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Siphon Draw Drainage Improvement Project
Geologic Hazard Assessment and
Geotechnical Characterization Report
Contract FCD 2007C012
Maricopa County, Arizona

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Geologic Hazard Assessment and
Geotechnical Characterization Report
Contract FCD 2007C012
Maricopa County, Arizona

Submitted to:

Stanley Consultants, Inc.
Phoenix, Arizona

Submitted by:

AMEC Earth & Environmental, Inc.
Tempe, Arizona

Registered Professional Engineer (Civil)
CERTIFICATE NO.
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9/3/08
Date Signed
ARIZONA, U.S.A.
Expires 12/31/09

September 3, 2008
AMEC Job No. 7-117-001080

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Stanley Consultants, Inc.
1661 East Camelback Road, Suite 400
Phoenix, Arizona 85016

Attn: Michael Lopez, P.E.

Re: Siphon Draw Drainage Improvements Project
Geologic Hazard Assessment and
Geotechnical Characterization Report
Contract FCD 2007C012
Maricopa County, Arizona

Submitted herewith is the Geologic Hazard Assessment and Geotechnical Characterization Report prepared by AMEC Earth & Environmental, Inc. for the above referenced project. Included are the results of an earth fissure and land subsidence geologic hazard assessment, geotechnical test drilling, seismic refraction surveys, laboratory testing, engineering analysis. Also presented are recommended design criteria for drainage improvements.

Should you have any questions concerning the content of this report, please do not hesitate in contacting us.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

Brett Barnlong
for

Kenneth C. Fergason, P.G.
Geologist

Registered Professional Engineer (Civil) CERTIFICATE NO. 40209 BRETT A. HOWEY Date Signed 9/3/08 ARIZONA, U.S.A. Expires 12/31/09

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CD-ROM

CD-ROM Project Photographs and Report

1.0 INTRODUCTION

This Initial Geologic Hazard Assessment and Geotechnical Characterization report is submitted pursuant to completion of a geologic and geotechnical review and appraisal by AMEC Earth & Environmental, Inc. (AMEC) of the Siphon Draw Drainage Improvement Project (Project). This geologic and engineering study was completed for Stanley Consultants, Inc. (Stanley) and the Flood Control District of Maricopa County (District), under Contract No. FCD 2007C012, in its development of the final Project design.

The purpose of the Geologic Hazard Assessment portion of this investigation was to specifically address the impacts of subsidence and earth fissuring on project elements. This investigation included additional search for earth fissures, characterization of known earth fissures and the delineation of subsidence and earth fissuring risk in the project area.

Subsequent to the Geologic Hazard Assessment field work and initial appraisal a failure modes and effects analysis (FMEA) workshop was completed on February 6 and 7, 2008 as part of the pre-design effort for the Project. The goals of the FMEA were to achieve an understanding of the most significant site-specific failure modes and the potential consequences of system failure. AMEC prepared a report (AMEC, 2008)[1] documenting the FMEA and providing recommendations for earth fissure defense mitigation. Defense mitigation alternatives are still being considered by the Project team as part of the final design development. Once a selected mitigation alternative is identified AMEC anticipates revision to the 2008 FMEA report to include the selected alternative. Fissure mitigation alternatives are not discussed within this report.

The purpose of the Geotechnical Characterization appraisal was to examine the geotechnical profile beneath the site and to evaluate the engineering properties of the subsurface materials. This information was used to prepare recommendations related to excavation, structure foundations and other aspects of the project where soil properties or behavior should be considered for design.

2.0 PROJECT DESCRIPTION

The Project is located within western Pinal County and eastern Maricopa County. The Project begins at Meridian Road approximately one (1) mile north of the Elliot Road alignment, and ends at Elliot Road. The Project is a partnership between the District and the City of Mesa (City), and includes a detention basin, maintenance access roads to and around the basins, an approximately 2/3-mile long channel north of the basin along the Meridian Road alignment (Reach 1), and other ancillary flood control structures. The Reach 2 channel, not part of this current project, will extend from Guadalupe Road north an additional ½ mile and will be designed at a later time. Landscaping, irrigation, trails, and other multi-use facilities may be provided along the channel alignment and within the basin.

[1] References are listed at the end of this report.

The purpose the Project is to capture the 100-year flood from the Central Arizona Project (CAP) over chutes, upstream watershed, and some of the Siphon Draw Wash flows, assuming future development and no on-site retention for approximately a 3-square mile area bounded by Meridian Road, Elliot Road, and the CAP; and convey this floodwater to the planned detention basin. Flows along the Meridian Road alignment will be captured by an open channel and directed into a detention basing whereas flows from Siphon Draw Wash will be directly captured by the flood control basin. Basin attenuated flood water will be outlet back into the Siphon Draw Wash west of the project area.

GEOLOGIC HAZARD ASSESSMENT

3.0 INVESTIGATION

The investigative approach for the earth fissure investigation was comprised of four primary elements: 1) review of existing data, including reports, Synthetic Aperture Radar Interferometry (InSAR), and high resolution aerial imagery, 2) ground reconnaissance, 3) seismic refraction profiling, and 4) excavation of test trenches. These elements were utilized in the revision of the previously developed earth fissure risk zones (AMEC, 2006) and the development of mitigative strategies.

3.1 Review of Existing Data

A review of existing data relative to the project was performed. The primary data source utilized was the Preliminary Earth Fissure Risk Zone Investigation Report (AMEC, 2006) and the data sources referenced therein. The reader is referred to that report for further information regarding the geologic and hydrogeologic conditions of the study area, and for discussion regarding the causal mechanisms of subsidence and earth fissuring.

Existing 2007 high resolution aerial photography and historical aerial photography, including imagery from 1937 and 1997, were evaluated for the purpose of identifying features indicative of the presence of earth fissures and updating of previous lineament analysis performed by AMEC (AMEC, 2006). Features included elongated fissure gullies, alignments of potholes and other small depressions, lineations in the vegetative cover, and subtle linear ground features caused by shading. The evaluation was performed using printed hard copies in conjunction with the digital product.

As part of this effort all available InSAR was reviewed. InSAR is a satellite-based remote sensing technology that has the capacity to detect and quantify minute changes in terrain elevation and is of profound significance in delineating the risk associated with subsidence and earth fissuring. InSAR data utilized for this investigation is presented in Appendix B.

3.2 Ground Reconnaissance

With the aid of lineament analyses, InSAR, and previous reports as discussed above, all lineaments and earth fissures within the study area with the potential to impact proposed facilities were visited on the ground. Minor adjustments to the alignment of some of the previously mapped features resulted from the round reconnaissance effort. Reconnaissance was conducted by Kenneth Fergason, P.G. and Kristi Diller, G.I.T., of AMEC. Photographs from site visits and other activities are presented in Appendix A.

3.3 Surface Seismic Refraction Surveys

To evaluate the absence or presence of earth fissuring within the project area, seventy-five (75) 120-foot long refraction seismic surveys were completed along the western edge of the project, and ten (10) 120-foot long refraction seismic surveys were completed at selected locations across the site by AMEC personnel under the field direction of Michael L. Rucker, P.E. (Figures 1 through 5.) Mr. Rucker performed field interpretations of the data as it was collected to identify the presence of seismic anomalies that might indicate the presence of fissuring. A seismic anomaly is identified by a method of visually examining seismic traces for a sudden decrease in signal amplitude (attenuation) and/or increase in arrival time (time offset) of the seismic signal between adjacent geophones.

A Geometrics Smartseis 12-channel signal enhancement seismograph and 12-geophone arrays were used. A sledgehammer energy source was used to collect compression wave (p-wave) data for seismic refraction analysis. Jumping beyond the end geophone array was performed to generate surface wave energy for refraction microtremor analysis to develop a one-dimensional vertical shear wave (s-wave) profile at each seismic line. Appendix C at the end of this report includes a brief description of the seismic refraction equipment and procedures used.

Due to the nature of the geophysical techniques utilized, all depths, locations and velocities presented on the interpretations are approximate. The maximum practical compression wave (p-wave) depth of investigation for 120-foot seismic lines is about 30 to 40 feet. However, actual depths of investigation vary according to the subsurface profile for each line. P-wave depth of investigation interpretations are included in the interpretations, and range from about 15 to 33 feet. Shear wave (s-wave) depths of investigation are typically deeper than p-wave depths of investigation. S-wave depths of investigation are also included in the interpretations, and are greater than 120 feet.

Velocity reversals, where softer, lower-velocity materials could underlie moderate- to higher-velocity materials, would not be detected using the p-wave seismic refraction technique. Significant, relatively large-scale velocity reversals might be detected in the vertical shear wave (s-wave) profile obtained from the refraction microtremor technique. Interpreted subsurface material p-wave velocities from the seismic lines are average values obtained over distances of 10 to 20 feet. Discrete zones of material could have slower or faster velocities, and therefore, be weaker or stronger than indicated by the average velocities interpreted from the seismic data.

Where p-wave results are not available to relevant depths, due to shallow depth of investigation or very low subsurface velocities similar to velocities of sound in air, s-wave results with deeper depth of investigation can be used to estimate corresponding deeper p-wave velocities. Given a typical soil Poisson's ratio of 0.33, a p-wave velocity can be estimated by doubling the corresponding s-wave velocity. Also, in subsurface profiles where the s-wave velocity is considerably less than one-half of the corresponding p-wave velocity, relatively thin horizontal-oriented cementation or the presence of a velocity reversal may be indicated.

