac{p_a}{\sigma'_{z0}}\right)^n$$

Where:

$\left(\frac{q_t - \sigma_z}{p_a}\right)$ is the dimensionless net cone resistance

$\left(\frac{p_a}{\sigma'_{z0}}\right)^n$ is the stress normalization factor

n is the stress exponent equal to $0.381(I_c) + 0.05\left(\frac{\sigma'_{z0}}{p_a}\right) - 0.15$

p_a is the atmospheric pressure in the same units as q_t and σ_z.

Contractive tailing behavior typically plots below the state parameter line whereas dilative tailing behavior typically plots at or above the state parameter line. In general, the tailing sands show dilative material behavior for the entire depth of each sounding. The behavior indicated in the 2012 crest CPT (CPT-2012-5-1) suggests a more dilative response when compared to the 2006 crest CPTs (CPT-2006-5-2 and CPT-2006-5-3). However, comparison of the 2012 impoundment CPT (2012-5-3) with respect to the 2006 impoundment CPTs (CPT-2006-5-6 and CPT-2006-5-7) does not conclusively show an increase in dilative response.

5.1.2 Whole and Cycloned Tailing

The whole and cycloned sand tailing is a relatively homogeneous layer, primarily consisting of silty sand and sand and is generally noted in the CPT sounding by a moderate tip resistance ranging between 50 to 200 tsf, low friction ratio, and low dynamic pore pressure.

CPT 2012-5-2 was located on the midslope bench of the downstream dam face as shown on Figure 3-1. Tip resistances were generally 50 to 150 tons per square foot (tsf) in the upper 50 feet and 100 to 180 tsf below 50 feet. Interpretation of the CPT data indicates the tailing is primarily silty sand and sand to a depth of about 134 feet where refusal was met.

Tip resistances in CPT 2012-5-1, CPT 2006-5-2, and CPT 2006-5-3 (advanced from the dam crest, within approximately the middle third of the dam as shown in Figure 3-1) were generally in the range of about 100 to 200 tsf. One notable exception is a drop to about 50 tsf in CPT 2006-5-2 between depths of about 193 and 198 feet. A similar drop was observed in CPT 2006-5-3 between about 112 and 113 feet. Interpretations of the CPT data indicate the soil as primarily silty sand to sand with minor ranges of silt and sandy silt in the upper 110 feet of the soundings. The sandy silt content generally increases below a depth of 110 feet and becomes the soil type below 135 feet. Refusal was encountered in CPT 2012-5-1 and CPT 2006-5-2 at about 203 feet. Refusal was met in CPT 2006-5-3 at about 114 feet.

CPT 2006-5-6, CPT 2006-5-7, and CPT 2012-5-3 were located approximately 350 to 700 feet upstream of the crest in approximately the middle third of the impoundment. These CPTs typically feature tip resistances of 50 to 100 tsf in the upper 50 feet and 100 to 200 tsf below 50 feet. Notable exceptions are approximate two-foot thicknesses at about 134 feet and 165 feet in CPT 2012-5-3 where tip resistances dropped to about 40 to 50 tsf. Interpretation of the data indicates the material type is sand to sandy silt in the upper 50 feet and silty sand to sand below 50 feet. The notable exception is a two-foot thickness at about 133 to 135 feet with a soil behavior type of clayey silt. Refusal was met at about 168 feet.

Uncorrected field blow counts for 2012 test holes in the tailing ranged from 4 to greater than 50 blows per foot, with an average blow count of 23. Based on the field-measured blow counts, the tailing can be generally described as medium dense, with lesser ranges of loose and dense tailing and very minor ranges of very dense tailing generally observed deep in the test holes. The material is generally partially saturated and was observed to be slightly moist to wet during sample collection. The CPT soundings indicated isolated layers of high dynamic pore pressures deep within the sounding. These higher isolated pore readings are also generally associated with the isolated layers of finer grained material as discussed in Subsection 5.1.4.

The collocated CPTs from 2006 and 2012 were compared to identify potential cementation caused by aging of the tailing. Minimal increases in tip resistance were observed between the older and newer data sets. This is not surprising as the CPTs were advanced 6 years apart and no change of conditions, other than continued drainage of the impoundment, has occurred in that time.

Material Characterization

Material classifications based on laboratory testing generally identified the whole tailing and cycloned sand as silty sand (SM). Fines contents of the tailing ranged between 10 and 50 percent (all but 2 were less than 30 percent), with an average measured fines content of 19 percent. Each of the 11 samples tested (in 2006 and the current investigation) for Atterberg limits were non-plastic.

Total unit weights among the 2006 and current laboratory tests ranged between 99 and 128 pcf, with an average unit weight of 111 pcf. An evaluation of the distribution of total unit weights throughout the 5 Dam whole and cycloned tailing sand suggests no significant trend of unit weight with depth. For the analyses, we selected a unit weight of 115 pcf.

Using criteria of peak obliquity and peak deviator stress, the results of triaxial tests conducted in 2006 and the current investigation were used to plot values of shear stress on the failure plane at failure (τ_{ff}) as a function of effective normal stress on the failure plane at failure (σ'_{ff}). The plot is presented on Figure 4-5. The data indicate that, using a design friction angle of 35^o, about $^2/_3$ of the laboratory data plot above the design strengths for normal stresses up to an effective normal stress of about 25,000 psf (equivalent depth of about 217 feet assuming an overburden density of 115 pcf). Above 25,000 psf, all the laboratory shear strength values plot above the design value.

Using 2006 and current triaxial test results and a failure criterion of peak obliquity, we plotted values of undrained shear strength ratio (shear normalized to consolidation stress, C_u/σ'_c) as a function of consolidation stress (see Figure 4-6). The pre-shear consolidation stresses used in the testing range from about 10,000 psf to 50,000 psf. Calculated values of C_u/σ'_c range between 0.31 and 0.86. The data indicate that, with an undrained strength ratio of 0.42, about 2/3 of the laboratory data plots above the design strength. With this in mind, we selected a design undrained shear strength ratio of 0.42.

Using the DSS test results and a failure criterion of 10% strain, we plotted values of undrained shear strength ratio (shear normalized to consolidation stress, C_u/σ'_c) as a function of consolidation stress as shown on Figure 4-7. The consolidation stresses used in the testing span range from about 7,000 psf to 25,000 psf. Calculated values of C_u/σ'_c range between 0.29 and 0.51. The data indicate that, with an undrained DSS strength ratio of 0.33, about 2/3 of the laboratory plots above the design strength. For design, we selected an undrained DSS strength ratio of 0.33.

For analysis of the post-earthquake cases, we evaluated several factors. We compared the CSR for the OBE earthquake to the tailing performance in the cyclic triaxial shear strength tests. For the OBE event, the number of equivalent cycles (at 0.65 τ_{max}) is expected to be on the order of 5 to 15 (Seed 1975 as presented in Kramer 1996). Based on the simplified cyclic stress approach and the equations presented by Idriss and Boulanger (2008), OBE CSRs are expected to range between about 0.04 and 0.07 within the tailing. When tested at CSRs of 0.19 and 0.30, pore pressure ratios in tailing samples reached values of about 28% and 95% after 1,000 and 248 cycles, respectively. The pore pressure ratios are shown in Figure 4-8. The OBE parameters and the cyclic triaxial test results indicate that the OBE event is very unlikely to induce widespread liquefaction in the tailing.

We also evaluated the triaxial stress paths and state parameters for the existing whole and cycloned sand tailing. The state parameter is equal to the soil's void ratio minus its critical state void ratio. Soils that are denser than the critical state have a negative state parameter and generally exhibit dilative behavior during shear. Dilative behavior during undrained shearing produces negative pore pressures, increasing the effective stresses and increasing the shear strength. The available data indicate the tailing is generally dilative during shearing

The performance and state of the existing tailing, along with the relatively high factors of safety against liquefaction triggering, and the relatively low stresses due to the OBE event indicate that wide-spread strength reduction due to liquefaction of the tailing is unlikely to occur for the OBE event. Without a significant loss of strength due to widespread liquefaction, we chose to analyze the post-OBE stability of 5 Dam using the undrained shear strengths of the tailing. The OBE event may induce excess pore pressures, essentially creating an undrained condition in the saturated tailing.

5.1.3 Fine Tailing (Slimes)

Historic characterization of the fine tailing (also known as slimes) has used a steady-state friction angle of 25 degrees with a cohesion intercept of 500 psf. The 2007 URS analyses used an undrained strength ratio of 0.40 for the material based on triaxial test data. DSS testing has not been completed on the fine tailing, but for analyses purposes an undrained DSS shear strength ratio of 0.30 was selected based on our experience with this type of material at similar tailing dams.

5.1.4 Sludge Layer

The sludge layer placed in the current decant pond (discussed previously in Section 1.2 with additional discussion, including stability considerations, in Appendix C) was not included as a separate layer in the seepage analyses but instead was included in the model with the fine tailing (slime) material. Based on the information available it is likely this material has a similar permeability.

5.2 STARTER DAM

The 2012 investigation collected new samples and blow count data for the starter dam. Historic characterization of the starter dam identified a unit weight of 145 pcf, a friction angle of 35 degrees, and a cohesion intercept of zero. The blow counts data and published material classification supports use of the same material properties in our current analyses.

5.3 FOUNDATION

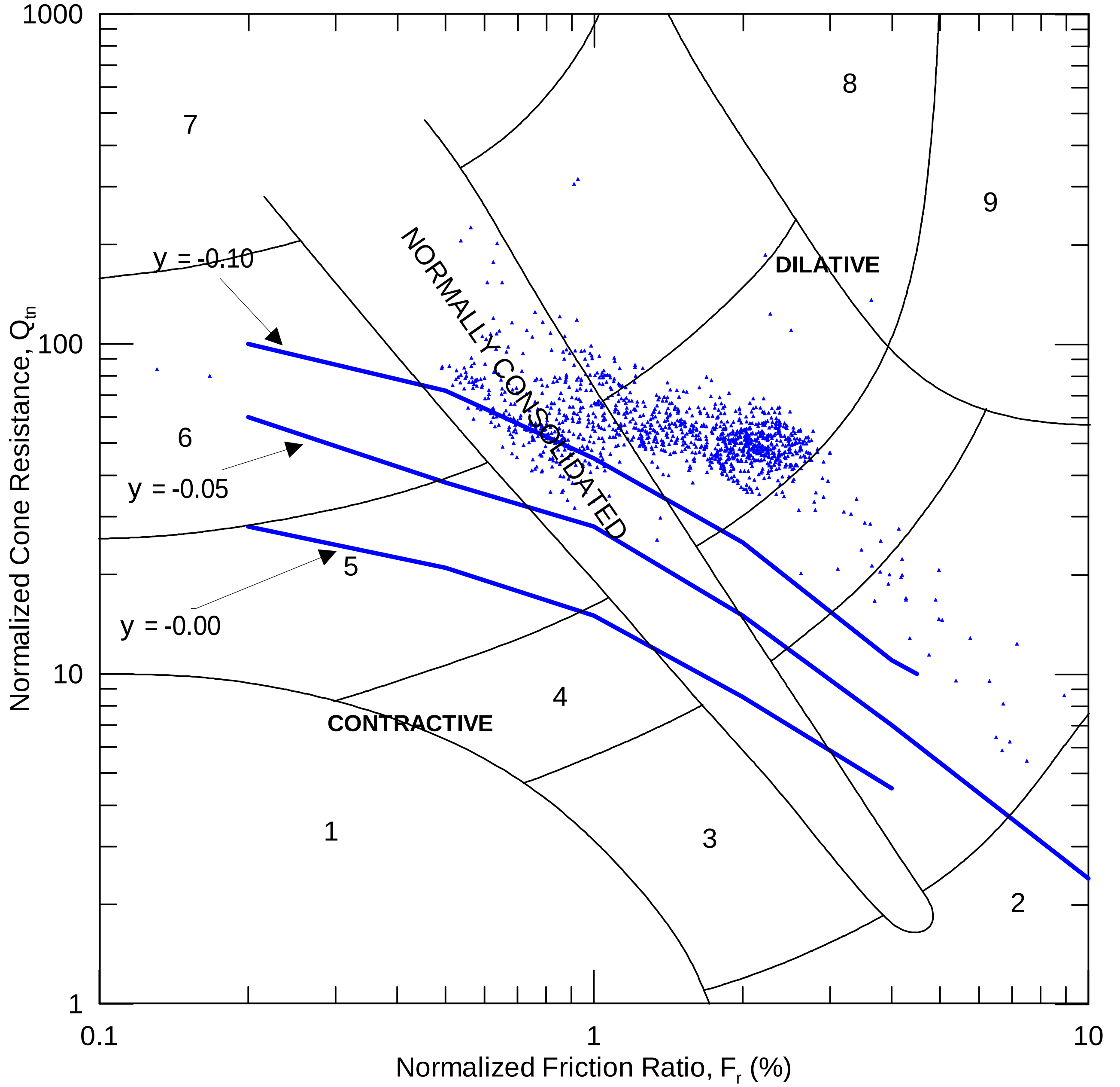
The 2012 investigation collected new data for the foundation layer, but due to the density of this material, data collection was generally limited to the upper range of this layer. Most CPT soundings and standard penetration tests met practical refusal within a few feet of the top of this layer. Historical characterization of the impoundment foundation has used a unit weight of 145 pcf, and a friction angle of 35 degrees with a cohesion intercept of 0 psf. Available blow count and CPT data indicate this is conservative.

5.4 BEDROCK

Analyses performed by URS in 2007 and 2012 for 3 Dam characterized the bedrock with a unit weight of 150 pcf, a friction angle of 50 degrees, and a cohesion intercept of 5,000 psf. No new data has been collected for the bedrock at the site, therefore the same material properties were used in our current analyses. These bedrock properties are consistent with the 3 Dam stability analyses completed in 2010.

5.5 PHREATIC SURFACE

The piezometers at 5 Dam (see Figure 3-1) are automated and measure the location of the phreatic surface within the 5 Dam embankment daily, with review of the data occurring at least on a monthly basis. Recent piezometric readings are shown on Figures 3-3 and 3-4. For the purposes of estimating a future phreatic surface at future crest elevation 10,820 feet, a seepage analysis was prepared that reviewed existing piezometric and CPT data. This is discussed in further detail in Section 6.0. Our stability analyses assumed 100% hydrostatic pore pressures below the phreatic surface.



Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2012-5-1** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-1

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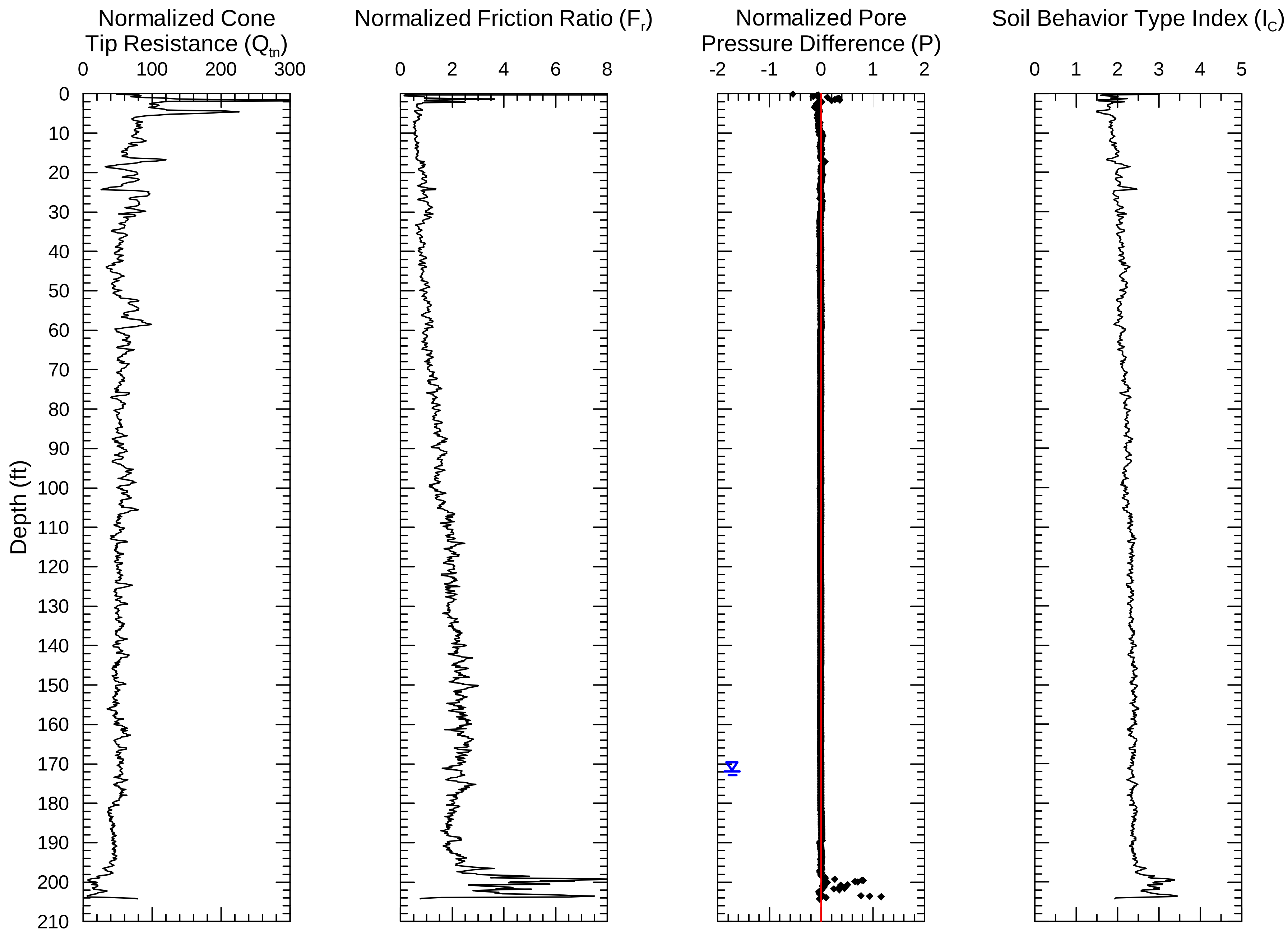

Project No. 22243088	Climax Mine Climax, CO	**Interpretive Tailing Cone Sounding CPT-2012-5-1**	Figure 5-2
URS			

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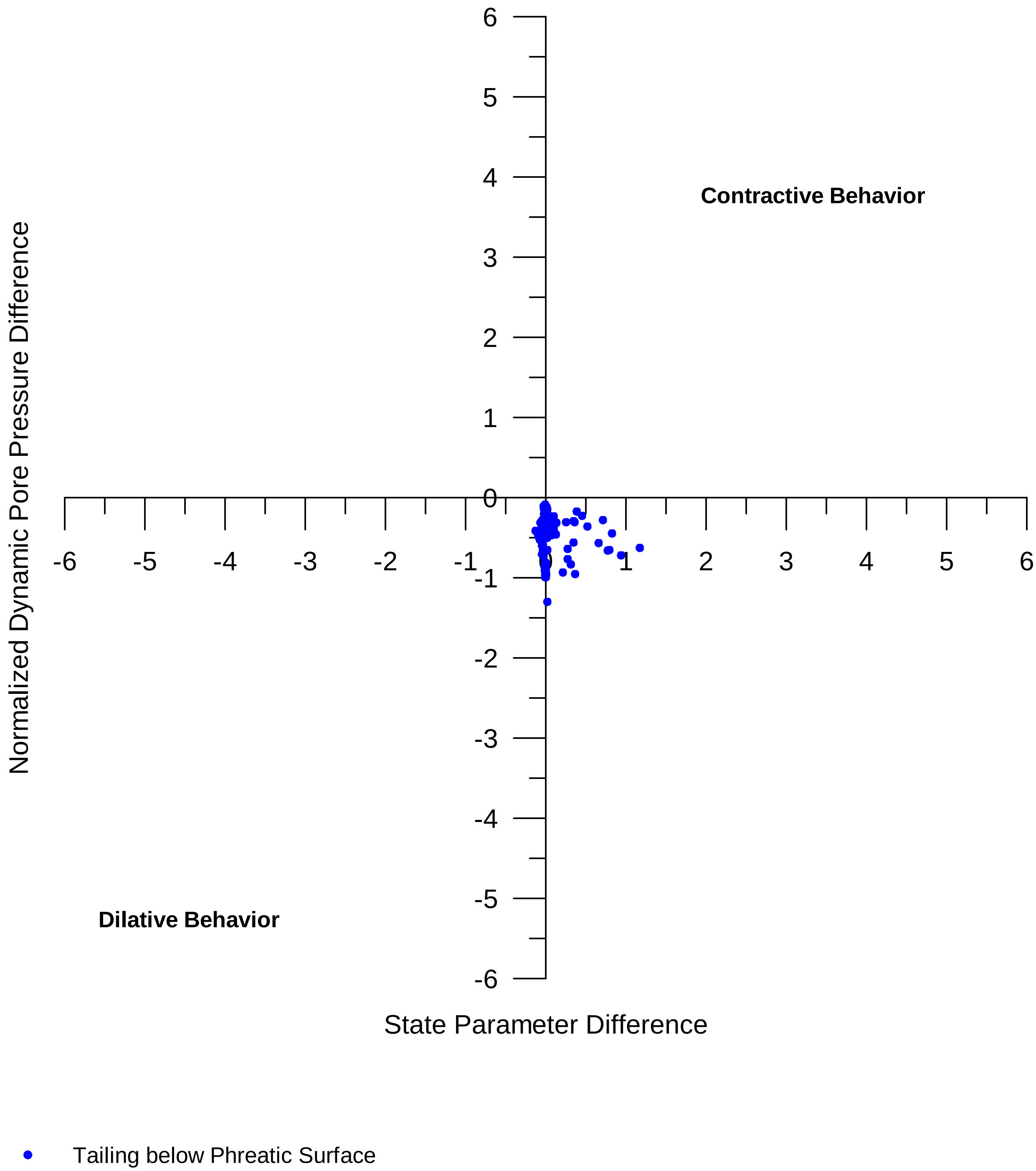

Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2012-5-1** **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference** **5 Dam**	FIGURE 5-3

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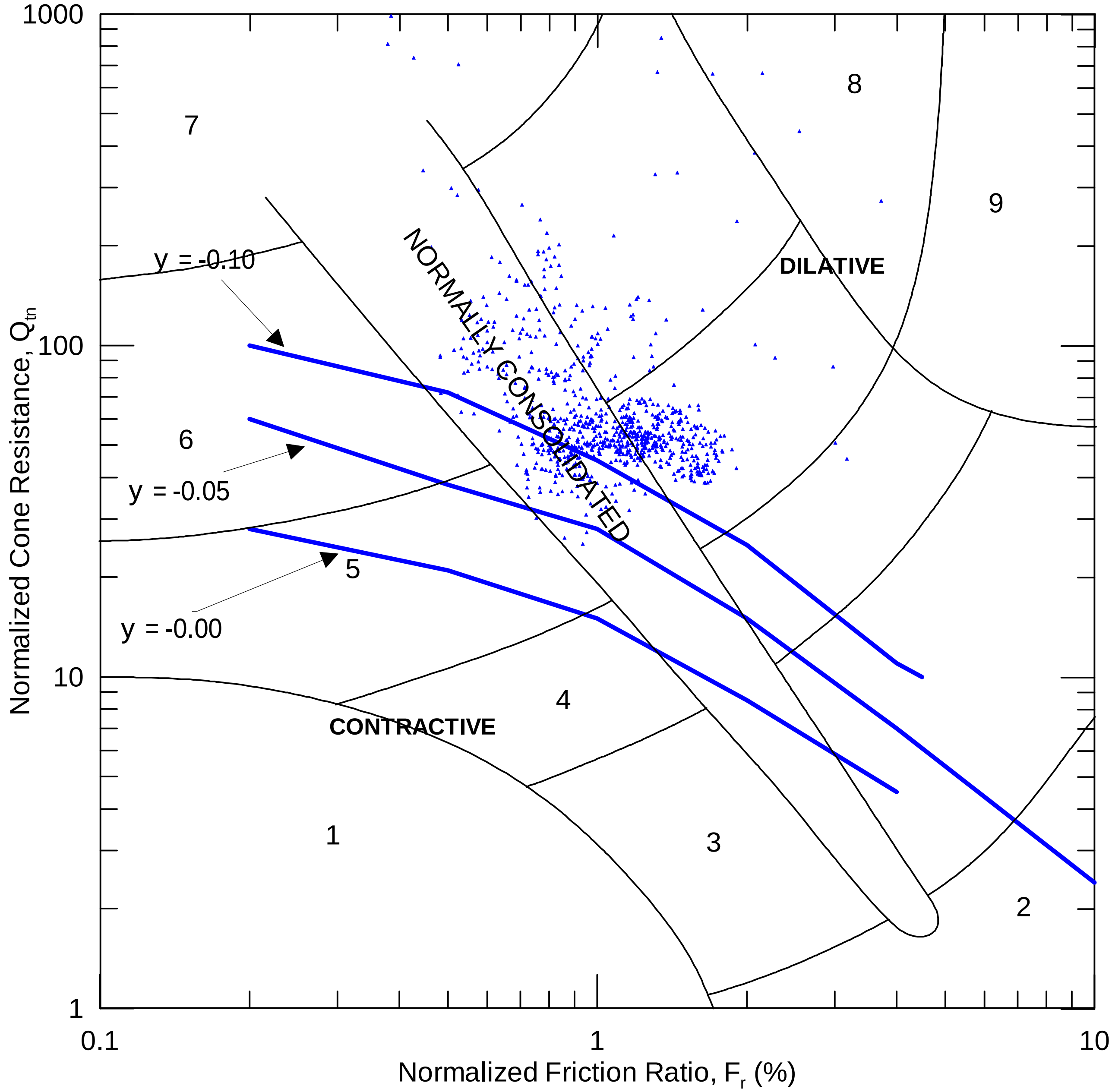

Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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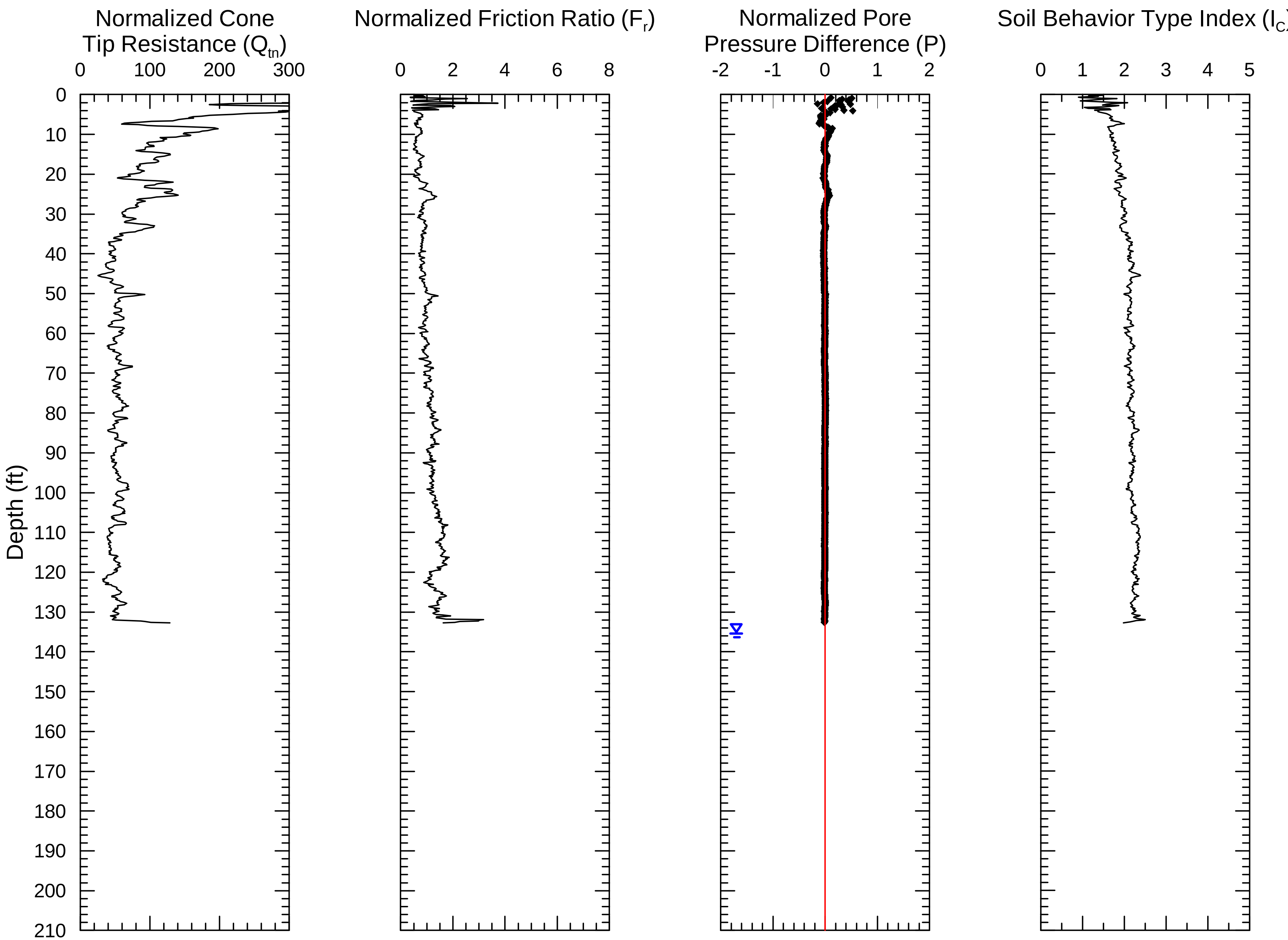
Project No. 22243088	Climax Mine Climax, CO	**CPT-2012-5-2** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-4
	URS		



Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	**Interpretive Tailing Cone Sounding CPT-2012-5-2**	Figure 5-5
URS			

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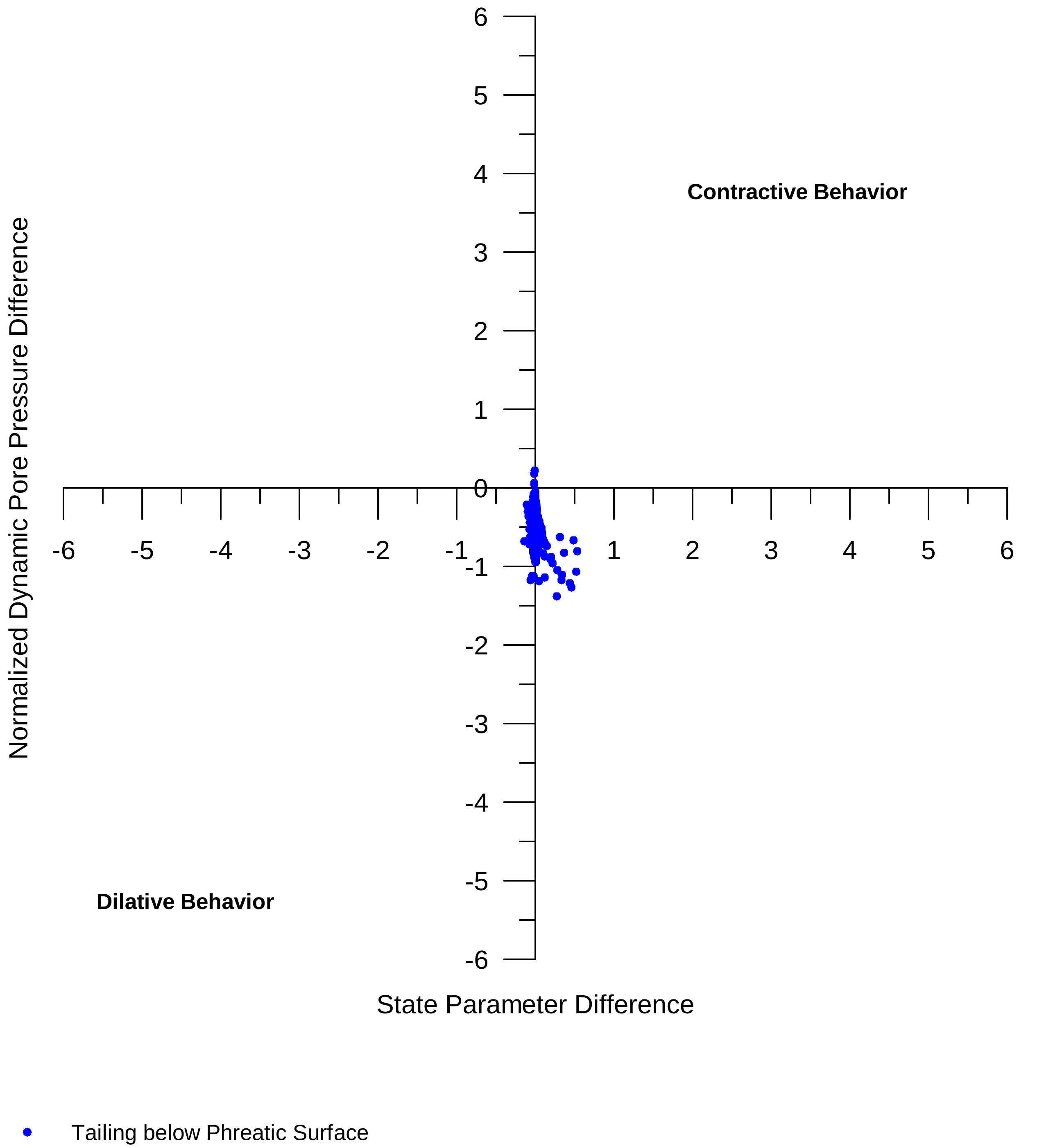

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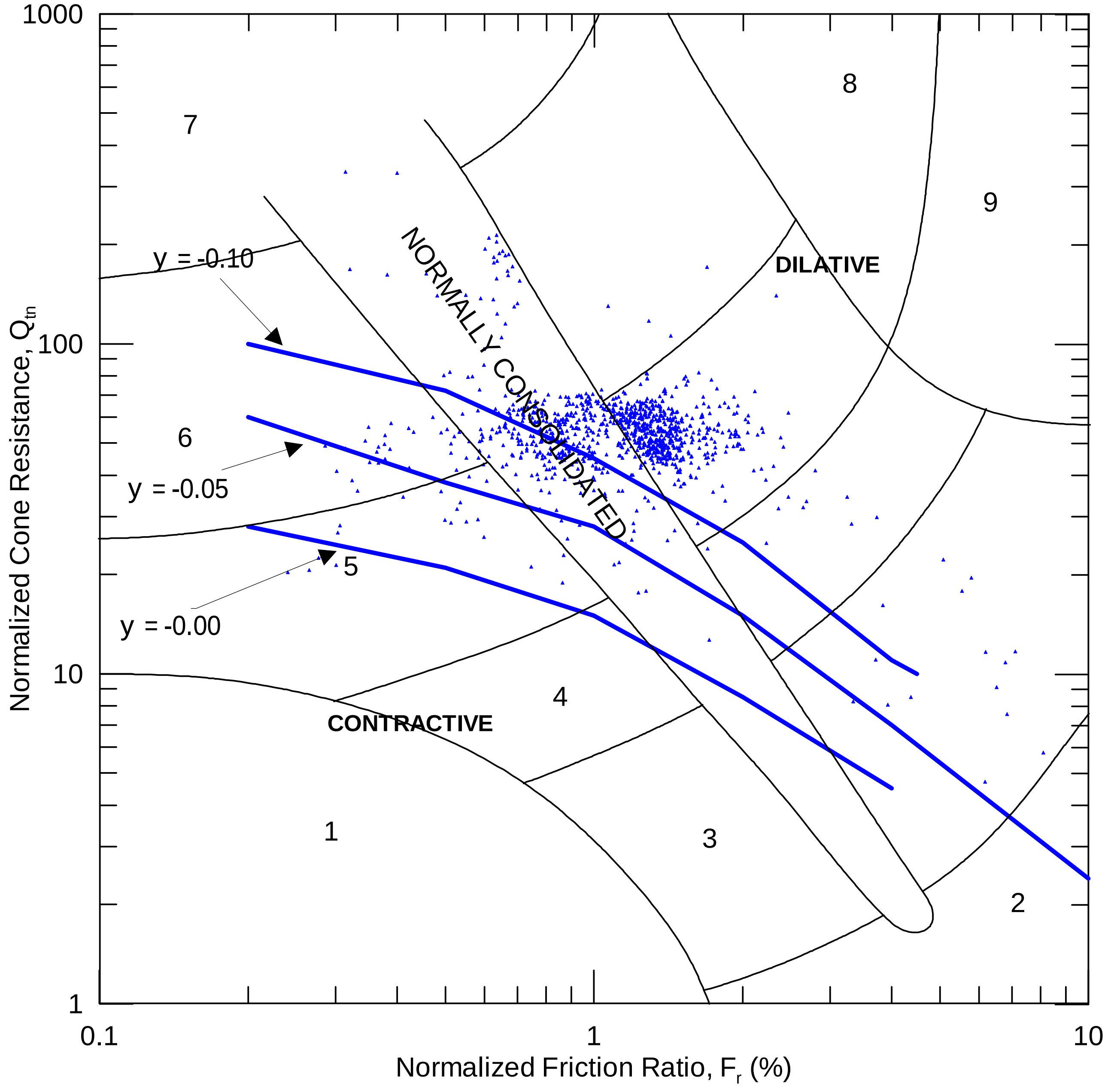
Project No. 22243088	Climax Mine Climax, CO	CPT-2012-5-2 Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference 5 Dam	FIGURE 5-6
	URS		



Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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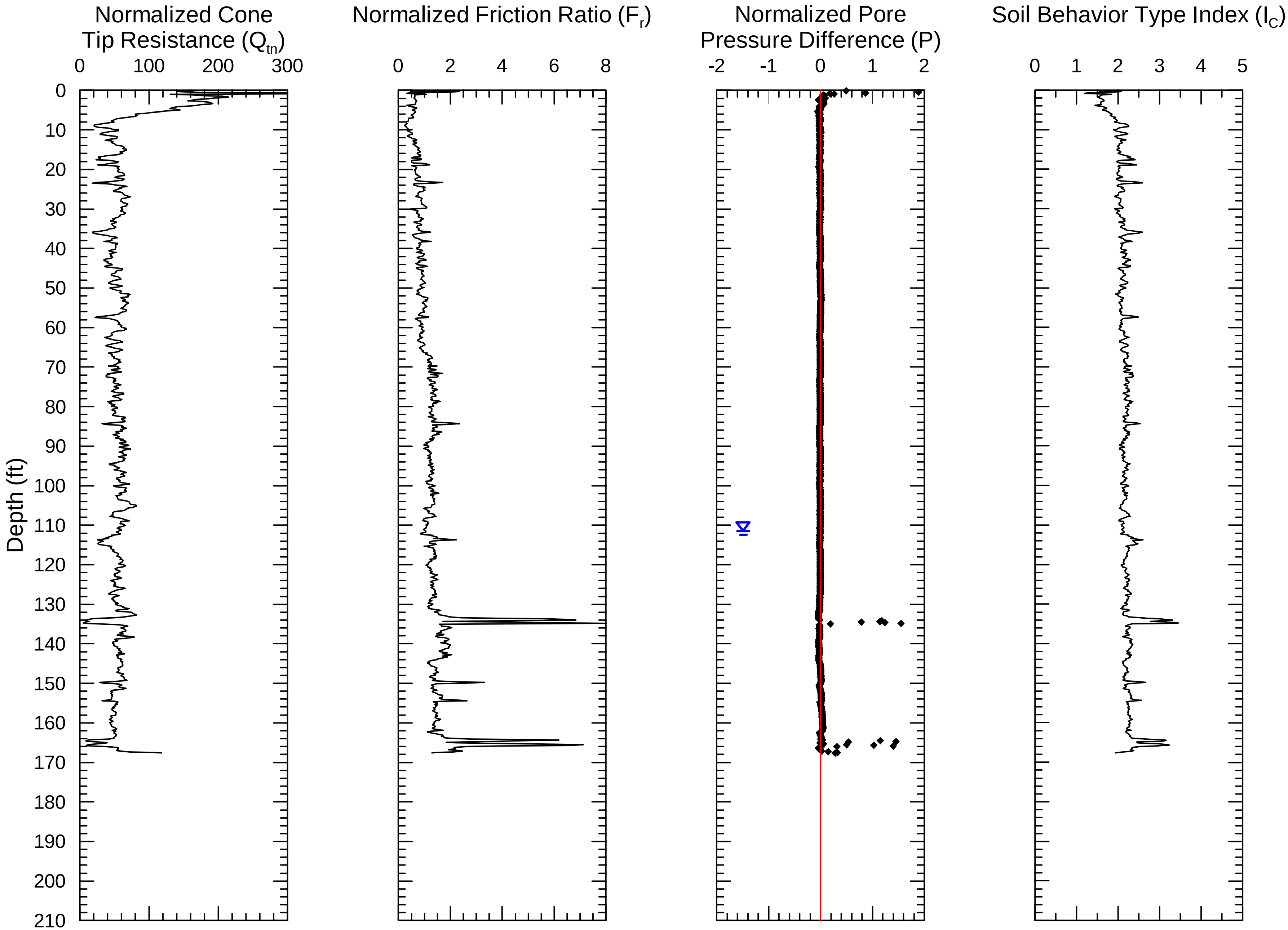
Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2012-5-3** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-7



Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	Interpretive Tailing Cone Sounding CPT-2012-5-3	Figure 5-8
	URS		

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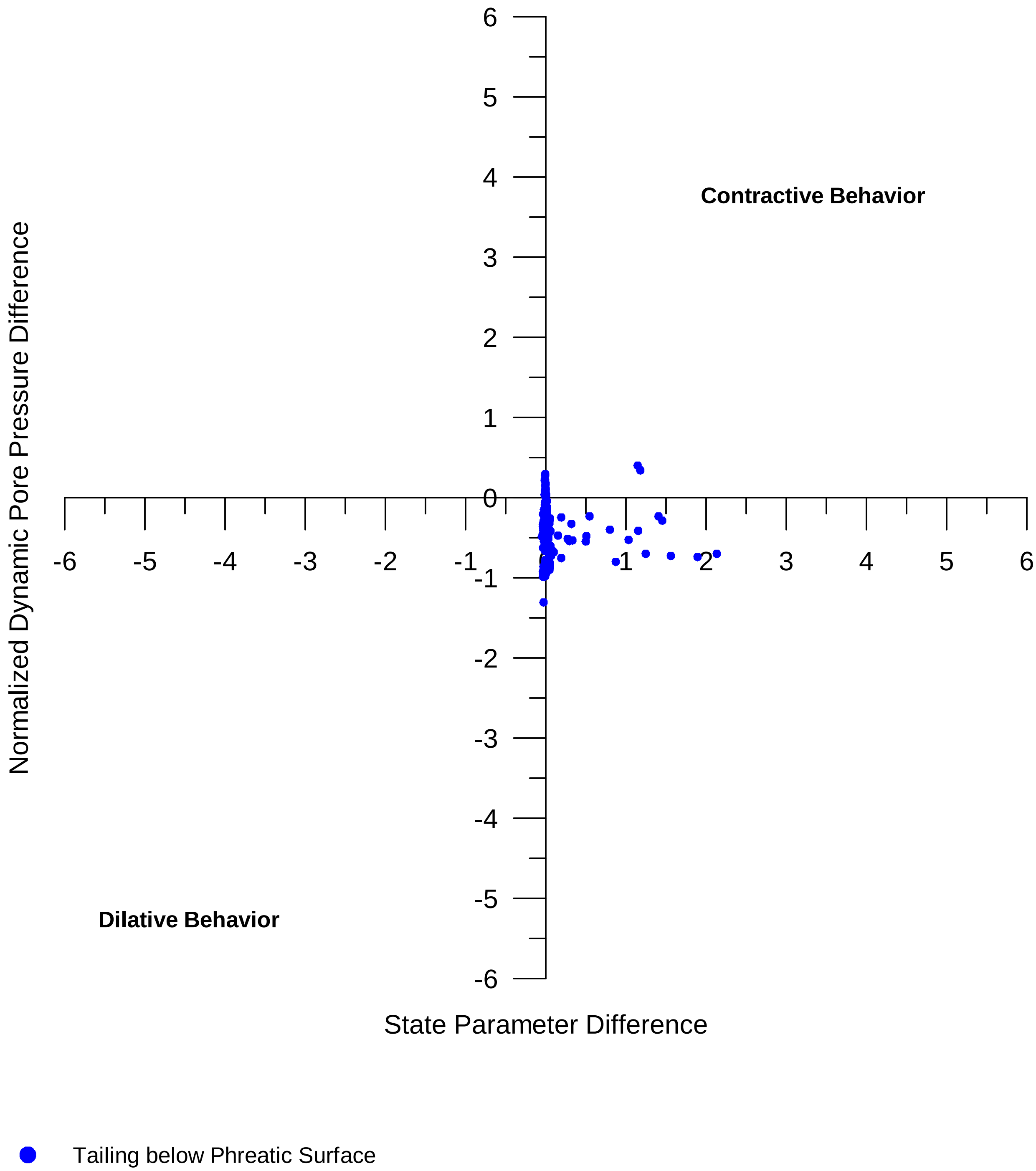

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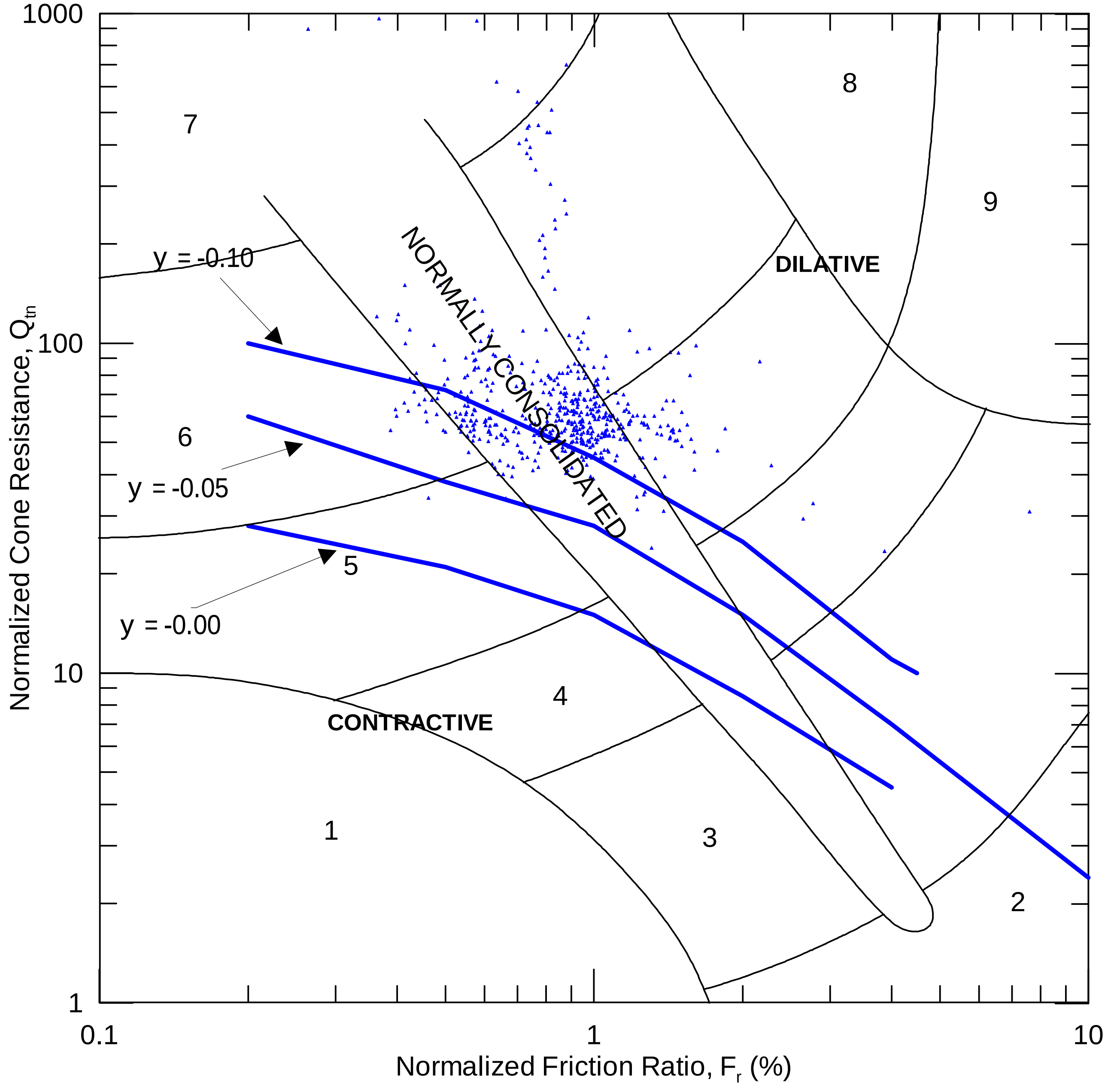
Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2012-5-3** **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference** **5 Dam**	FIGURE 5-9



▲ Tailing Data Points

Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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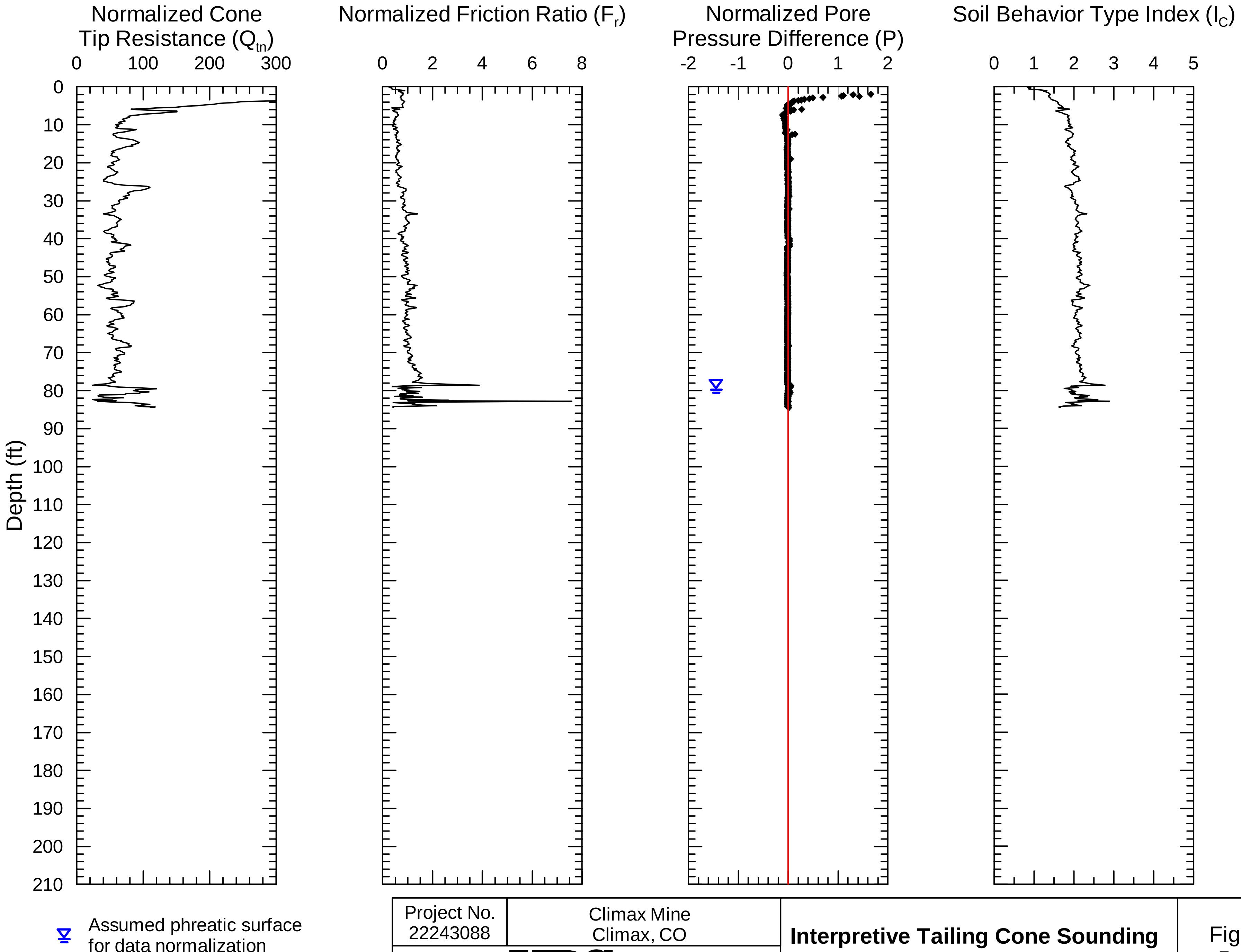
Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-1** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-10
URS			



Project No. 22243088	Climax Mine Climax, CO	**Interpretive Tailing Cone Sounding** **CPT-2006-5-1**	Figure 5-11
	URS		

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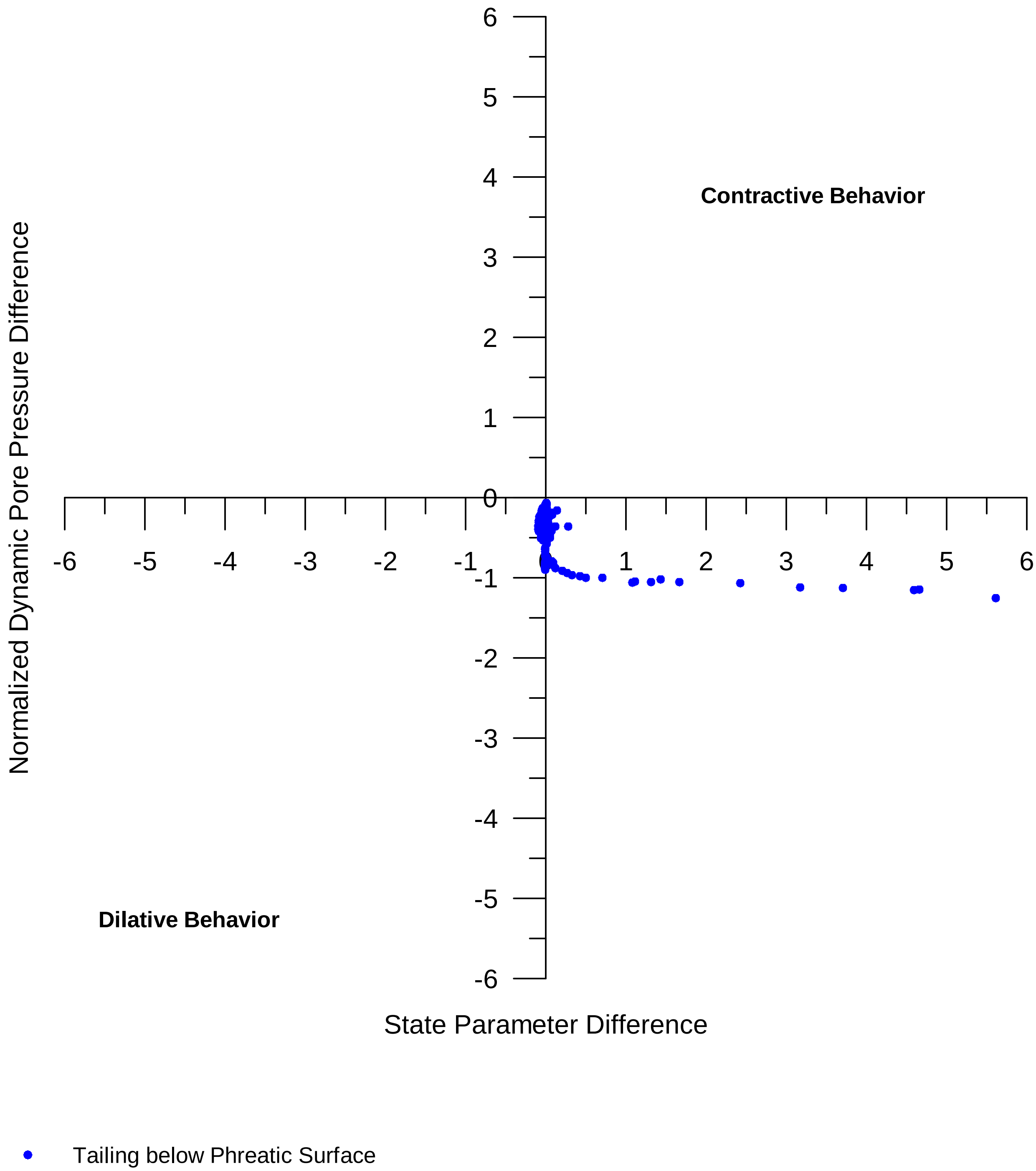

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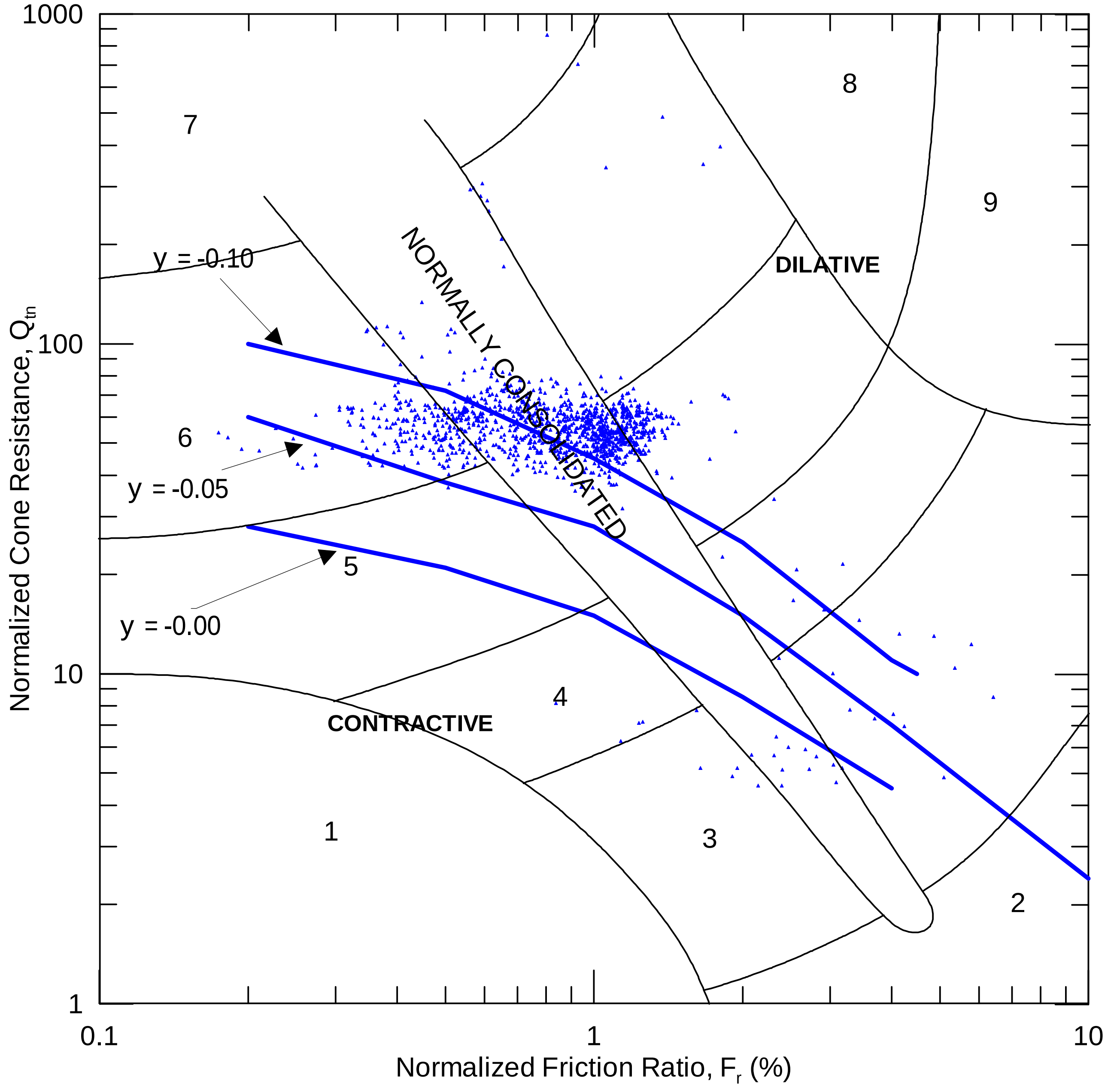
Project No. 22243088	Climax Mine Climax, CO	CPT-2006-5-1 **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference 5 Dam**	FIGURE 5-12
	URS		



Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-2** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-13

URS

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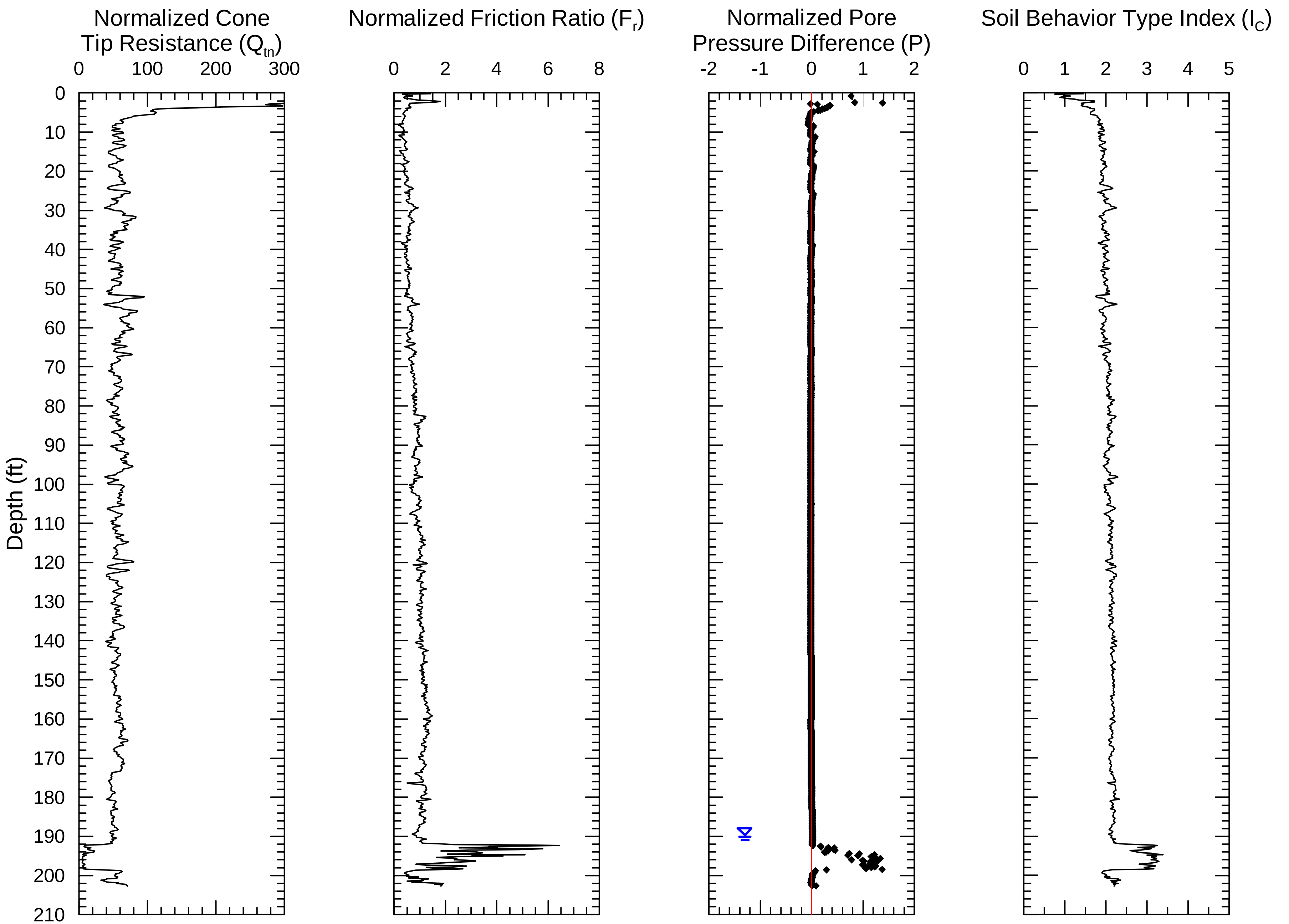

Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	**Interpretive Tailing Cone Sounding CPT-2006-5-2**	Figure 5-14
URS			

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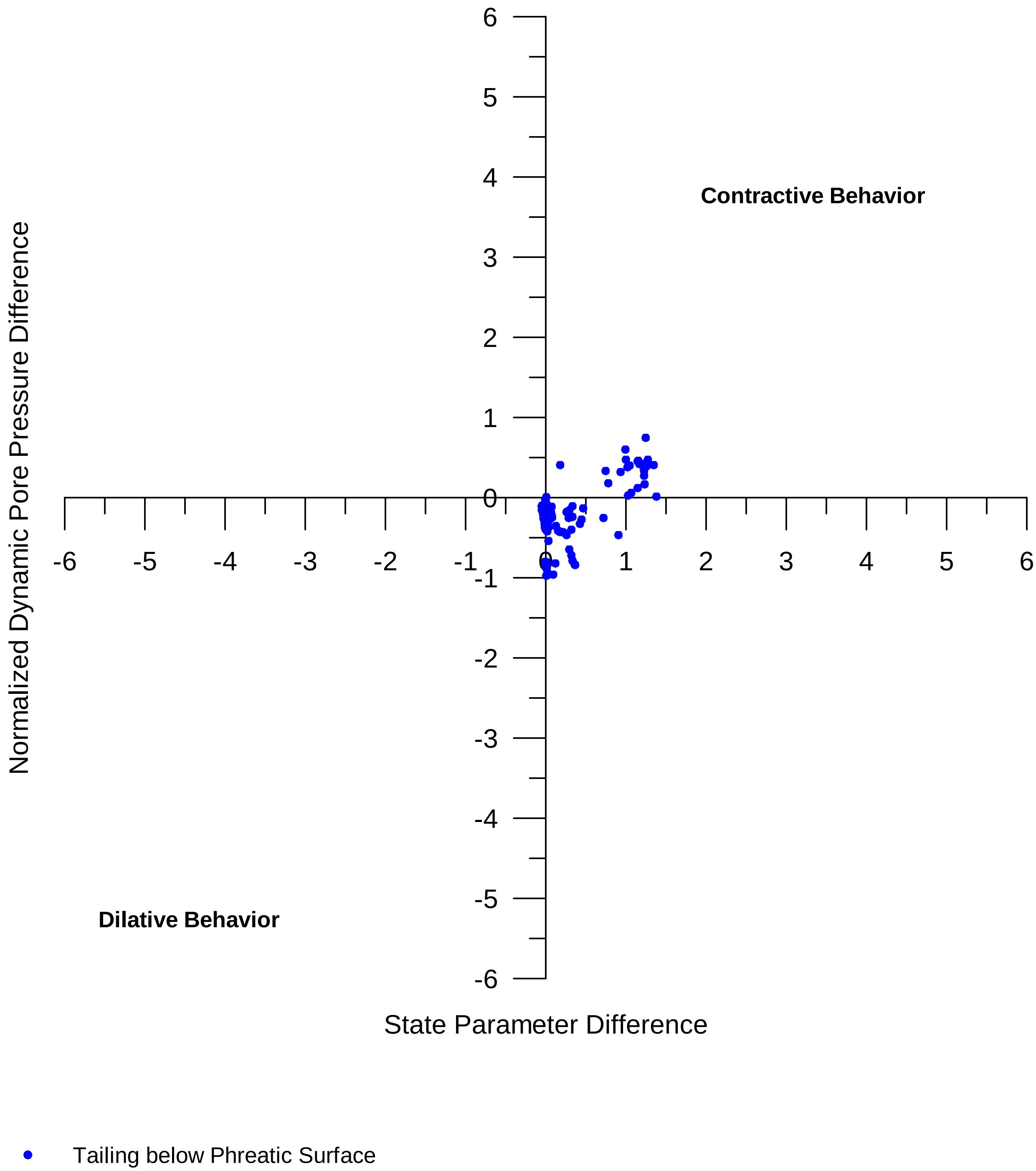

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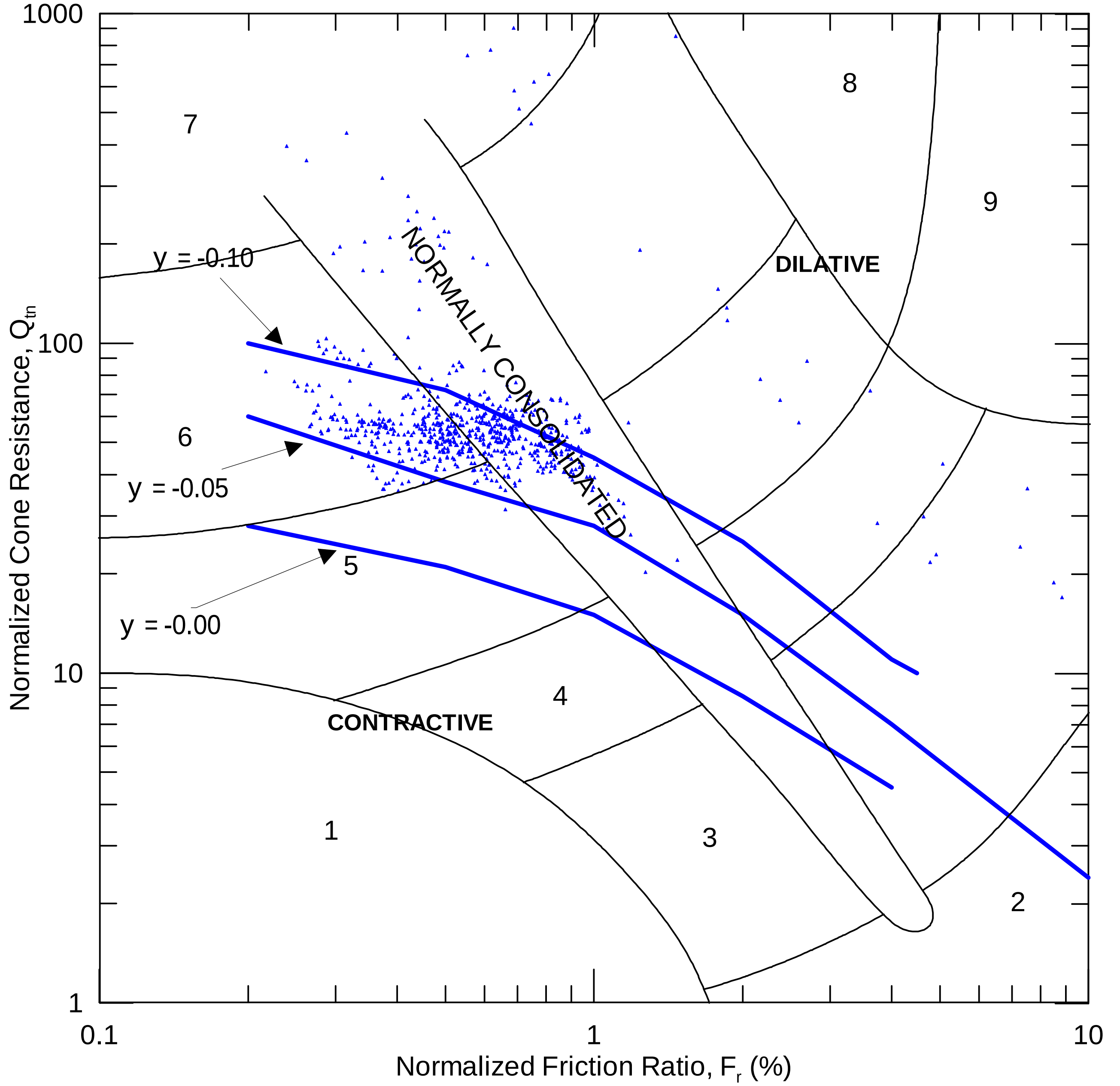
Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2006-5-2** **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference** **5 Dam**	FIGURE 5-15



▲ Tailing Data Points

Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-3** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-16
	URS		

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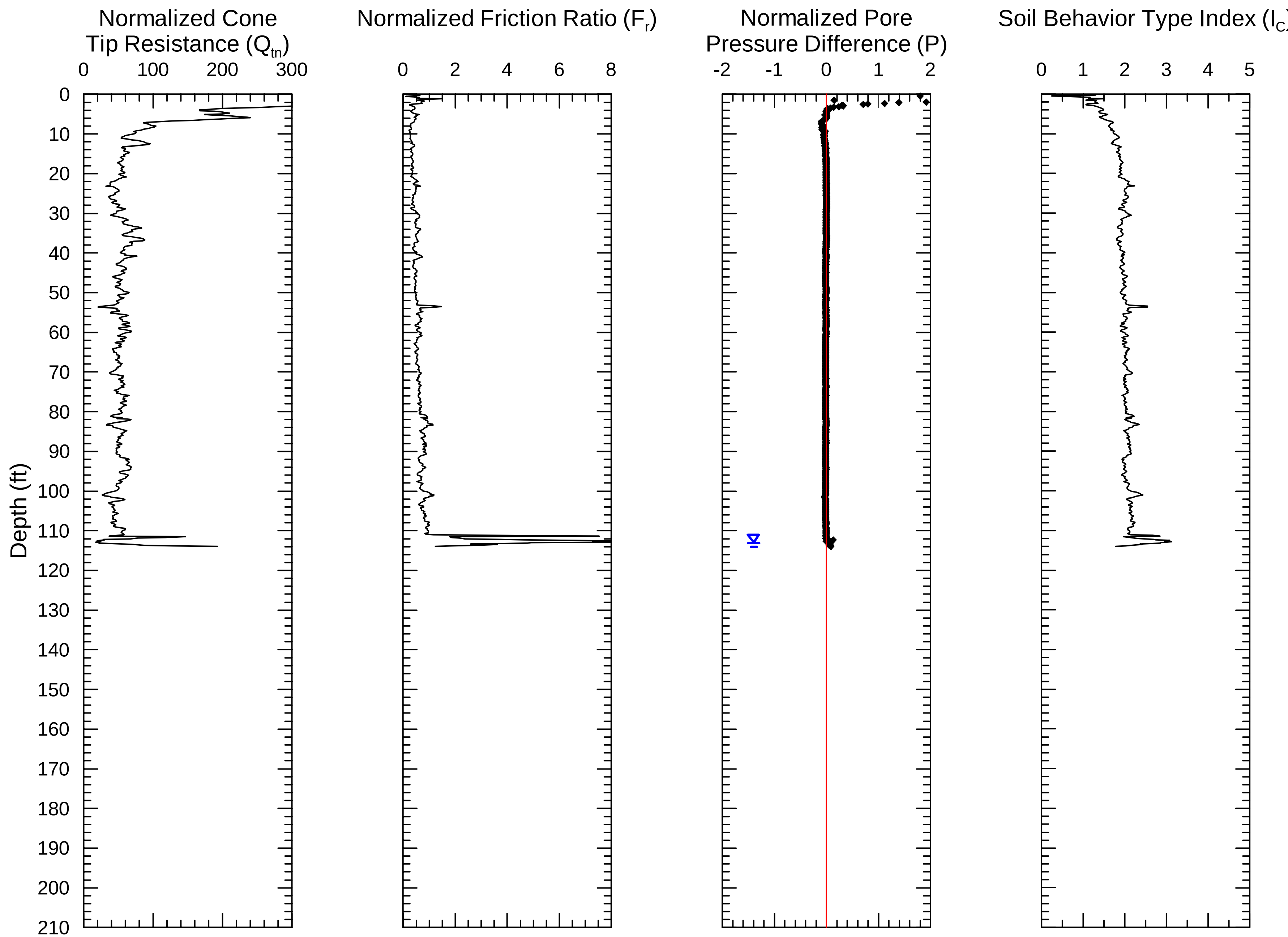

Project No. 22243088	Climax Mine Climax, CO	**Interpretive Tailing Cone Sounding CPT-2006-5-3**	Figure 5-17
	URS		

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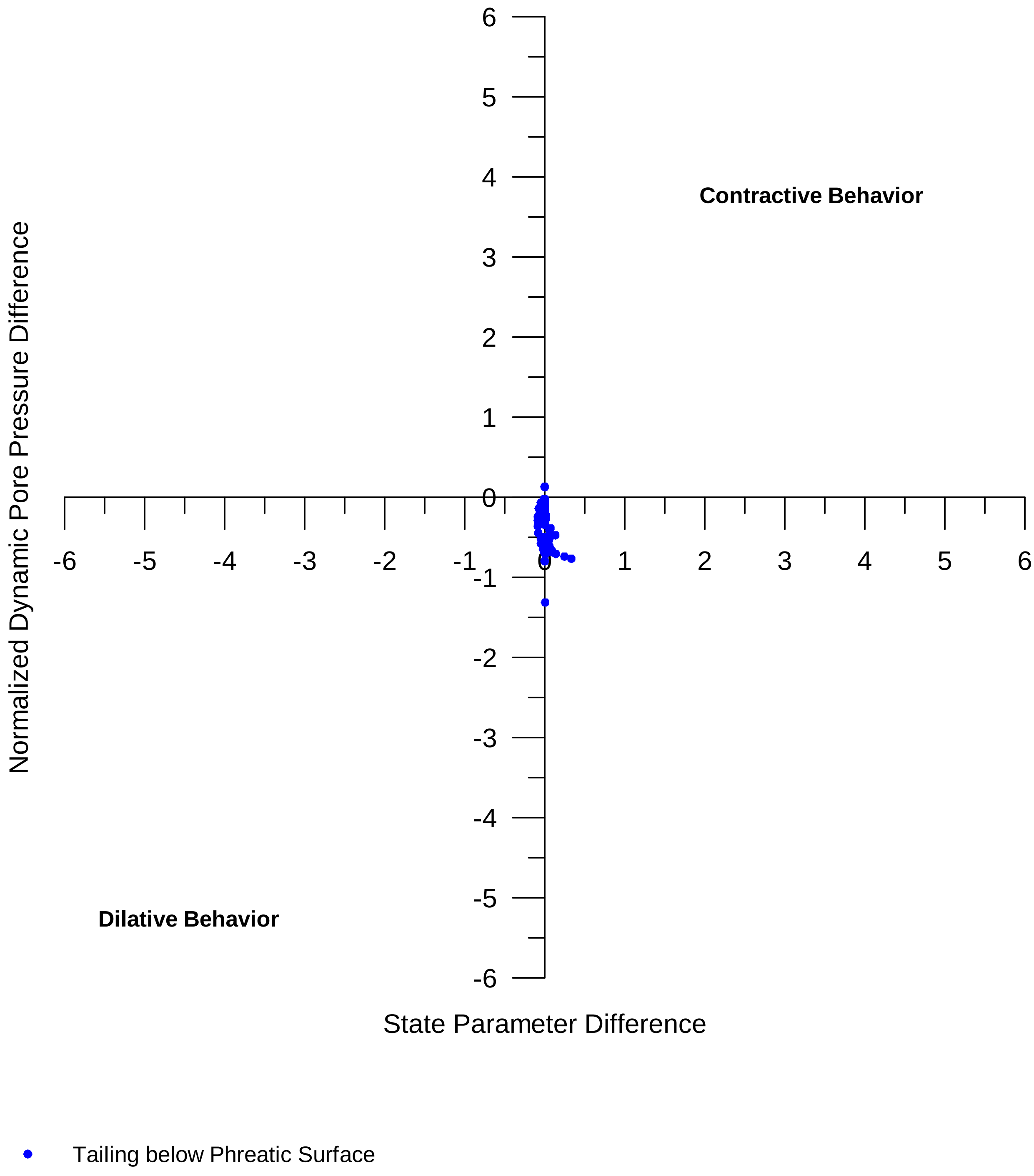
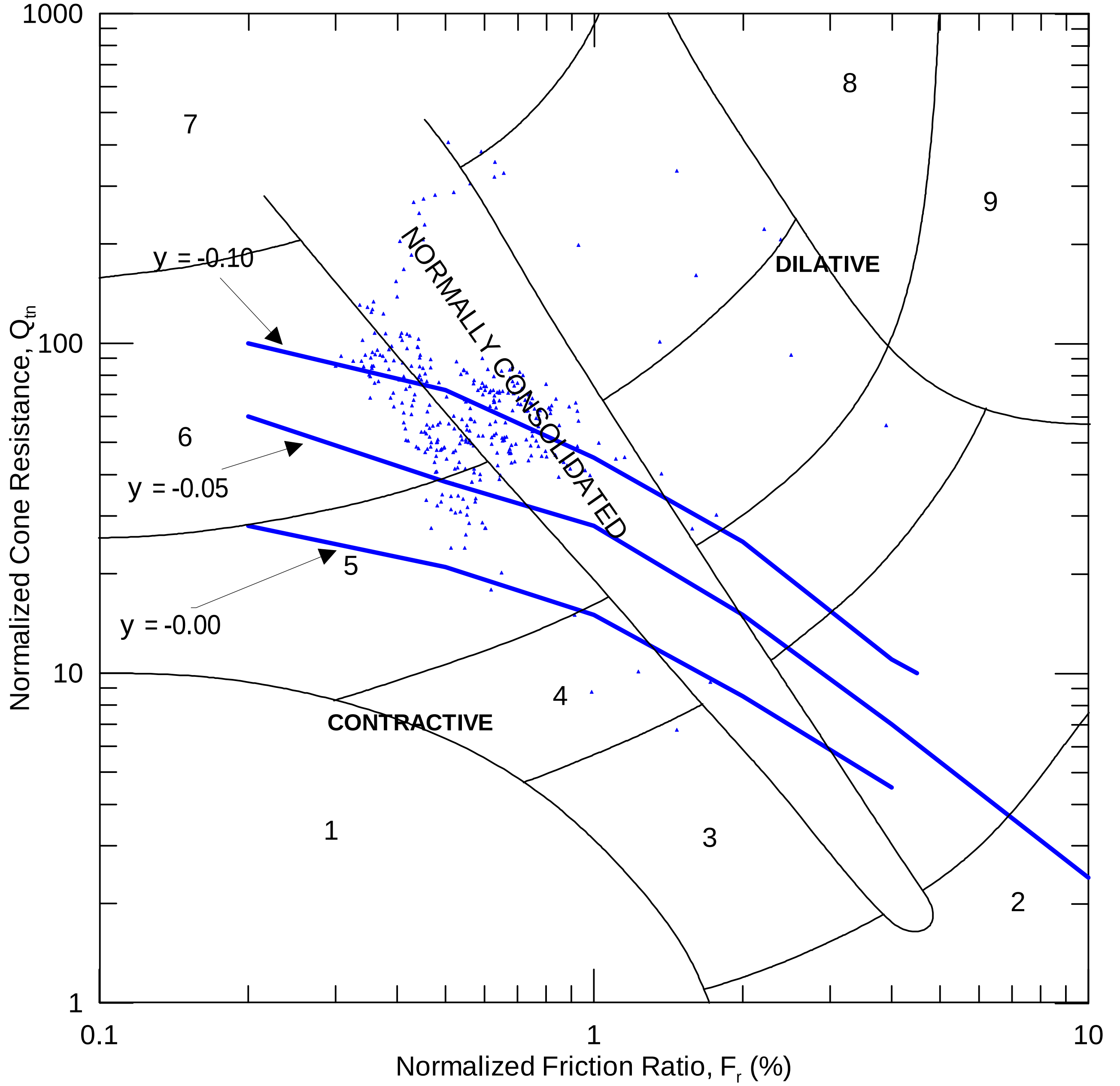


Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-3 Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference 5 Dam**	FIGURE 5-18
	URS		



▲ Tailing Data Points

Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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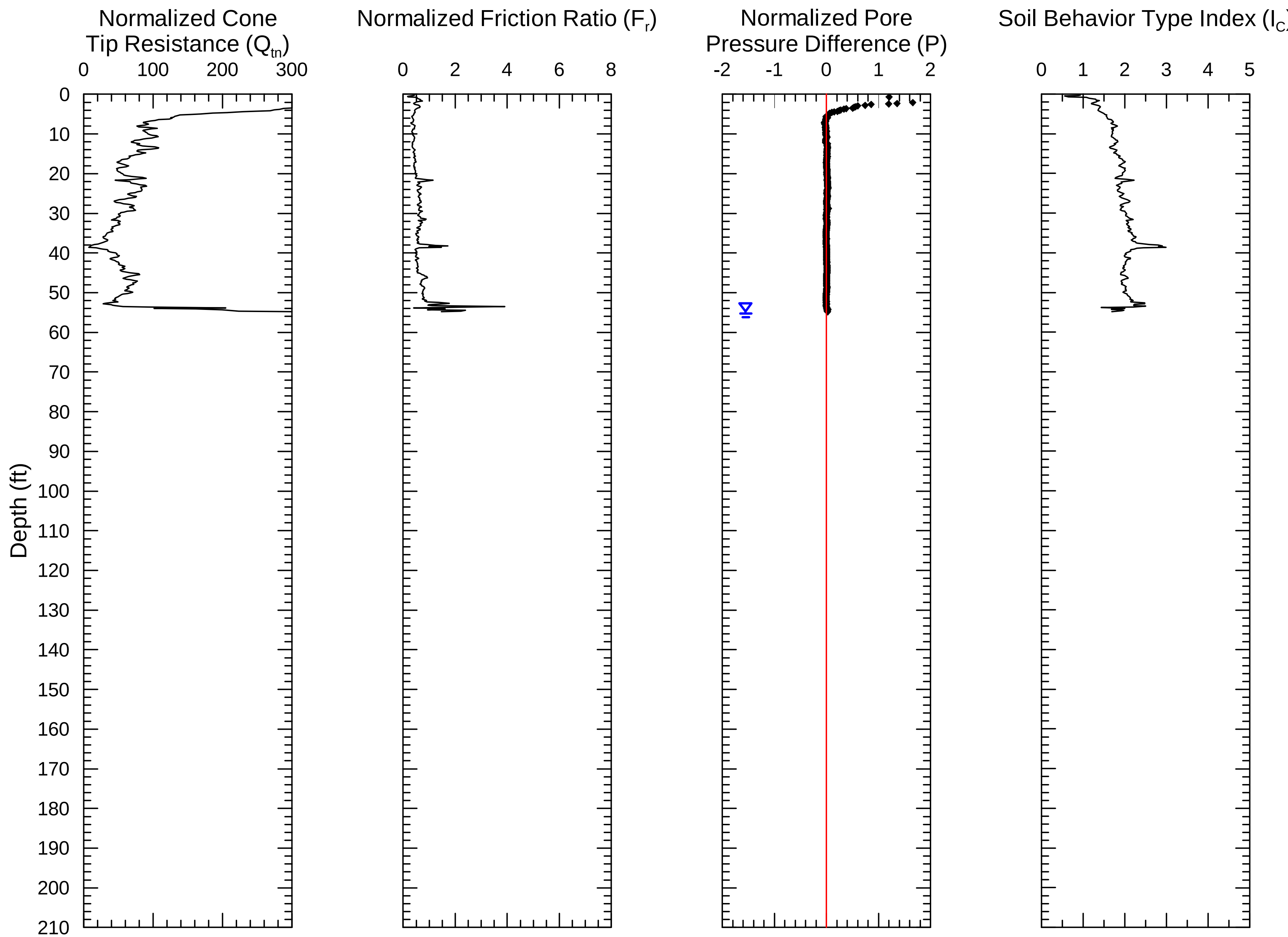
Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-4** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-19
	URS		



Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	Interpretive Tailing Cone Sounding CPT-2006-5-4	Figure 5-20

URS

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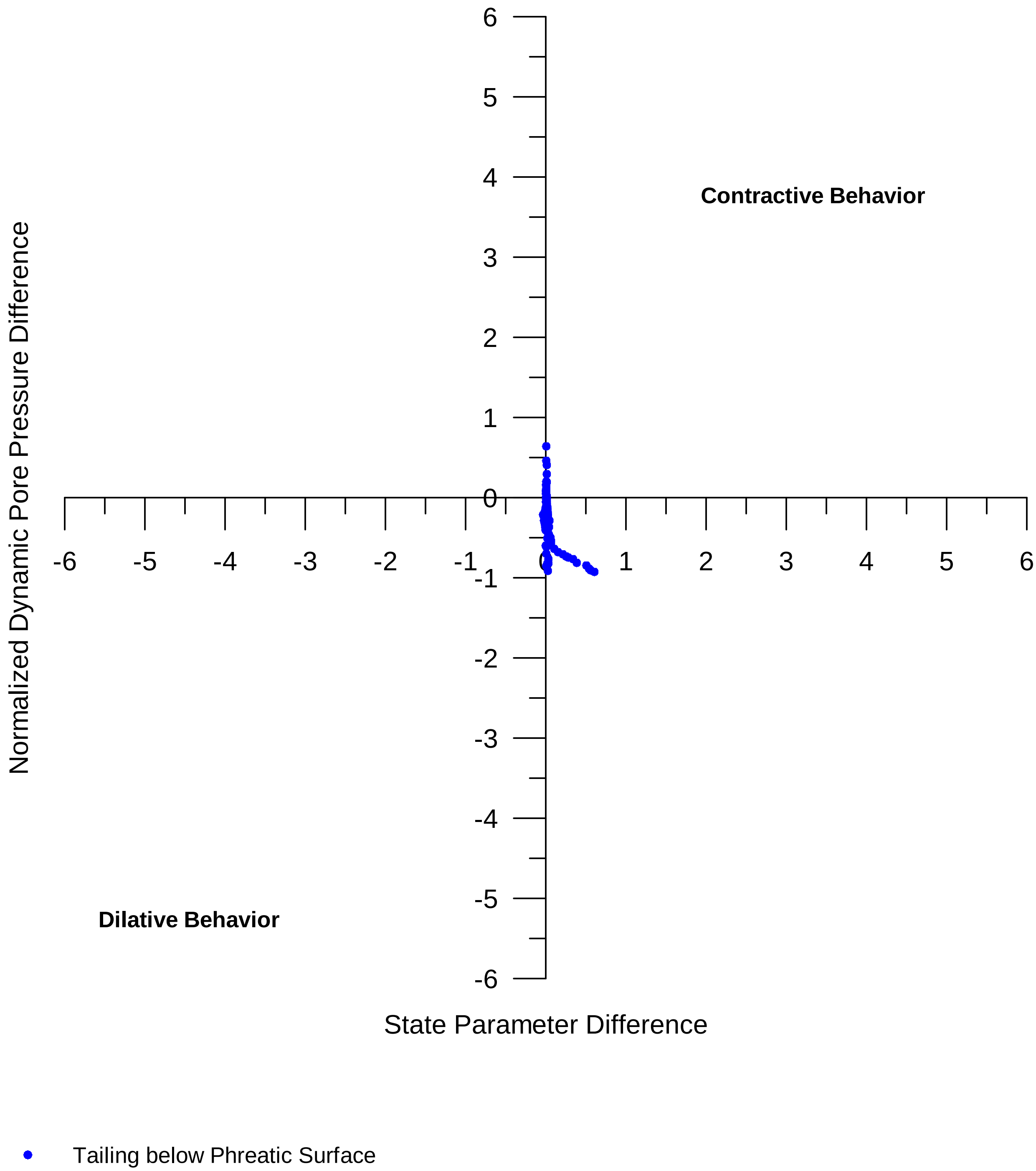
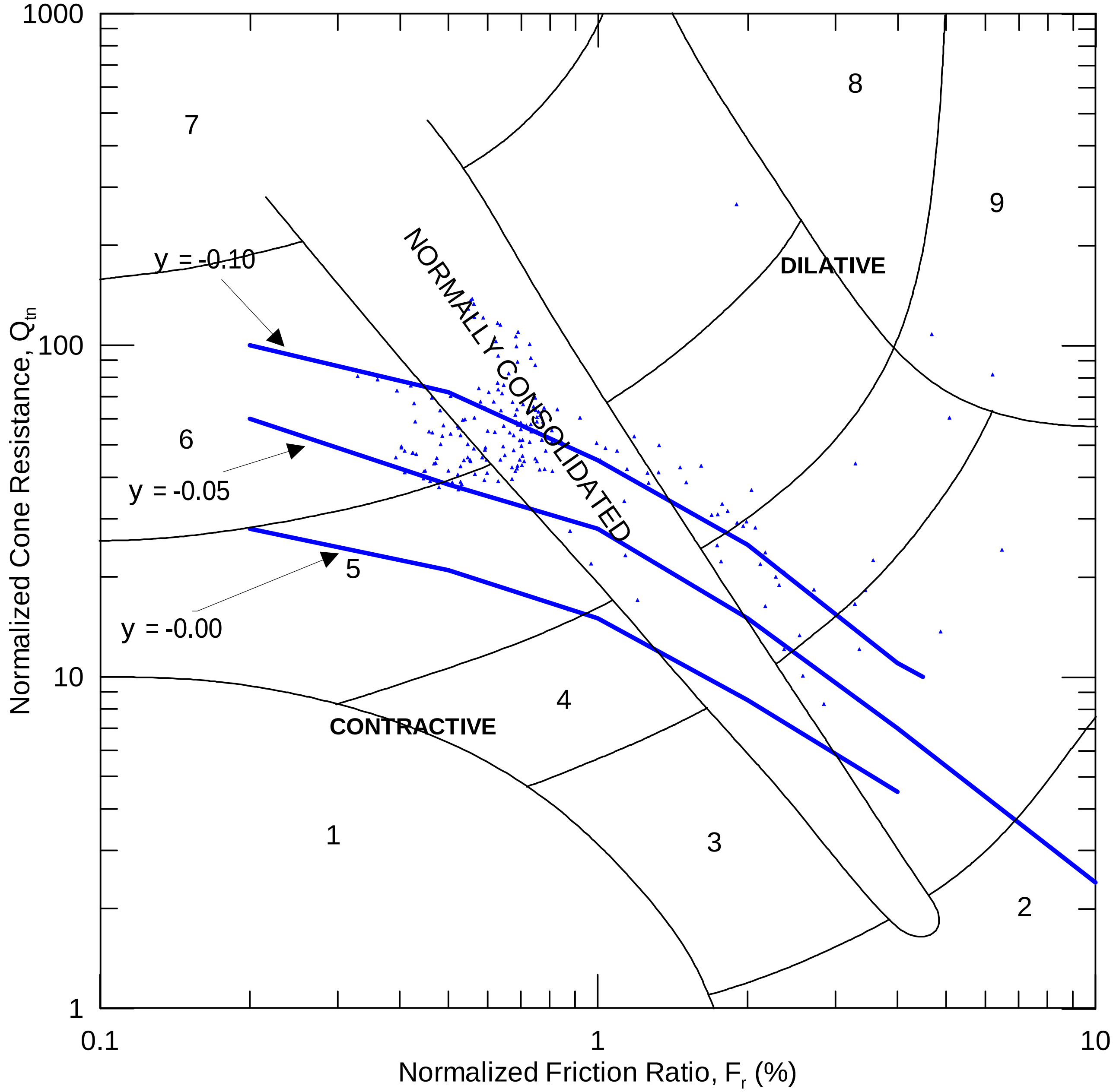


Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2006-5-4** **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference** **5 Dam**	FIGURE 5-21



Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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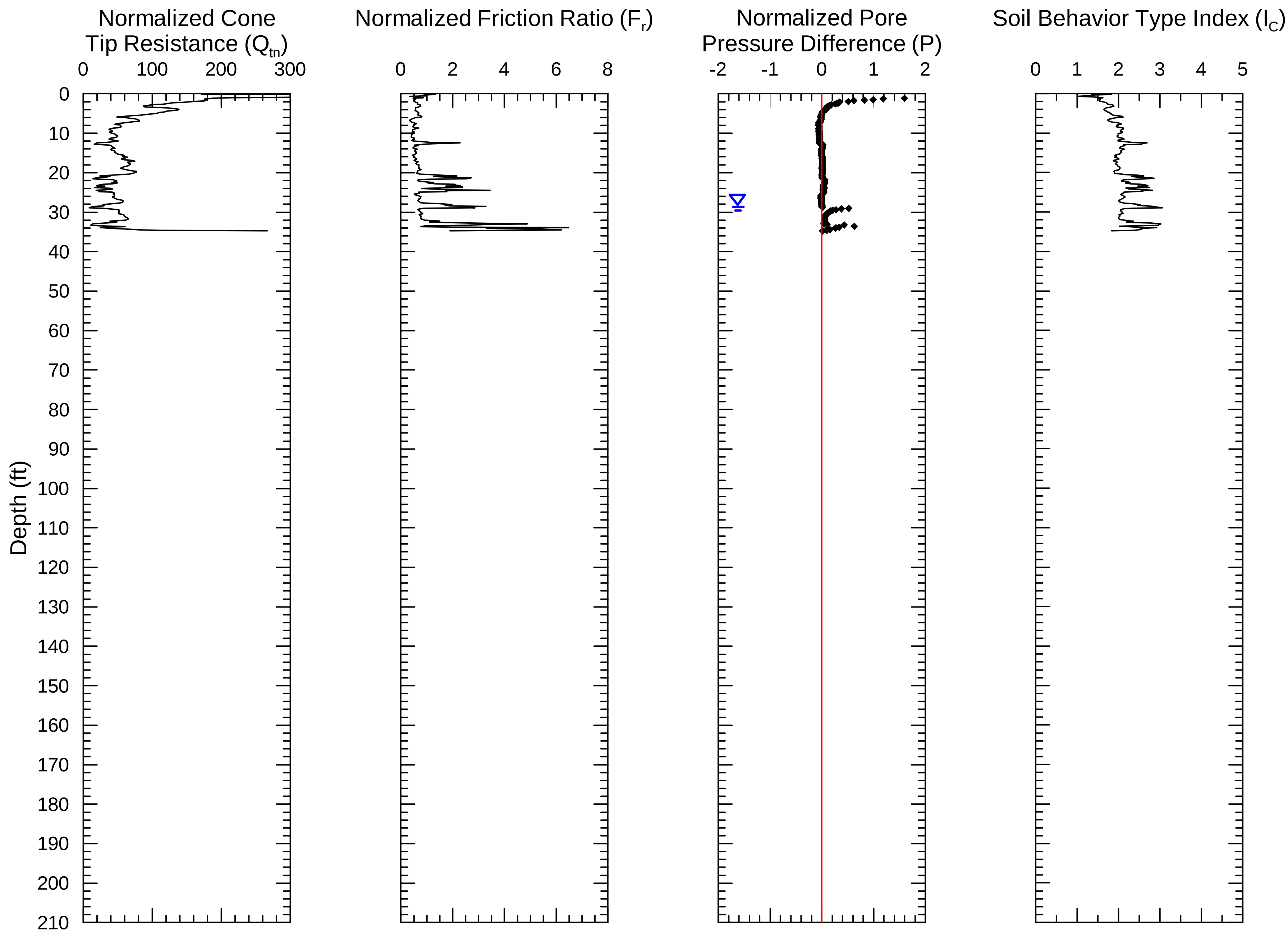
Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-5 Normalized Friction Ration vs. Normalized Cone Resistance 5 Dam**	FIGURE 5-22
URS			



Project No. 22243088	Climax Mine Climax, CO	Interpretive Tailing Cone Sounding CPT-2006-5-5	Figure 5-23
	URS		

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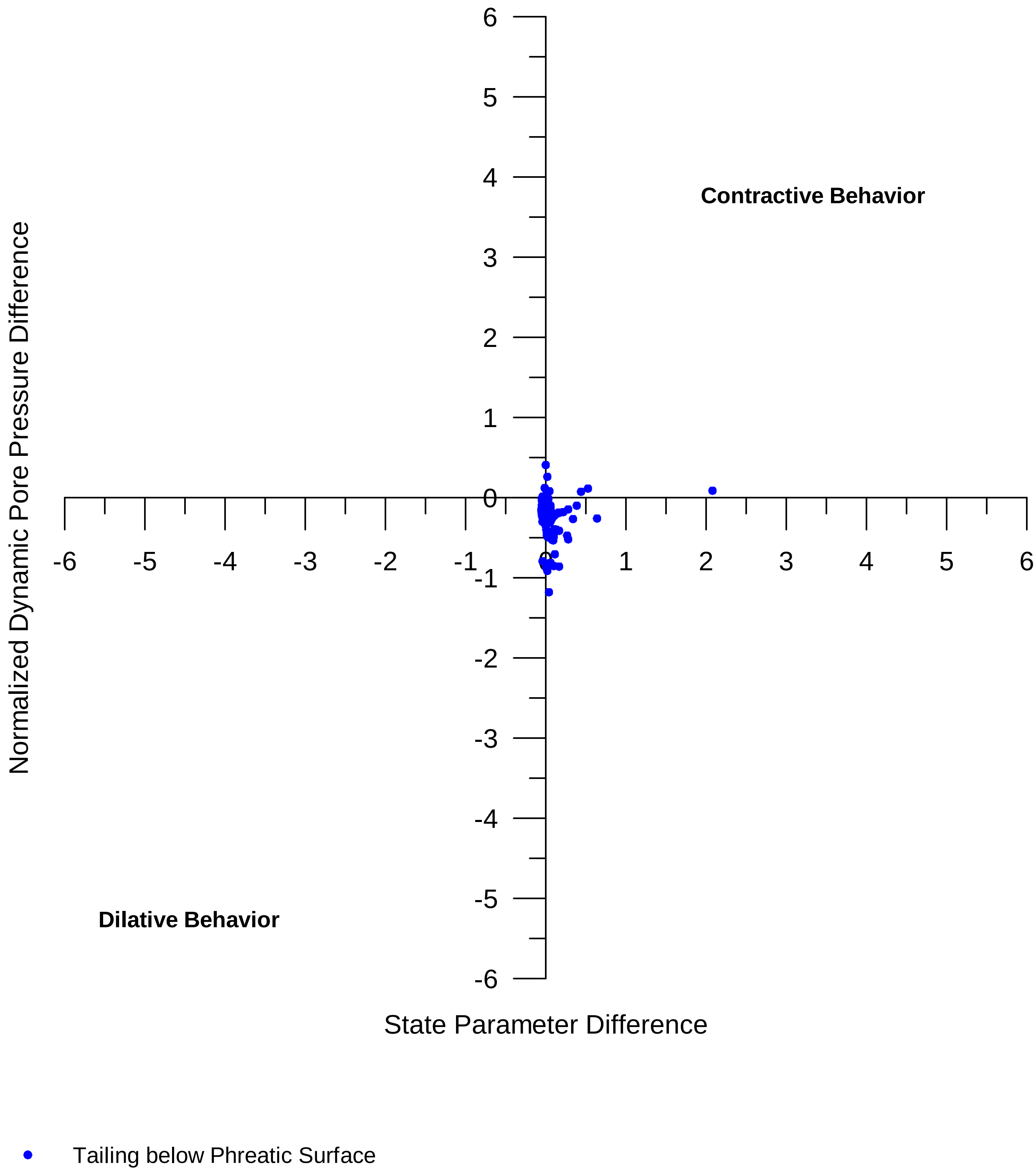

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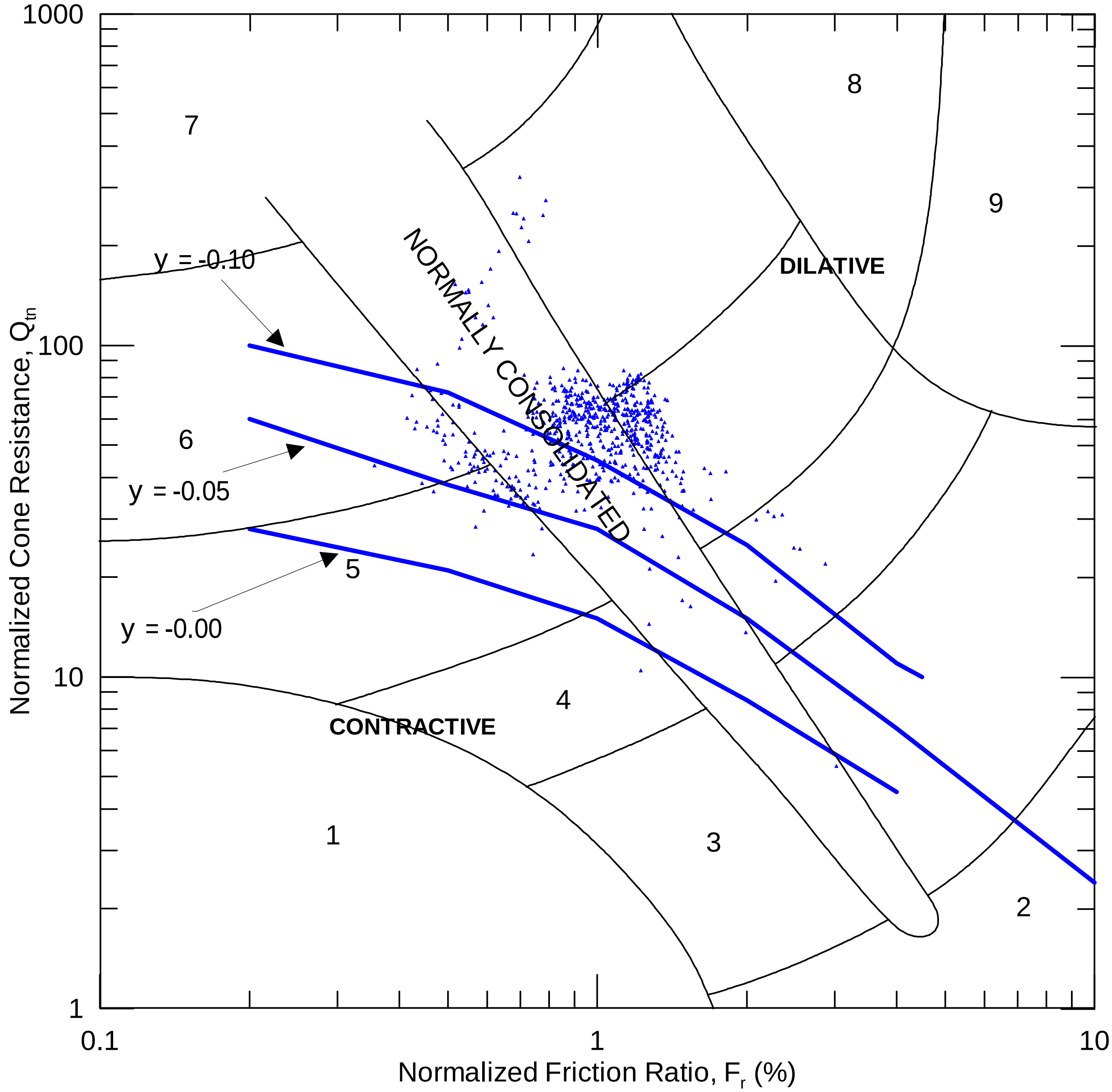
Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-5 Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference 5 Dam**	FIGURE 5-24
	URS		



▲ Tailing Data Points

Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

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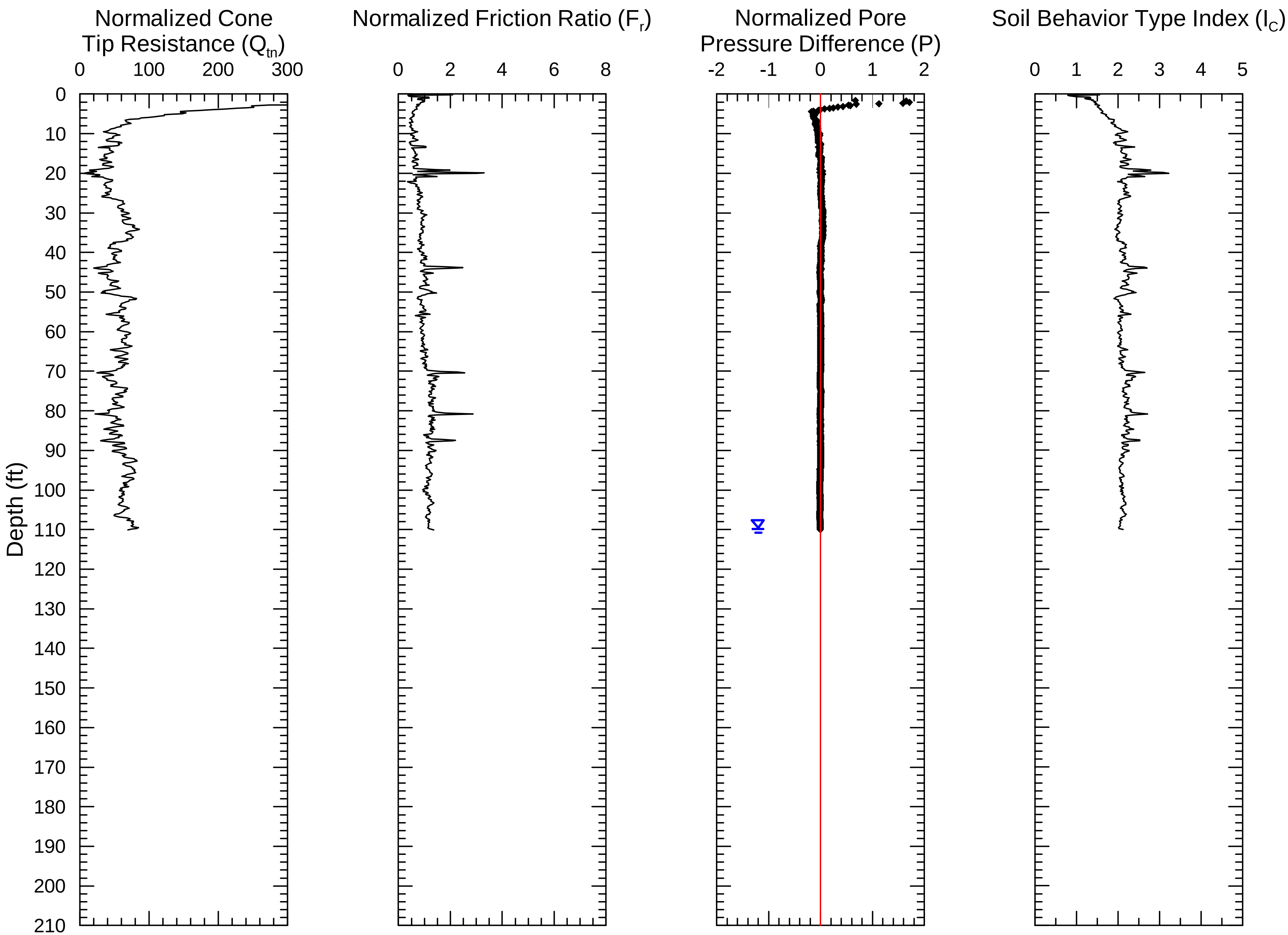
Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-6** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-25
URS			



Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	Interpretive Tailing Cone Sounding CPT-2006-5-6	Figure 5-26
	URS		

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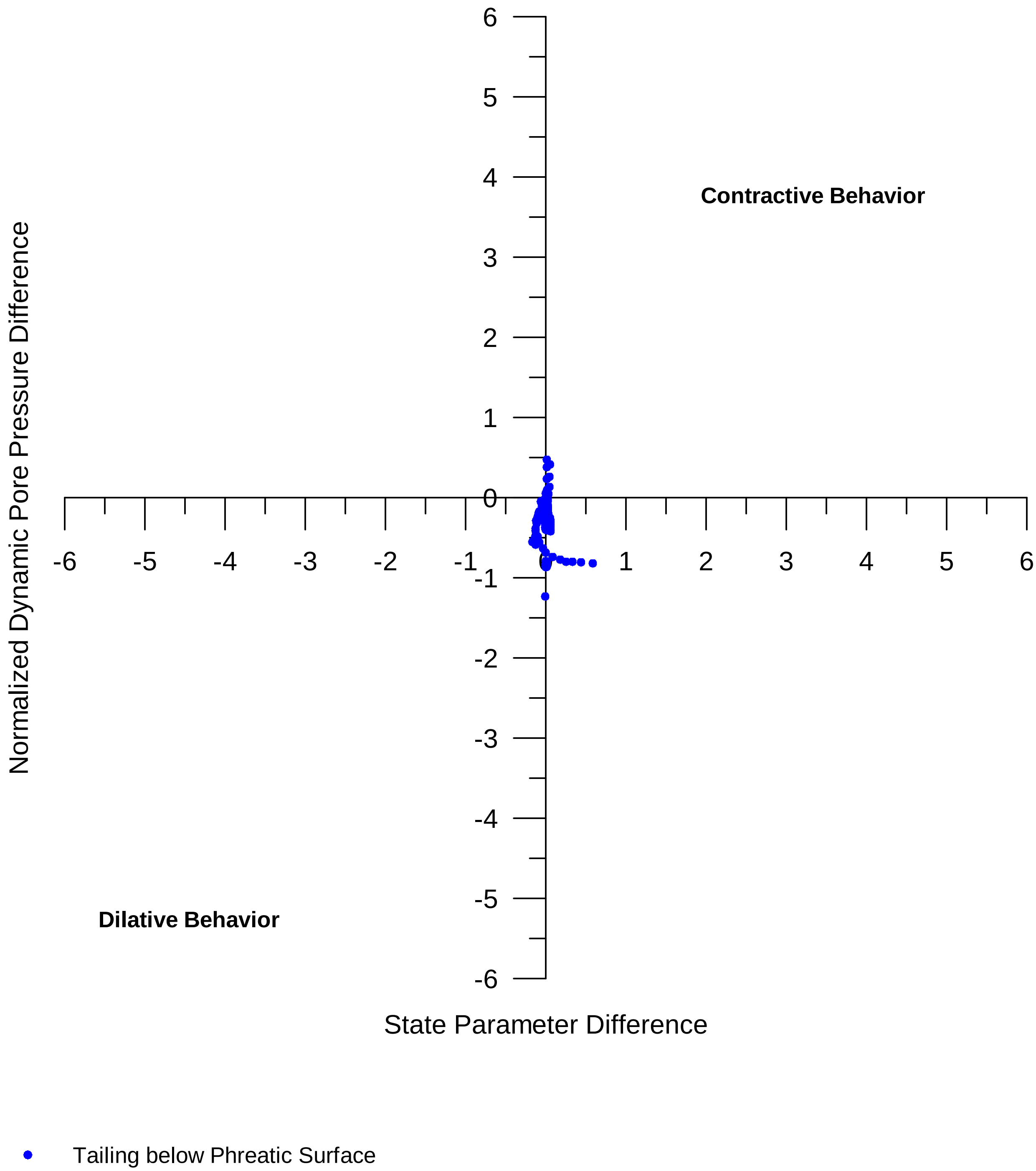
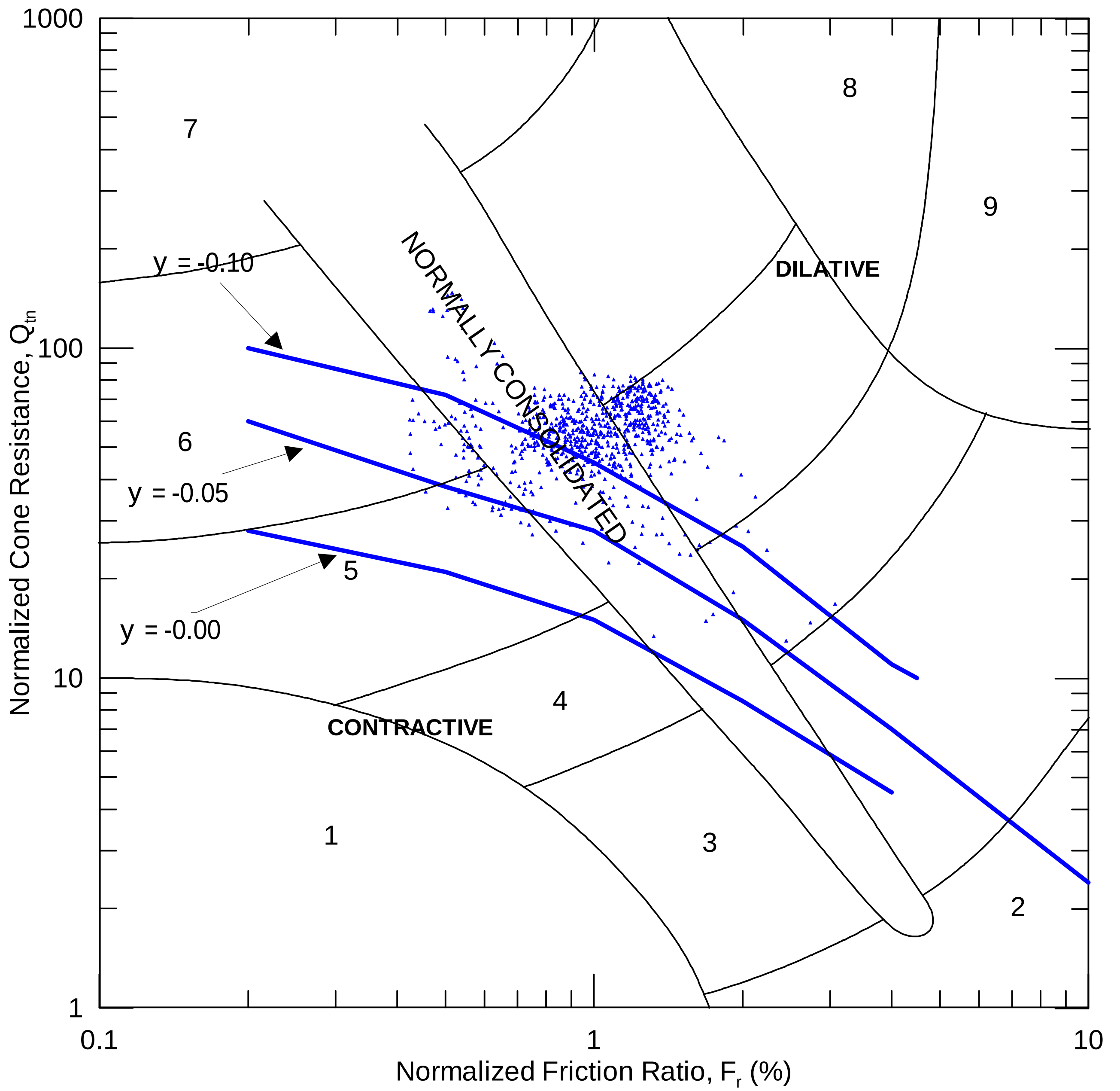


Project No. 22243088	Climax Mine Climax, CO URS	**CPT-2006-5-6** **Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference** **5 Dam**	FIGURE 5-27



Zone	Soil Behavior Type	Ic
1	*Sensitive, fine grained*	N/A
2	*Organic soils-peats*	>3.6
3	*Clays-silty clay to clay*	2.95-3.6
4	*Silt mixtures-clayey silt to silty clay*	2.6-2.95
5	*Sand mixtures-silty sand to sandy silt*	2.05-2.6
6	*Sands-clean sand to silty sand*	1.31-2.05
7	*Gravelly sand to dense sand*	<1.31
8	*Very stiff sand to clayey sand**	N/A
9	*Very stiff, fine grained**	N/A

**Heavily overconsolidated or cemented*

Project No. 22243088	Climax Mine Climax, CO	**CPT-2006-5-7** **Normalized Friction Ration vs. Normalized Cone Resistance** **5 Dam**	FIGURE 5-28
	URS		

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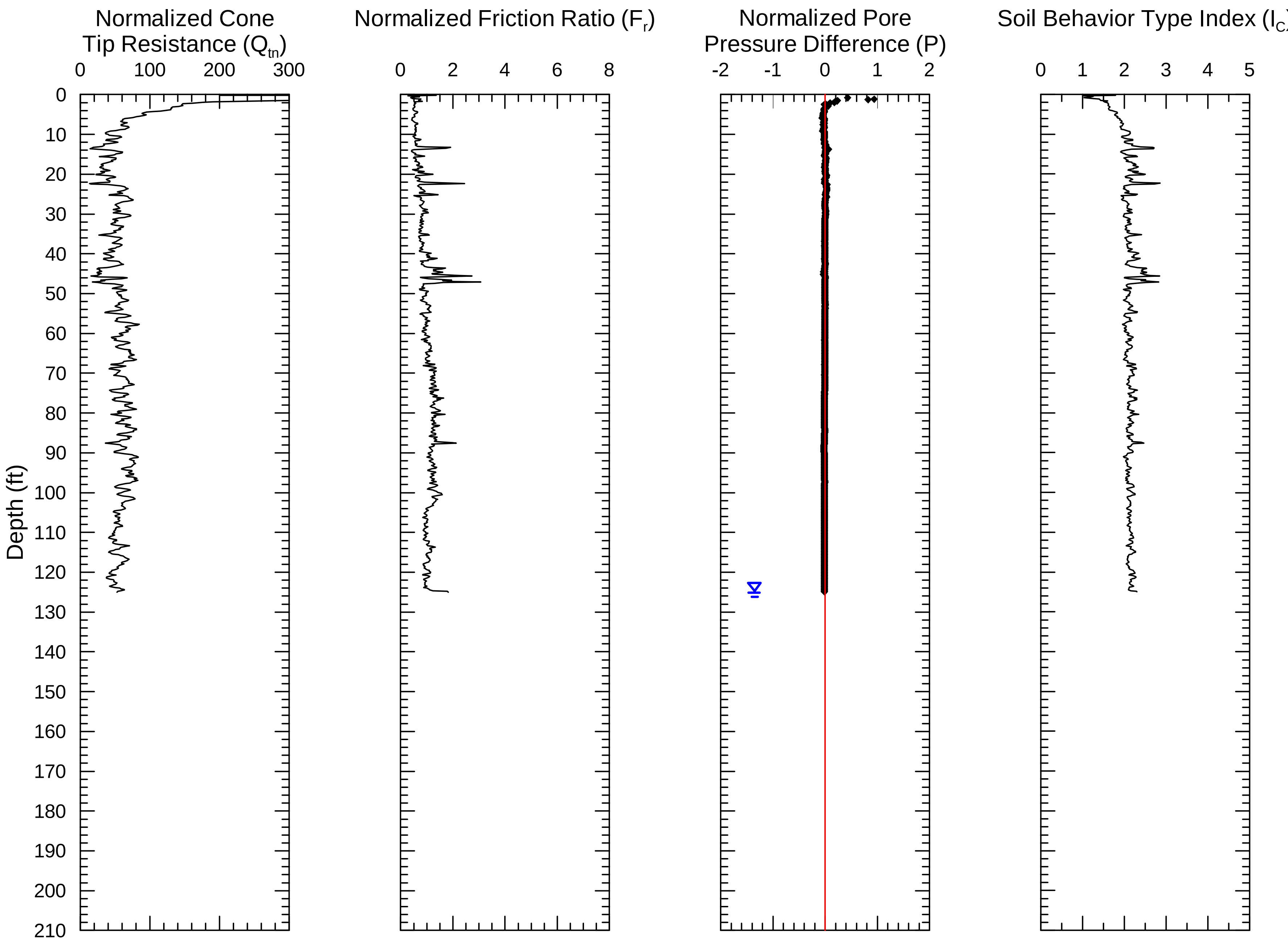

Assumed phreatic surface for data normalization

Project No. 22243088	Climax Mine Climax, CO	Interpretive Tailing Cone Sounding CPT-2006-5-7	Figure 5-29
	URS		

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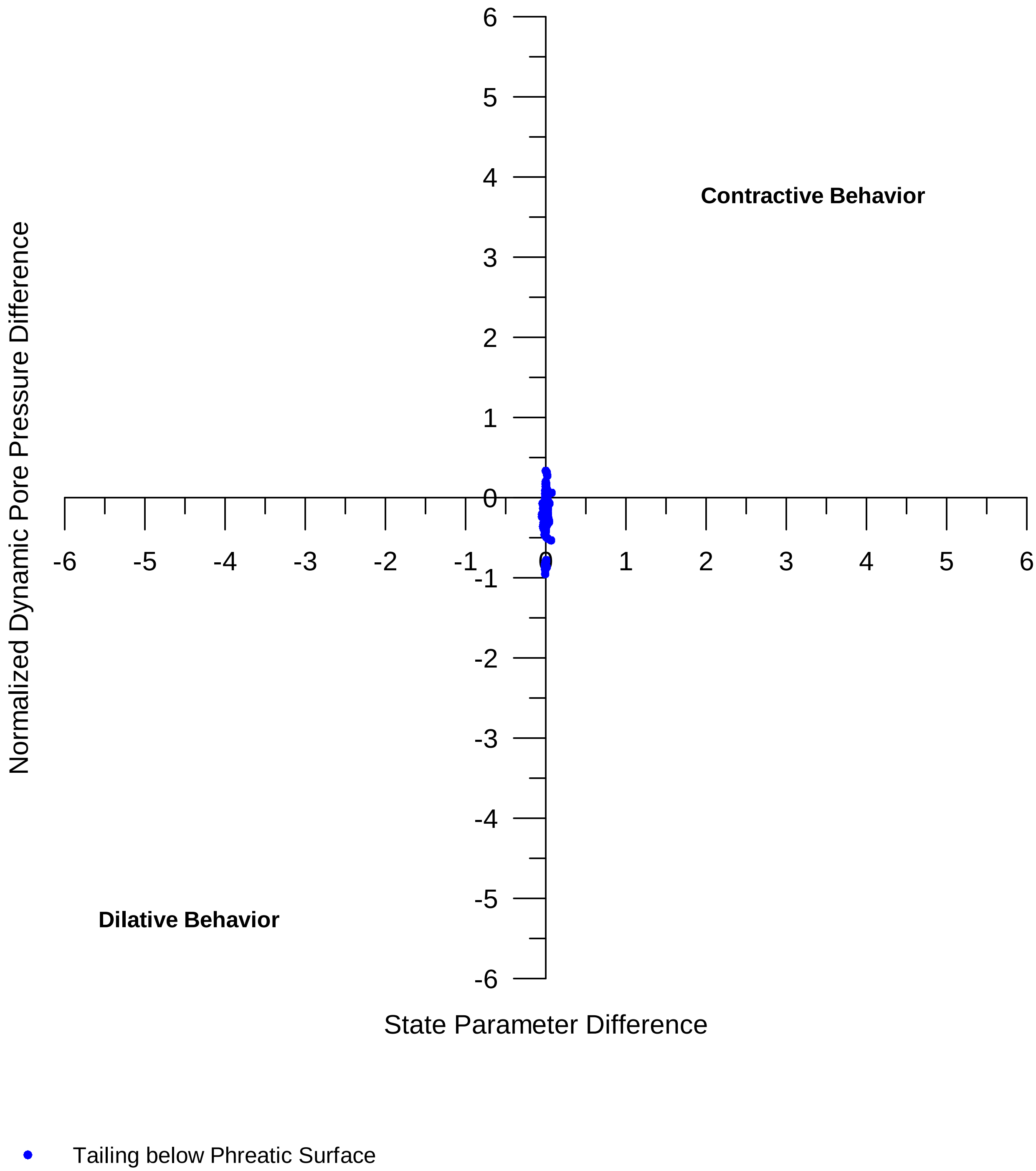

Project No. 22243088	Climax Mine Climax, CO	CPT-2006-5-7 Normalized Dynamic Pore Pressure Difference vs. State Parameter Difference 5 Dam	FIGURE 5-30

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A two-dimensional seepage analysis was performed to model the impacts of tailing deposition on the pore pressure conditions in the existing 5 Dam. The seepage model was developed and calibrated to existing conditions at the maximum section, as shown on Figure 3-1. Details of the seepage modeling, including analysis approach and methodology, model development, input parameters, boundary conditions, and results are discussed in the following subsections.

6.1 APPROACH AND METHODOLOGY

The SEEP/W program (Version 8.0.10.6504, Geo-Slope, Inc.) was used for the analyses (GEO-SLOPE 2012). SEEP/W is a finite element software package that can be used to simulate the flow and pore water distribution within porous media. The program simulates both saturated and unsaturated flow of water, under steady-state or transient conditions, and is therefore ideally suited to analyzing flow of water through the embankment and foundation soils.

Steady-state refers to the condition of a flow system where influx (i.e., water moving into the system) is equal to discharge and there is no change in water stored in the system over time.

Transient seepage refers to a model where a change in boundary conditions is applied to an initial starting condition over a specified period of time. The influx into the system does not equal the discharge of the system in a transient analysis. The resulting recharge, in influx over time, can be evaluated relative to the initial condition.

Three cases were evaluated for the maximum section:

- **Case 1** – <u>*Calibration of Existing Conditions*</u> **–** Calibrate the material properties under steady-state conditions to estimate a phreatic condition representative of the current crest elevation of 10,612 feet (deposition berm at 10,632 feet), phreatic and seepage conditions. The seepage model was then calibrated based on observed phreatic levels, decant pond levels and measured seepage outflows.
- **Case 2** – <u>*Steady-State Model*</u> – Develop a steady-state model to represent the long-term conditions at the future design crest elevation of 10,820 feet. The analysis was performed for a decant pond located 800 feet upstream of the raised crest, which corresponds to the recommended minimum beach width under normal conditions.
- **Case 3** – <u>*Transient Model*</u> – Develop a transient model to represent temporary active future deposition from the crest of the embankment at the future design crest elevation of 10,820 feet. The transient analysis was performed for 35 days, which corresponds to the anticipated maximum deposition time in any one area based on our understanding of potential tailing operations. The Case 2 calculated phreatic condition was used as an initial condition to evaluate changes or re-charge of the phreatic condition due to deposition upstream of the crest.

A flux section was incorporated in the analyses for each analyzed case to calculate the unit discharge. Each case and applied boundary conditions are described in more detail below.

6.2 MODEL DEVELOPMENT

A two-dimensional seepage model was created for the maximum dam section as shown on Figure 3-1. The geometries, material properties, and analysis scenarios are discussed in more detail below.

Cross-Section Geometry

The existing external geometry was developed based on topography from the 2012 deposition berm as-built survey data combined with the 2006 aerial survey.

The existing dam crest is at approximate elevation 10,612 feet. A deposition, or raise, berm was constructed in 2012. The new raise berm was moved upstream (stepped back) from the dam crest about 25 feet and the new berm has a maximum elevation of 10,632 feet. Tailing will be deposited upstream of the berm and the dam will be raised upstream to a future LOM design elevation of 10,820 feet (approximate). The dam will be raised with an overall 4 horizontal:1 vertical (4H:1V) slope. The decant pond will be operated at least 800 feet upstream of the raised crest, which is considered the minimum recommended beach width under normal conditions.

The interface between whole tailing sands, fine tailing (slimes), and cyclone sands was based on review of historic reports and data as well as current CPT sounding and test hole data from the 2012 field investigation. The highest elevation of cyclone sand, as reported by Woodward-Clyde Consultants (WCC 1982), was 10,528 feet with a 5% slope towards the back of the impoundment. Historic reports indicate the minimum active beach width was 1,200 feet. The interface of sands and slimes was conservatively set at 1,000 from the dam face at a slope of 4H:1V.

The starter dam elevation is 10,475 feet with a 1.2H:1V upstream slope and 1.7H:1V downstream slope (WCC 1978). The foundation and bedrock contact was modeled based on pre-dam topographic maps provided in a 1978 report by Woodward-Clyde Consultants summarizing the investigations for the placement and design of 5 Dam (WCC 1978).

The sludge layer (see Subsection 1.2 and Appendix C) was not included in our analyses.

The cross-section geometries for existing and estimated future conditions are presented on Figure 6-1.

Material Properties

Material properties used for the seepage analyses include saturated hydraulic permeabilities, horizontal to vertical permeability ratios, hydraulic conductivity and volumetric water content functions. Material properties were developed using current and historic laboratory data, field testing data, historical performance, published values, and engineering judgment. We also reviewed the material properties used in the 2003 URS seepage analyses when selecting properties for the current analysis.

The sludge layer placed in the current decant pond (discussed previously in Section 1.2, Section 5.1.4 and Appendix C) was not included as a separate layer in the seepage analyses but instead was included in the model with the fine tailing (slime) material. Based on the information available it is likely this material has a similar permeability.

Gradations performed on the current and historic tailing samples at 5 Dam were evaluated using the Kozney-Carmen correlation (Carrier 2003) relating gradation to vertical hydraulic conductivity (k_v) to assist in establishing the range of permeabilities for the tested tailing materials. The results showed vertical hydraulic conductivities for the cycloned tailing sand range from approximately 2.0 x 10^{-4} to 1.0 x 10^{-5} feet per second (ft/s) while whole tailing sand conductivities ranged from approximately 3.0 x 10^{-7} to 1.0 x 10^{-4} ft/s.

The tailing sand hydraulic conductivities and other input parameter properties were further calibrated for the current seepage analyses based on review of slope geometry, and recent piezometer and seepage outflow data. The calibrated material properties for the current seepage analysis are presented in Table 6-1. These properties are similar to those developed for previous studies at the site, and properties we have developed for similar sites, and are reasonable compared to laboratory and calculated ranges.

Table 6-1
SUMMARY OF MATERIAL PROPERTIES USED IN SEEPAGE ANALYSES

Material	Horizontal Hydraulic Conductivity k_h (cm/s)	Horizontal Hydraulic Conductivity k_h (ft/s)	Anisotropy Ratio k_h/k_v
Cycloned Tailing Sand	1.1×10^{-2}	3.7×10^{-4}	2
Whole Tailing Sand	2.8×10^{-3}	9.3×10^{-5}	1
Fine Tailing (Slimes)	1.7×10^{-3}	5.6×10^{-5}	10
Deposition Berm	5.7×10^{-2}	1.9×10^{-3}	2
Starter Dam	2.3×10^{-2}	7.4×10^{-4}	1
Drain	1.1×10^{-1}	3.7×10^{-3}	10
Glacial Foundation Material	5.7×10^{-3}	1.9×10^{-4}	10
Bedrock	4.5×10^{-4}	1.5×10^{-5}	1

CPT sounding data and historic and current piezometric data was reviewed to assess the subsurface conditions in relation to the phreatic surface and associated contours. The analyses were calibrated to observed phreatic levels (Case 1) located at the maximum section. Piezometers P-4, P1-N and test hole TH 2006-5-1, as shown on Figure 3-1, were used to calibrate the current analysis due to their proximity to the maximum dam section. The saturated permeabilities and anisotropic permeability ratios were adjusted from the previous URS model until the predicted conditions were similar to observed phreatic conditions.

The total discharge from the calibrated model was estimated at about 1,200 gpm, which matches the observed seepage outflow provided by W.W. Wheeler and Associates, Inc.

Analysis Scenarios

A description of the approach used for each analyzed case is provided below. The boundary conditions for each case are presented on Figure 6-1.

Case 1: Calibration of Existing Conditions

The objective of Case 1 was to calibrate the seepage model under steady-state conditions to the most recent piezometer readings (as of April 2013) at the maximum section and observed seepage rates at the toe of the embankment Boundary conditions applied to this model include total head nodes assigned 1,200 feet upstream of the existing slope crest. The total head nodes correspond to the maximum sustained elevation of the pond at 10,598 feet as estimated from the topographic map and knowledge of the current pond location. Review nodes were modeled along the existing downstream slope and downstream of the toe while no flow nodes were located below the bedrock.

Case 2: Future Design Crest Elevation with Decant Pond Under Long Term Conditions

The calibrated material properties from Case 1 were used for the Case 2 calculations. Total head nodes were conservatively applied 800 feet upstream of the crest of the proposed embankment raise to model the decant pond. This pond distance represents the minimum recommended beach width under normal conditions. The deposited tailing surface was modeled as decreasing at a slope of approximately 0.5 percent towards the interior, which results in an assumed elevation of the decant pond at 10,816 feet corresponding to 4 feet of freeboard. Total head nodes of 10,816 feet were applied to model the decant pond. Review nodes were modeled along the existing downstream slope from mid-height to the toe. No flow nodes were located below the bedrock.

Case 3: Active Deposition Under Transient Seepage Conditions

The calibrated material properties from Case 1 were used for the Case 3 calculations. A flux was applied in the area between the crest and the edge of the decant pond from Case 2 to model active deposition for 35 days during spigotting from the future design crest. The steady-state phreatic condition from the Case 2 analysis was used as the "initial condition" for the transient Case 3 calculations. A unit flux was applied to model active deposition at a rate of 28,000 tpd with 35% solids. The unit flux was applied 30 feet upstream of the embankment crest to be consistent with depositional practices. Review nodes were modeled along the existing downstream slope from mid-height to the toe. No flow nodes were located below the bedrock. Our analysis conservatively assumes all water discharged from the spigots infiltrates into the impoundment. In reality, some water will report to the decant pond and some will be lost to evaporation.

6.3 RESULTS

The results of the seepage model were used as input into development of the phreatic surface used for the stability analysis. Results for each case are discussed below, and are presented on Figure 6-1.

Case 1: Calibration of Existing Conditions

A sustained decant pond elevation of 10,598, approximately 1,200 feet upstream of the dam crest, was modeled for existing conditions for steady-state seepage conditions. The resulting phreatic surface from the model closely aligns with the observed current phreatic conditions. The calibrated phreatic surface was about 1 foot below the latest reading for piezometer TH2006-5-1, 8 feet above the highest reading for piezometer P-4. The seepage outflow calculated in the model matches the current observed outflow at the site of around 1,200 gpm. Modeled differences are within tolerable calibration limits.

Case 2: Future Design Crest with Decant Pond Under Long Term Conditions

A sustained decant pond elevation of 10,816 feet, approximately 800 feet upstream of the future dam crest, was modeled for steady-state conditions to evaluate long-term steady-state seepage conditions. The raise in the crest elevation to 10,820 feet and decreased beach width (by 400 feet) resulted in an outflow difference from the existing model (Case 1) that was about six times greater at approximately 7,200 gpm. This result is attributed to an increase in total head as well as the pond location being above the more permeable whole tailing sand. The resulting phreatic surface increased by 43 feet at TH 2006-5-1 and 27 feet at P-4 as compared to Case 1.

Case 3: Active Deposition Under Transient Seepage Conditions

The transient seepage analysis for the future design elevation showed an increase in the phreatic surface for the upper portion of the dam but generally matched the phreatic surface in the lower portion of Case 2. The effect of deposition on the phreatic surface at TH 2006-5-1 and P-4 was approximately 2 feet. Seepage outflow showed a slight increase from Case 2 to 7,350 gpm (150 gpm). The stability models developed for future conditions used the resulting phreatic surface from this case to reflect active deposition.

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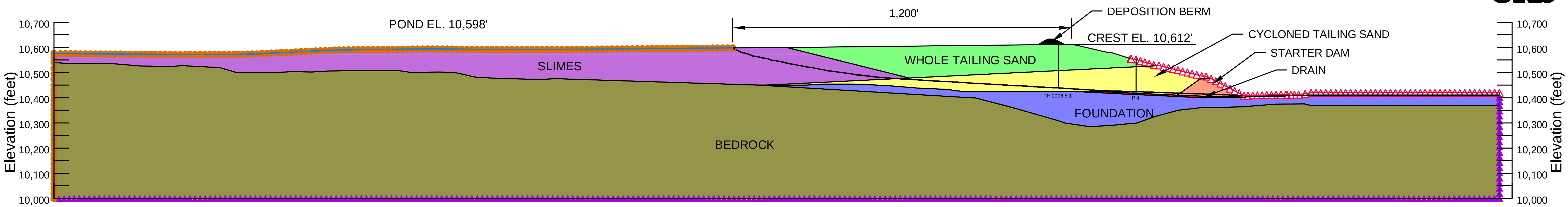
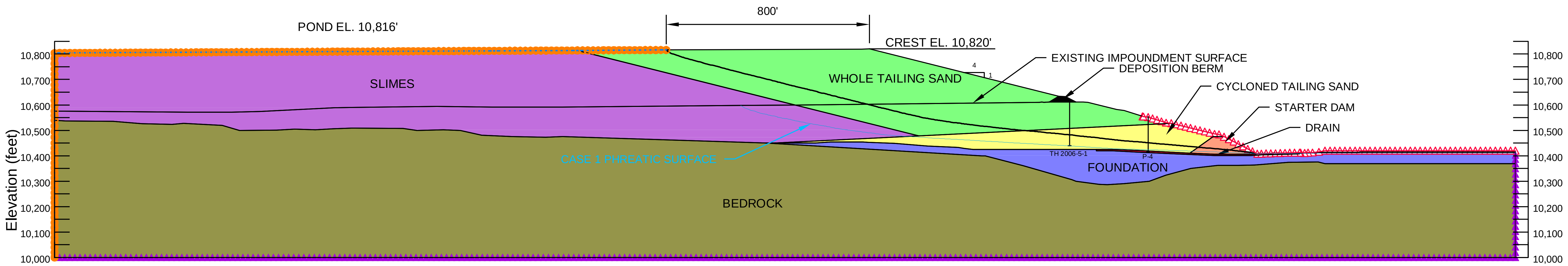
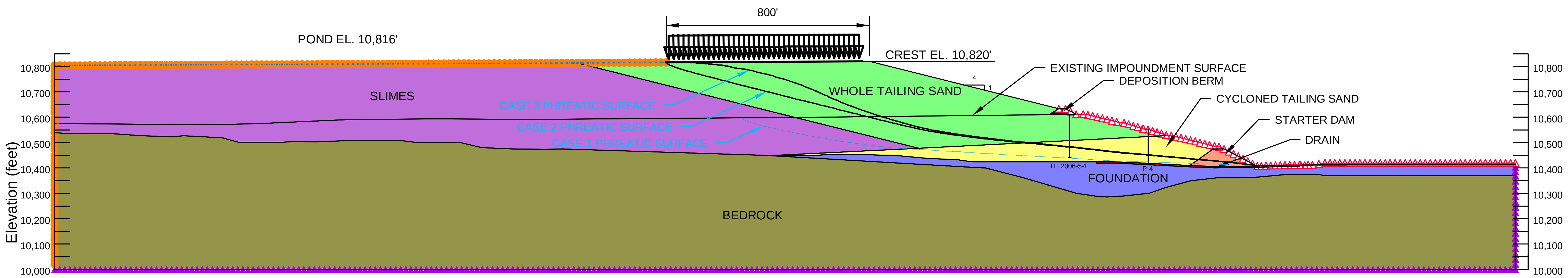


CASE 1 - CALIBRATION OF EXISTING CONDITIONS (ELEVATION 10,612')



CASE 2 - FUTURE 10,820' DESIGN CREST ELEVATION CONDITIONS



CASE 3 - FUTURE 10,820' DESIGN CREST ELEVATION
WITH ACTIVE DEPOSITION UNDER TRANSIENT SEEPAGE CONDITIONS

LEGEND

- DEPOSITION UNIT FLUX = 1.25×10^{-5} ft/s
- NO FLOW
- EXISTING CONDITIONS TOTAL HEAD EL. 10,598'
- FUTURE 10,820' DESIGN CREST ELEVATION TOTAL HEAD EL. 10,816'
- POTENTIAL SEEPAGE REVIEW (REVIEW NODES)
- PHREATIC SURFACE (CALCULATED)
- EXISTING PHREATIC SURFACE LEVEL FOR PIEZOMETER P-4

NOTE: SLUDGE NOT DIFFERENTIATED FROM SLIMES IN THESE ANALYSES.

0 200 400 800
SCALE IN FEET

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Prepared By : JSE	
Date : SEPTEMBER 2013	

FIG. 6-1

Liquefaction triggering and slope stability analyses were completed to evaluate the current and future estimated conditions at 5 Dam while in active operation. The design criteria for the analyses, and approach to the analyses and results are described in further detail below.

7.1 DESIGN CRITERIA

Climax requested DRMS review the proposed seismic design criteria of both 3 Dam and 5 Dam in 2008. The design criteria proposed consists of the OBE for the operating period of the facility. These design criteria were accepted by DRMS in a letter to Climax dated February 14, 2008.The OBE was calculated using probabilistic methods considering a 7.0 magnitude earthquake with a 475-year return period. The calculated associated peak ground motions are 0.06g.

URS has recommended Climax maintain the decant pond at least 800 feet from the dam crest to facilitate development of a relatively free-draining shell of coarse sand. Seepage analyses performed for the LOM dam crest (elevation 10,820) located the beach 800 feet from the crest. The current slope stability analyses are also based on this recommendation. Our experience with similar TSFs indicates the decant pond will likely be located even farther upstream, so our analyses are likely conservative.

DRMS does not have specific requirements for FS values calculated as part of slope stability analyses. Recommended minimum FS values for the analyses, in accordance with generally accepted engineering practice, are:

- Slope Stability, Steady-State Conditions: 1.5
- Slope Stability, Undrained Conditions: 1.2
- Slope Stability, Post-Earthquake Conditions: 1.0

7.2 LIQUEFACTION TRIGGERING

Liquefaction triggering analysis is used to evaluate if the tailing would liquefy should an OBE event occur. The generation of excess pore pressures and resulting reduction in shear strength (liquefaction) is caused by soil contraction during strong shaking (earthquake loading) and is a function of saturation, tailing density, and permeability. Fine soils, such as tailing, are sensitive because they are hydraulically deposited, are generally slow to dissipate excess pore pressure and typically contract upon shearing.

7.2.1 Methodology

Liquefaction potential was evaluated using semi-empirical methods described by Idriss and Boulanger (2008). SPT- and CPT-based triggering assessments, utilizing SPT and collocated CPT data from the current field investigation, were used to evaluate the potential for liquefaction while conservatively assuming all subsurface soils were “sand-like” soils. The assessments evaluate the cyclic resistance ratio (CRR) of soils to the CSR to calculate the FS values against liquefaction triggering.

The CSR was computed using the simplified liquefaction evaluation that compares earthquake-induced shear stresses to vertical effective confining stresses. This approach to estimate CSR values has been the industry standard and is a result of research by Seed and Idriss (1971).

The empirical procedure by Idriss and Boulanger (2008) using corrected blow counts was used to evaluate the "sand-like" tailing. SPT values were corrected for overburden effects and fines content of 17.5 percent unless specific laboratory data was available. Liquefaction triggering FS values are typically not calculated above the phreatic surface; however, the phreatic surface was conservatively set at ground level with 100 percent hydrostatic conditions for the assessments.

7.2.2 Results

The results of the liquefaction analysis are presented on Figure 7-1. The figure presents the CRR and CSR values and the calculated FS values against liquefaction with depth for each current test hole and CPT sounding. The FS values were calculated for each SPT and CPT data point; this is conservative because a phreatic surface and resultant near-saturation of the soil is required for liquefaction to occur.

Results from the liquefaction triggering analyses show calculated FS values greater than1.0 for both approaches (generally above 2.0 and increasing with depth) for all test holes and CPTs from the 2012 investigation, which indicates low potential for liquefaction triggering for the OBE event.

The available data indicate the coarse tailing is generally dilative during shearing. Results of the cyclic triaxial tests show the whole and cycloned tailing did not lose strength after being cycled for motions much higher than the OBE event (see discussion in Subsection 5.1.2). The performance and state of the existing tailing, along with the relatively high factors of safety against liquefaction triggering, and the relatively low stresses due to the OBE event indicate that wide-spread strength reduction due to liquefaction of the tailing is unlikely to occur for the OBE event.

7.3 SLOPE STABILITY ANALYSES

Slope stability analyses were performed for the existing conditions and the current LOM design elevation, corresponding to crest elevations of 10,612 and 10,820 feet, respectively. The stability of each configuration was evaluated for one study section representing the maximum cross section. Discussions of our approach to the analyses, loading conditions, model development, material properties, and results are presented below.

7.3.1 Approach and Methodology

The analyses were performed using UTEXAS4 (Wright, 2008). The program was used to calculate the FS against instability along circular and non-circular shear surfaces. The program assumes that a distinct failure surface occurs in the soil mass. The stability of the slope is calculated in terms of FS. The FS is defined as the ratio of the average available shear strength and average mobilized shear stress along a given failure surface. Spencer's method of slices was used for the analyses. Spencer's method satisfies conditions of static equilibrium, including horizontal and vertical force imbalance and moment imbalance. Non-circular and circular shear surfaces were identified for each case using the iterative search routines in the program to identify the minimum FS under each loading condition.

7.3.2 Loading Conditions

Our evaluation focused on the operating conditions for 5 Dam. The pertinent loading conditions considered in our analysis are described below.

Steady-State (Static Drained)

The steady-state seepage drained loading condition represents the long-term stability of the dam. Stability analyses were performed using drained shear strengths for the tailing sands, slimes, and cycloned sand. The minimum required FS is 1.5 for the steady-state condition.

Undrained

The undrained loading condition represents the stability of the dam when significant excess pore pressures within saturated materials exist. Undrained conditions can be created during tailing deposition by poor drainage, high raise rates, or during rapid loading, unloading or any other triggering mechanism that could cause a relatively sudden change in stress conditions.

While drained strengths apply to the unsaturated materials, the undrained loading condition assumes no drainage in the saturated materials; in reality, some drainage occurs depending on the rate of loading and the permeability of the materials. Therefore, the actual loading condition is somewhere between the drained and undrained condition, making the analysis conservative. The minimum required FS is typically 1.2 for the undrained condition.

Post-Earthquake (Operation Basis Earthquake Event)

The OBE event has low ground motions that are not anticipated to liquefy nor cause the coarse tailing to undergo significant shear strength loss during shaking (as evident by the cyclic triaxial test results) as discussed in Section 5. However, the OBE event may induce excess pore pressures, essentially creating an undrained loading condition in the saturated materials; therefore the post-earthquake loading condition was analyzed as identical to the undrained loading condition. The minimum required FS for the post-earthquake condition is 1.0.

7.3.3 Model Development

Slope stability analyses were performed for the existing dam conditions and the future design elevation at the study section located at the generalized maximum section of 5 Dam, as shown on Figure 3-1. The pore pressure conditions and material properties used in our stability models and analyses are described below.

Cross-Section Geometry

The cross-section geometry used in the stability analyses was the same as that used in the seepage analyses. A discussion of the geometry is included in Subsection 6.2.

Pore Pressure Conditions

The phreatic surface used for existing conditions was based on measured observed piezometer readings with an estimated increase due to deposition activities.

The phreatic surface estimated for the future design elevation section was based on the seepage analysis that assumes the decant pond is maintained 800 feet from the dam crest with deposition occurring continuously for 35 days (Case 3, as discussed in Section 6).

Our stability analyses assumed 100% hydrostatic pore pressures below the phreatic surface.

Material Properties

The material properties used in the stability analyses were developed as part of the material characterizations discussed in Section 5.0.

Table 7-2
SUMMARY OF MATERIAL PROPERTIES USED IN STABILITY ANALYSES

Material	Unit Weight (pcf)	Steady-State Drained Shear Strength		Undrained/Post-Earthquake Shear Strength	
		c' (psf)	ϕ' (degrees)	c' (psf)	ϕ' (degrees)
Existing Cycloned Sands	115	0	35	S_u/p' = 0.42 (TXC) S_u/p' = 0.33 (DSS)	
Existing Whole Tailing Sand	115	0	35	S_u/p' = 0.42 (TXC) S_u/p' = 0.33 (DSS)	
Existing Slimes	110	500	25	S_u/p' = 0.40 (TXC) S_u/p' = 0.30 (DSS)	
Future Whole Tailing Sand	115	0	35	S_u/p' = 0.42 (TXC) S_u/p' = 0.33 (DSS)	
Future Slimes	110	500	25	S_u/p' = 0.40 (TXC) S_u/p' = 0.30 (DSS)	
Starter Dam	145	0	35	0	35
Drain	135	0	35	0	35
Foundation	145	0	35	0	35
Bedrock	150	5,000	50	5,000	50

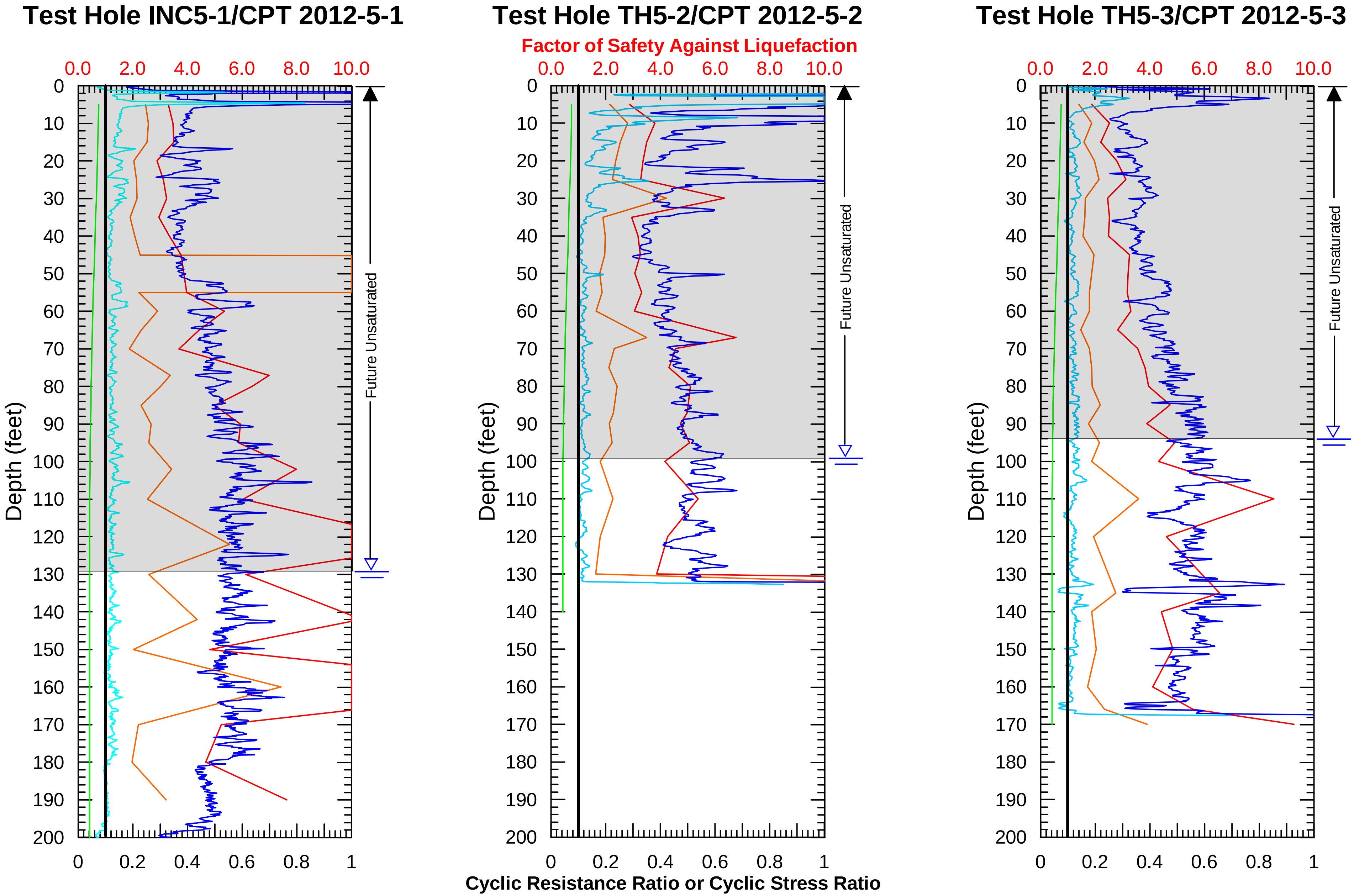
7.4 RESULTS

For each section analyzed, minimum FS values against slope failure were computed for circular and non-circular failure surfaces of different sizes. The failure surfaces evaluated were deep-seated, occurring through the foundation, the drain and the deeper portions of the whole and cycloned tailing. These failures are generally considered catastrophic, undermining the overall dam stability. Some additional, relatively shallow failure surfaces were identified and are generally influenced by the steeper starter dam slope. Potential failures along these shallow shear surfaces generally would not significantly affect the impoundment but are included for completeness.

A summary of the deep-seated stability analyses results for steady-state, undrained and OBE event post-earthquake loading conditions during active operations for existing and future design elevations is presented in Table 7-3. The localized shallow failure surfaces through the starter dam have a minimum FS value of 1.5. The deep-seated and shallow calculated critical shear surfaces are shown on Figures 7-2 through 7-5. The results show that our calculated theoretical FS values meet or exceed required criteria.

Table 7-3
CALCULATED THEORETICAL FACTORS-OF-SAFETY FOR STABILITY ANALYSES

Loading Condition	Design Section	Failure Surface	Calculated Minimum FS (Global Failure)	Minimum Recommended FS
Steady-State (Static Drained)	Existing Conditions (Elevation 10,612)	Circular	2.6	1.5
		Noncircular	3.0	
	Future Design Elevation (Elevation 10,820)	Circular	2.7	
		Noncircular	2.7	
Undrained/ Post-Earthquake (OBE Event)	Existing Conditions (Elevation 10,612)	Circular	2.5	1.2/1.0
		Noncircular	2.4	
	Future Design Elevation (Elevation 10,820)	Circular	2.1	
		Noncircular	2.0	



Cyclic Stress Ratio (Both SPT and CPT)
SPT Cyclic Resistance Ratio
SPT Factor of Safety Against Liquefaction
CPT Cyclic Resistance Ratio
CPT Factor of Safety Against Liquefaction

Note: Future calculated depth to phreatic surface is deeper than established correlations account for.
For analysis purposes, liquefaction calculations were conservatively based on a fully saturated soil column.

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	URS		Prepared by: JSE
			Figure 7-1

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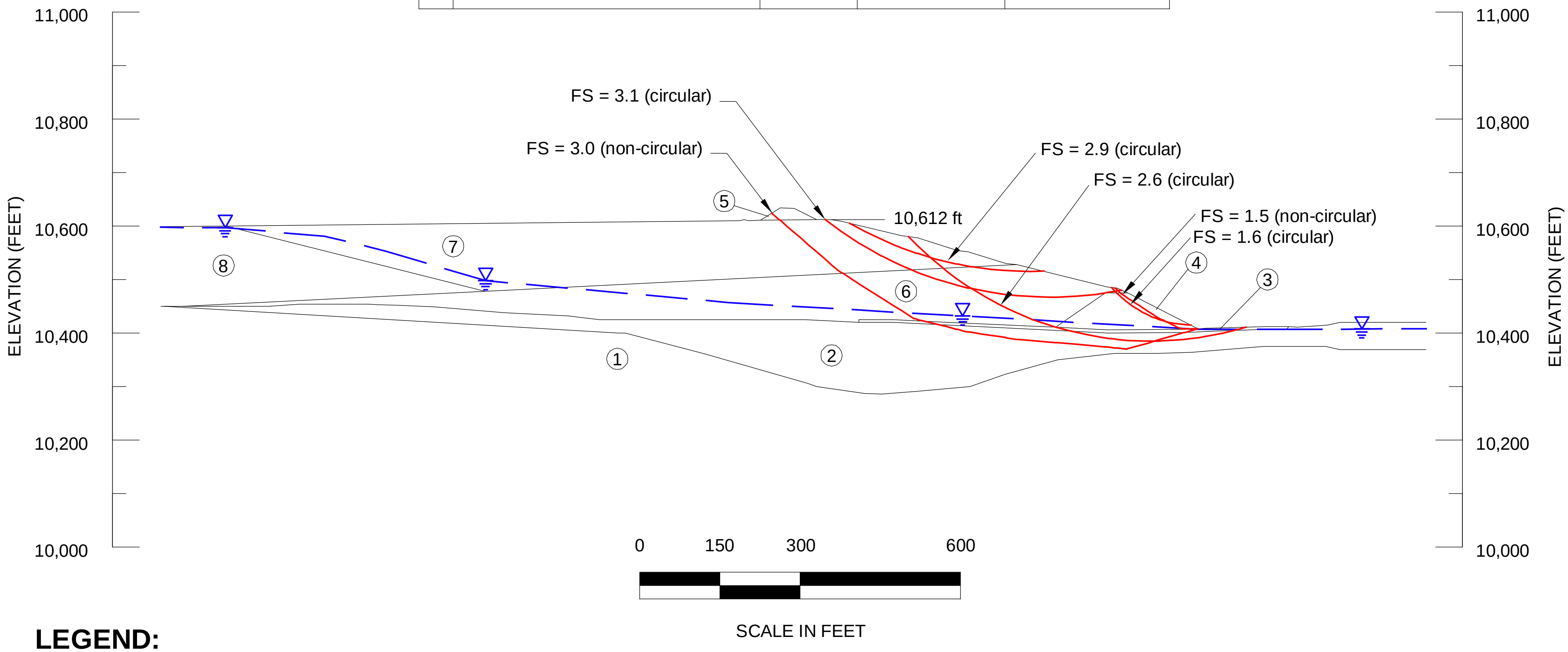
No.	DESCRIPTION	UNIT WEIGHT (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)
1	BEDROCK	150	5,000	50
2	FOUNDATION	145	0	35
3	DRAIN	135	0	35
4	STARTER DAM	145	0	35
5	DEPOSITION BERM	115	0	35
6	CYCLONED SAND	115	0	35
7	WHOLE TAILING SAND	115	0	35
8	SLIMES	110	500	25



LEGEND:

PHREATIC SURFACE
SHEAR SURFACE

NOTES:

1. "FS" DESIGNATES CALCULATED FACTOR OF SAFETY.
2. THE LOCATION OF THE STUDY SECTION IS SHOWN ON FIGURE 3-1.
3. STABILITY ANALYSES WERE PERFORMED USING UTEXAS4 SOFTWARE.
4. PROCESS SLUDGE LAYER HAS BEEN EXCLUDED FROM ANALYSIS.

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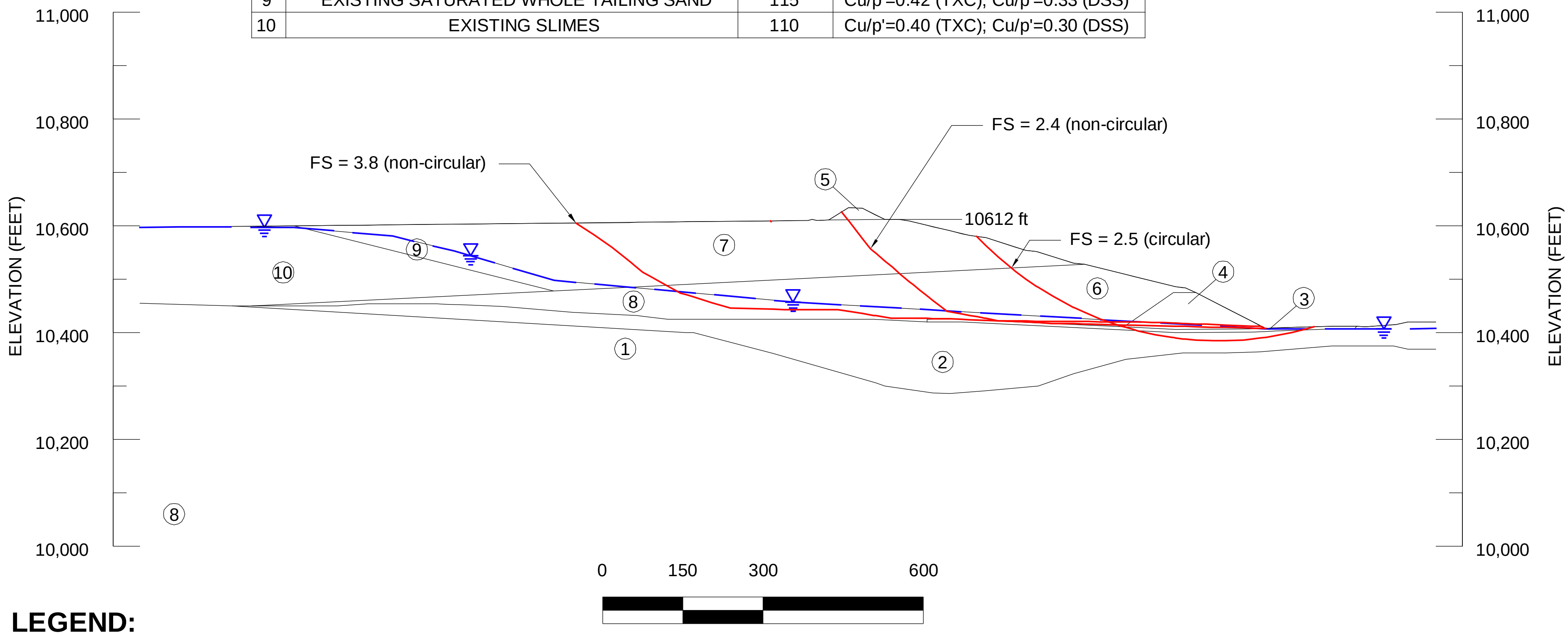
Prepared By :	KMM
Date :	SEPTEMBER 2013

5 DAM STABILITY ANALYSIS
EXISTING CONDITIONS
STEADY-STATE

FIG. 7-2

No.	DESCRIPTION	UNIT WEIGHT (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)
1	BEDROCK	150	5,000	50
2	FOUNDATION	145	0	35
3	DRAIN	135	0	35
4	STARTER DAM	145	0	35
5	DEPOSITION BERM	115	0	35
6	EXISTING UNSATURATED CYCLONED SAND	115	0	35
7	EXISTING UNSATURATED WHOLE TAILING SAND	115	0	35
8	EXISTING SATURATED CYCLONED SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
9	EXISTING SATURATED WHOLE TAILING SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
10	EXISTING SLIMES	110	Cu/p'=0.40 (TXC); Cu/p'=0.30 (DSS)	



LEGEND:

PHREATIC SURFACE
SHEAR SURFACE

NOTES:

1. "FS" DESIGNATES CALCULATED FACTOR OF SAFETY.
2. THE LOCATION OF THE STUDY SECTION IS SHOWN ON FIGURE 3-1.
3. STABILITY ANALYSES WERE PERFORMED USING UTEXAS4 SOFTWARE.
4. PROCESS SLUDGE LAYER HAS BEEN EXCLUDED FROM ANALYSIS.

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Prepared By :	KMM
Date :	SEPTEMBER 2013

5 DAM STABILITY ANALYSIS
EXISTING CONDITIONS
UNDRAINED/POST-EARTHQUAKE
(OBE)

FIG. 7-3

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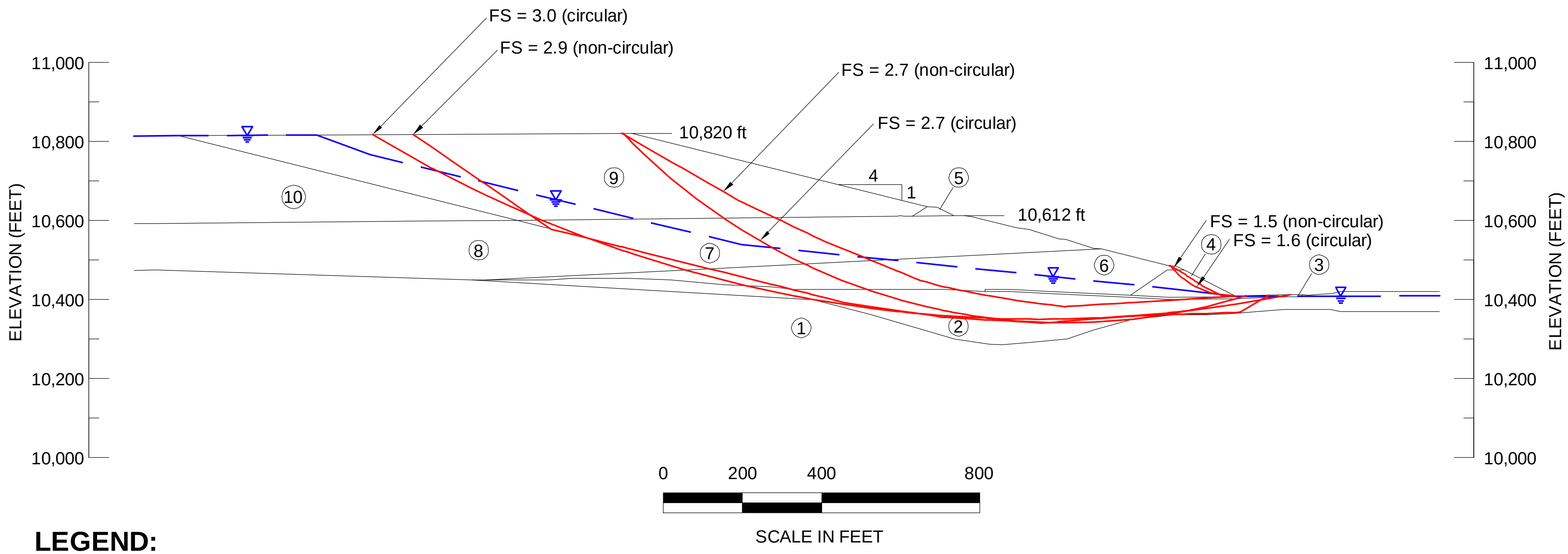
DRAWING PATH: N:\Projects\22243088_Mayflower_Eval_Des\Sub_00110.0_Calculations_Analysis_Data\Stability Analysis\5 - Report Figures\FIG 7-3 EXISTING UNDRAINED.dwg

URS

No.	DESCRIPTION	UNIT WEIGHT (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)
1	BEDROCK	150	5,000	50
2	FOUNDATION	145	0	35
3	DRAIN	135	0	35
4	STARTER DAM	145	0	35
5	DEPOSITION BERM	115	0	35
6	EXISTING CYCLONED SAND	115	0	35
7	EXISTING WHOLE TAILING SAND	115	0	35
8	EXISTING SLIMES	110	500	25
9	FUTURE WHOLE TAILING SAND	115	0	35
10	FUTURE SLIMES	110	500	25



LEGEND:

PHREATIC SURFACE

SHEAR SURFACE

NOTES:

1. "FS" DESIGNATES CALCULATED FACTOR OF SAFETY.
2. THE LOCATION OF THE STUDY SECTION IS SHOWN ON FIGURE 3-1.
3. STABILITY ANALYSES WERE PERFOMED USING UTEXAS4 SOFTWARE.
4. PROCESS SLUDGE LAYER HAS BEEN EXCLUDED FROM ANALYSIS.

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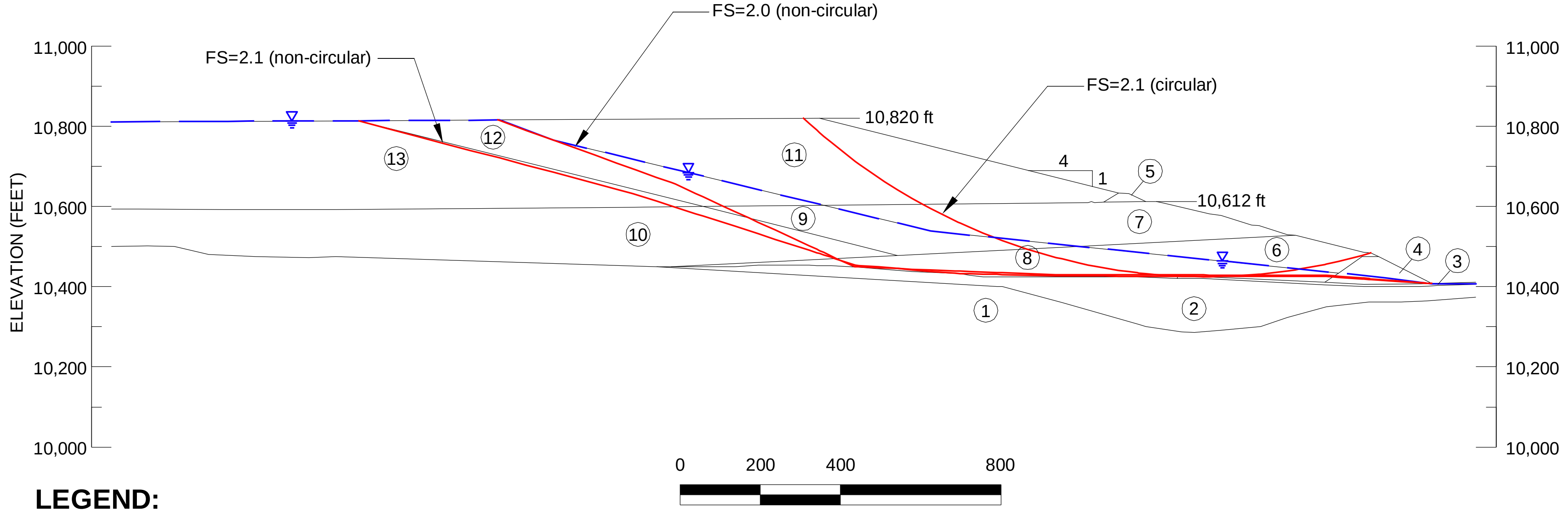
Prepared By : KMM		
Date : SEPTEMBER 2013		

FIG. 7-4

No.	DESCRIPTION	UNIT WEIGHT (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)
1	BEDROCK	150	5,000	50
2	FOUNDATION	145	0	35
3	DRAIN	135	0	35
4	STARTER DAM	145	0	35
5	DEPOSITION BERM	115	0	35
6	EXISTING UNSATURATED CYCLONED SAND	115	0	35
7	EXISTING UNSATURATED WHOLE TAILING SAND	115	0	35
8	EXISTING SATURATED CYCLONED SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
9	EXISTING SATURATED WHOLE TAILING SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
10	EXISTING SLIMES	110	Cu/p'=0.40 (TXC); Cu/p'=0.30 (DSS)	
11	FUTURE UNSATURATED WHOLE TAILING SAND	115	0	35
12	FUTURE SATURATED WHOLE TAILING SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
13	FUTURE SLIMES	110	Cu/p'=0.40 (TXC); Cu/p'=0.30 (DSS)	



LEGEND:

PHREATIC SURFACE
SHEAR SURFACE

NOTES:

1. "FS" DESIGNATES CALCULATED FACTOR OF SAFETY.
2. THE LOCATION OF THE STUDY SECTION IS SHOWN ON FIGURE 3-1.
3. STABILITY ANALYSES WERE PERFORMED USING UTEXAS4 SOFTWARE.
4. PROCESS SLUDGE LAYER HAS BEEN EXCLUDED FROM ANALYSIS.