Interpreted s-wave ReMi profiles provide a different characterization of high velocity cemented horizons or bedrock compared to p-wave seismic refraction results. Being a one-dimensional vertical profile, each ReMi interpretation is conceptually similar to a boring, where the subsurface profile must be interpolated between adjacent interpretations. Thus, when subsurface interface profiles are be developed using ReMi interpretations, the resulting profiles are much less detailed than a corresponding p-wave seismic refraction profile. Of course, seismic refraction typically can only provide the depth to the highest velocity horizon profile, while ReMi can provide simplified profile interfaces deeper into the geo-material mass. Similarly, in laterally variable profiles, ReMi interpretations may be influenced by low velocity geo-materials adjacent to higher velocity geo-materials. At high s-wave velocities in the deepest portion of the ReMi profile, the interpretation process may become less sensitive to the specific s-wave velocity. Thus, the deepest s-wave velocities must be considered to be very approximate.

3.4 Test Trench Excavation

Based on the results of the seismic refraction profiling, an optional task to excavate 125 lineal feet of test trenches was initiated. Four (4) test trenches were excavated at the known earth fissure and at seismic anomalies identified by the seismic profiling. A change order was approved to excavate an additional five (5) test trenches (approximately 150 lineal feet) to address additional seismic anomalies identified, for a total of nine (9) test trenches. The locations of the test trenches are shown on Figures 1 through 5, and on Sheet 1. Excavation of the test trenches were in a benched fashion, with the first bench established at a depth of approximately 4 feet, followed by a vertical–walled, 4-foot excavation keyed into the floor of the initial excavation. Upon completion of the field investigation, the test trenches were backfilled with compacted excavation spoils by District personnel.

The alluvial deposits exposed on the walls and upper benches of each excavation were characterized in regard to their pedological and geological properties. Particular attention was paid to the stages of carbonate cementation and soil development. As depicted in Appendix D, a standardized system of logging the trenches was employed utilizing the Unified Soil Classification System (USCS) (ASTM Designation D2487), a carbonate morphology classification system originally developed by Gile and others (1981), and modified soil horizon descriptions presented by Birkeland (1999). One wall of each trench was logged, with selected portions of each excavation photographed. To remove any machine effects, trench surfaces were cleaned, largely along the floor of the upper bench and within the wall of the lower, narrow trench. As described in the discussion below, detailed logging of the test trenches was impacted

by rain events. Logging of the test trenches was performed by Ms. Diller and Mr. Fergason and reviewed by Mr. Fergason. Trench logs are presented in Appendix D, and all photographs are included on the CD-ROM at the end of this report.

4.0 DISCUSSION

The previous AMEC (2006) report indicates that the proposed basin and channel system lie within a moderate to high earth fissure risk zone and that the southwestern-most earth fissure (southwestern fissure) in the known SRP fissure complex trends toward the proposed basin location (Figure 1). A second known earth fissure (eastern fissure) is located east of the southwestern fissure, trending north and south. Also identified were a number of lineaments that may be associated with earth fissuring. In the time since the AMEC (2006) report, the Arizona Geological Survey (2008) has released the Earth Fissure Study Area Map for Apache Junction, covering the study area. The earth fissures identified in this investigation are consistent with this publication.

4.1 Results of Lineament Analysis

Examination of historical aerial photography from 1937 showed that a majority of the identified lineaments were present at that time, which is presumed to be prior to the initiation of subsidence sufficient magnitude to cause earth fissuring. Other lineaments as determined by field inspection are local erosional features, generally appearing to be anthropogenic in origin. Therefore the identified lineaments were determined to not be associated with earth fissuring.

4.2 Results of InSAR Analysis

The InSAR data presented in Appendix B was used to generate two (2) profiles (Profiles A and B on Figure 1) showing subsidence that has occurred in the study area since 1992. These profiles are presented in Figures 6 and 7. The InSAR data along Profile A is orientated north-south along Meridian Road and indicates that a maximum of approximately seven (7) inches of subsidence has occurred in the vicinity of the proposed basin since 1992; however, it is noted that the InSAR coverage is not continuous over that time with a gap of about two (2) years occurring between 2000 and 2002. This contrasts with the four (4) to five (5) inches of subsidence that occurred during that same time period at the north end of the proposed Reach 1 Channel. Profile B is oriented east-west along Elliot Road and indicates that approximately five (5) inches of subsidence has occurred since 1992 south of the proposed basin.

In areas experiencing differential subsidence, grades can be altered. This affect is particularly noticeable in long, linear flood control facilities. The proposed basin location is generally subsiding at the same rate throughout the basin area and is small enough that if differential subsidence were to occur it would not likely affect the performance of the basin. The length and linear nature of the Reach 1 Channel make it potentially susceptible to grade change from differential subsidence. The past subsidence observed through InSAR (Figures 6 and 7) indicates that subsidence that has occurred in the past has increased the grade along this

proposed channel. It is anticipated that if subsidence continues into the future that this pattern will continue.

4.3 Results of Seismic Refraction Surveys

The initial seventy-five (75) seismic refraction surveys identified six (6) anomalies. Five (5) of the six (6) identified anomalies were characterized as weak anomalies and one (1) was characterized as a strong anomaly. Strong seismic anomalies are generally considered to have a greater probability of resulting from the presence of a soil discontinuity than weak anomalies. The optional ten (10) seismic lines identified three (3) additional weak seismic anomalies, two (2) along the projection of the southwestern fissure and one (1) at the southernmost surficial indication of the eastern fissure. Several geologic conditions are recognized as potential sources of seismic anomalies. In addition to the presence of soil discontinuities and ground strain, these conditions include dipping stratigraphic beds, sub-vertical cementation variations, and abrupt compositional changes such as buried channel deposits.

A few days prior to performing the optional seismic lines, a rain event occurred where 2 to 3 inches of rain fell in the Apache Junction area. This event extended the surficial expression of the southwestern fissure approximately an additional 250 feet from the end of the previous surficial expression identified in the previous AMEC (2006) investigation (Figures 1 and 2). This extension occurred toward the southwest, which is approaching the location of the proposed basin. No change was observed in the eastern fissure.

4.4 Results of Test Trench Analysis

Nine (9) test trenches were excavated by District operators and equipment as part of this investigation. Test Trench TT-1 was excavated a few feet beyond the end of the extended surficial expression of the southwestern fissure (Figure 1). Test Trenches TT-2 and TT-3 were excavated at seismic anomalies about 250 and 550 feet, respectively, beyond along the fissure's projection. Test Trenches TT-4 through TT-9 were excavated at seismic anomalies along the long north-south oriented seismic profile, with TT-4 excavated at the strong seismic anomaly. One weak seismic anomaly was not trenched. This anomaly is located at the southernmost surficial indication of the eastern fissure, and is removed from proposed project elements.

Test Trench TT-1 was excavated at the end of the surficial expression of the southwestern fissure with the intent of observing the character of the earth fissure in cemented soils. After excavation of the trench and prior to detailed logging, a rain event occurred that initiated lateral flow in the southwestern fissure, filling trench TT-1 with water. Water remained ponded within the excavated trench and did not drain through the earth fissure, indicating a lack of connectivity between the earth fissure and the test trench. Over a period of five (5) hours, the water level in the trench fell about 0.27 feet (about 3¼ inches), indicating a relatively low infiltration rate. The water was pumped out of the trench by District personnel and the trench was re-excavated with a backhoe to flatten the trench side slopes for safety and to re-establish the use of the trench for

investigation. The amount of moisture in the trench as a result of flooding prevented detailed logging of soil discontinuities and observation of the fissure at depth. Nevertheless, the observed interaction of the water within the trench and the subsurface provided valuable information.

No evidence of earth fissuring was identified in Test Trenches TT-2 through TT-9. Test Trenches TT-2, TT-3, and TT-6 through TT-9 were also excavated at times when rain events either flooded or partially flooded the trenches. Logging sufficient to identify trench stratigraphy and determination of the presence or absence of earth fissures was accomplished, but logging detailed enough to identify subtle soil discontinuities and evidence of strain was prevented by the level of moisture in the soil. Test Trenches TT-4 and TT-5 were not inundated with water.

In summary, the southwestern fissure (see Figures 1 and 2) trends toward the proposed basin. Field observations show that this fissure extended an additional approximately 250 feet toward the proposed basin after a single rain event. Two (2) seismic anomalies were identified along the trend of the fissure, though no fissuring was evident in Test Trenches TT-02 and TT-03 excavated at these locations. No other earth fissures were found in proximity to the proposed Project elements.

4.5 Fissure Risk Zones

The earth fissure risk zonation presented in the previous AMEC (2006) report was updated based upon the findings of this investigation. As depicted on Figure 8, the following is offered as definitions of four (4) earth fissure risk zones in order of decreasing hazard:

- **Zone 1 (Red)** - Earth fissures are present or have a high probability of being present at this time, and will likely continue to develop in the future, as evidenced by multiple investigative methods including published and un-published mapping, photo lineament analysis, InSAR data and patterns, subsidence history, and ground reconnaissance.
- **Zone 2 (Orange)** - Conditions for the development of earth fissures are present through multiple lines of evidence; however, earth fissures have not been positively identified. A high probability for the future development of fissures exists, and there is a distinct possibility that concealed earth fissures are present. Evidence supporting the possible presence of concealed fissures and the probability for future fissuring includes the proximity to and trends of known earth fissures, InSAR data and patterns, subsidence history, and the distribution and orientation of photo-lineaments.
- **Zone 3 (Yellow)** - A moderate probability of future earth fissure formation is present, if future differential subsidence occurs, coupled with the current elevated state of horizontal, tensional strain. Evidence supporting this designation includes InSAR data and patterns, subsidence history, and photo-lineament analysis.

- **Zone 4 (Green) -** A low probability of future earth fissure formation exists in Zone 4. Evidence suggests that no significant tensional strain will develop from the occurrence of future subsidence following current patterns.

The observation of the extension of the southwestern earth fissure by about 250 feet following a rain event provides direct evidence that there is a high probability of continued extension of this fissure to the southwest. Therefore, a significant portion of the proposed basin falls within Zones 1 and 2. Reach 1 of the proposed Meridian Channel falls within Zone 3 and no elements of the project are in Zone 4.

The earth fissure risk zones presented in this report are empirically derived through multiple lines of evidence including but not limited to published earth fissure maps, photogeologic analysis, InSAR, field reconnaissance, seismic refraction profiling, other available data, and the professional opinion of Arizona registered geologists. The results do not represent a quantifiable probability.

4.6 Future Subsidence

Future subsidence is in large part dependent upon future groundwater levels. If the groundwater decline were to stop at the present time, subsidence would likely proceed into the future at a reduced rate. If groundwater withdrawal continues, subsidence would likely occur into the future at rates that are related to the groundwater decline and physical properties of the subsurface geologic profile.

Well data presented in the previous AMEC (2006) report shows that the groundwater in the vicinity of the study area is currently declining at a rate of about 1 to 5 feet per year. Future groundwater elevation simulations recently published by ADWR (Hipke, 2007) indicate that an additional decline of 50 to 400 feet groundwater elevation will likely occur in the vicinity of the study area by the year 2100. This indicates that subsidence has the potential to continue to occur into the future.

Accurately predicting future subsidence with any measurable precision is a challenging effort. Subsidence is dependent upon the physical characteristics of the underlying alluvial materials as well as the behavior of the groundwater system. Uncertainties in the data and unknowns associated with future groundwater declines impact our ability to predict future subsidence occurring for any given groundwater drop. Additionally, without more accurately knowing what the future groundwater decline might be, it is very difficult, with confidence, to predict future subsidence that may adversely impact operation of the Siphon Draw flood control project. As engineers and geologists our best means of assuring safe operation is to design and consider some reasonable amount of future subsidence as a guide, then monitor for continued long-term safety.

4.7 Monitoring and Instrumentation

Recent experiences with risk assessments related to earth fissuring has shown that scheduled surveillance and monitoring reduce risk. Therefore, it is recommended that a monitoring and instrumentation program be implemented in areas of moderate to high fissure risk for the purpose of providing a means in which to reduce risk to flood control facilities. This risk reduction will be realized by quantifying the rate and distribution of ground deformation in the vicinity of the facilities.

Various methods of monitoring relevant to the Project include conventional and advanced techniques. The conventional techniques include the use optical leveling, GPS surveys, geologic ground reconnaissance, and photogeological analysis. Advanced techniques include the processing and interpretation of InSAR imagery, and photo-lineament analysis of low sun angle or high-resolution color aerial photography.

Development of a comprehensive monitoring system will occur in a separate task of this design project once all project elements are well defined. Design considerations will include location, types of monitoring instrumentation, and the procedural components of the monitoring system, including methods of measurement, monitoring frequency, precision minimums and action initiation thresholds.

GEOTECHNICAL CHARACTERIZATION

5.0 INVESTIGATION

5.1 Field Investigation Preparation

The boring locations were initially identified by AMEC and a boring location plan was provided to the District and the City for review and comment. Limited modifications to the boring location plan were required. Subsequent to approval of the boring location plan AMEC staked the boring location in the field prior to starting the drilling program. Blue Stake was contacted and the borings were cleared of underground utilities prior to starting the drilling program.

5.2 Exploratory Drilling

Twenty-five (25) borings (BH-1 to BH-25) were advanced to depths of 15 to 25 feet below existing site grades. All test borings were advanced utilizing a CME-75 drill rig equipped with 6 5/8-inch hollow stem auger. Standard penetration testing and open-end drive sampling were performed at selected intervals in the borings. The soils encountered during drilling were continuously examined, visually classified and logged by Mark Keyes, P.G., and Emily Corkery, E.I.T., with AMEC, in accordance with American Society of Testing and Materials (ASTM) and AMEC guidelines.

Boring logs are presented in Appendix E, along with descriptions of drilling techniques, a summary of the Unified Soil Classification System (USCS) (ASTM D2487), and an explanation of the terminology used in describing the soils. The locations of the borings are shown on Sheet 1 in the enclosed map pocket.

5.3 Laboratory Testing

Laboratory testing of representative soil samples recovered from the borings was performed to characterize the physical properties of the soil and rock and the geotechnical conditions of the site subsurface. The following tests were performed:

- Sieve analysis in accordance with ASTM D-2487.
- Liquid limit and plasticity index in accordance with ASTM D4318/ASTM D-2487.
- Moisture content in accordance with ASTM D2216 and ASTM D2937.
- Moisture-density relationships in accordance with ASTM D698.
- One-dimensional consolidation in accordance with ASTM D2435.
- Corrosion potential testing (total soluble sulfates and chlorides) in accordance with Arizona Test Methods 733 and 736.

All testing was performed by AMEC, with the exception of total soluble sulfates and chlorides, which were tested by Motzz Laboratory, Inc. of Tempe, Arizona. Copies of the laboratory reports are included in Appendix F.

5.4 Surface Seismic Refraction Surveys

As discussed in the Geologic Hazard Assessment section of this report eighty-five (85) refraction seismic surveys were completed along the western edge of the project to evaluate the absence or presence of earth fissuring. Ten (10) of these lines (Lines 16, 22, 25, 28, 31, 34, 36, 39, 56 and 69) were fully interpreted for geotechnical characterization. Results of the interpreted refraction seismic surveys are presented in Appendix C.

6.0 SITE CONDITIONS AND GEOTECHNICAL PROFILE

6.1 Geotechnical Profile

The soils encountered within the borings at the site generally consist of silt and silty sand within the upper 3 feet. Below 3 feet the soils are predominantly a mixture of clay, sand, sandy clay and clayey sand. In general the near surface soils are predominantly medium to coarse grained, subangular to subrounded, uncemented, light brown, and exhibit low plasticity. These soils are typically soft to moderately firm. The underlying clay and sandy clay soils are predominantly fine to medium grained, subangular to subrounded, uncemented to moderately cemented, and light brown to reddish brown in color. These soils typically exhibit low to medium

plasticity and are firm to hard. The sand and clayey sands are predominantly well graded, subangular to subrounded, uncemented to weakly cemented, light brown to brown, and exhibit low plasticity to no plasticity. These soils are typically firm to hard and medium dense to very dense.

To assist in the development and design of earth fissure mitigation a geologic characterization profile was completed. Geotechnical information from borings BH-7 through BH-21 and seismic refraction profile Lines 16, 22, 25, 28, 31, 34, and 36 were utilized. An approximate transition between very erodible near surface soils and less erodible underlying soils was interpreted and depicted on the profile. The interpreted geologic characterization profile is shown on Sheet 2 in the enclosed map pocket.

6.2 Results of Refraction Microtremor Investigation

In general, a layer of very low velocity material is indicated to be present along most of the seismic lines to typical depths of about 1 to 5 feet. This surficial horizon has a range of compression wave (p-wave) velocities less than 1,000 feet per second (f/s), and shear wave (s-wave) velocities less than 500 f/s. Such material velocities are consistent with surficial soils that are typically uncemented (Stage I cementation, see Rucker and Fergason, 2006). At some lines, such as Line 36 and parts of Lines 16, 39 and 56, an interpreted surficial horizon p-wave velocity of about 1,100 f/s may be due to the picking of the air wave sound of the hammer striking the target plate rather than p-wave energy traveling through the ground. At Lines 16, 36 and 39, the depth of this 'air wave' horizon may extend as deep as about 10 feet. Underlying the surficial horizon, material p-wave velocities range from 1,200 to 2,700 f/s and s-wave velocities range from about 600 to 1,200 f/s. Such material velocities are consistent with uncemented (Stage I cementation) materials to weakly cemented (Stage II cementation) geo-materials. Stronger materials, with p-wave velocities in the range of 2,200 to 3,300 f/s and s-wave velocities of about 1,100 to 1,600 f/s, (Stage II to III cementation) are interpreted to underlie portions of the subsurface profiles beginning at typical depths of about 10 to 15 feet.

Interpreted s-wave profiles indicate that the higher velocity horizons are underlain by uncemented to weakly cemented (Stage I cementation) materials with typical s-wave velocities of about 740 to 840 f/s, and occasionally about 1,100 f/s, beginning at approximate depths of about 18 to 23 feet. This low seismic velocity horizon is interpreted to extend to depths of about 40 to 60 feet. Finally, a deep, high s-wave velocity horizon is interpreted to begin at depths of about 40 to 60 feet.

6.3 Seismic Velocity, Excavatability and Erodability

Seismic propagation velocities, including p- and s-waves, are a function of the low-strain (dynamic) modulus or moduli of the material mass through which the seismic waves propagate. Since s-waves are minimally affected by fluid saturation, they are especially useful in characterizing material mass strength in the presence of fluid saturation. Stronger (higher modulus) material masses are more resistant to excavation or erosion than weaker material

masses. Estimated ranges of hydraulic stream power needed to initiate head cutting erosion in various strength cemented soil to soft or weak clastic rock geo-material masses are summarized in Table 1. Details presented in Table 1 may vary somewhat for other geo-material types. In Table 1, material mass strength is quantified through seismic velocity or the Kirsten Excavatability Index (Kirsten, 1982, 1988).