Job No. :	22243088
Prepared By :	KMM
Date :	SEPTEMBER 2013

5 DAM STABILITY ANALYSIS
ESTIMATED FUTURE CONDITIONS
UNDRAINED/POST-EARTHQUAKE
(OBE)

FIG. 7-5

URS was requested by Climax to perform seepage and stability analyses for 5 Dam to satisfy the DRMS stability evaluation review requirements prior to initiating deposition activities. Seepage analyses were completed for 5 Dam to calibrate the existing phreatic surface and predict future phreatic levels during active deposition. Slope stability analyses for 5 Dam included evaluating steady-state, undrained, and post-earthquake (OBE event) loading conditions for the existing height and the future design height using seepage analysis results. Cyclic testing performed on whole tailing samples show the tailing did not lose strength at simulated ground motions higher than those anticipated for the OBE event; therefore, the post-earthquake loading condition was analyzed as equivalent to the undrained loading condition.

Presented below is a summary of conclusions followed by recommendations for further actions. Conclusions and recommendations were developed based on the results of the analyses and on our experience with this and other tailing dams.

8.1 CONCLUSIONS

Review of available CPT data, test hole blow counts, and laboratory test results indicate the whole tailing is generally dilative during shearing. The relatively low stresses due to the OBE event indicate that wide-spread strength reduction due to liquefaction of the tailing is unlikely to occur for the OBE event.

A seepage model was used to calculate the future phreatic surface under deposition for use in the stability analyses. The model was first calibrated to existing conditions and then used to estimate conditions at future crest elevation 10,820 feet at steady-state seepage and under active deposition conditions. The existing model calibrated within tolerances to the existing phreatic surface and measured seepage flows of 1,200 gpm. The future model conditions showed an expected rise in the phreatic surface when the dam was raised to elevation 10,820 feet. A transient analysis, depicting active deposition, was also completed for a period of 35 days to evaluate the impact to phreatic surface. A slight raise in the upper portion of the phreatic surface was observed. This resulting phreatic surface was used in the stability model.

Stability analyses were completed for existing and future dam heights considering steady-state, undrained, and post-earthquake (OBE event) loading conditions. The dam met or exceeded the minimum FS results of 1.5 for steady-state conditions and 1.2 for undrained conditions. Results of the cyclic triaxial tests show the whole and cycloned tailing did not lose strength after being cycled for motions higher than the OBE event. The OBE may cause excess pore pressures, creating the equivalent of undrained loading conditions. Therefore the post-earthquake analysis is identical to the undrained analysis. The results of the analyses show 5 Dam meets or exceeds minimum recommended FS of 1.0 for post-earthquake loading conditions. In summary, the stability results for the maximum dam section indicate the dam meets or exceeds the minimum FS design criteria for all cases analyzed.

8.2 RECOMMENDATIONS

The operation of 5 Dam will depend on the proper management of the tailing facility and emplacing tailing with properties envisioned for this dam. It will be important to observe and capture the tailing grind changes due to the mill operation or the ore body encountered. These changes will have an impact on material properties and may have potential impacts on the overall operations of the TSF.

As discussed in Subsection 1.1, comparing historically-deposited mill tailing with those presently emplaced is important to the overall successful operation of the facility and part of what is known as the "observational approach." The observational approach is an iterative process that occurs through the life of the dam and consists of evaluating the in-place tailing properties with those modeled in previous analyses. With this in mind, we recommend the following activities associated with deposition on 5 Dam:

- Perform beach profile sampling to evaluate newly deposited tailing to verify the material properties are consistent with those envisioned in the design. This will include evaluating the new whole tailing gradation as it compares to past whole tailing gradations. Profile sampling should be performed near the end of the first spigot season (estimated early fall 2014). The sampling should include collection of relatively undisturbed samples along 2 to 3 profile lines from the crest extending into the impoundment. Selected samples will be tested to measure index properties of the tailing.
- Evaluate the tailing beach and beach topography to verify the beach slope is consistent with that envisioned in the original design. The beach area should be surveyed near the end of the first spigot season. Evaluation of the differences with prior surveys should be performed on an annual basis.
- Maintain the decant pond at least 800 feet from the crest under normal operating conditions.
- Implement weekly review of the data from currently installed piezometers during start-up. Piezometric data review may be decreased to a monthly basis as deemed appropriate by the Engineer-of-Record (EOR) after review of the weekly readings.
- Install additional piezometers, as deemed necessary by the EOR, along the crest and face of the dam to evaluate the phreatic surface and material changes resulting from tailing deposition and to continue to support the observational approach. Frequency and location of piezometer installation will be established during regularly scheduled inspections and piezometric data review. Laboratory testing on selected materials should also be completed during piezometer installation to confirm design assumptions. Initial piezometric data generated at start-up will be reviewed with consideration to whether additional piezometers are required.

Should variations in the material properties be identified, the source or cause should be reviewed and it may be potentially necessary to revise the stability analyses. The need for updating the stability analyses should be reviewed by the engineer-of-record and implemented as needed in the future.

The recommendations provided above are common to any start-up, expected and planned for at this dam, and typical for construction of an upstream method tailing dam. The recommendations have been discussed with Climax and will be implemented as part of the operations strategy and as part of normal operation and maintenance. Implementation of the recommendations will be addressed in the Mayflower TSF Operations and Maintenance Manual.

Professional judgments are presented in this report. These are based partly on evaluation of technical information gathered and partly on our general experience with similar projects.

It is important to note the condition of a tailing dam is evolutionary in nature and depends on numerous and constantly changing internal and external conditions. It would be incorrect to assume the present condition of a dam will continue to represent the condition of that dam at some point in the future. Only through periodic, updated inspections and ongoing monitoring can unsafe conditions be detected so that corrective action can be taken. Likewise, continued care and maintenance are necessary to minimize the risk of unsafe conditions.

URS services were performed within the limits prescribed by our client, with the usual thoroughness and competence of the engineering profession. No warranty, guarantee, or other representation, either expressed or implied, is included or intended in our proposals, contracts, or reports.

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Appendix A

CPT Data

Appendix A.1

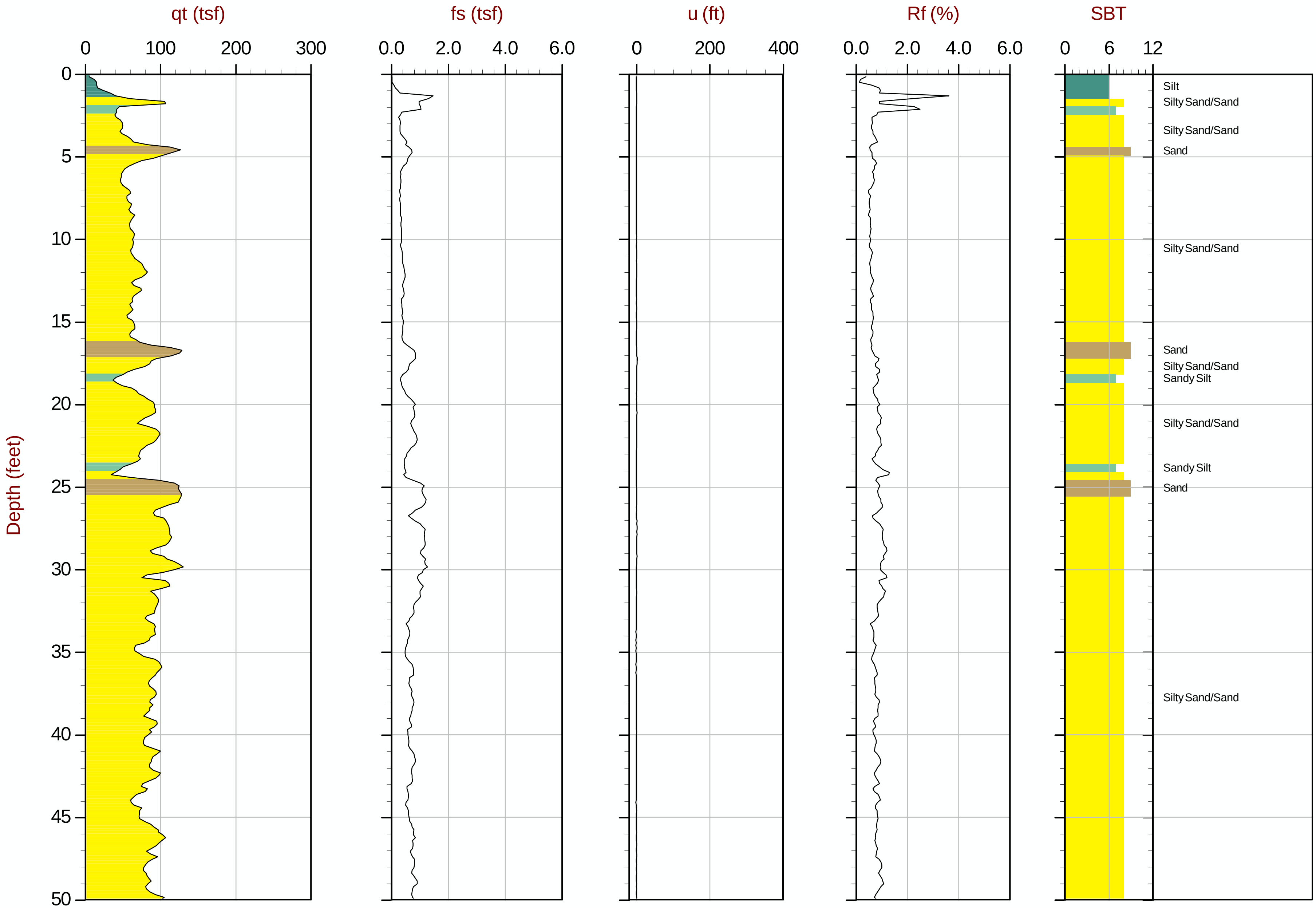
2012 CPT Field-Collected Data Plots

ConeTec

URS Corporation

Job No: 12-400
Date: 10:04:12 09:20
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296:T1500F15U500



Max Depth: 62.250 m / 204.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-1.COR
Unit Wt: SBT Chart Soil Zones

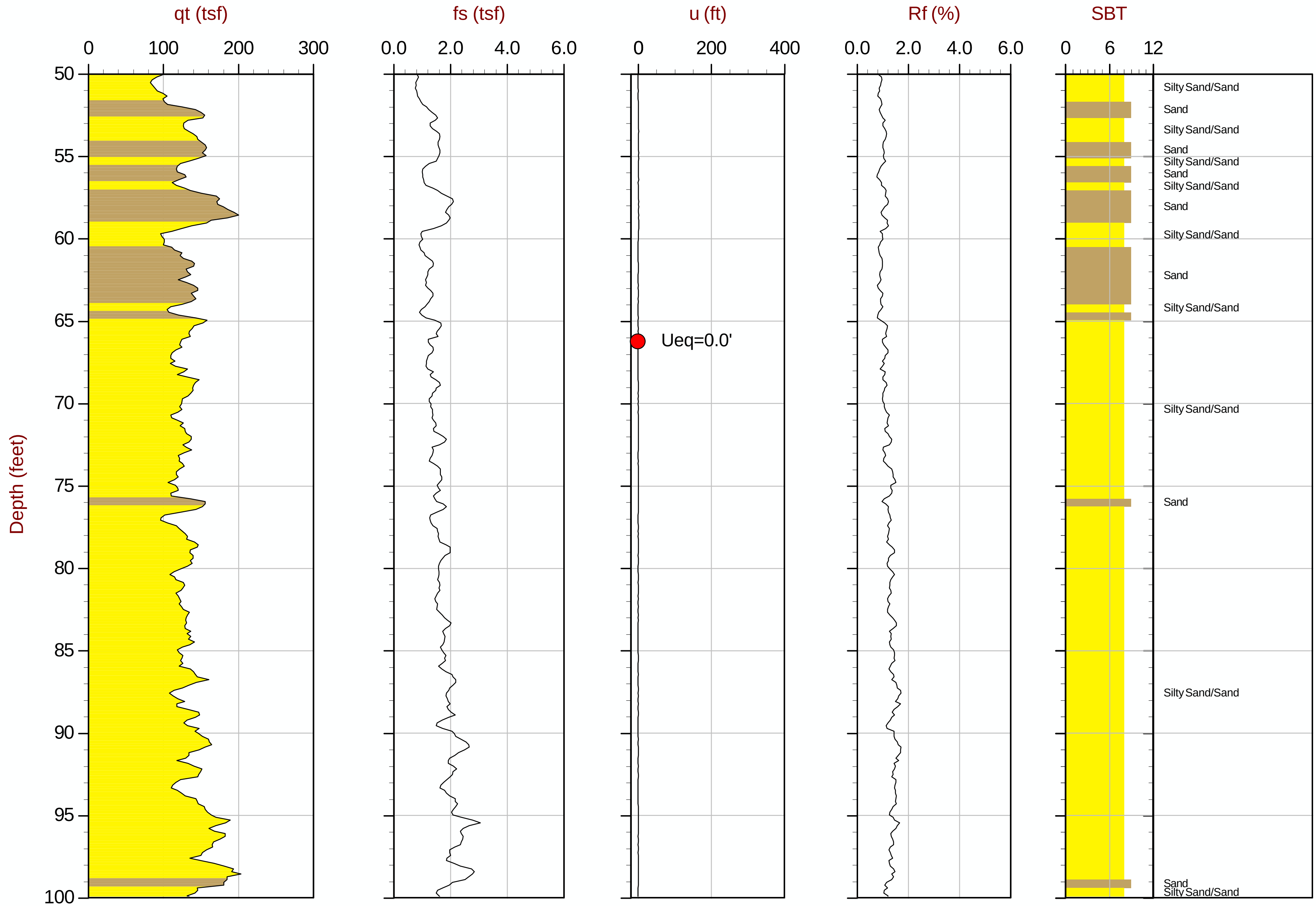
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.440483 Long: -106.169950
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:04:12 09:20
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296:T1500F15U500



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Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-1.COR
Unit Wt: SBT Chart Soil Zones

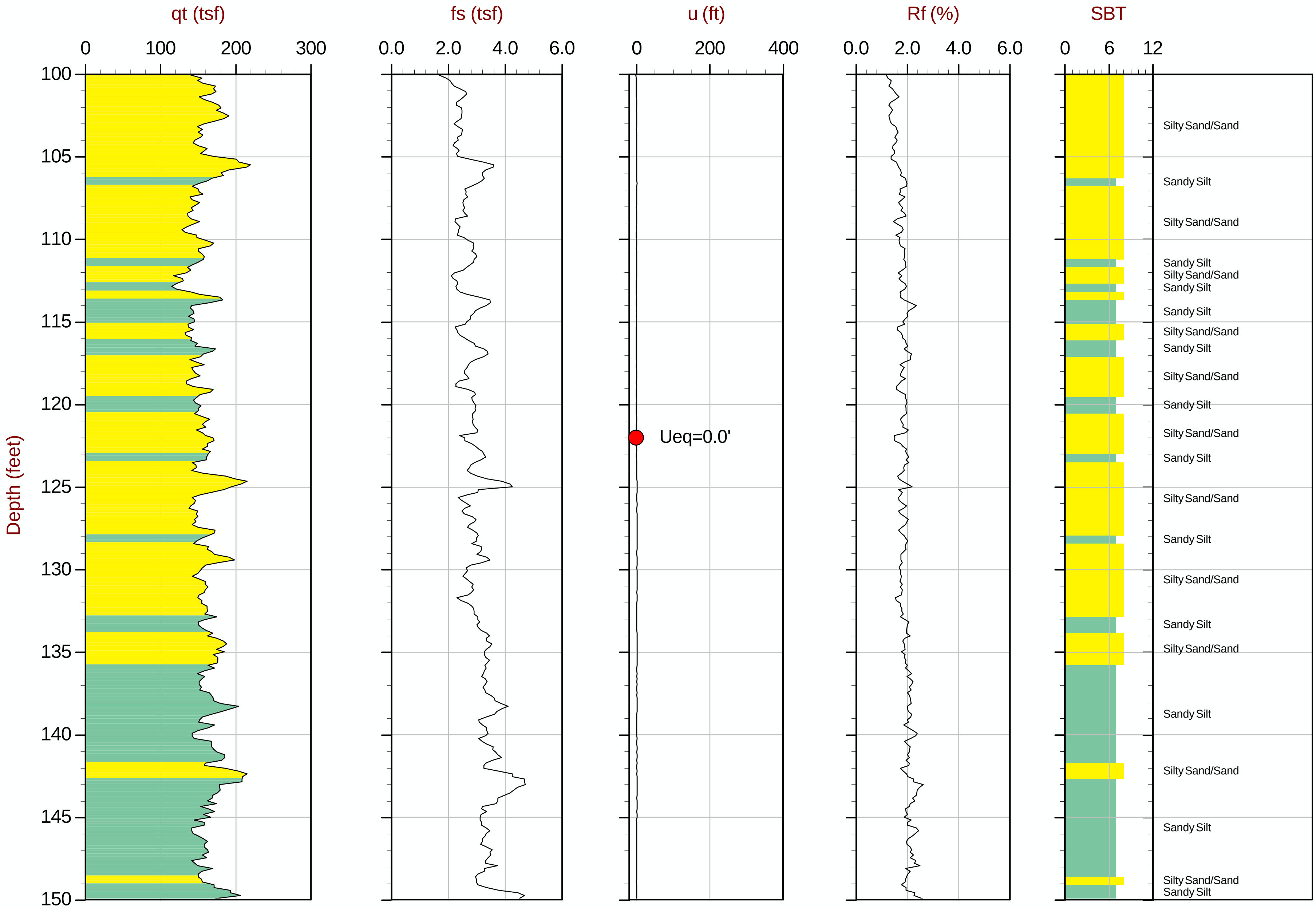
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.440483 Long: -106.169950
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:04:12 09:20
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296:T1500F15U500



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Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-1.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.440483 Long: -106.169950

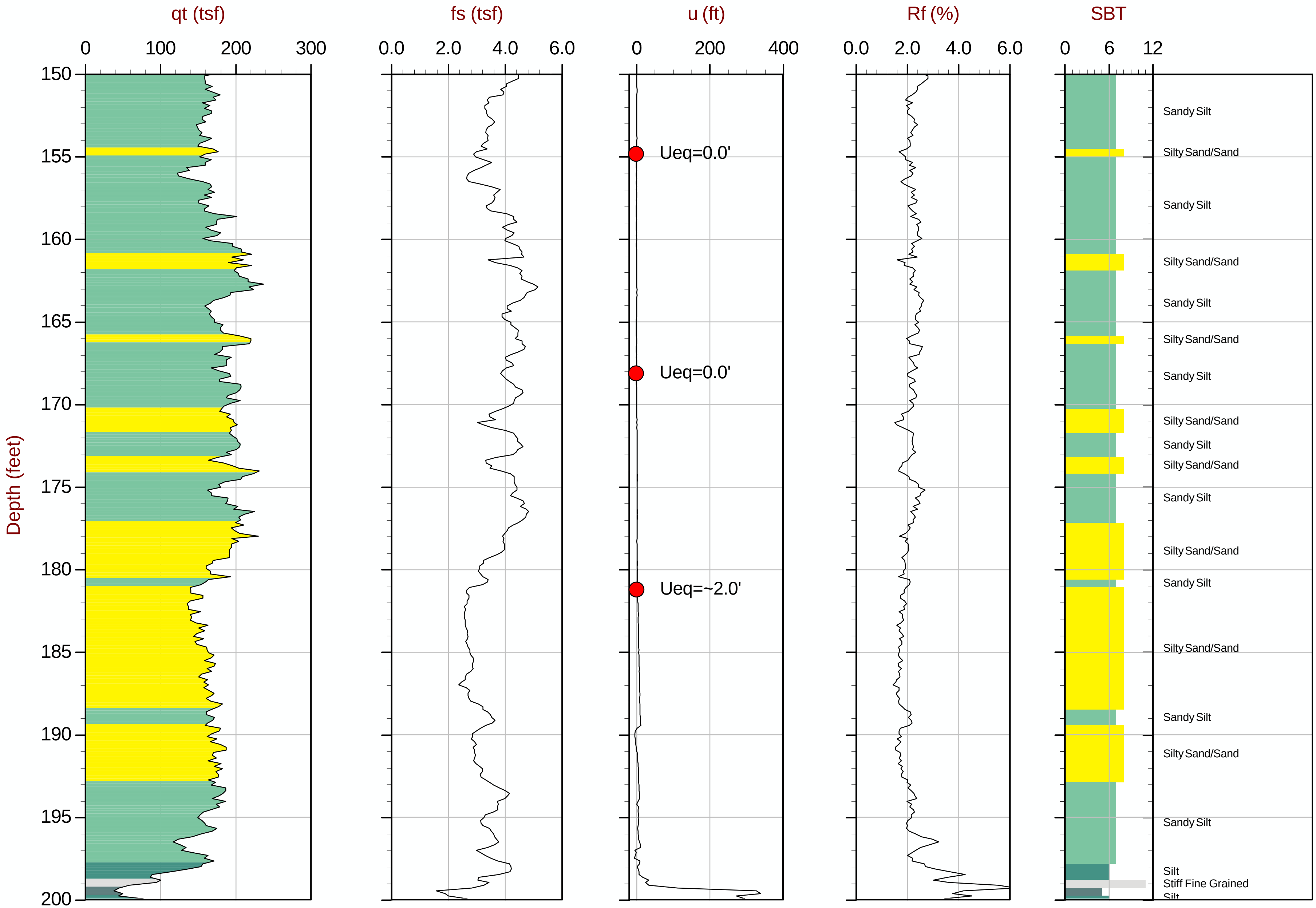
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:04:12 09:20
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296:T1500F15U500



Max Depth: 62.250 m / 204.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-1.COR
Unit Wt: SBT Chart Soil Zones

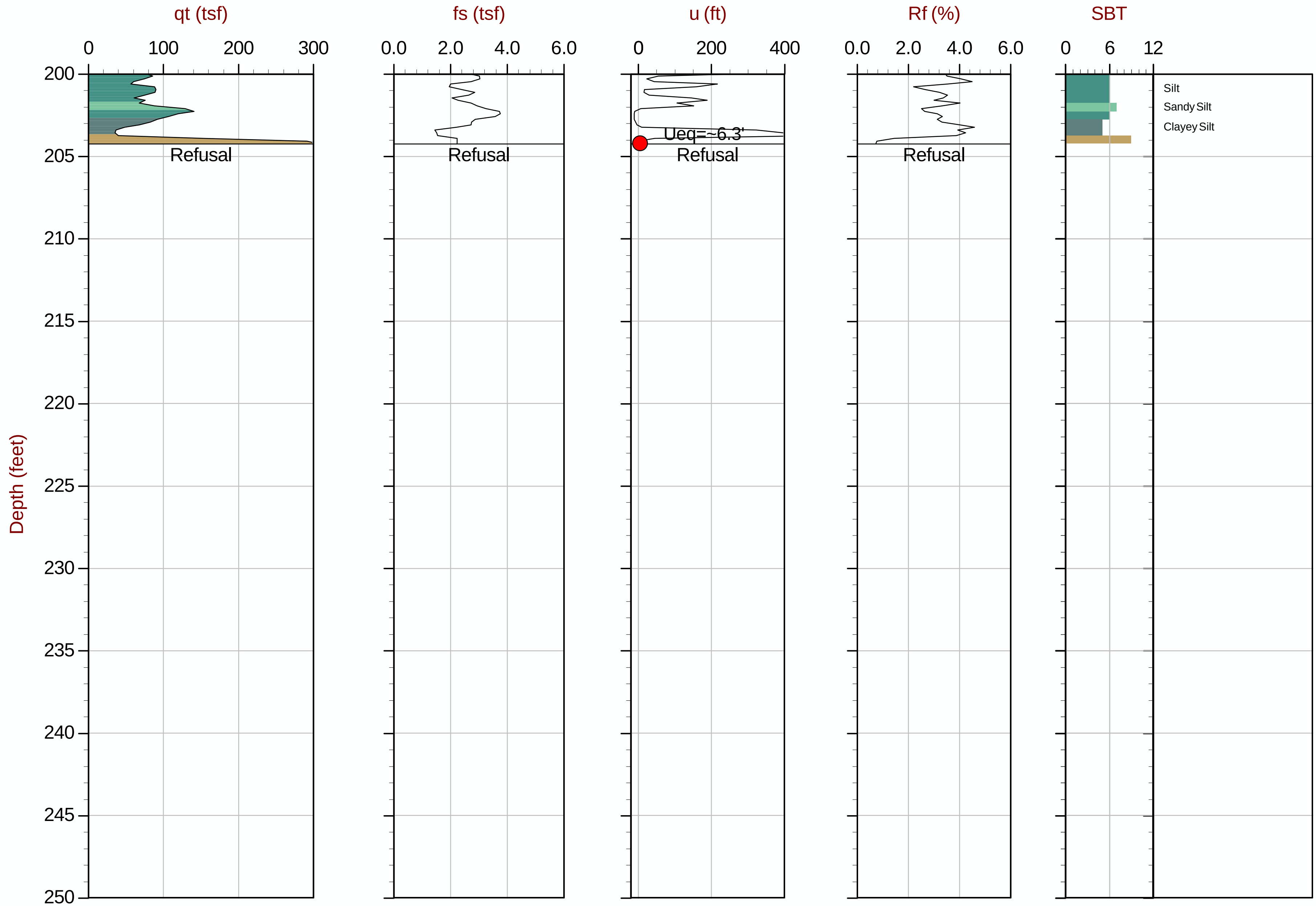
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.440483 Long: -106.169950
● Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:04:12 09:20
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296:T1500F15U500



Max Depth: 62.250 m / 204.23 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-1.COR
Unit Wt: SBT Chart Soil Zones

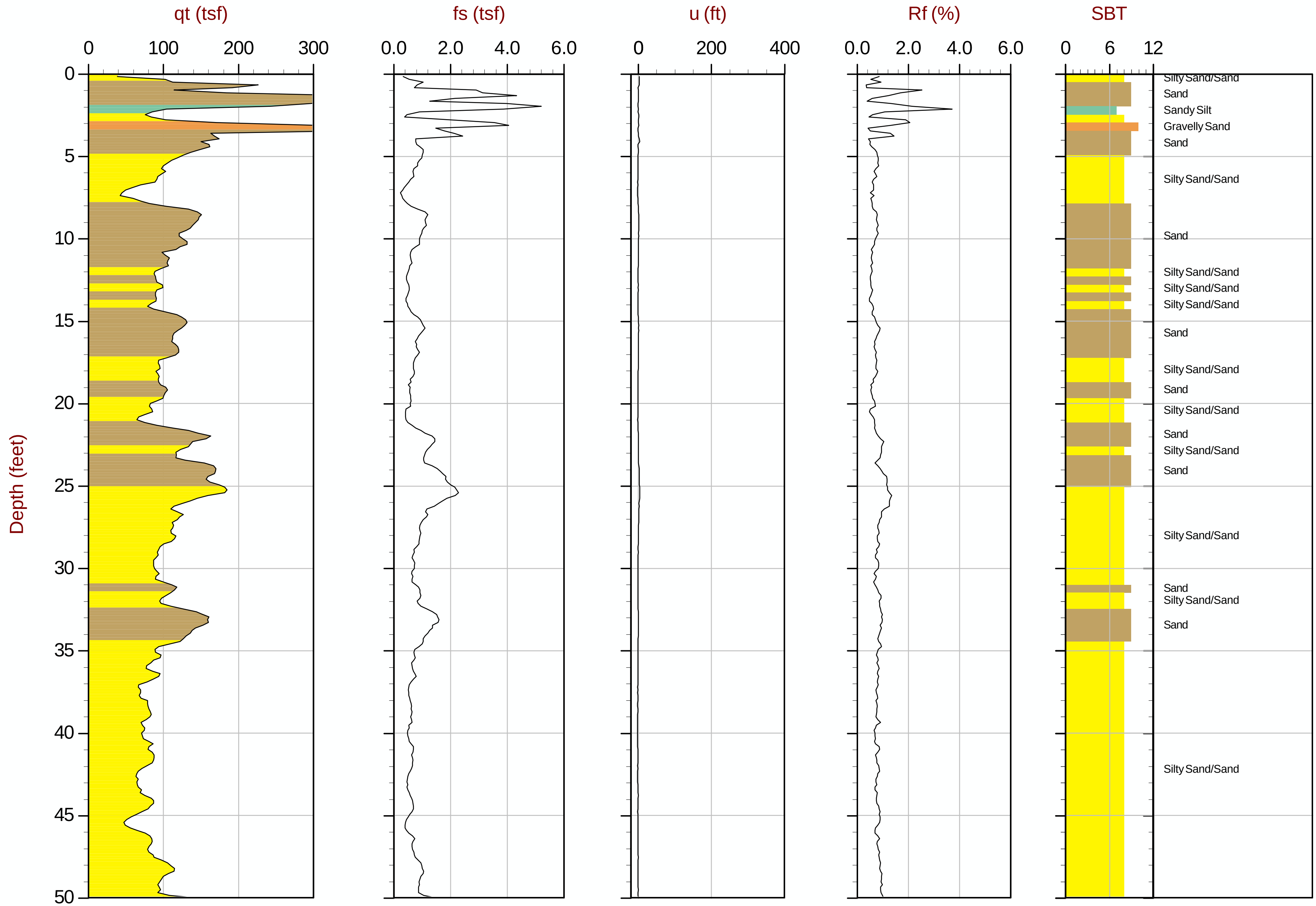
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.440483 Long: -106.169950
● Equilibrium Pore Pressure from Dissipation

ConeTec

URS Corporation

Job No: 12-400
Date: 10:03:12 12:16
Site: MAYFLOWER

Sounding: CPT-2012-5-2
Cone: 296:T1500F15U500



Max Depth: 40.450 m / 132.71 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-2.COR
Unit Wt: SBT Chart Soil Zones

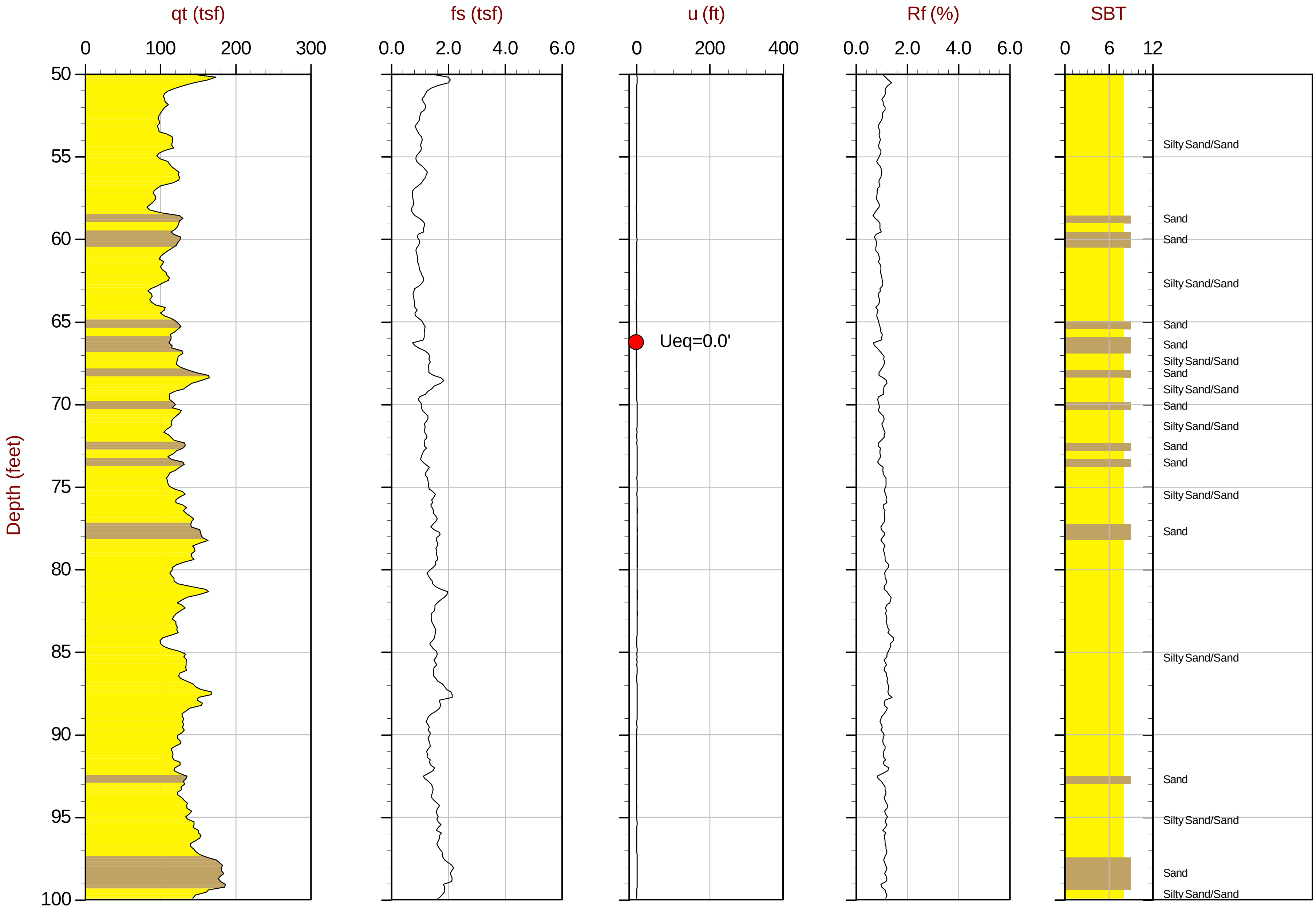
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.441000 Long: -106.169250
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:03:12 12:16
Site: MAYFLOWER

Sounding: CPT-2012-5-2
Cone: 296:T1500F15U500



Max Depth: 40.450 m / 132.71 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-2.COR
Unit Wt: SBT Chart Soil Zones

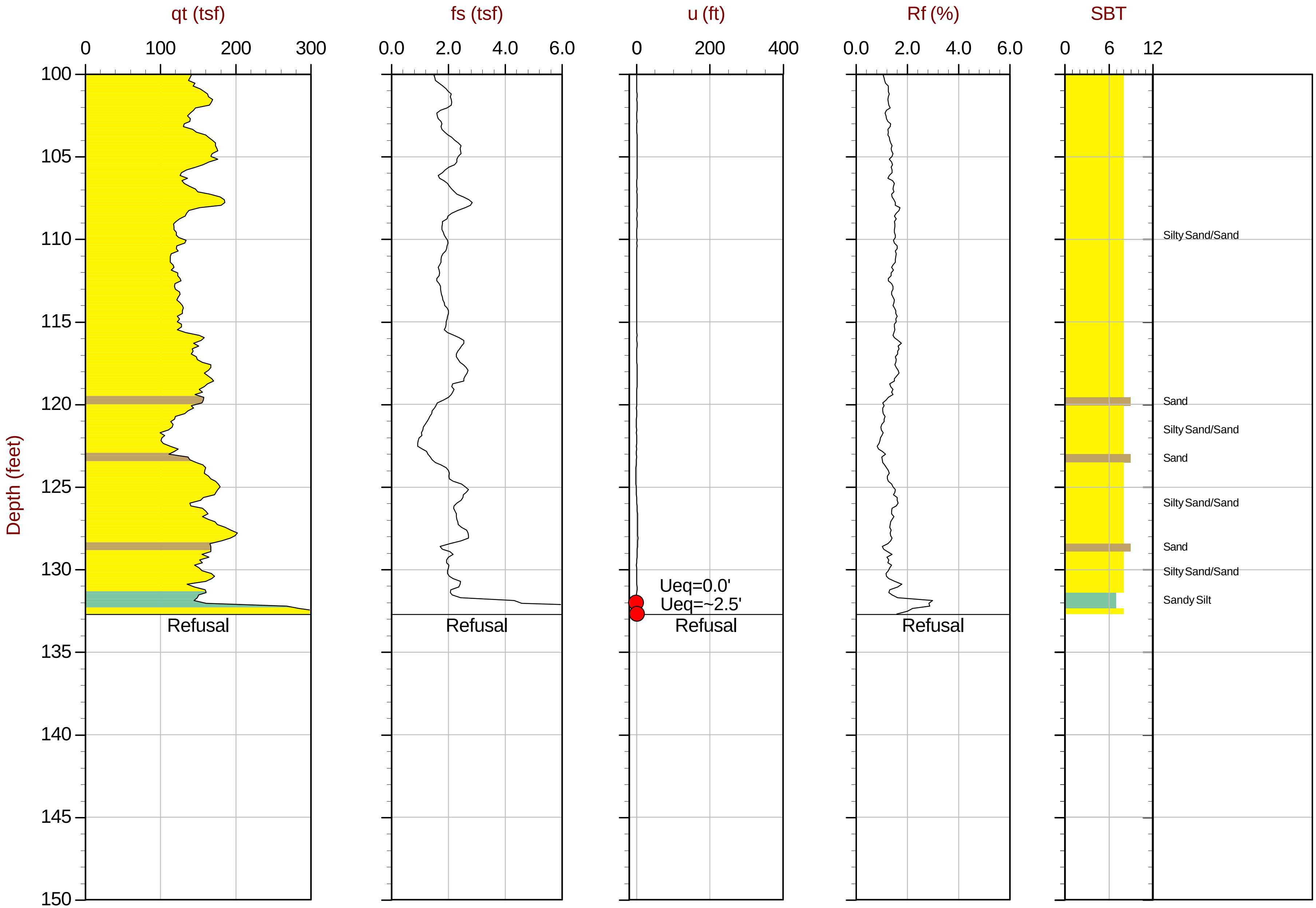
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.441000 Long: -106.169250
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:03:12 12:16
Site: MAYFLOWER

Sounding: CPT-2012-5-2
Cone: 296:T1500F15U500



Max Depth: 40.450 m / 132.71 ft
Depth Inc: 0.050 m / 0.164 ft
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File: 12-400RCPT-5-2.COR
Unit Wt: SBT Chart Soil Zones

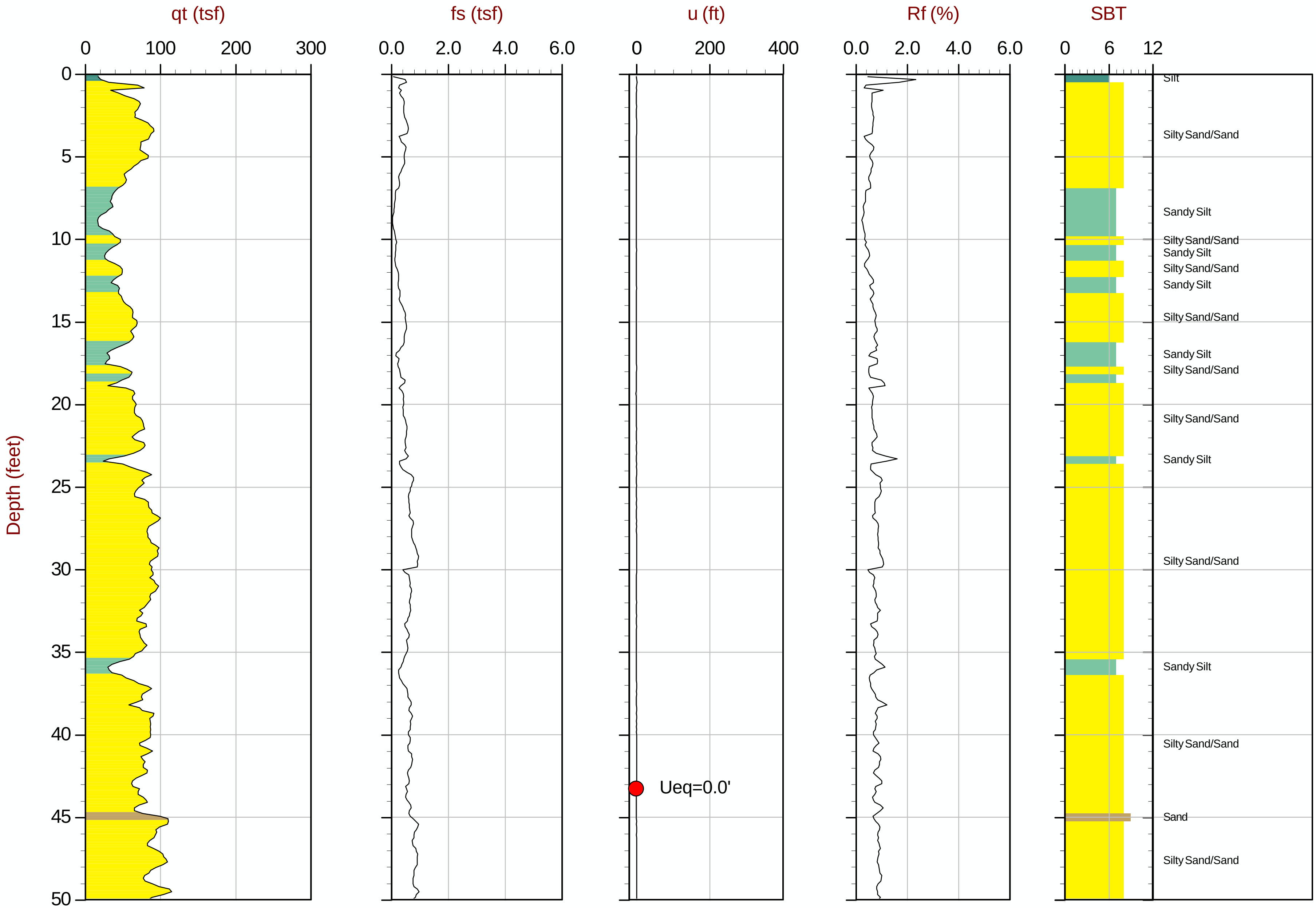
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.441000 Long: -106.169250
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:03:12 14:52
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296:T1500F15U500



Max Depth: 51.100 m / 167.65 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-3.COR
Unit Wt: SBT Chart Soil Zones

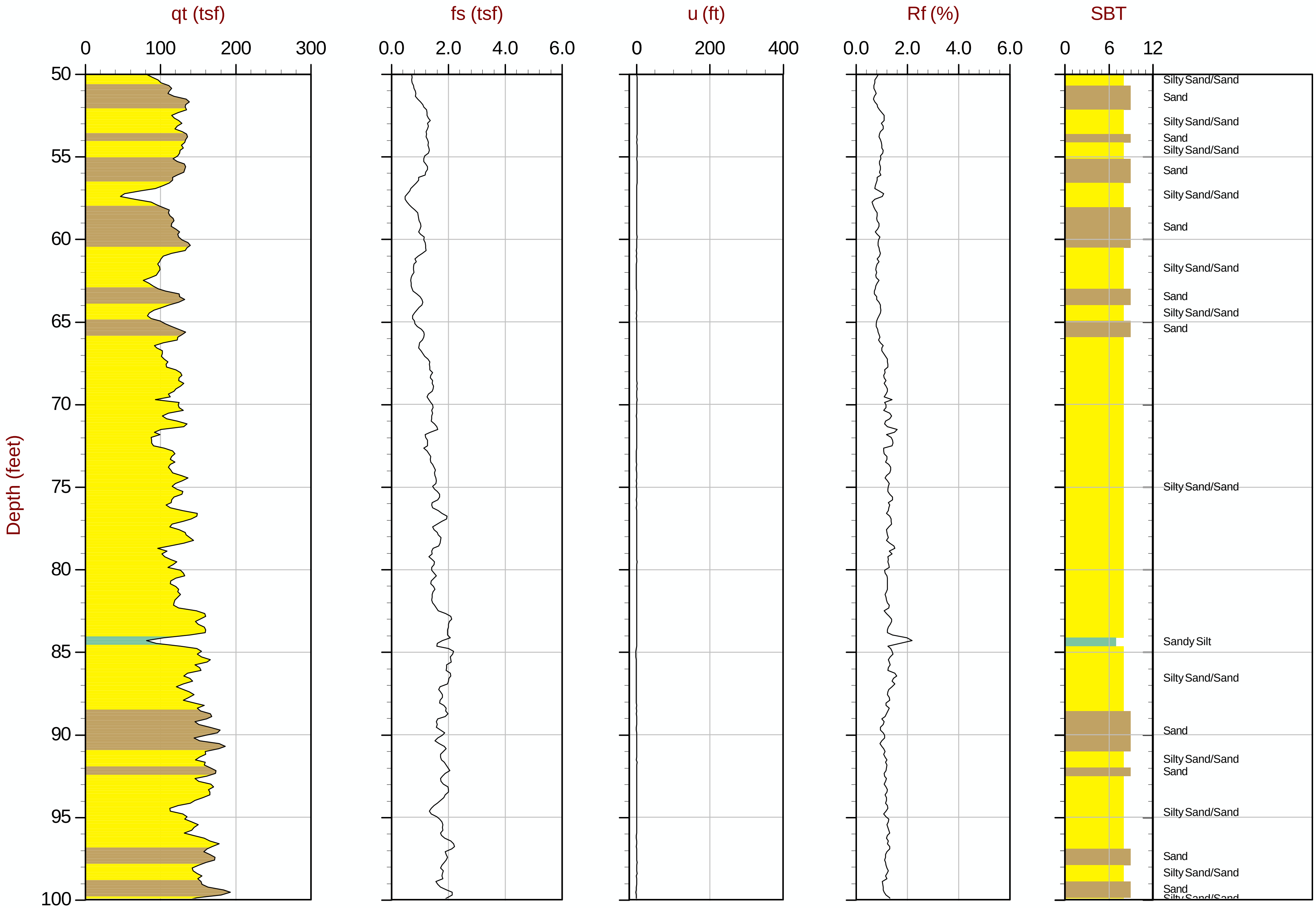
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.439533 Long: -106.171350
Equilibrium Pore Pressure from Dissipation

ConeTec

URS Corporation

Job No: 12-400
Date: 10:03:12 14:52
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296:T1500F15U500



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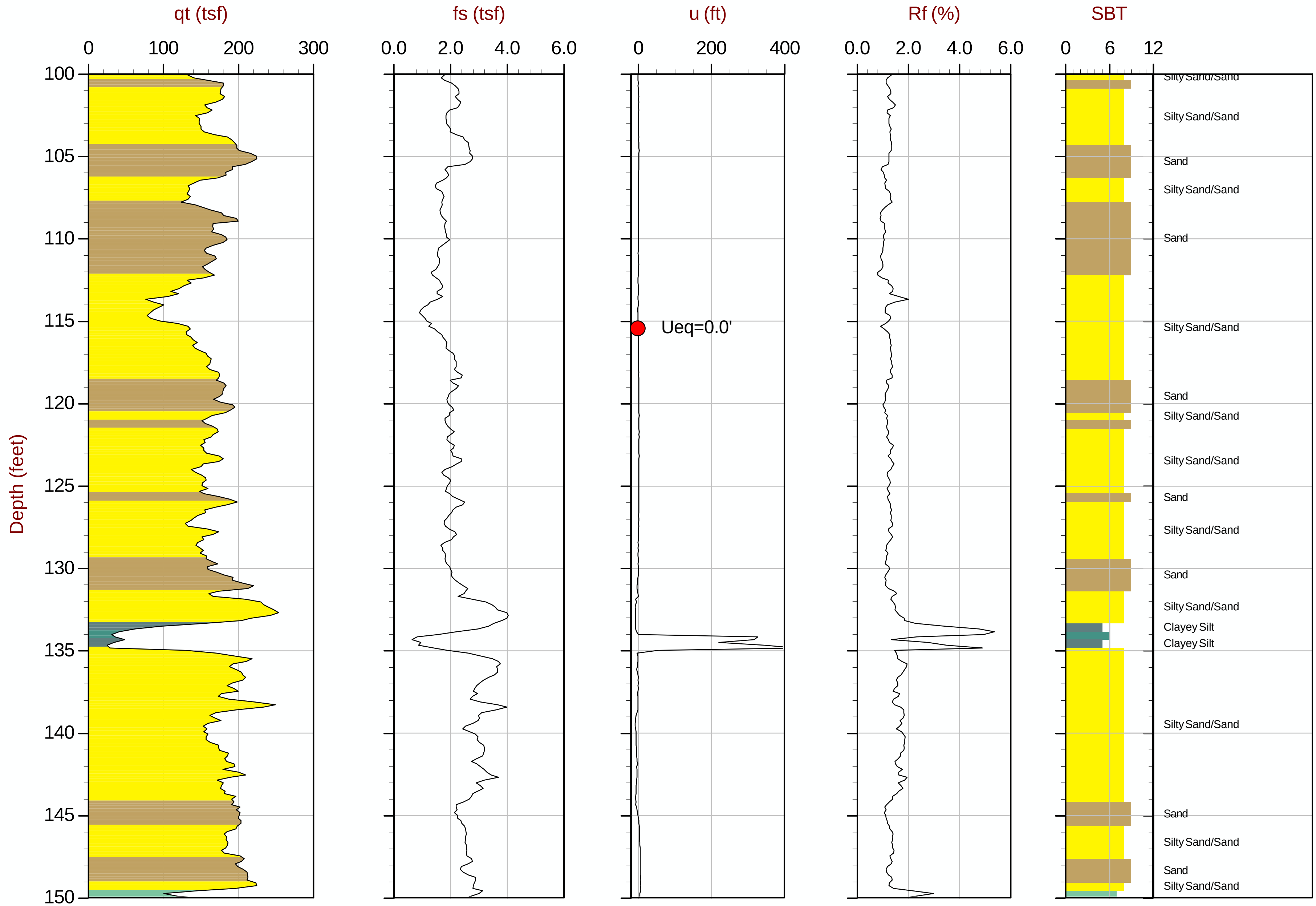
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-3.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.439533 Long: -106.171350
Equilibrium Pore Pressure from Dissipation

URS Corporation	Job No: 12-400 Date: 10:03:12 14:52 Site: MAYFLOWER	Sounding: CPT-2012-5-3 Cone: 296:T1500F15U500



Max Depth: 51.100 m / 167.65 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-3.COR
Unit Wt: SBT Chart Soil Zones

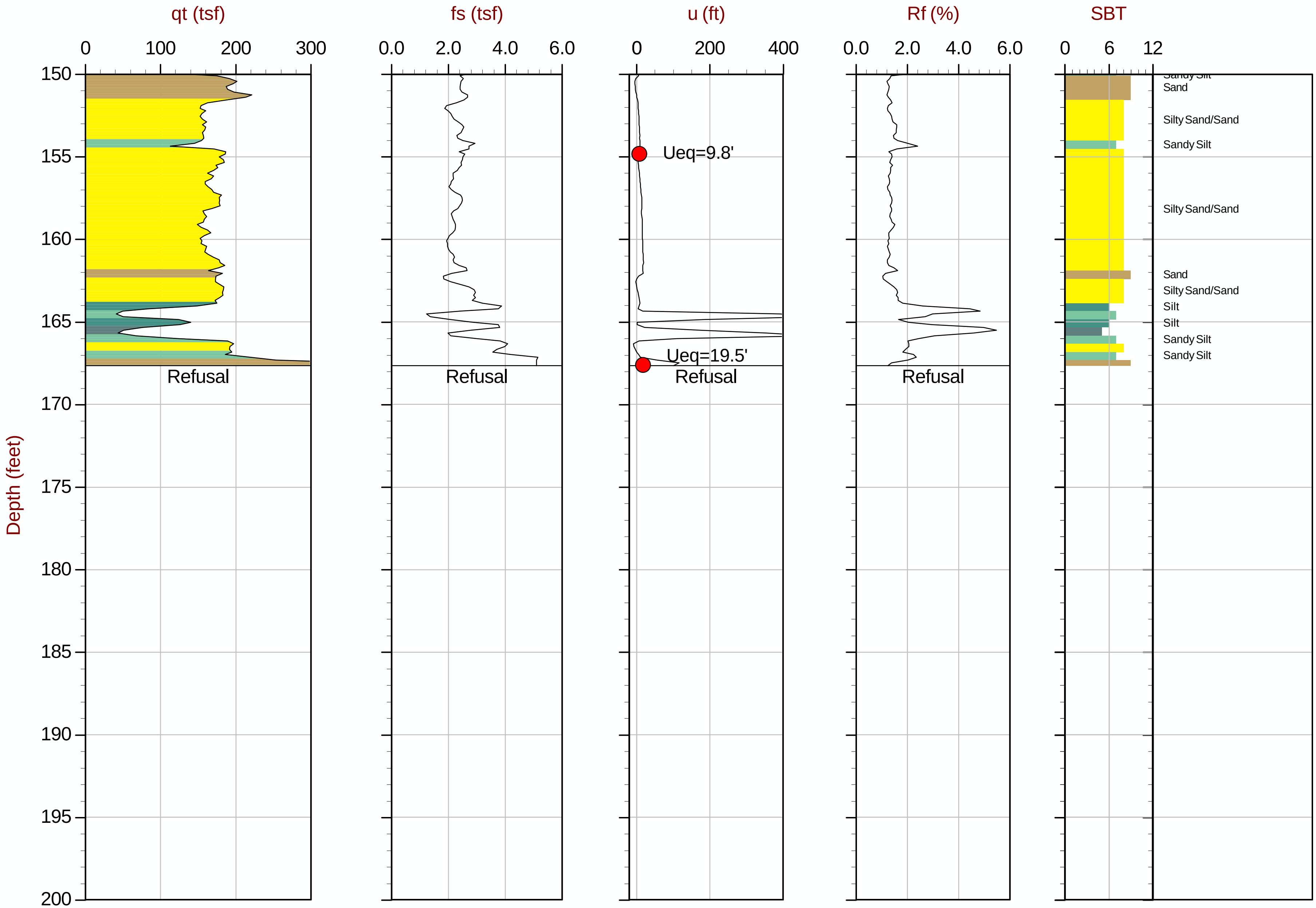
SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.439533 Long: -106.171350
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Job No: 12-400
Date: 10:03:12 14:52
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296:T1500F15U500



Max Depth: 51.100 m / 167.65 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.150 m

File: 12-400RCPT-5-3.COR
Unit Wt: SBT Chart Soil Zones

SBT: Lunne, Robertson and Powell, 1997
Coords: Lat: 39.439533 Long: -106.171350
Equilibrium Pore Pressure from Dissipation

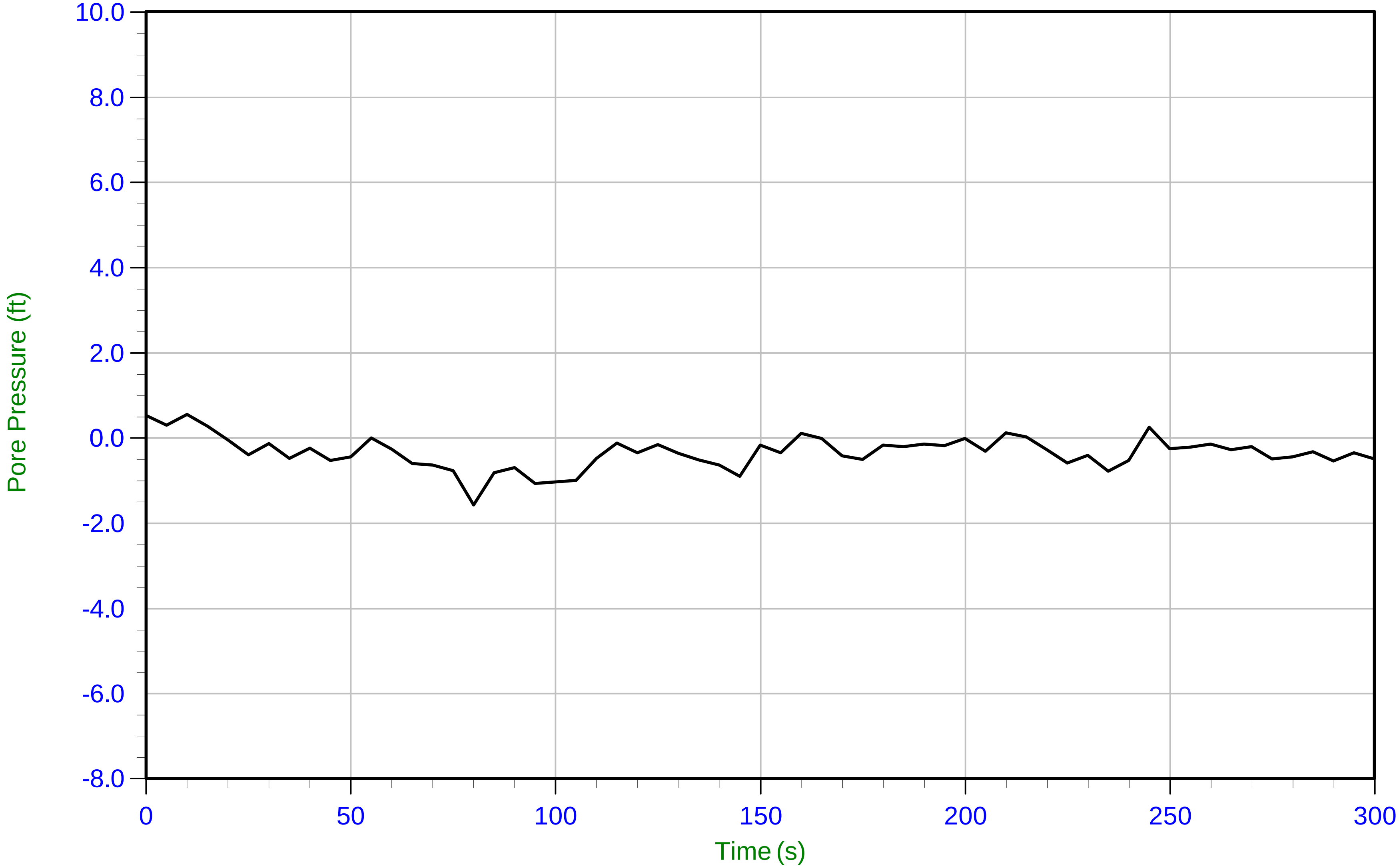
Appendix A.2

2012 Pore Pressure Dissipation Test Results

URS Corporation

Job No: 12-400
Date: 04-Oct-2012 09:20:57
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

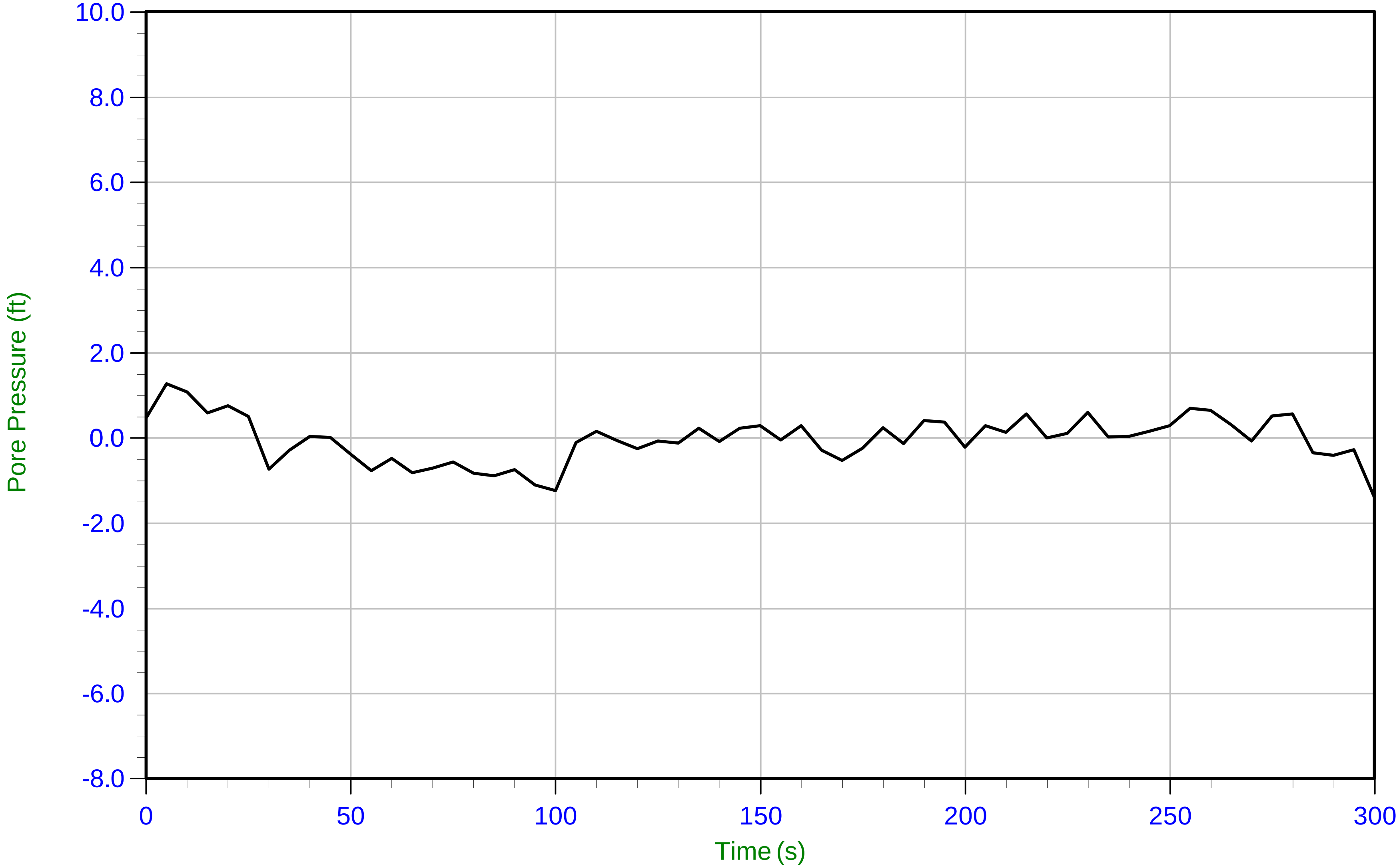
Filename: 12-400RCPT-5-1.PPD	U Min: -1.6 ft	WT: 20.217 m / 66.327 ft
Depth: 20.200 m / 66.272 ft	U Max: 0.6 ft	Ueq: -0.1 ft
Duration: 300.0 s		

CONETEC

URS Corporation

Job No: 12-400
Date: 04-Oct-2012 09:20:57
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-1.PPD
Depth: 37.200 m / 122.046 ft
Duration: 300.0 s

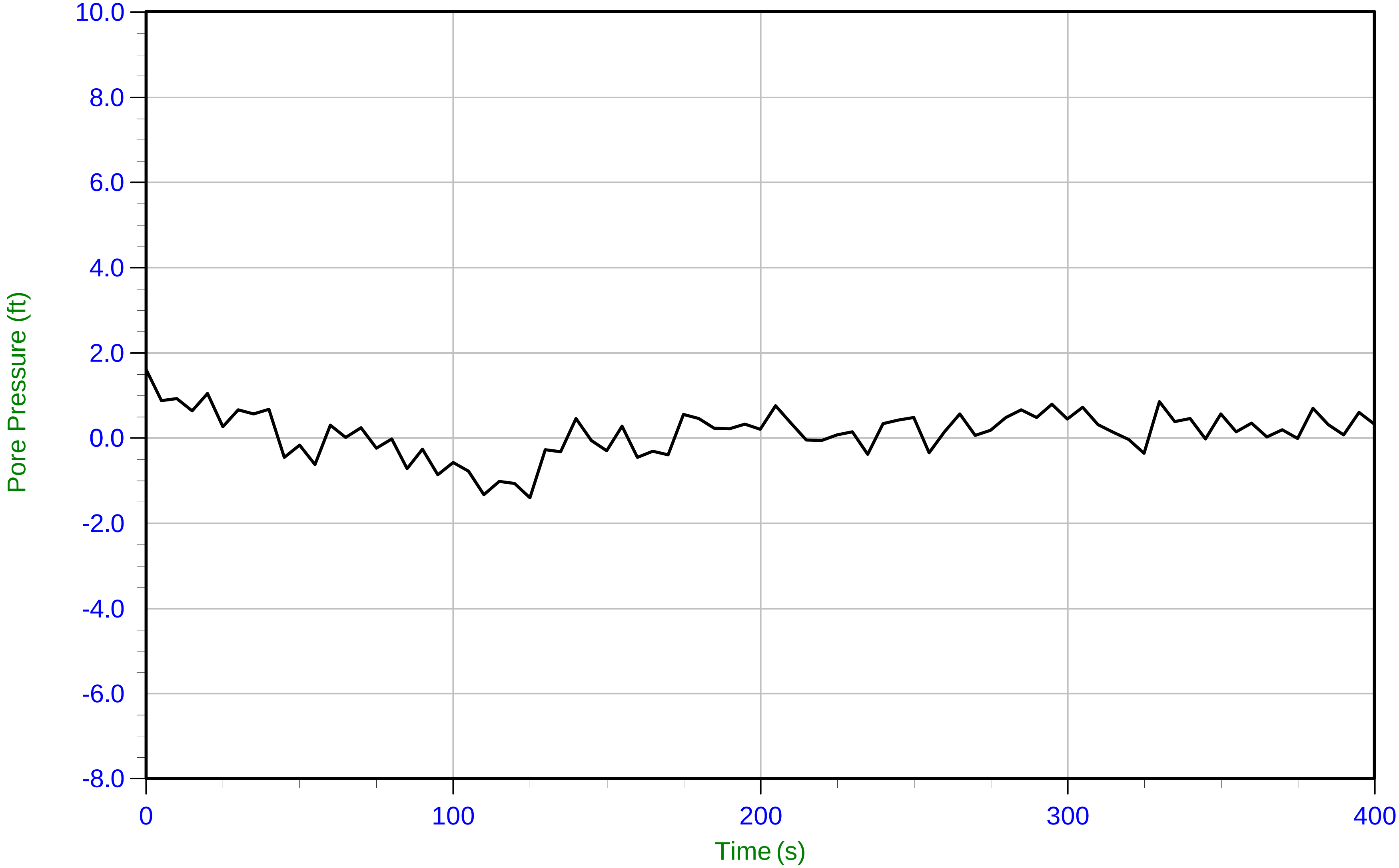
U Min: -1.4 ft
U Max: 1.3 ft

WT: 37.217 m / 122.100 ft
Ueq: -0.1 ft

URS Corporation

Job No: 12-400
Date: 04-Oct-2012 09:20:57
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

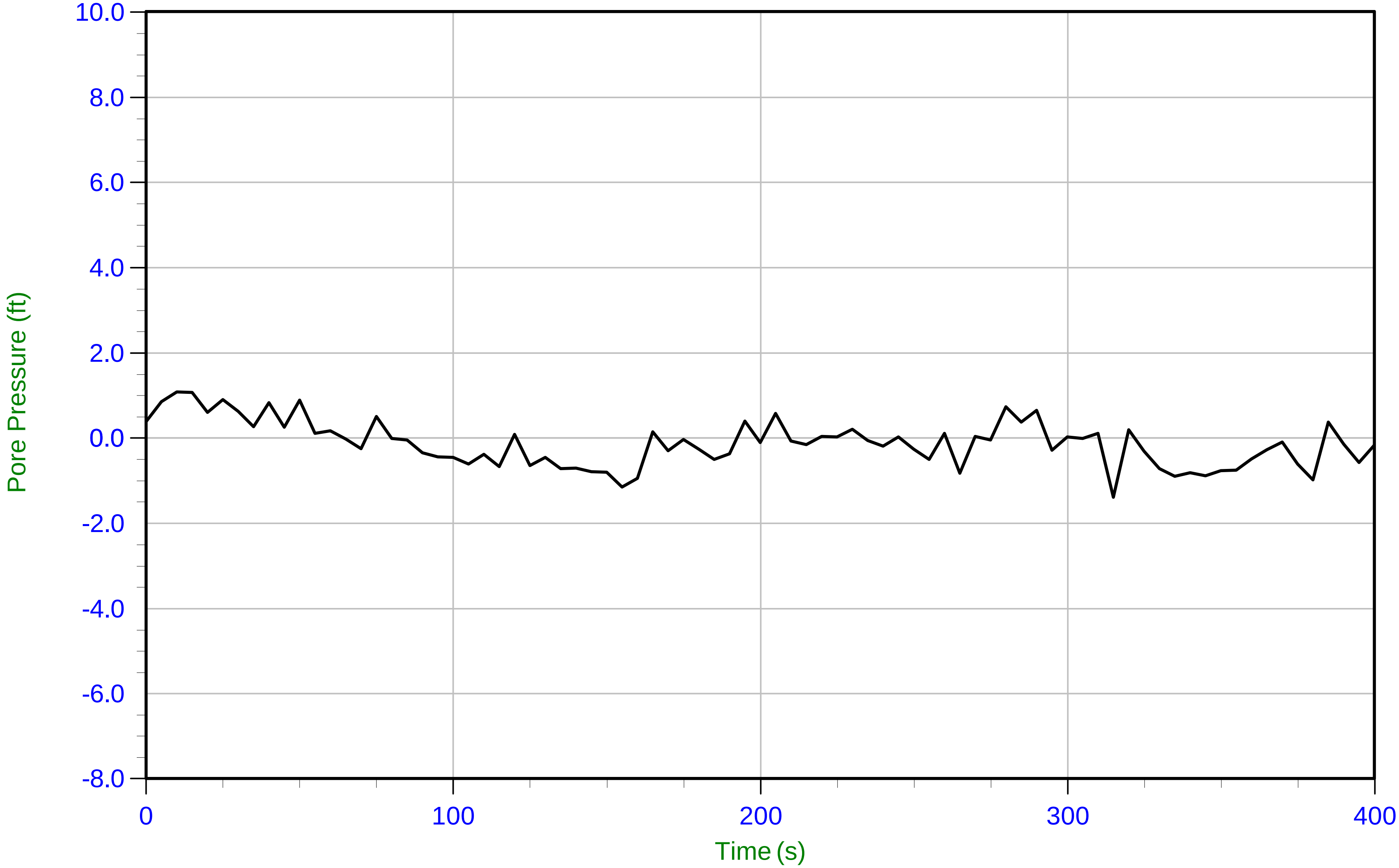
Filename: 12-400RCPT-5-1.PPD
Depth: 47.200 m / 154.854 ft
Duration: 400.0 s

U Min: -1.4 ft
U Max: 1.6 ft

WT: 47.205 m / 154.870 ft
Ueq: -0.0 ft

CONETEC

URS Corporation	Job No: 12-400	Sounding: CPT-2012-5-1
	Date: 04-Oct-2012 09:20:57	Cone: 296
	Site: MAYFLOWER	Cone Area: 15 sq cm

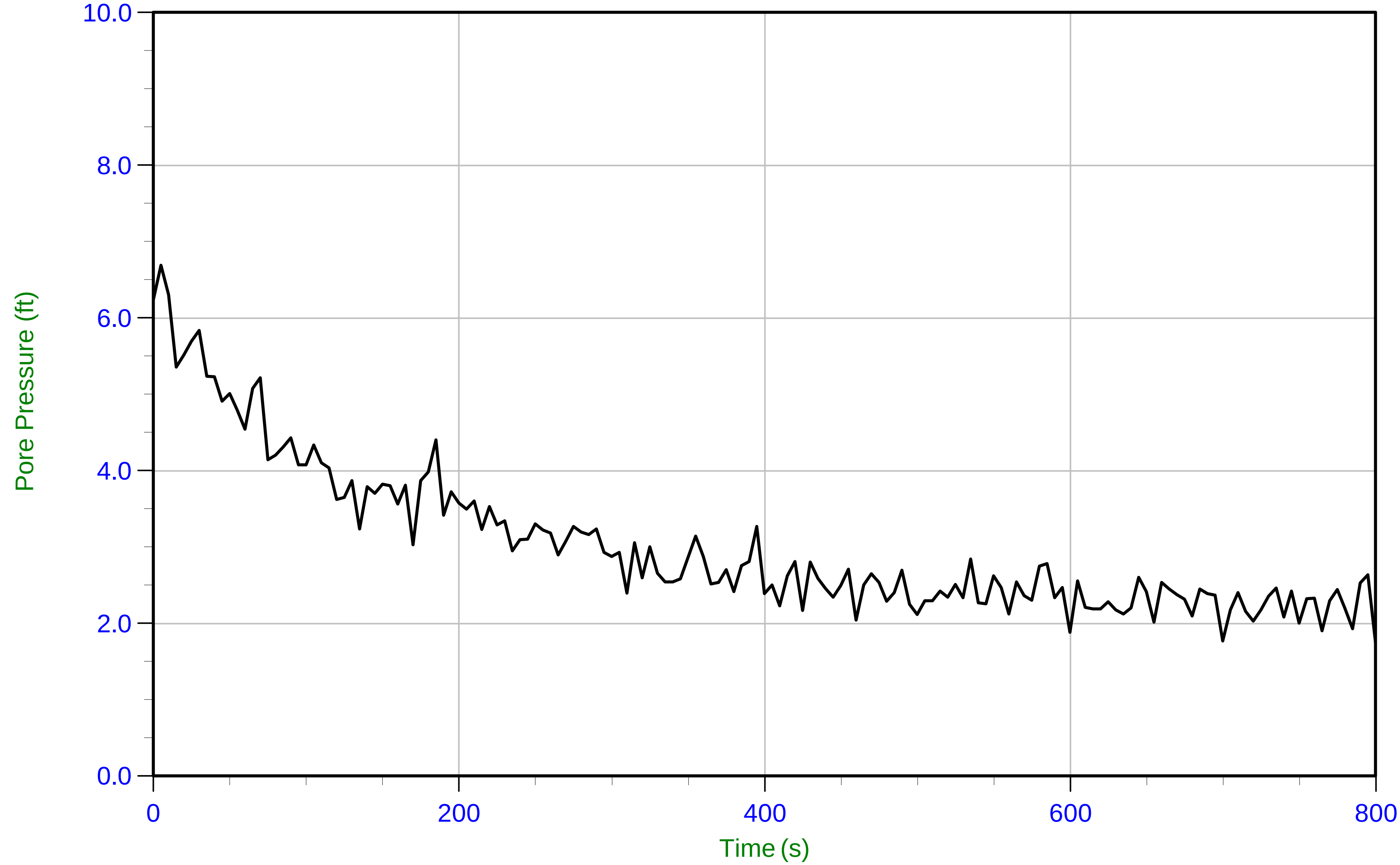


Trace Summary:	Filename: 12-400RCPT-5-1.PPD	U Min: -1.4 ft	WT: 51.267 m / 168.195 ft
	Depth: 51.250 m / 168.141 ft	U Max: 1.1 ft	Ueq: -0.1 ft
	Duration: 400.0 s		

URS Corporation

Job No: 12-400
Date: 04-Oct-2012 09:20:57
Site: MAYFLOWER

Sounding: CPT-2012-5-1
Cone: 296
Cone Area: 15 sq cm



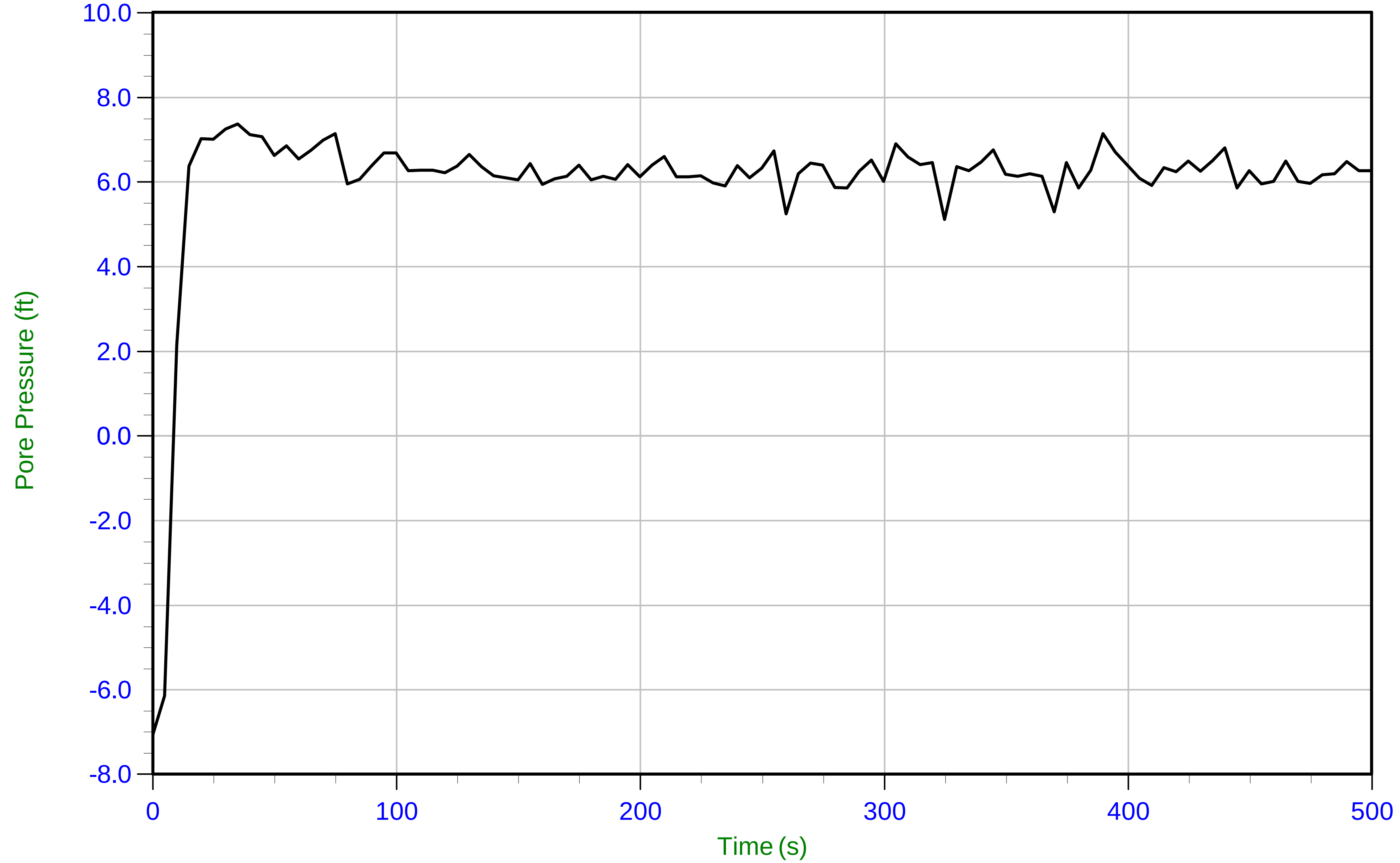
Trace Summary:

Filename: 12-400RCPT-5-1.PPD
Depth: 55.250 m / 181.264 ft
Duration: 800.0 s

U Min: 1.8 ft
U Max: 6.7 ft

WT: 54.593 m / 179.109 ft
Ueq: 2.2 ft

URS Corporation	Job No: 12-400	Sounding: CPT-2012-5-1
	Date: 04-Oct-2012 09:20:57	Cone: 296
	Site: MAYFLOWER	Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-1.PPD
Depth: 62.250 m / 204.230 ft
Duration: 500.0 s

U Min: -7.1 ft
U Max: 7.4 ft

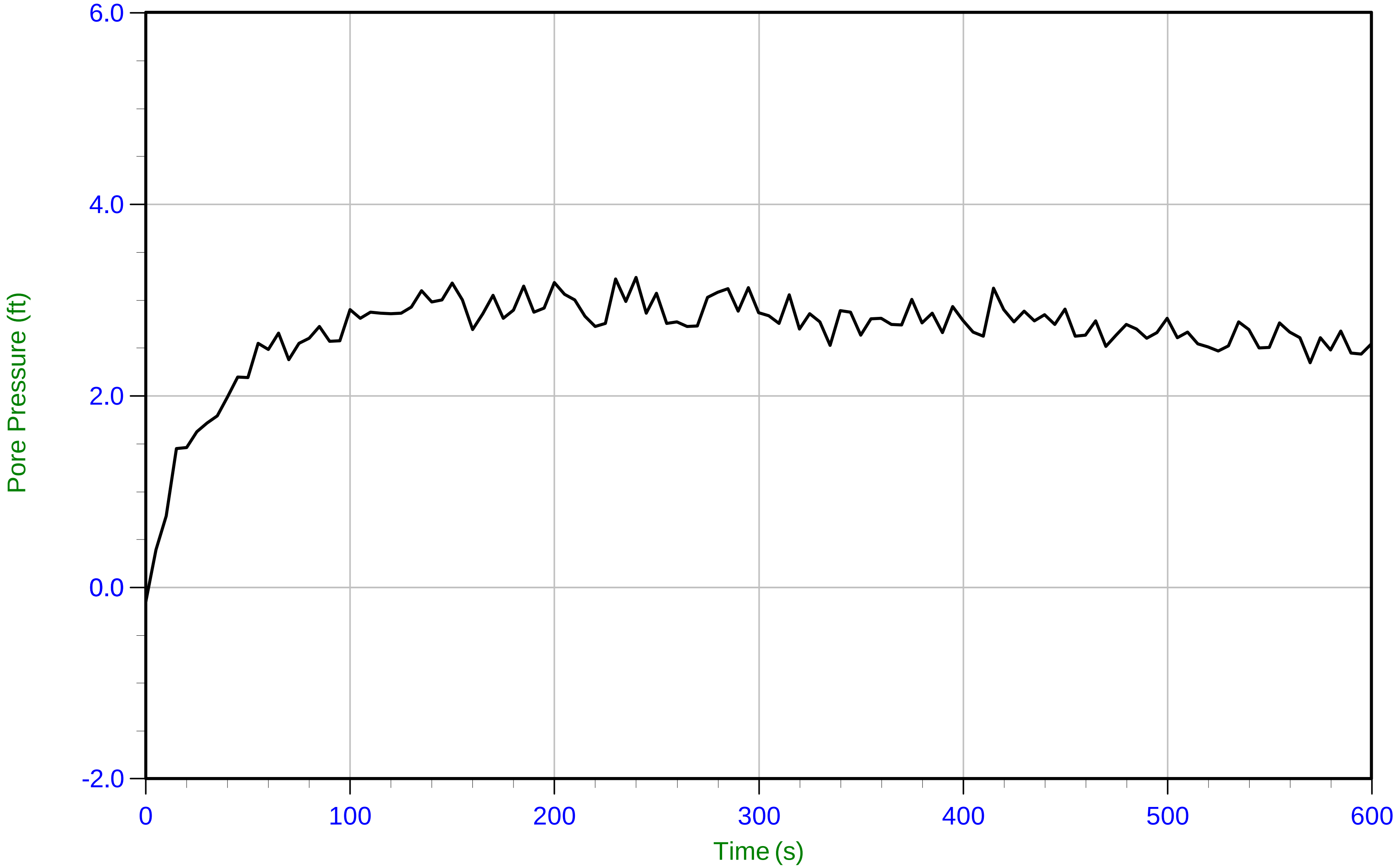
WT: 60.338 m / 197.958 ft
Ueq: 6.3 ft

CONETEC

URS Corporation

Job No: 12-400
Date: 03-Oct-2012 12:16:02
Site: MAYFLOWER

Sounding: CPT-2012-5-2
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-2.PPD
Depth: 40.450 m / 132.708 ft
Duration: 600.0 s

U Min: -0.1 ft
U Max: 3.2 ft

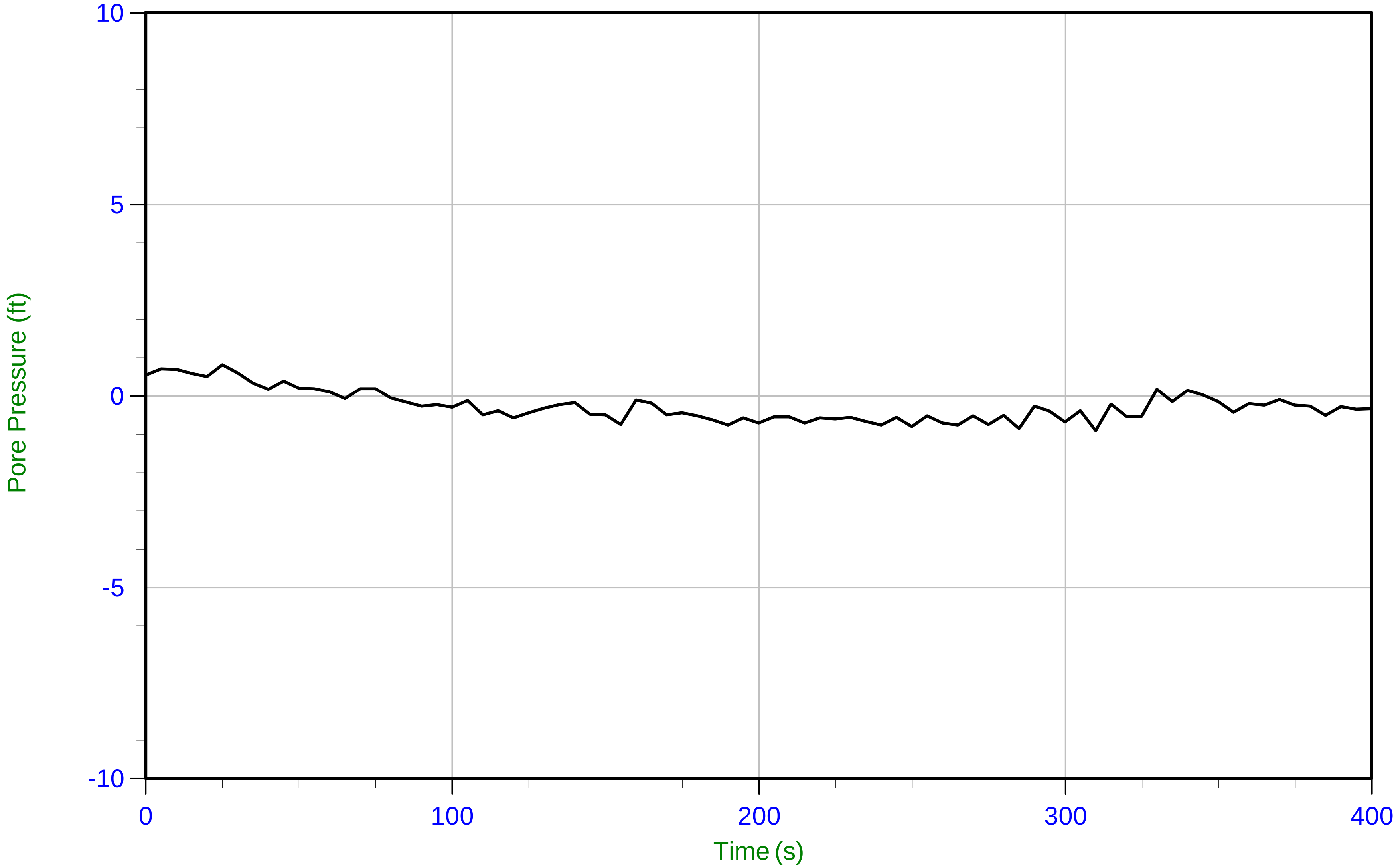
WT: 39.692 m / 130.223 ft
Ueq: 2.5 ft

CONETEC

URS Corporation

Job No: 12-400
Date: 03-Oct-2012 14:52:55
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