Annandale (1995) reviews determination of stream power as a function of hydraulic flow conditions. For purposes of comparison and correlation, ranges of hydraulic stream power are compared to excavation equipment needed to perform effective excavation as estimated (quantified) by seismic p-wave velocities. Annandale (1995) presents relations of stream power to initiation of head cutting erosion through an erodability index based on the Kirsten excavatability index for geo-materials. Procedures to determine erodability index for geo-materials, initially for dam spillway design applications, have been established and published by the National Resource Conservation Service (NRCS, 2001) utilizing the Kirsten concepts and procedures.

Correlations of seismic velocity with other geotechnical parameters useful for geotechnical design or assessment have also been performed (Rucker and Fergason, 2006). Because of the potential for velocity reversals that could hide underlying lower velocity (lower strength) horizons from p-wave seismic refraction, such correlations need to be based on s-wave velocity profiles where significant velocity reversals can be identified and quantified.

6.4 Moisture Sensitive Soils

Ten (10) consolidation/collapse tests were completed on samples from ten (10) of the borings. The test results indicate the native soils below the site have a high collapse potential upon wetting. The testing indicated a range in collapse potential of 0 to 8.0 percent for samples having dry densities of 85 to 110 pcf, and in situ moisture contents of 3 to 7 percent.

6.5 Soil Moisture and Groundwater Conditions

Measured moisture contents of the soils were described as moist to slightly moist near the surface and slightly moist at depth. Laboratory moisture contents varied from 2 to 12 percent below 4.5 feet. Depths to groundwater are estimated to be approximately 500 feet below ground surface (ADWR, 2005).

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 Support for Inlet and Outlet Structures

7.1.1 Design Criteria for Downward Loads

Allowable bearing pressures and immediate settlement estimates for spread-type or mat-type foundations bearing on the native site soils and structural backfill were developed using SPT results corrected for overburden pressure and field procedures; methods of estimating elastic

settlement for rectangular, rigid footings as presented in Bowles (1982); and estimates of elastic modulus developed using correlations with SPT blow count and typical values for similar soils presented in Bowles (1982), AASHTO (2002, Article 4.4.7) and Kulhawy and Mayne (1990). Allowable bearing pressures were estimated for the case of limiting the settlement of the structure footing to 1 inch in the computations.

The location of the resultant of pressure on the base of footings should be maintained within the middle one-third of the footing at its base (Article 4.4.7 of AASHTO, 2002). The allowable bearing pressure should account for the depth of embedment of footings; therefore, it is recommended that the weight of any soil directly above the footing, the weight of the structure and the weight of the foundation concrete be summed to calculate footing dimensions according to the recommended allowable pressure. A unit weight of 115 pcf should be used to represent the structure backfill soil above the top of footings.

Presented below are the recommended uniform allowable bearing pressures as a function of the bearing depth of the footing for use in design of spread-type or mat-type foundations.

Recommended Equivalent Uniform Allowable Bearing Pressures (Dead Plus Live Loads) for Design of Foundations

Structure Type and Location	Approximate Footing Bearing Elevation (feet)	Allowable Bearing Pressure (psf)
Box Culvert Meridian Channel Future Guadalupe Rd Crossing	1503.0	3,500
Box Culvert Meridian Channel Inlet	1492.0	3,000
Box Culvert Siphon Draw Basin Outlet	1490.0	3,000
Energy Dissipater Siphon Draw Inlet	1490.0	3,500

The above allowable bearing pressures are based on the assumption that footings are a minimum of 2 feet below the lowest adjacent finished grade.

Footings should not be placed on or above the silty soils that exhibit high collapse potentials. These soils are typically located in the upper 10 feet of the geologic profile from the middle of the basin to the end of the Meridian Channel. At the southern end of the project from about mid-basin to the southern edge of the basin the collapsible soils may be as deep as 25 feet. Based on the 30 percent design drawings the high collapse potential soils will be removed during excavation to meet design grades at both Meridian Road box culvert locations, and thus do not require special treatment. The foundation soils for the Siphon Draw basin outlet box culvert and the inlet dissipater require removal and replacement with suitable material prior to construction of the structure. A minimum of 5 feet (to about elevation 1485.0) of existing

foundation material below these two structures should be removed and replaced with structural fill compacted to a density of at least 95 percent of maximum dry density and to within 2 percent of the optimum moisture content as determined in accordance with ASTM D698.

The final bearing surface for the foundations should be observed by a qualified Geotechnical Engineer to confirm the anticipated bearing stratum. If unexpected or inadequate bearing strata or loose or soft zones are encountered they should be over excavated and replaced with suitable material at the direction of the Geotechnical Engineer.

7.1.2 Estimated Settlements

The allowable bearing pressures presented herein were estimated assuming a maximum settlement of 1 inch. Settlement is anticipated to be immediate and should be essentially complete upon application of the initial live load. Moisture increases in supporting soils could result in further long-term settlements.

7.2 Resistance to Lateral Loads

The passive resistance against the edges of footings and other vertical foundation elements, in contact with properly compacted structure backfill or native site soils, should be considered as being equal to the force exerted by a fluid pressure of 300 psf per foot of depth for footings constructed at a depth of at least 3.0 feet below existing or finished grade, whichever is lower. A coefficient of friction of 0.35 is recommended for computing the lateral resistance between the bases of footings and the soil when analyzing lateral loads. This value may be increased to 0.45 if passive resistance, when existing, is neglected.

7.3 Lateral Earth Pressures

The lateral earth pressure acting on retaining walls will depend upon the degree of restraint. Rigid, absolutely restrained walls will be subjected to at-rest earth pressures represented by a triangular hydrostatic load diagram of 55 psf per foot of depth for level structure backfill. Rotation or lateral translation of the walls equal to or greater than about 0.001 times the height of the wall will reduce earth pressures to the active state, represented by an equivalent fluid pressure of 35 psf per foot of depth for level backfill. Wall backfill should consist of structure backfill as outlined below; thus, cohesionless backfill parameters of a friction angle of 36 degrees and moist (compacted) unit weight of 125 pcf were assumed in estimating the earth pressures.

A safety factor of 2.0 for long-term loads should be used in the analysis of lateral loads with respect to overturning of walls, and a FOS of 1.5 should be used for sliding (Article 5.5.5, AASHTO, 2002). The resultant of forces transmitted to the wall footing should be maintained within the middle third of the footing at its base.

7.3.1 Salt River Project Crane Surcharge Loading

AMEC understands that the channel lining must be designed to withstand a surcharge load applied by a crane outrigger to allow periodic overhead electric line servicing by Salt River Project (SRP). The anticipated surcharge loading will be a maximum of 320 pounds per square inch (psi) on a 27 inch diameter outrigger pad.

To assess the loading imposed by the surcharge AMEC utilized two methods to develop two design charts (Figures 9 and 10). For a crane surcharge within a distance of two times the anticipated channel depth (7 feet) the surcharge was considered to be finite in area, whereas for a surcharge positioned greater than two times the channel depth an infinite area surcharge was utilized. The finite area method tends to be overly conservative at a distance of two times the channel depth. Design Figures 9 and 10 may be utilized to determine lateral earth pressures for varying distances from the channel edge.

7.4 Structure Backfill Requirements

Free-draining granular backfill should be utilized behind any walls up to an elevation equal to 2 feet below adjacent finished grade. The grading requirements for the free-draining backfill material as determined by ASTM C136, should be as follows:

Sieve Size (square openings)	Percent Passing by Weight
3 inch	100
¾-inch	60-100
No. 8	35-80
No. 200	0-12

The plasticity index of the fraction of material passing the no. 40 sieve should be no more than 5 when tested by ASTM D4318.

Some blending of materials may be required where coarser or finer grained and higher PI soils are encountered. Where predominantly finer-grained soils are present, imported soils from other areas of the project meeting the above requirements should be utilized.

Granular material should be placed in lifts no thicker than 1.0 foot and mechanically compacted. If the gradation of the fill is generally fine enough to permit testing by conventional means, the fill should be compacted to a density of at least 95 percent of maximum dry density and to within 2 percent of the optimum moisture content as determined in accordance with ASTM D698.

7.5 Cut-slope and Trench Stability

7.5.1 Temporary Cut-Slopes

It is recommended that temporary cut slopes be made no steeper than 1.5H:1V (horizontal to vertical). These recommended slopes are based on the weakly cemented to uncemented noncohesive materials encountered in the borings and OSHA requirements. Classification of these soils, as based on OSHA requirements, is Type C. Steeper temporary excavations, including those to employ trench shoring, should be made only if based on stability analyses by a registered geotechnical engineer. The analysis should take into account the slope angles, trench geometries, and any surcharge loadings due to equipment and spoil piles.

It is recommended that heavy equipment (trackhoes, cranes or other heavy equipment) be no closer than 10 feet from the crest of the slope of excavations. Spoil piles should be located no closer than 6 feet from the crest of the slopes. Large particles, including large clods, should be kept away from the crest of the slopes. Moisture increases in the soils will weaken them and could cause slope failures. The soils in the slopes and directly beneath the slopes should be maintained at or below current moisture conditions. Some localized raveling could occur as the exposed soils dry. The excavations should be protected from stormwater runoff or other sources of moisture. Small berms may be necessary to protect the excavations from storm runoff. If the soils are subjected to moisture increases, the stability of the slopes should be re-evaluated.