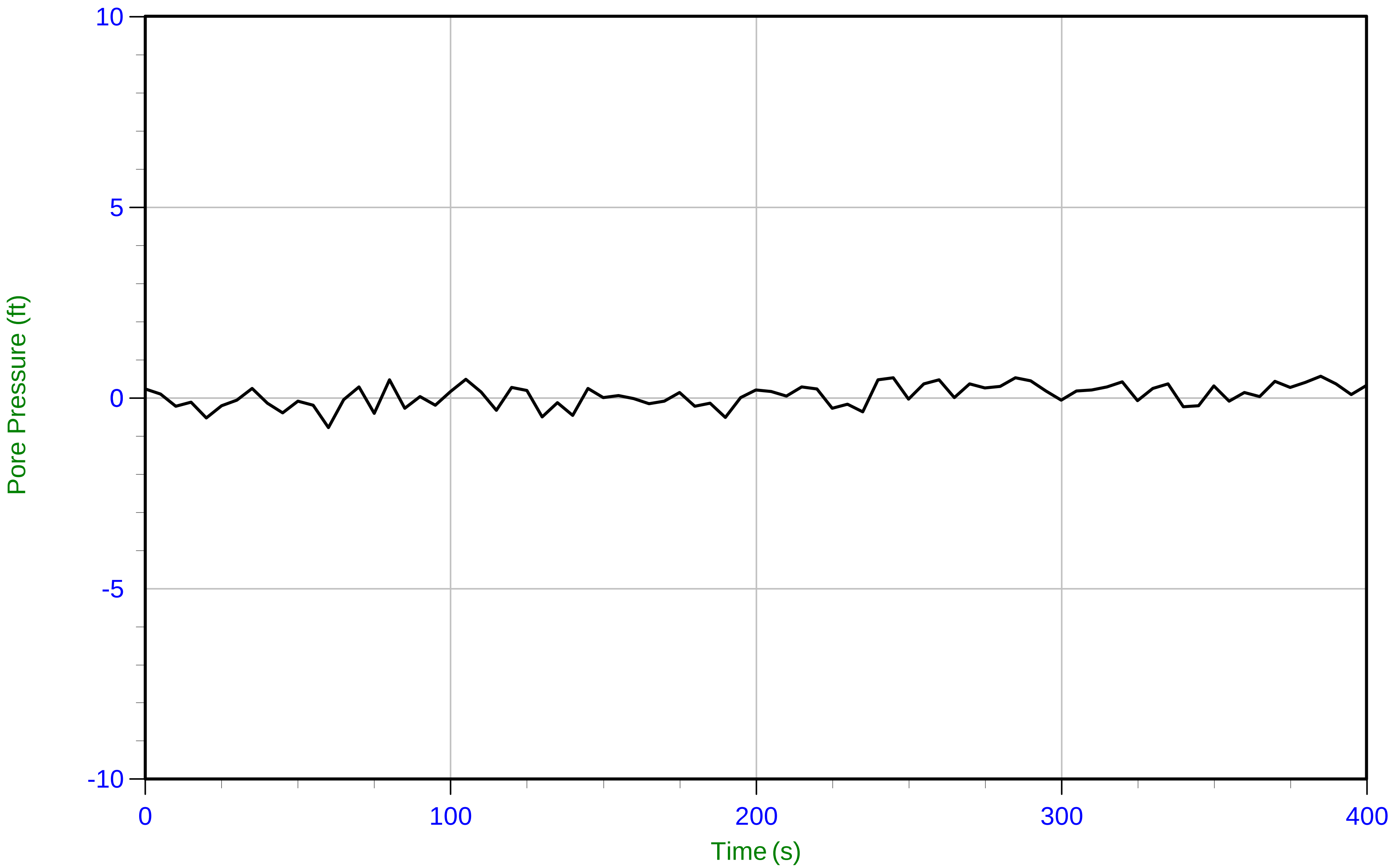
Filename: 12-400RCPT-5-3.PPD
Depth: 13.200 m / 43.307 ft
Duration: 400.0 s

U Min: -0.9 ft
U Max: 0.8 ft

WT: 13.184 m / 43.254 ft
Ueq: 0.1 ft

CONETEC

URS Corporation	Job No: 12-400	Sounding: CPT-2012-5-3
	Date: 03-Oct-2012 14:52:55	Cone: 296
	Site: MAYFLOWER	Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-3.PPD
Depth: 35.200 m / 115.484 ft
Duration: 400.0 s

U Min: -0.8 ft
U Max: 0.6 ft

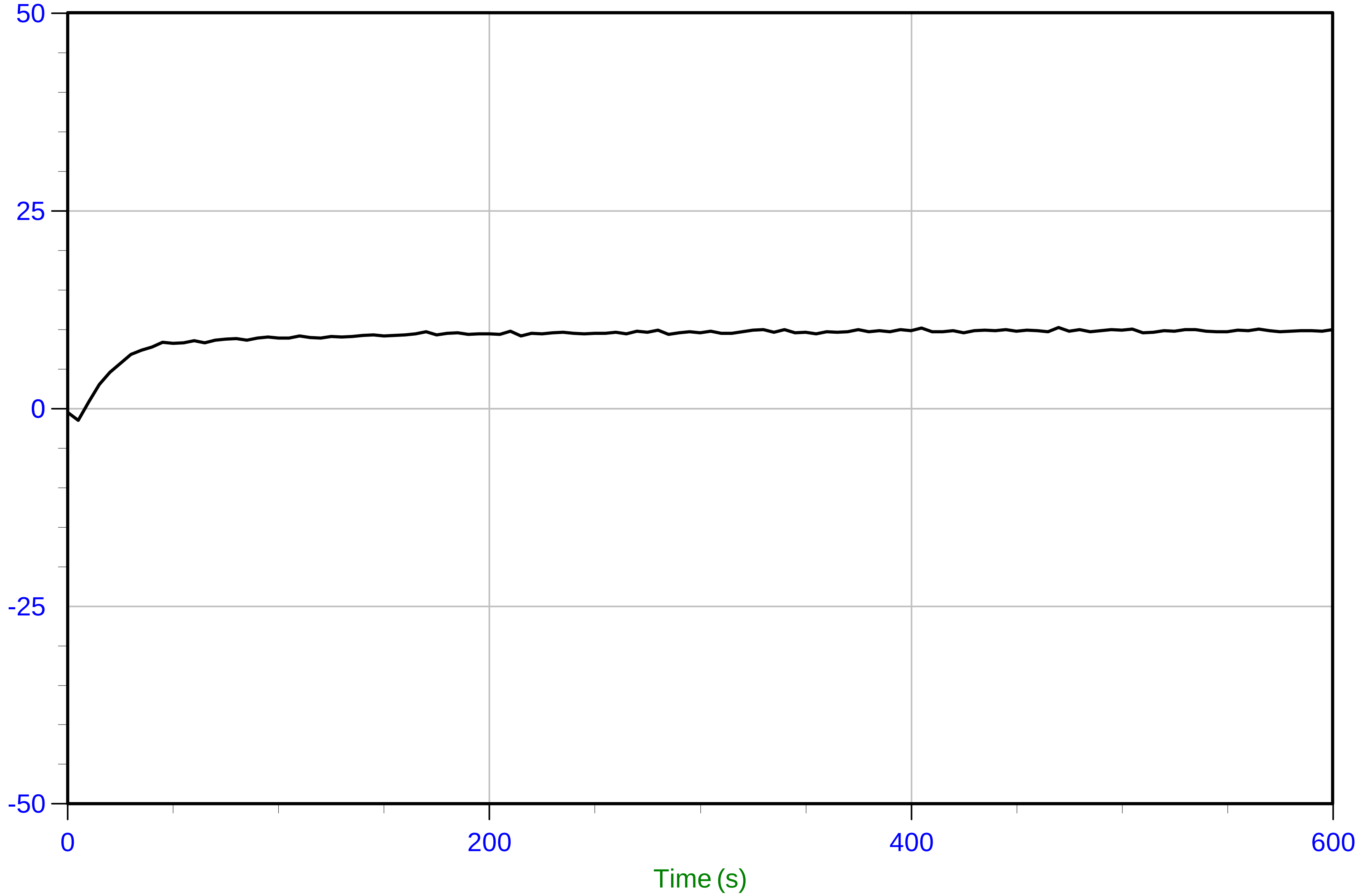
WT: 35.200 m / 115.484 ft
Ueq: 0.0 ft

CONETEC

URS Corporation

Job No: 12-400
Date: 03-Oct-2012 14:52:55
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-3.PPD
Depth: 47.200 m / 154.854 ft
Duration: 600.0 s

U Min: -1.5 ft
U Max: 10.2 ft

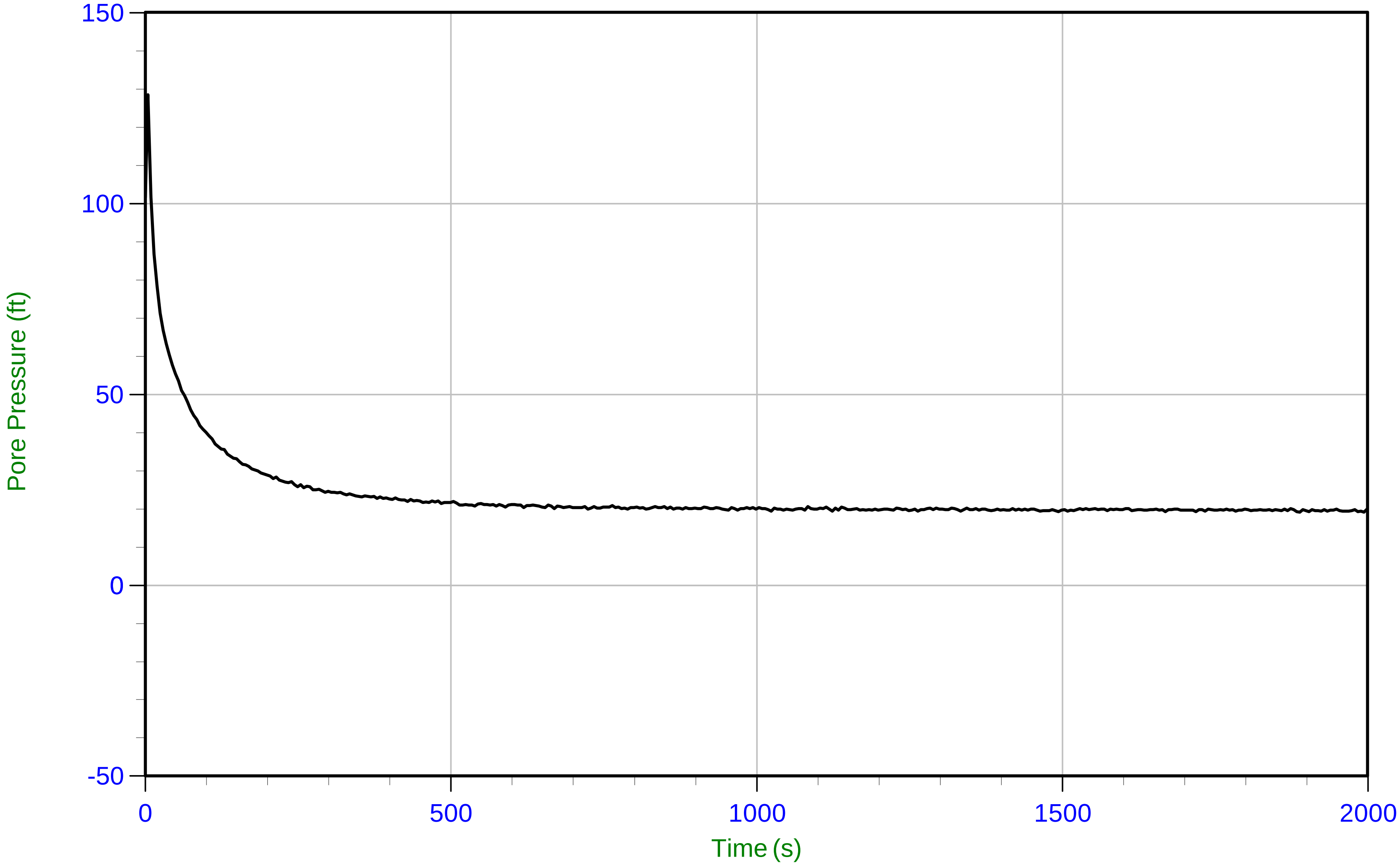
WT: 44.203 m / 145.021 ft
Ueq: 9.8 ft

CONETEC

URS Corporation

Job No: 12-400
Date: 03-Oct-2012 14:52:55
Site: MAYFLOWER

Sounding: CPT-2012-5-3
Cone: 296
Cone Area: 15 sq cm



Trace Summary:

Filename: 12-400RCPT-5-3.PPD
Depth: 51.100 m / 167.649 ft
Duration: 2000.0 s

U Min: 19.1 ft
U Max: 128.4 ft

WT: 45.170 m / 148.193 ft
Ueq: 19.5 ft

Appendix A.3

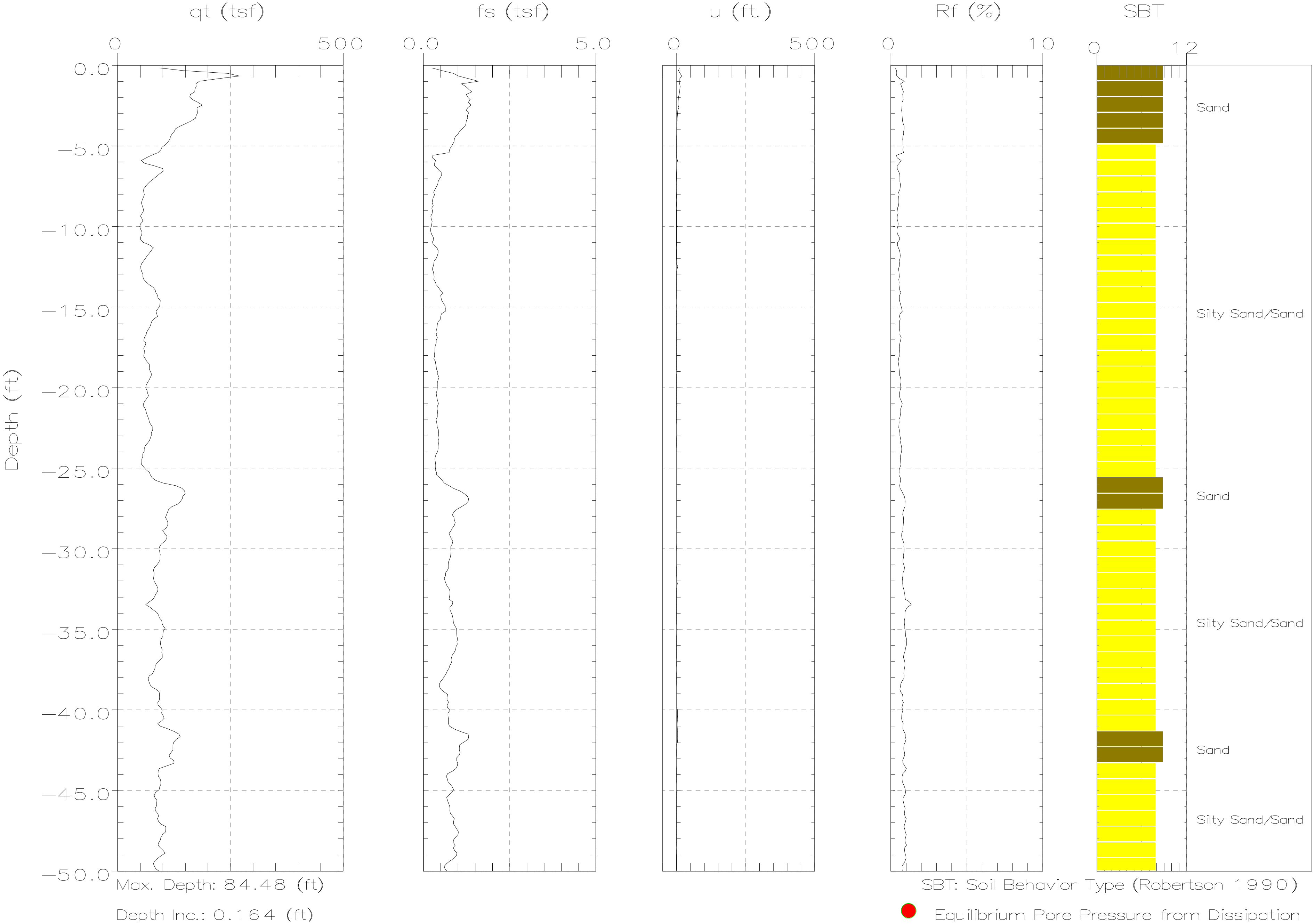
2006 CPT Field-Collected Data Plots

ConeTec

URS Corporation

Hole No.:CPT5-01
Location:CLIMAX DAM 5

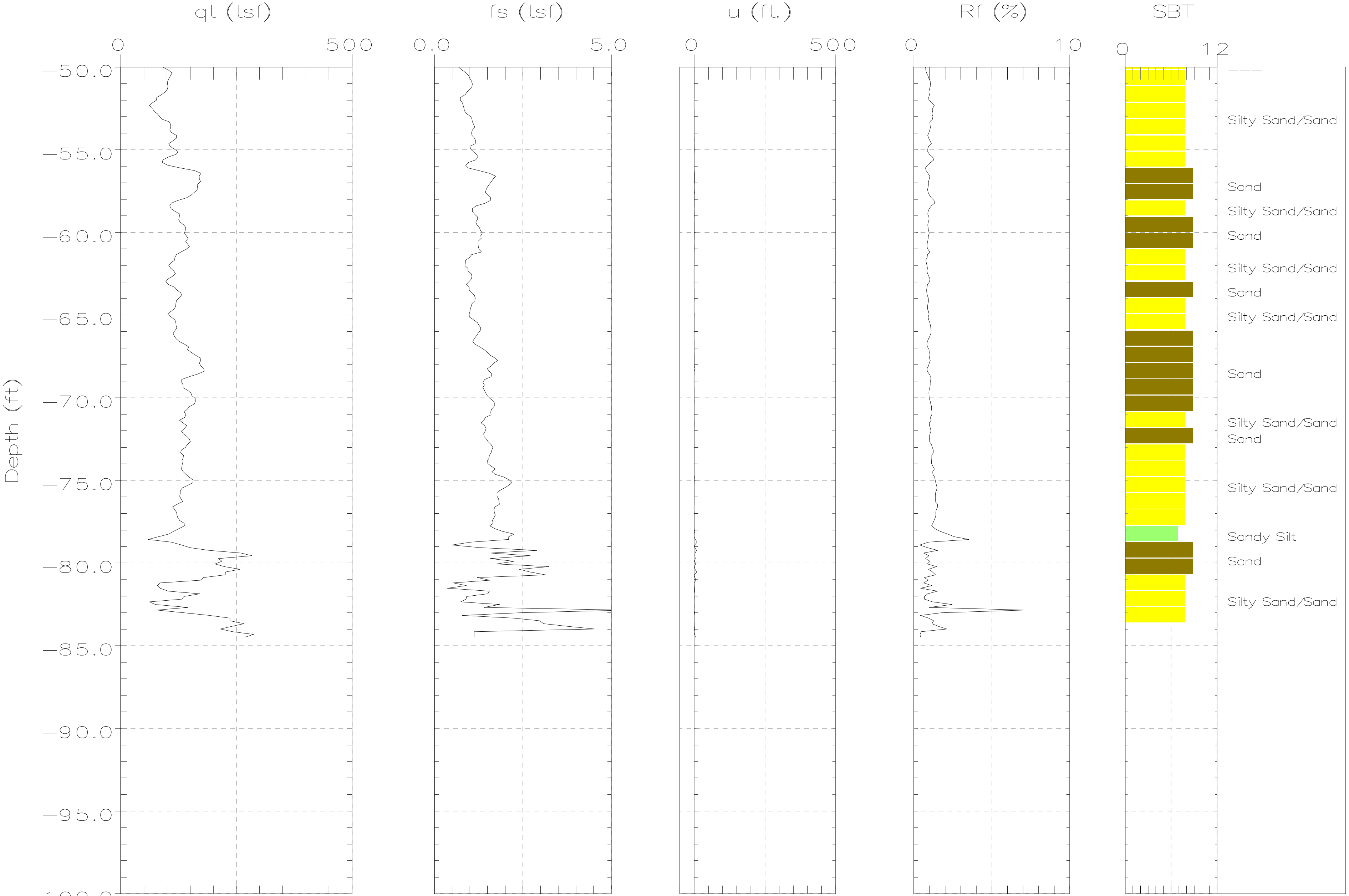
Cone: 20 Ton St 183
Date:08:12:06 10:41



URS Corporation

Hole No.:CPT5-01
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 10:41

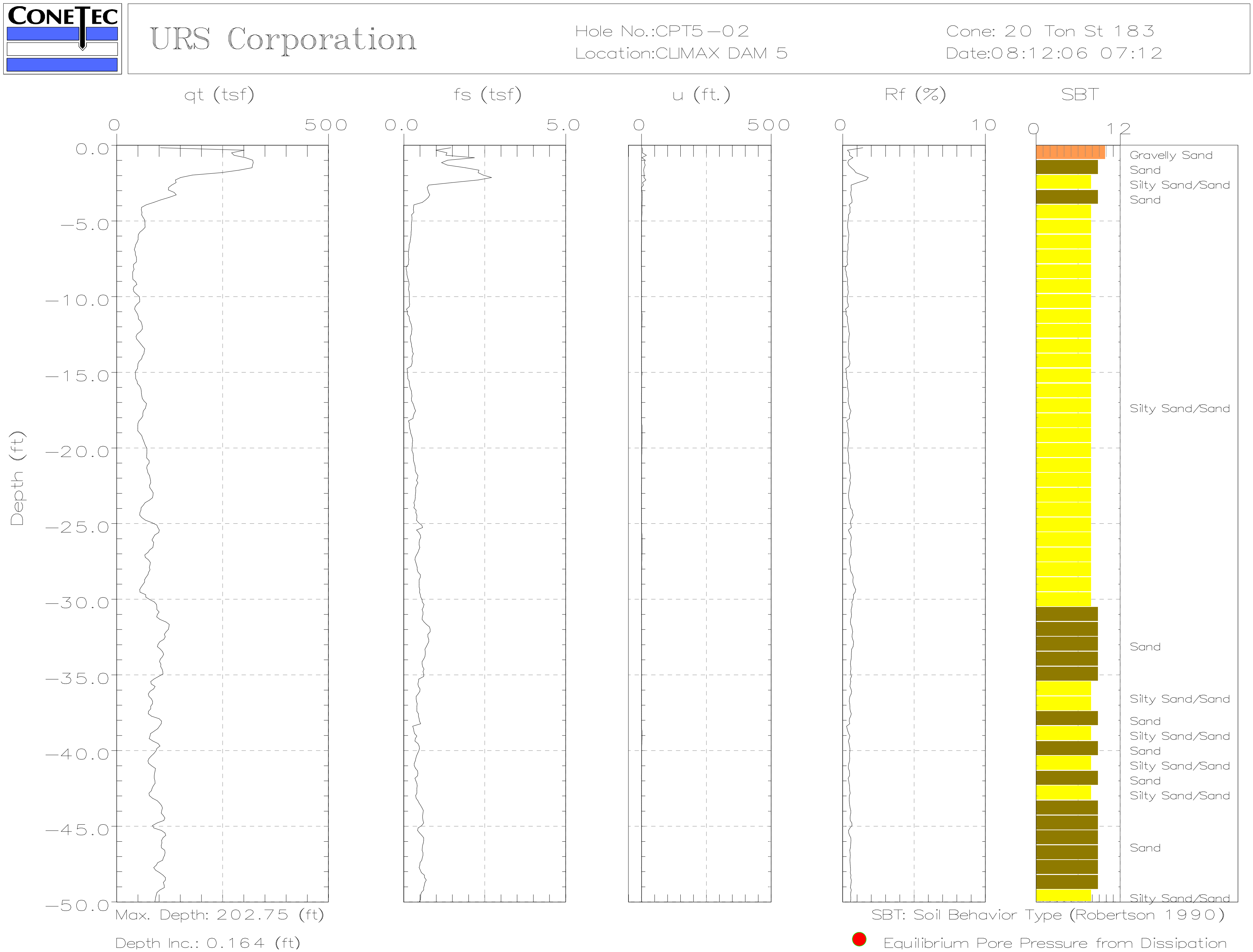


Max. Depth: 84.48 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation

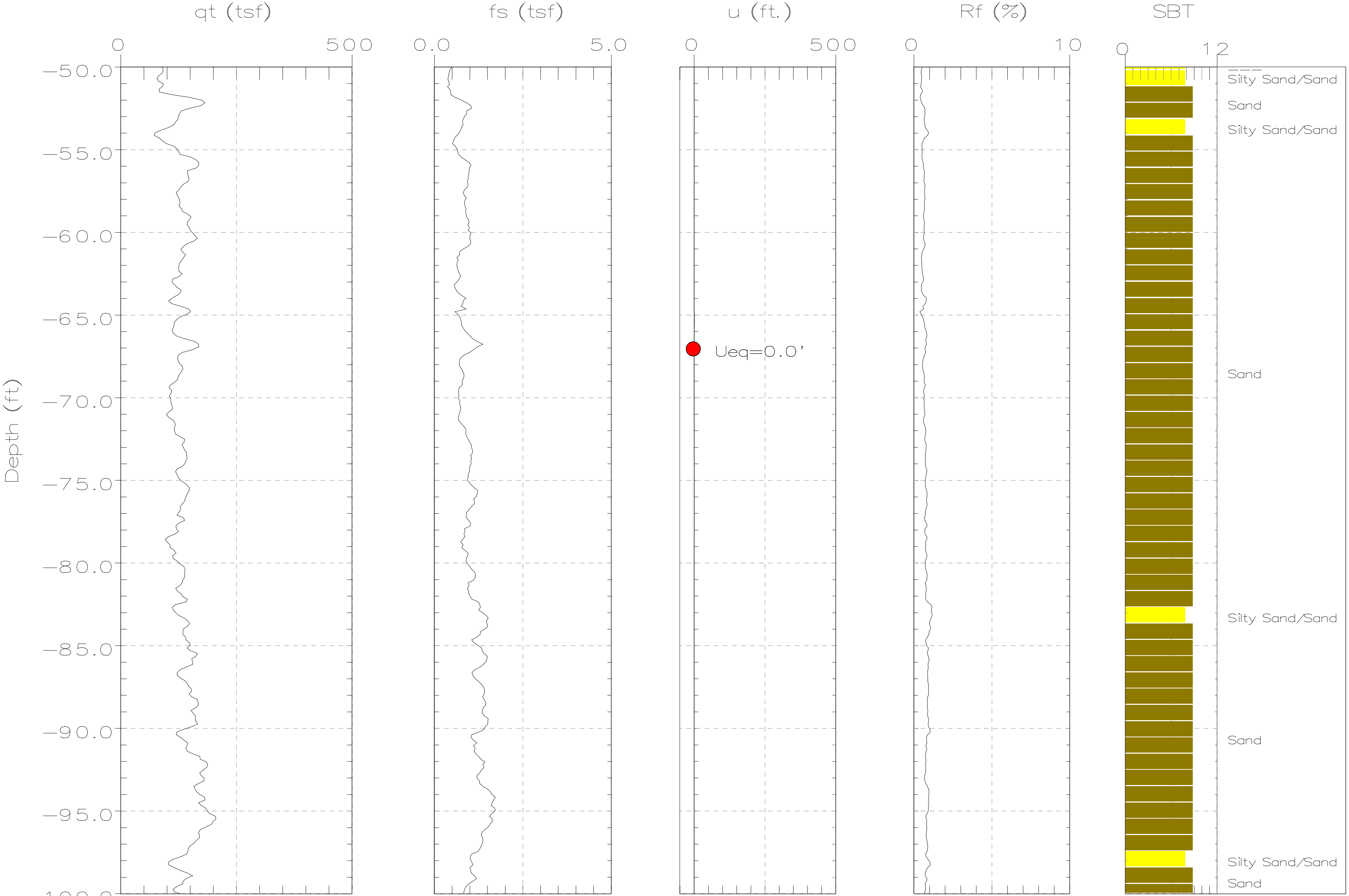


CONETEC
URS Corporation
Hole No.:CPT5-02
Location:CLIMAX DAM 5
Cone: 20 Ton St 183
Date:08:12:06 07:12
qt (tsf)
fs (tsf)
u (ft.)
Rf (%)
SBT
0
500
0.0
5.0
0
500
0
10
0
12
Depth (ft)
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
Gravelly Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Max. Depth: 202.75 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12



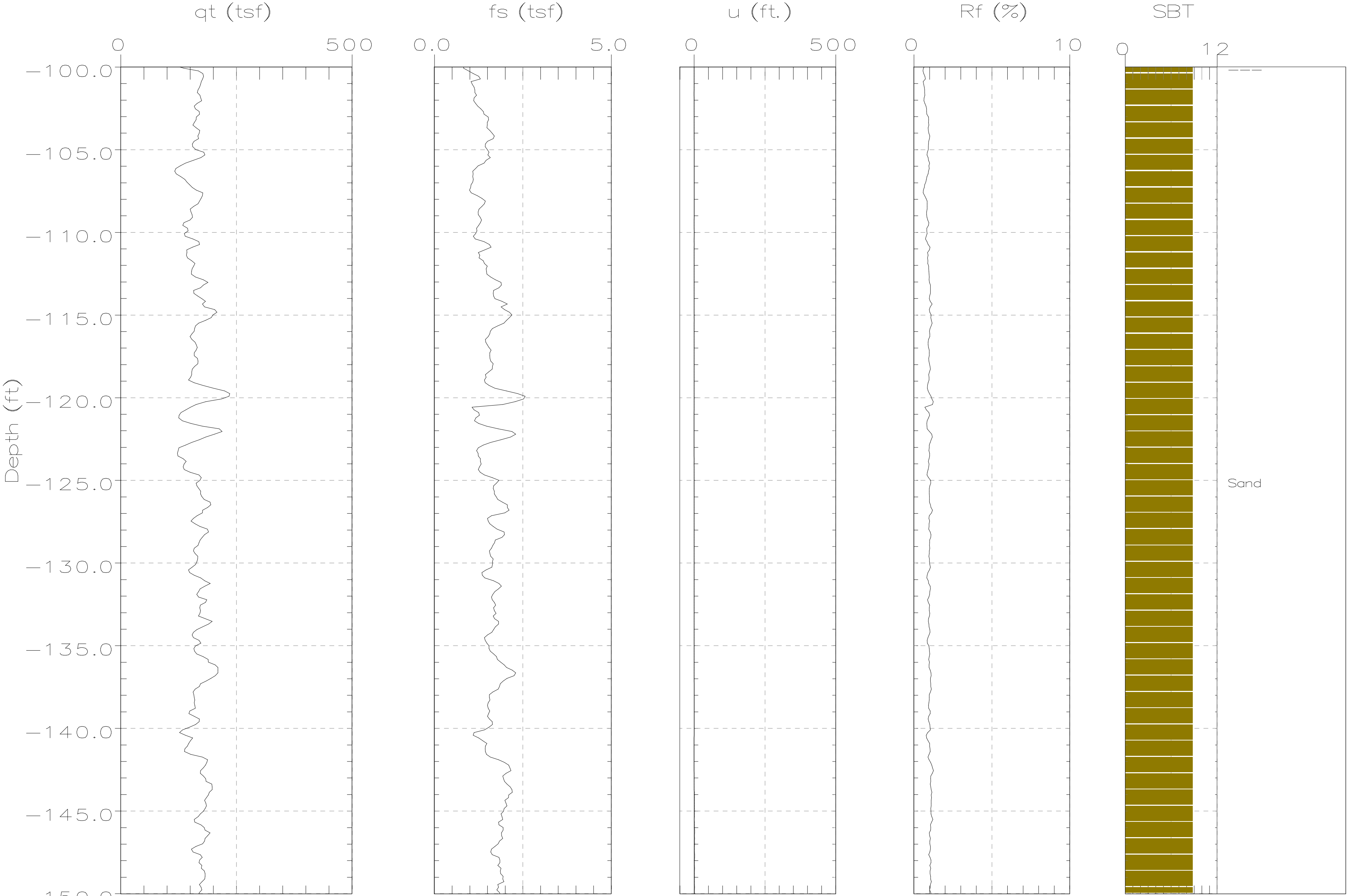
Max. Depth: 202.75 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12



Max. Depth: 202.75 (ft)

Depth Inc.: 0.164 (ft)

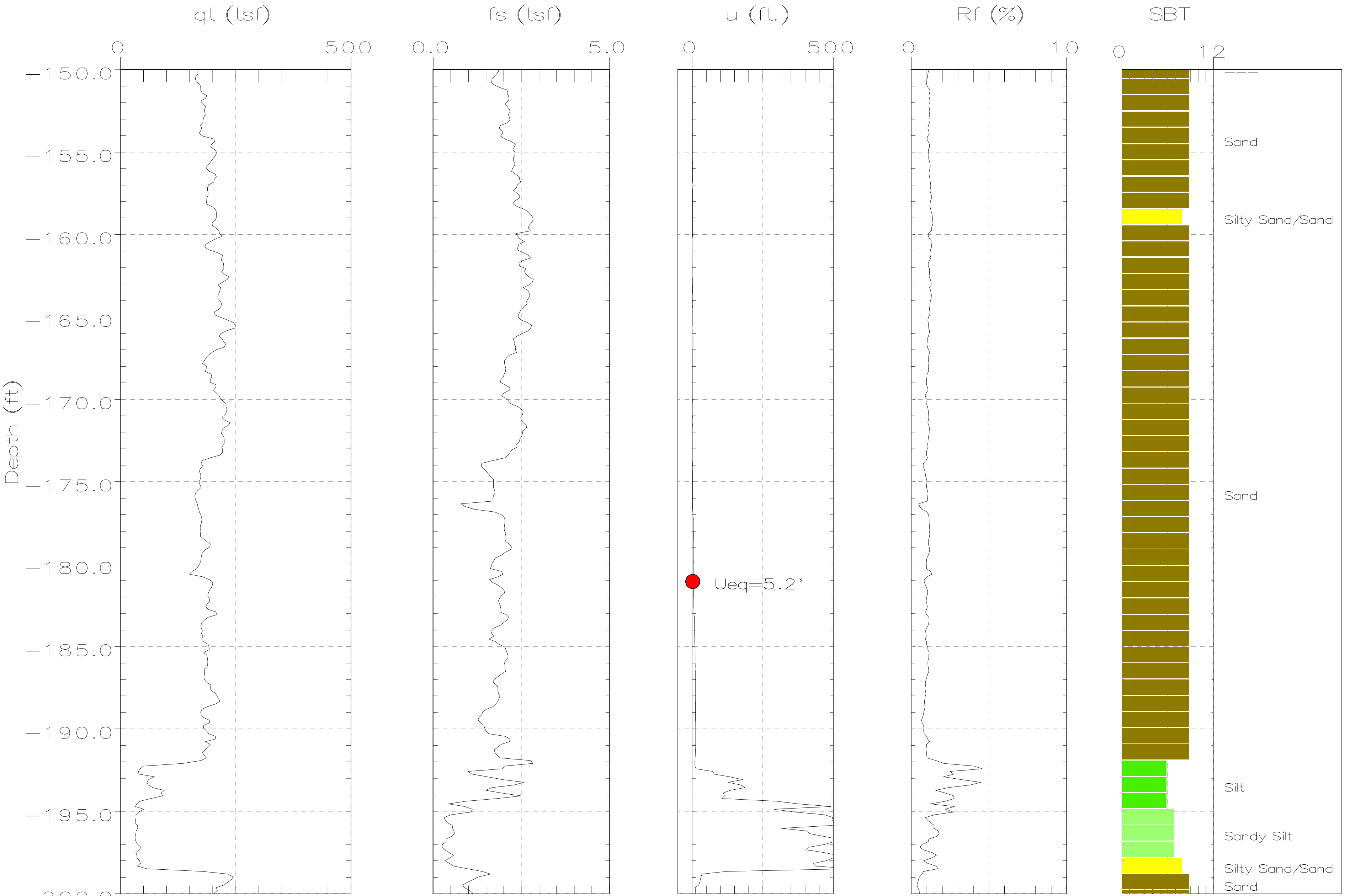
SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12



Max. Depth: 202.75 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12

Max. Depth: 202.75 (ft)
Depth Inc.: 0.164 (ft)

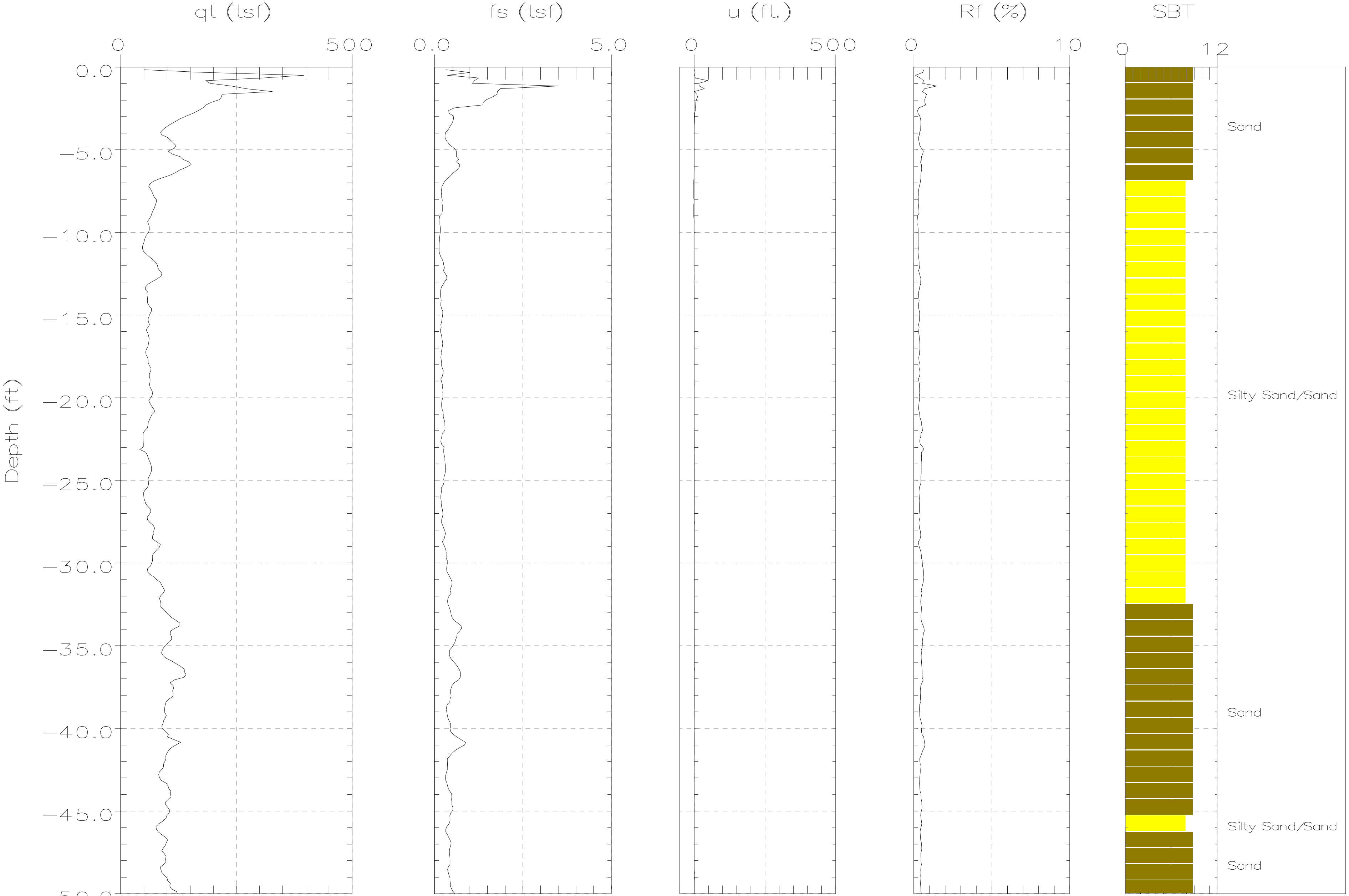
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

ConeTec

URS Corporation

Hole No.:CPT5-03
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:11:06 14:29



Max. Depth: 114.01 (ft)
Depth Inc.: 0.164 (ft)

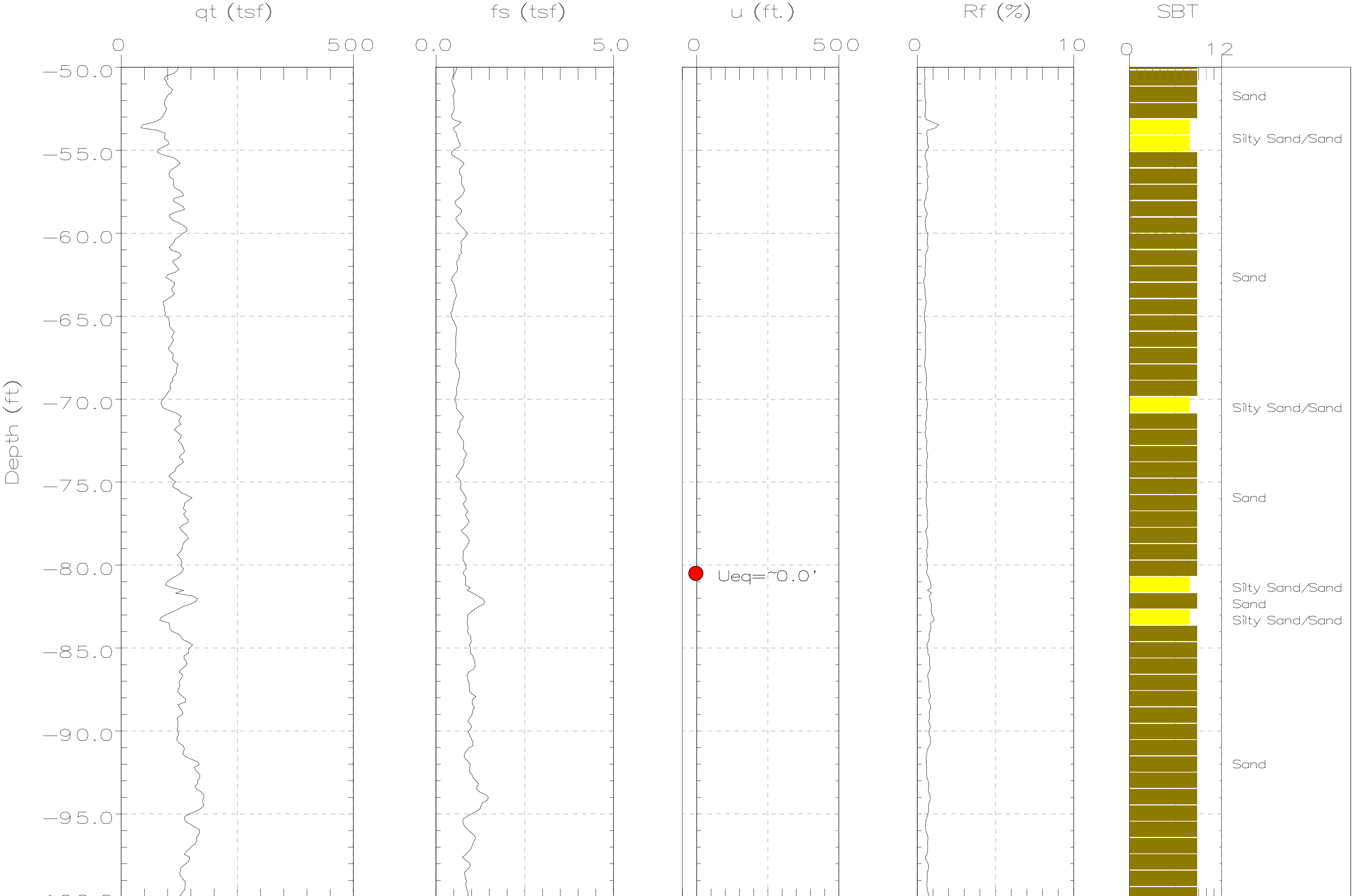
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

ConeTec

URS Corporation

Hole No.:CPT5-03
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:11:06 14:29



Max. Depth: 114.01 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

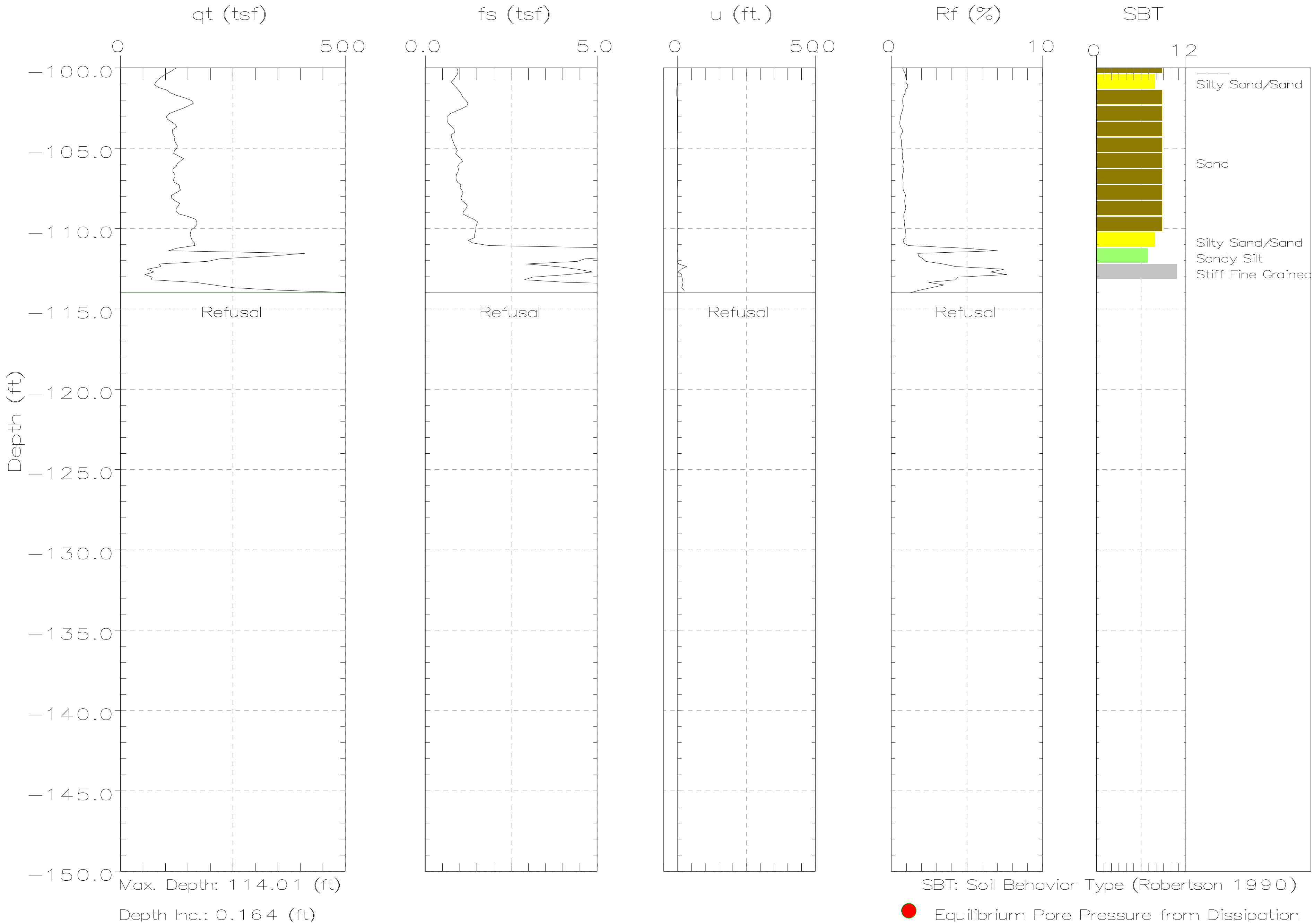
Equilibrium Pore Pressure from Dissipation

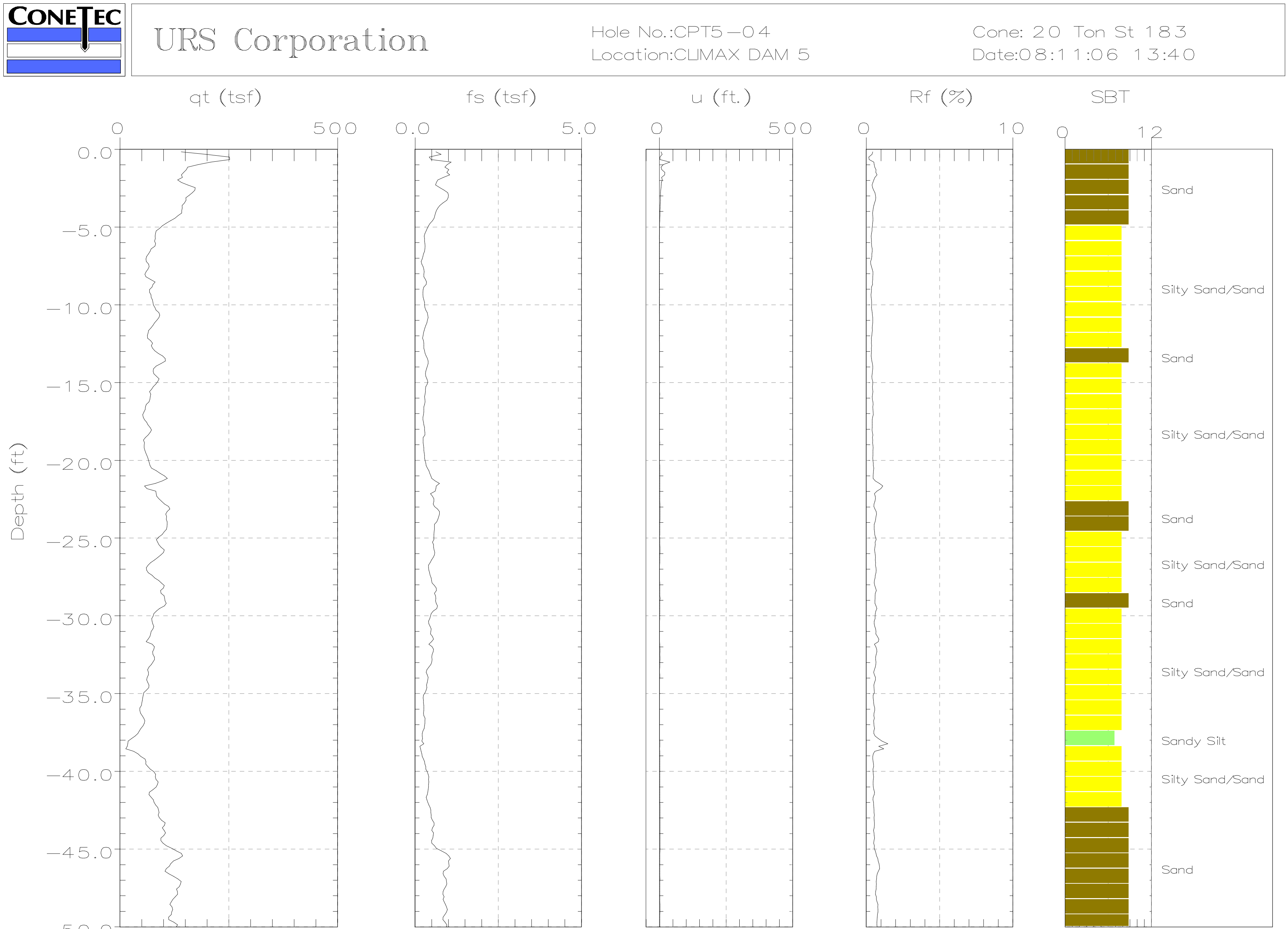
ConeTec

URS Corporation

Hole No.:CPT5-03
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:11:06 14:29



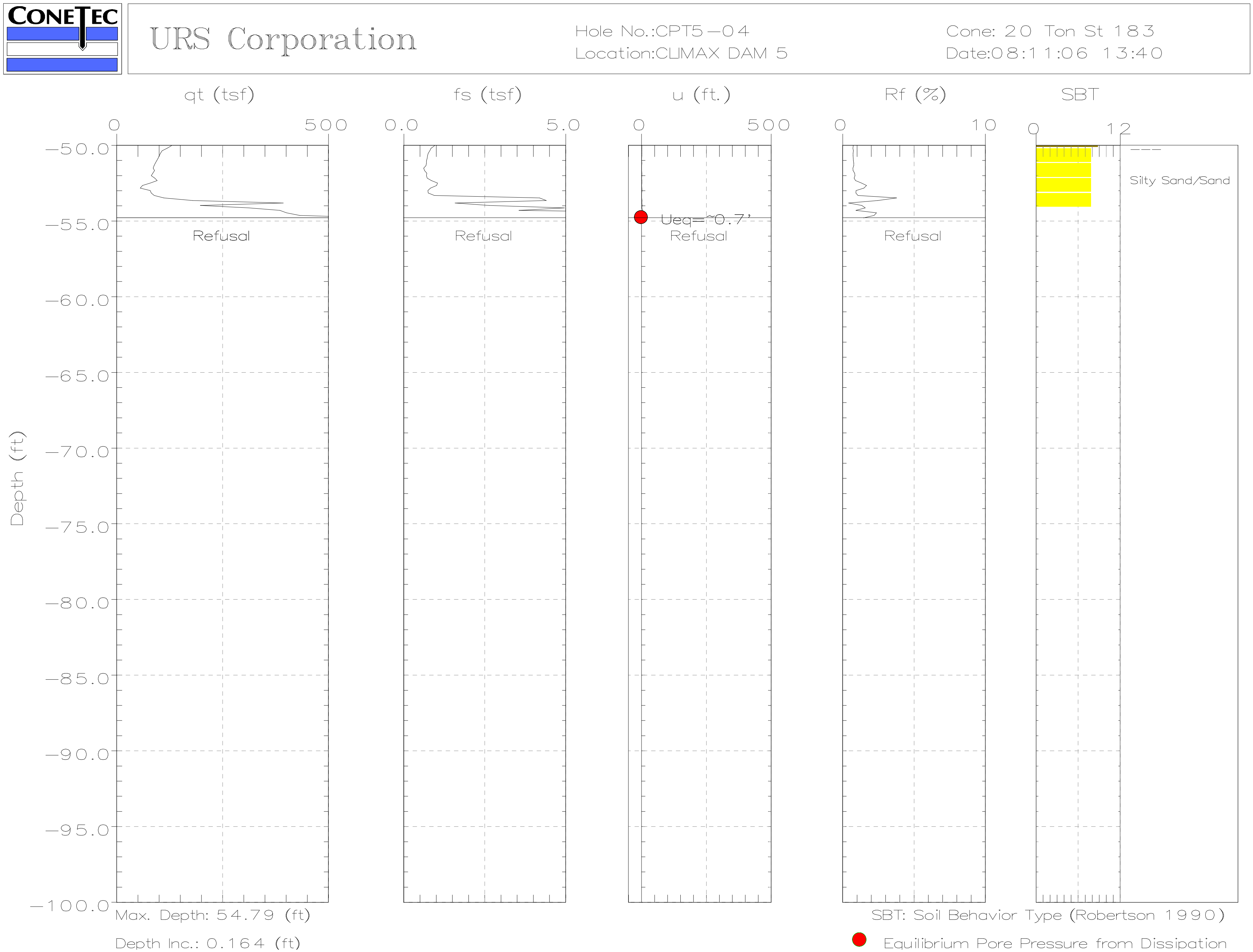


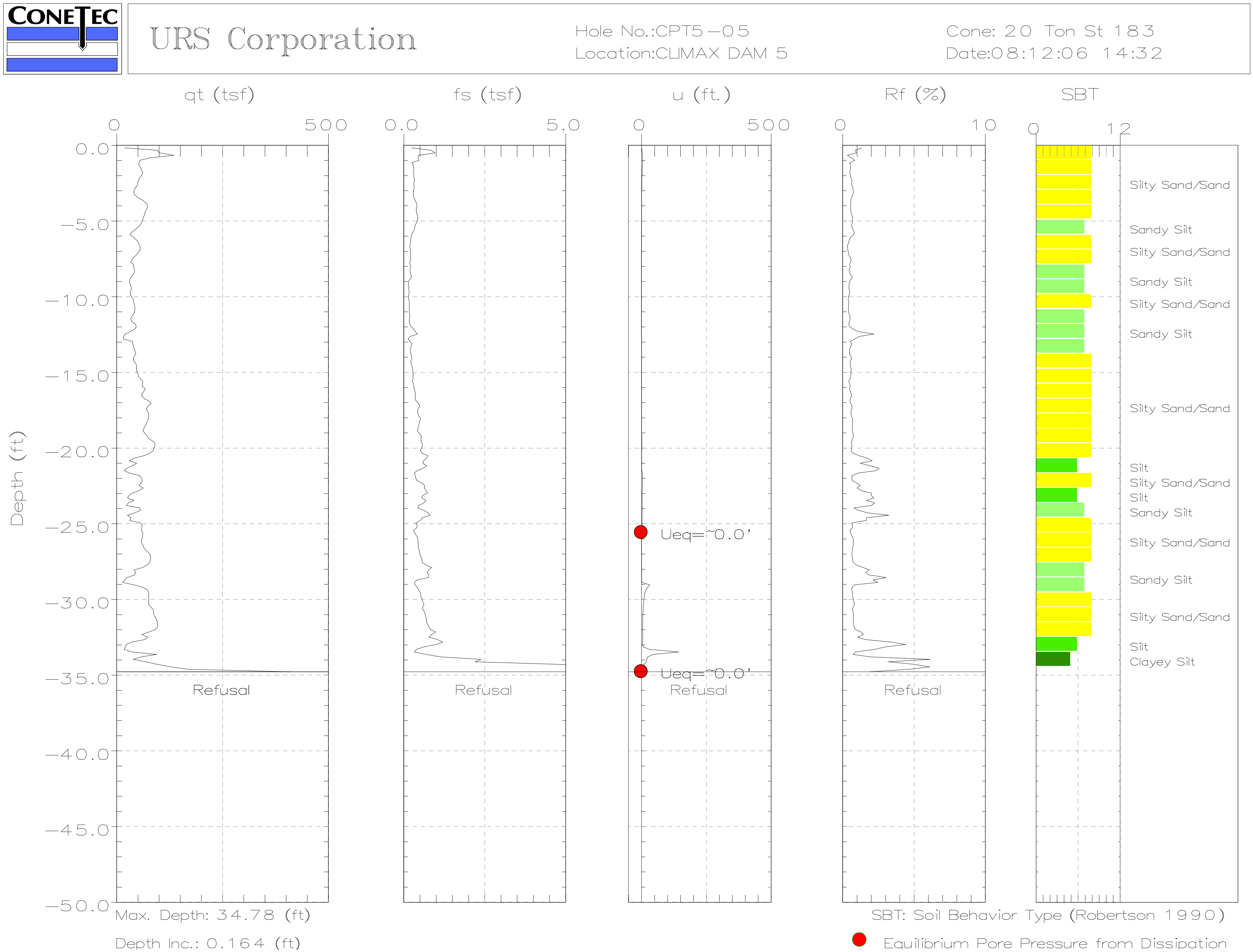
Max. Depth: 54.79 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation


ConeTec
URS Corporation
Hole No.:CPT5-04
Location:CLIMAX DAM 5
Cone: 20 Ton St 183
Date:08:11:06 13:40
qt (tsf)
fs (tsf)
u (ft.)
Rf (%)
SBT
0
500
0.0
5.0
10
12
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
Depth (ft)
Refusal
Ueq=~0.7'
Silty Sand/Sand
Max. Depth: 54.79 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation



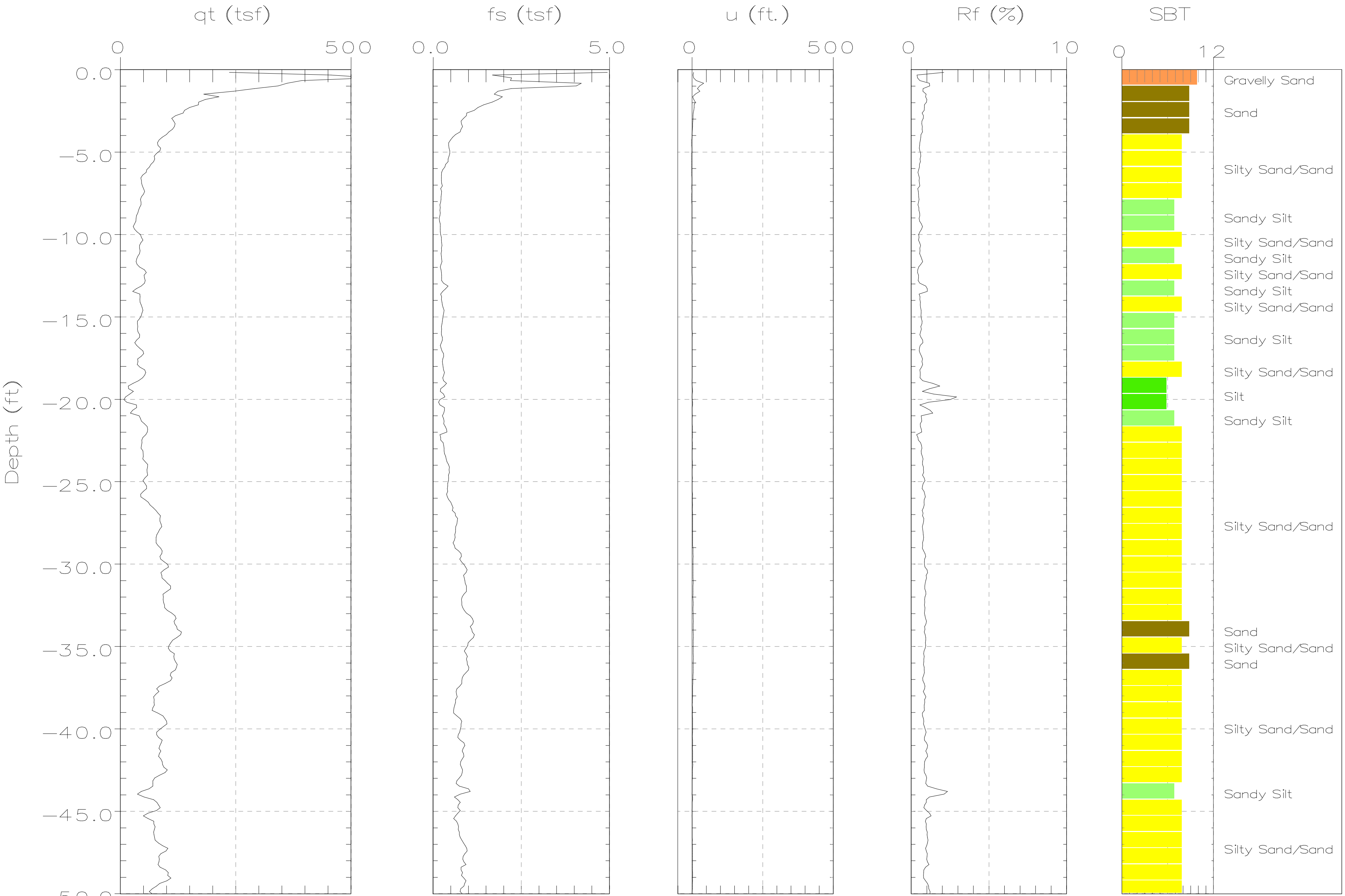
CONETEC
URS Corporation
Hole No.:CPT5-05
Location:CLIMAX DAM 5
Cone: 20 Ton St 183
Date:08:12:06 14:32
qt (tsf)
fs (tsf)
u (ft.)
Rf (%)
SBT
0
500
0.0
5.0
0
500
0
10
0
12
Depth (ft)
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
Refusal
Refusal
Refusal
Refusal
Ueq=~0.0'
Ueq=~0.0'
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Silt
Silty Sand/Sand
Silt
Sandy Silt
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Silt
Clayey Silt
Max. Depth: 34.78 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

ConeTec

URS Corporation

Hole No.:CPT5-06
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 11:49

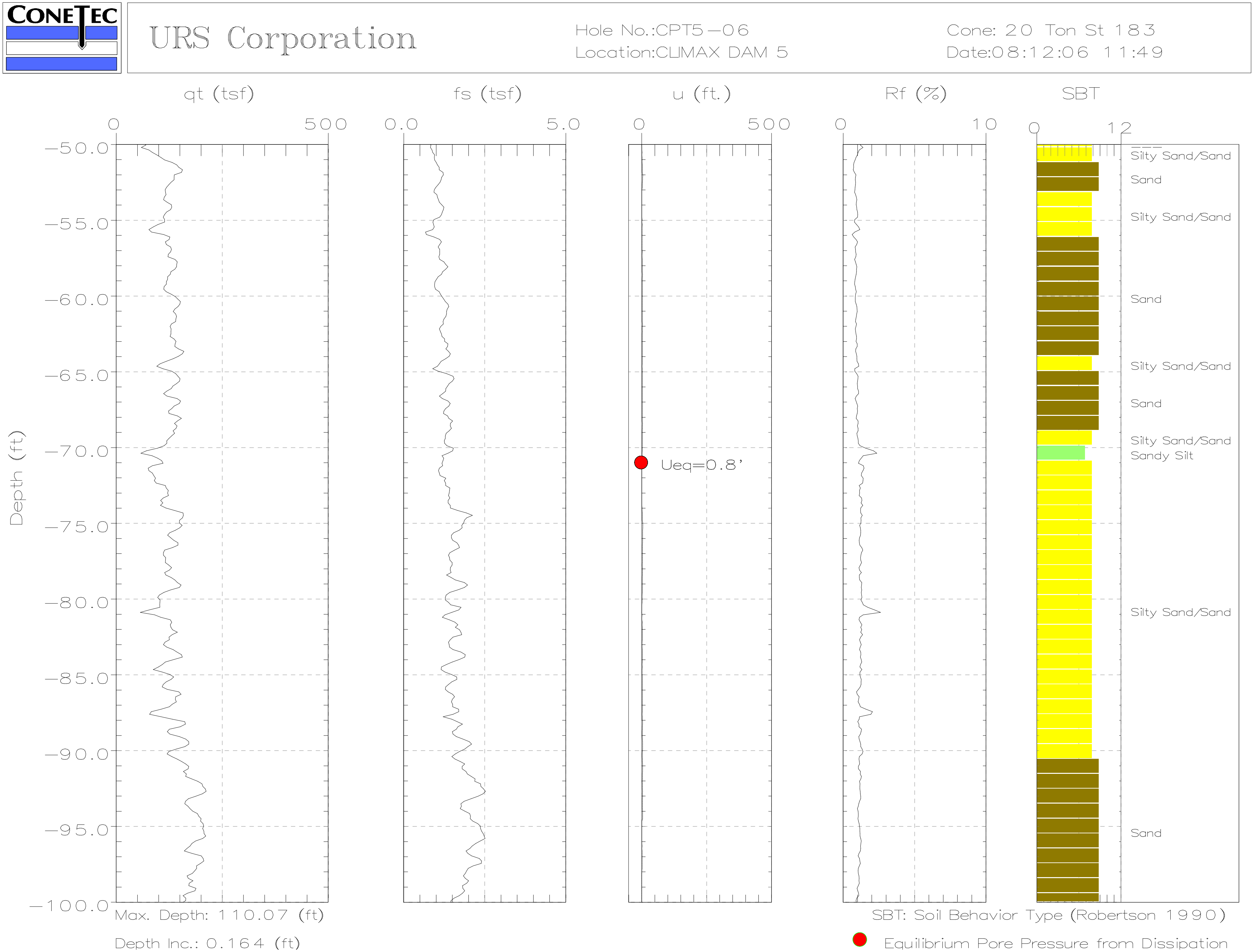


Max. Depth: 110.07 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation



URS Corporation
Hole No.:CPT5-06
Location:CLIMAX DAM 5
Cone: 20 Ton St 183
Date:08:12:06 11:49
qt (tsf)
fs (tsf)
u (ft.)
Rf (%)
SBT
0
500
0.0
5.0
0
500
0
10
0
12
Depth (ft)
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
Ueq=0.8'
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sand
Silty Sand/Sand
Sandy Silt
Silty Sand/Sand
Sand
Max. Depth: 110.07 (ft)
Depth Inc.: 0.164 (ft)
SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-06
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 11:49

Max. Depth: 110.07 (ft)
Depth Inc.: 0.164 (ft)

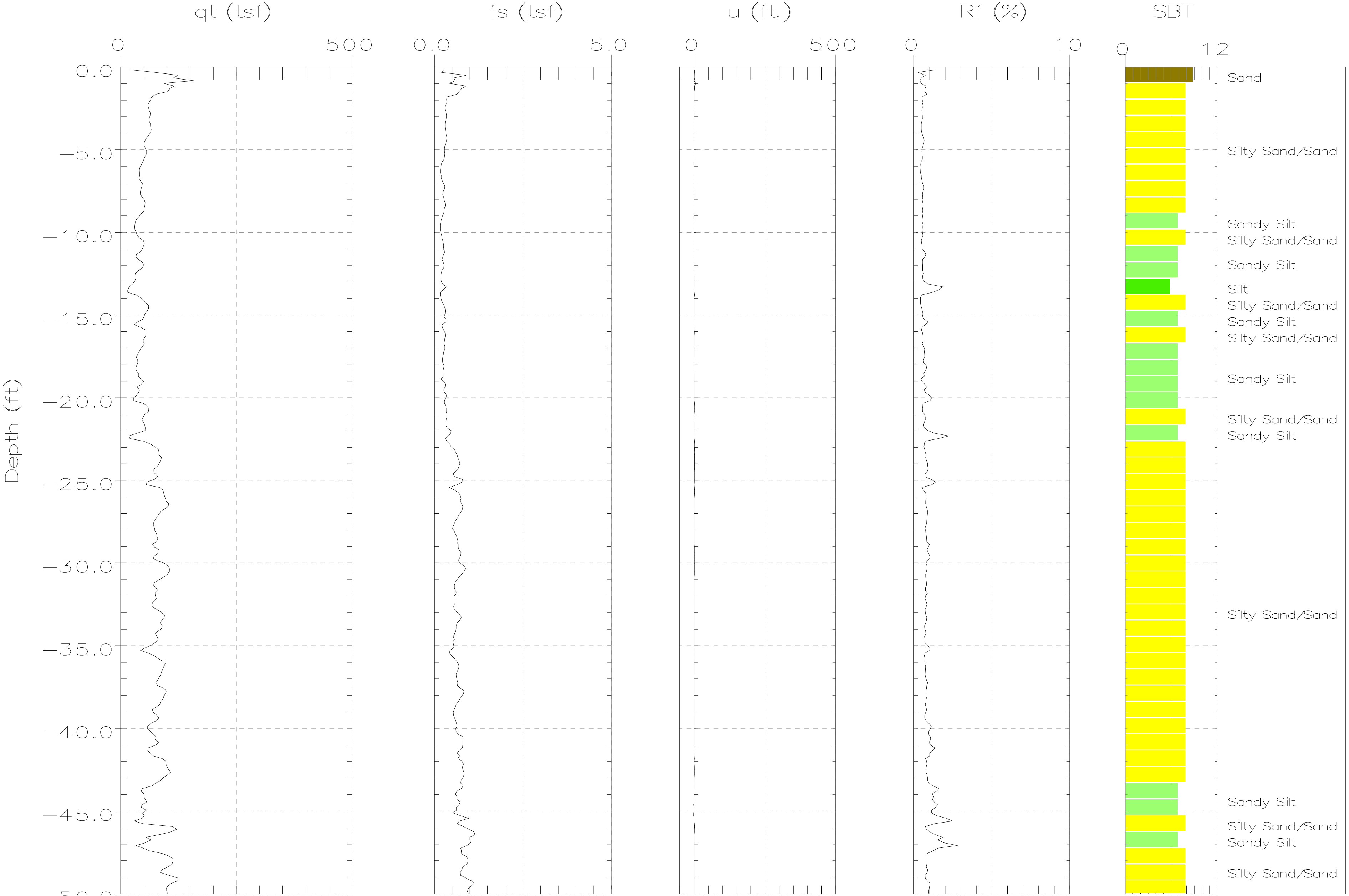
SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-07
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 13:09



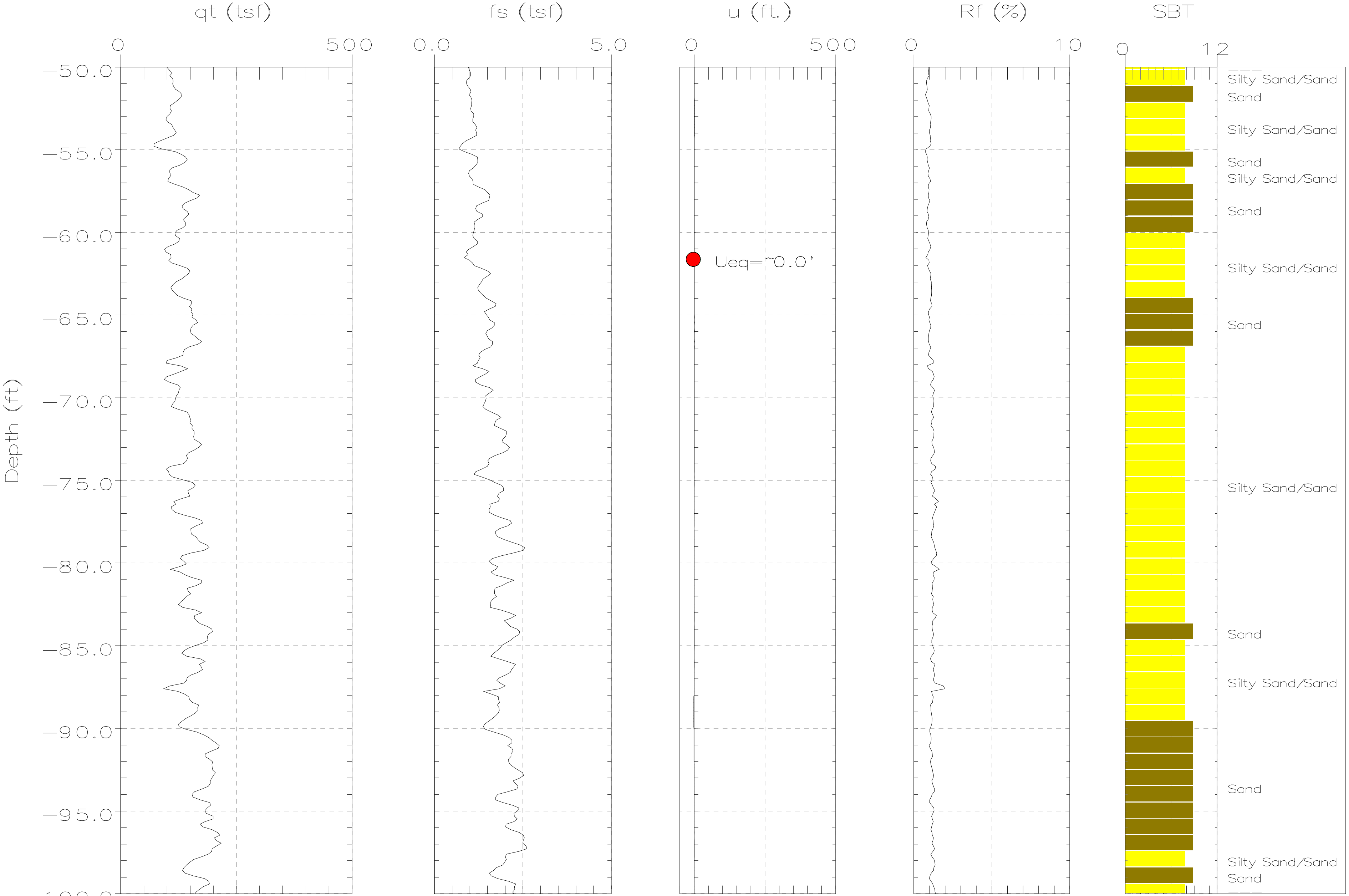
Max. Depth: 125.00 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Equilibrium Pore Pressure from Dissipation

URS Corporation

Hole No.:CPT5-07
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 13:09



Max. Depth: 125.00 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

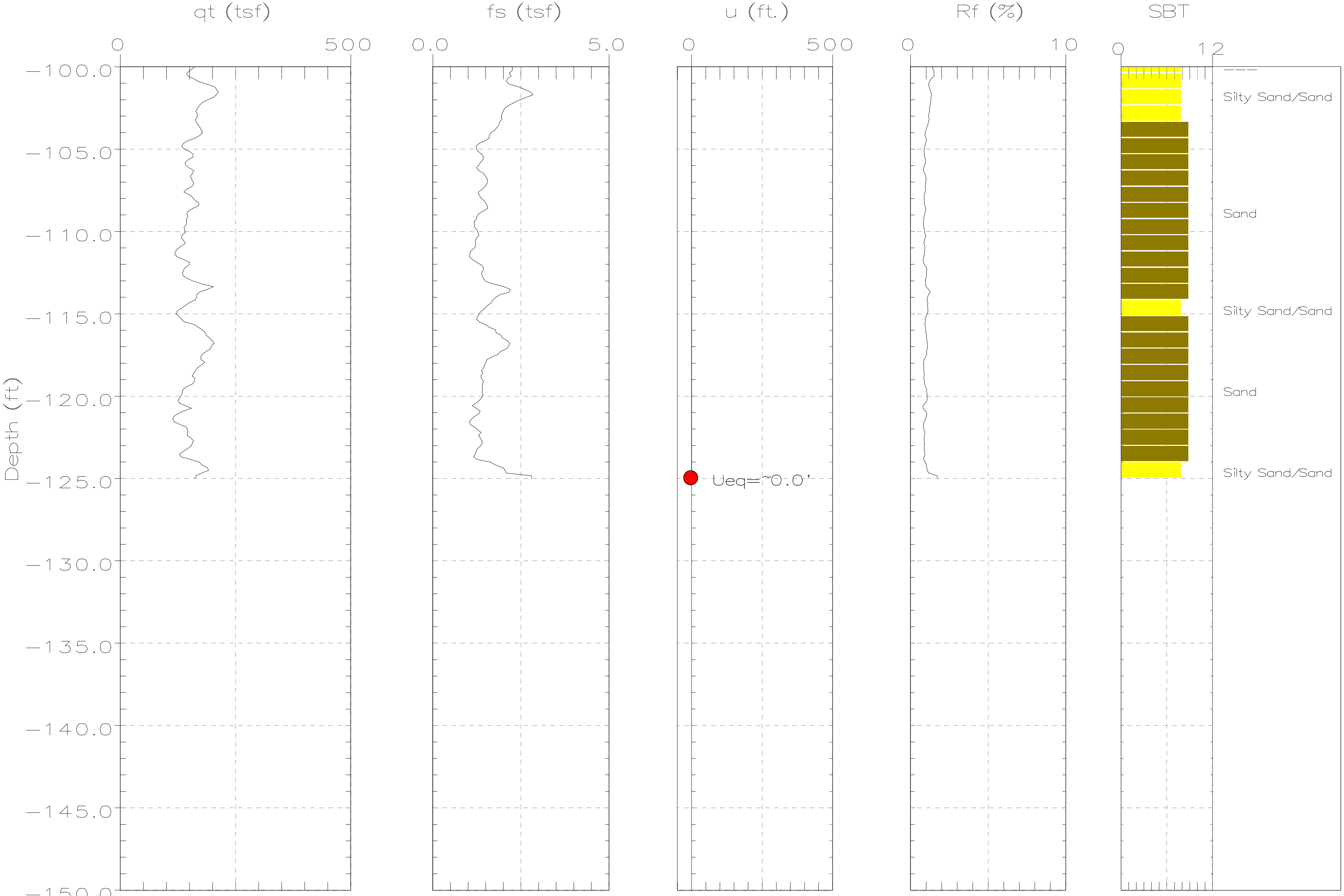
Equilibrium Pore Pressure from Dissipation

CONETEC

URS Corporation

Hole No.:CPT5-07
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 13:09



Max. Depth: 125.00 (ft)

Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Equilibrium Pore Pressure from Dissipation

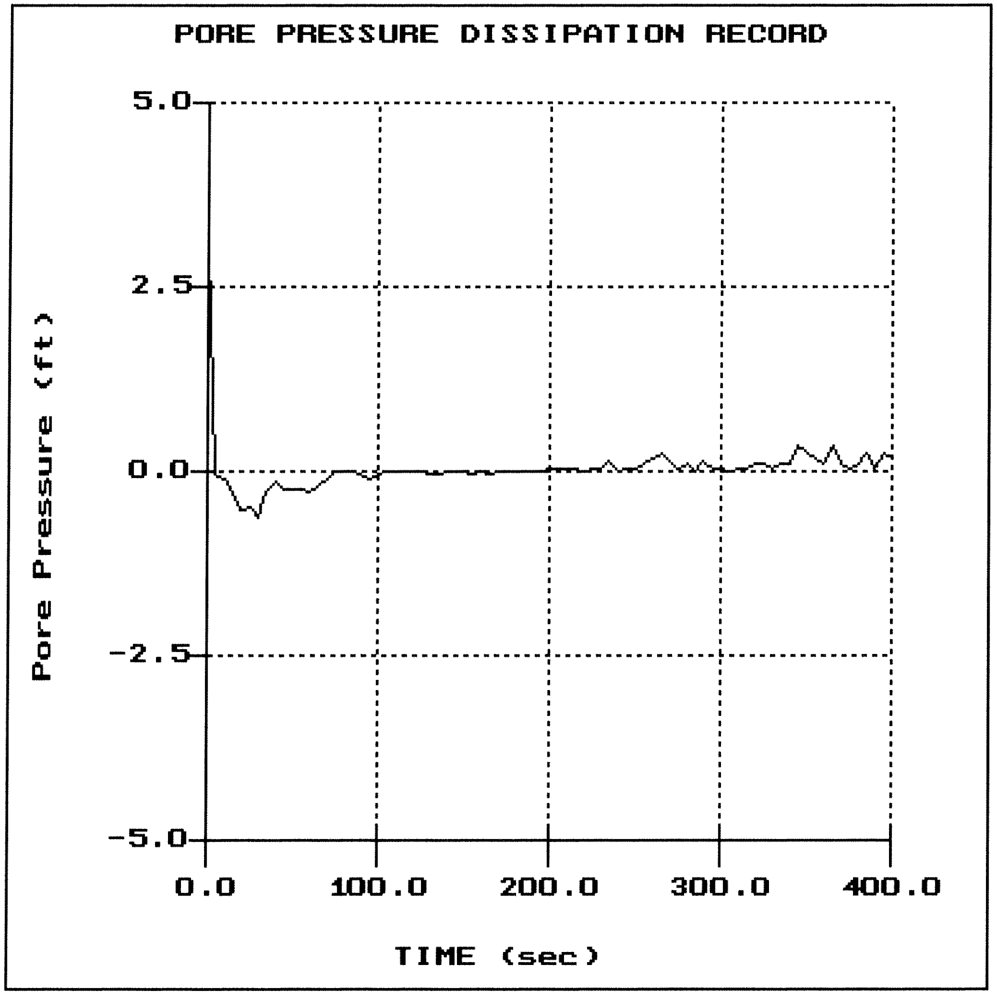
Appendix A.4

2006 Pore Pressure Dissipation Test Results

URS Corporation

Hole No.:CPT5-01
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 10:41



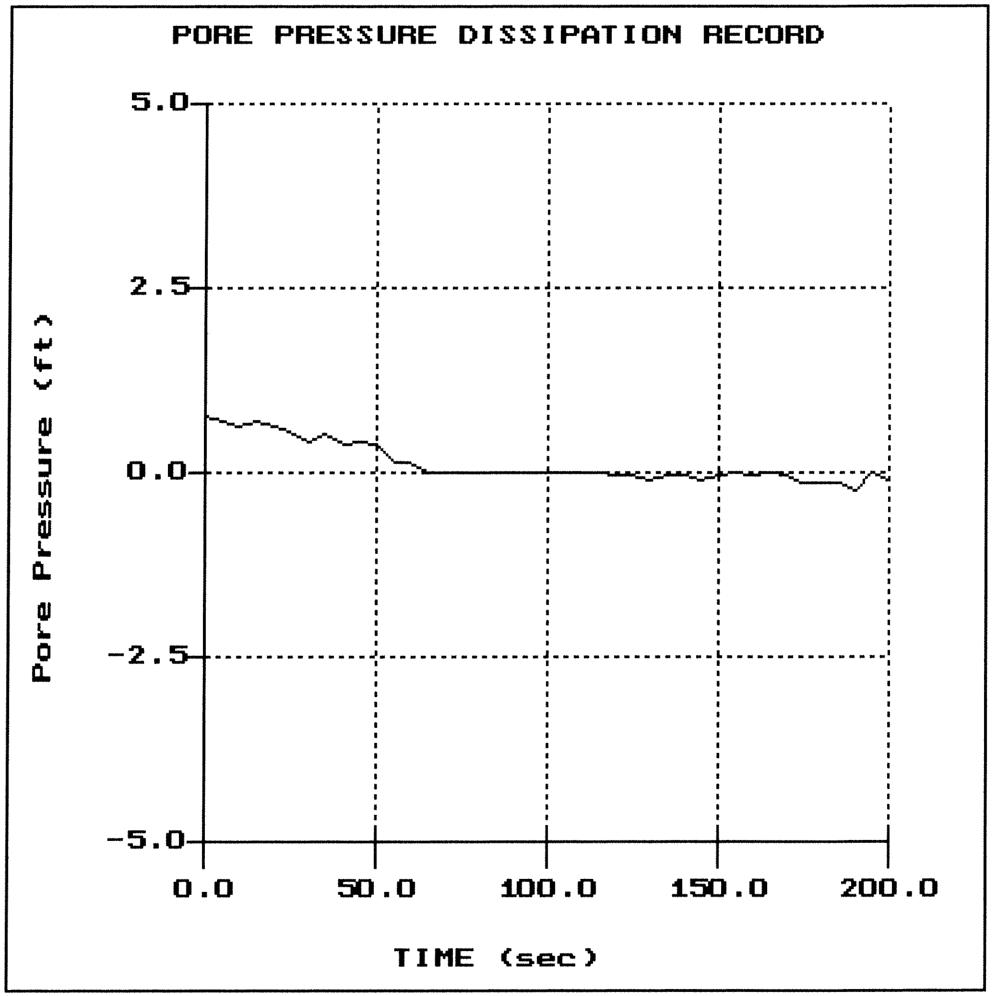
File: 393C5O1.PPD
Depth (m): 24.75
(ft): 81.20
Duration : 400.0s
U-min: -0.61 30.0s
U-max: 3.10 0.0s

URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12

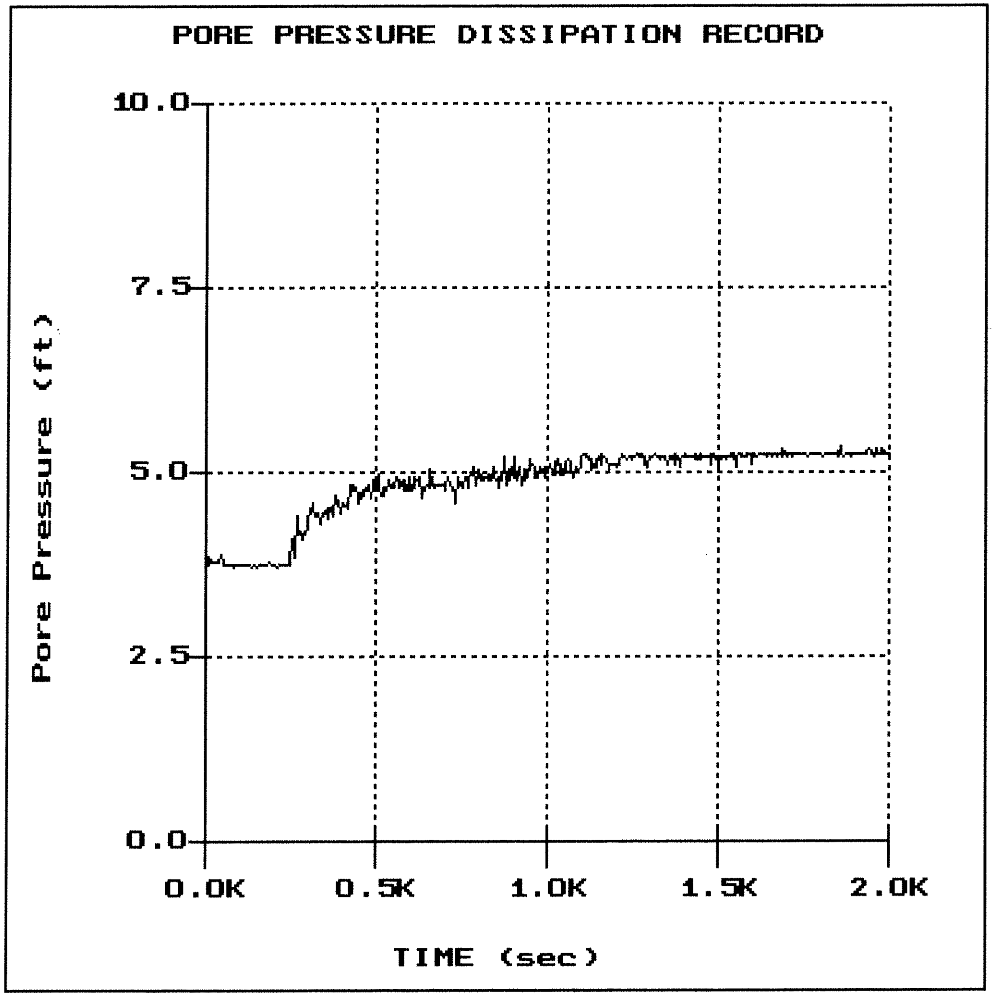
File: 393C502.PPD
Depth (m): 20.45
(ft): 67.09
Duration : 200.0s
U-min: -0.23 190.0s
U-max: 0.75 0.0s



URS Corporation

Hole No.:CPT5-02
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 07:12

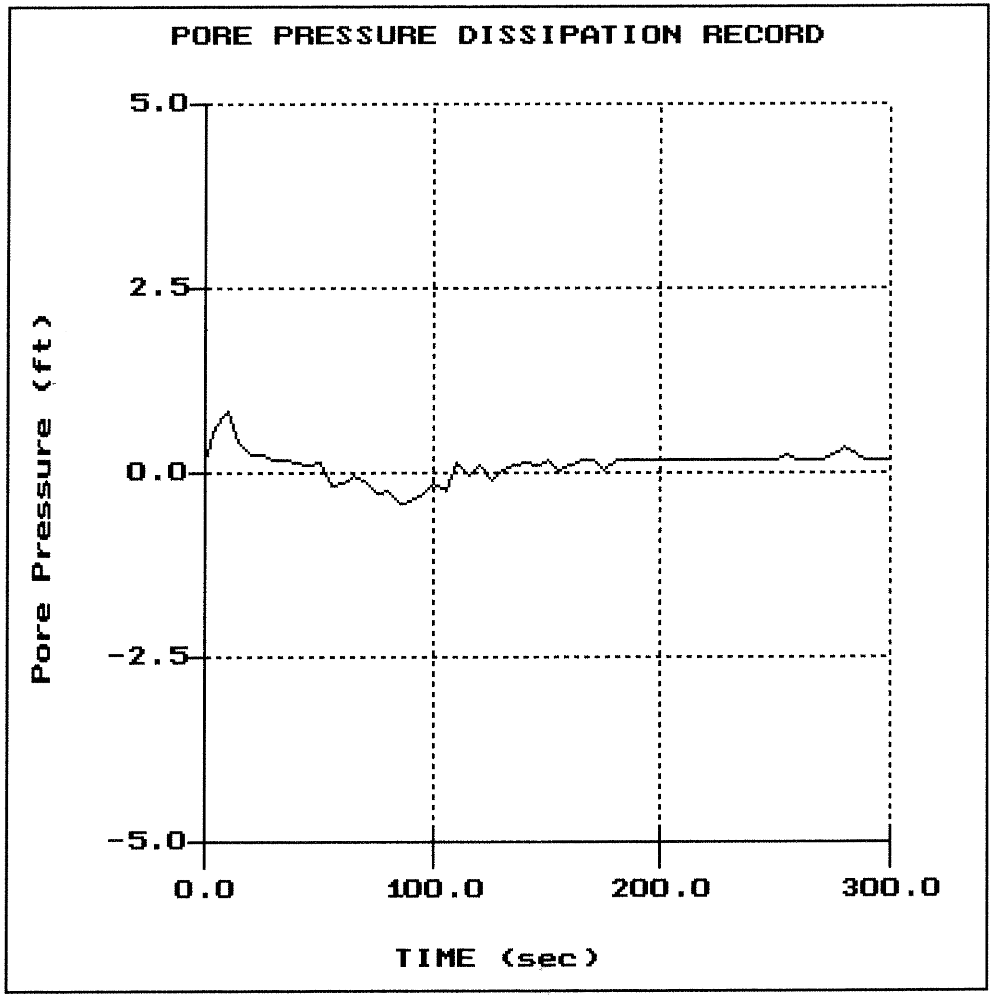


File: 393C502.PPD
Depth (m): 55.20
(ft): 181.10
Duration : 2000.0s
U-min: 3.71 210.0s
U-max: 5.35 1855.0s

URS Corporation

Hole No.:CPT5-03
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:11:06 14:29



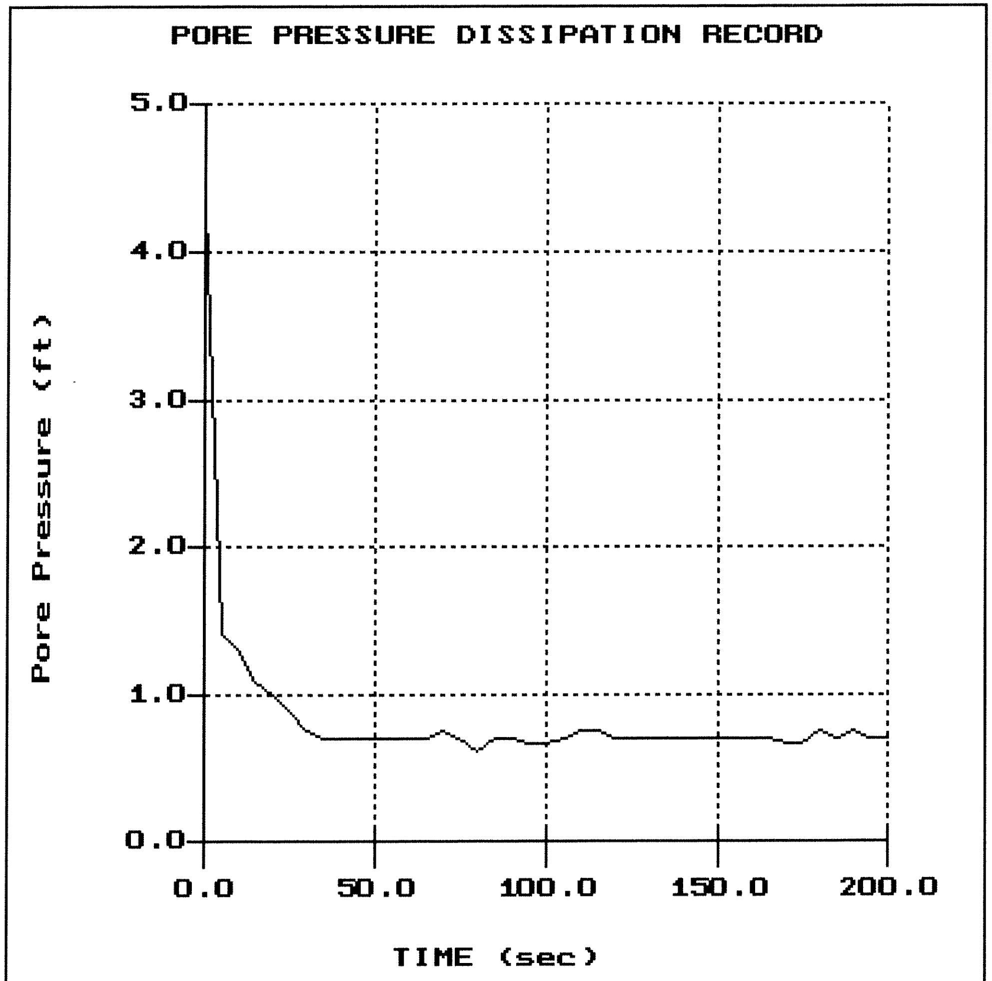
File: 393C503.PPD
Depth (m): 24.55
(ft): 80.54
Duration : 300.0s
U-min: -0.42 85.0s
U-max: 0.84 10.0s

URS Corporation

Hole No.:CPT5-04
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:11:06 13:40

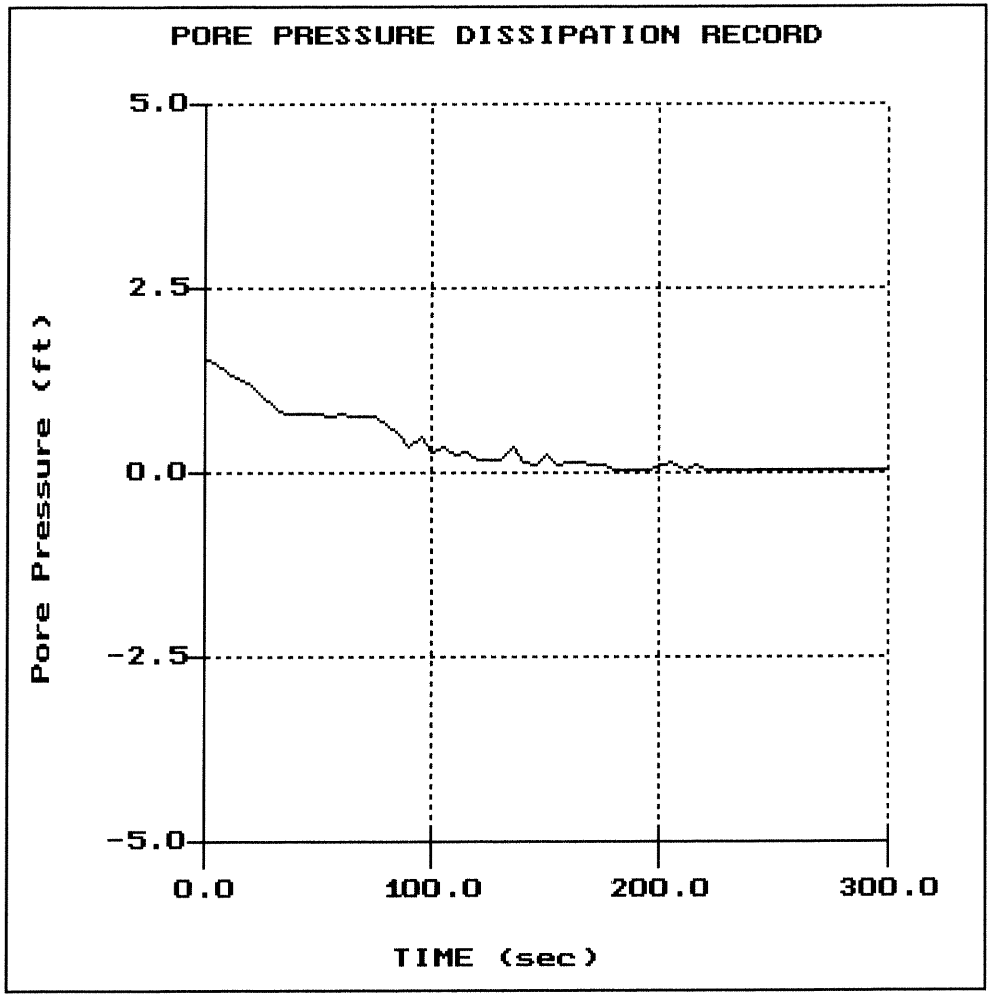
File: 393C504.PPD
Depth (m): 16.70
(ft): 54.79
Duration : 200.0s
U-min: 0.61 80.0s
U-max: 4.32 0.0s



URS Corporation

Hole No.:CPT5-05
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 14:32



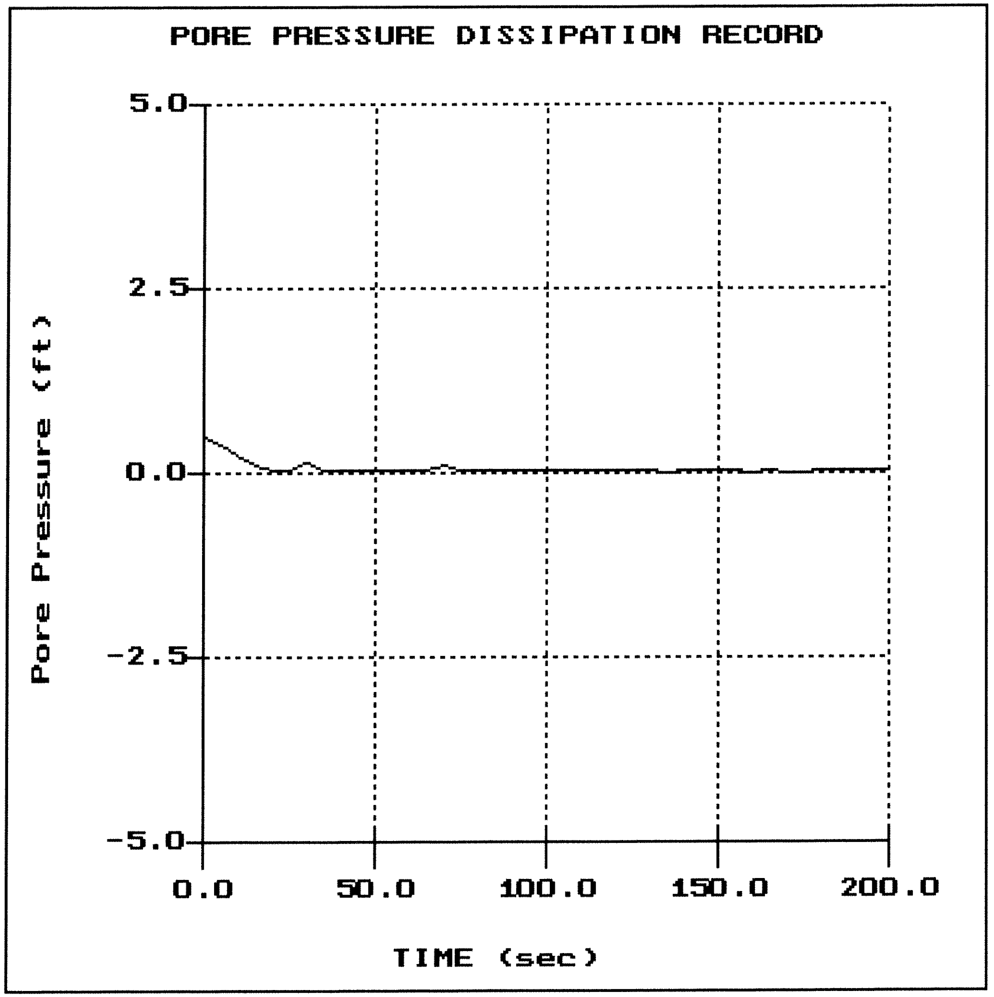
File: 393C505.PPD
Depth (m): 7.80
(ft): 25.59
Duration : 300.0s
U-min: 0.05 300.0s
U-max: 1.55 0.0s

URS Corporation

Hole No.:CPT5-05
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 14:32

File: 393C505.PPD
Depth (m): 10.60
(ft): 34.78
Duration : 200.0s
U-min: 0.00 175.0s
U-max: 0.47 0.0s

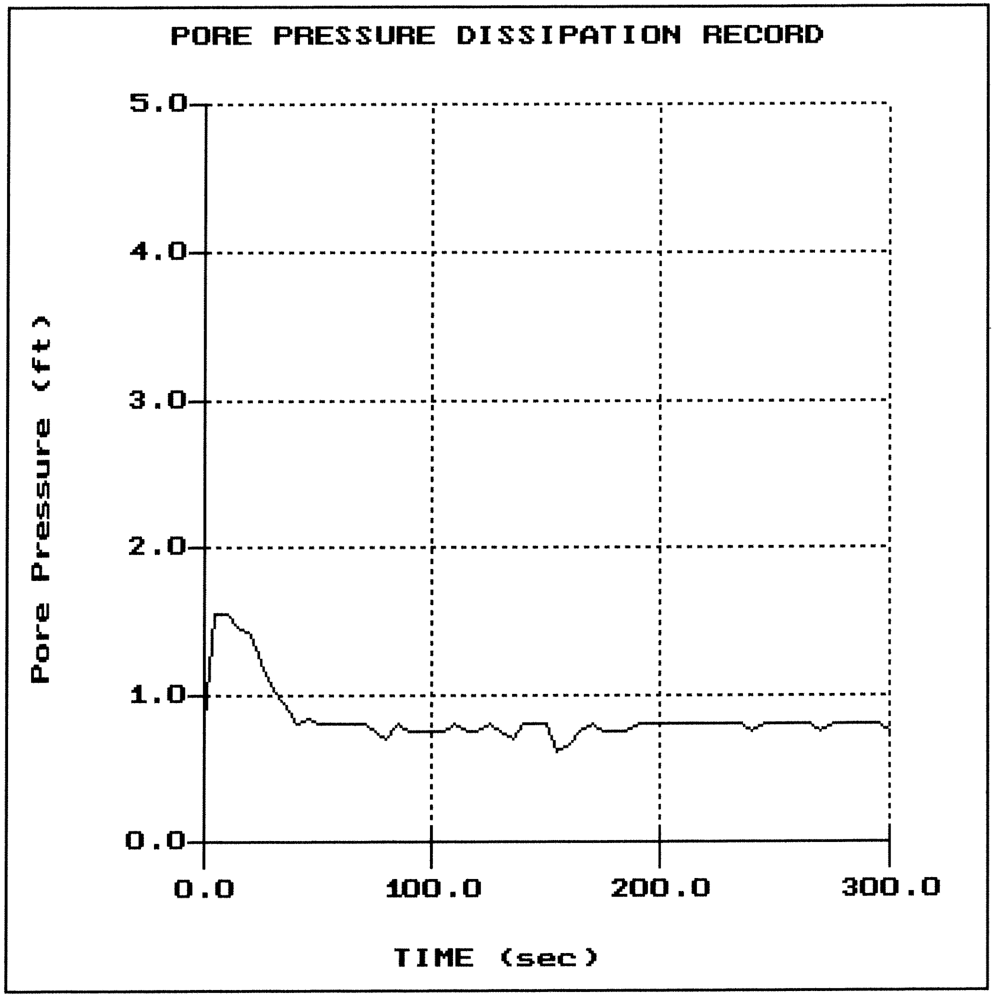


URS Corporation

Hole No.:CPT5-06
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 11:49

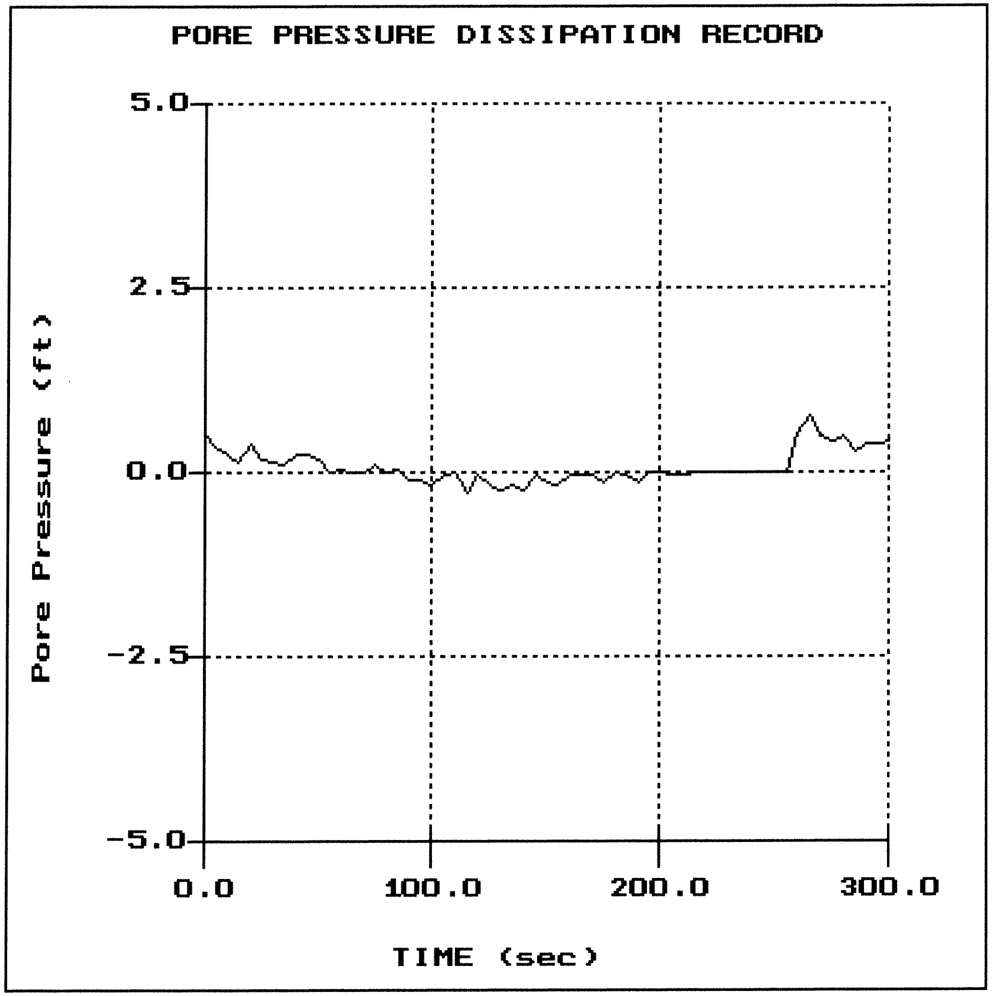
File: 393C506.PPD
Depth (m): 21.65
(ft): 71.03
Duration : 300.0s
U-min: 0.61 155.0s
U-max: 1.55 10.0s



URS Corporation

Hole No.:CPT5-07
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 13:09

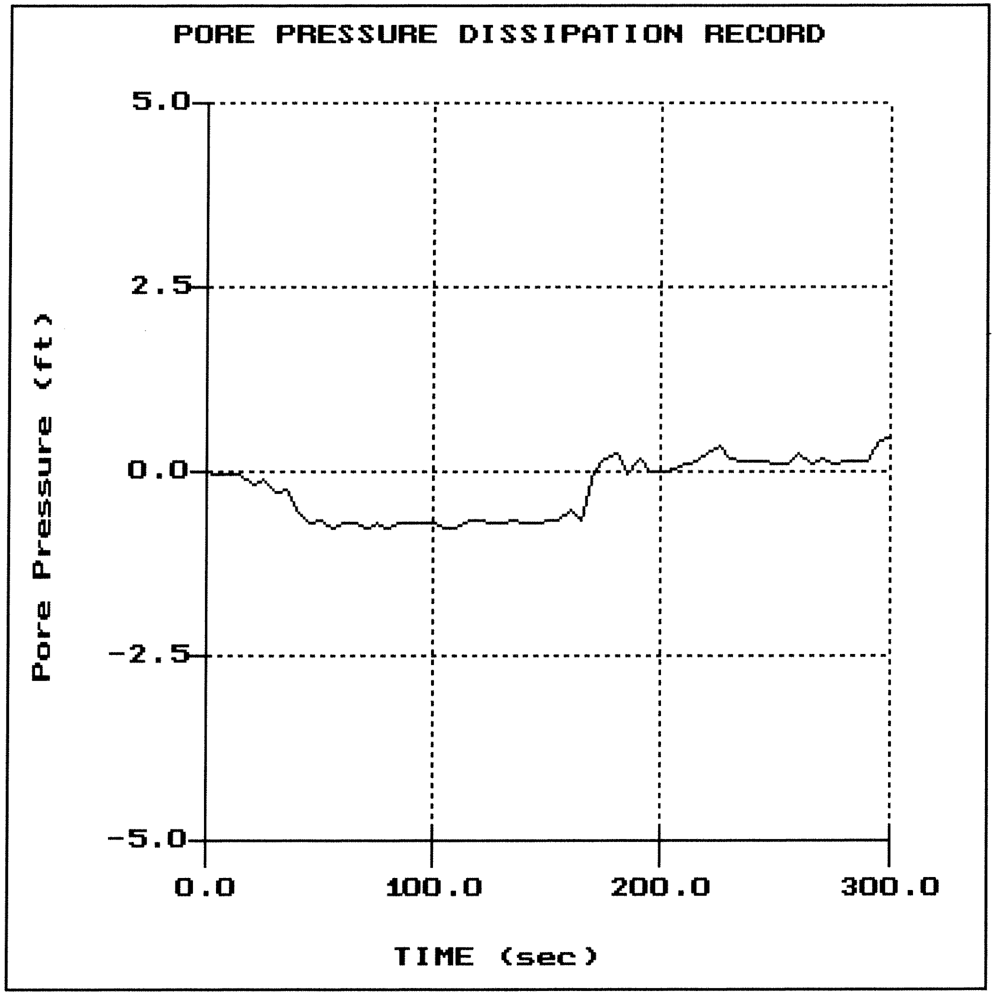


File: 393C507.PPD
Depth (m): 18.80
(ft): 61.68
Duration : 305.0s
U-min: -0.28 115.0s
U-max: 0.75 265.0s

URS Corporation

Hole No.:CPT5-07
Location:CLIMAX DAM 5

Cone: 20 Ton St 183
Date:08:12:06 13:09



File: 393C507.PPD
Depth (m): 38.10
(ft): 125.00
Duration : 300.0s
U-min: -0.75 110.0s
U-max: 0.47 300.0s

Appendix B

Laboratory Test Results

Appendix B.1

2013 Index Test Results

URS Corporation #22243088
Mayflower Investigation
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION INITIAL CONDITIONS		REMARKS
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	(cm/sec)	TEST TYPE	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	VOID RATIO (-)	SATUR-ATION (%)	
INC-5-1		20	9.6				SM	12.3										
INC-5-1	SN-11	50-52								113.2								
INC-5-1	SN-11	50.2	6.8															
INC-5-1	SN-11A	50.45	9.5				SP-SM	11.7		111.0	101.4	2.5E-4						P9651
INC-5-1	SN-11	50.75	8.8															
INC-5-1	SN-11B	50.9	10.3							108.6	98.4		DSS	3.5	16.9			DSS795
INC-5-1	SN-11	51.15	12.1															
INC-5-1	SN-11C	51.25	12.1							98.8	88.1		DSS	4.8	18.8			DSS796
INC-5-1	SN-11	51.5	15.0															
INC-5-1	SN-11D	51.65	19.2							118.9	99.7		DSS	11.1	14.8			DSS797
INC-5-1		75-77																
INC-5-1		76	11.3															
INC-5-1		76.25	13.1				SM	17.3		113.5	100.4		Cyclic	*				CTXS465
INC-5-1		90	6.8				SM	12.9										
INC-5-1		95	9.9				SM	22.1										
INC-5-1		100						b										hold
INC-5-1		110	4.0				SM	14.1										
INC-5-1	SN-25	120-122																
INC-5-1		121.65	10.1															
INC-5-1	A	121.9	15.5	np	np	np	SM	13.9	0	110.3	95.5		Cyclic	*				CTXS466
INC-5-1		140-142								114.6								
INC-5-1	A	140.2	22.4	np	np	np	SM	45.6		127.8	104.4		CIU	9.7	20.9			T3395
INC-5-1		140.45	21.0															
INC-5-1		140.55	15.5				SP-SM			100.7	87.2	7.6E-4	CIU	17.6	18.6			TP3396
INC-5-1	C	141.0	18.3				SP-SM			113.7	96.1		CIU	27.3	12.7			T3400
INC-5-1	SN-31	160-162								112.8								
INC-5-1	SN-31 A	160.15	21.1				SM			127.2	105.0		DSS	5.2	16.4			DSS794
INC-5-1	SN-31 B	160.5	16.0	np	np	np	SM	15.8		102.8	88.6		DSS	6.9	11.6			DSS793
INC-5-1	SN-31 C	160.8	23.9				SM			118.5	95.6		DSS	13.8	17.5			DSS792
INC-5-1		193.5						d										hold

Prepared by: JR
Reviewed by: ________
Date: 5/15/2013

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

Project No.: T22243088
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URS Corporation #22243088
Mayflower Investigation
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	PERMEABILITY (cm/sec)	STRENGTH TEST TYPE	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS VOID RATIO (-)	SATUR-ATION (%)	REMARKS
P-11		75-77								107.9								
P-11		75.65	6.1															
P-11	B	75.9	15.5				SM			116.8	101.2	2.1E-4	CIU	15.6	24.3			TP3428
P-11		76.2	21.1															
P-11	C	76.45	18.0				SM	17.0		113.9	96.6		CIU	18.4	13.0			T3429
P-11	D	77.0	18.2				SM			119.3	101.0		CIU	32.1	14.2			T3427
TH-5-2		20	13.4	np	np	np	SM	16.6	1									
TH-5-2		25	16.7				SM	16.6										
TH-5-2		30	10.6				SM	14.1										
TH-5-2		35	20.4				SP-SM	11.9										
TH-5-2	SN-13	65-67								102.2								
TH-5-2	SN-13	65.65	12.5															
TH-5-2	SN-13 B	65.9	21.9				SP-SM	9.5		114.5	94.0	2.7E-4						P9657
TH-5-2		85						h										hold
TH5-2		110-111.5								104.0								
TH5-2		110.55	11.5															
TH5-2	B	110.8	20.1	np	np	np	SM	20.5	0	115.6	96.3					0.718	74	C13056
TH-5-3		20	18.0				SM	17.2										
TH-5-3		50	18.5	np	np	np	SM	22.5	0									
TH-5-3		83.5-85								109.7								
TH-5-3		84.15	8.5															
TH-5-3	B	84.4	13.1				SM	26.3		105.7	93.4	2.0E-5						P9673
TH-5-3		100	19.8				SM	21.3										
TH-5-3		110	14.7				SM	21.5										
TH-5-3		120	14.2				SM	16.1										
TH-5-3		132.5						k										hold
TH-5-3		150	19.7	np	np	np	SM	26.2	0									

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: JR
Reviewed by: ________
Date: 5/15/2013

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Totowa, NJ 07512

Project No.: T22243088
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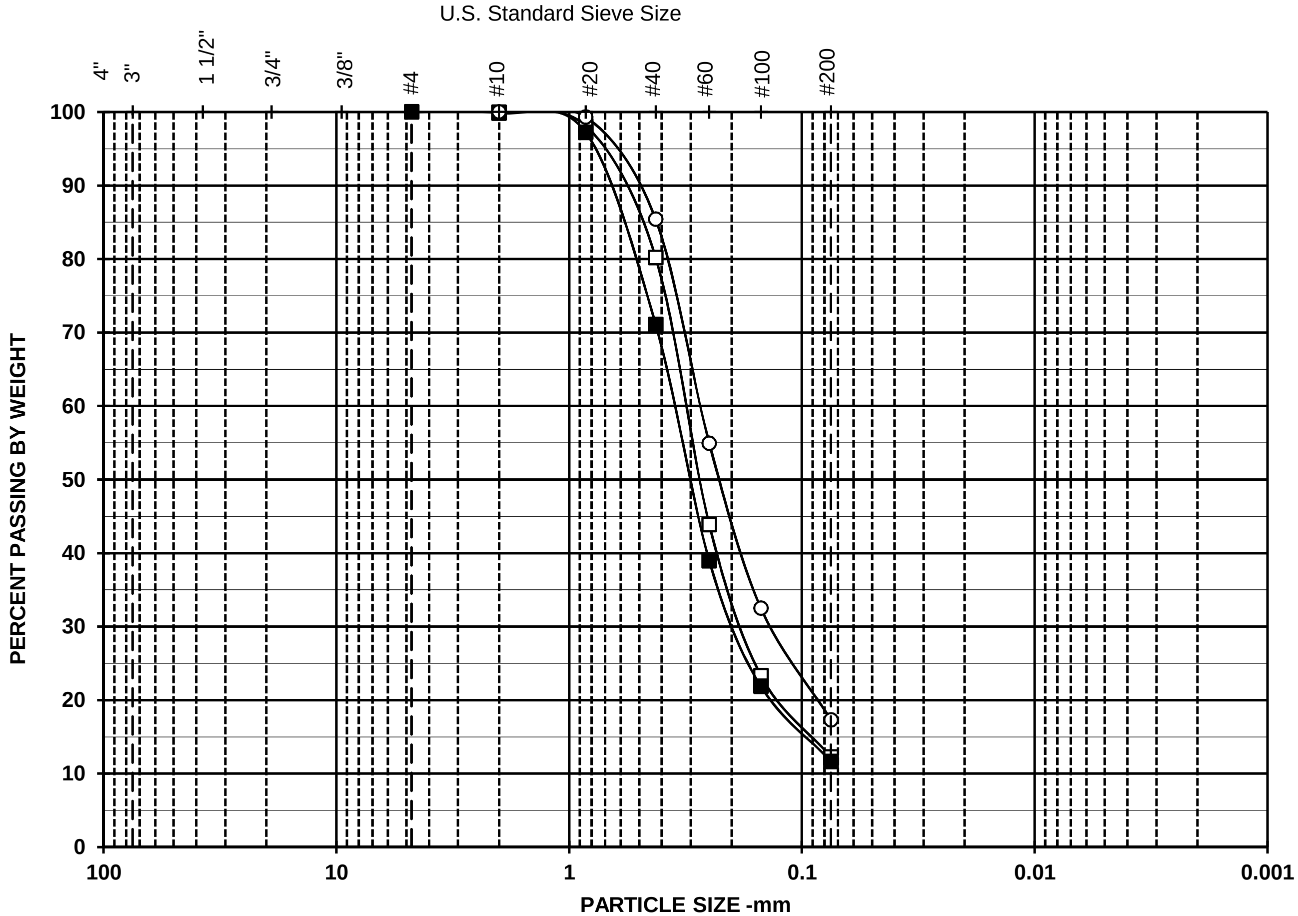
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	INC-5-1	INC-5-1	INC-5-1
Sample		S-11A	
Depth	20	50.45	76.25
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% SAND	87.7	88.3	82.7
%C SAND	0.0	0.1	0.0
%M SAND	19.8	28.8	14.6
%F SAND	68.0	59.4	68.1
% FINES	12.3	11.7	17.3
% -2μ			
D_{100} (mm)	4.75	4.75	2.00
D_{60} (mm)	0.33	0.36	0.28
D_{30} (mm)	0.18	0.20	0.14
D_{10} (mm)		0.06	
Cc		1.7	
Cu		5.8	

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4		100.0	
10	100.0	99.9	100.0
20	98.1	97.3	99.3
40	80.2	71.1	85.4
60	43.9	38.9	54.9
100	23.3	21.9	32.5
200	12.3	11.7	17.3

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	9.6				SM	Brown, Silty sand	3/13/2013
■					SP-SM	Brown, Poorly-graded sand with silt	4/5/2013
○					SM	Gray, Silty sand	4/18/2013

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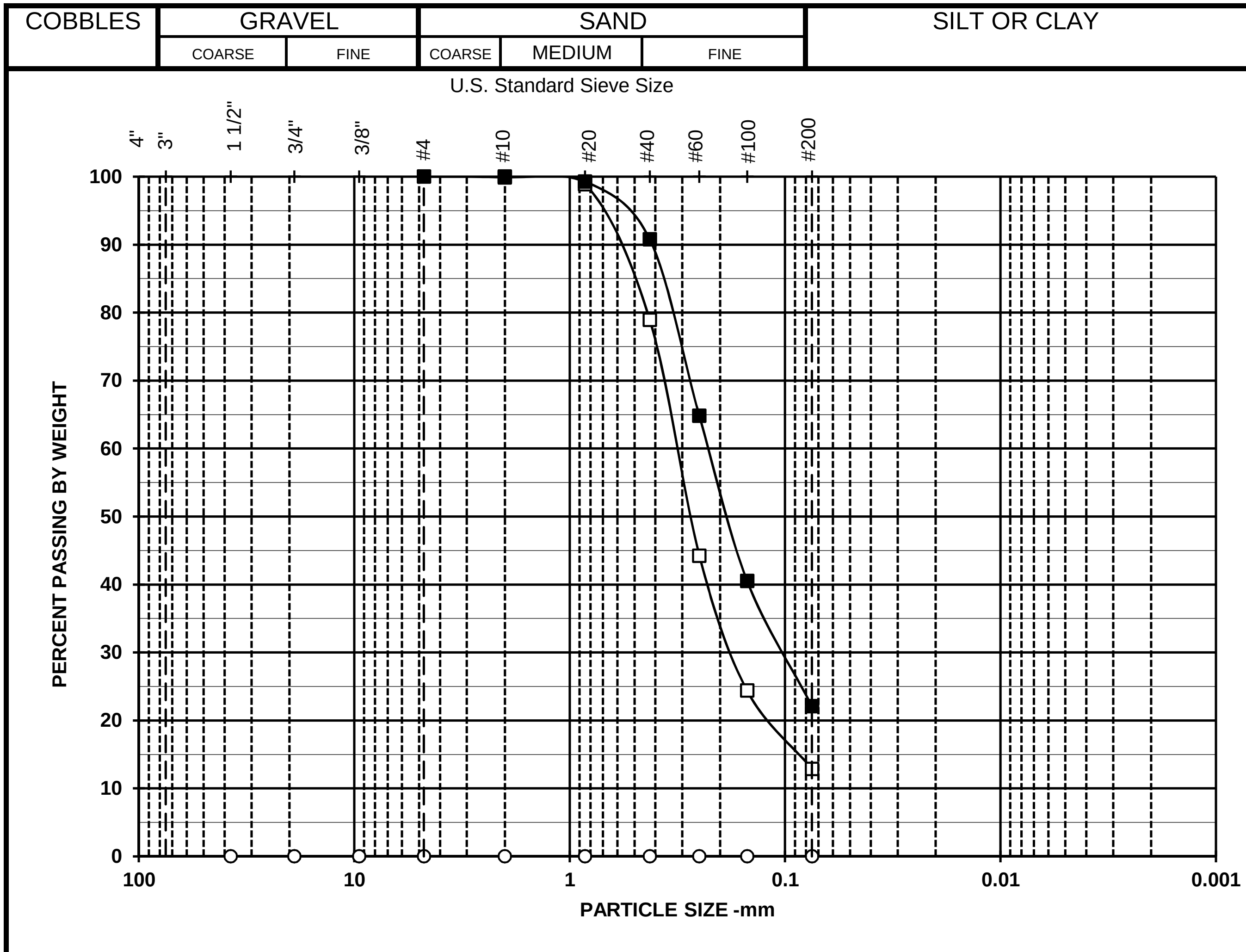

Symbol	□	■	○
Boring	INC-5-1	INC-5-1	INC-5-1
Sample			
Depth	90	95	100
% +3"	0.0	0.0	
% Gravel	0.0	0.0	
% SAND	87.1	77.9	
%C SAND	0.0	0.1	
%M SAND	21.0	9.1	
%F SAND	66.1	68.7	
% FINES	12.9	22.1	
% -2µ			
D_{100} (mm)	2.00	4.75	
D_{60} (mm)	0.33	0.23	
D_{30} (mm)	0.18	0.11	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4		100.0	
10	100.0	99.9	
20	98.9	99.3	
40	79.0	90.8	
60	44.2	64.8	
100	24.4	40.5	
200	12.9	22.1	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	6.8				SM	Brown, Silty sand	3/13/2013
■	9.9				SM	Brown, Silty sand	3/13/2013
○							

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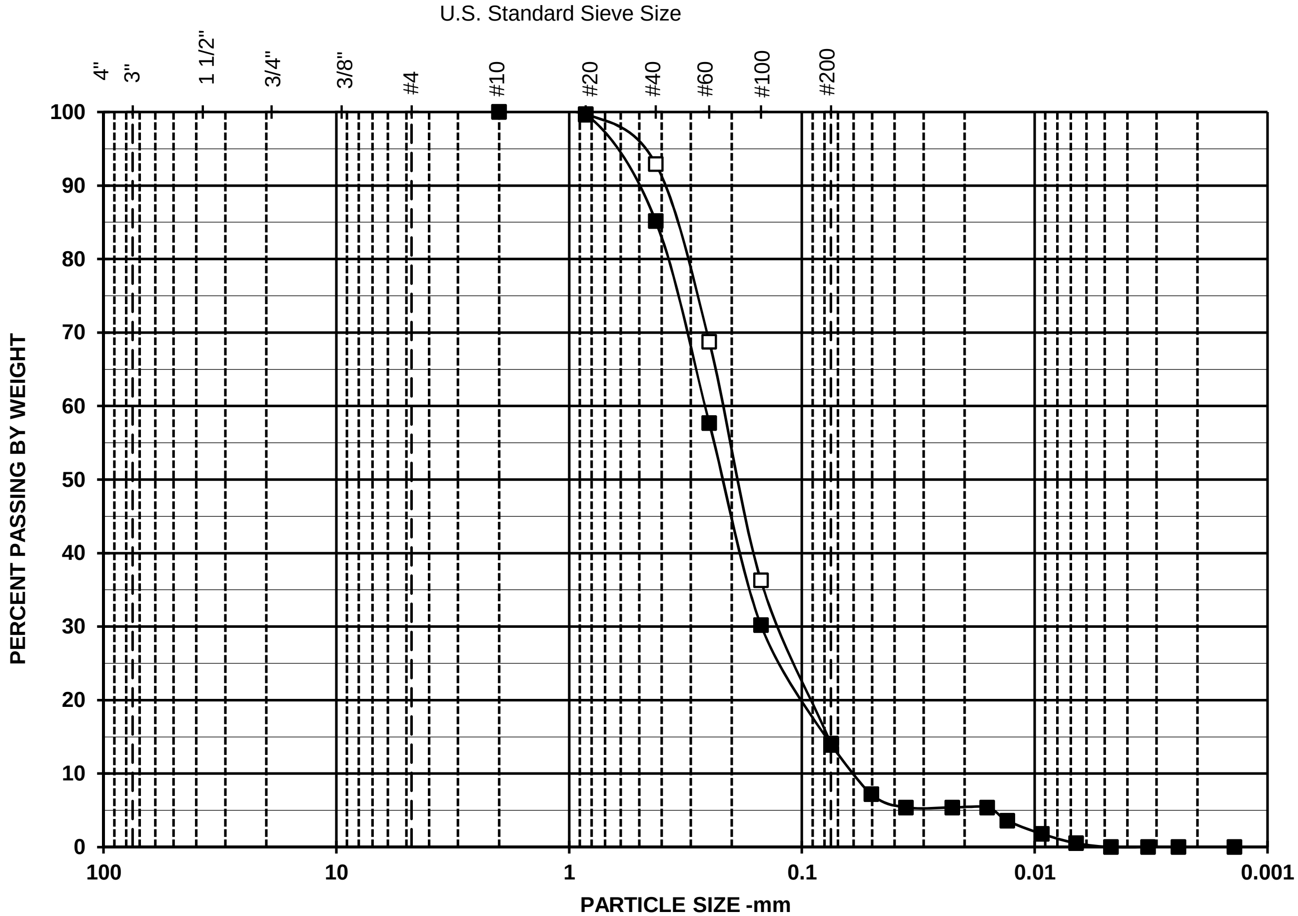
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	INC-5-1	INC-5-1	
Sample		SN25 A	
Depth	110	121.9	
% +3"	0.0	0.0	
% Gravel	0.0	0.0	
% SAND	85.9	86.1	
%C SAND	0.0	0.0	
%M SAND	7.1	14.8	
%F SAND	78.9	71.3	
% FINES	14.1	13.9	
% -2μ		0	
D_{100} (mm)	2.00	2.00	
D_{60} (mm)	0.22	0.26	
D_{30} (mm)	0.13	0.15	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0	100.0	
20	99.7	99.6	
40	92.9	85.2	
60	68.8	57.7	
100	36.3	30.2	
200	14.1	13.9	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	4.0				SM	Brown, Silty sand	3/13/2013
■		np	np	np	SM	Light brown, Silty sand	4/12/2013
○							

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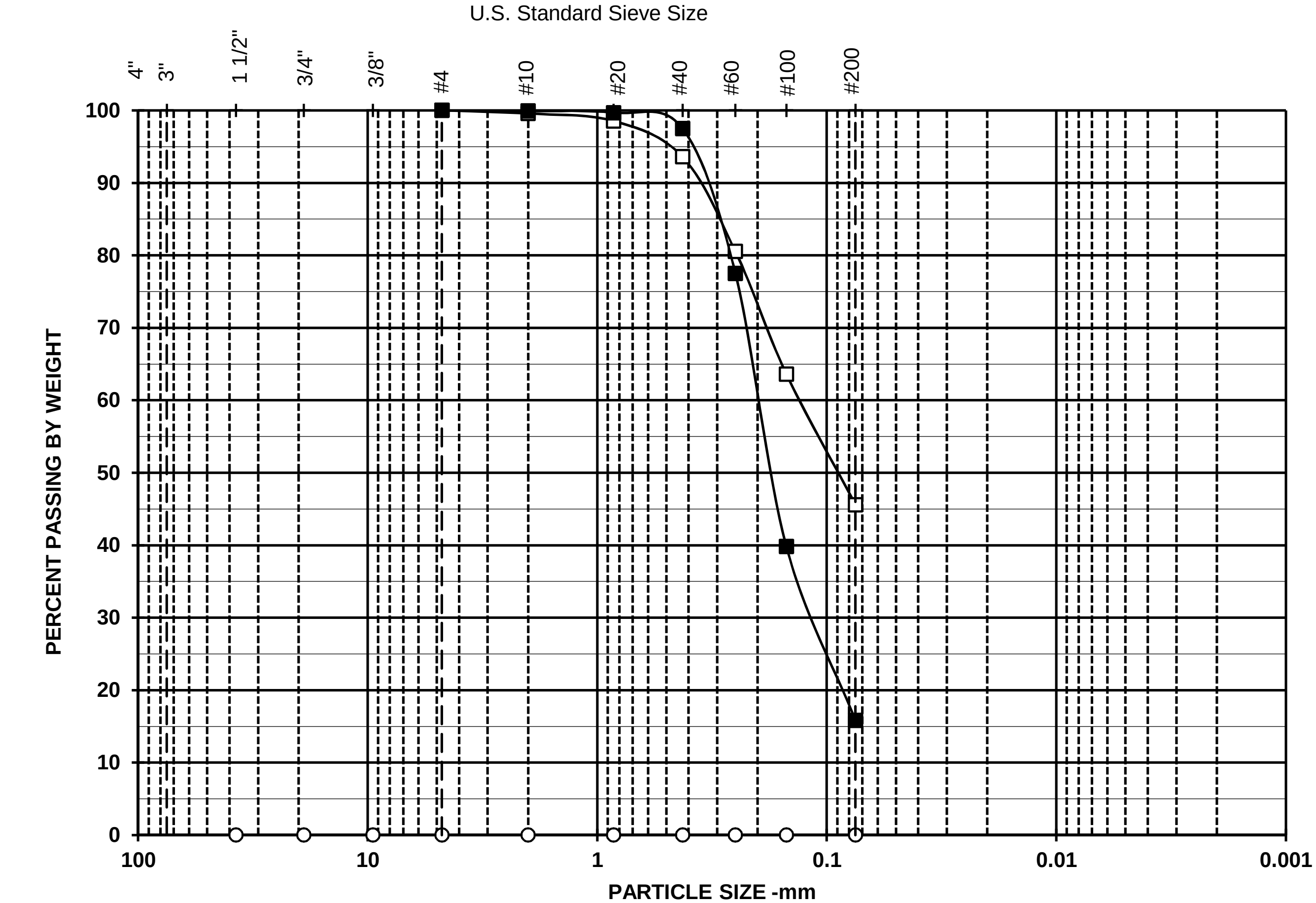
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	INC5-1	INC-5-1	INC-5-1
Sample	A	B	
Depth	140.2	160.5	193.5
% +3"	0.0	0.0	
% Gravel	0.0	0.0	
% SAND	54.4	84.2	
%C SAND	0.4	0.1	
%M SAND	6.0	2.4	
%F SAND	48.0	81.7	
% FINES	45.6	15.8	
% -2μ			
D_{100} (mm)	4.75	4.75	
D_{60} (mm)	0.13	0.20	
D_{30} (mm)		0.12	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	PERCENT FINER ■	PERCENT FINER ○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4	100.0	100.0	
10	99.6	99.9	
20	98.6	99.7	
40	93.6	97.5	
60	80.6	77.5	
100	63.6	39.8	
200	45.6	15.8	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□		np	np	np	SM	Brown, Silty sand	12/28/2010
■		np	np	np	SM	Brown, Silty sand	4/12/2013
○							

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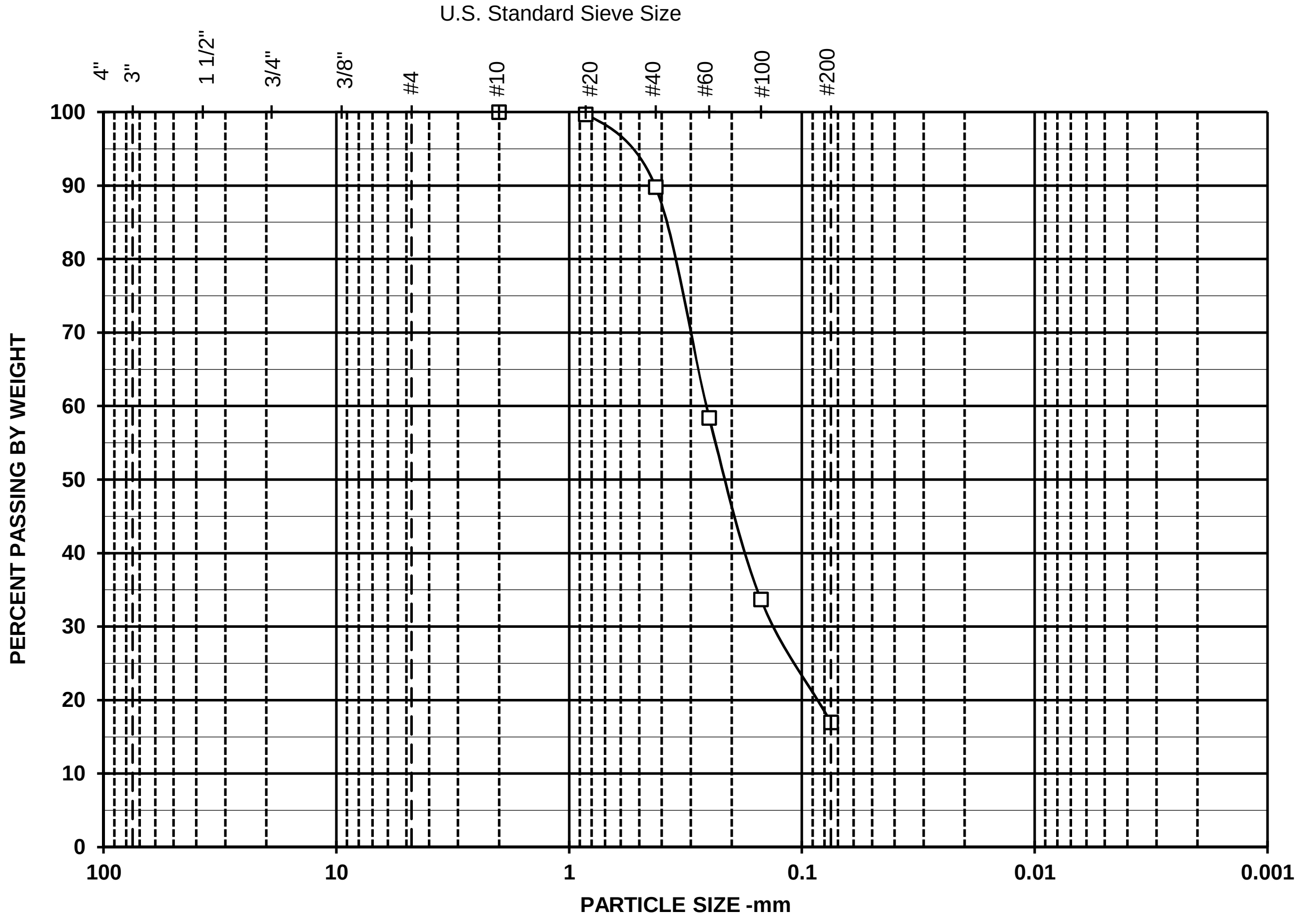
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	P-11		
Sample	C		
Depth	76.45		
% +3"	0.0		
% Gravel	0.0		
% SAND	83.0		
%C SAND	0.0		
%M SAND	10.2		
%F SAND	72.8		
% FINES	17.0		
% -2μ			
D_{100} (mm)	4.75		
D_{60} (mm)	0.26		
D_{30} (mm)	0.13		
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0		
20	99.7		
40	89.8		
60	58.4		
100	33.7		
200	17.0		

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□					SM	Brown, Silty sand	4/10/2013
■							
○							

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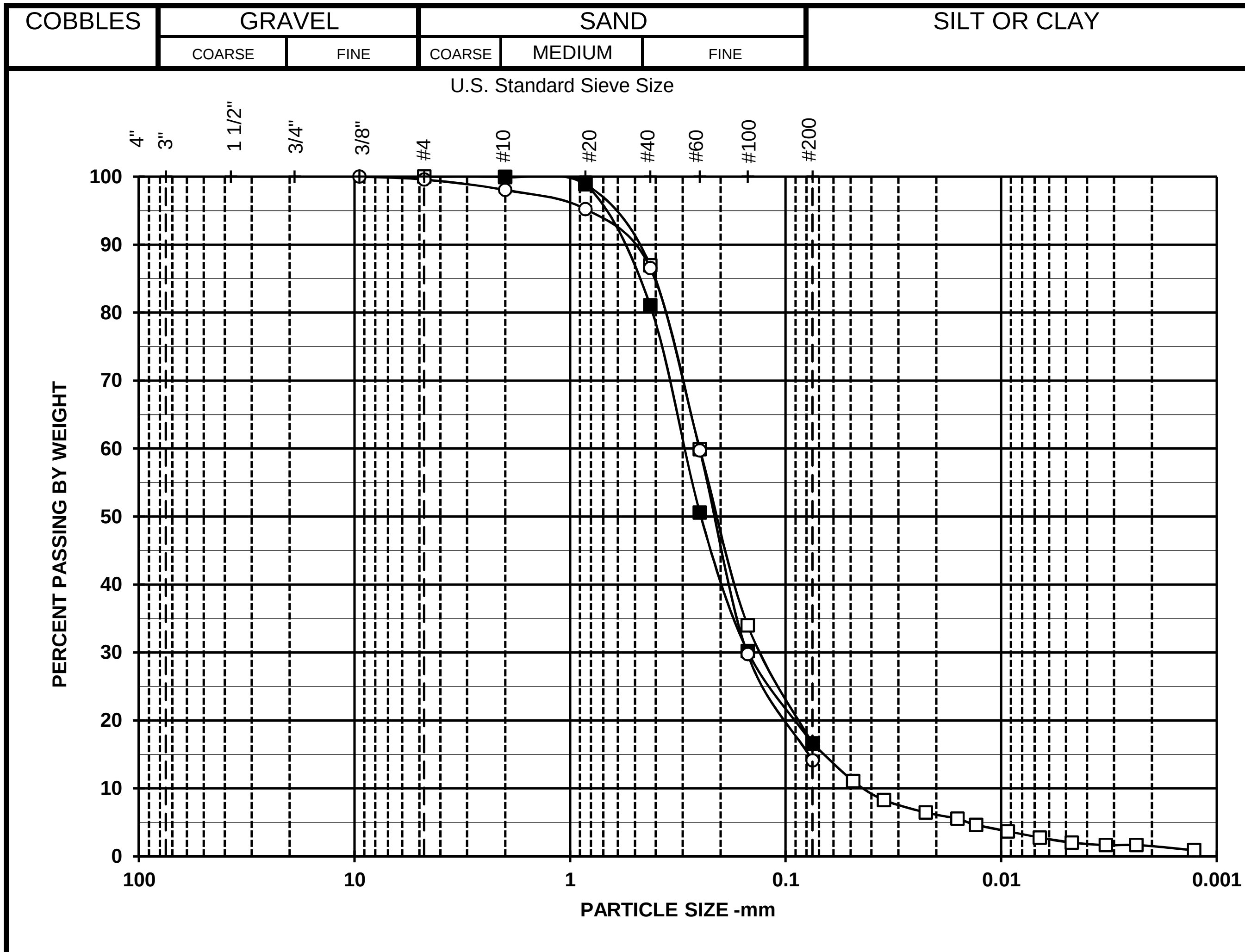

Symbol	□	■	○
Boring	TH-5-2	TH-5-2	TH-5-2
Sample			
Depth	20	25	30
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.4
% SAND	83.4	83.4	85.5
%C SAND	0.1	0.0	1.5
%M SAND	13.0	18.9	11.5
%F SAND	70.3	64.5	72.5
% FINES	16.6	16.6	14.1
% -2μ	1		
D_{100} (mm)	4.75	4.75	9.50
D_{60} (mm)	0.25	0.30	0.25
D_{30} (mm)	0.13	0.15	0.15
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			100.0
4	100.0		99.6
10	99.9	100.0	98.0
20	98.9	98.9	95.2
40	86.9	81.1	86.6
60	59.9	50.6	59.7
100	34.0	30.2	29.7
200	16.6	16.6	14.1

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	13.4	np	np	np	SM	Brown, Silty sand	3/15/2013
■	16.7				SM	Brown, Silty sand	3/13/2013
○	10.6				SM	Brown, Silty sand	3/13/2013

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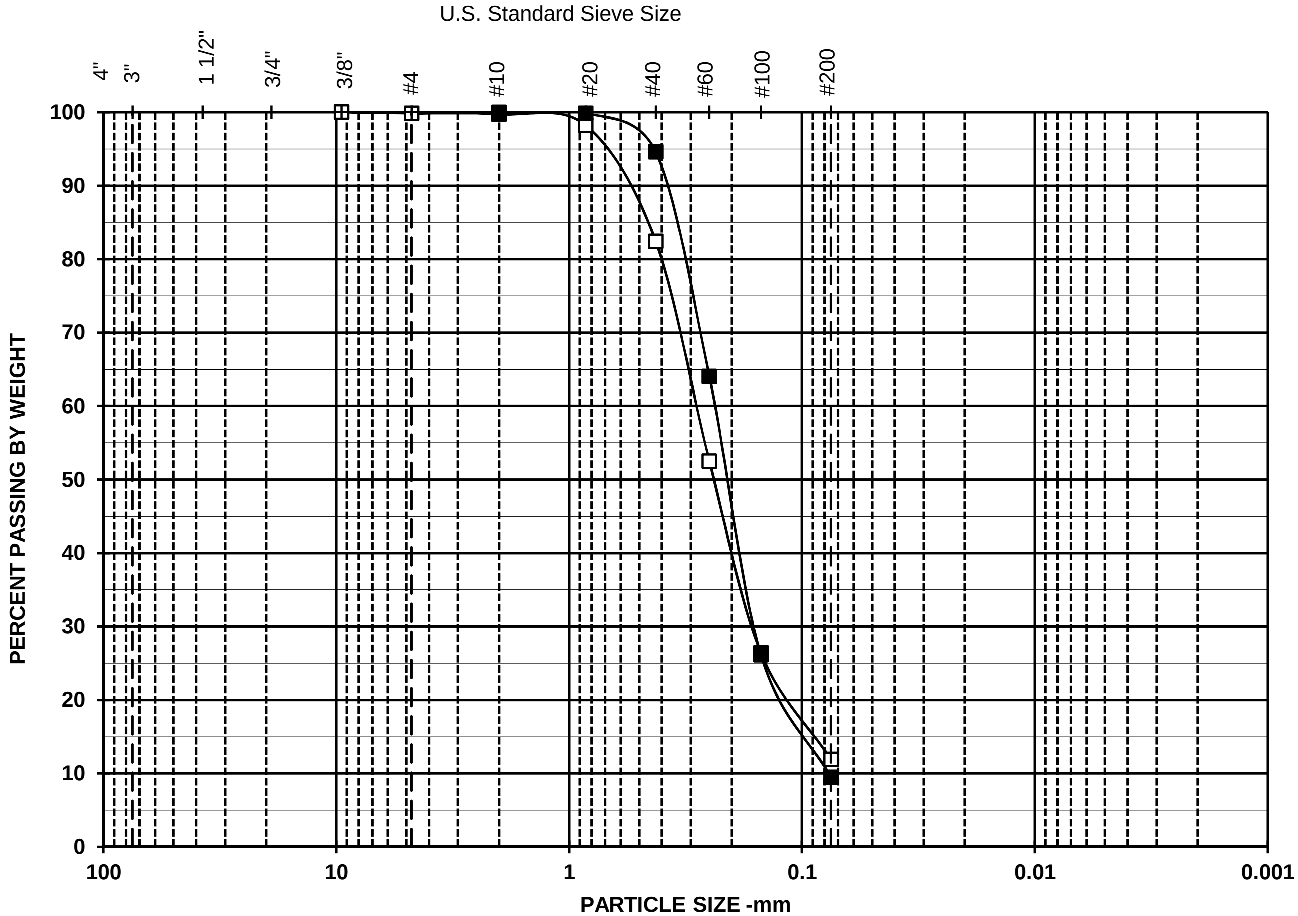
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	



Symbol	□	■	○
Boring	TH-5-2	TH-5-2	
Sample		SN-13B	
Depth	35	65.9	
% +3"	0.0	0.0	
% Gravel	0.1	0.0	
% SAND	88.0	90.5	
%C SAND	0.1	0.0	
%M SAND	17.3	5.4	
%F SAND	70.5	85.1	
% FINES	11.9	9.5	
% -2μ			
D_{100} (mm)	9.50	4.75	
D_{60} (mm)	0.29	0.24	
D_{30} (mm)	0.16	0.16	
D_{10} (mm)	0.07	0.08	
Cc	1.4	1.4	
Cu	4.5	3.1	

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"	100.0		
4	99.9		
10	99.7	100.0	
20	98.2	99.9	
40	82.4	94.6	
60	52.5	64.1	
100	26.4	26.2	
200	11.9	9.5	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	20.4				SP-SM	Brown, Poorly-graded sand with silt	3/13/2013
■					SP-SM	Brown, Poorly-graded sand with silt	4/9/2013
○							

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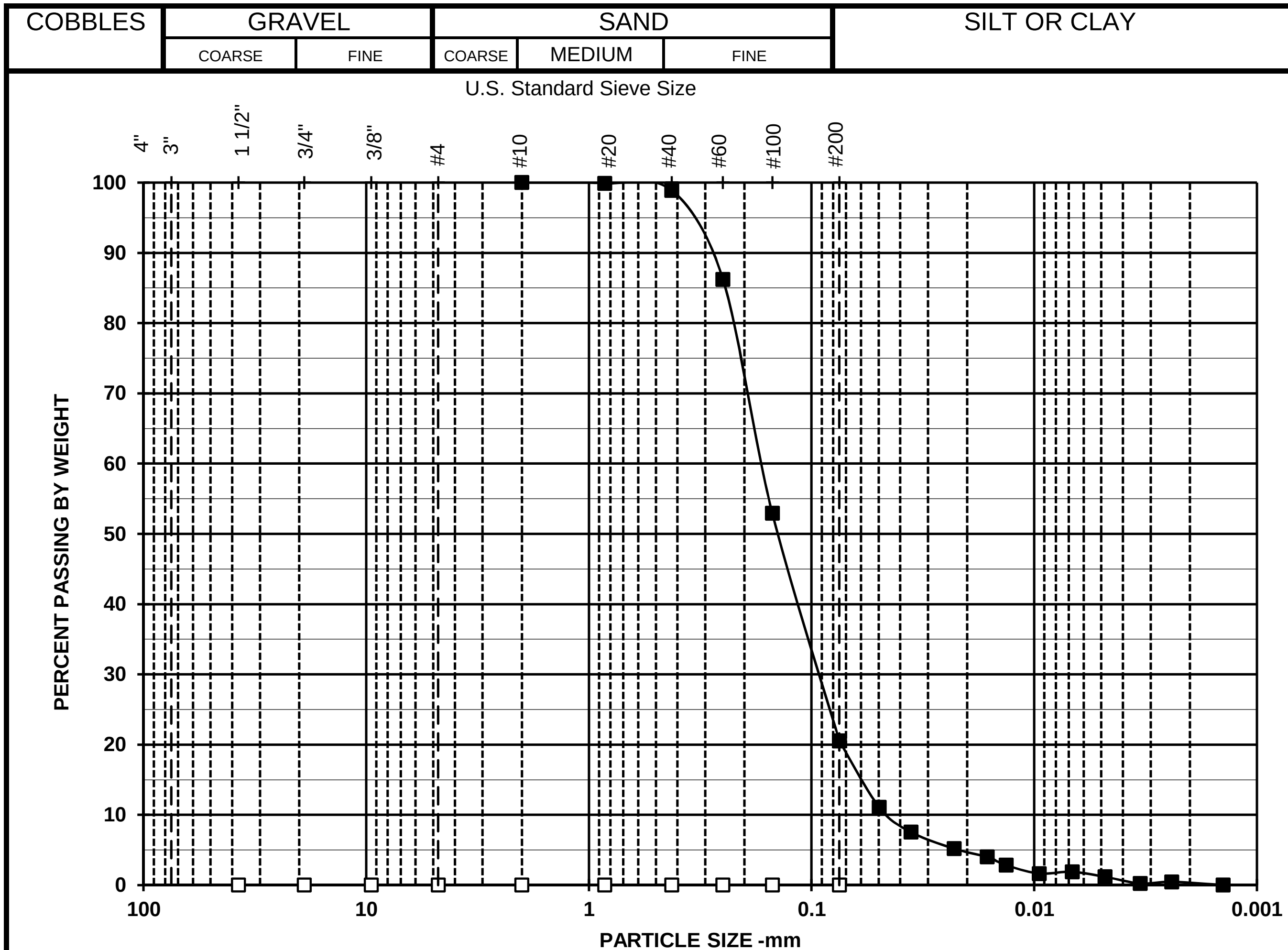

Symbol	□	■	○
Boring	TH-5-2	TH5-2	
Sample		B	
Depth	85	110.8	
% +3"		0.0	
% Gravel		0.0	
% SAND		79.5	
%C SAND		0.0	
%M SAND		1.1	
%F SAND		78.3	
% FINES		20.5	
% -2μ		0	
D_{100} (mm)		2.00	
D_{60} (mm)		0.17	
D_{30} (mm)		0.10	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10		100.0	
20		99.9	
40		98.9	
60		86.2	
100		52.9	
200		20.5	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□							
■		np	np	np	SM	Brown, Silty sand	12/28/2010
○							

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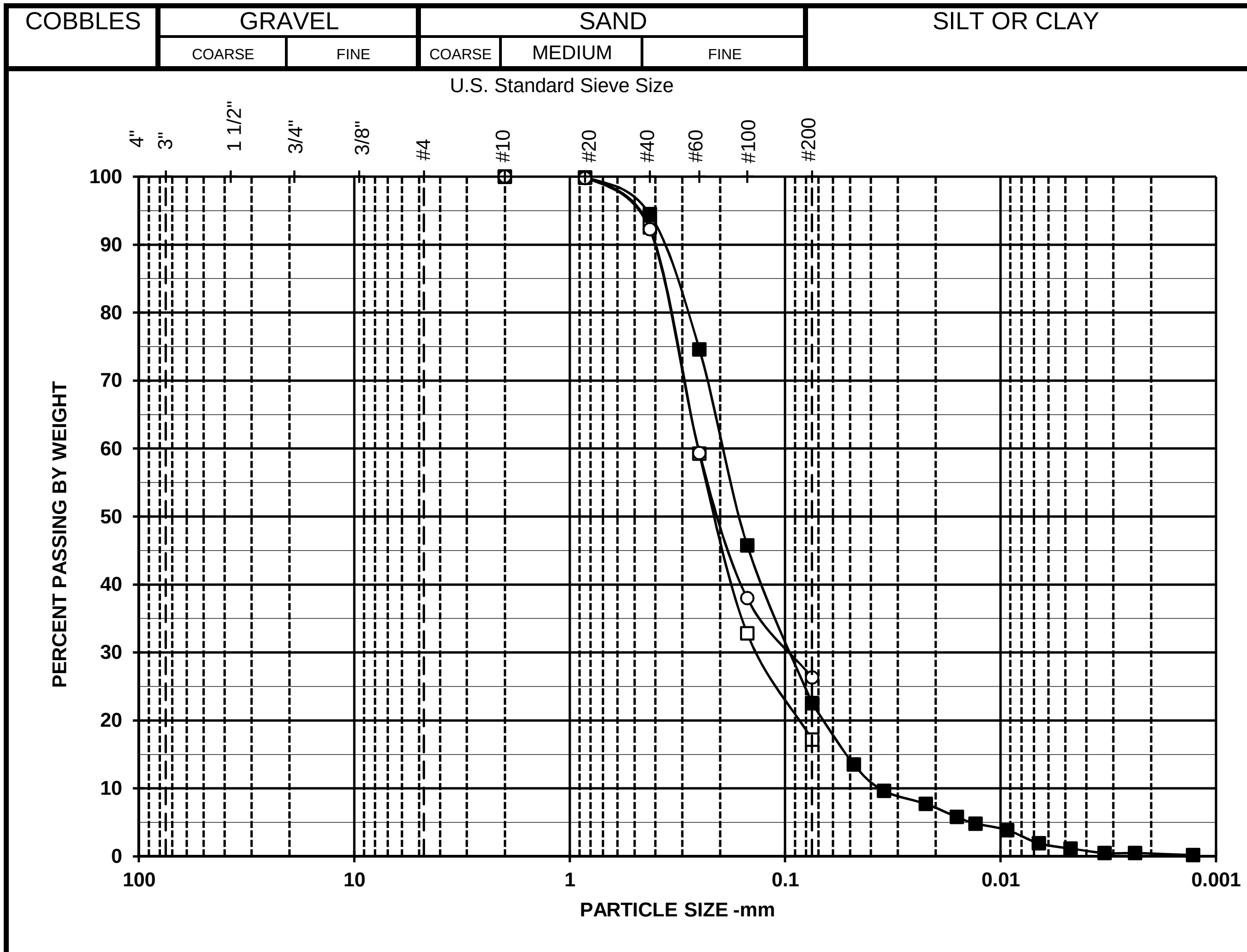

Symbol	□	■	○
Boring	TH-5-3	TH-5-3	TH-5-3
Sample			B
Depth	20	50	84.4
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% SAND	82.8	77.5	73.7
%C SAND	0.0	0.0	0.0
%M SAND	7.5	5.5	7.7
%F SAND	75.3	71.9	65.9
% FINES	17.2	22.5	26.3
% -2µ		0	
D_{100} (mm)	2.00	4.75	2.00
D_{60} (mm)	0.25	0.20	0.25
D_{30} (mm)	0.14	0.10	0.10
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0	100.0	100.0
20	99.9	99.8	99.8
40	92.5	94.5	92.3
60	59.2	74.6	59.4
100	32.8	45.8	38.0
200	17.2	22.5	26.3

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	18.0				SM	Brown, Silty sand	3/13/2013
■	18.5	np	np	np	SM	Brown, Silty sand	3/14/2013
○					SM	Brown, Silty sand	4/15/2013

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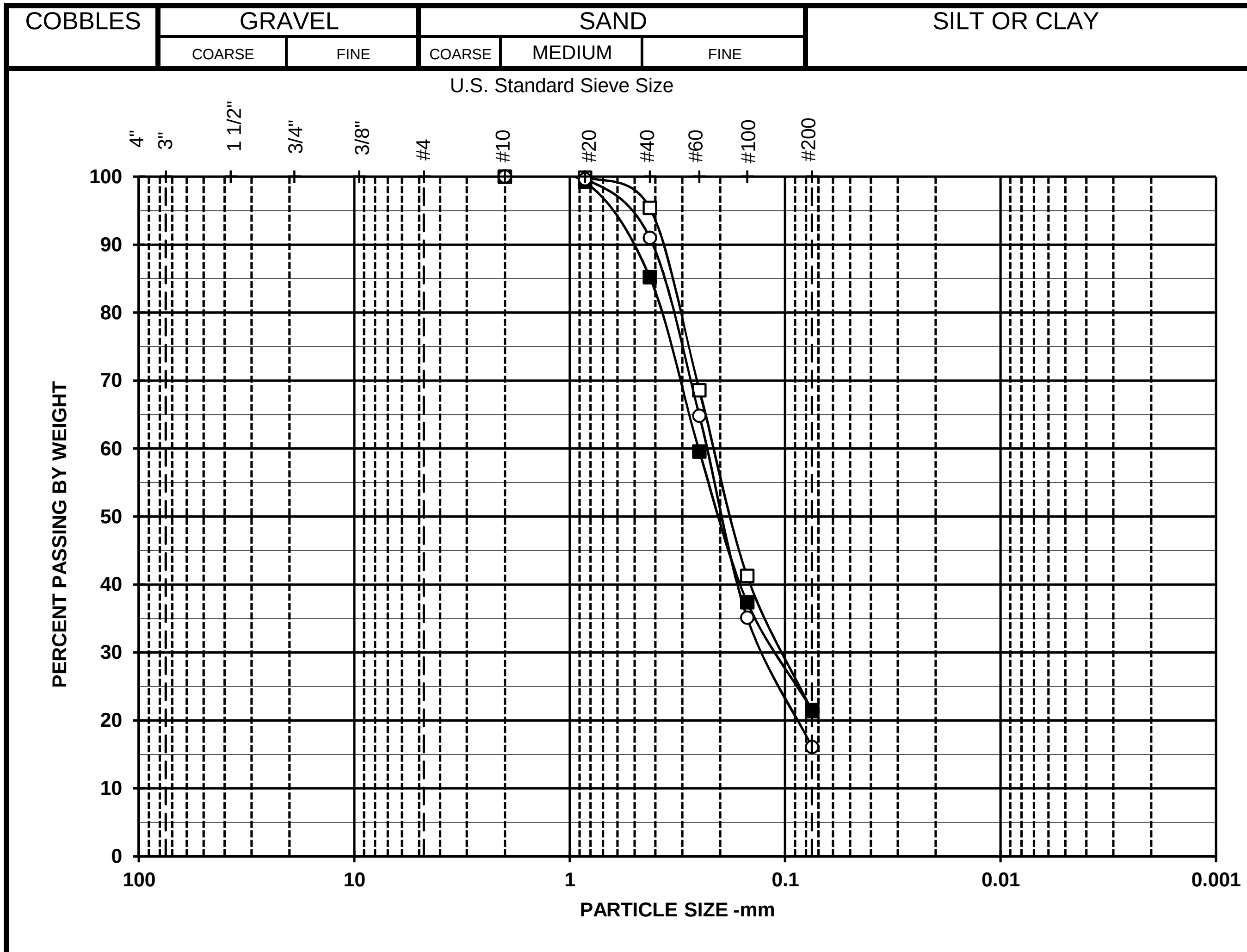


Symbol	□	■	○
Boring	TH-5-3	TH-5-3	TH-5-3
Sample			
Depth	100	110	120
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% SAND	78.7	78.5	83.9
%C SAND	0.0	0.0	0.0
%M SAND	4.6	14.8	9.0
%F SAND	74.0	63.7	74.9
% FINES	21.3	21.5	16.1
% -2μ			
D_{100} (mm)	4.75	4.75	2.00
D_{60} (mm)	0.22	0.25	0.23
D_{30} (mm)	0.11	0.12	0.13
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10	100.0	100.0	100.0
20	99.9	99.2	99.6
40	95.4	85.2	91.0
60	68.6	59.6	64.8
100	41.2	37.4	35.1
200	21.3	21.5	16.1

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□	19.8				SM	Brown, Silty sand	3/13/2013
■	14.7				SM	Brown, Silty sand	3/13/2013
○	14.2				SM	Brown, Silty sand	3/13/2013

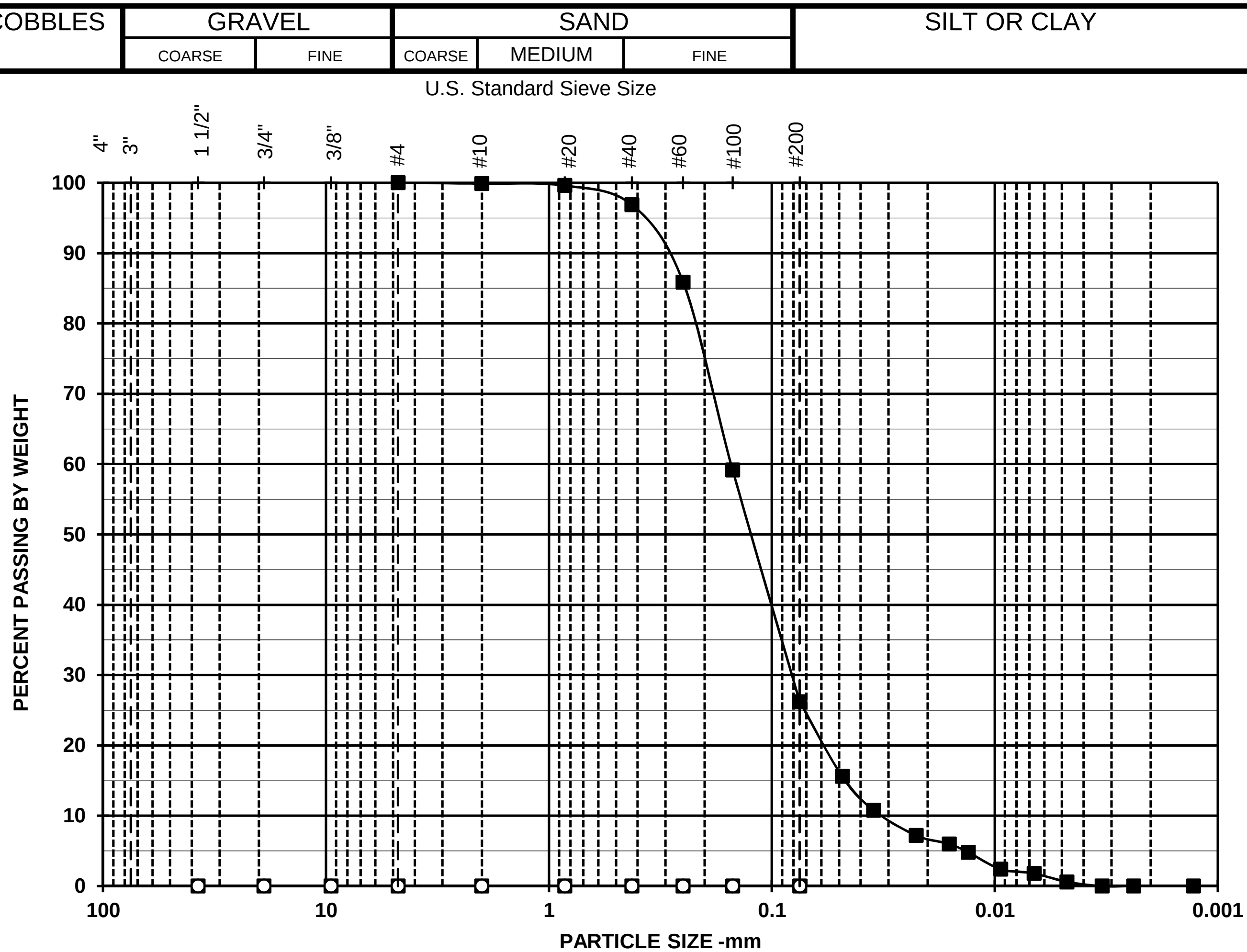
TerraSense, LLC	URS Corporation
T22243088	22243088

PARTICLE SIZE DISTRIBUTION

Mayflower Investigation

Analysis File: 3SV-MasterRev4b

Siev1j.xls 4/17/2013



Symbol	□	■	○
Boring	TH-5-3	TH-5-3	TH-5-3
Sample			
Depth	132.5	150	164
% +3"		0.0	
% Gravel		0.0	
% SAND		73.8	
%C SAND		0.1	
%M SAND		3.0	
%F SAND		70.7	
% FINES		26.2	
% -2μ		0	
D_{100} (mm)		4.75	
D_{60} (mm)		0.15	
D_{30} (mm)		0.08	
D_{10} (mm)			
Cc			
Cu			

Particle Size (Sieve #)	PERCENT FINER □	PERCENT FINER ■	PERCENT FINER ○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4		100.0	
10		99.9	
20		99.6	
40		96.9	
60		85.9	
100		59.2	
200		26.2	

SYMBOL	w (%)	LL	PL	PI	USCS	DESCRIPTION AND REMARKS	Date Tested
□							
■	19.7	np	np	np	SM	Brown, Silty sand	3/14/2013
○							

TerraSense, LLC	URS Corporation
T22243088	22243088

PARTICLE SIZE DISTRIBUTION

Mayflower Investigation

Analysis File: 3SV-MasterRev4b

Siev1k.xls 4/17/2013

Appendix B.2

2013 Engineering Test Results

URS Corporation #22243088
Mayflower Investigation
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									PERMEABILITY	STRENGTH			CONSOLIDATION INITIAL CONDITIONS		REMARKS
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 μm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	(cm/sec)	TEST TYPE	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	VOID RATIO (-)	SATUR-ATION (%)	
INC-5-1		20	9.6				SM	12.3										
INC-5-1	SN-11	50-52								113.2								
INC-5-1	SN-11	50.2	6.8															
INC-5-1	SN-11A	50.45	9.5				SP-SM	11.7		111.0	101.4	2.5E-4						P9651
INC-5-1	SN-11	50.75	8.8															
INC-5-1	SN-11B	50.9	10.3							108.6	98.4		DSS	3.5	16.9			DSS795
INC-5-1	SN-11	51.15	12.1															
INC-5-1	SN-11C	51.25	12.1							98.8	88.1		DSS	4.8	18.8			DSS796
INC-5-1	SN-11	51.5	15.0															
INC-5-1	SN-11D	51.65	19.2							118.9	99.7		DSS	11.1	14.8			DSS797
INC-5-1		75-77																
INC-5-1		76	11.3															
INC-5-1		76.25	13.1				SM	17.3		113.5	100.4		Cyclic	*				CTXS465
INC-5-1		90	6.8				SM	12.9										
INC-5-1		95	9.9				SM	22.1										
INC-5-1		100						b										hold
INC-5-1		110	4.0				SM	14.1										
INC-5-1	SN-25	120-122																
INC-5-1		121.65	10.1															
INC-5-1	A	121.9	15.5	np	np	np	SM	13.9	0	110.3	95.5		Cyclic	*				CTXS466
INC-5-1		140-142								114.6								
INC-5-1	A	140.2	22.4	np	np	np	SM	45.6		127.8	104.4		CIU	9.7	20.9			T3395
INC-5-1		140.45	21.0															
INC-5-1		140.55	15.5				SP-SM			100.7	87.2	7.6E-4	CIU	17.6	18.6			TP3396
INC-5-1	C	141.0	18.3				SP-SM			113.7	96.1		CIU	27.3	12.7			T3400
INC-5-1	SN-31	160-162								112.8								
INC-5-1	SN-31 A	160.15	21.1				SM			127.2	105.0		DSS	5.2	16.4			DSS794
INC-5-1	SN-31 B	160.5	16.0	np	np	np	SM	15.8		102.8	88.6		DSS	6.9	11.6			DSS793
INC-5-1	SN-31 C	160.8	23.9				SM			118.5	95.6		DSS	13.8	17.5			DSS792
INC-5-1		193.5						d										hold

Prepared by: JR
Reviewed by: ________
Date: 5/15/2013

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

Project No.: T22243088
File: Indx1.xls

URS Corporation #22243088
Mayflower Investigation
LABORATORY TESTING DATA SUMMARY

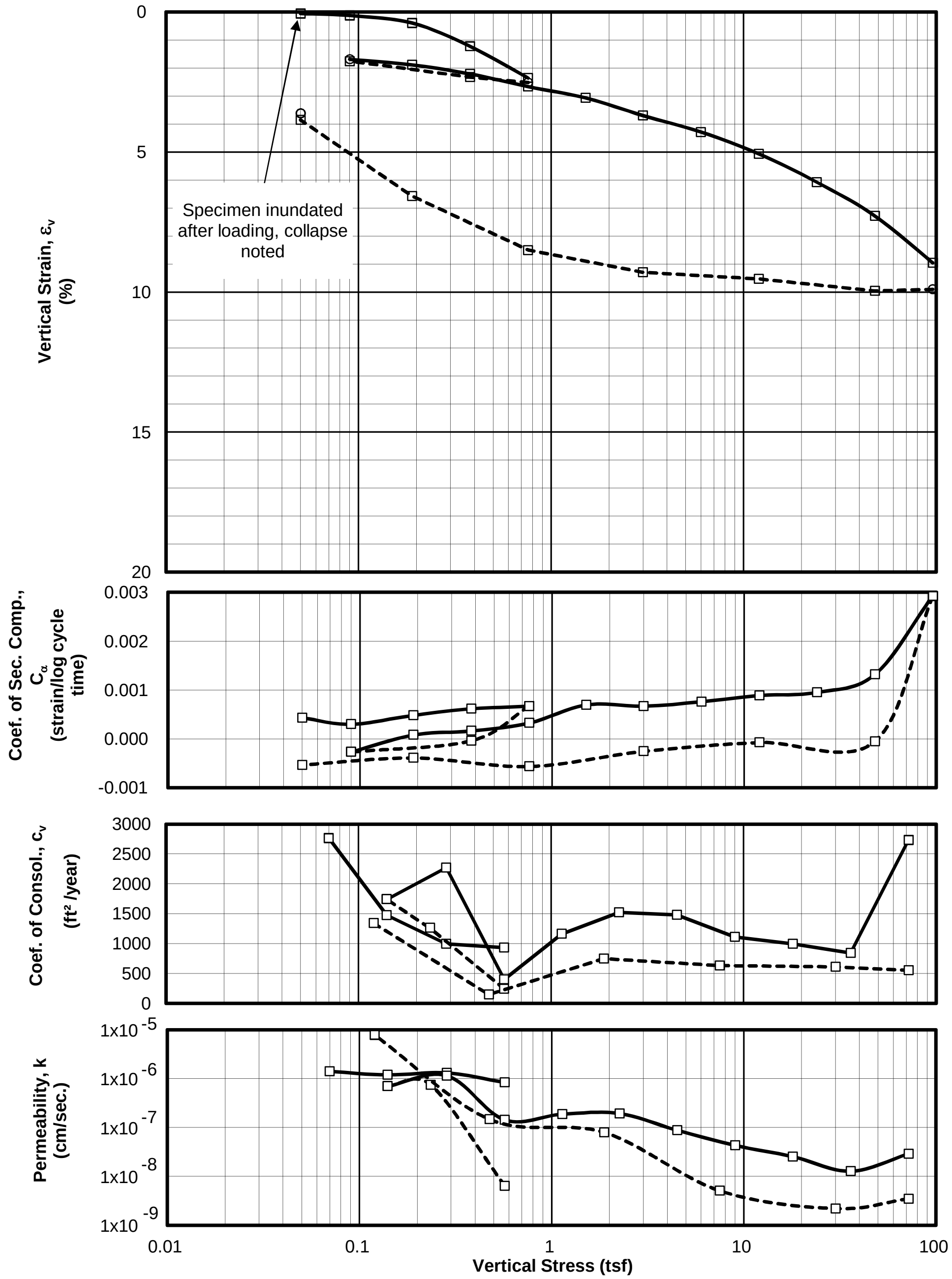
BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	PERMEABILITY (cm/sec)	STRENGTH: TEST TYPE	PEAK SHEAR STRESS (ksf)	STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS
P-11		75-77								107.9								
P-11		75.65	6.1															
P-11	B	75.9	15.5				SM			116.8	101.2	2.1E-4	CIU	15.6	24.3			TP3428
P-11		76.2	21.1															
P-11	C	76.45	18.0				SM	17.0		113.9	96.6		CIU	18.4	13.0			T3429
P-11	D	77.0	18.2				SM			119.3	101.0		CIU	32.1	14.2			T3427
TH-5-2		20	13.4	np	np	np	SM	16.6	1									
TH-5-2		25	16.7				SM	16.6										
TH-5-2		30	10.6				SM	14.1										
TH-5-2		35	20.4				SP-SM	11.9										
TH-5-2	SN-13	65-67								102.2								
TH-5-2	SN-13	65.65	12.5															
TH-5-2	SN-13 B	65.9	21.9				SP-SM	9.5		114.5	94.0	2.7E-4						P9657
TH-5-2		85						h										hold
TH5-2		110-111.5								104.0								
TH5-2		110.55	11.5															
TH5-2	B	110.8	20.1	np	np	np	SM	20.5	0	115.6	96.3					0.718	74	C13056
TH-5-3		20	18.0				SM	17.2										
TH-5-3		50	18.5	np	np	np	SM	22.5	0									
TH-5-3		83.5-85								109.7								
TH-5-3		84.15	8.5															
TH-5-3	B	84.4	13.1				SM	26.3		105.7	93.4	2.0E-5						P9673
TH-5-3		100	19.8				SM	21.3										
TH-5-3		110	14.7				SM	21.5										
TH-5-3		120	14.2				SM	16.1										
TH-5-3		132.5						k										hold
TH-5-3		150	19.7	np	np	np	SM	26.2	0									

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: JR
Reviewed by: ________
Date: 5/15/2013

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512

Project No.: T22243088
File: Indx1.xls



SAMPLE INFORMATION

Boring:	TH5-2
Sample:	B
Depth:	110.80 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	SM, brown silty sand

LL = 0, PL = 0, PI = 0

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.62	inch
Diameter:	2.50	inch

Initial water content:	20.1	%
Initial total unit weight:	115.6	pcf
Initial dry unit weight:	96.3	pcf
Initial void ratio:	0.718	
Initial degree of saturation:	74	%
Final water content:	22.5	%
Final total unit weight:	124.4	pcf
Final dry unit weight:	101.5	pcf
Final void ratio:	0.629	
Final degree of saturation:	95	% (assumed specific gravity = 2.65)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	5.0 (Range: 1.8 to 29.1)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.056
Compression Index (void ratio per log cycle stress):	0.096
Swell Ratio (strain per log cycle stress):	0.009
Swell Index (void ratio per log cycle stress):	0.015
Recompression Ratio (strain per log cycle stress):	0.010
Recompression Index (void ratio per log cycle stress):	0.017
Remarks:	

LEGEND: □ End of primary o End of Stage ———— Loading - - - - - - Unloading

Test Date: 2/13/13 Tested By: TK/CMJ Checked By: GET

URS Corporation Project No. 22243088	Mayflower Investigation	ONE DIMENSIONAL CONSOLIDATION TEST Boring: TH5-2 Depth: 110.80 feet
TerraSense, LLC	Project No. T22243088	April 2013

PROJECT:	Mayflower Investigation				
PROJECT NO.:	T22243088	Initial height:	0.619 inch	Final height:	0.587 inch
BORING:	TH5-2	Initial water content:	20.1 %	Final water content:	22.5 %
SAMPLE:	B	Initial dry density:	96.3 pcf	Final dry density:	101.5 pcf
TEST:	C13056	Initial total density:	115.6 pcf	Final total density:	124.4 pcf
DEPTH, feet:	110.8	Initial saturation:	74 %	Final saturation:	95 %
BY:	TK/CMJ	Initial void ratio:	0.718	Final void ratio:	0.629
TEST DATE:	2/13/2013			Final strain:	5.2 %

EQUIPMENT:

Load Frame No.: 2

Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: SM, brown silty sand

G	LL	PL	PI
2.65	np	np	np

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.050	0.0004	0.062	0.717	0.252	0.714	475.59	0.0004	80.90	1.77E-07
2	0.090	0.0008	0.129	0.716	0.220	0.714	2764.00	0.0003	59.13	1.41E-06
3	0.190	0.0025	0.399	0.711	0.529	0.709	1472.36	0.0005	37.06	1.20E-06
4	0.380	0.0076	1.233	0.697	1.377	0.694	996.10	0.0006	22.80	1.32E-06
5	0.760	0.0146	2.364	0.677	2.516	0.675	932.10	0.0007	33.57	8.38E-07
6	0.380	0.0144	2.331	0.678	2.326	0.678	240.07	0.0000	1137.29	6.37E-09
7	0.090	0.0109	1.761	0.688	1.692	0.689	1259.92	-0.0003	50.91	7.47E-07
8	0.190	0.0117	1.895	0.685	1.898	0.685	1739.79	0.0001	75.01	7.00E-07
9	0.380	0.0137	2.214	0.680	2.264	0.679	2270.00	0.0002	59.41	1.15E-06
10	0.760	0.0165	2.669	0.672	2.740	0.671	396.87	0.0003	83.61	1.43E-07
11	1.51	0.0190	3.072	0.665	3.252	0.662	1160.08	0.0007	186.31	1.88E-07
12	3.00	0.0229	3.700	0.654	3.871	0.652	1519.05	0.0007	237.25	1.93E-07
13	6.00	0.0266	4.291	0.644	4.487	0.641	1477.84	0.0008	507.25	8.79E-08
14	12.0	0.0314	5.067	0.631	5.288	0.627	1108.18	0.0009	773.38	4.32E-08
15	24.0	0.0377	6.083	0.614	6.306	0.610	993.35	0.0010	1180.60	2.54E-08
16	48.0	0.0451	7.280	0.593	7.735	0.585	843.28	0.0013	2005.88	1.27E-08
17	96.0	0.0555	8.960	0.564	9.899	0.548	2734.11	0.0029	2857.17	2.89E-08
18	48.0	0.0617	9.962	0.547	9.952	0.547	551.48	-0.0001	4788.09	3.47E-09
19	12.0	0.0590	9.536	0.554	9.524	0.554	610.61	-0.0001	8438.10	2.18E-09
20	3.00	0.0575	9.296	0.558	9.230	0.559	629.79	-0.0003	3756.75	5.06E-09
21	0.760	0.0526	8.504	0.572	8.296	0.576	744.48	-0.0006	282.72	7.94E-08
22	0.190	0.0407	6.579	0.605	6.501	0.606	144.49	-0.0004	29.61	1.47E-07
23	0.050	0.0239	3.861	0.652	3.624	0.656	1339.44	-0.0005	5.15	7.84E-06

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST
ASTM D 5084 - 90

Project No. **T22243088** BORING: INC5-1
Project Name: **Mayflower Investigation** SAMPLE: SN11-A DEPTH (ft): 50.45 Test No.: **P9651**

Specimen - Apparatus set-up - Test Information Apparatus No. C-2 Cell No. 4 stone Stage 5

1) Specimen Tested in : [x] Triaxial Cell or [ ] with stones or [ ] Compaction Mold or [ ] Stones with filter paper or [ ] top + bottom
2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove air: [x] No [ ] Yes
4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only
5) Direction of permeant : [x] Up during or [ ] Down during permeation
6) Permeant: water used [x] Tap [ ] Distilled [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Consol Stage-Trial No.	Temp. °C	Date	Time hr	Time min	Time sec	Initial σ_c psi	Initial Ub psi	Dial Indicator in	Pressure Head Reading Mercury (inch)	Pressure Head Reading Gage (psi)	Flow Reading (cm)	Flow Vol (cm3) / Rate (cm3/sec)	Fluid Head Reading Head (cm)	Fluid Head Reading Tail (cm)	Total Head Uncorrected / Correction / Corrected (cm)	Gradient	Permeability Preliminary / Final at 20ºC cm/sec
initial	22.5	4/6/13	00	00	00	121.7	80.0				4.40	64.108	63.90	36.35	27.55		
final	22.6	4/6/13	00	39	32						7.50	0.0270	63.90	36.35	1.96		2.66E-04
1	RT = 0.940	dT =		39.53 min		σ'_c =	6.0 ksf						63.9	36.35	25.59	2.53	2.51E-04
initial	22.6	4/6/13	00	00	00	121.7	100.0				4.10	74.448	63.90	36.35	27.55		
final	23.0	4/6/13	00	45	52						7.70	0.0271	63.90	36.35	1.96		2.66E-04
2	RT = 0.934	dT =		45.87 min		σ'_c =	3.1 ksf						63.9	36.35	25.59	2.52	2.50E-04
initial	23.0	4/6/13	00	00	00	121.7	100.0				4.60	76.516	63.90	36.35	27.55		
final	23.0	4/6/13	00	48	32						8.30	0.0263	63.90	36.35	1.90		2.58E-04
3	RT = 0.930	dT =		48.53 min		σ'_c =	3.1 ksf						63.9	36.35	25.65	2.53	2.41E-04
initial	23.0	4/6/13	00	00	00	121.7	100.0				4.40	86.856	63.90	36.35	27.55		
final	23.0	4/6/13	00	54	32						8.60	0.0265	63.90	36.35	1.92		2.61E-04
4	RT = 0.930	dT =		54.53 min		σ'_c =	3.1 ksf						63.9	36.35	25.63	2.53	2.44E-04
initial																	
final																	
5																	
initial																	
final																	
6																	

Preliminary Length/Area Calculations

Lo =	4.021	in	Lo=	10.212	cm
Ao=	6.341	in^2	Ao =	40.91	cm^2
Vo=	25.493	in^3	Vo =	417.76	cm^3
Lc =	3.991	in	Lc =	10.136	cm
Ac=	6.245	in^2	Ac=	40.292	cm^2
Vc =	24.923	in^3	Vc =	408.41	cm^3

Tested By: BR/DT Reviewed By: G. Thomas

TEST CONDITIONS

Final Specimen and Test Conditions

Lc = 10.136 cm ε_{axial} = 0.7%
Ac = 40.026 cm^2
Vc= 405.71 cm^3 ε_{vol} = 2.9%

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	9.49	111.0	101.4	39.8
PreTest	22.04	127.5	104.4	100.0

Project No. T22243088
Project Name: Mayflower Investigation

BORING: INC5-1
SAMPLE: SN11-A Depth: 50.45

HYDRAULIC CONDUCTIVITY TEST SUMMARY

Averages for trials: 1-4
ave K @ 20 ºC: **2.47E-04** cm/sec
(i_o)ave = 2.53

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST
ASTM D 5084 - 90

Project No. **T22243088** Boring: INC 5-1

Project Name: **Mayflower Investigation** Sample: Depth: 140.55 Test No.: **TP3396**

Specimen - Apparatus set-up - Test Information Apparatus No. C-2 Cell No. H-6 stone Stage 8

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
		with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
		Demineralized		0.005 N calcium sulfate (CaSO4)		

Consol Stage- Trial No.	Temp. °C	Date	Time hr	Time min	Time sec	Initial σ_c psi	Initial Ub psi	Dial Indicator in	Pressure Head Reading Mercury (inch)	Pressure Head Reading Gage (psi)	Flow Reading (cm)	Flow Vol (cm3) / Rate (cm3/sec)	Fluid Head Reading Head (cm)	Fluid Head Reading Tail (cm)	Total Head Uncorrected / Correction / Corrected (cm)	Gradient	Permeability Preliminary / Final at 20ºC cm/sec
initial	22.4	3/1/13	00	00	00	258.3	50.0	0.321			3.60	101.332	66.30	37.05	29.25		
final	22.5	3/1/13	00	46	57						8.50	0.0360	66.30	37.05	4.85		8.17E-04
1	RT = 0.942	dT =		46.95 min		σ'_c =	30.0 ksf						66.3	37.05	24.40	2.51	7.70E-04
initial	22.5	3/1/13	00	00	00	258.3	100.0	0.321			4.50	86.856	66.30	37.05	29.25		
final	22.7	3/1/13	00	40	49						8.70	0.0355	66.30	37.05	4.78		8.03E-04
2	RT = 0.938	dT =		40.82 min		σ'_c =	22.8 ksf						66.3	37.05	24.47	2.52	7.54E-04
initial	22.8	3/1/13	00	00	00	258.3	100.0	0.321			4.30	80.652	66.30	37.05	29.25		
final	22.8	3/1/13	00	37	21						8.20	0.0360	66.30	37.05	4.85		8.18E-04
3	RT = 0.934	dT =		37.35 min		σ'_c =	22.8 ksf						66.3	37.05	24.40	2.51	7.64E-04
initial	22.8	3/1/13	00	00	00	258.3	100.0	0.321			4.20	103.4	66.30	37.05	29.25		
final	23.0	3/1/13	00	48	12						9.20	0.0358	66.30	37.05	4.82		8.11E-04
4	RT = 0.932	dT =		48.20 min		σ'_c =	22.8 ksf						66.3	37.05	24.43	2.51	7.56E-04
initial																	
final																	
5																	
initial																	
final																	
6																	

Preliminary Length/Area Calculations

Lo =	3.945	in	Lo=	10.020	cm
Ao=	2.900	in^2	Ao =	18.71	cm^2
Vo=	11.440	in^3	Vo =	187.46	cm^3
Lc =	3.824	in	Lc =	9.713	cm
Ac=	2.716	in^2	Ac=	17.525	cm^2
Vc =	10.387	in^3	Vc =	170.21	cm^3

Tested By: DT Reviewed By: GET

TEST CONDITIONS

Final Specimen and Test Conditions

Lc = 9.713 cm ε_{axial} = 3.1%

Ac = 17.515 cm^2

Vc= 170.12 cm^3 ε_{vol} = 9.2%

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	15.45	100.7	87.2	45.1
PreTest	27.63	122.7	96.1	100.0

Project No. T22243088

Project Name: Mayflower Investigation

Boring: INC 5-1

Sample: Depth: 140.55

HYDRAULIC CONDUCTIVITY TEST SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **7.61E-04** cm/sec

(i_o)ave = 2.51

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST
ASTM D 5084 - 90

Project No. **T22243088** Boring: P-11
Project Name: **Mayflower Investigation** Sample: B Depth: 75.9 Test No.: **TP3428**

Specimen - Apparatus set-up - Test Information Apparatus No. C-2 Cell No. H-2 stone Stage 7

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or	
		with stones or		Stones with filter paper or	top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination	
3) During saturation: Water flushed up sides of specimen to remove air:			x	No	Yes
4) During consolidation:	x	Top and bottom drainage or		Top	Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation	
6) Permeant: water used	x	Tap		Distilled	
		Demineralized		0.005 N calcium sulfate (CaSO4)	

Consol Stage-Trial No.	Temp. °C	Date	Time hr	Time min	Time sec	Initial σ_c psi	Initial Ub psi	Dial Indicator in	Pressure Head Reading Mercury (inch)	Pressure Head Reading Gage (psi)	Flow Reading (cm)	Flow Vol (cm3) / Rate (cm3/sec)	Fluid Head Reading Head (cm)	Fluid Head Reading Tail (cm)	Total Head Uncorrected / Correction / Corrected (cm)	Gradient	Permeability Preliminary / Final at 20ºC cm/sec
initial	23.0	4/6/13	00	00	00	149.4	80.0				4.40	47.564	71.65	36.35	35.30		
final	23.0	4/6/13	00	40	32						6.70	0.0196	71.65	36.35	2.64		2.24E-04
1	RT = 0.930	dT =		40.53 min		σ'_c =	10.0 ksf						71.65	36.35	32.66	2.15	2.11E-04
initial	23.0	4/6/13	00	00	00	149.4	100.0				4.30	47.564	71.65	36.35	35.30		
final	23.0	4/6/13	00	40	12						6.60	0.0197	71.65	36.35	2.66		2.26E-04
2	RT = 0.930	dT =		40.20 min		σ'_c =	7.1 ksf						71.65	36.35	32.64	2.15	2.13E-04
initial	23.0	4/6/13	00	00	00	149.4	100.0				4.40	53.768	71.65	36.35	35.30		
final	23.0	4/6/13	00	46	32						7.00	0.0193	71.65	36.35	2.60		2.21E-04
3	RT = 0.930	dT =		46.53 min		σ'_c =	7.1 ksf						71.65	36.35	32.70	2.16	2.08E-04
initial	23.0	4/6/13	00	00	00	149.4	100.0				4.80	72.38	71.65	36.35	35.30		
final	23.3	4/6/13	00	63	06						8.30	0.0191	71.65	36.35	2.58		2.19E-04
4	RT = 0.926	dT =		63.10 min		σ'_c =	7.1 ksf						71.65	36.35	32.72	2.16	2.05E-04
initial																	
final																	
5																	
initial																	
final																	
6																	

Preliminary Length/Area Calculations

Lo =	6.009	in	Lo=	15.262	cm
Ao=	6.359	in^2	Ao =	41.02	cm^2
Vo=	38.206	in^3	Vo =	626.08	cm^3
Lc =	5.969	in	Lc =	15.160	cm
Ac=	6.273	in^2	Ac=	40.473	cm^2
Vc =	37.443	in^3	Vc =	613.58	cm^3

Tested By: DT Reviewed By:

TEST CONDITIONS

Final Specimen and Test Conditions

Lc = 15.160 cm ε_{axial} = 0.7%
Ac = 39.956 cm^2
Vc= 605.74 cm^3 ε_{vol} = 3.2%

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	15.46	116.8	101.2	64.5
PreTest	21.97	127.5	104.6	100.0

Project No. T22243088
Project Name: Mayflower Investigation
Boring: P-11
Sample: B Depth: 75.9

HYDRAULIC CONDUCTIVITY TEST SUMMARY

Averages for trials: 1-4
ave K @ 20 ºC: **2.09E-04** cm/sec
(i_o)ave = 2.16

CONSTANT HEAD HYDRAULIC CONDUCTIVITY TEST
ASTM D 5084 - 90

Project No. **T22243088** BORING: TH-5-2
Project Name: **Mayflower Investigation** SAMPLE: SN-13 B DEPTH (ft): 65.9 Test No.: **p9657**

Specimen - Apparatus set-up - Test Information Apparatus No. C-2 Cell No. 1 stone Stage 6

1) Specimen Tested in : [x] Triaxial Cell or [ ] Compaction Mold or [ ] with stones or [ ] Stones with filter paper or [ ] top + bottom
2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove air: [x] No [ ] Yes
4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only
5) Direction of permeant : [x] Up during or [ ] Down during permeation
6) Permeant: water used [x] Tap [ ] Distilled [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Consol Stage- Trial No.	Temp. °C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	Dial Indicator in	Pressure Head Reading Mercury (inch)	Gage (psi)	Flow Reading (cm)	Flow Vol (cm3) / Rate (cm3/sec)	Fluid Head Reading Head (cm)	Tail (cm)	Total Head Uncorrected / Correction / Corrected (cm)	Gradient	Permeability Preliminary / Final at 20ºC cm/sec
initial	23.2	4/8/13	00	00	00	149.4	80.0				4.00	82.72	71.65	36.35	35.30		
final	23.4	4/8/13	00	38	45						8.00	0.0356	71.65	36.35	2.57		2.88E-04
1	RT = 0.923	dT =		38.75 min		σ'_c =	10.0 ksf						71.65	36.35	32.73	3.29	2.58E-04
initial	23.4	4/8/13	00	00	00	149.4	100.0				5.10	68.244	71.65	36.35	35.30		
final	23.5	4/8/13	00	32	19						8.40	0.0352	71.65	36.35	2.55		2.85E-04
2	RT = 0.920	dT =		32.32 min		σ'_c =	7.1 ksf						71.65	36.35	32.75	3.29	2.54E-04
initial	23.5	4/8/13	00	00	00	149.4	100.0				3.90	84.788	71.65	36.35	35.30		
final	23.9	4/8/13	00	37	45						8.00	0.0374	71.65	36.35	2.71		3.04E-04
3	RT = 0.915	dT =		37.75 min		σ'_c =	7.1 ksf						71.65	36.35	32.59	3.28	2.70E-04
initial	23.2	4/8/13	00	00	00	149.4	100.0				4.30	97.196	71.65	36.35	35.30		
final	23.4	4/8/13	00	41	45						9.00	0.0388	71.65	36.35	2.81		3.17E-04
4	RT = 0.923	dT =		41.75 min		σ'_c =	7.1 ksf						71.65	36.35	32.49	3.27	2.83E-04
initial																	
final																	
5																	
initial																	
final																	
6																	

Preliminary Length/Area Calculations

Lo =	3.984	in	Lo=	10.119	cm
Ao=	6.026	in^2	Ao =	38.87	cm^2
Vo=	24.006	in^3	Vo =	393.38	cm^3
Lc =	3.916	in	Lc =	9.947	cm
Ac=	5.816	in^2	Ac=	37.524	cm^2
Vc =	22.777	in^3	Vc =	373.24	cm^3

Tested By: BR/DT Reviewed By: G. Thomas

TEST CONDITIONS

Final Specimen and Test Conditions

Lc = 9.947 cm ε_{axial} = 1.7%
Ac = 38.727 cm^2
Vc= 385.20 cm^3 ε_{vol} = 2.1%

	w (%)	γ_τ (pcf)	γ_d (pcf)	S (%)
Initial	21.87	114.5	94.0	74.4
PreTest	28.02	122.8	96.0	100.0

Project No. T22243088
Project Name: Mayflower Investigation

BORING: TH-5-2
SAMPLE: SN-13 B Depth: 65.9

HYDRAULIC CONDUCTIVITY TEST SUMMARY

Averages for trials: 1-4
ave K @ 20 ºC: **2.66E-04** cm/sec
(i_o)ave = 3.28

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - Method F

Project No.: T22243088 | BORING: TH5-3 | Test No.: P9673

Project Name: Mayflower Investigation | SAMPLE: B | DEPTH (ft): 84.4

Specimen - Apparatus set-up - Test Information | Cell No. H-8 | Apparatus No. 2 | Stage No.: 8

Preliminary Length/Area Calculations

Lo =	3.978	in	Lo=	10.104	cm
dLc=	0.067	in	Ao =	40.72	cm^2
Lc=	3.911	in	Vo =	411.44	cm^3
			Lc=	9.934	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	20.79	cm^3
			Vc =	390.65	cm^3
Sc =	0.253	cm^{-1}	Ac=	39.325	cm^2

1) Specimen Tested in : [x] Triaxial Cell or [ ] Compaction Mold or
[x] with stones or [ ] Stones with filter paper or ______ top + bottom
2) Specimen orientation for: [x] Vertical or [ ] Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove air [x] No [ ] Yes
4) During consolidation: [x] Top and bottom drainage or [ ] Top [ ] Bottom only
5) Direction of permeant : [x] Up during or [ ] Down during permeation
6) Permeant: water used [x] Tap [ ] Distilled
or [ ] Demineralized [ ] 0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000746 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt   TubeC= 1.3214

Consol Stage- Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	23.4	4/15/13	00	00	00	205.0	80.0	51.00	45.60	1.00	2.20E-05
final	23.4	4/15/13	00	01	08			48.00	46.56		2.04E-05
1	RT = 0.921	dT =	1.13 min			σ'_c =	18 ksf	0.223	0.222	io= 6.8	1%
initial	23.4	4/15/13	00	00	00	205.0	80.0	51.00	45.60	1.00	2.17E-05
final	23.4	4/15/13	00	01	09			48.00	46.56		2.01E-05
2	RT = 0.921	dT =	1.15 min			σ'_c =	18 ksf	0.223	0.222	io= 6.8	-1%
initial	23.4	4/15/13	00	00	00	205.0	80.0	51.00	45.60	1.00	2.17E-05
final	23.4	4/15/13	00	01	09			48.00	46.56		2.01E-05
3	RT = 0.921	dT =	1.15 min			σ'_c =	18 ksf	0.223	0.222	io= 6.8	-1%
initial	23.4	4/15/13	00	00	00	205.0	80.0	51.00	45.60	1.00	2.20E-05
final	23.4	4/15/13	00	01	08			48.00	46.56		2.04E-05
4	RT = 0.921	dT =	1.13 min			σ'_c =	18 ksf	0.223	0.222	io= 6.8	1%
initial											
final											
5											
initial											
final											
6											

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 9.934 cm ε_{axial} = 1.7%

Ac = 39.099 cm^2

Vc= 388.41 cm^3 ε_{vol} = 5.6%

Sc = 0.254 cm^{-1} Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	13.14	105.7	93.4	45.1
PreTest	25.37	124.0	98.9	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **2.03E-05** cm/sec

(i_o)ave = 6.8

Tested By: DT   Reviewed By: G. Thomas

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (ksf) / OCR	$\sigma'_{v,c}$ (ksf) / $K_c = \sigma'_{v,c} / \sigma'_{h,c}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
												at Peak Deviator Stress / at Peak Obliquity					
T3395	INC 5-1		140.2	SM	22.4	127.8	104.4	15.00	15.00	2.0		20.9	9.70	17.58	3.46	0.367	33.5
				(2.68)	18.5	132.6	111.9	1.0	1.00	6.7	1.4	8.6	7.93	13.90	3.66	0.570	34.8
TP3396	INC 5-1		140.6	SP-SM	15.5	100.7	87.2	30.0	30.0	3.1		18.6	17.61	28.22	4.32	0.550	38.6
				(2.68)	27.6	122.7	96.1	1.0	1.00	9.2	1.4	9.9	16.44	25.96	4.46	0.623	39.3
T3400	INC5-1	C	141	SM	18.3	113.7	96.1	50.0	50.0	4.1		12.7	27.3	44.9	4.11	0.594	37.5
				(2.68)	23.2	127.1	103.2	1.0	1.00	6.8	1.5	7.1	25.7	41.8	4.21	0.660	38.0

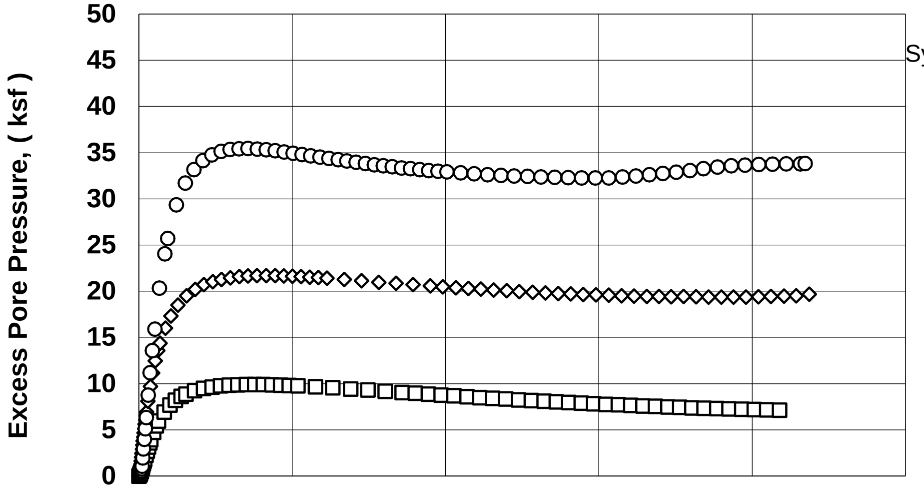
Test No	Description of Material Tested and Remarks
T3395	SM, brown silty fine sand with SP top and bottom
TP3396	SP-SM, brown fine Sand, trace silt
T3400	SM, brown silty fine Sand

Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	37.4	0.000	31.2	0.000	--
	2	38.1	0.000	31.7	0.000	--

Failure Criteria: 1 - Peak Deviator Stress; 2 - Peak Obliquity

URS Corporation	Project No. 22243088	Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements INC 5-1 SUMMARY
TerraSense, LLC	Project No. T22243088		

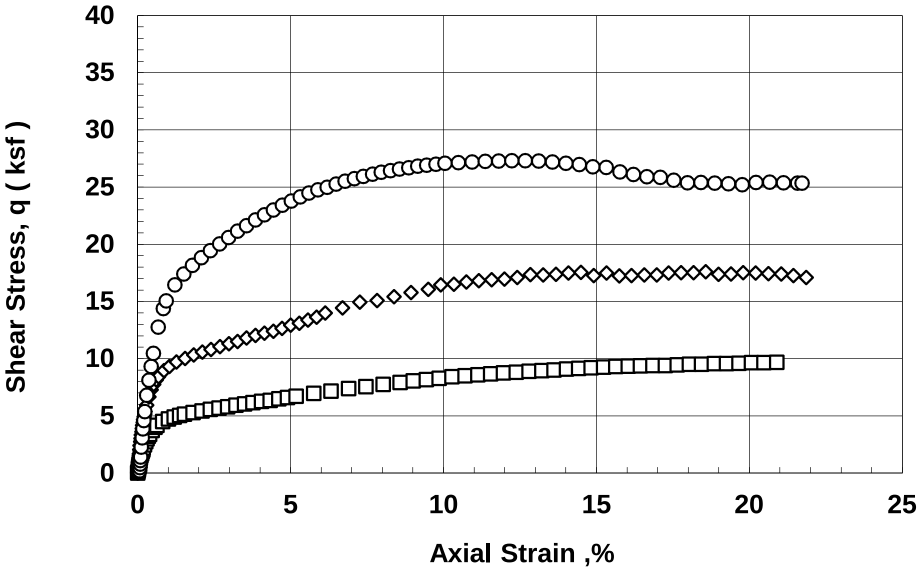


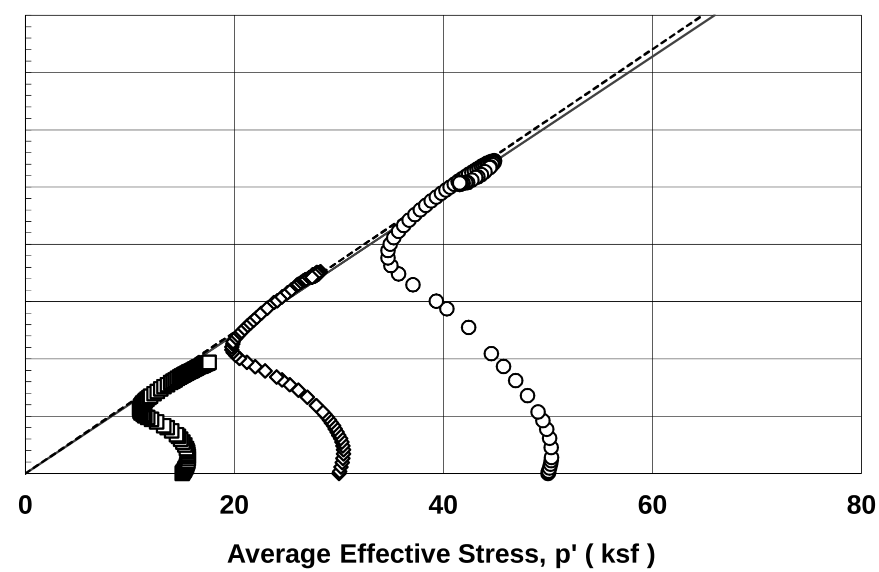
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T3395	INC 5-1		140.2	22.4	127.8	15.00
◊	TP3396	INC 5-1		140.6	15.5	100.7	30.00
○	T3400	INC5-1	C	141.0	18.3	113.7	50.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
solid line	Peak Deviator Stress	0.00	37.4
dotted line	Peak Obliquity	0.00	38.1



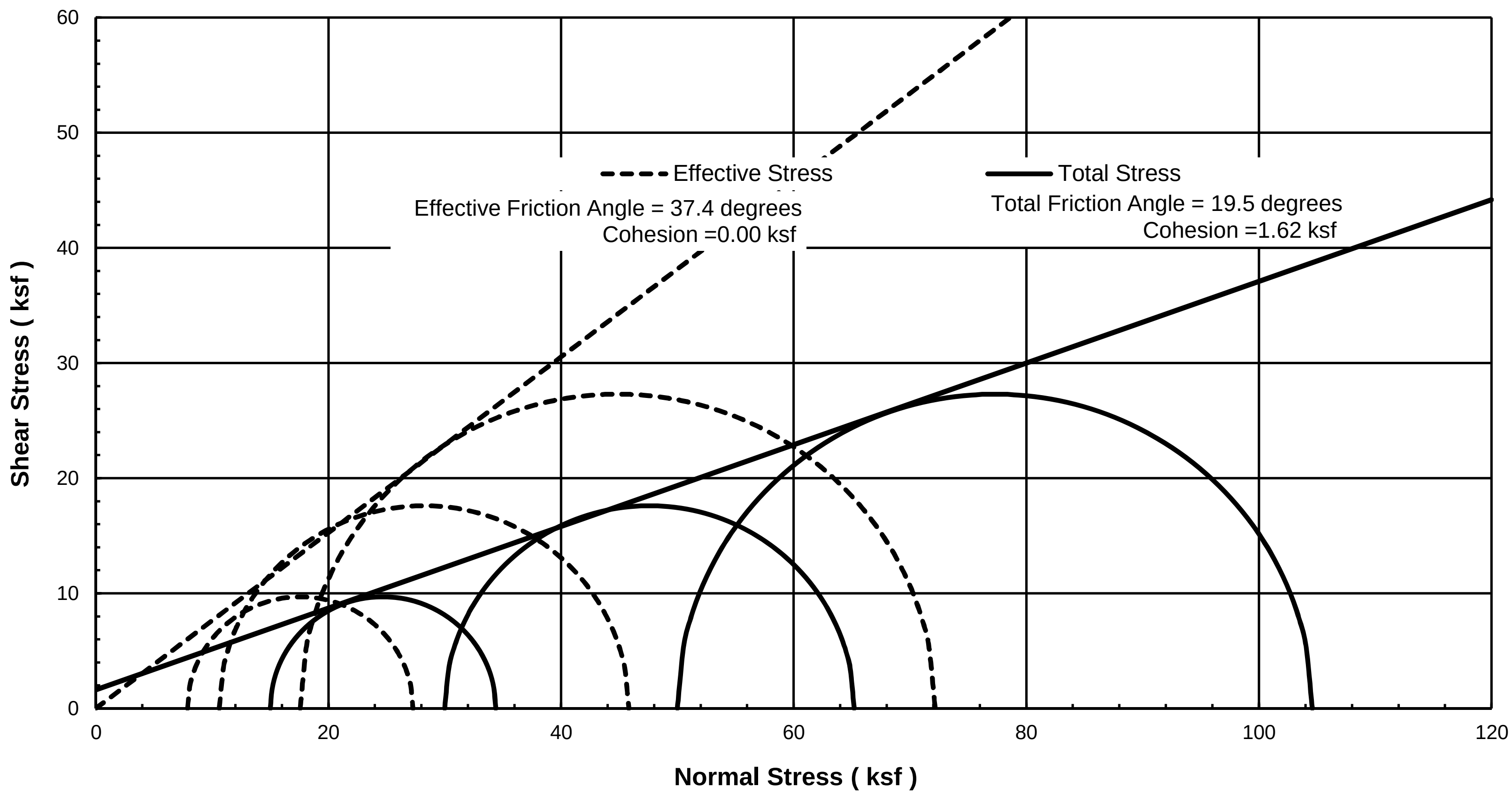


URS Corporation	Project No. 22243088	Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements INC 5-1 SUMMARY
TerraSense, LLC	Project No. T22243088		

Prepared by: CMJ
Checked by: G. Thomas

Analysis File: Cu'sum3v4

4/17/2013 Test: CiuINC5-1sum.xlsx



URS Corporation	Project No. 22243088	Mayflower Investigation	Mohr Circles of Total and Effective Stresses at Peak
TerraSense, LLC	Project No. T22243088		CIU' Triaxial Test INC 5-1 SUMMARY

SAMPLE INFORMATION

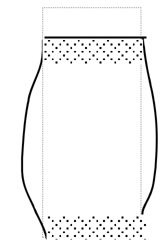
Boring: INC 5-1 Sample: Depth: 140.2 ft
Type: Intact tube sample
Description: SM, brown silty fine sand with SP top and bottom

SPECIMEN INFORMATION (Initial)

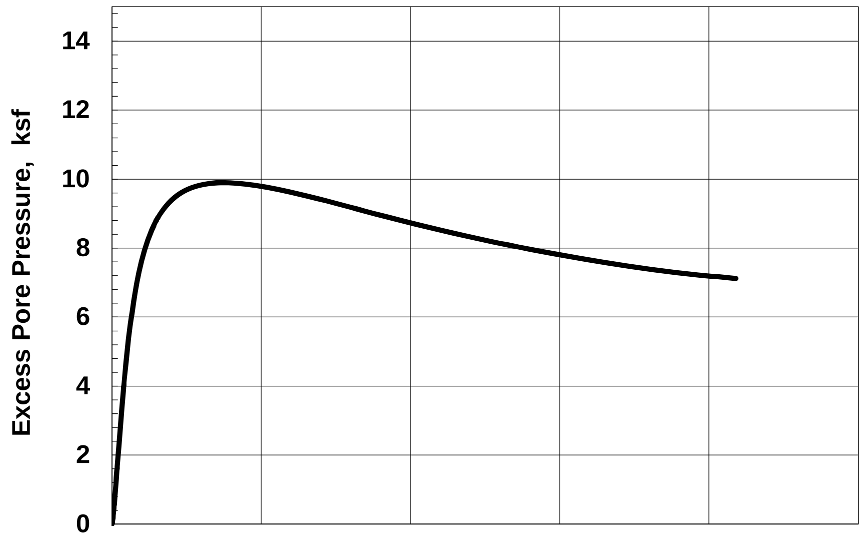
Height: 3.95 inch Diameter: 1.92 inch Area: 2.90 in²
Water Content: 22.4 % Total Unit Weight: 127.8 pcf

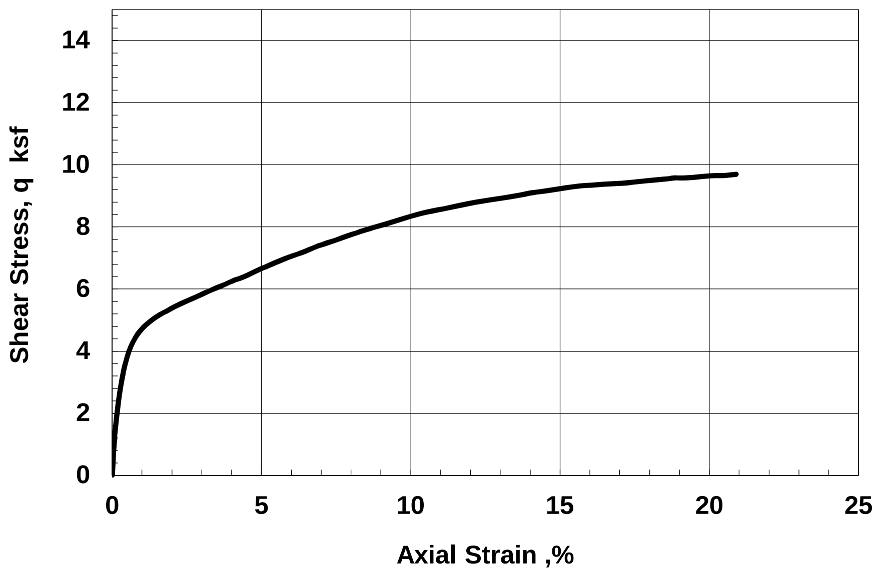
TEST SUMMARY

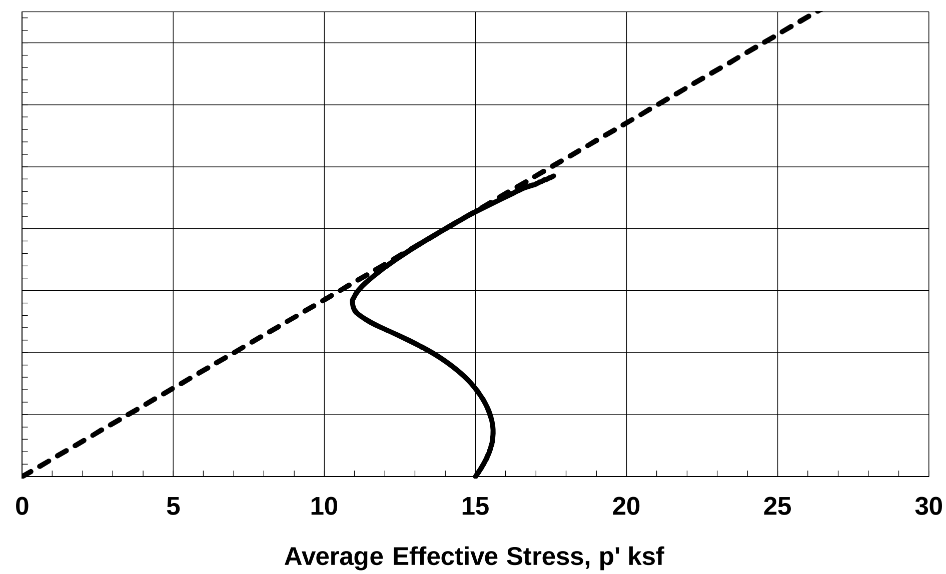
Consolidation Stresses: 15.00 ksf vertical, 15.00 ksf lateral
Water Content: 18.5 % Total Unit Weight: 132.6 pcf
B Coefficient: Strain Rate: 0.023 %/min
Peak Shear Strength: 9.70 ksf @ 20.9 % Strain
Peak Effective Friction Angle: 34.8°


Failure Sketch

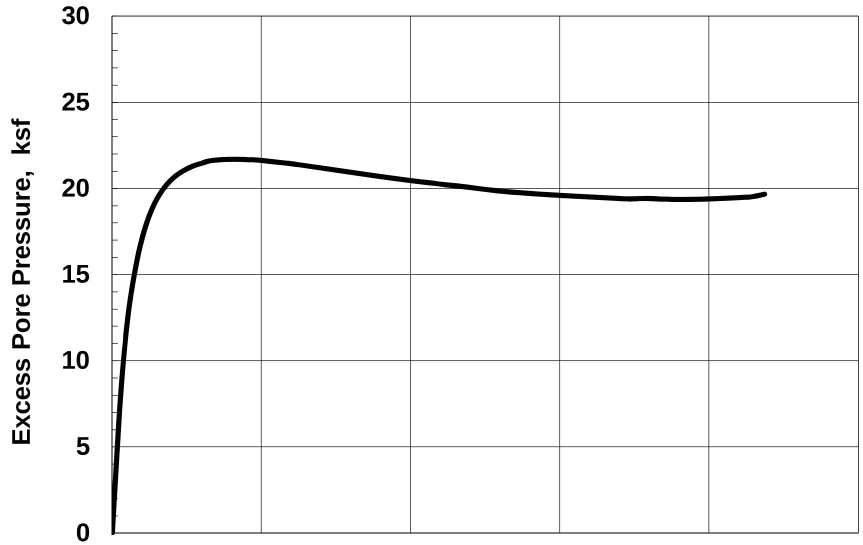
REMARKS:







Test by: DT	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: INC 5-1 Sample:	April 2013



SAMPLE INFORMATION

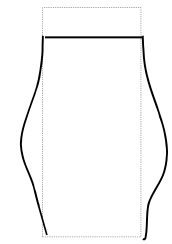
Boring: INC 5-1 Sample: Depth: 140.55ft
Type: Intact tube sample
Description: SP-SM, brown fine Sand, trace silt

SPECIMEN INFORMATION (Initial)

Height: 3.95 inch Diameter: 1.92 inch Area: 2.90 in²
Water Content: 15.5 % Total Unit Weight: 100.7 pcf

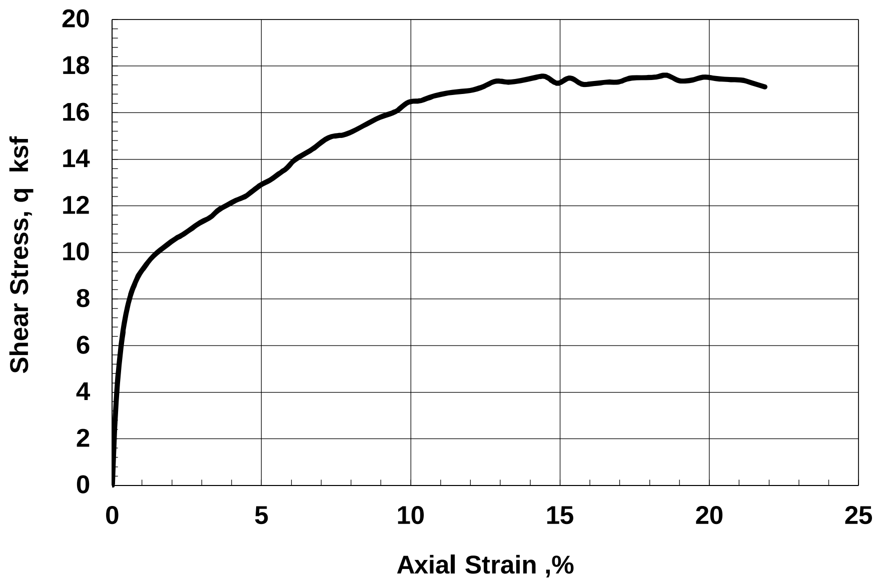
TEST SUMMARY

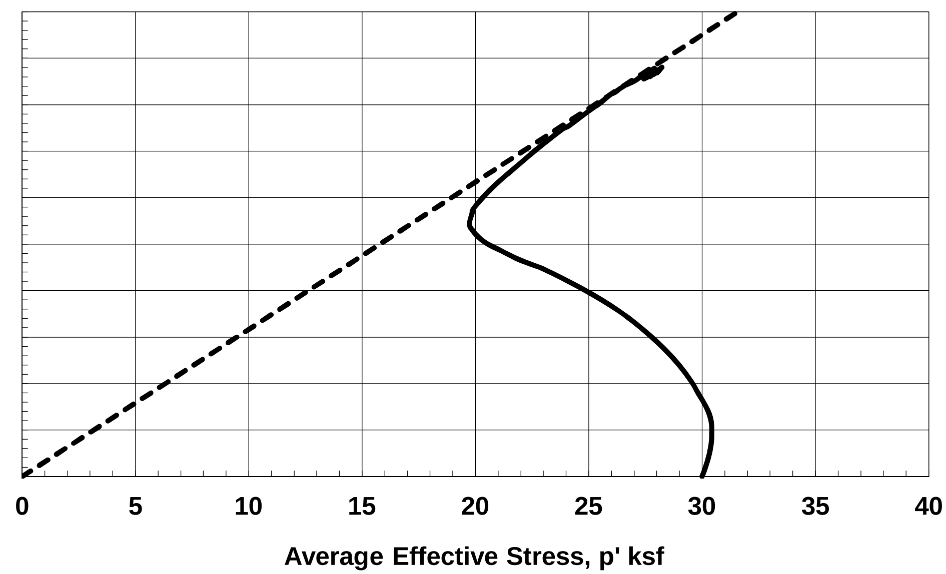
Consolidation Stresses: 30.00 ksf vertical, 30.00 ksf lateral
Water Content: 27.6 % Total Unit Weight: 122.7 pcf
B Coefficient: Strain Rate: 0.023 %/min
Peak Shear Strength: 17.61 ksf @ 18.6 % Strain
Peak Effective Friction Angle: 39.3°



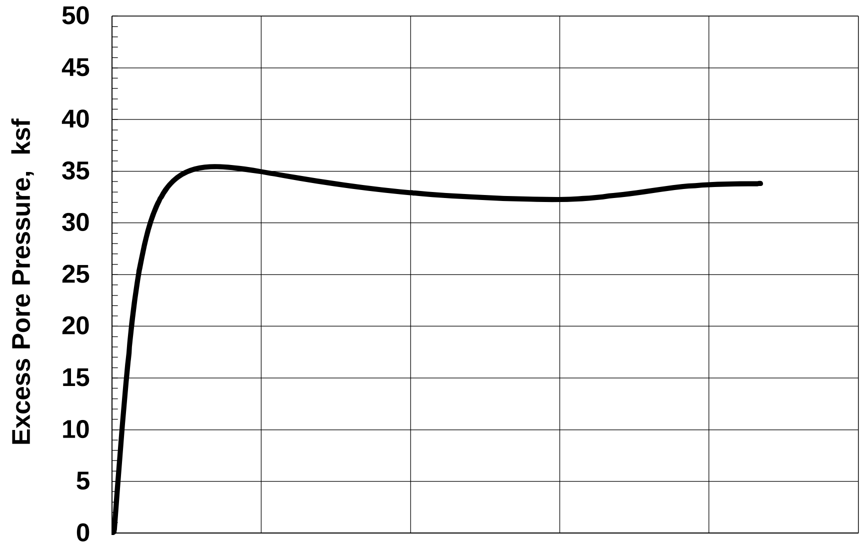
Failure Sketch

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: INC 5-1 Sample:	April-13



SAMPLE INFORMATION

Boring: INC5-1 Sample: C Depth: 141ft

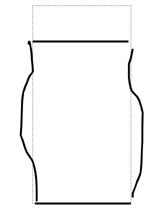
Type: Intact tube sample

Description: SM, brown silty fine Sand

SPECIMEN INFORMATION (Initial)

Height: 3.93 inch Diameter: 1.94 inch Area: 2.96 in²

Water Content: 18.3 % Total Unit Weight: 113.7 pcf



Failure Sketch

TEST SUMMARY

Consolidation Stresses: 50.00 ksf vertical, 50.00 ksf lateral

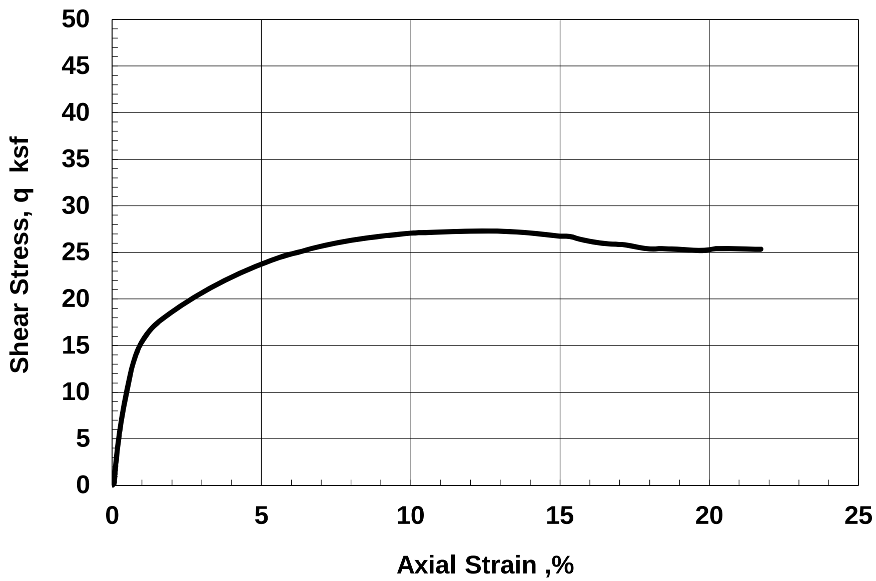
Water Content: 23.2 % Total Unit Weight: 127.1 pcf

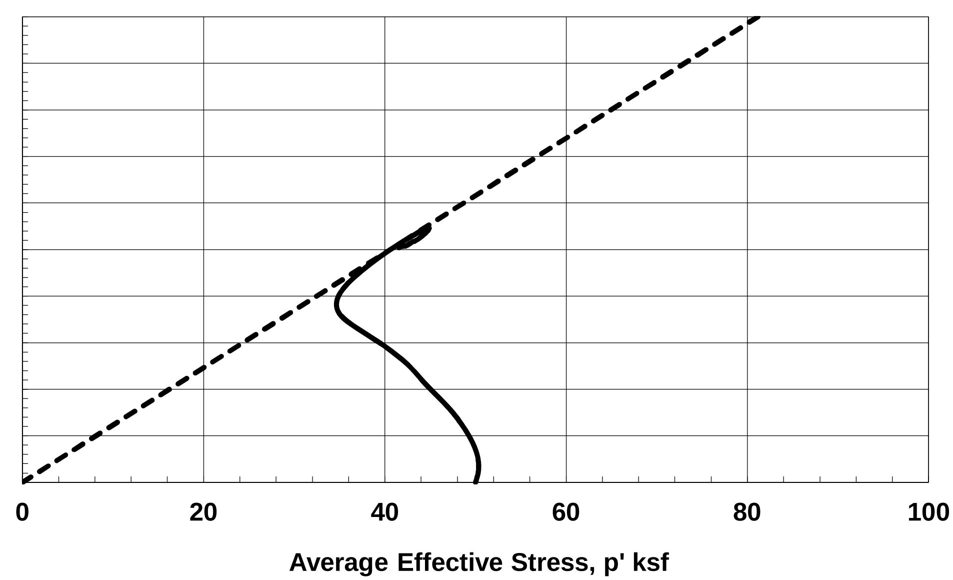
B Coefficient: Strain Rate: 0.024 %/min

Peak Shear Strength: 27.30 ksf @ 12.7 % Strain

Peak Effective Friction Angle: 38.0°

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: INC5-1 Sample: C	April-13
Checked by: GET	TerraSense, LLC			

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

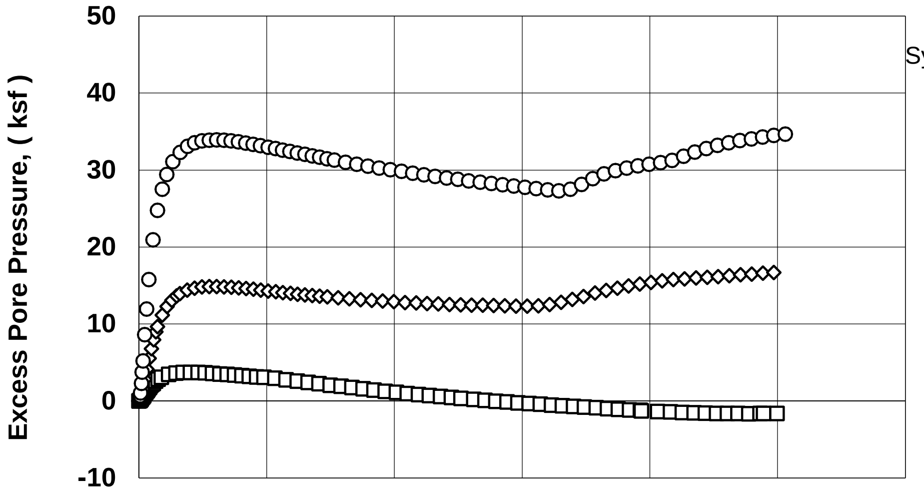
Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (ksf) / OCR	$\sigma'_{v,c}$ (ksf) / $K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	at Peak Deviator Stress / at Peak Obliquity: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
TP3428	P-11	B	75.9	SM	15.5	116.8	101.2	9.99	9.99	0.7		24.3	15.58	27.20	3.68	-0.052	34.9
				(2.65)	22.0	127.5	104.6	1.0	1.00	3.3	1.4	6.6	10.60	18.17	3.80	0.114	35.7
T3429	P-11	C	76.45	SM	18.0	113.9	96.6	25.0	25.0	1.6	97.2	13.0	18.36	30.90	3.93	0.339	36.5
				(2.65)	24.3	125.1	100.6	1.0	1.00	4.0	1.4	6.2	16.75	27.87	4.01	0.414	36.9
T3427	P-11	D	77	SM	18.2	119.3	101.0	50.0	50.0	1.9		14.2	32.1	54.0	3.93	0.438	36.5
				(2.65)	20.3	129.4	107.6	1.0	1.00	6.1	1.5	6.2	28.3	46.0	4.18	0.570	37.9

Test No	Description of Material Tested and Remarks
TP3428	SM, brown silty sand
T3429	SM, brown silty sand
T3427	SM, gray & brown silty sand

Strength Envelope Summary						
Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	36.2	0.000	30.6	0.000	--
	2	37.4	0.000	31.3	0.000	--

Failure Criteria: 1 - Peak Deviator Stress
2 - Peak Obliquity

URS Corporation	Project No. 22243088	Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements P-11 SUMMARY
TerraSense, LLC	Project No. T22243088		

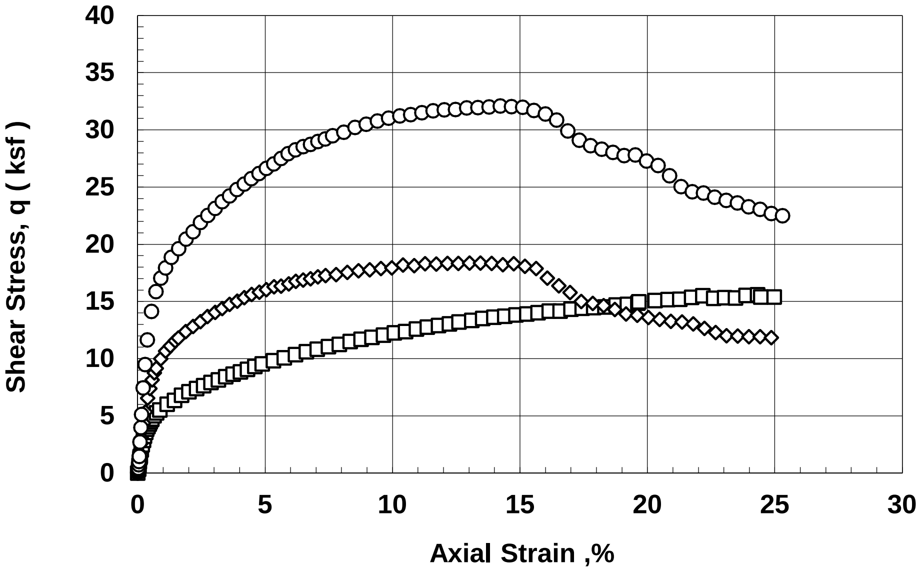


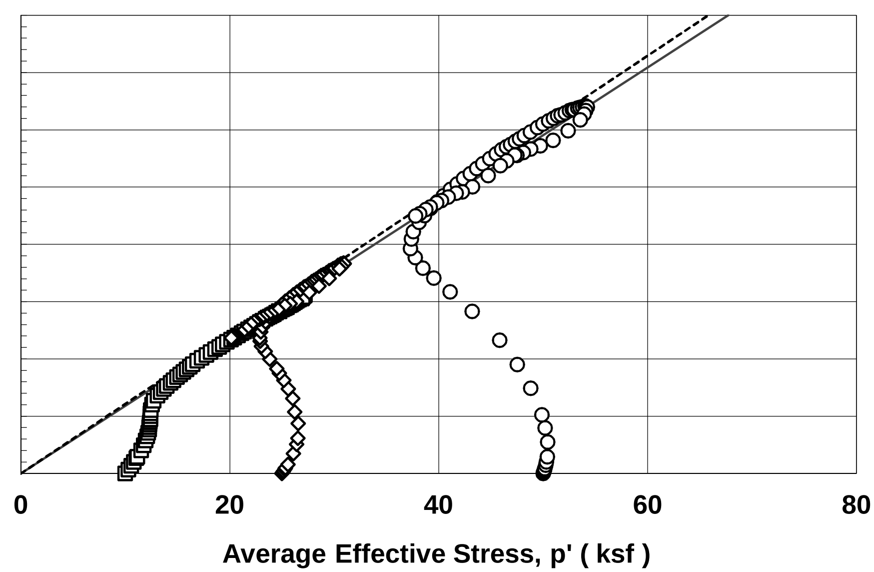
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	TP3428	P-11	B	75.9	15.5	116.8	9.99
◊	T3429	P-11	C	76.5	18.0	113.9	25.00
○	T3427	P-11	D	77.0	18.2	119.3	50.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
———	Peak Deviator Stress	0.00	36.2
········	Peak Obliquity	0.00	37.4

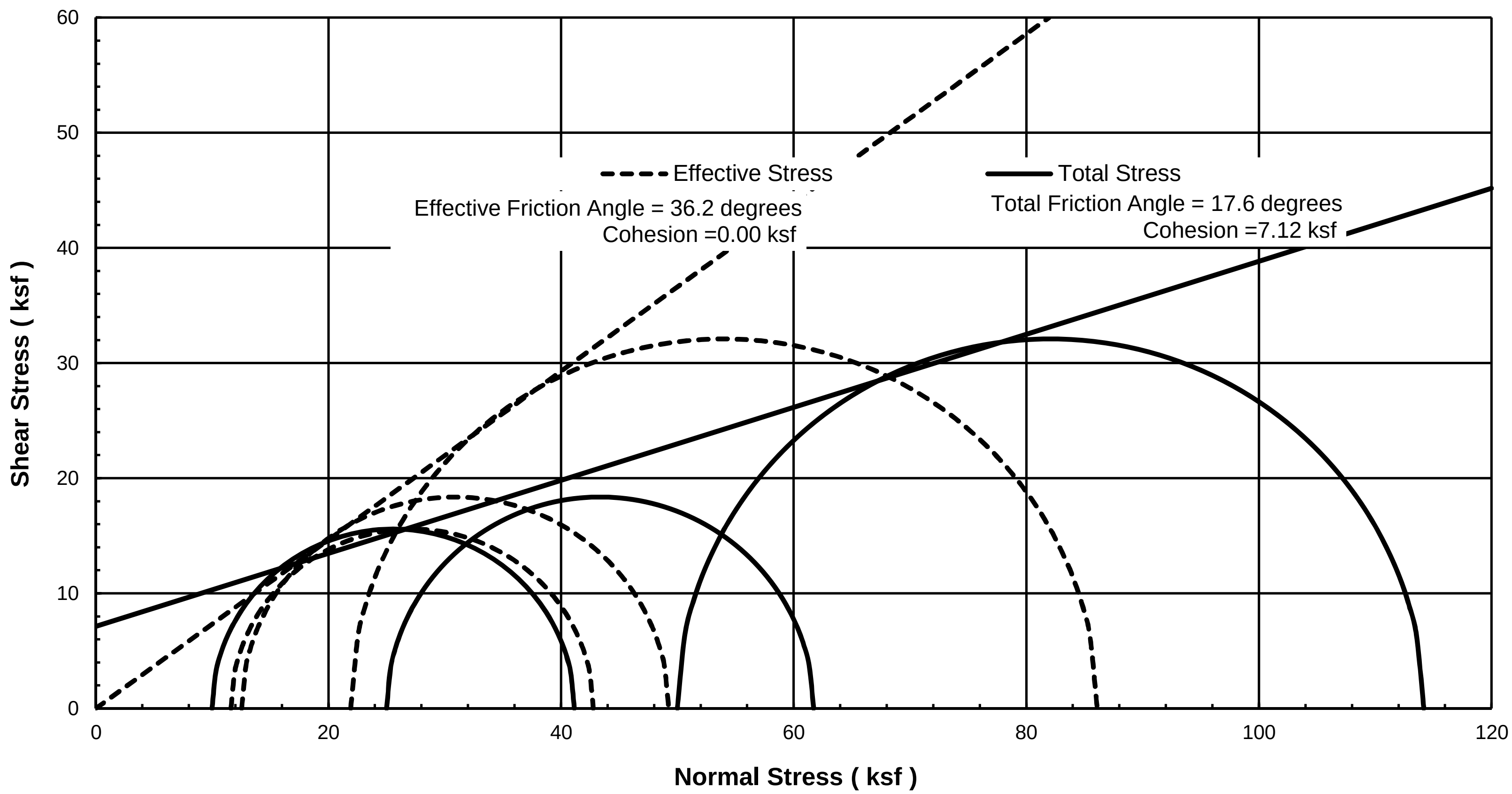




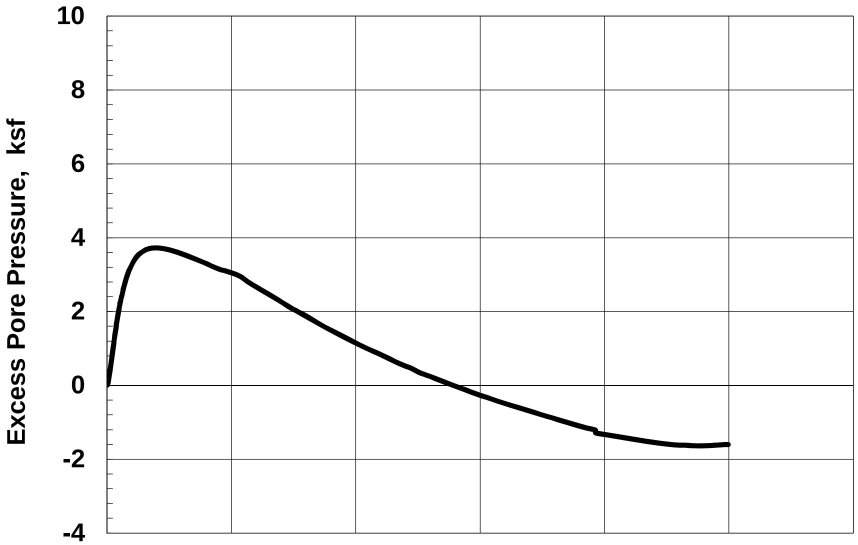
Prepared by: CMJ Checked by: G. Thomas	**URS Corporation**	**Project No. 22243088**	**Mayflower Investigation**	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION** **with Pore Pressure Measurements** **P-11 SUMMARY**
	TerraSense, LLC	**Project No. T22243088**		

Analysis File: Cu'sum3v4

4/17/2013 Test: CiuP11sum.xlsx



URS Corporation	Project No. 22243088	Mayflower Investigation	Mohr Circles of Total and Effective Stresses at Peak
TerraSense, LLC	Project No. T22243088		CIU' Triaxial Test P-11 SUMMARY



SAMPLE INFORMATION

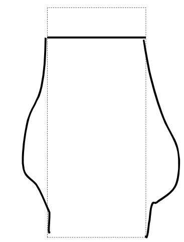
Boring: P-11 Sample: B Depth: 75.9ft
Type: Intact tube sample
Description: SM, brown silty sand

SPECIMEN INFORMATION (Initial)

Height: 6.01 inch Diameter: 2.85 inch Area: 6.36 in²
Water Content: 15.5 % Total Unit Weight: 116.8 pcf

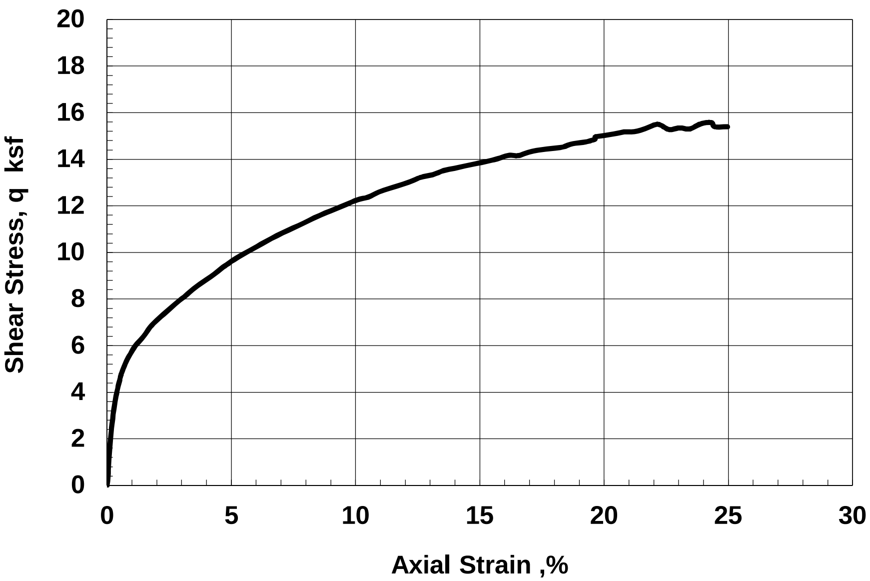
TEST SUMMARY

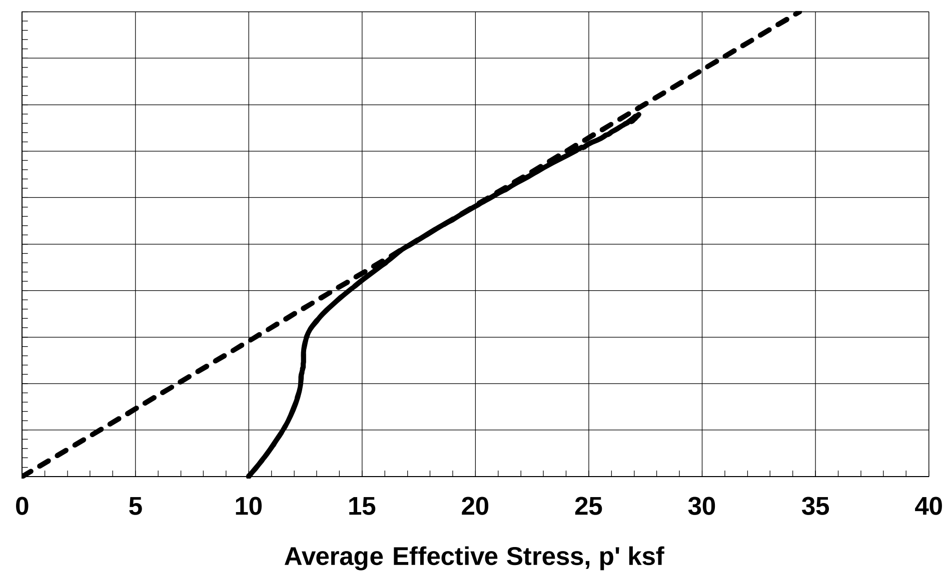
Consolidation Stresses: 9.99 ksf vertical, 9.99 ksf lateral
Water Content: 22.0 % Total Unit Weight: 127.5 pcf
B Coefficient: Strain Rate: 0.024 %/min
Peak Shear Strength: 15.58 ksf @ 24.3 % Strain
Peak Effective Friction Angle: 35.7°



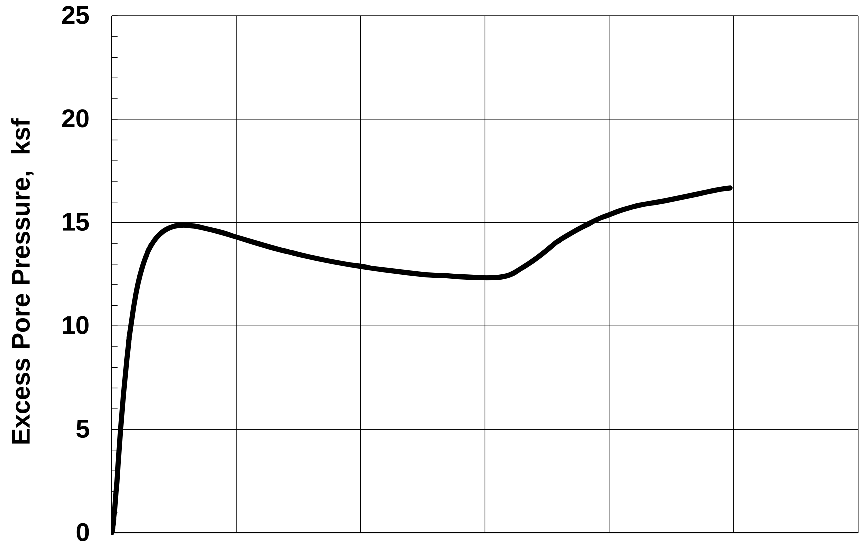
Failure Sketch

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: P-11 Sample: B	April-13



SAMPLE INFORMATION

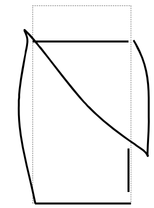
Boring: P-11 Sample: C Depth: 76.45ft
Type: Intact tube sample
Description: SM, brown silty sand

SPECIMEN INFORMATION (Initial)

Height: 6.04 inch Diameter: 2.80 inch Area: 6.15 in²
Water Content: 18.0 % Total Unit Weight: 113.9 pcf

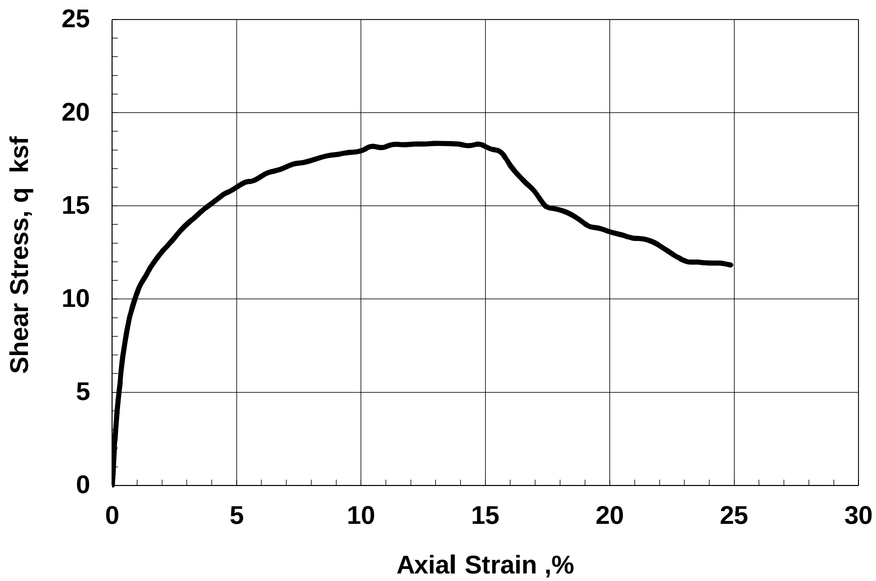
TEST SUMMARY

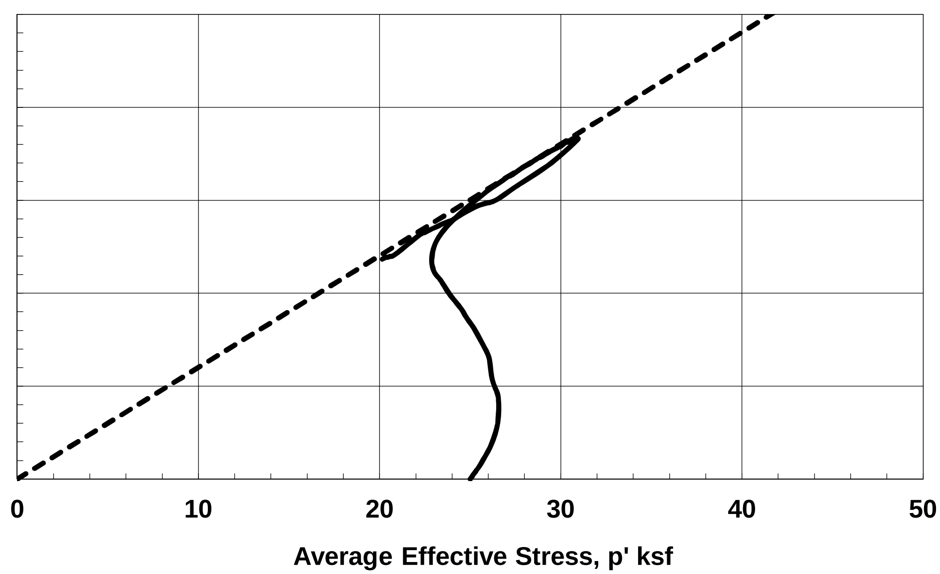
Consolidation Stresses: 25.00 ksf vertical, 25.00 ksf lateral
Water Content: 24.3 % Total Unit Weight: 125.1 pcf
B Coefficient: 97.2 Strain Rate: 0.024 %/min
Peak Shear Strength: 18.36 ksf @ 13.0 % Strain
Peak Effective Friction Angle: 36.9°



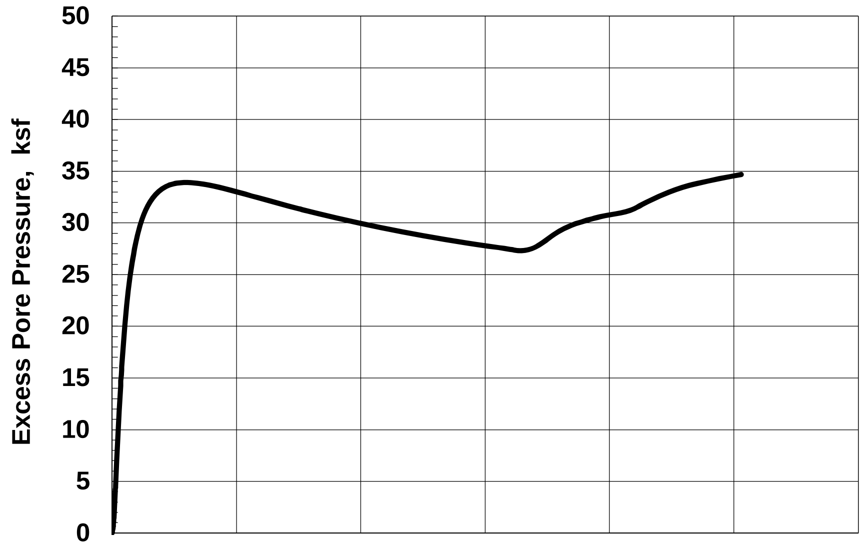
Failure Sketch

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	TerraSense, LLC		Boring: P-11 Sample: C	April-13

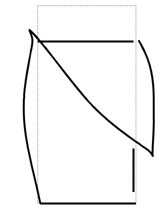


SAMPLE INFORMATION

Boring: P-11 Sample: D Depth: 77ft
Type: Intact tube sample
Description: SM, gray & brown silty sand

SPECIMEN INFORMATION (Initial)

Height: 6.03 inch Diameter: 2.85 inch Area: 6.40 in²
Water Content: 18.2 % Total Unit Weight: 119.3 pcf

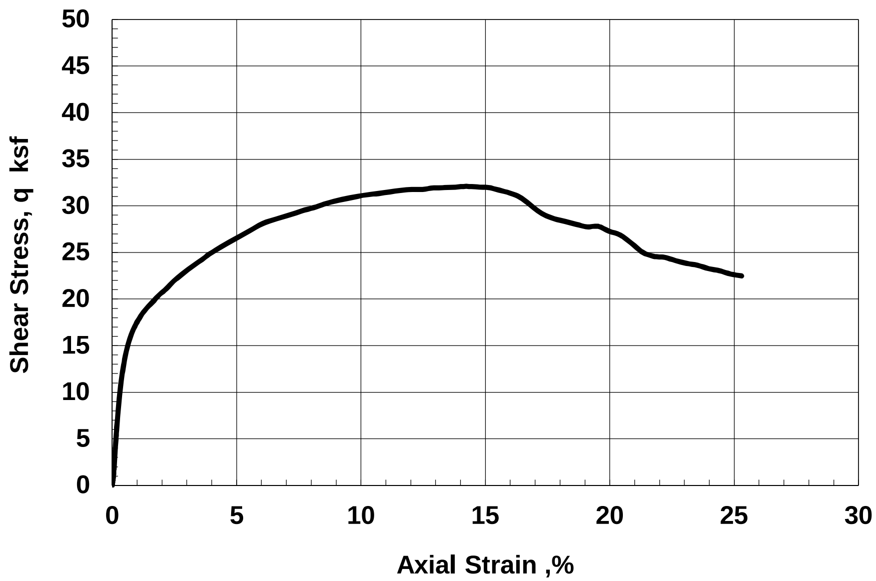


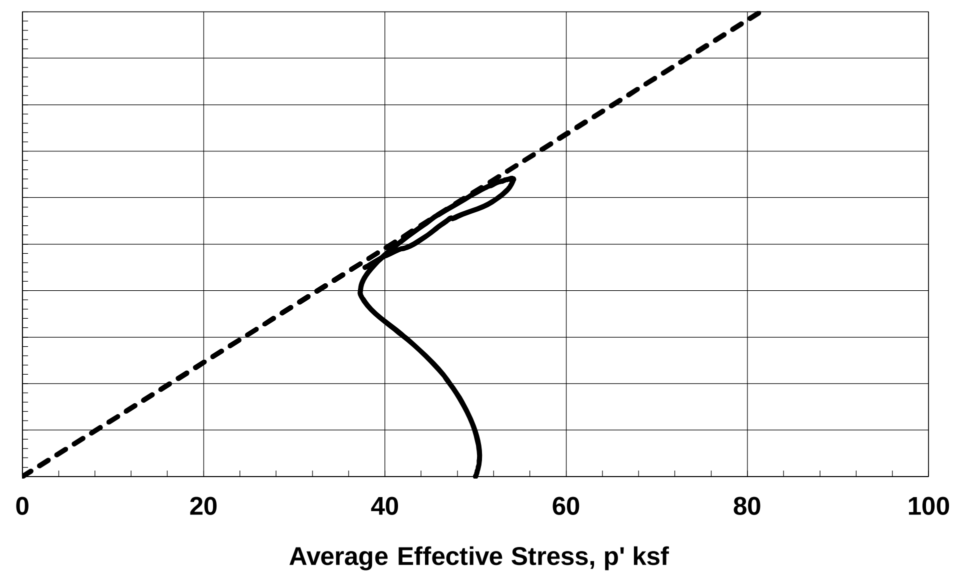
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 50.00 ksf vertical, 50.00 ksf lateral
Water Content: 20.3 % Total Unit Weight: 129.4 pcf
B Coefficient: Strain Rate: 0.024 %/min
Peak Shear Strength: 32.09 ksf @ 14.2 % Strain
Peak Effective Friction Angle: 37.9°

REMARKS:





Test by: DT Checked by: GET	Project No. T22243088	URS Corporation Mayflower Investigation	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring: P-11 Sample: D	April-13
	TerraSense, LLC			

SUMMARY OF MONOTONIC DSS TESTS ON INTACT TUBE SPECIMENS

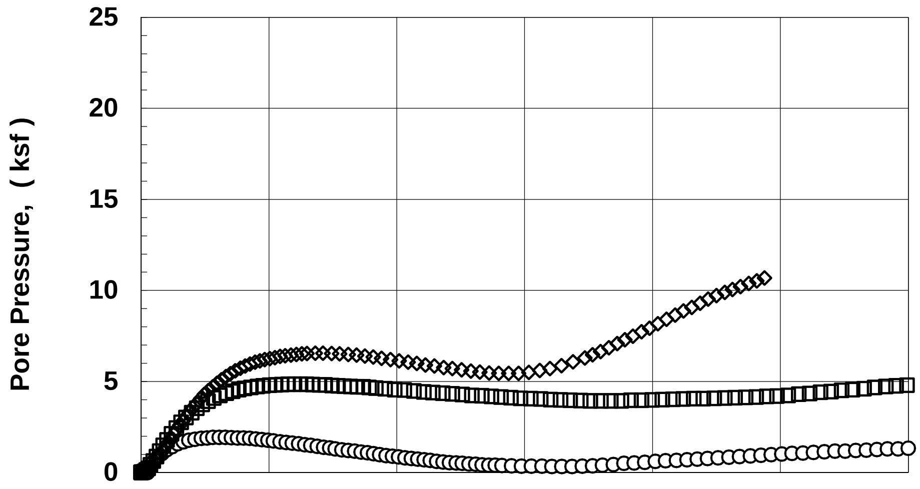
Test Series / Test No.	Boring No.	Tube / Spec. No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{vc,max}$ / $\sigma'_{v,c}$ (ksf)	$\varepsilon_{v,c}$ (%) / $\varepsilon_{vol,c}$ (%)	γ_{rate} (%/hr)	at Peak Shear Stress / at Peak Friction / at High Strain: γ (%)	τ_h (ksf)	τ_h / σ'_v	$\Delta U / \sigma'_{v,c}$	$Su / \sigma'_{v,c}$
1	INC 5-1		50.9	10.3	108.6	98.4	6.0	2.5	3.8	16.86	3.50	0.62	0.06	0.58
										29.99	3.03	0.65	0.22	0.50
DSS795		B		11.3	111.8	100.4	6.0	1.9		29.99	3.03	0.65	0.22	0.50
1	INC 5-1		51.3	12.1	98.8	88.1	12.0	5.1	3.7	18.78	4.82	0.60	0.33	0.40
										29.94	4.46	0.62	0.40	0.37
DSS796		C		10.7	102.2	92.3	12.0	4.5		29.94	4.46	0.62	0.40	0.37
1	INC 5-1		51.7	19.2	118.9	99.7	25.0	4.1	3.2	14.76	11.11	0.57	0.22	0.44
										24.38	8.71	0.61	0.43	0.35
DSS797		D		18.6	122.4	103.2	25.0	3.4		24.38	8.71	0.61	0.43	0.35

Test No	Description of Material Tested and Remarks
DSS795	SP-SM, brown poorly graded sand with silt
DSS796	SP-SM, brown poorly graded sand with silt
DSS797	SP-SM, brown poorly graded sand with silt

Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	Correlation Coefficient
1	1			
	2			
	3			

Failure Criteria: 1 - at Peak Shear Stress; 2 - at Peak Friction; 3 - at High Strain