7.5.2 Permanent Cut-Slopes

Static stability analysis of a proposed typical cut section along the Meridian Channel alignment was performed using the computer program PCSTABL6 (Purdue University, 1999) and conservative soil strength parameters. PCSTABL6 is a software product that uses limit equilibrium theory to compute the factor of safety of earth and rock slopes. The factors of safety presented herein were computed using the Modified Bishop Method of Slices, which is conservative in comparison to solutions obtained by other limited equilibrium methods.
The purpose of the stability evaluation was to asses the steepest cut slope currently under consideration for the Meridian Channel. The slope geometry analyzed was a 10-foot high 2:H:1V (horizontal to vertical) cut with a 250 psf surcharge applied to the top of the slope, 5 feet from the edge of the slope, to account for potential Operation and Maintenance vehicle traffic adjacent to the channel. The minimum factors of safety for the most critical failure surfaces were determined for static conditions using the program's search features. The analyses indicate that an adequate factor of safety (FS = 2.2) is obtained with a slope of 2H:1V. Cut slopes at or flatter than 2H:1V are acceptable from a slope stability standpoint.

7.5.3 Trench Stability

Excavation of vertical sided trenches to depths of approximately 20 feet may be required to construct fissure mitigation. A simplified assessment of the trench wall stability was performed

utilizing conservative soil strength parameters and a construction surcharge of 250 psf applied for a width of 11 feet, 10 feet from the trench sidewall. Results of our assessment and experience with vertical sidewall trenches in similar soil conditions indicates the site soils will allow excavation to 20 feet below ground surface (bgs) without the need for lateral support. However, soils conditions can be quite variable outside the areas of our direct investigation. Minor sloughing and localized instability could occur. The duration associated with having an open trench should be minimized as much as possible.

It is recommended that heavy equipment (trackhoes, cranes or other heavy equipment) be no closer than 10 feet from the sidewalls of the trench excavations. Spoil piles should be located no closer than 15 feet from the edge of the excavations. Moisture increases in the soils will weaken them and could cause side-wall failures. The soils in the trench sidewalls should be maintained at or below current moisture conditions. Some localized raveling could occur as the exposed soils dry. The trenches should be protected from stormwater runoff or other sources of moisture. Small berms may be necessary to protect the excavated trenches from storm runoff. If the soils are subjected to moisture increases, the stability of the slopes should be re-evaluated.

7.6 Excavatability

The soils encountered at the sites vary somewhat in firmness, with the majority of the soils being very firm to hard. Most of the firm soils encountered were due to the presence of some cementation (Stage I to III). Site soils at the depths of the planned project excavations (0 to 15 feet bgs) exhibited p-wave velocities less than 1,000 feet per second (f/s) near surface to 3,300 f/s at depths from 10 to 15 feet. Based on the in situ condition of the soils, normal equipment may be used to excavate to the full depth in most areas such as a CAT D6 dozer or CAT 325BL track hoe. Possible heavier equipment may be required in areas where increased cementation is encountered or deeper trenching is required. However, during excavation moderate to significant caving or sloughing of soils should be anticipated.

7.7 Estimated Earthwork Factors

Earthwork factors were estimated based on evaluation and analysis of data from several test borings and results of laboratory tests (moisture-density relationship and dry density) performed on representative samples of the site soils.

Twenty-eight (28) dry density tests of open-end drive samples and three moisture-density relationships (ASTM D698, standard Proctor) on bulk samples were performed. The dry density test samples were obtained throughout the projects site. The moisture-density test samples were obtained within the basin limits.

Standard Proctor maximum dry densities ranged from 117 to 123 pcf; the average of all the tests was 120 pcf, with a standard deviation of 3.4 pcf. It is AMEC's assumption that the excavated material will not be utilized as structural fill. Therefore, the material will not be

compacted to the typical 95 percent values usually associated with structural fill placement. However, it is assumed that the material will be subjected to some compactive effort during spoiling and/or stockpiling adjacent to the project. For calculation purposes, 102 pcf, or 85 percent of the average maximum dry density, was utilized in the earthwork factor determinations.

In order to determine the shrink/swell values across the entire project, the dry density test values were sorted by depth into 5-foot intervals and compared with the 85 percent average maximum dry density value. The following equation was used:

$$\% \text{ Shrink} = \left[1 - \frac{\gamma_{ex}}{\gamma_{emb}}\right] \times 100$$

where: γ_{ex} = in place dry density of material to be excavated

γ_{emb} = dry density of compacted embankment fill

Based on the above-described computations the following earthwork factor is recommended for use on the project for excavation:

Recommended Earthwork Factors

Geologic Unit	Earthwork Factor
Upper Basin and Channel Soils	5% shrink

7.8 Corrosion Potential

Relative to potential for attack of concrete by site soils, eight soluble sulfate tests were performed on samples of site soils recovered from selected test borings in accordance with Arizona Test Method 733, which tests for the water-leachable or "available" sulfate content. Total soluble sulfate values ranged from between 2 to 195 parts per million (ppm). These results were compared to Table 4.3.1 (Requirements for Concrete Exposed to Sulfate-Containing Solutions), specifically the "Sulfate (SO_4) in water, ppm" column in the table, in Section 4.3 of the American Concrete Institute (ACI) Manual of Concrete Practice (ACI 318/318R, 2001). Seven of the eight test results were found to be “negligible” in terms of sulfate exposure, indicating that Type I or Type II Portland cement would be adequate for concrete structures in contact with these materials. However, one sample from boring BH-8 at a depth of 14.5 feet indicated a “moderate” sulfate exposure, indicating that Type II, IP(MS), IS(MS), P(MS), I(PM)(MS), or I(SM)(MS) Portland cement would be required to protect against corrosion.

Chloride test results for soils encountered during the investigation ranged from 9 to 93 ppm. Regarding chloride attack, Section 4.4.2 of ACI 318/318R (2001) indicates that when concretes are exposed to external sources of chlorides, the water-cementitious materials ratio, concrete strength, and minimum concrete cover requirements should be evaluated by the designer. The magnitude of the concentration of chloride in the external source is not specified by ACI.

8.0 REFERENCES

AMEC Earth & Environmental Inc. (AMEC), 2008. Siphon Draw Drainage Improvement Project Failure Modes and Effects Analysis Report, Maricopa County, Arizona. Prepared for the Flood Control District of Maricopa County on Behalf of Stanley Consultants, Inc, Contract FCD 2007C012, AMEC Job No. 7-117-001080, March 10.

AMEC Earth & Environmental Inc. (AMEC), 2006. Preliminary Earth Fissure Risk Zone Investigation Report, Hawk Rock Study Area, Maricopa and Pinal Counties, Arizona. Prepared for the Flood Control District of Maricopa County, Contract FCD 2006C005 Work Assignment 2, AMEC Job No. 6-117-001053, September 25.

American Association of State Highway and Transportation Officials (AASHTO), 2002, Standard Specifications for Highway Bridges, Seventeenth Edition, Washington, D.C.

American Concrete Institute (ACI) Manual of Concrete Practice, 2001, "Use of Concrete in Building Design, Specifications and Related Topics", 318/318R.

Annandale, G.W., 1995, Erodibilty, Journal of Hydraulic Research, Vol. 33, 1955, No. 4.

Arizona Department of Water Resources (ADWR), 2005, Maps showing groundwater conditions in the Phoenix Active Management Area, Maricopa, Pinal, and Yavapai Counties, AZ- Nov. 2002-Feb 2003, HMS No. 35

Arizona Geological Survey, 2008. Earth Fissure Map of the Apache Junction Study Area, Maricopa and Pinal Counties, Arizona, Arizona Geological Survey Digital Map Series - Earth Fissure Map 2 (DM-EF-2), Tucson, Arizona, April.

Birkeland, P.W., 1999. Soils and Geomorphology; Oxford University Press, New York.

Bowles, J.E., 1982, Foundation Analysis and Design, Third Edition, McGraw-Hill Book Co., New York, New York.

Caterpillar Tractor Company, (Cat), 1984, Caterpillar Performance Handbook, Edition 15, Peoria, Illinois, October.

Caterpillar Tractor Company, (Cat), 1993, Caterpillar Performance Handbook, Edition 24, Peoria, Illinois, October.

Caterpillar Tractor Company, (Cat), 2001, Caterpillar Performance Handbook, Edition 31, Peoria, Illinois, October.

Gile, L.H., Hawley, J.W., and Grossman, R.B., 1981. Soils and geomorphology in the Basin and Range area of southern New Mexico – Guidebook to the Desert Project, New Mexico Bureau of Mines and Mineral Resources Memoir 39.

Hipke, Wesley, 2007. East Valley Water Forum Scenarios for the East Salt River Valley Sub-basin an Application of the Regional Groundwater Flow Model of the Salt River Valley, Arizona, Arizona Department of Water Resources Modeling Report 17, Phoenix, Arizona, April.

Kirsten, H.A.D., 1982, A classification system for excavation in natural materials: Civil Engineer in South Africa, 24(7), 293-308.

Kirsten, H.A.D., 1988, Case histories of groundmass characterization for excavatability, *in* Kirkaldie, L, Rock Classification Systems for Engineering Purposes, ASTM STP 984: American Society for Testing and Materials, Philadelphia, Pennsylvania, 102-120.