URS Corporation	22243088	CONSTANT VOLUME DIRECT SIMPLE SHEAR	**Mayflower Investigation**
TerraSense, LLC	T22243088	INC 5-1 SAMPLE SN11 SUMMARY	April 2013



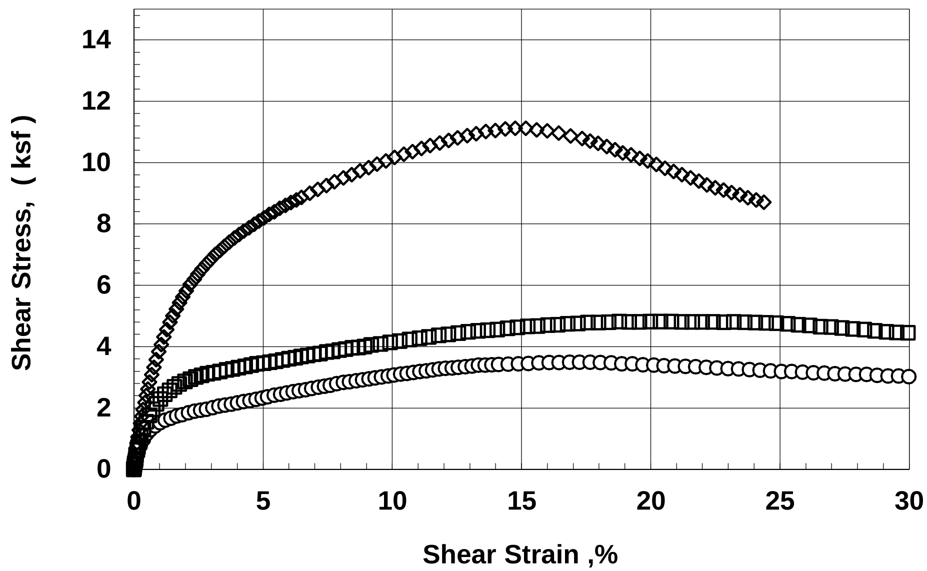
SAMPLE INFORMATION

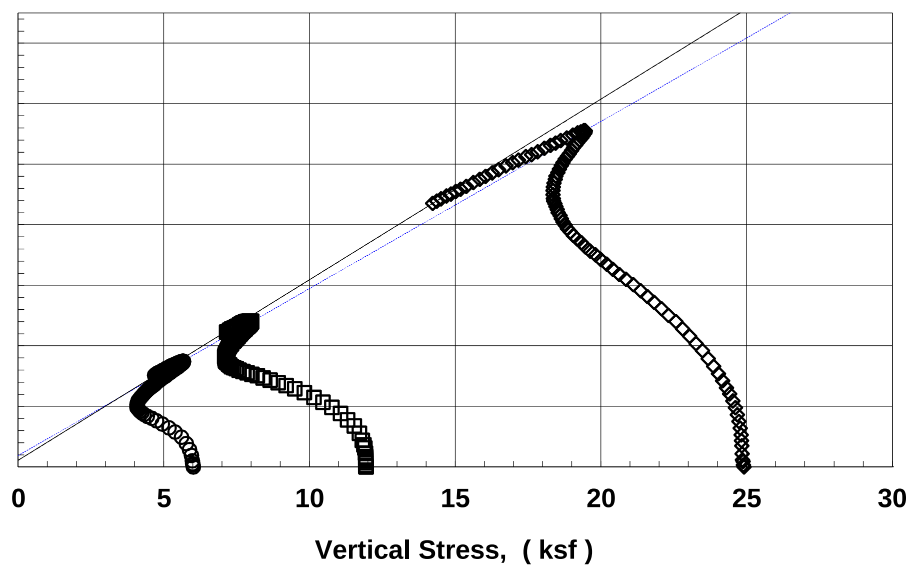
Symbol	Test	Sample	Depth (feet)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)	σ'_{cmax} (ksf)
○	DSS795	INC 5-1	50.9	10.3	108.6	6.01	6.01
□	DSS796	INC 5-1	51.3	12.1	98.8	12.00	12.00
◊	DSS797	INC 5-1	51.7	19.2	118.9	25.00	25.00

TEST SUMMARY

	Key	φ' (deg)	c' (ksf)
at Peak Shear Stress			
at Peak Friction			
at High Strain			

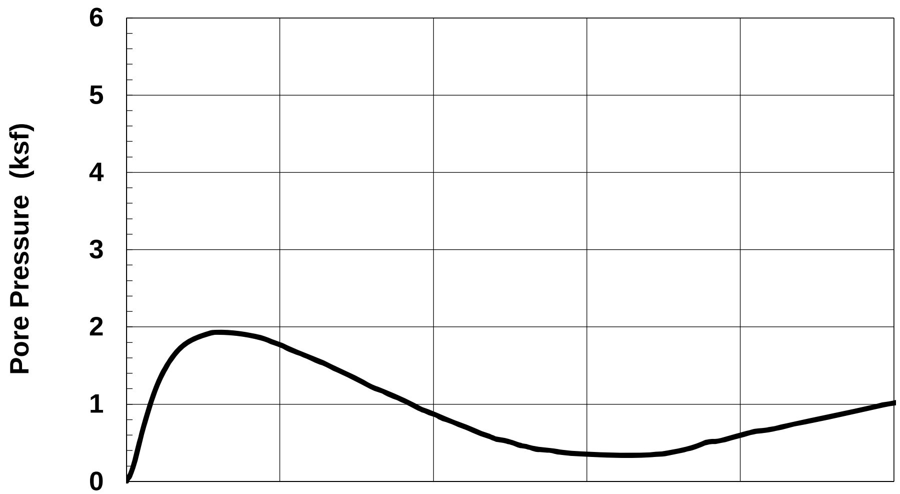
REMARKS:





Checked by: G. Thomas

URS Corporation	Project No. 22243088	CONSTANT VOLUME DIRECT SIMPLE SHEAR INC 5-1 Sample SN11 SUMMARY	Mayflower Investigation
TerraSense, LLC	Project No. T22243088		April 2013



SAMPLE INFORMATION

Boring: INC 5-1 Sample: SN11 Depth: 50.9 feet
Type: Intact tube sample
Description: SP-SM, brown poorly graded sand with silt

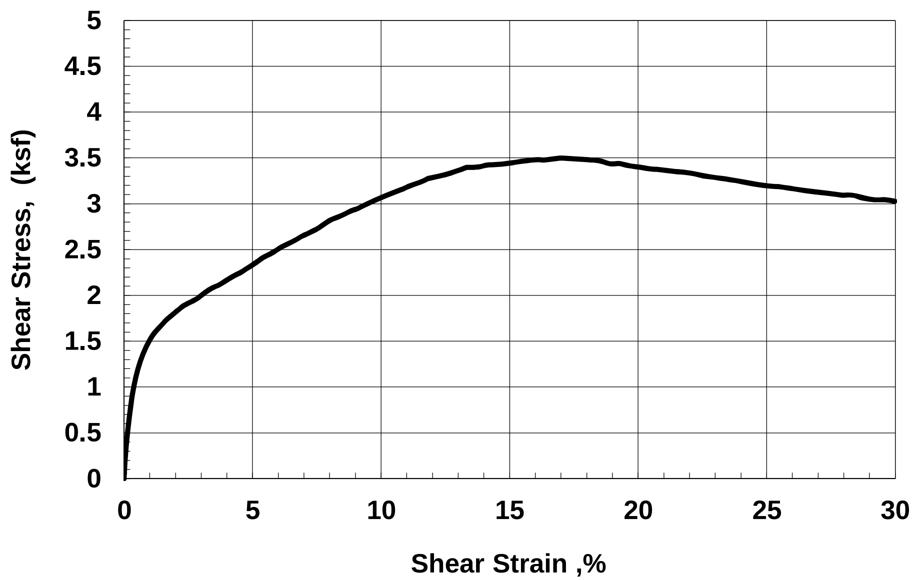
SPECIMEN INFORMATION (Initial)

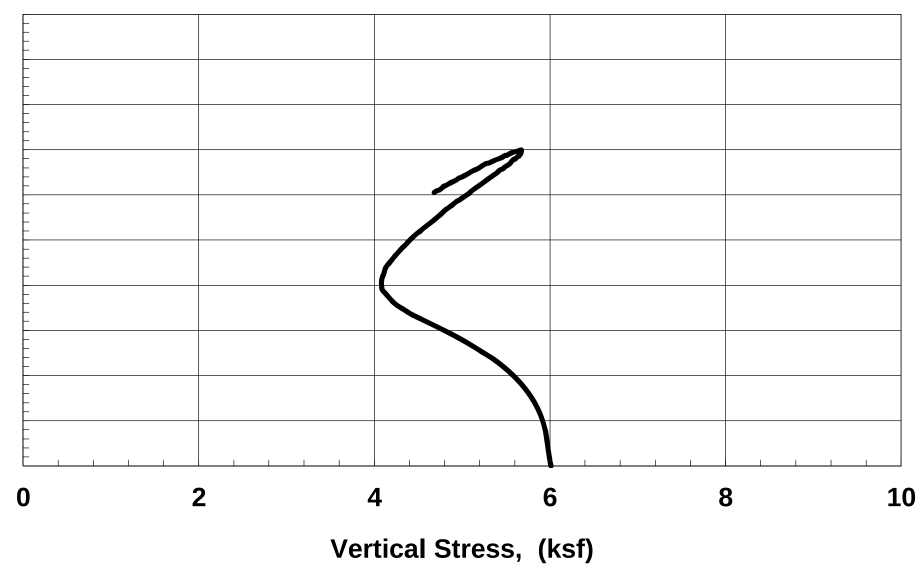
Height: 0.71 Diameter: 2.64 inch Area: 5.47 in²
Water Content: 10.3 % Total Unit Weight: 108.6 pcf

TEST SUMMARY

Vertical Consolidation Stress: 6.01 ksf OCR = 1.0
Water Content: 11.3 % Total Unit Weight: 111.8 pcf
Peak Shear Strength: 3.50 ksf @ 16.9 % Strain
Strain Rate: 0.063 %/min

REMARKS:

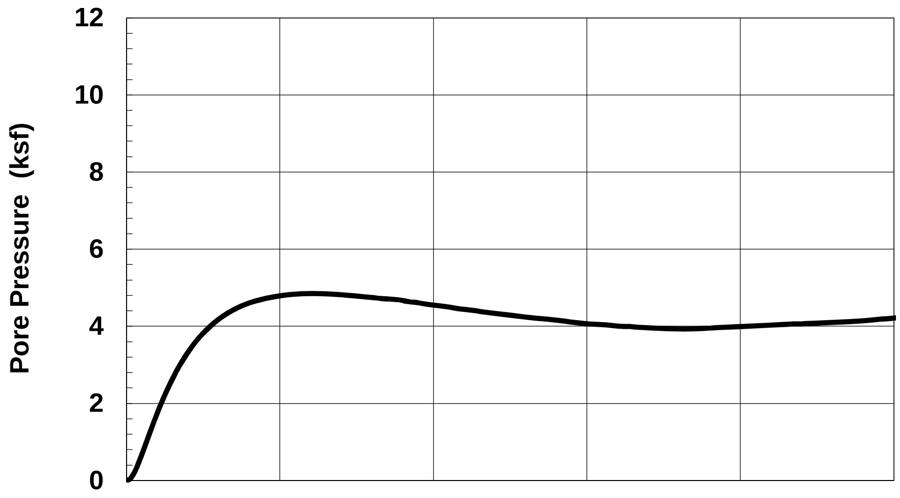




Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	TerraSense, LLC		DIRECT SIMPLE SHEAR INC 5-1 SN11 Depth: 50.9 feet	April 2013

Analysis File: DSSV5a.XLS

4/17/2013 DSS795.xlsx



SAMPLE INFORMATION

Boring: INC 5-1 Sample: SN11 Depth: 51.25 feet
Type: Intact tube sample
Description: SP-SM, brown poorly graded sand with silt

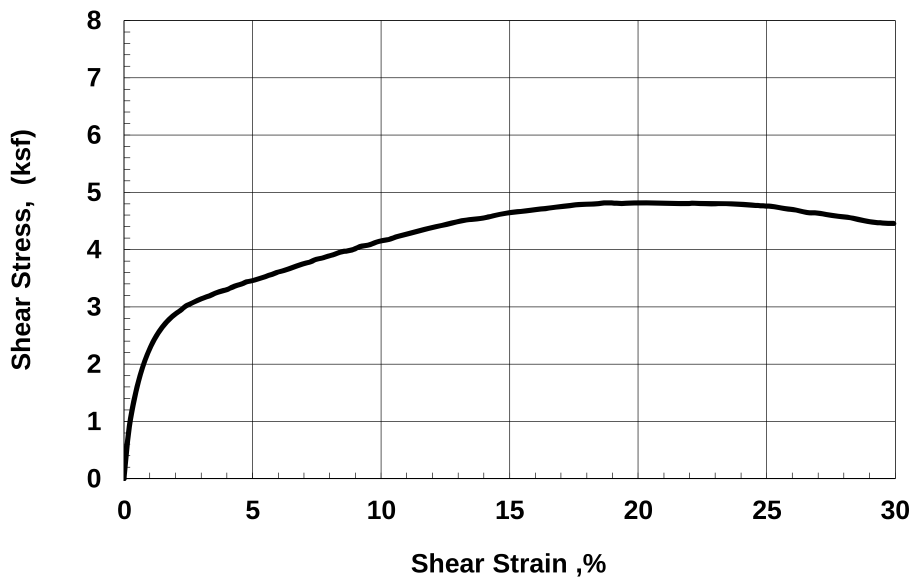
SPECIMEN INFORMATION (Initial)

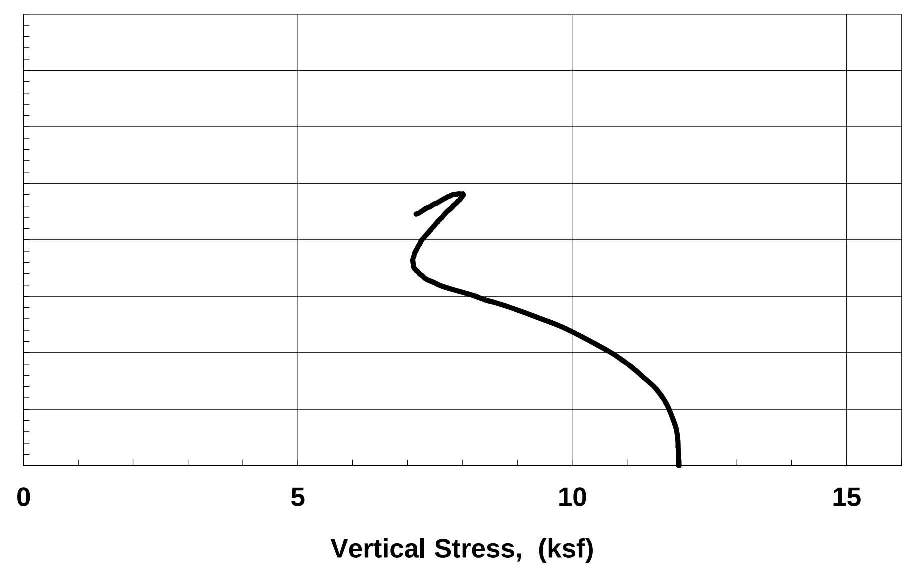
Height: 0.72 Diameter: 2.64 inch Area: 5.47 in²
Water Content: 12.1 % Total Unit Weight: 98.8 pcf

TEST SUMMARY

Vertical Consolidation Stress: 12.00 ksf OCR = 1.0
Water Content: 10.7 % Total Unit Weight: 102.2 pcf
Peak Shear Strength: 4.82 ksf @ 18.8 % Strain
Strain Rate: 0.061 %/min

REMARKS:

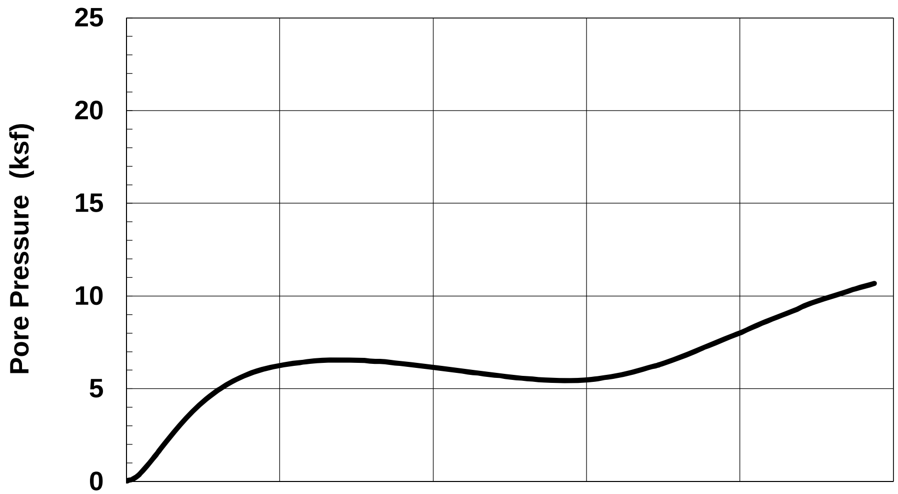




Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	**TerraSense, LLC**		DIRECT SIMPLE SHEAR INC 5-1 SN11 Depth: 51.25 feet	April 2013

Analysis File: DSSV5a.XLS

4/17/2013 DSS796.xlsx

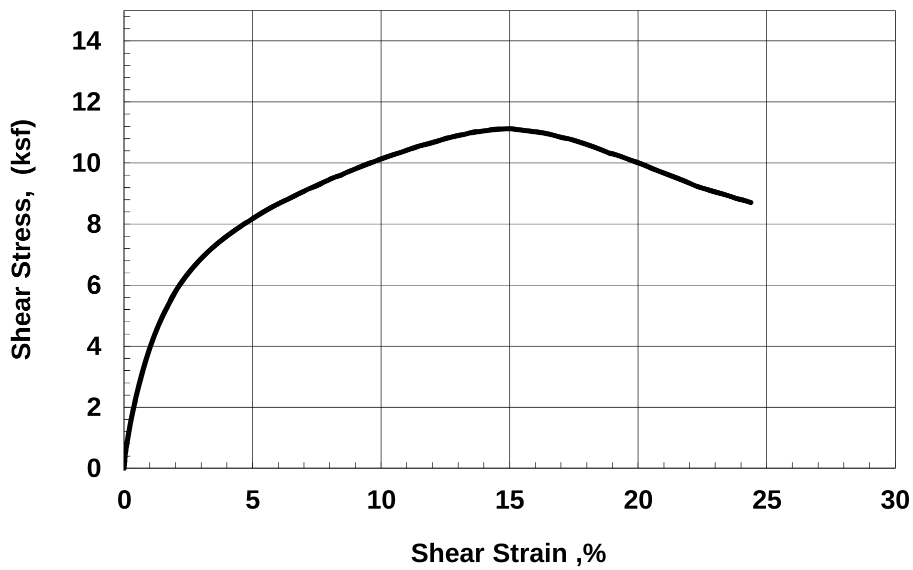


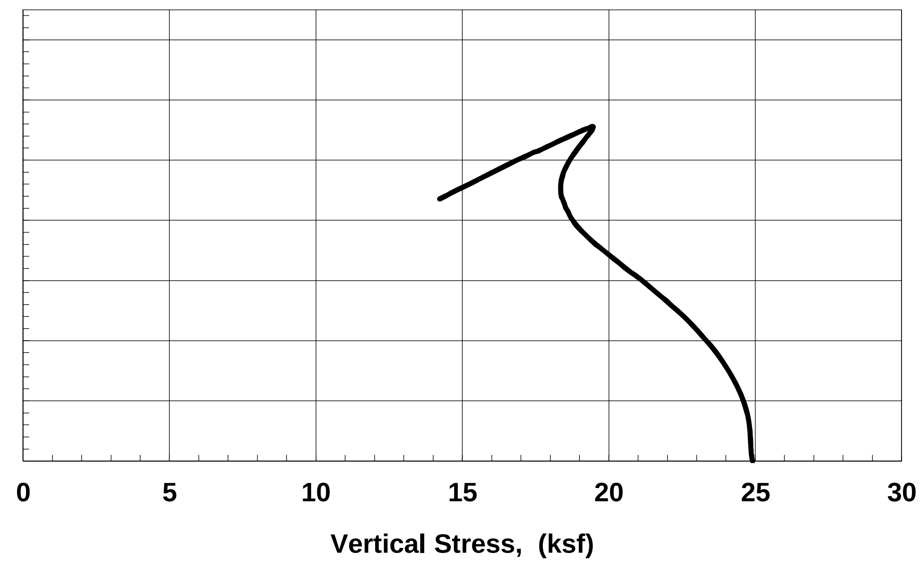
SAMPLE INFORMATION
Boring: INC 5-1 Sample: SN11 Depth: 51.65 feet
Type: Intact tube sample
Description: SP-SM, brown poorly graded sand with silt

SPECIMEN INFORMATION (Initial)
Height: 0.72 Diameter: 2.64 inch Area: 5.47 in²
Water Content: 19.2 % Total Unit Weight: 118.9 pcf

TEST SUMMARY
Vertical Consolidation Stress: 25.00 ksf OCR = 1.0
Water Content: 18.6 % Total Unit Weight: 122.4 pcf
Peak Shear Strength: 11.11 ksf @ 14.8 % Strain
Strain Rate: 0.053 %/min

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	**TerraSense, LLC**		DIRECT SIMPLE SHEAR INC 5-1 SN11 Depth: 51.65 feet	April 2013

Analysis File: DSSV5a.XLS 4/17/2013 DSS797.xlsx

SUMMARY OF MONOTONIC DSS TESTS ON INTACT TUBE SPECIMENS

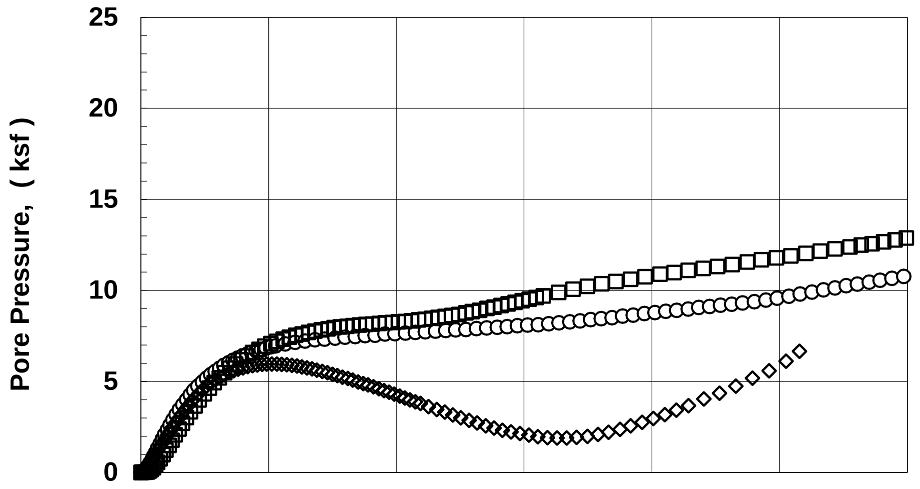
Test Series / Test No.	Boring No.	Tube / Spec. No.	Depth (ft)	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{vc,max}$ / $\sigma'_{v,c}$ (ksf)	$\varepsilon_{v,c}$ (%) / $\varepsilon_{vol,c}$ (%)	γ_{rate} (%/hr)	at Peak Shear Stress / at Peak Friction / at High Strain: γ (%)	τ_h (ksf)	τ_h / σ'_v	$\Delta U / \sigma'_{v,c}$	$Su / \sigma'_{v,c}$
1	INC 5-1	SN-31	160.2	21.1	127.2	105.0	17.5	5.2	3.8	16.36	5.18	0.56	0.47	0.30
										29.85	4.02	0.60	0.62	0.23
DSS794		A		19.1	131.3	110.2	17.5	4.7		29.85	4.02	0.60	0.62	0.23
1	INC 5-1	SN-31	160.5	16.0	102.8	88.6	21.5	4.1	3.7	11.64	6.87	0.53	0.40	0.32
										29.95	5.21	0.60	0.60	0.24
DSS793		B		20.4	110.7	92.0	21.5	3.6		29.95	5.21	0.60	0.60	0.24
1	INC 5-1	SN-31	160.8	23.9	118.5	95.6	24.7	3.2	3.1	17.47	13.79	0.61	0.08	0.56
										25.25	12.03	0.65	0.25	0.49
DSS792		C		22.6	119.8	97.7	24.7	2.1		25.78	11.65	0.64	0.27	0.47

Test No	Description of Material Tested and Remarks
DSS794	SM, brown silty sand
DSS793	SM, brown silty sand
DSS792	SM, brown silty sand

Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	Correlation Coefficient
1	1			
	2			
	3			

Failure Criteria:
1 - at Peak Shear Stress
2 - at Peak Friction
3 - at High Strain

URS Corporation	22243088	CONSTANT VOLUME DIRECT SIMPLE SHEAR	**Mayflower Investigation**
TerraSense, LLC	T22243088	INC 5-1 SAMPLE 1 SUMMARY	April 2013



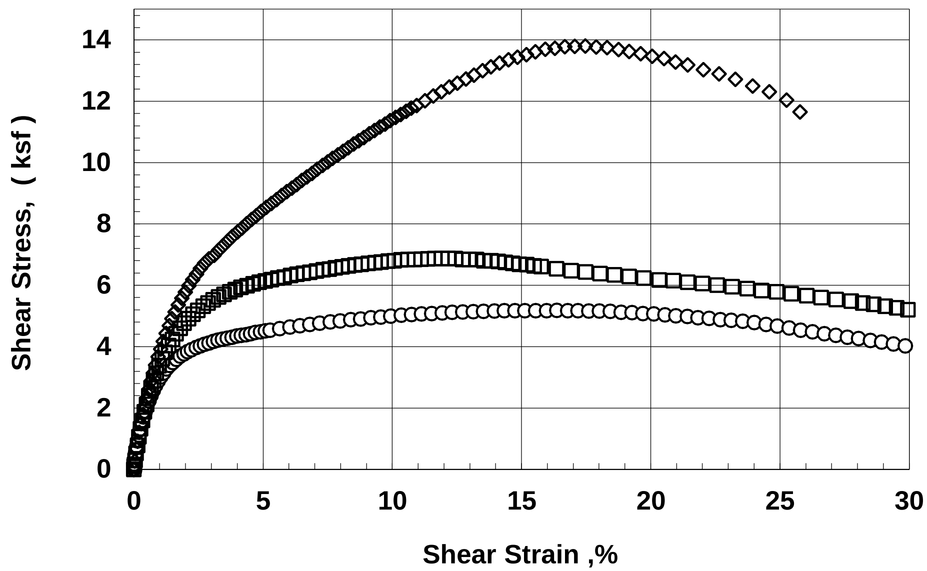
SAMPLE INFORMATION

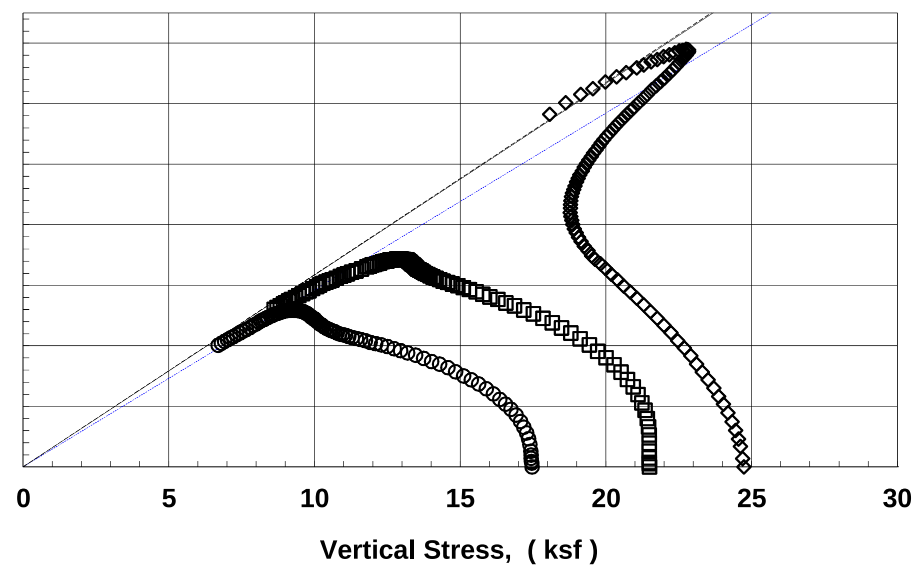
Symbol	Test	Sample	Depth (feet)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)	σ'_{cmax} (ksf)
○	DSS794	INC 5-1	160.2	21.1	127.2	17.50	17.50
□	DSS793	INC 5-1	160.5	16.0	102.8	21.50	21.50
◊	DSS792	INC 5-1	160.8	23.9	118.5	24.73	24.73

TEST SUMMARY

	Key	φ' (deg)	c' (ksf)
at Peak Shear Stress			
at Peak Friction			
at High Strain			

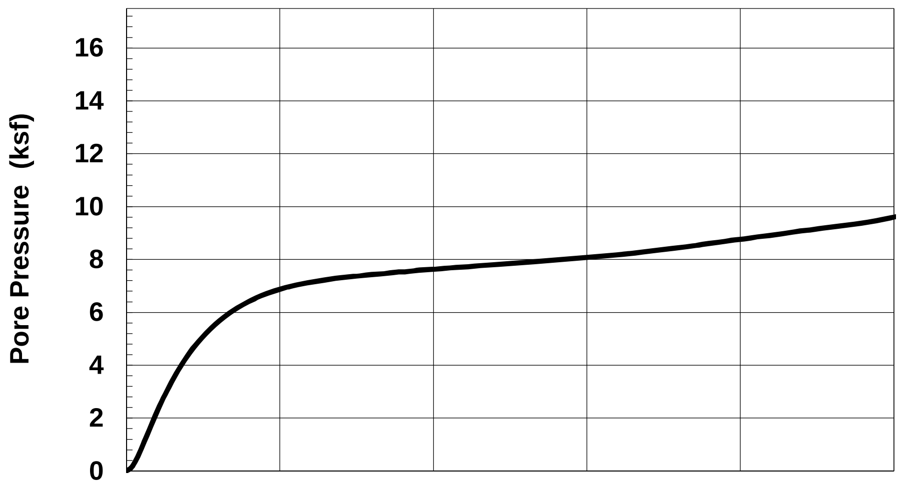
REMARKS:





URS Corporation	Project No. 22243088	CONSTANT VOLUME DIRECT SIMPLE SHEAR INC 5-1 Sample 1 SUMMARY	Mayflower Investigation
TerraSense, LLC	Project No. T22243088		April 2013

Checked by: G. Thomas



SAMPLE INFORMATION

Boring: INC 5-1 Sample: SN-31 Depth: 160.15 feet
Type: Intact tube sample
Description: SM, brown silty sand

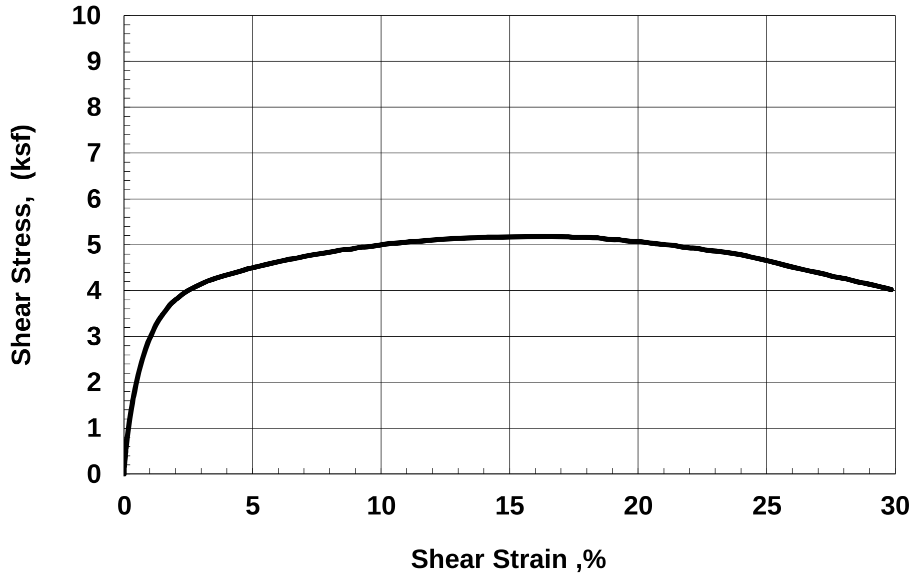
SPECIMEN INFORMATION (Initial)

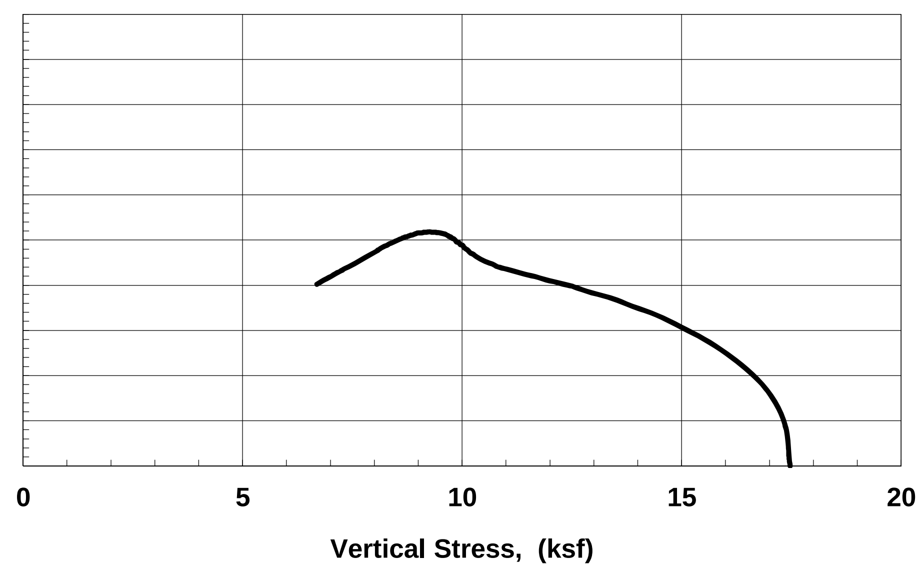
Height: 0.71 Diameter: 2.64 inch Area: 5.46 in²
Water Content: 21.1 % Total Unit Weight: 127.2 pcf

TEST SUMMARY

Vertical Consolidation Stress: 17.50 ksf OCR = 1.0
Water Content: 19.1 % Total Unit Weight: 131.3 pcf
Peak Shear Strength: 5.18 ksf @ 16.4 % Strain
Strain Rate: 0.064 %/min

REMARKS:

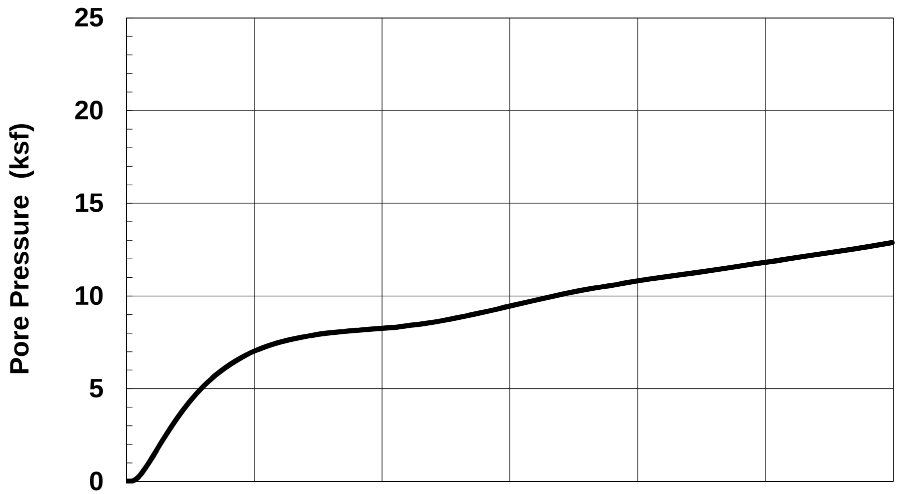




Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	TerraSense, LLC		DIRECT SIMPLE SHEAR INC 5-1 SN-31 Depth: 160.15 feet	April 2013

Analysis File: DSSV5a.XLS

4/17/2013 DSS794.xlsx

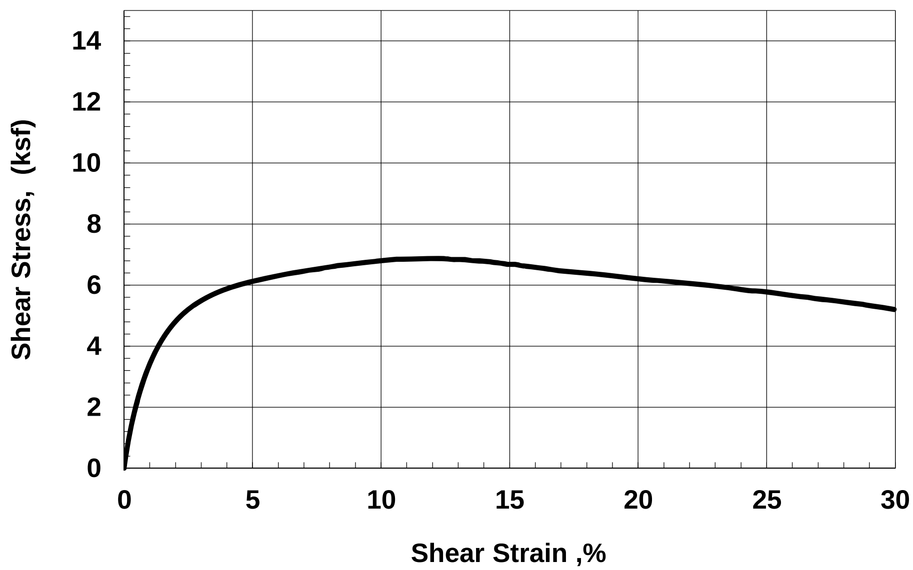


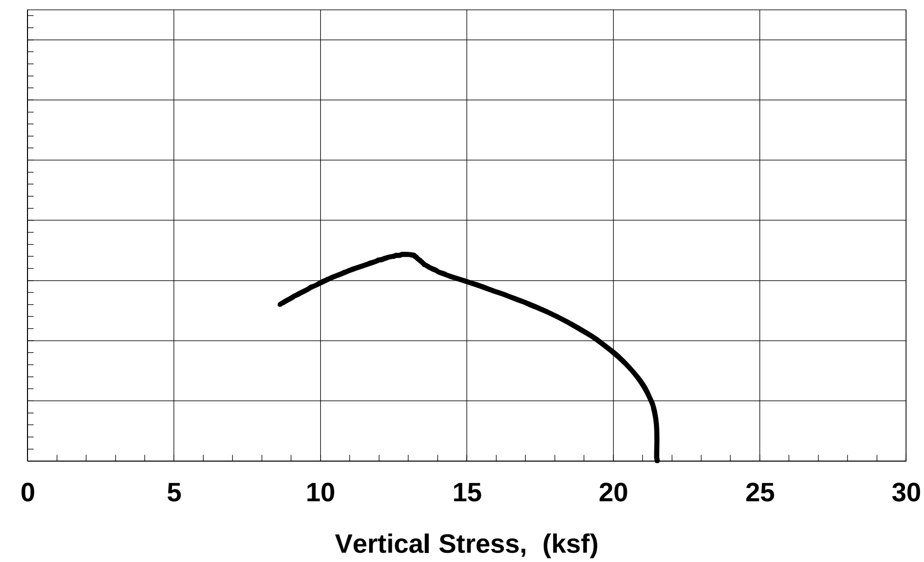
SAMPLE INFORMATION
Boring: INC 5-1 Sample: SN-31 Depth: 160.5 feet
Type: Intact tube sample
Description: SM, brown silty sand

SPECIMEN INFORMATION (Initial)
Height: 0.72 Diameter: 2.64 inch Area: 5.46 in²
Water Content: 16.0 % Total Unit Weight: 102.8 pcf

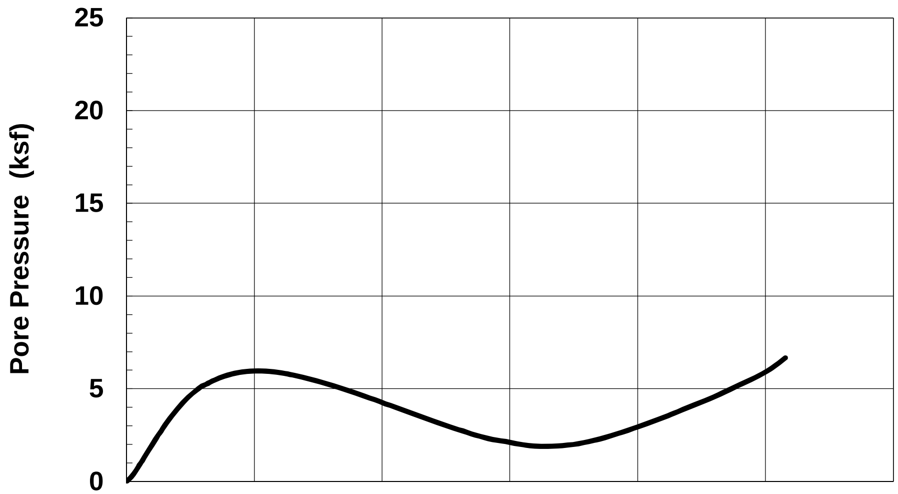
TEST SUMMARY
Vertical Consolidation Stress: 21.50 ksf OCR = 1.0
Water Content: 20.4 % Total Unit Weight: 110.7 pcf
Peak Shear Strength: 6.87 ksf @ 11.6 % Strain
Strain Rate: 0.062 %/min

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	TerraSense, LLC		DIRECT SIMPLE SHEAR INC 5-1 SN-31 Depth: 160.5 feet	April 2013



SAMPLE INFORMATION

Boring: INC 5-1 Sample: SN-31 Depth: 160.8 feet
Type: Intact tube sample
Description: SM, brown silty sand

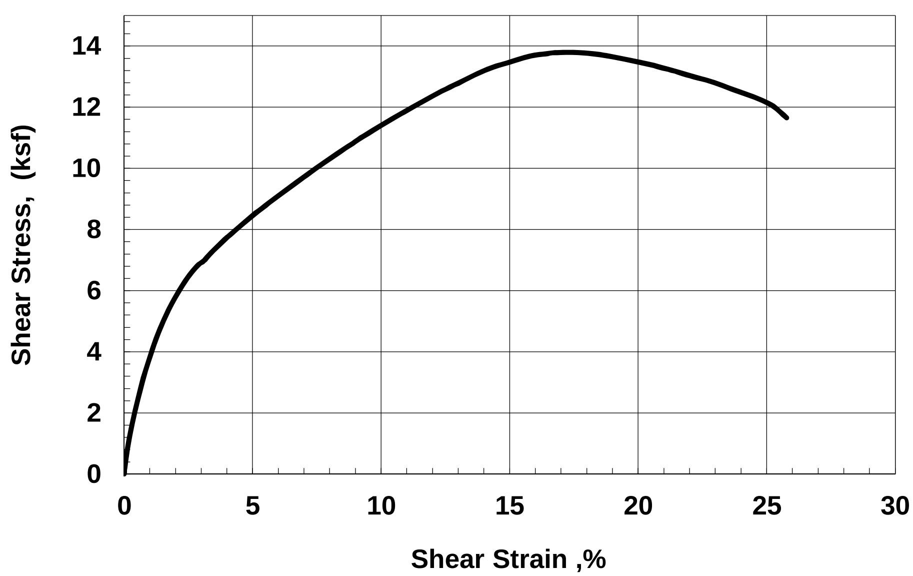
SPECIMEN INFORMATION (Initial)

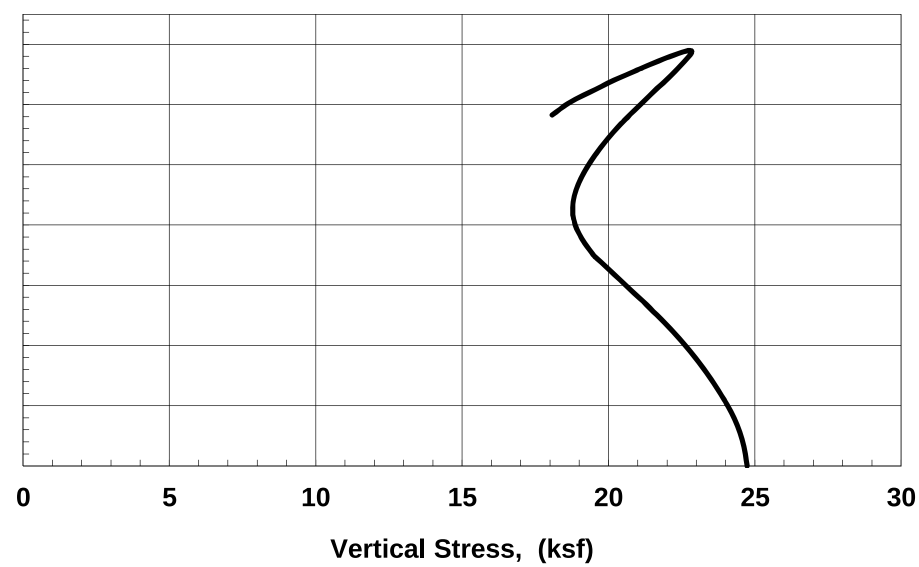
Height: 0.71 Diameter: 2.64 inch Area: 5.46 in²
Water Content: 23.9 % Total Unit Weight: 118.5 pcf

TEST SUMMARY

Vertical Consolidation Stress: 24.73 ksf OCR = 1.0
Water Content: 22.6 % Total Unit Weight: 119.8 pcf
Peak Shear Strength: 13.79 ksf @ 17.5 % Strain
Strain Rate: 0.051 %/min

REMARKS:





Test by: DT	Project No. T22243088	URS Corporation #22243088 Mayflower Investigation	CONSTANT VOLUME	
Checked by: GET	**TerraSense, LLC**		DIRECT SIMPLE SHEAR INC 5-1 SN-31 Depth: 160.8 feet	April 2013

Analysis File: DSSV5a.XLS 4/17/2013 DSS792.xlsx

SAMPLE

Sample: INC 5-1

Type: Intact tube sample

SPECIMEN

Section No.: A

Depth: 76.25 ft

w_o: 13.1 %

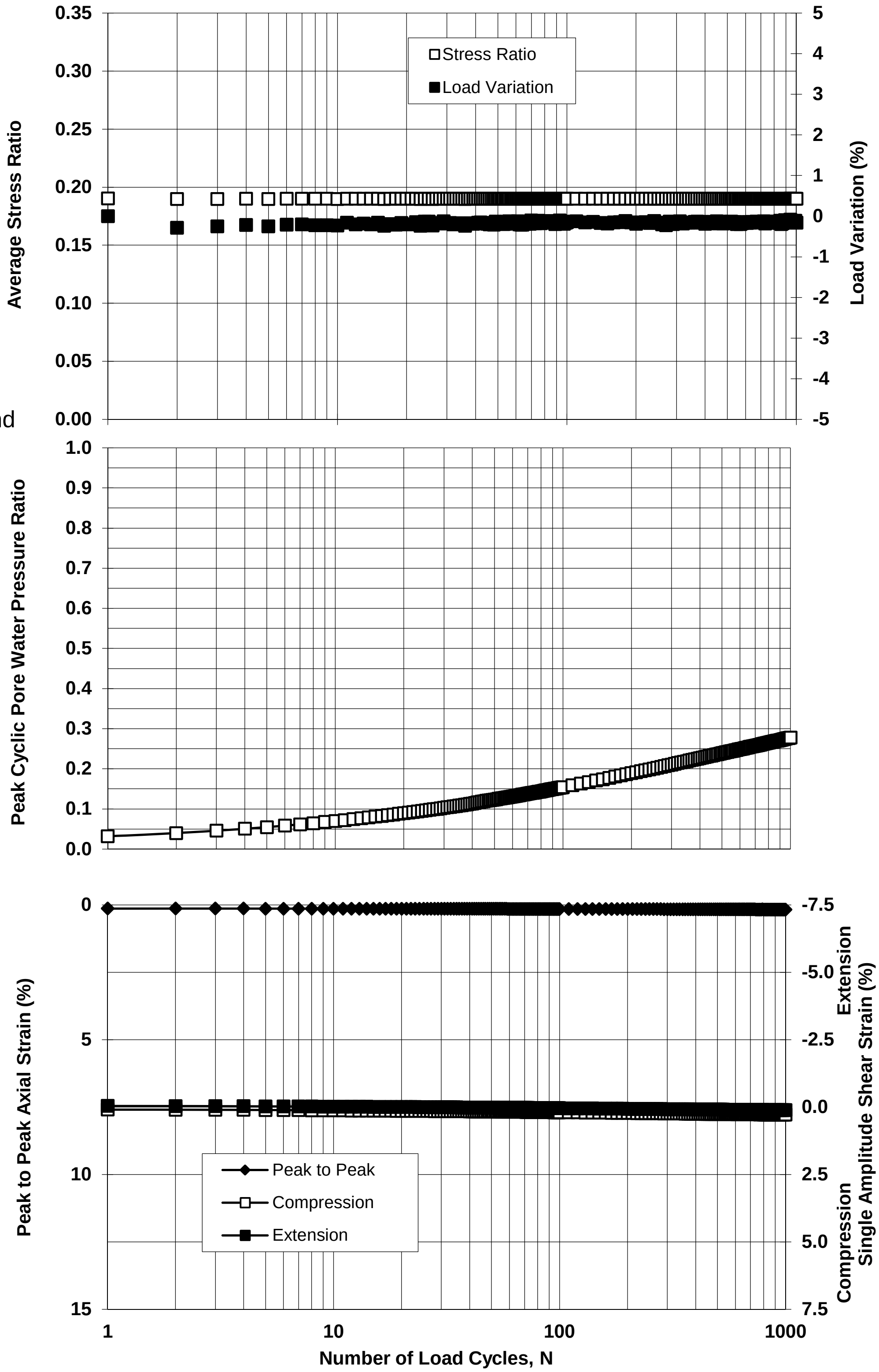
γ_{to}: 113.5 pcf

γ_{do}: 100.4 pcf

Specimen Description

USCS: SM

Light brown silty fine sand



TEST CONDITIONS

w_c: 21.9 %

γ_{tc}: 127.6 pcf

γ_{dc}: 104.6 pcf

σ'_{vc}: 15 ksf

ε_{ac}: 1.6

ε_{vc}: 4.1

Saturation 100.0 %

Summary

Method: ASTM D 5311

Load Form: Sinusoidal

Frequency: 0.5 Hz

SRm
0.19

N for eda (%) of

2.5	5.0	10	15
>1000	>1000	>1000	>1000

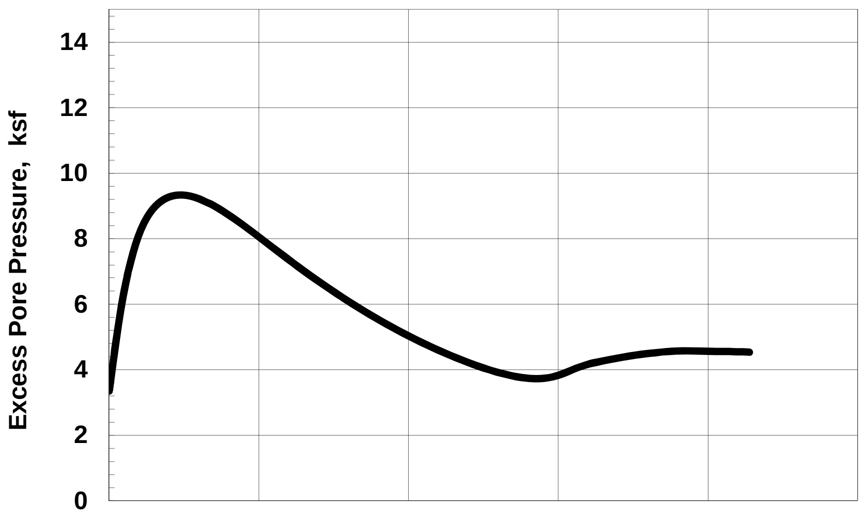
N for PP Ratio of

0.1	0.2	1	0.95
24	230	>1000	>1000

Test by: DT/GT

Checked by: GET

Project No. T22243088	Mayflower Investigation	LOAD CONTROL CYCLIC TRIAXIAL STRENGTH TEST Sample: INC 5-1 @ 76.25 ft.	
TerraSense, LLC			4/17/13



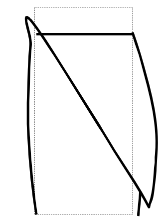
SAMPLE INFORMATION

Sample: INC 5-1 Depth: 76.25 ft
Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: SM, Light brown silty fine sand

Height: 6.00 inch Diameter: 2.83 inch Area: 6.29 in²
Water Content: 13.1 %
Total Unit Weight: 113.5 pcf Dry Unit Weight: 100.4 pcf

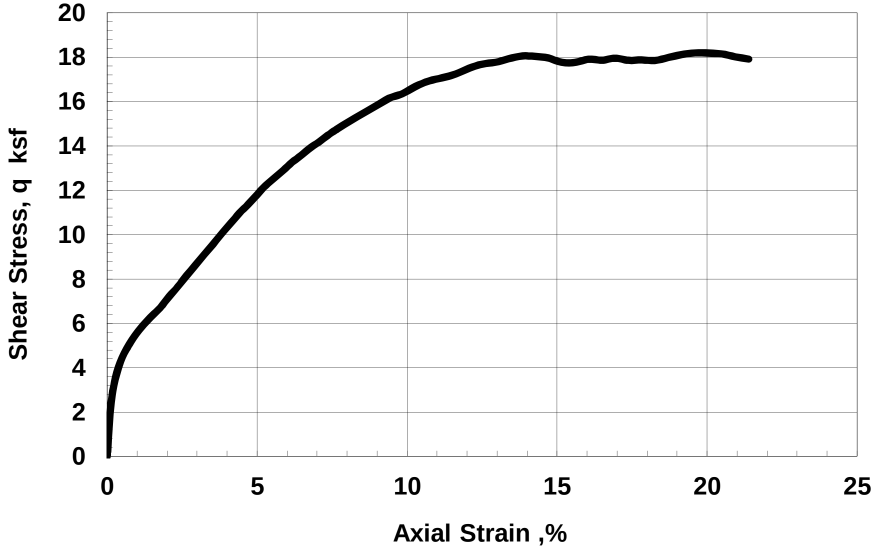


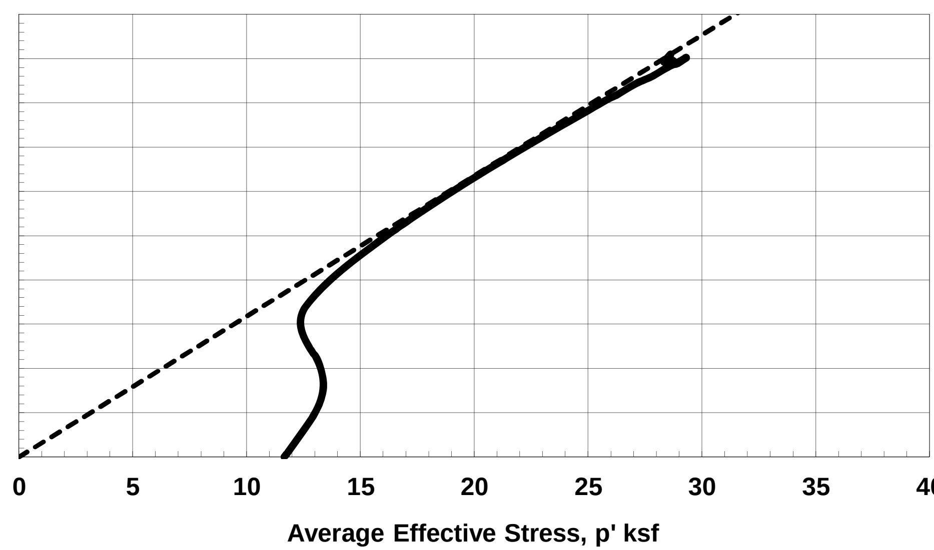
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 15.00 ksf vertical, 15.00 ksf lateral
Water Content: 21.9 % B Coefficient: 96.20
Total Unit Weight: 127.6 pcf Dry Unit Weight: 104.6 pcf
Peak Shear Strength: 18.19 ksf @ 19.6 % Strain Strain Rate: 0.025 %/min
Peak Effective Friction Angle: 39.5°

REMARKS: Static Shear performed after 1000 cycles undrained cyclic loading to peak pore pressure ratio of 0.28





Test by: DT

Checked by: GET

URS Corporation Mayflower Investigation		POST CYCLIC CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
TerraSense, LLC	Project No. T22243088	Sample: INC 5-1 Depth: 76.25 ft

SAMPLE

Sample: INC 5-1

Type: Intact tube sample

SPECIMEN

Section No.: A

Depth: 121.9 ft

w_o: 15.5 %

γ_{to}: 110.3 pcf

γ_{do}: 95.5 pcf

Specimen Description

USCS: SM

Light brown silty sand

TEST CONDITIONS

w_c: 25.2 %

γ_{tc}: 124.2 pcf

γ_{dc}: 99.3 pcf

σ_{vc}: 25 ksf

ε_{ac}: 2.1

ε_{vc}: 3.8

Saturation 100.0 %

Summary

Method: ASTM D 5311

Load Form: Sinusoidal

Frequency: 0.5 Hz

SRm
0.30

N for eda (%) of

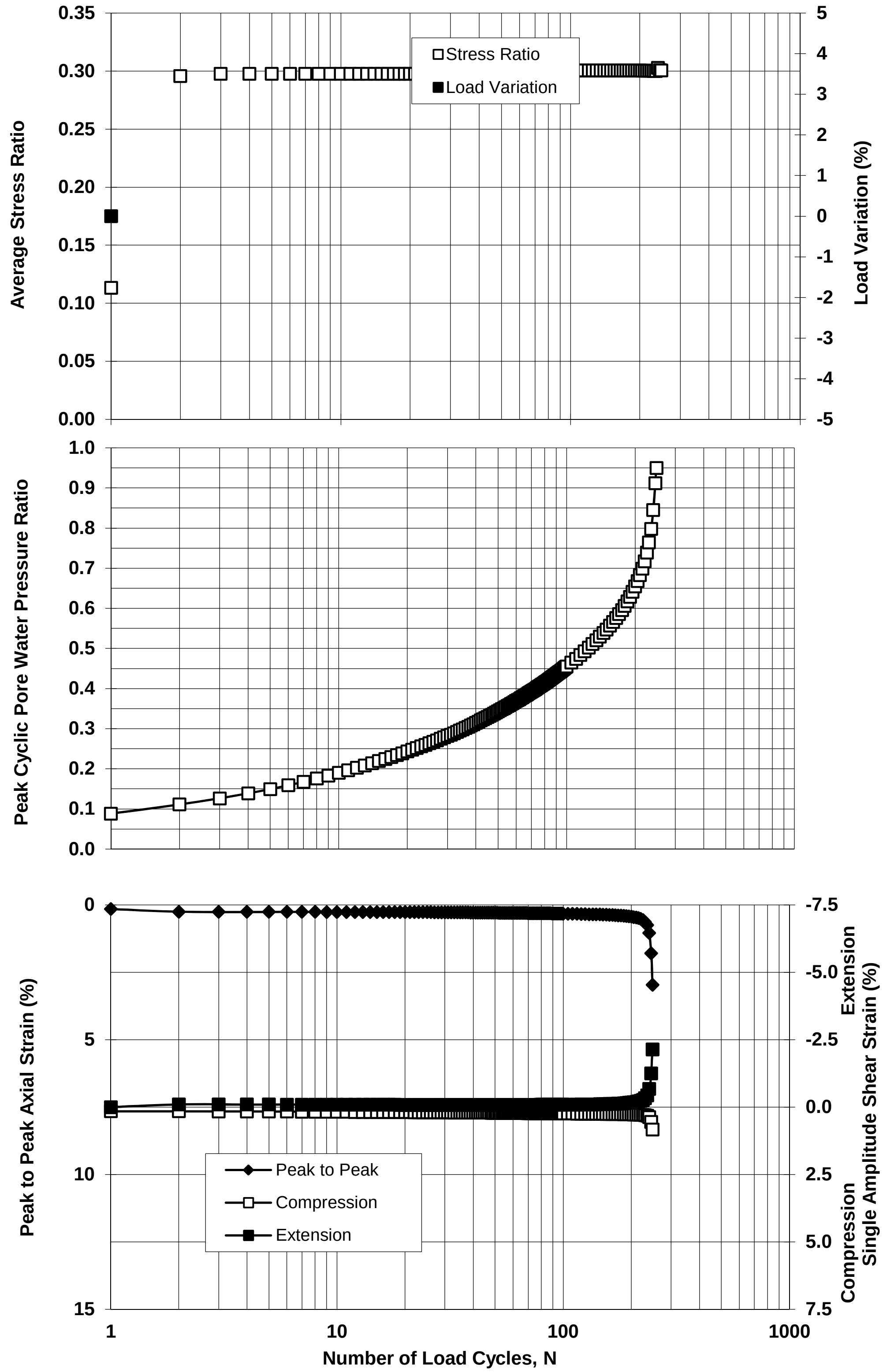
2.5	5.0	10	15
248	>248	>248	>248

N for PP Ratio of

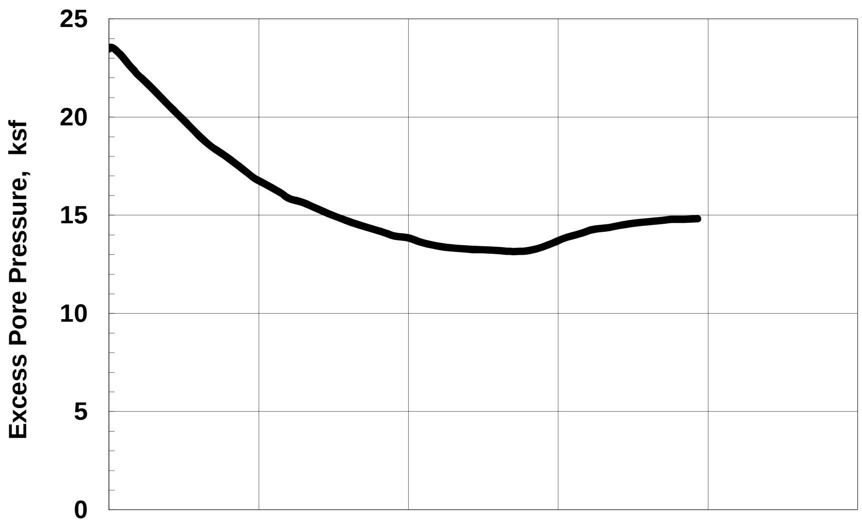
0.1	0.2	1	0.95
7	11	125	248

Test by: DT/GT

Checked by: GET



Project No. T22243088	Mayflower Investigation	LOAD CONTROL CYCLIC TRIAXIAL STRENGTH TEST Sample: INC 5-1 @ 121.9 ft.	
TerraSense, LLC			4/17/13



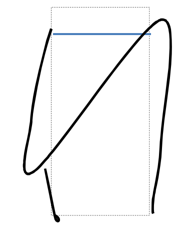
SAMPLE INFORMATION

Sample: INC 5-1 Sample: SN-125 Depth: 121.9 ft
Type: Intact tube sample

SPECIMEN INFORMATION (Initial)

Description: SM, Light brown silty sand

Height: 6.03 inch   Diameter: 2.81 inch   Area: 6.18 in²
Water Content: 15.5 %
Total Unit Weight: 110.3 pcf   Dry Unit Weight: 95.5 pcf

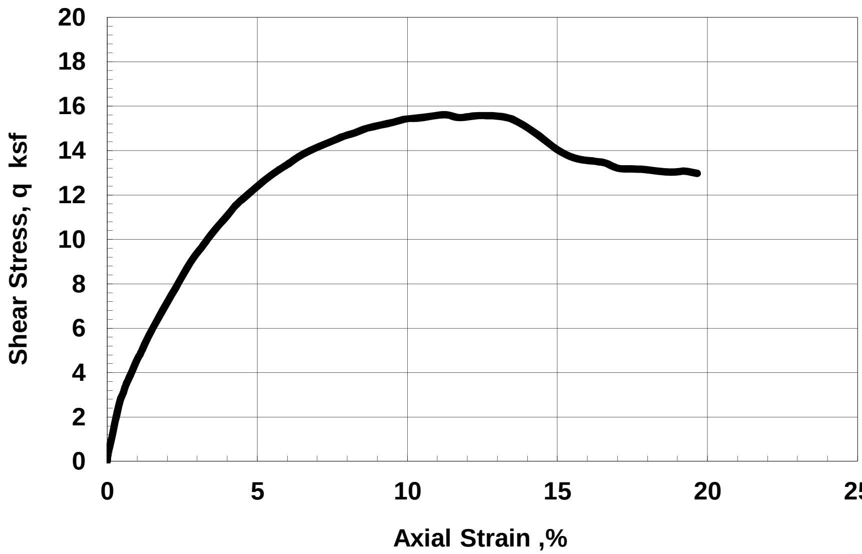


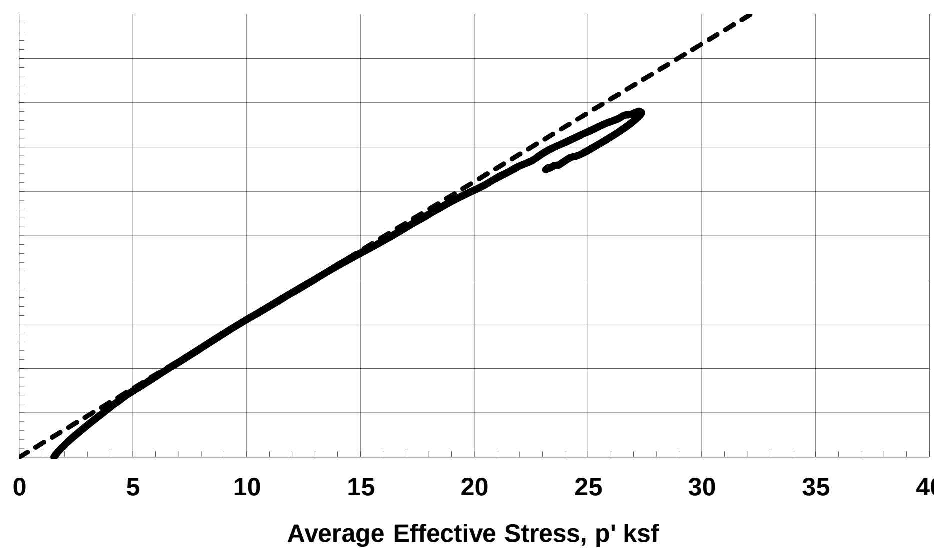
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 25.00 ksf vertical, 25.00 ksf lateral
Water Content: 25.2 %   B Coefficient: 96.40
Total Unit Weight: 124.2 pcf   Dry Unit Weight: 99.3 pcf
Peak Shear Strength: 15.61 ksf   @ 11.3 % Strain   Strain Rate: 0.024 %/min
Peak Effective Friction Angle: 38.5°

REMARKS: Static Shear performed after 248 cycles undrained cyclic loading to peak pore pressure ratio = 0.95





Test by: DT

Checked by: GET

URS Corporation Mayflower Investigation		POST CYCLIC CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Sample: INC 5-1 Sample: SN-125 Depth: 121.9 ft
TerraSense, LLC	Project No. T22243088	

Appendix B.3

2006 Index Test Results

Project No.: 22238824 File: SumDAM5.xls

Climax Mine

5 Dam

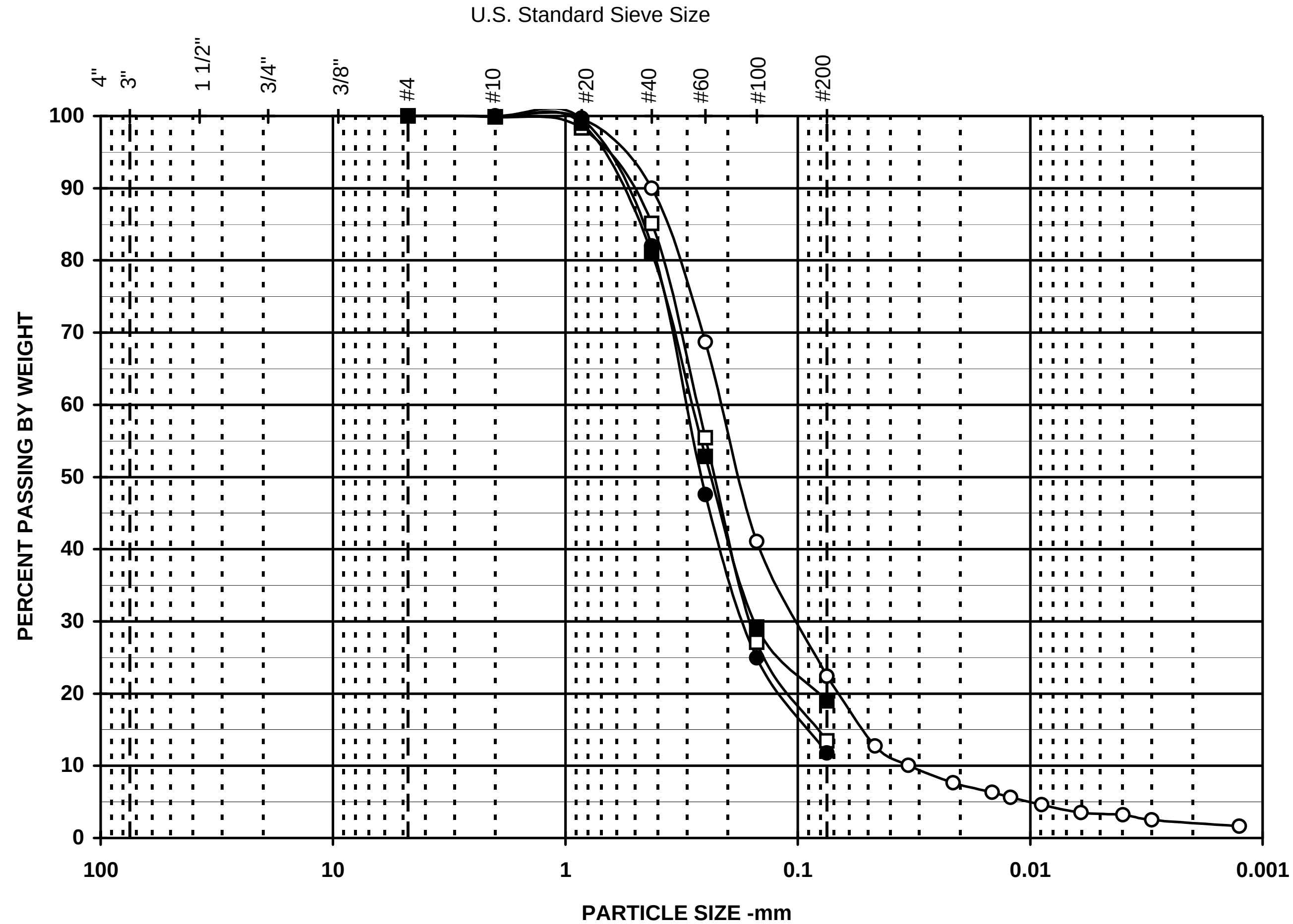
LABORATORY TESTING DATA SUMMARY

BORING NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY (-)	PERMEABILITY (cm/sec)	STRENGTH: Type Test & Stress	PEAK SHEAR STRESS (ksf)	AXIAL STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS & Test ID
TH-5-1	12.5-14	16.2				SM	13.5											
TH-5-1	20-22.5								105.8									
TH-5-1	20.25	15.4				SP			103.6				CIU'@15	14.4	14.5			T2649
TH-5-1	20.55	8.8																
TH-5-1	20.8	19.0				SP*	19.0		111.7			1.2E-5	CIU'@25	13.4	13.2			T2650 *clay seam present
TH-5-1	21.1	9.8																
TH-5-1	21.35	9.3				SP			99.5				CIU'@50	19.1	12.2			T2651
TH-5-1	21.65	19.3																
TH-5-1	21.9	13.8	np	np	np	SM			104.7	92.1	2.726					0.849	44	C06235
TH-5-1	22.5-24					SM	22.4	2										
TH-5-1	31-32.5	21.5				SP-SM	11.8											
TH-5-1	40-41.5																	
TH-5-1	40.3	5.4																
TH-5-1	40.85	7.9																
TH-5-1	41.1	11.4	np	np	np	SM	12.5											
TH-5-1	41.4	12.5																
TH-5-1	42.5-43.5	18.5				SM	17.5											
TH-5-1	50-51.5	17.8				SM	17.5											
TH-5-1	60-61.5	19.8				SM	12.6											
TH-5-1	70-71.5		np	np	np	SM	18.1	2										
TH-5-1	80-81.5	18.4				SM	18.3											
TH-5-1	90-91.5		np	np	np	SM												
TH-5-1	100-101.5	26.2				SM	17.8											
TH-5-1	120-121.5	27.8				SM	13.4											
TH-5-1	140-141.5	21.0				SM	19.2											
TH-5-1	160					SM	14.8	1										
TH-5-1	180	26.7				CL	50.3											
TH-5-2	10					SM	18.4	3										
TH-5-2	11-12.5	20.8				SM	19.3											
TH-5-2	20-22.5								106.7									
TH-5-2	20.85	18.7				SM	30.4											
TH-5-2	22.5					SM	21.5	3										
5 Dam	Composite					SM	20.1											See slurry-sedimented triaxial tests

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: RV Reviewed by: GET Date: 12/12/2006

COBBLES	GRAVEL COARSE	GRAVEL FINE	SAND COARSE	SAND MEDIUM	SAND FINE	SILT OR CLAY



SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	brown m-f SAND, some silt.
○	brown m-f SAND, some silt.
●	brown m-f SAND, trace silt.

Symbol	□	■	○	●
Boring	TH5-1	TH5-1	TH5-1	TH5-1
Sample				
Spec				
Depth	12.5-14	20.8	22.5-24	31-32.5
% +3"				
% Gravel				
% SAND	86.5	81.0	77.6	88.2
% FINES	13.5	19.0	22.4	11.8
% -2µ			2	
Cc				1.5
Cu				4.8
LL				
PL				
PI				
USCS	SM	SM	SM	SP-SM
w (%)	16.2			21.5

Particle Size (Sieve #)	PERCENT FINER □	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				
4	100.0	100.0		
10	99.9	99.9	100.0	100.0
20	98.3	99.0	99.7	99.6
40	85.1	81.0	90.0	82.0
60	55.4	52.9	68.7	47.5
100	27.1	29.2	41.1	24.9
200	13.5	19.0	22.4	11.8

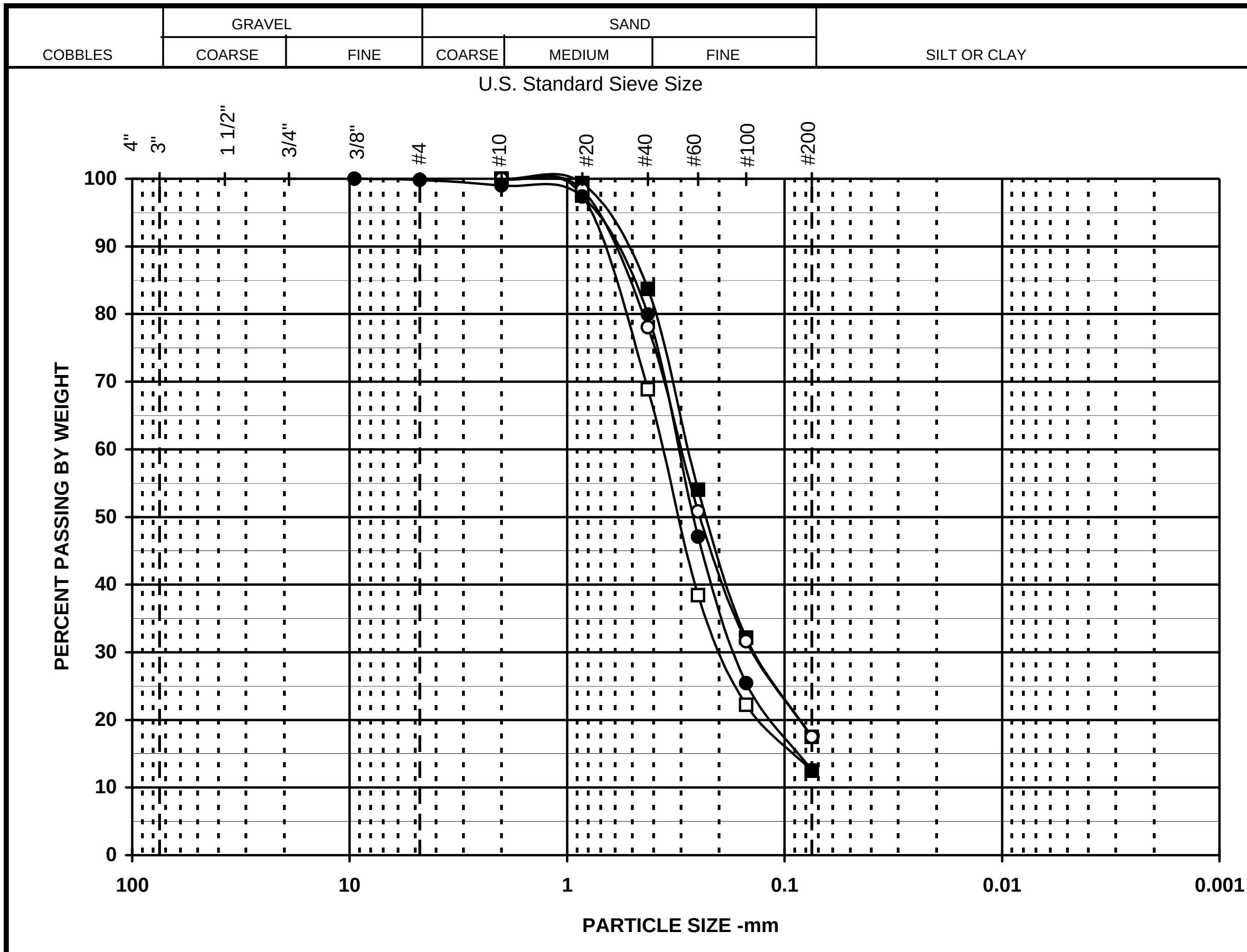
PARTICLE SIZE DISTRIBUTION

Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_51a.xls 12/11/2006



SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	brown m-f SAND, some silt.
○	light brown m-f SAND, some silt.
●	light brown m-f SAND, some silt.

Symbol	□	■	○	●
Boring	TH5-1	TH5-1	TH5-1	TH5-1
Sample				
Spec	B			
Depth	41.1	42-43.5	50-51.5	60-61.5
% +3"				
% Gravel				0.2
% SAND	87.5	82.5	82.5	87.2
% FINES	12.5	17.5	17.5	12.6
% -2μ				
Cc				
Cu				
LL				
PL				
PI				
USCS	SM	SM	SM	SM
w (%)	11.4	18.5	17.8	19.8

Particle Size	PERCENT FINER			
(Sieve #)	□	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				100.0
4				99.8
10	100.0	100.0	100.0	99.0
20	97.5	99.3	98.4	97.4
40	68.9	83.7	78.0	79.9
60	38.4	54.0	50.8	47.1
100	22.2	32.1	31.6	25.4
200	12.5	17.5	17.5	12.6

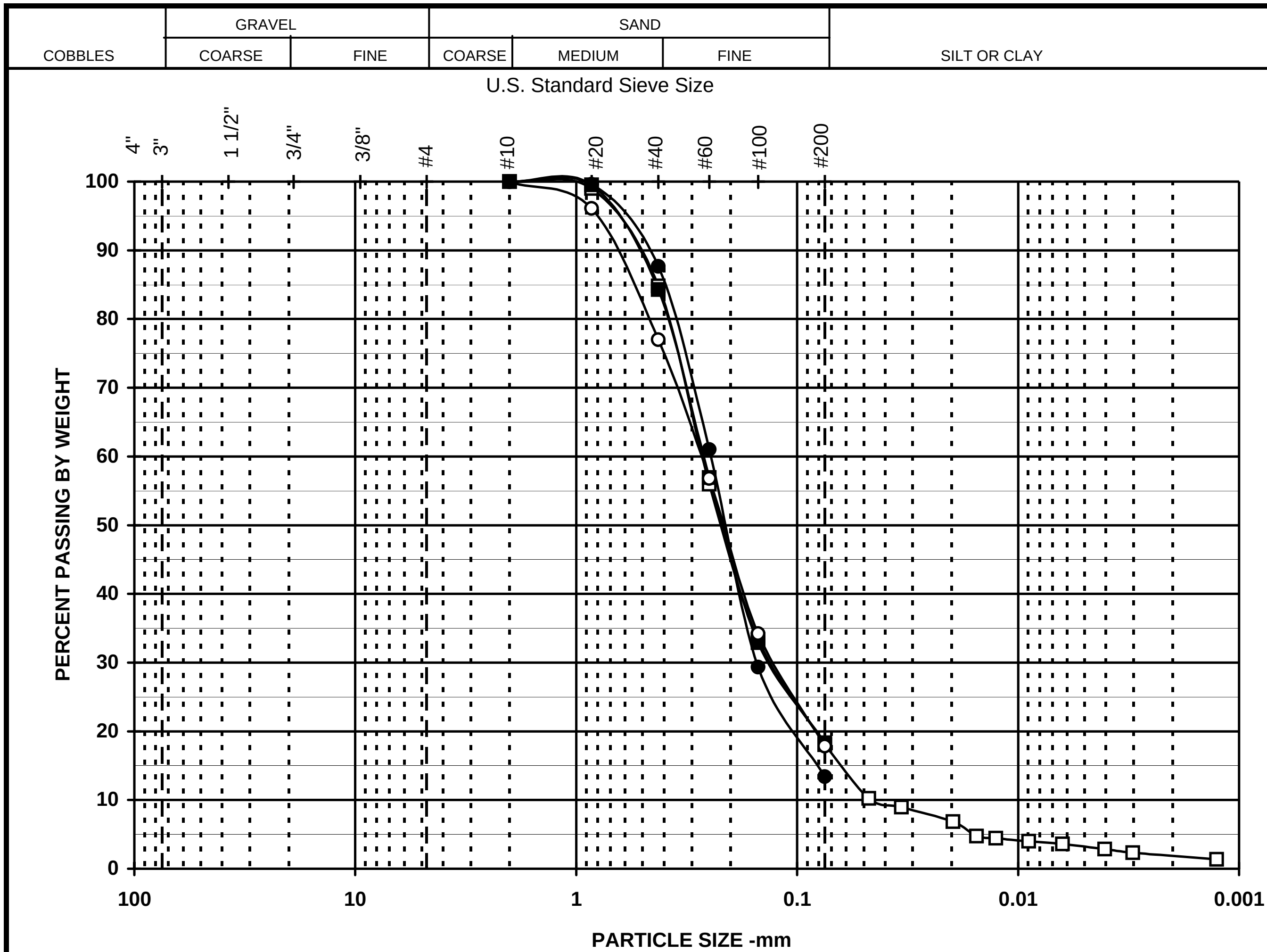
PARTICLE SIZE DISTRIBUTION

Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_51b.xls 12/12/2006



Symbol	□	■	○	●
Boring	TH5-1	TH5-1	TH5-1	TH5-1
Sample				
Spec				
Depth	70-71.5	80-81.5	100-101.5	120-121.5
% +3"				
% Gravel				
% SAND	81.9	81.7	82.2	86.6
% FINES	18.1	18.3	17.8	13.4
% -2µ	2			
Cc				
Cu				
LL	np			
PL	np			
PI				
USCS	SM	SM	SM	SM
w (%)		18.4	26.2	27.8

Particle Size (Sieve #)	PERCENT FINER □	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				
4				
10	100.0	100.0	100.0	100.0
20	99.0	99.5	96.1	99.6
40	84.8	84.3	77.0	87.7
60	55.9	56.9	56.8	61.0
100	33.3	32.9	34.2	29.3
200	18.1	18.3	17.8	13.4

SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	light brown m-f SAND, some silt.
○	gray m-f SAND, some silt.
●	light brown m-f SAND, some silt.