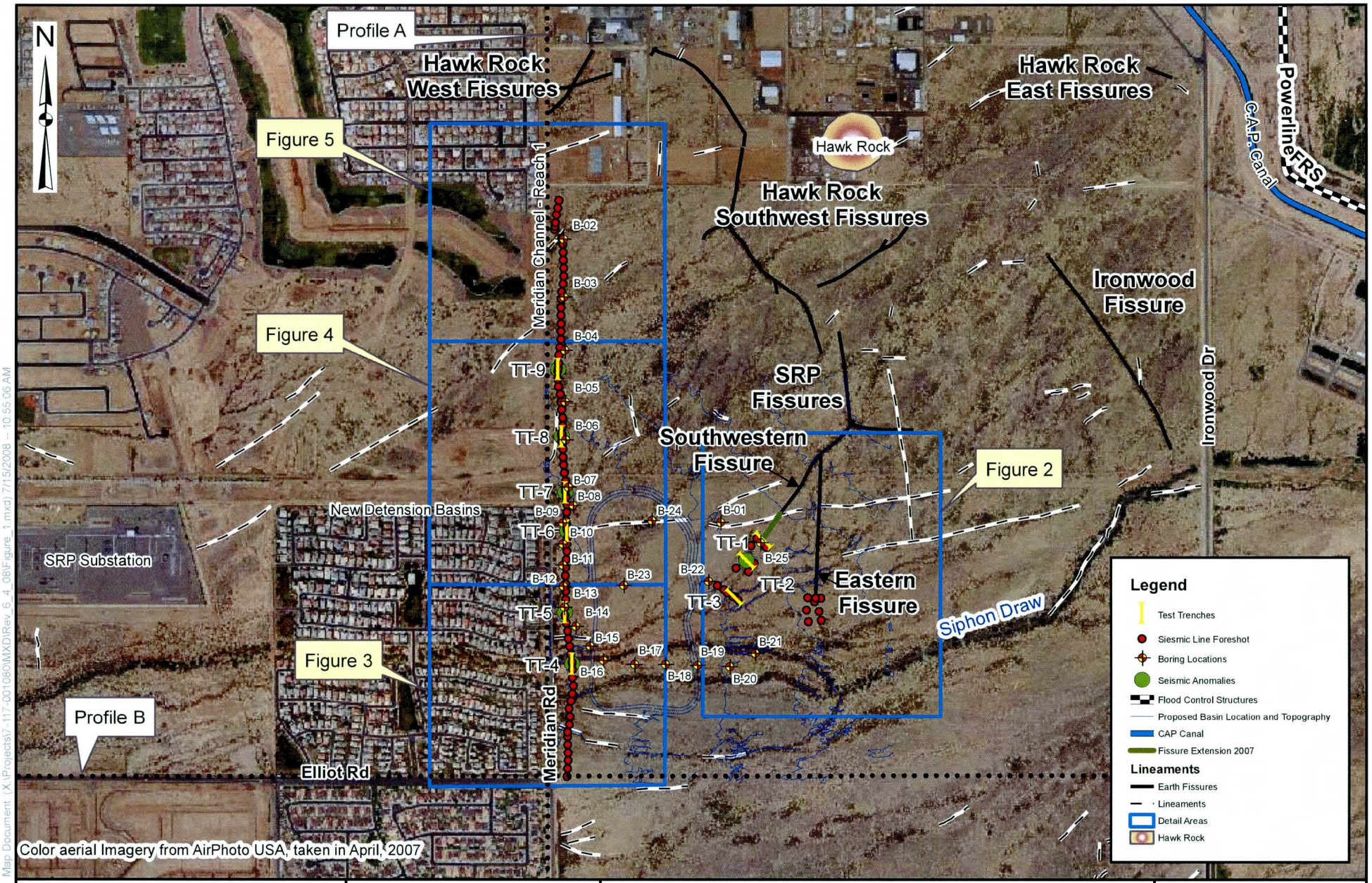
Kulhawy, F.H. and Mayne, P.W., 1990, Manual on Estimating Soil Properties for Foundation Design, Electric Power Research Institute, Palo Alto California, prepared by Geotechnical Engineering Group, Cornell University, Ithaca, New York, Final Report, Report No. EL-6800, August.

NRCS, 2001, Field procedures guide for the headcut erodability index, Chapter 52, Part 628, National Engineering Handbook: U.S. Department of Agriculture Natural Resources Conservation Service, 210-VI-NEH, rev. 1, March.

Purdue University, 1999, Users Manual for PCSTABL6, West Lafayette, Indiana.

Rucker, M.L. and Fergason, K.C., 2006, Characterizing unsaturated cemented soil profiles for strength, excavatability and erodability using surface seismic methods, in Unsaturated Soils, Miller, G.A., Zapata, C.E., Houston, S.L. and Fredlund, D.G., eds, Geotechnical Special Publication No. 147, ASCE, Reston, Va., pp. 589-600.

FIGURES



0 500 1,000 2,000 Feet

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GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

Site Plan

FIGURE
1

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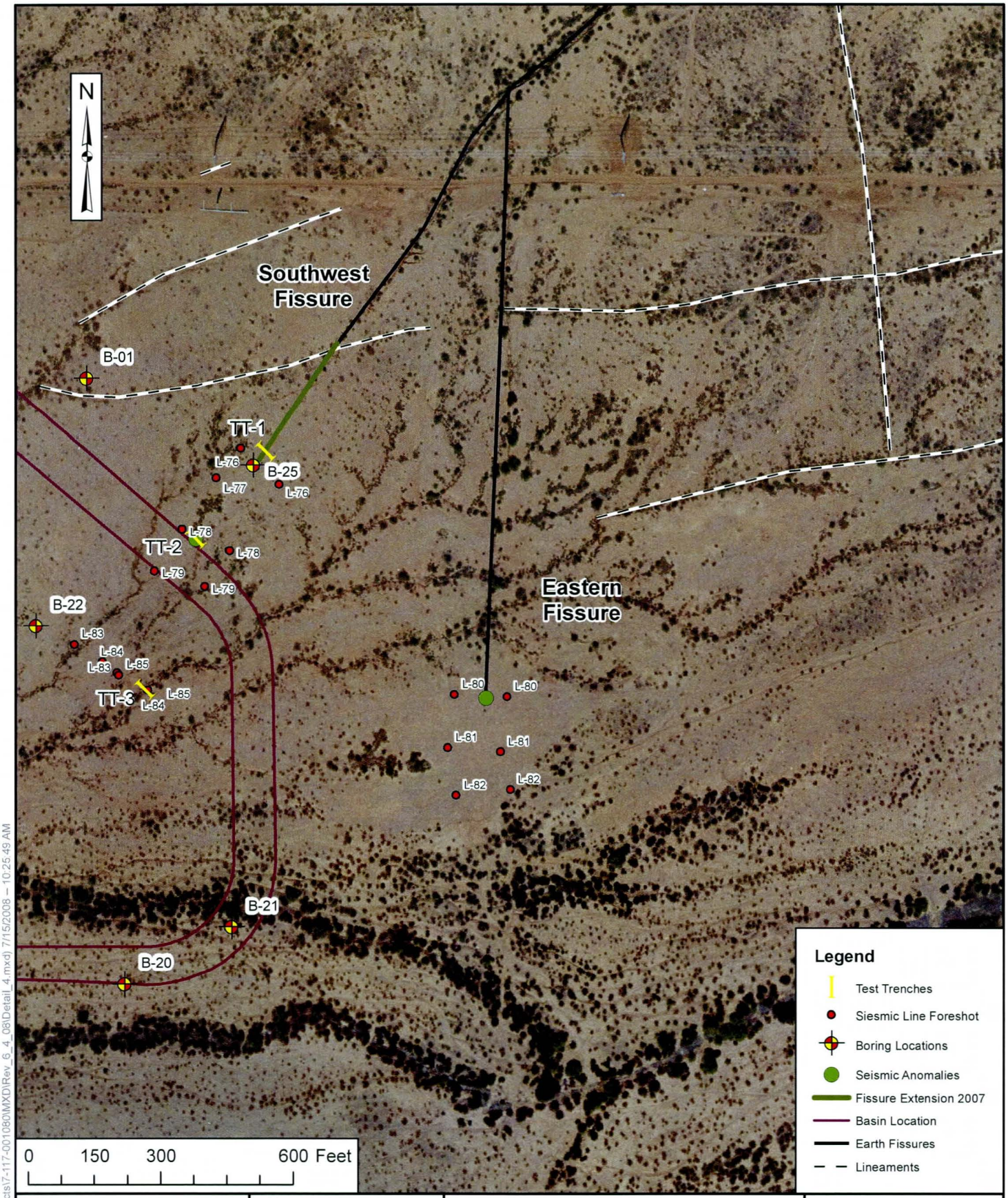

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DETAIL 1

FIGURE **2**

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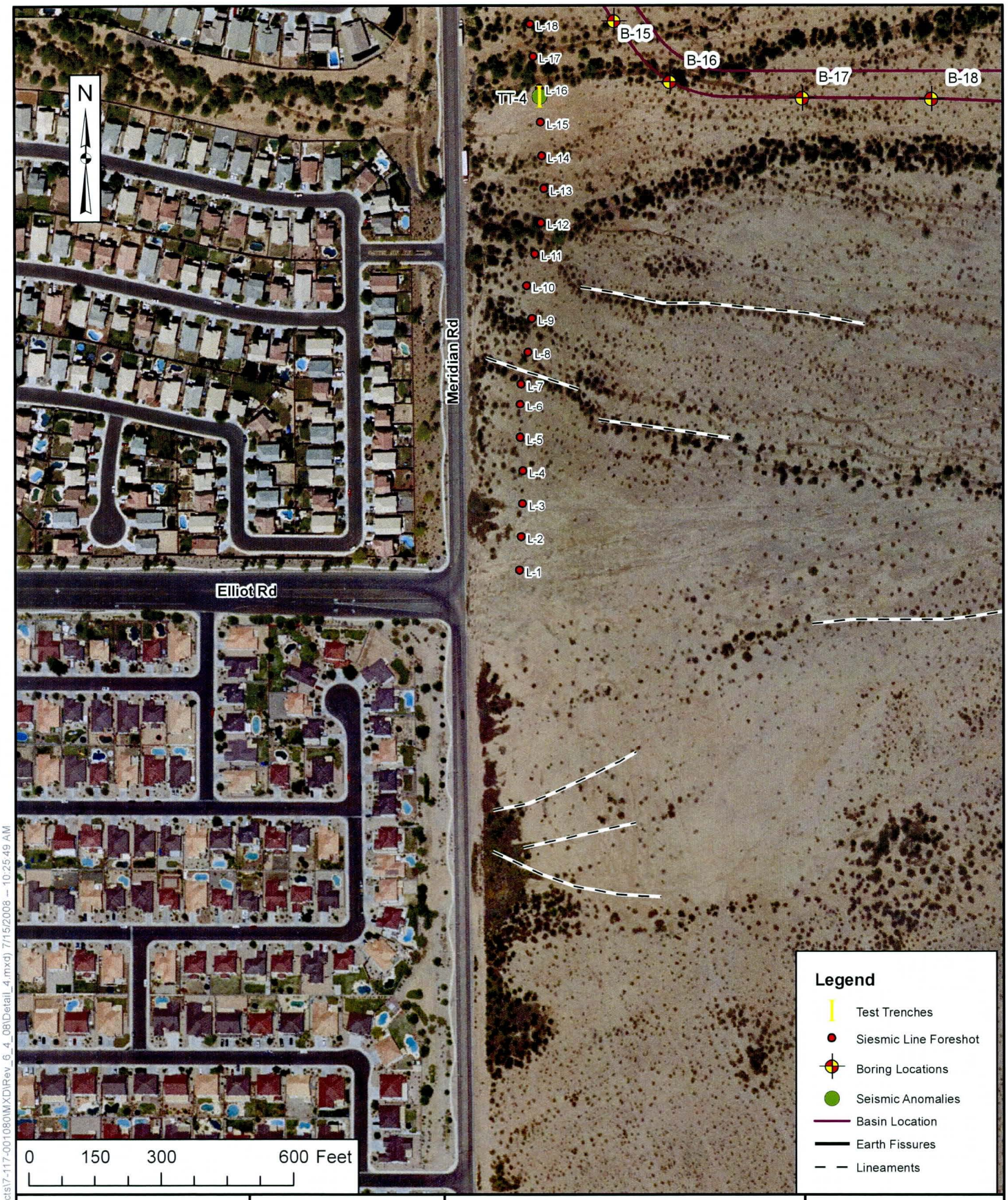

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DETAIL 2

FIGURE 3

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DETAIL 3

FIGURE **4**

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DETAIL 4

FIGURE **5**

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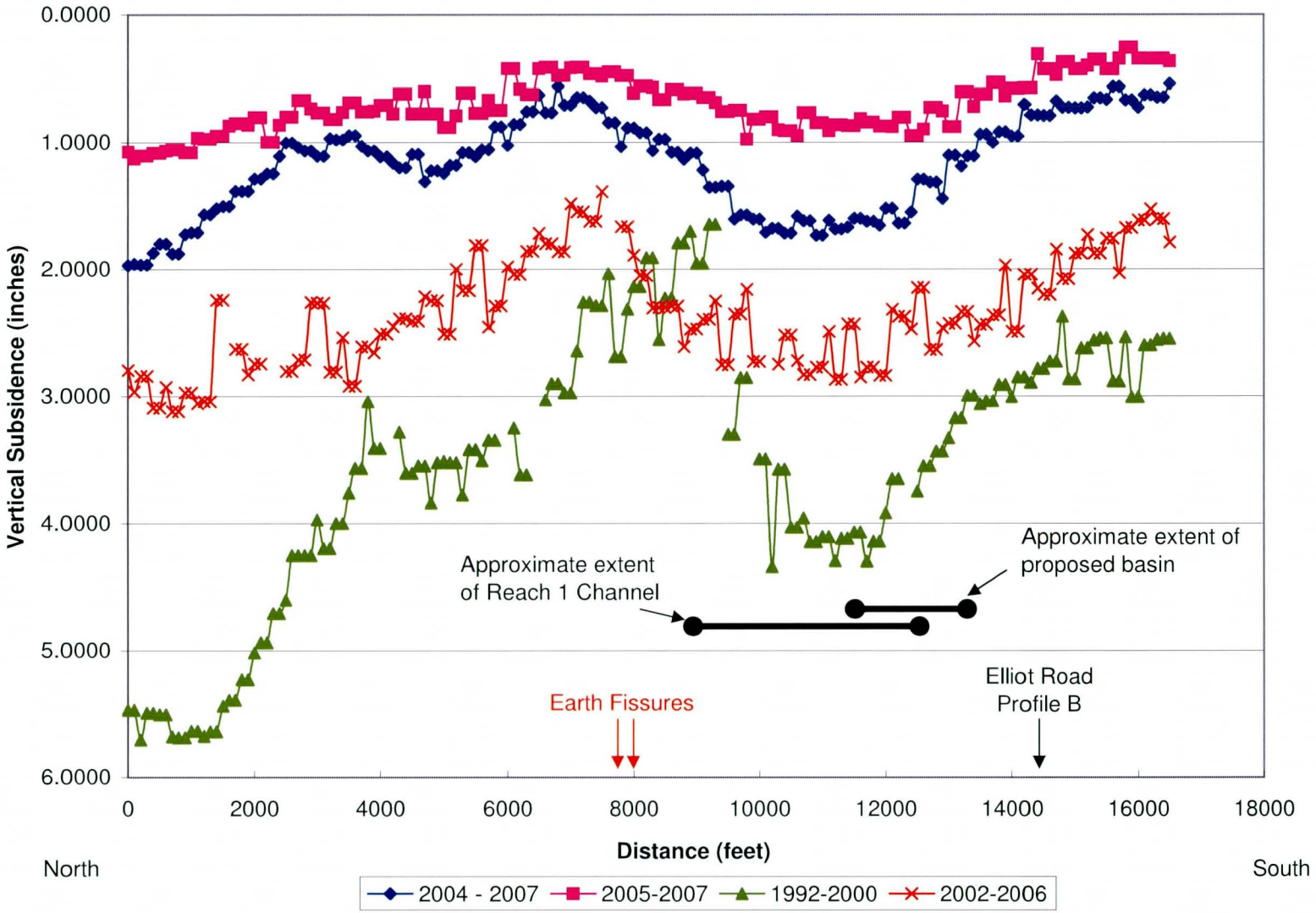
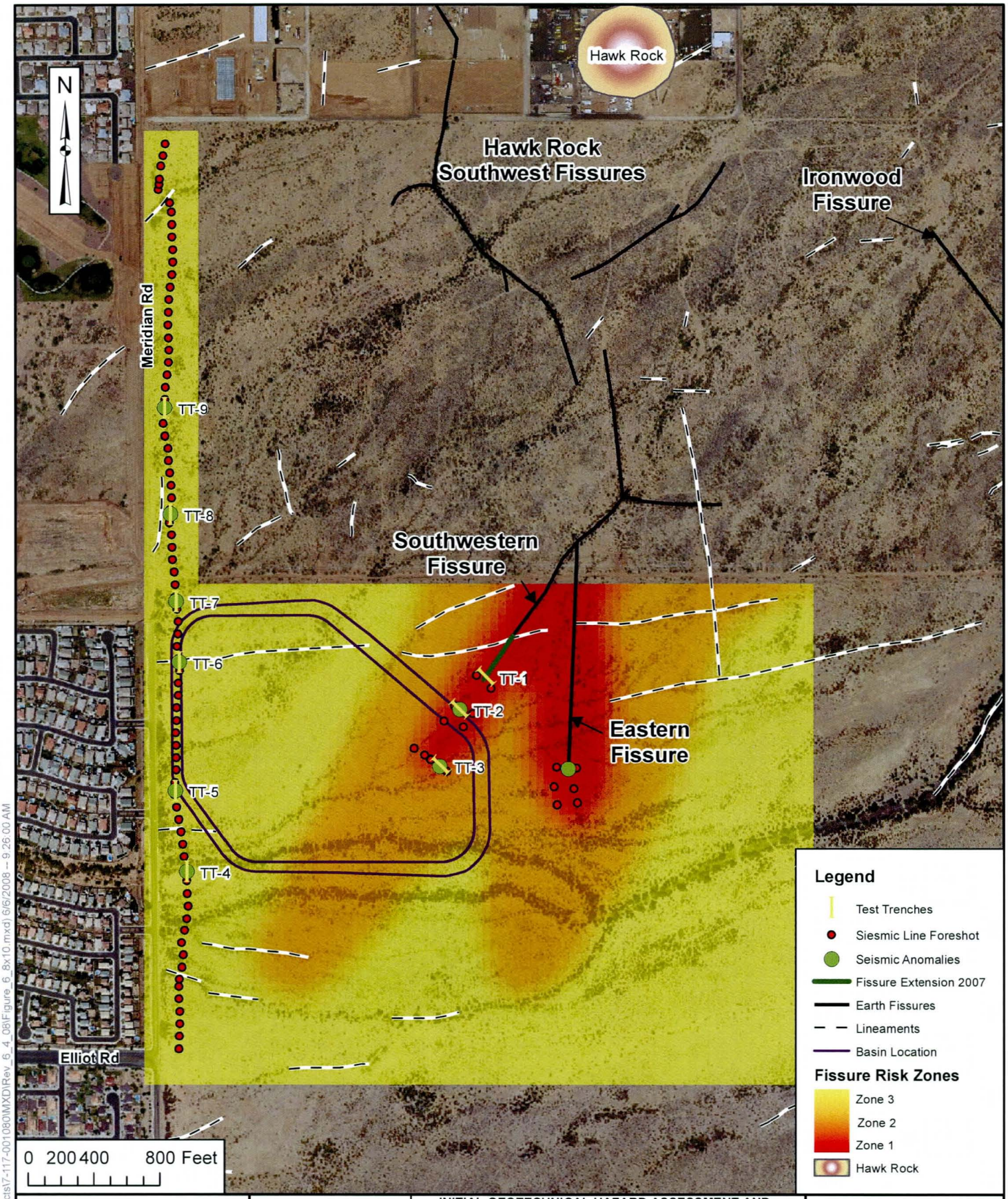
Figure 6
InSAR Profile A
Meridian Road