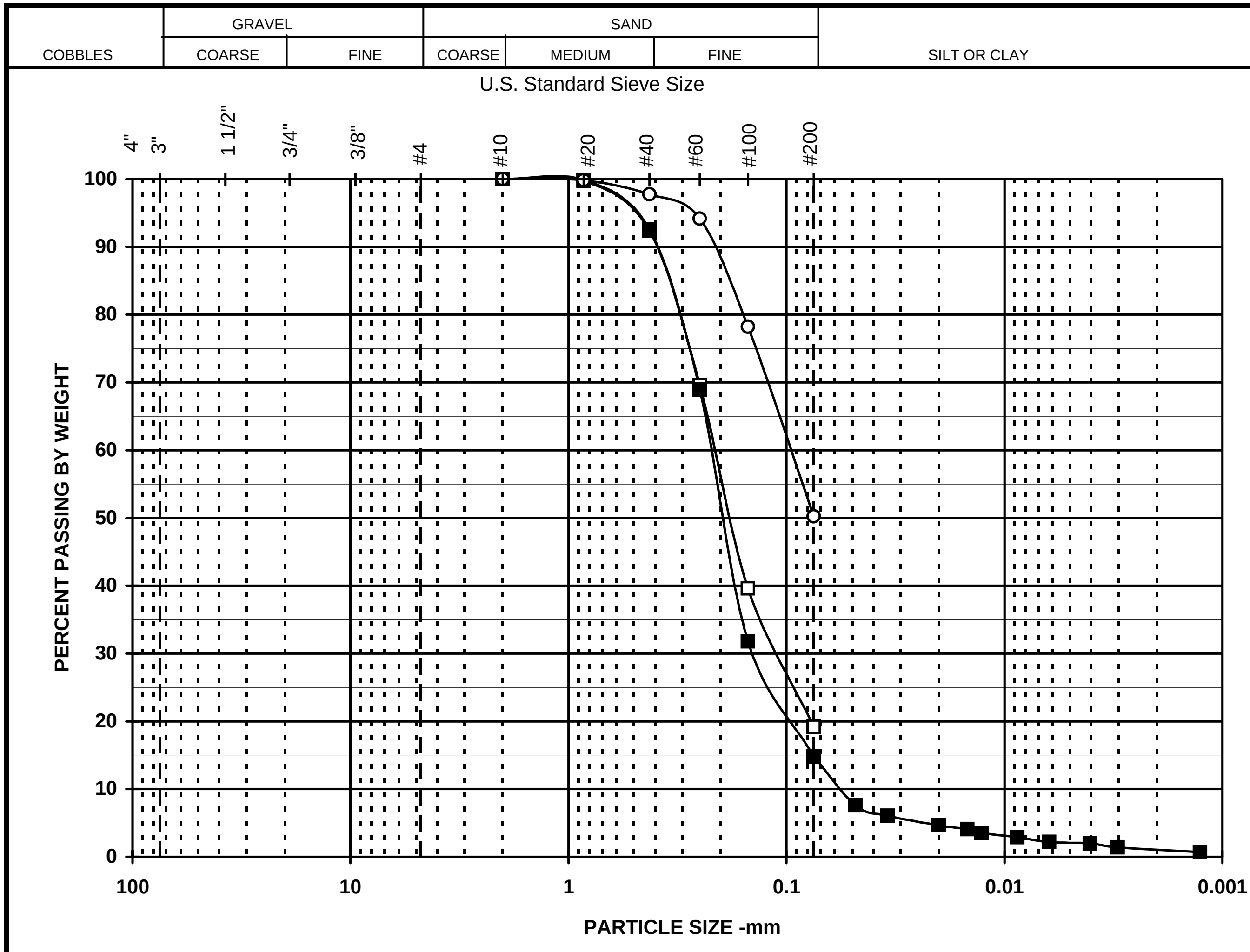
PARTICLE SIZE DISTRIBUTION

Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_51c.xls 12/12/2006



Symbol	□	■	○	●
Boring	TH5-1	TH5-1	TH5-1	
Sample				
Spec				
Depth	140-141.5	160	180	
% +3"				
% Gravel				
% SAND	80.8	85.2	49.7	
% FINES	19.2	14.8	50.3	
% -2μ		1		
Cc				
Cu				
LL				
PL				
PI				
USCS	SM	SM	CL	
w (%)	21.0		26.7	

Particle Size (Sieve #)	PERCENT FINER □	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				
4				
10	100.0	100.0	100.0	
20	99.7	99.9	99.8	
40	92.4	92.5	97.8	
60	69.6	68.9	94.2	
100	39.6	31.8	78.2	
200	19.2	14.8	50.3	

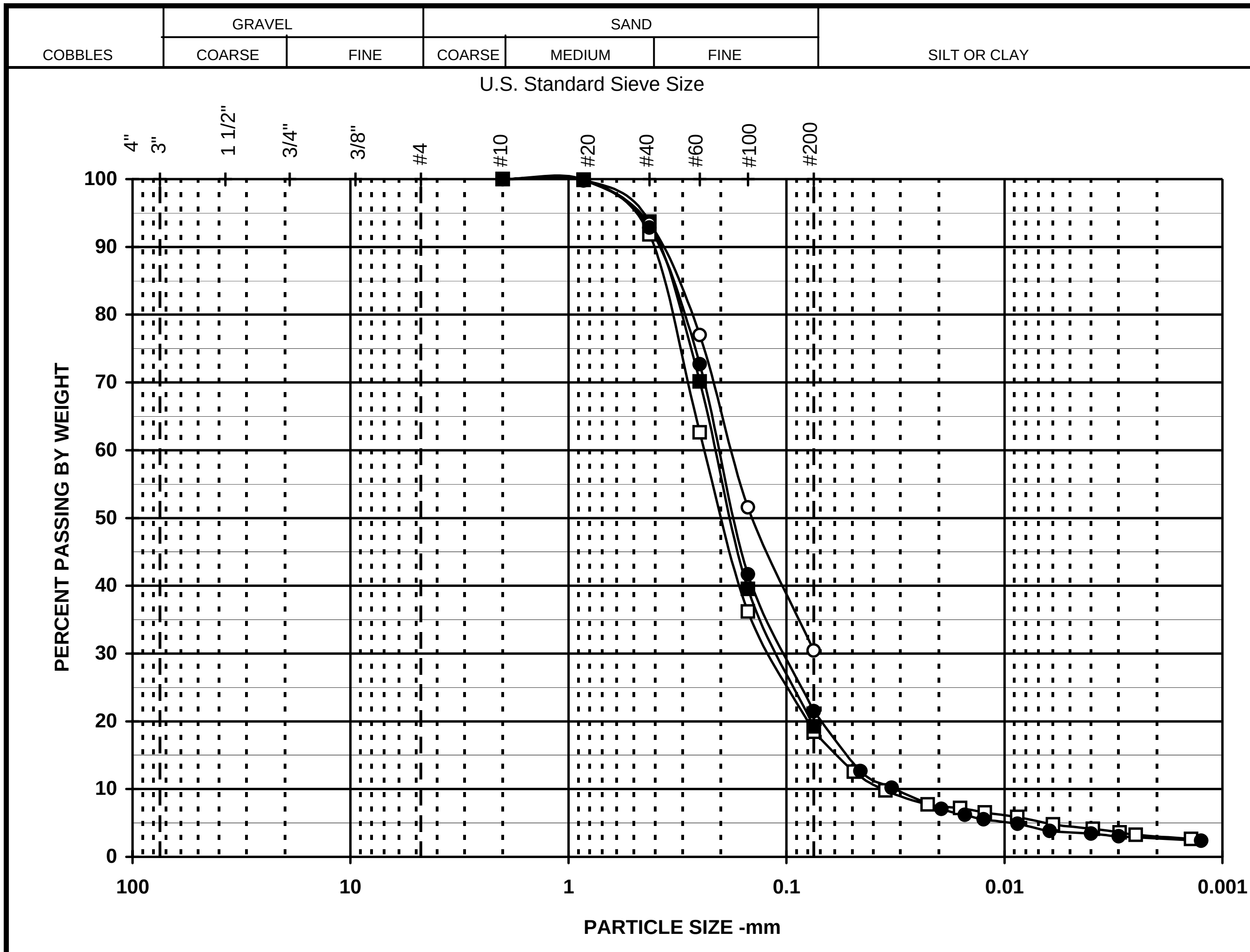
SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	gray m-f SAND, some silt.
○	brown f. sandy CLAY, trace m. sand.
●	

PARTICLE SIZE DISTRIBUTION
Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_51d.xls 12/12/2006



SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	light brown m-f SAND, some silt.
○	brown silty f. SAND, trace m. sand.
●	brown m-f SAND, some silt.

Symbol	□	■	○	●
Boring	TH5-2	TH5-2	TH5-2	TH5-2
Sample				
Spec				
Depth	10	11-12.5	20.85	22.5
% +3"				
% Gravel				
% SAND	81.6	80.7		
% FINES	18.4	19.3	30.4	21.5
% -2μ	3			3
Cc				
Cu				
LL				
PL				
PI				
USCS	SM	SM	SM	SM
w (%)		20.8	18.7	

Particle Size (Sieve #)	PERCENT FINER □	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				
4				
10	100.0	100.0	100.0	100.0
20	99.9	99.9	99.9	99.8
40	91.8	93.7	93.4	92.9
60	62.6	70.1	77.0	72.7
100	36.2	39.5	51.6	41.7
200	18.4	19.3	30.4	21.5

PARTICLE SIZE DISTRIBUTION

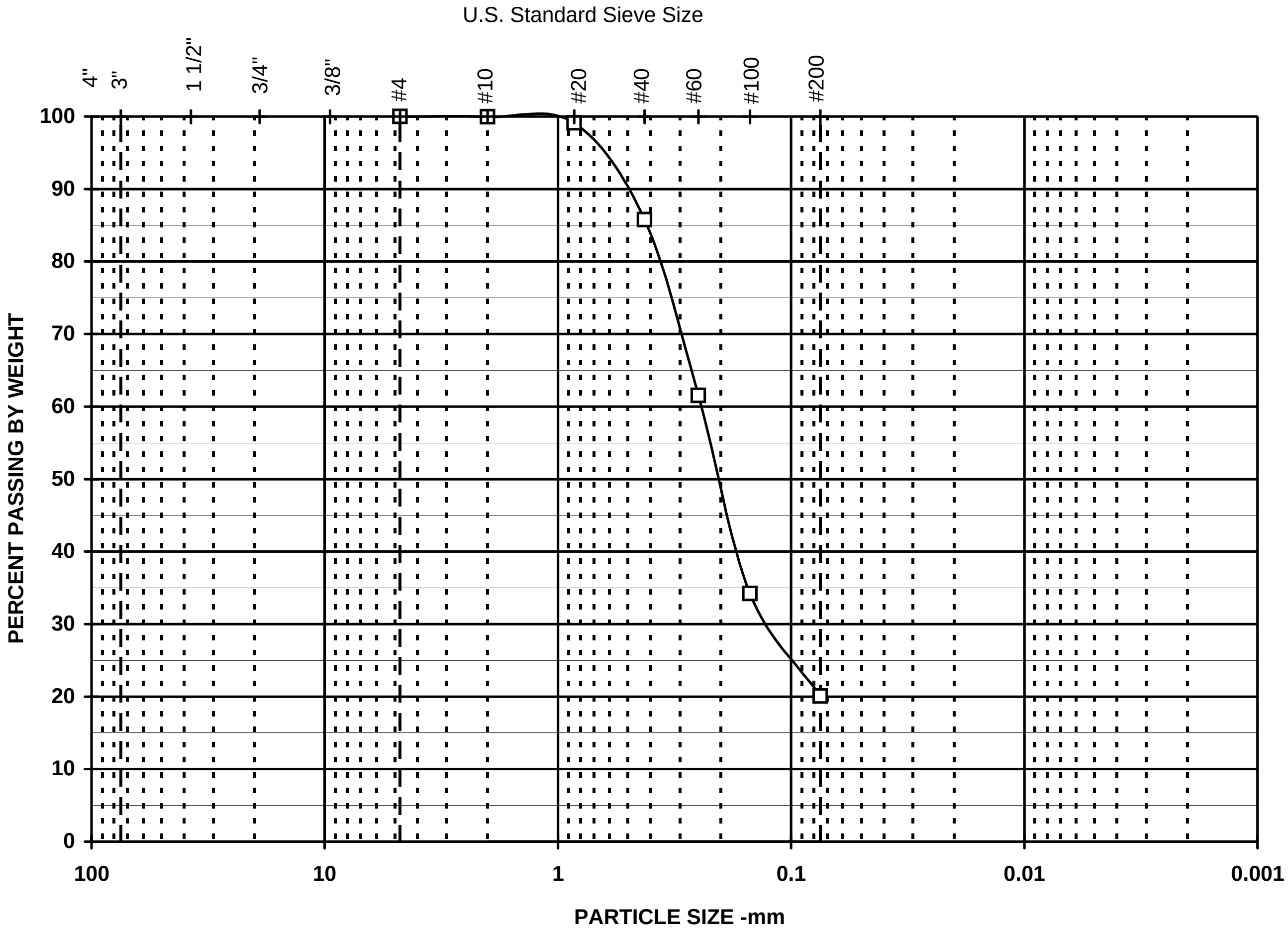
Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_52a.xls 12/12/2006

GRAVEL		SAND			
COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT OR CLAY



Symbol	□	■	○	●
Boring	5 Dam			
Sample	Composite			
Spec				
Depth				
% +3"				
% Gravel				
% SAND	79.9			
% FINES	20.1			
% -2µ				
Cc				
Cu				
LL				
PL				
PI				
USCS	SM			
w (%)	19.5			

Particle Size (Sieve #)	PERCENT FINER □	■	○	●
4"				
3"				
1 1/2"				
3/4"				
3/8"				
4	100.0			
10	99.9			
20	99.1			
40	85.8			
60	61.5			
100	34.2			
200	20.1			

SYMBOL	DESCRIPTION AND REMARKS
□	brown m-f SAND, some silt.
■	
○	
●	

PARTICLE SIZE DISTRIBUTION
Climax Mine 5 Dam

Project No. 22238824	December 2006	Figure

URS Corporation

siev1_51comp.xls 12/11/2006

Appendix B.4

2006 Engineering Test Results

Climax Mine

5 Dam

LABORATORY TESTING DATA SUMMARY

BORING NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	TOTAL UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	SPECIFIC GRAVITY (-)	PERMEABILITY (cm/sec)	STRENGTH: Type Test & Stress	PEAK SHEAR STRESS (ksf)	AXIAL STRAIN @ PEAK STRESS (%)	CONSOLIDATION INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS & Test ID
TH-5-1	12.5-14	16.2				SM	13.5											
TH-5-1	20-22.5								105.8									
TH-5-1	20.25	15.4				SP			103.6				CIU'@15	14.4	14.5			T2649
TH-5-1	20.55	8.8																
TH-5-1	20.8	19.0				SP*	19.0		111.7			1.2E-5	CIU'@25	13.4	13.2			T2650 *clay seam present
TH-5-1	21.1	9.8																
TH-5-1	21.35	9.3				SP			99.5				CIU'@50	19.1	12.2			T2651
TH-5-1	21.65	19.3																
TH-5-1	21.9	13.8	np	np	np	SM			104.7	92.1	2.726					0.849	44	C06235
TH-5-1	22.5-24					SM	22.4	2										
TH-5-1	31-32.5	21.5				SP-SM	11.8											
TH-5-1	40-41.5																	
TH-5-1	40.3	5.4																
TH-5-1	40.85	7.9																
TH-5-1	41.1	11.4	np	np	np	SM	12.5											
TH-5-1	41.4	12.5																
TH-5-1	42.5-43.5	18.5				SM	17.5											
TH-5-1	50-51.5	17.8				SM	17.5											
TH-5-1	60-61.5	19.8				SM	12.6											
TH-5-1	70-71.5		np	np	np	SM	18.1	2										
TH-5-1	80-81.5	18.4				SM	18.3											
TH-5-1	90-91.5		np	np	np	SM												
TH-5-1	100-101.5	26.2				SM	17.8											
TH-5-1	120-121.5	27.8				SM	13.4											
TH-5-1	140-141.5	21.0				SM	19.2											
TH-5-1	160					SM	14.8	1										
TH-5-1	180	26.7				ML	50.3											
TH-5-2	10					SM	18.4	3										
TH-5-2	11-12.5	20.8				SM	19.3											
TH-5-2	20-22.5								106.7									
TH-5-2	20.85	18.7				SM	30.4											
TH-5-2	22.5					SM	21.5	3										
5 Dam	Composite					SM	20.1											See slurry-sedimented triaxial tests

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: RV Reviewed by: GET Date: 12/13/2006

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

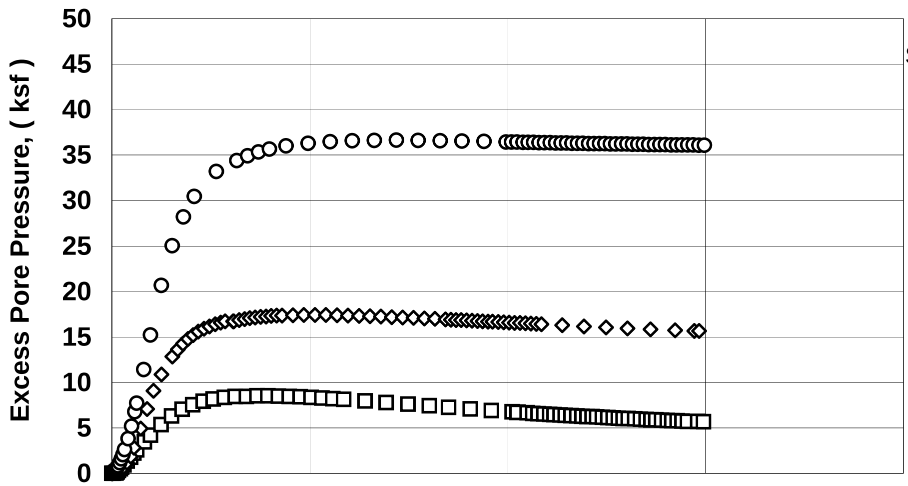
Test No	Boring No	Sample Section No	Depth / Elev (ft)	USCS Group Symbol / Gs	w_o / w_c (%)	$\gamma_{t,o}$ / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (ksf) / OCR	$\sigma'_{v,c}$ (ksf) / $K_c = \frac{\sigma'_{v,c}}{\sigma'_{h,c}}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	at Peak Deviator Stress / at Peak Obliquity: ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
T2649	TH5-1	A	20.25	SP	15.4	103.6	89.8	15.00	15.00	1.0		14.5	14.35	23.64	4.09	0.199	37.4
				(2.73)	28.4	123.1	95.9	1.0	1.00	6.4	1.4	6.9	12.10	19.32	4.36	0.322	38.8
T2650	TH5-1	B	20.8	SP*	19.0	111.7	93.9	25.00	25.00	2.3		13.0	13.44	22.49	3.97	0.593	36.7
				(2.73)	27.0	124.5	98.1	1.0	1.00	4.2	1.4	8.2	12.52	20.53	4.12	0.678	37.6
T2651	TH5-1	C	21.35	SP	9.3	99.5	91.0	50.00	50.00	2.3		12.2	19.11	32.86	3.78	0.949	35.6
				(2.73)	25.9	125.6	99.7	1.0	1.00	8.7	1.4	10.0	18.96	32.53	3.80	0.960	35.7

Test No	Description of Material Tested and Remarks
T2649	SP, brown f. SAND, trace silt.
T2650	SP*, brown m-f SAND, thin clay layer present
T2651	SP, brown m-f SAND.

Strength Envelope Summary						
Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	37.0	0.000	31.1	0.000	--
	2	19.7	5.929	18.7	5.580	1.000
Envelopes based on sample sections "A" & "C" only						

Failure Criteria: 1 - Peak Deviator Stress; 2 - Peak Obliquity

Project No. 22238824	**Climax Mine** **5 Dam**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements TH5-1 20-22.5 ft SUMMARY	
URS Corporation			November 2006



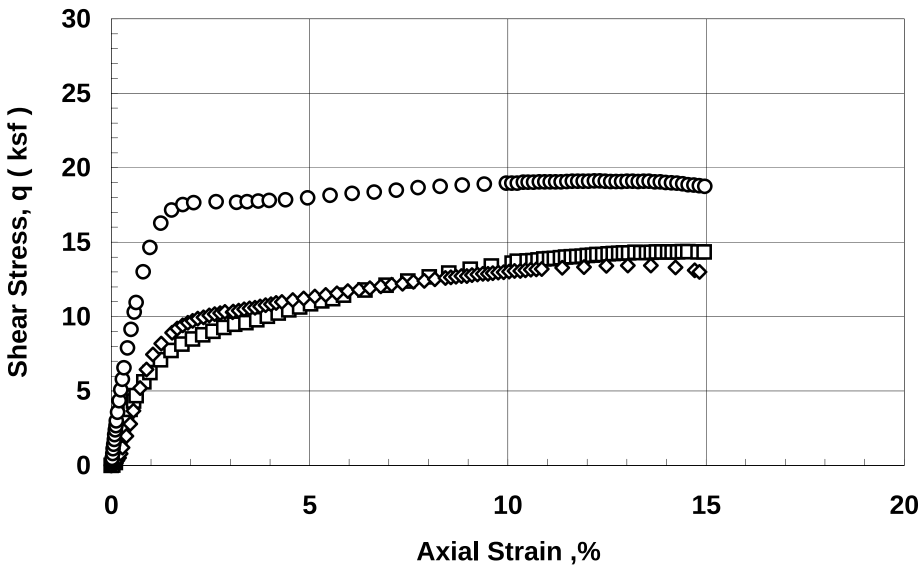
LEGEND AND SUMMARY INFORMATION

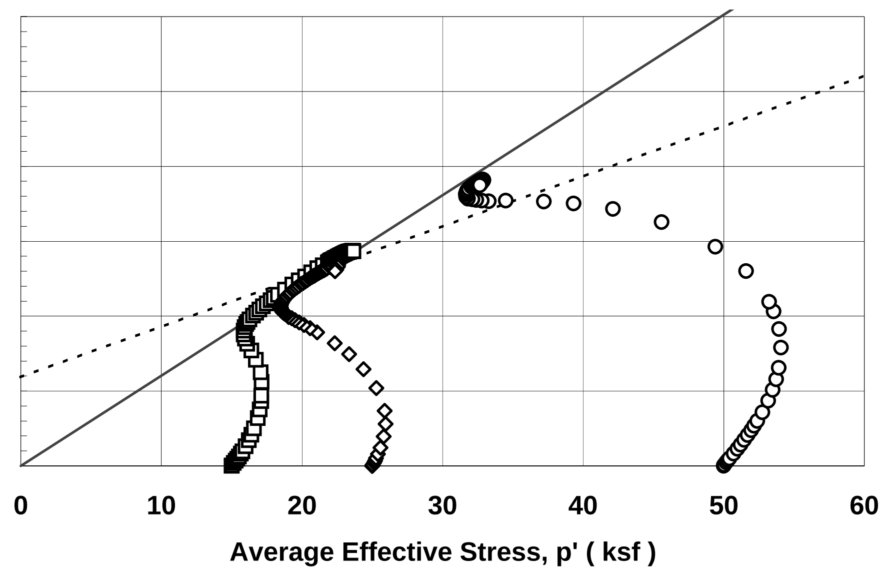
Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T2649	TH5-1	A	20.3	15.4	103.6	15.00
◊	T2650	TH5-1	B	20.8	19.0	111.7	25.00
○	T2651	TH5-1	C	21.4	9.3	99.5	50.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
———	Peak Deviator Stress	0.00	37.0
········	Peak Obliquity	5.93	19.7

Envelopes based on sample sections "A" & "C" only





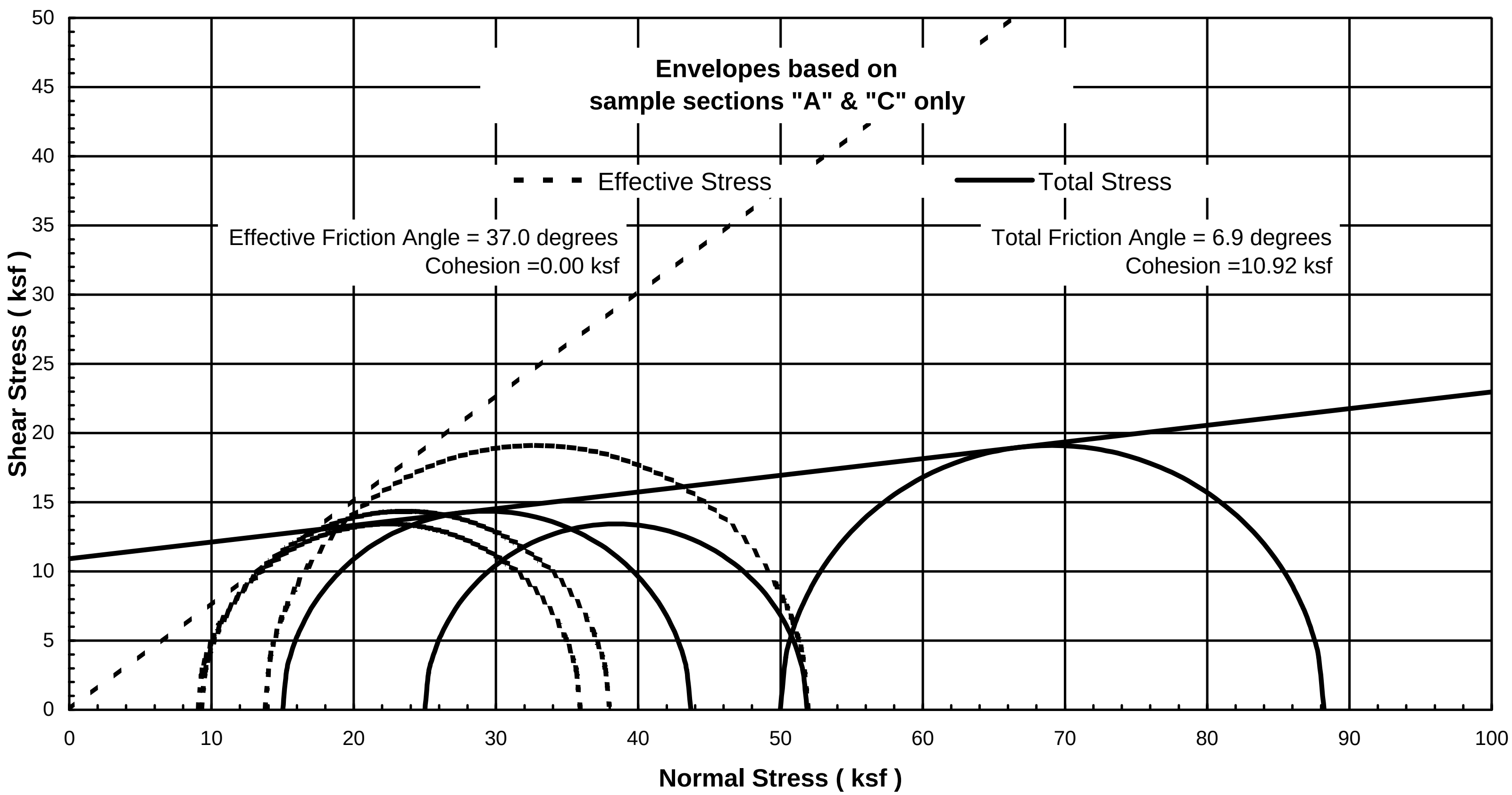
Project No. 22238824	**Climax Mine** **5 Dam**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements TH5-1 20-22.5 ft SUMMARY	Figure 1
URS Corporation			November 2006

Prepared by: C. Jordan

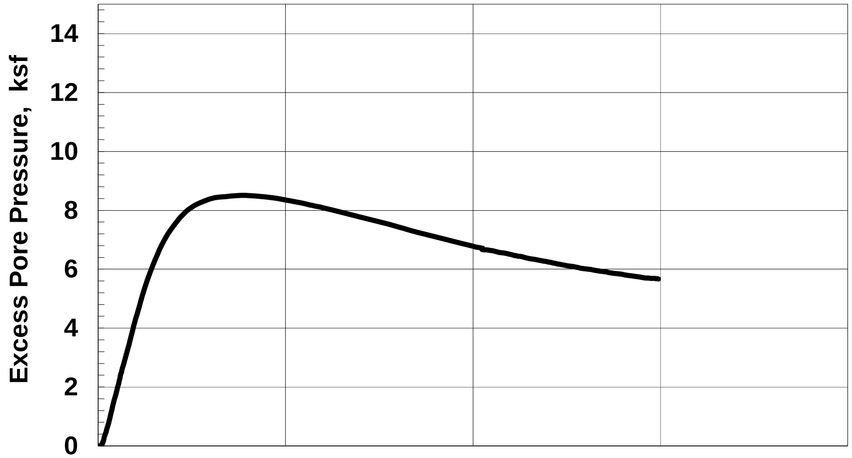
Checked by: G. Thomas

GSI Analysis File: Cu'sum3v4

12/12/2006 Test: 5DamCIUSum.xls



Project No. 22238824	Climax Mine 5 Dam	Mohr Circles of Total and Effective Stresses at Peak CIU' Triaxial Test TH5-1 20-22.5 ft SUMMARY	Figure 2
URS Corporation			November 2006

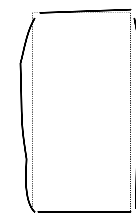


SAMPLE INFORMATION
Boring: TH5-1 Sample: A Depth: 20.25ft
Type: Undisturbed
Description: SP, brown f. SAND, trace silt.

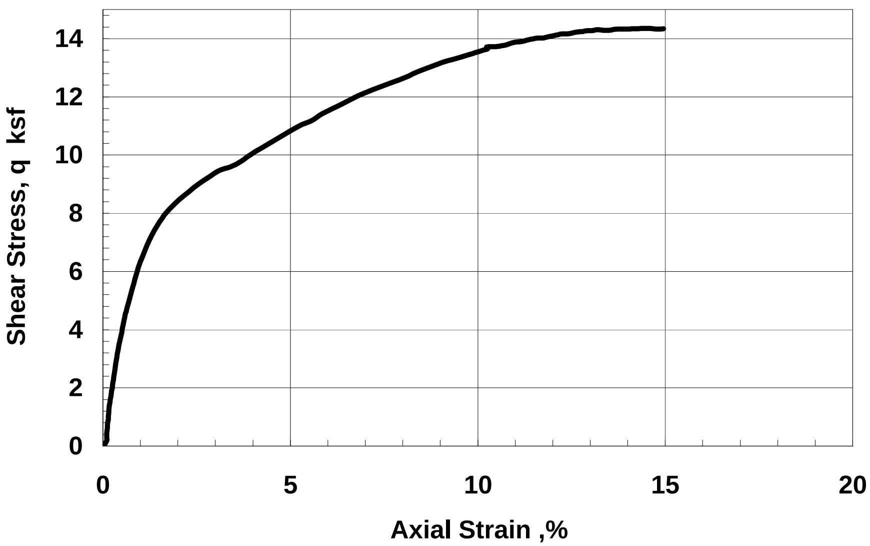
SPECIMEN INFORMATION (Initial)
Height: 6.01 inch Diameter: 2.86 inch Area: 6.43 in²
Water Content: 15.4 % Total Unit Weight: 103.6 pcf

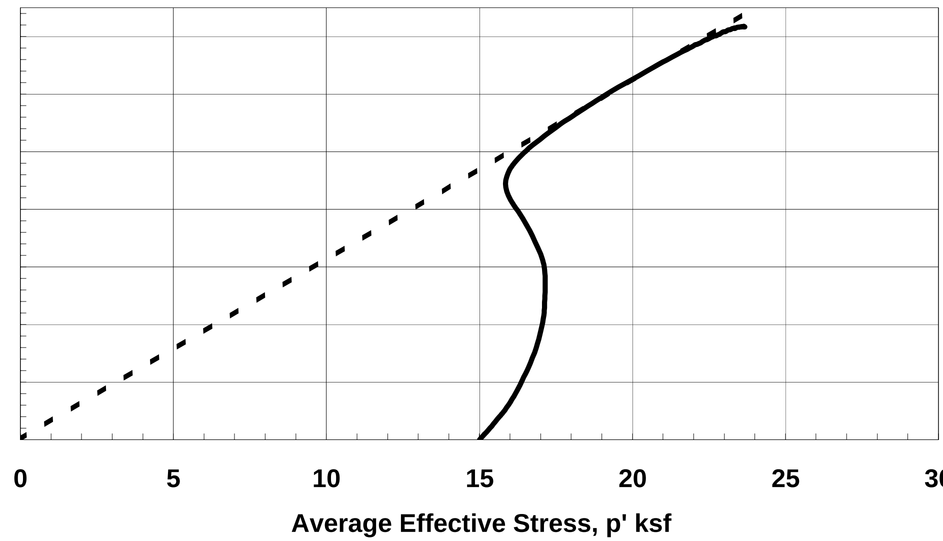
TEST SUMMARY
Consolidation Stresses: 15.00 ksf vertical, 15.00 ksf lateral
Water Content: 28.4 % Total Unit Weight: 123.1 pcf
B Coefficient: Strain Rate: 0.023 %/min
Peak Shear Strength: 14.35 ksf @ 14.5 % Strain
Peak Effective Friction Angle: 38.8°

REMARKS:

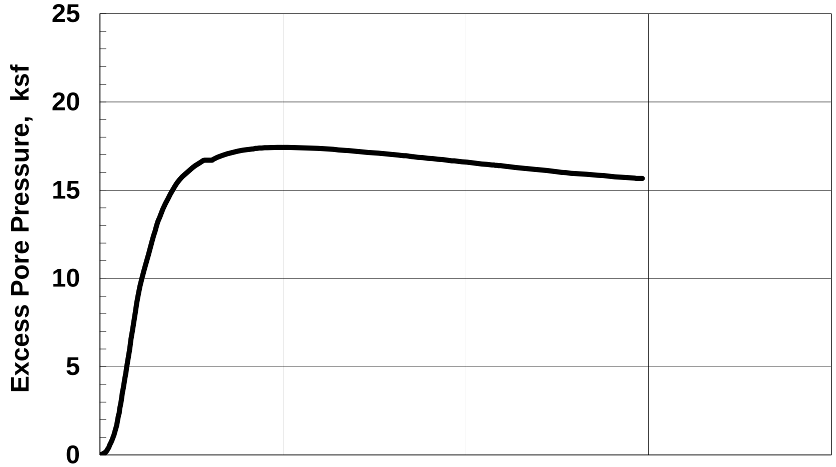


Failure Sketch



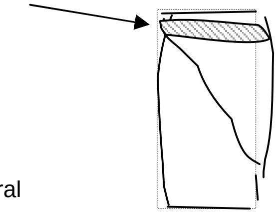


Test by: DT	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring TH5-1 Depth 20.25 ft.	
Checked by: GET	URS Corporation			December-06



SAMPLE INFORMATION

Boring: TH5-1 Sample: B Depth: 20.8ft
Type: Undisturbed
Description: SP*, brown m-f SAND, thin clay layer present



Failure Sketch

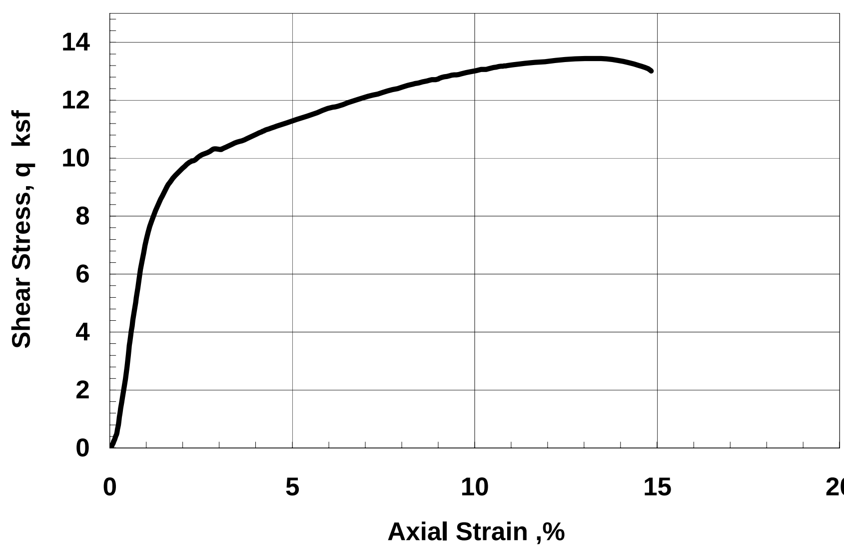
SPECIMEN INFORMATION (Initial)

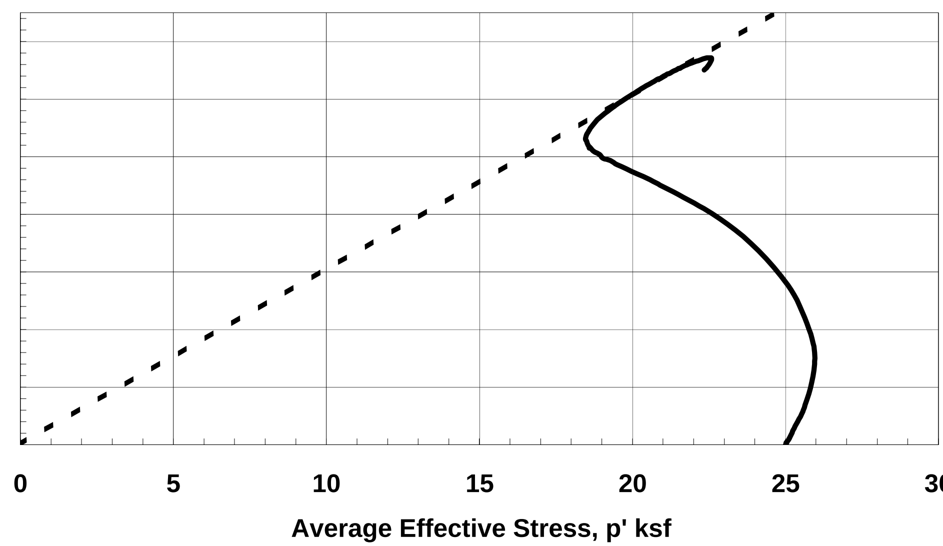
Height: 5.97 inch Diameter: 2.77 inch Area: 6.03 in²
Water Content: 19.0 % Total Unit Weight: 111.7 pcf

TEST SUMMARY

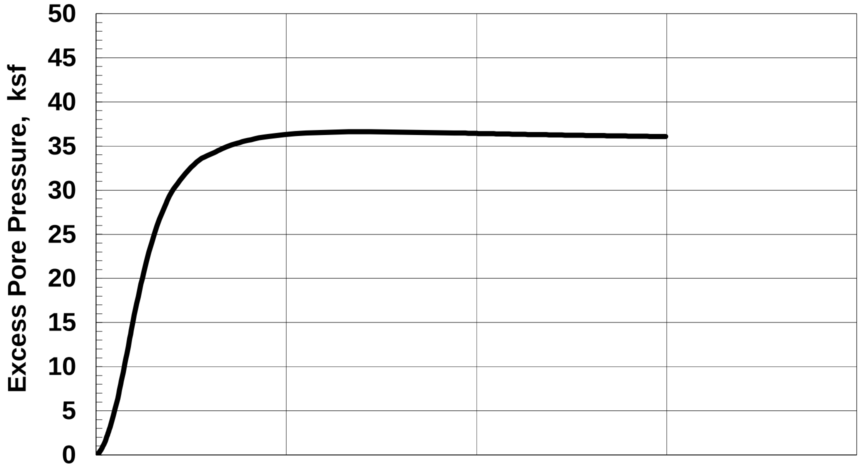
Consolidation Stresses: 25.00 ksf vertical, 25.00 ksf lateral
Water Content: 27.0 % Total Unit Weight: 124.5 pcf
B Coefficient: Strain Rate: 0.023 %/min
Peak Shear Strength: 13.44 ksf @ 13.0 % Strain
Peak Effective Friction Angle: 37.6°

REMARKS:





Test by: DT	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements
Checked by: GET	URS Corporation		Boring TH5-1 Depth 20.8 ft.	December-06



SAMPLE INFORMATION

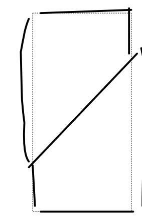
Boring: TH5-1 Sample: C Depth: 21.35ft
Type: Undisturbed
Description: SP, brown m-f SAND.

SPECIMEN INFORMATION (Initial)

Height: 6.00 inch Diameter: 2.83 inch Area: 6.27 in²
Water Content: 9.3 % Total Unit Weight: 99.5 pcf

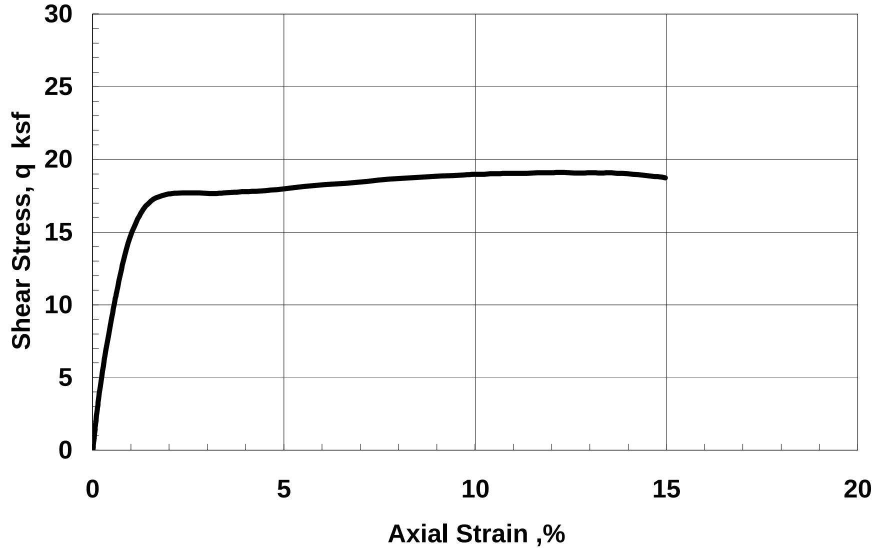
TEST SUMMARY

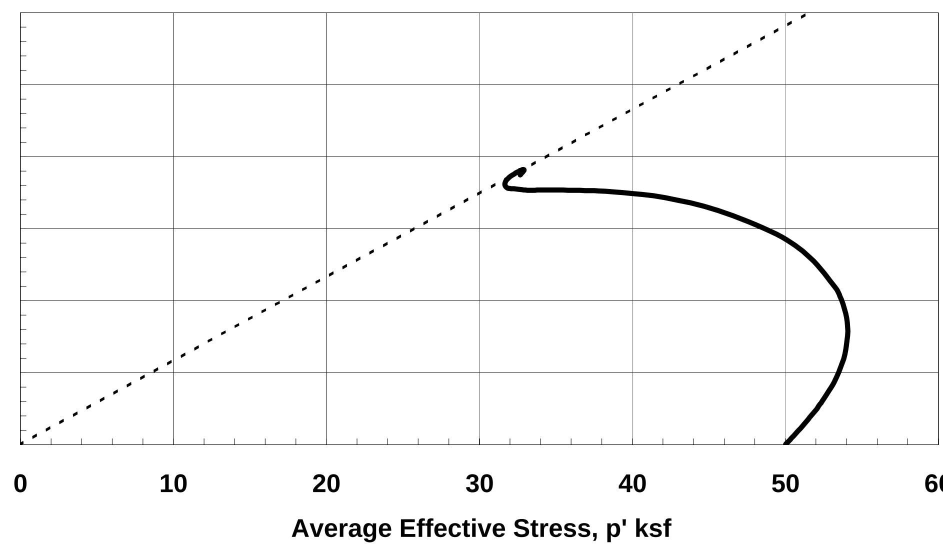
Consolidation Stresses: 50.00 ksf vertical, 50.00 ksf lateral
Water Content: 25.9 % Total Unit Weight: 125.6 pcf
B Coefficient: Strain Rate: 0.023 %/min
Peak Shear Strength: 19.11 ksf @ 12.2 % Strain
Peak Effective Friction Angle: 35.7°



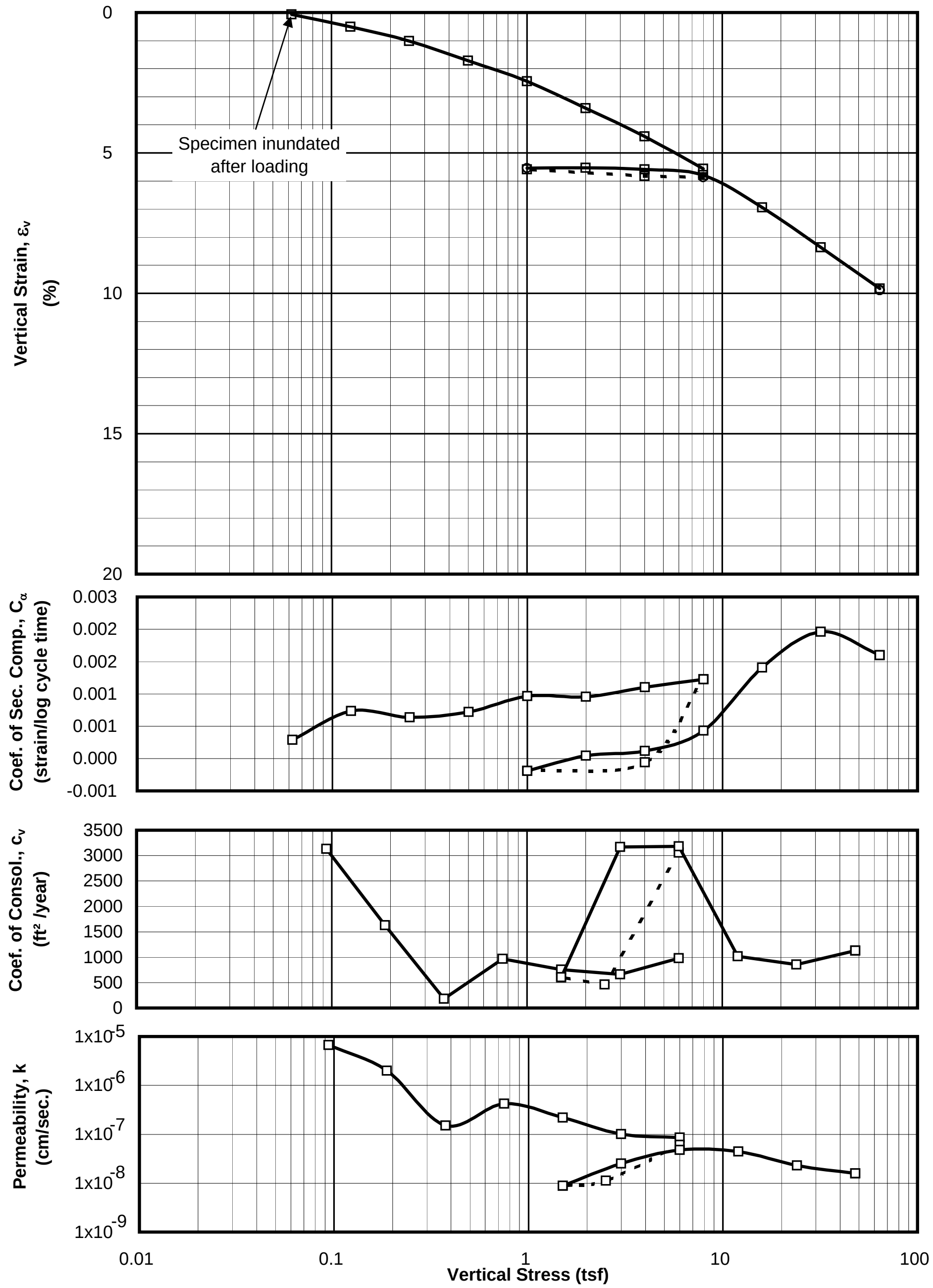
Failure Sketch

REMARKS:





Test by: DT	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring TH5-1 Depth 21.35 ft.
Checked by: GET	**URS Corporation**		December-06



SAMPLE INFORMATION

Boring:	TH5-1
Sample:	D
Depth:	21.90 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	SM brown m-f SAND, some silt.

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.62	inch
Diameter:	2.50	inch

Initial water content:	13.8	%
Initial total unit weight:	104.7	pcf
Initial dry unit weight:	92.1	pcf
Initial void ratio:	0.849	
Initial degree of saturation:	44	%
Final water content:	20.0	%
Final total unit weight:	119.1	pcf
Final dry unit weight:	99.3	pcf
Final void ratio:	0.715	
Final degree of saturation:	76	%

(assumed specific gravity = 2.73)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	2.8 (Range: 1.9 to 3.9)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.048
Compression Index (void ratio per log cycle stress):	0.089
Swell Ratio (strain per log cycle stress):	0.004
Swell Index (void ratio per log cycle stress):	0.007
Recompression Ratio (strain per log cycle stress):	0.002
Recompression Index (void ratio per log cycle stress):	0.004

Remarks: **No final unload stage performed due to equipment problem.**

LEGEND: □ End of primary o End of Stage ———— Loading - - - - - - - Unloading

Test Date: 11/3/06 Tested By: RV Checked By: GET

	Climax Mine 5 Dam	ONE DIMENSIONAL CONSOLIDATION TEST Boring: TH5-1 Depth: 21.90 feet
URS Corporation	Project No. 22238824	November 2006

GSI Analysis File: Conv31.xls (10/05) C06235.xls 11/27/2006

PROJECT:	Climax Mine				
PROJECT NO.:	22238824	Initial height:	0.620 inch	Final height:	0.564 inch
BORING:	TH5-1	Initial water content:	13.8 %	Final water content:	20.0 %
SAMPLE:	D	Initial dry density:	92.1 pcf	Final dry density:	99.3 pcf
TEST:	C06235	Initial total density:	104.7 pcf	Final total density:	119.1 pcf
DEPTH, feet:	21.9	Initial saturation:	44 %	Final saturation:	76 %
BY:	RV	Initial void ratio:	0.849	Final void ratio:	0.715
TEST DATE:	11/3/2006			Final strain:	9.1 %

EQUIPMENT:
Load Frame No.: 2
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: SM
brown m-f SAND, some silt.

G	LL	PL	PI
2.726	np	np	np

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0004	0.070	0.847	0.346	0.842	264.72	0.0003	89.18	8.96E-08
2	0.125	0.0032	0.511	0.839	0.809	0.834	3130.81	0.0007	14.18	6.66E-06
3	0.250	0.0063	1.021	0.830	1.291	0.825	1631.19	0.0006	24.51	2.01E-06
4	0.500	0.0106	1.715	0.817	1.933	0.813	180.91	0.0007	35.99	1.52E-07
5	1.00	0.0152	2.445	0.803	2.731	0.798	964.67	0.0010	68.49	4.25E-07
6	2.00	0.0211	3.406	0.786	3.627	0.782	756.10	0.0010	104.12	2.19E-07
7	4.00	0.0274	4.413	0.767	4.650	0.763	658.71	0.0011	198.61	1.00E-07
8	8.00	0.0345	5.563	0.746	5.865	0.740	980.93	0.0012	347.92	8.51E-08
9	4.00	0.0361	5.826	0.741	5.809	0.741	3056.24	-0.0001	1515.92	6.08E-08
10	1.00	0.0346	5.584	0.745	5.543	0.746	463.42	-0.0002	1236.75	1.13E-08
11	2.00	0.0343	5.535	0.746	5.564	0.746	604.80	0.0000	2059.66	8.86E-09
12	4.00	0.0347	5.588	0.745	5.618	0.745	3166.43	0.0001	3791.95	2.52E-08
13	8.00	0.0359	5.786	0.742	5.916	0.739	3182.97	0.0004	2020.33	4.75E-08
14	16.0	0.0431	6.941	0.720	7.299	0.714	1014.56	0.0014	692.73	4.42E-08
15	32.0	0.0519	8.362	0.694	8.825	0.686	855.76	0.0020	1125.58	2.29E-08
16	64.0	0.0610	9.835	0.667	9.884	0.666	1131.43	0.0016	2172.67	1.57E-08
17										
18										
19										
20										
21										

SUMMARY FOR STATIC CIU' TRIAXIAL TESTS SPECIMENS

Test No	Boring No	Sample	USCS Group Symbol / Gs	w_o (%) / w_c (%)	$\gamma_{t,o}$ (pcf) / $\gamma_{t,c}$ (pcf)	$\gamma_{d,o}$ (pcf) / $\gamma_{d,c}$ (pcf)	$\sigma'_{c,max}$ (ksf) / OCR	$\sigma'_{v,c}$ (ksf) / $K_c = \sigma'_{v,c} / \sigma'_{h,c}$	$\varepsilon_{a,c}$ / $\varepsilon_{v,c}$ (%)	B factor (%) / ε_{rate} (%/hr)	ε_a (%)	$\frac{\sigma_1 - \sigma_3}{2}$ (ksf)	$\frac{\sigma'_1 + \sigma'_3}{2}$ (ksf)	σ'_1 / σ'_3	A factor	ϕ' for c'=0
											at Peak Deviator Stress / at Peak Obliquity					
T2660	5 Dam	Composite	SM	28.3	112.3	87.6	15	15	3.1	95.2	14.9	6.60	11.40	3.75	0.773	35.4
			(2.73)	25.0	126.5	101.3	1.0	1.00	13.5	1.2	14.4	6.55	11.30	3.75	0.783	35.4
T2668	5 Dam	Composite	SM	26.6	114.4	90.3	30	30	4.0		15.0	15.50	26.52	3.81	0.612	35.8
			(2.73)	22.8	128.9	104.9	1	1.00	13.9	1.3	9.9	12.98	22.02	3.87	0.807	36.1
T2661	5 Dam	Composite	SM	29.6	116.1	89.6	60	60	5.9	96.4	15.0	17.58	28.84	4.12	1.386	37.6
			(2.73)	21.8	130.0	106.8	1.0	1.00	16.1	1.4	11.1	16.94	27.60	4.18	1.456	37.9

Test No	
T2660	SM, brown m-f. SAND, some silt.
T2668	SM, brown m-f. SAND, some silt.
T2661	SM, brown m-f. SAND, some silt.

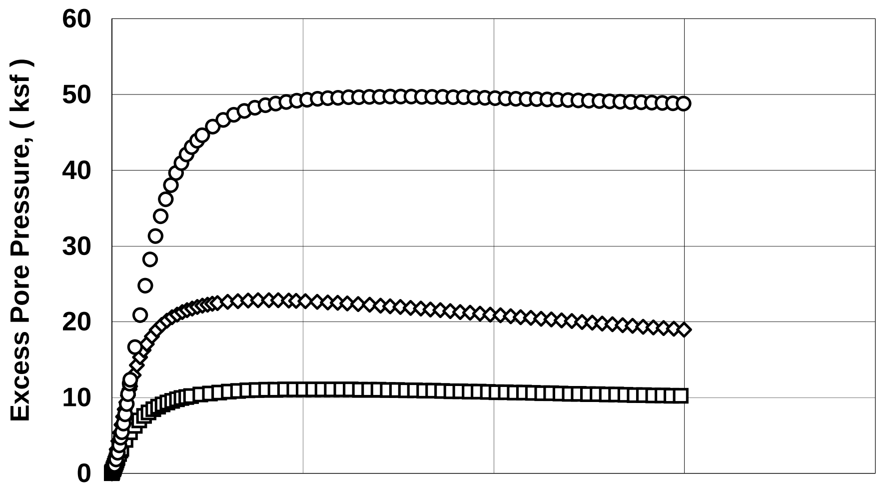
Strength Envelope Summary

Test Series	Failure Criteria	ϕ' (deg)	c' (ksf)	α' (deg)	a' (ksf)	Correlation Coefficient
1	1	36.6	0.000	30.8	0.000	--
	2	37.0	0.000	31.0	0.000	--

Failure Criteria: 1 - Peak Deviator Stress
2 - Peak Obliquity

Project No. 22238824	**Climax Mine** **5 Dam**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements 5 Dam Composite SUMMARY	December 2006

URS Corporation

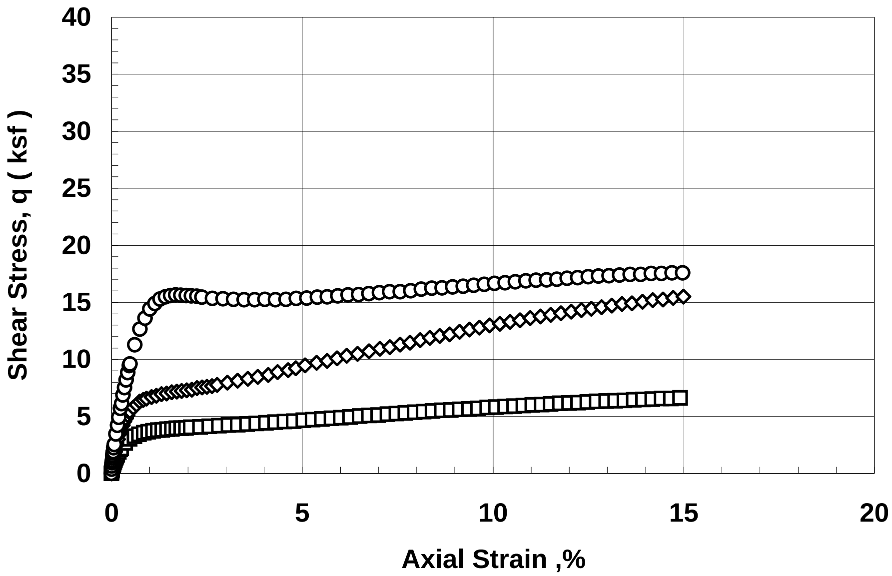


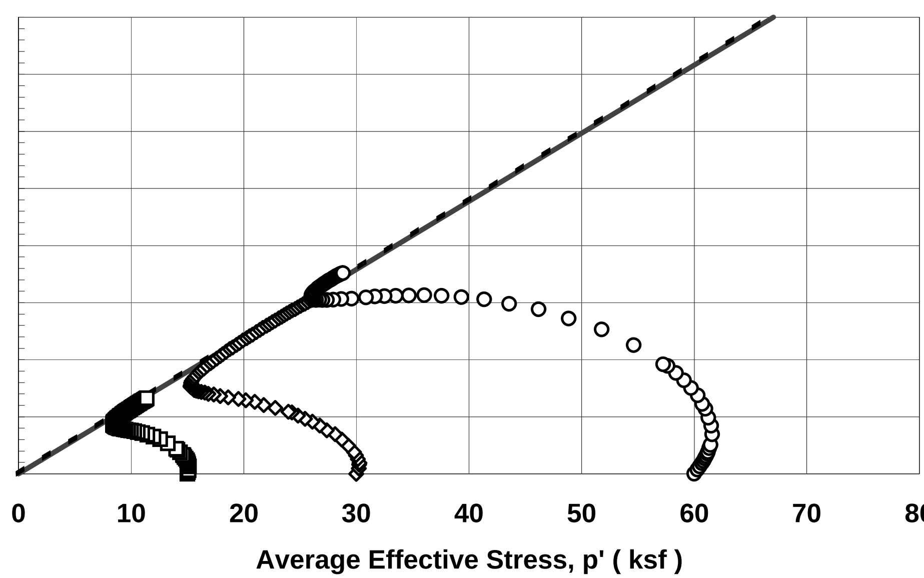
LEGEND AND SUMMARY INFORMATION

Symbol	Test	Boring	Sample	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T2660	5 Dam	Composite	28.3	112.3	15.00
◊	T2668	5 Dam	Composite	26.6	114.4	30.00
○	T2661	5 Dam	Composite	29.6	116.1	60.00

SERIES SUMMARY

Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
———	Peak Deviator Stress	0.00	36.6
········	Peak Obliquity	0.00	37.0





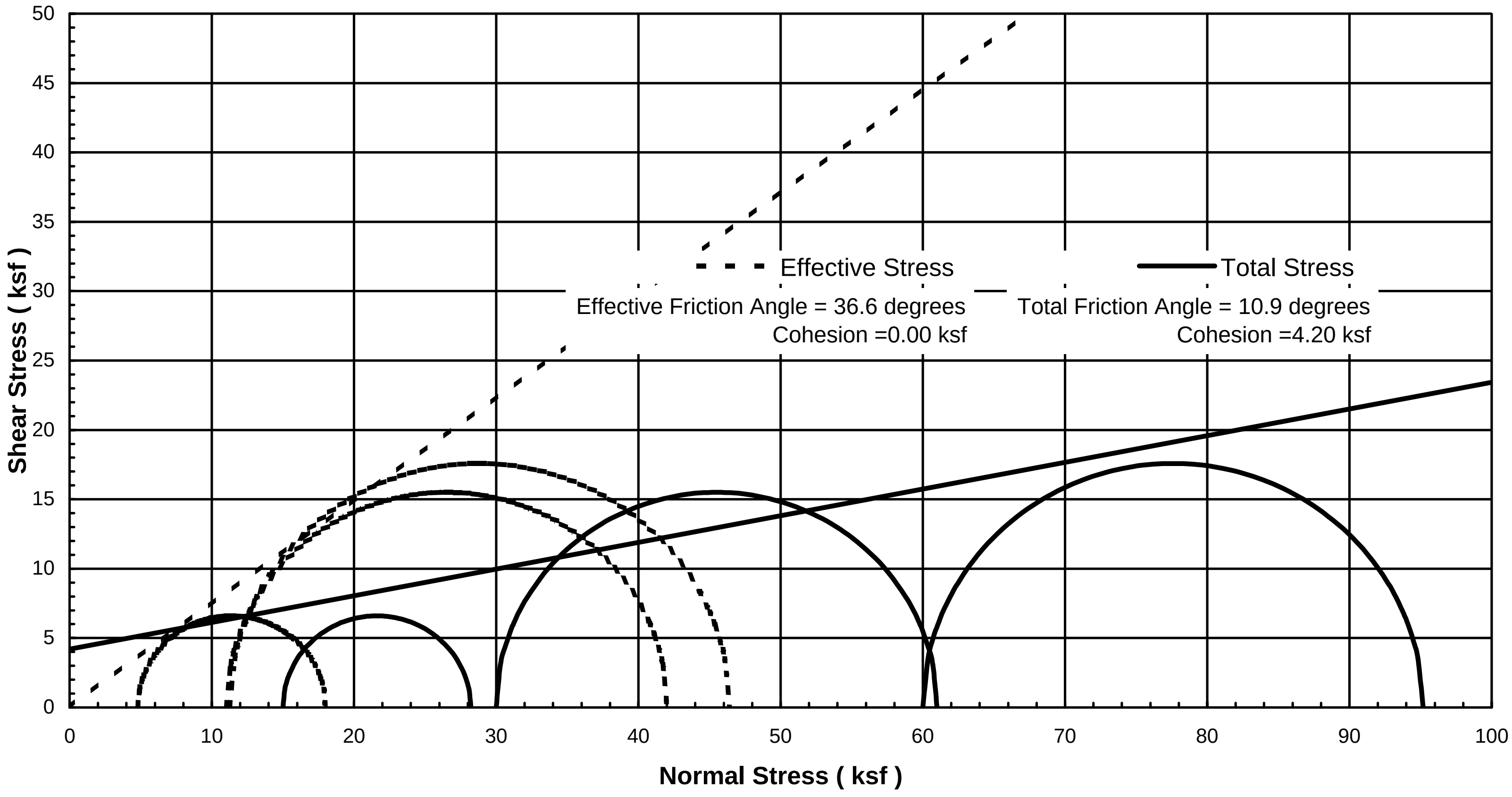
Project No. 22238824	**Climax Mine** **5 Dam**	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements 5 Dam Composite SUMMARY	Figure 1
URS Corporation			December 2006

Prepared by: C. Jordan

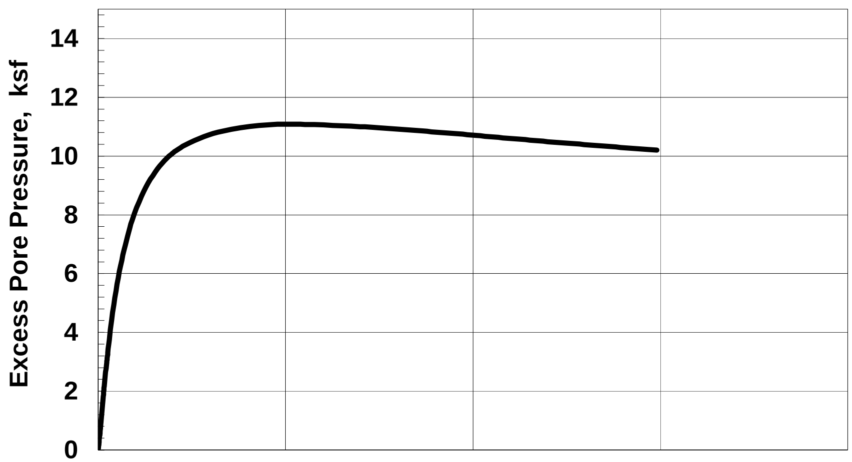
Checked by: G. Thomas

GSI Analysis File: Cu'sum3v4

12/12/2006 Test: Dam5Composite.xls



Project No. **22238824**	**Climax Mine** **5 Dam**	**Mohr Circles of Total and Effective Stresses at Peak** **CIU' Triaxial Test** **5 Dam Composite SUMMARY**	**Figure** **2** **December 2006**
URS Corporation			



SAMPLE INFORMATION

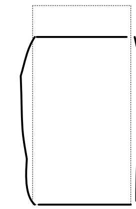
Boring: 5 Dam   Sample: Composite
Type: Slurry Sedimented
Description: SM, brown m-f. SAND, some silt.

SPECIMEN INFORMATION (Initial)

Height: 4.09 inch   Diameter: 1.99 inch   Area: 3.12 in²
Water Content: 28.3 %   Total Unit Weight: 112.3 pcf

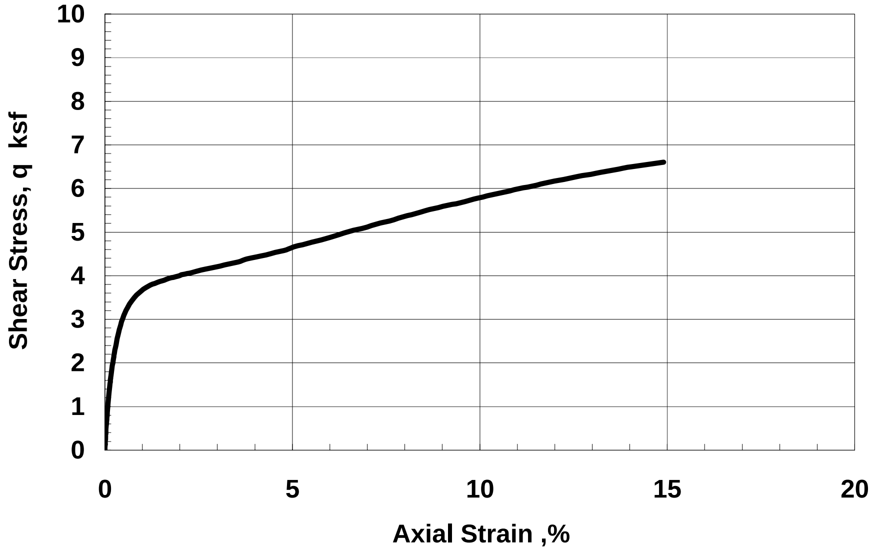
TEST SUMMARY

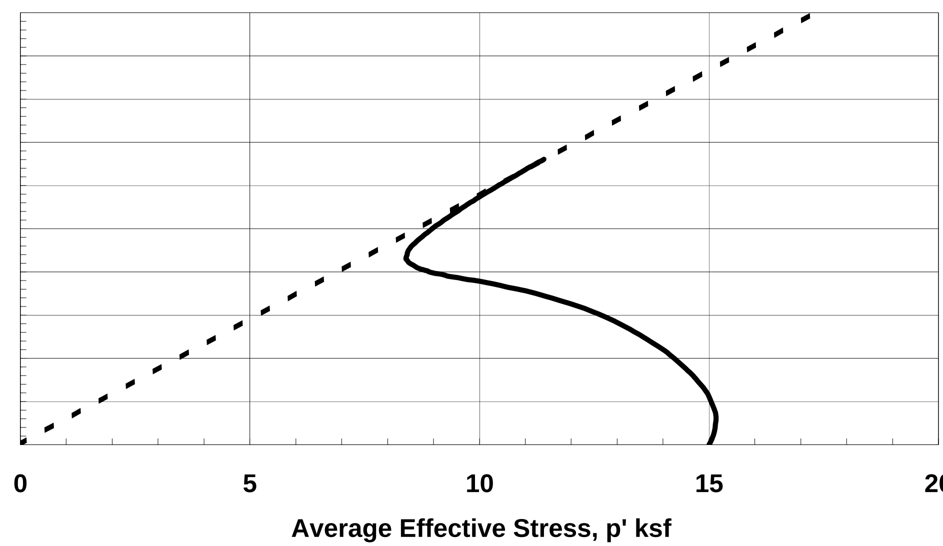
Consolidation Stresses: 15.00 ksf vertical, 15.00 ksf lateral
Water Content: 25.0 %   Total Unit Weight: 126.5 pcf
B Coefficient: 95.2   Strain Rate: 0.020 %/min
Peak Shear Strength: 6.60 ksf @ 14.9 % Strain
Peak Effective Friction Angle: 35.4°



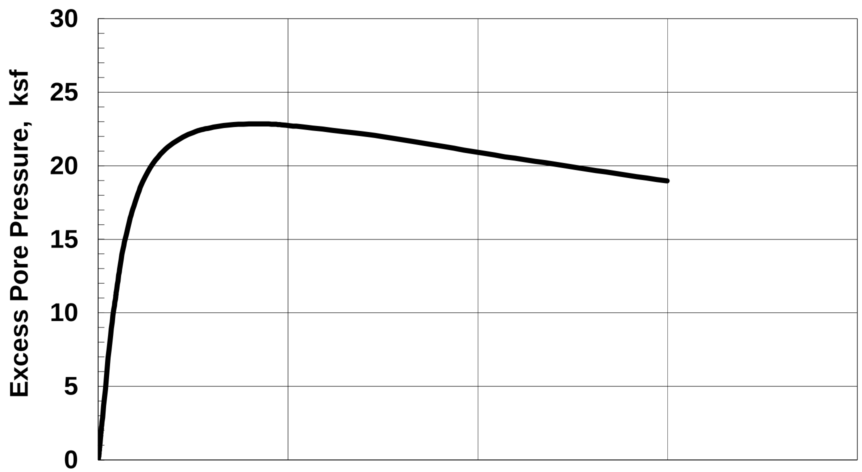
Failure Sketch

REMARKS:





Test by: DT	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	URS Corporation		Boring 5 Dam Composite	December-06



SAMPLE INFORMATION

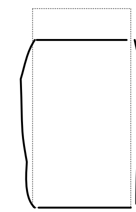
Boring: 5 Dam Sample: Composite
Type: Slurry Sedimented
Description: SM, brown m-f. SAND, some silt.

SPECIMEN INFORMATION (Initial)

Height: 4.02 inch Diameter: 1.98 inch Area: 3.08 in²
Water Content: 26.6 % Total Unit Weight: 114.4 pcf

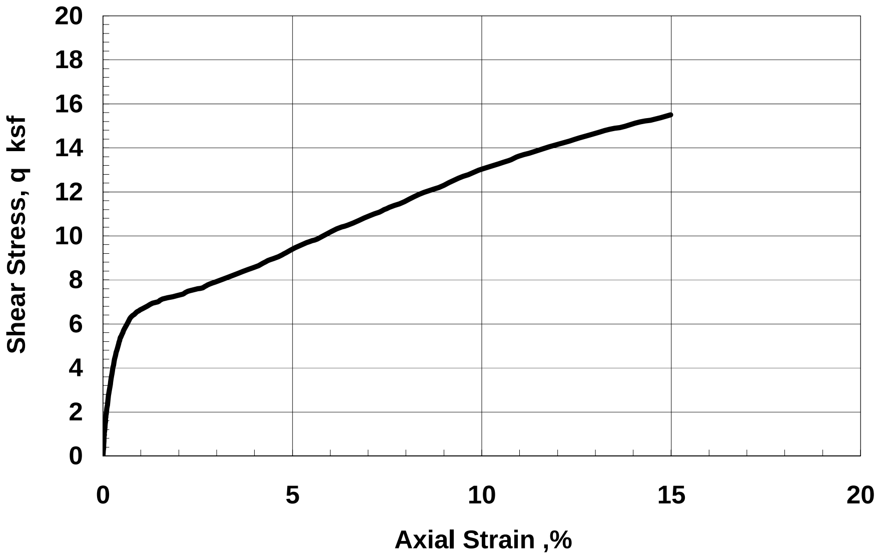
TEST SUMMARY

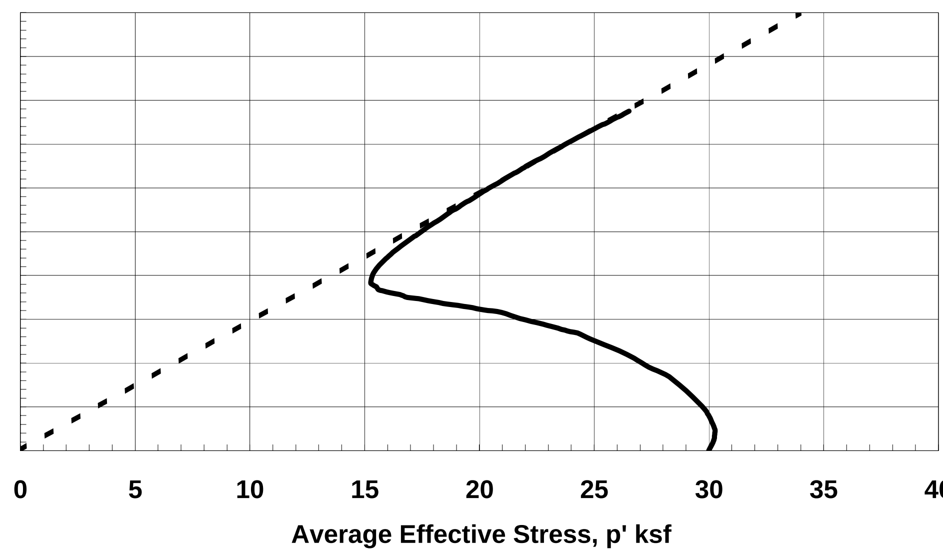
Consolidation Stresses: 30.00 ksf vertical, 30.00 ksf lateral
Water Content: 22.8 % Total Unit Weight: 128.9 pcf
B Coefficient: Strain Rate: 0.022 %/min
Peak Shear Strength: 15.50 ksf @ 15.0 % Strain
Peak Effective Friction Angle: 36.1°



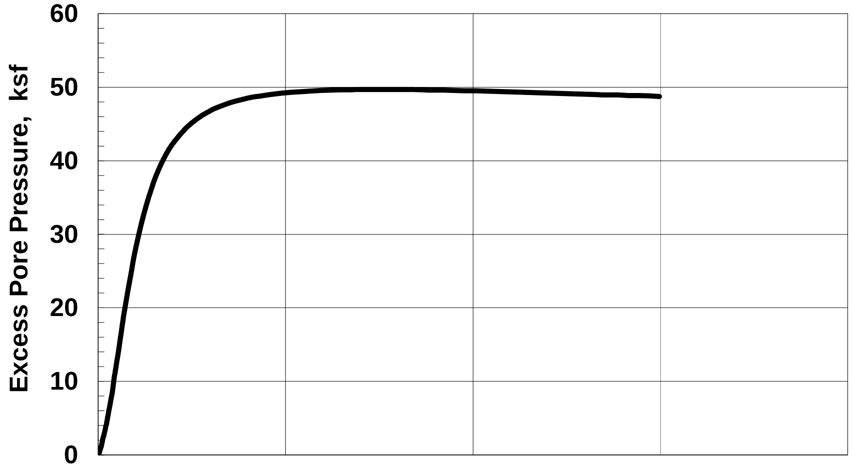
Failure Sketch

REMARKS:





Test by: DT	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements	
Checked by: GET	URS Corporation		Boring 5 Dam Composite	December-06

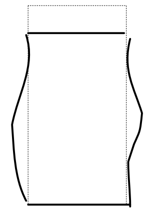


SAMPLE INFORMATION

Boring: 5 Dam Sample: Composite
Type: Slurry Sedimented
Description: SM, brown m-f. SAND, some silt.

SPECIMEN INFORMATION (Initial)

Height: 3.99 inch Diameter: 1.96 inch Area: 3.01 in²
Water Content: 29.6 % Total Unit Weight: 116.1 pcf

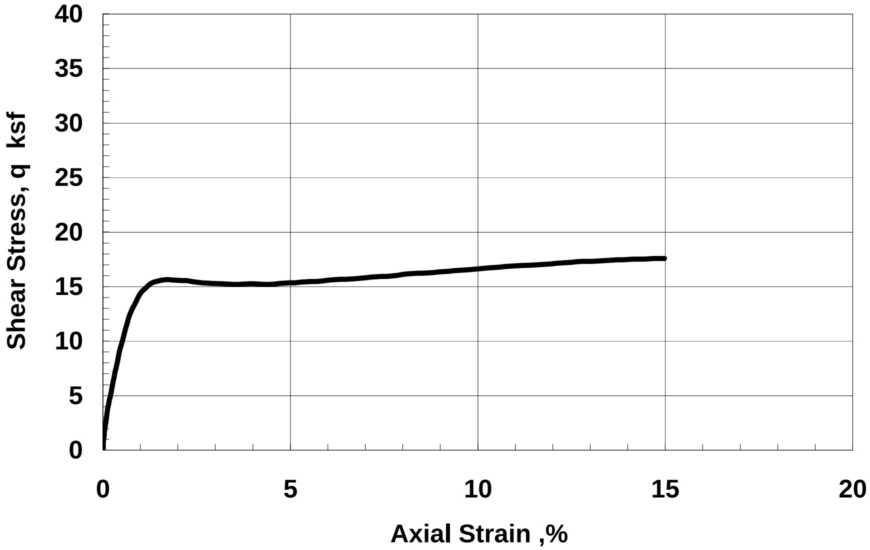


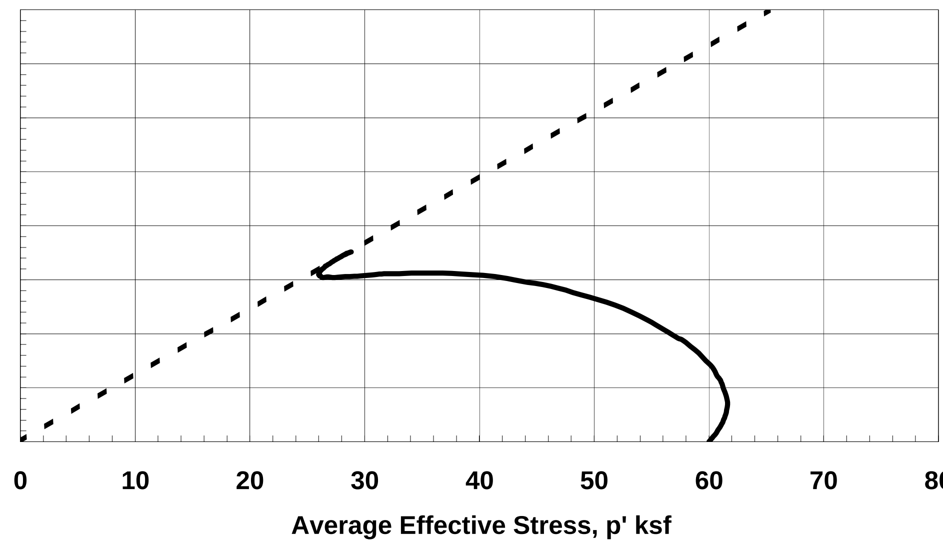
Failure Sketch

TEST SUMMARY

Consolidation Stresses: 60.00 ksf vertical, 60.00 ksf lateral
Water Content: 21.8 % Total Unit Weight: 130.0 pcf
B Coefficient: 96.4 Strain Rate: 0.023 %/min
Peak Shear Strength: 17.58 ksf @ 15.0 % Strain
Peak Effective Friction Angle: 37.9°

REMARKS:





Test by: DT Checked by: GET	Project No. 22238824	Climax Mine 5 Dam	CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION with Pore Pressure Measurements Boring 5 Dam Composite	December-06
	URS Corporation			

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - 90

Project No.: 22238824 | BORING: TH5-1 | Test No.: T2650

Project Name: Climax Mine | SAMPLE: B | DEPTH: 20.8

Specimen - Apparatus set-up - Test Information | Cell No. P | Apparatus No. 2 | Stage No.: 8

Preliminary Length/Area Calculations

Lo =	5.970	in	Lo=	15.164	cm
dLc=	0.138	in	Ao =	38.89	cm^2
Lc=	5.832	in	Vo =	589.79	cm^3
			Lc=	14.814	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	40.90	cm^3
			Vc =	548.89	cm^3
Sc =	0.400	cm^{-1}	Ac=	37.053	cm^2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or
	x	with stones or		Stones with filter paper or top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination
3) During saturation: Water flushed up sides of specimen to remove ai	x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top / Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation
6) Permeant: water used	x	Tap		Distilled
or		Demineralized		0.005 N calcium sulfate (CaSO4)

Equations Used

Kt = - 0.0000746 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 ºC = RT * Kt   TubeC= 1.3214

Consol Stage- Trial No.	Temp. º C	Date	Time hr	min	sec	Initial σ_c psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20ºC cm/sec Dev. from Ave.
initial	21.5	11/6/2006	15	59	00	223.6	50.0	55.00	44.55	0.99	1.24E-05
final	21.5	11/6/2006	16	00	42			51.00	45.85		1.16E-05
1	RT = 0.968	dT =	1.70 min			σ'_c =	25 ksf	0.298	0.301	io= 8.9	0%
initial	21.5	11/6/2006	00	00	00	223.6	50.0	55.00	44.55	0.99	1.24E-05
final	21.5	11/6/2006	00	01	09			52.00	45.52		1.16E-05
2	RT = 0.968	dT =	1.15 min			σ'_c =	25 ksf	0.223	0.225	io= 8.9	0%
initial	21.5	11/6/2006	00	00	00	223.6	50.0	55.00	44.55	0.99	1.24E-05
final	21.5	11/6/2006	00	01	42			51.00	45.85		1.16E-05
3	RT = 0.968	dT =	1.70 min			σ'_c =	25 ksf	0.298	0.301	io= 8.9	0%
initial	21.5	11/6/2006	00	00	00	223.6	50.0	55.00	44.55	1.00	1.23E-05
final	21.5	11/6/2006	00	01	25			51.50	45.68		1.16E-05
4	RT = 0.968	dT =	1.42 min			σ'_c =	25 ksf	0.260	0.262	io= 8.9	0%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 14.814 cm ε_{axial} = 2.3%

Ac = 38.123 cm^2

Vc= 564.74 cm^3 ε_{vol} = 4.2%

Sc = 0.389 cm^{-1} Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	18.96	111.7	93.9	63.6
PreTest	26.97	124.5	98.1	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 ºC: **1.16E-05** cm/sec

(i_o)ave = 8.9

Tested By: DT   Reviewed By: GET

Appendix C

Sludge Sensitivity Analysis

Historic water treatment activities at Climax have produced "process sludge." Some of this sludge has precipitated and settled in the 5 Dam decant pond. The sludge layer is reportedly 1 to 3 feet thick near the upstream end of the current pond (about 1,200 feet from the crest) and increases to approximately 30 feet thick at the back of the decant pond.

Samples of the sludge deposited in Robinson Lake (URS 2002) were collected in 2002 as part of a field investigation. Samples collected for the URS report showed a total unit weight of 73.2 to 73.8 pcf. Torvane testing showed the material had a low shear strength ranging from 1,200 psf to 2,900 psf.

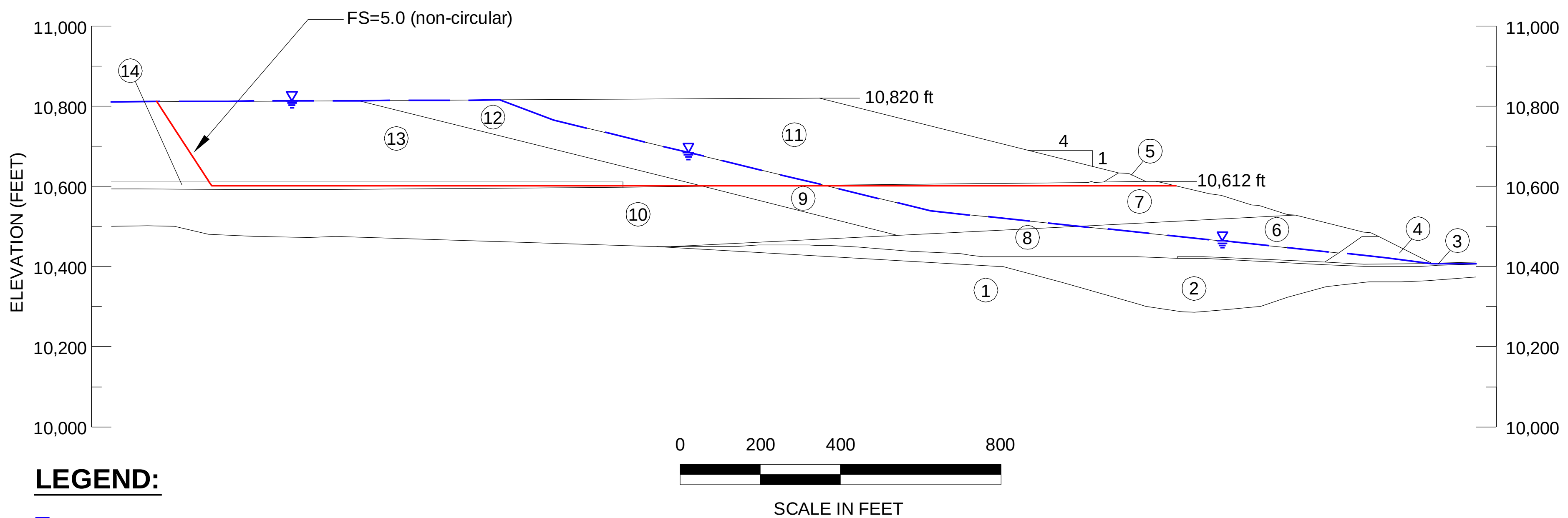
MWH Global Inc. (MWH) performed a stability analysis in 2005 to evaluate additional sludge placement in 5 Dam decant pond (MWH 2005). MWH used a total unit weight of 64 pcf with cohesion varying from 0 to 1,000 psf in their analysis. Climax did not move forward with additional sludge placement into the decant pond.

URS included the sludge layer in our 5 Dam analyses completed in 2007 (URS 2007). The sludge was modeled with a unit weight of 73 pcf and cohesion of only 1,200 psf for steady-state loading conditions, and zero cohesion for undrained and post-earthquake loading conditions.

The sludge layer was not directly included as part of the current stability evaluations presented in Section 7; an undrained/post-earthquake (OBE event) analysis (controlling stability loading case) at the LOM crest (elevation 10,820) was performed to confirm the sludge layer is located at a distance far away enough from the crest as to not impact overall stability of the facility. The calculated FS for the analysis is 5.0 (noncircular failure surface), as seen on Figure C-1. Circular failure surfaces did not reach far enough into the impoundment to intercept the sludge layer. Note that the critical failure surfaces presented within the main body of the text of this report also do not extend far enough back to reach this sludge layer.

URS

No.	DESCRIPTION	UNIT WEIGHT (pcf)	COHESION (psf)	FRICTION ANGLE (degrees)
1	BEDROCK	150	5,000	50
2	FOUNDATION	145	0	35
3	DRAIN	135	0	35
4	STARTER DAM	145	0	35
5	DEPOSITION BERM	115	0	35
6	EXISTING UNSATURATED CYCLONED SAND	115	0	35
7	EXISTING UNSATURATED WHOLE TAILING SAND	115	0	35
8	EXISTING SATURATED CYCLONED SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
9	EXISTING SATURATED WHOLE TAILING SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
10	EXISTING SLIMES	110	Cu/p'=0.40 (TXC); Cu/p'=0.30 (DSS)	
11	FUTURE UNSATURATED WHOLE TAILING SAND	115	0	35
12	FUTURE SATURATED WHOLE TAILING SAND	115	Cu/p'=0.42 (TXC); Cu/p'=0.33 (DSS)	
13	FUTURE SLIMES	110	Cu/p'=0.40 (TXC); Cu/p'=0.30 (DSS)	
14	SLUDGE	73	0	0



LEGEND:

PHREATIC SURFACE
SHEAR SURFACE

NOTES:

1. "FS" DESIGNATES CALCULATED FACTOR OF SAFETY.
2. THE LOCATION OF THE STUDY SECTION IS SHOWN ON FIGURE 3-1.
3. STABILITY ANALYSES WERE PERFORMED USING UTEXAS4 SOFTWARE.
4. PROCESS SLUDGE LAYER INCLUDED IN ANALYSIS.

Job No. :	22243088
Prepared By :	KMM
Date :	SEPTEMBER 2013

5 DAM STABILITY ANALYSIS
ESTIMATED FUTURE CONDITIONS
UNDRAINED/POST-EARTHQUAKE
(OBE)

FIG. C-1