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Earth Fissure Risk Zones

FIGURE
8

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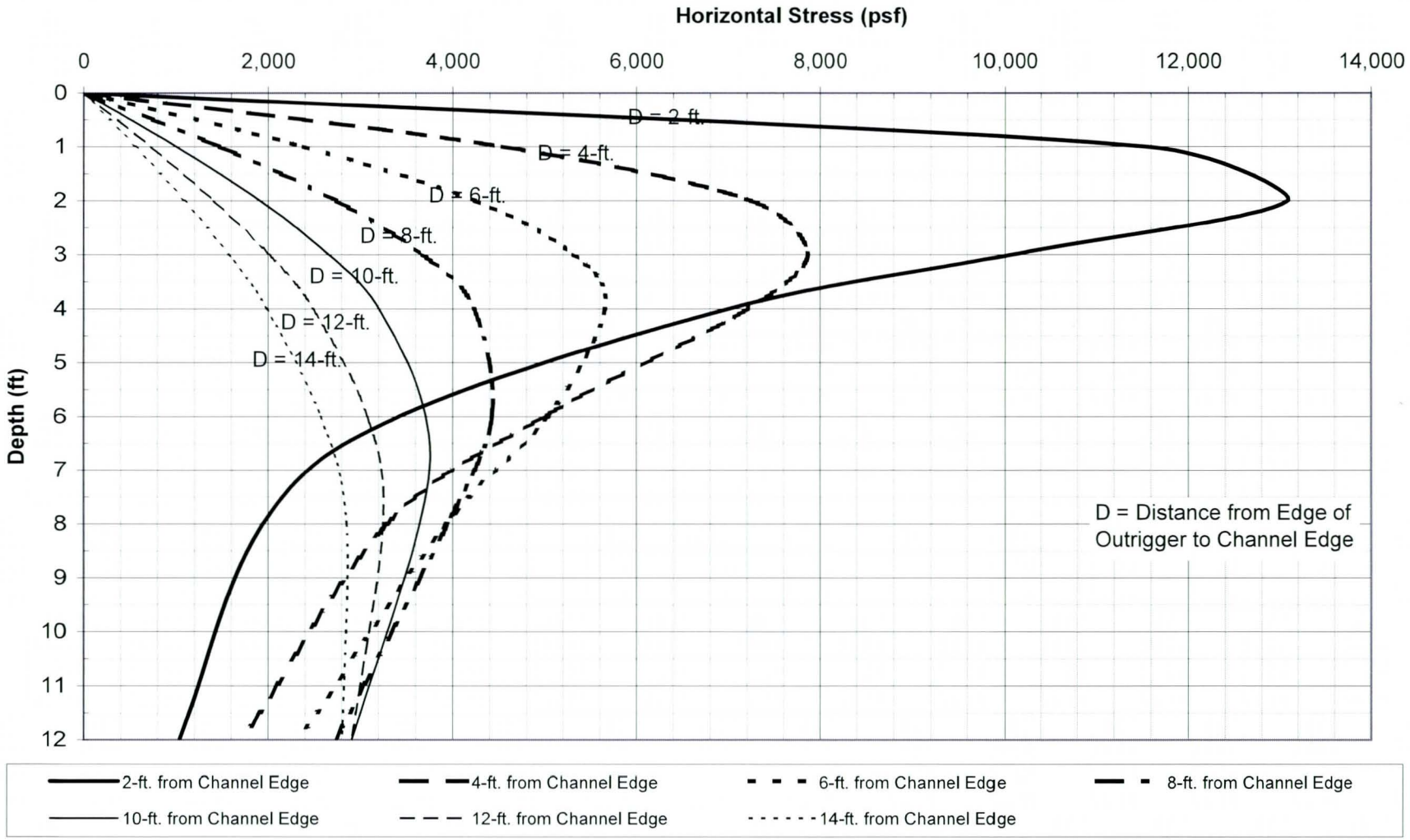
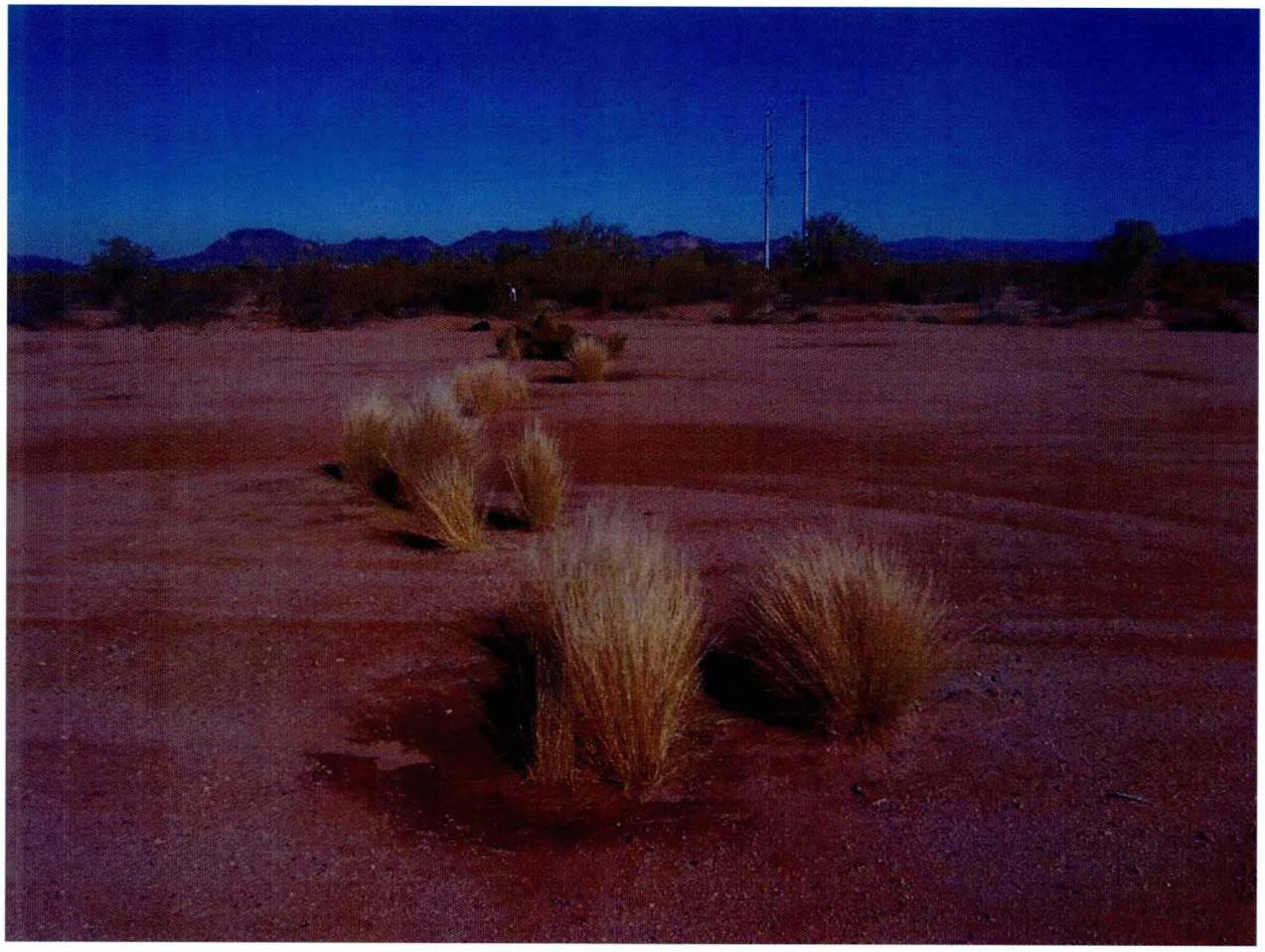
FIGURE 9
Lateral Earth Pressures - SRP Crane Loading
(Edge of outrigger 2 to 14 feet away from channel edge)



Select Photographs

Southwest Fissure – 2007 extension. View to the southwest.

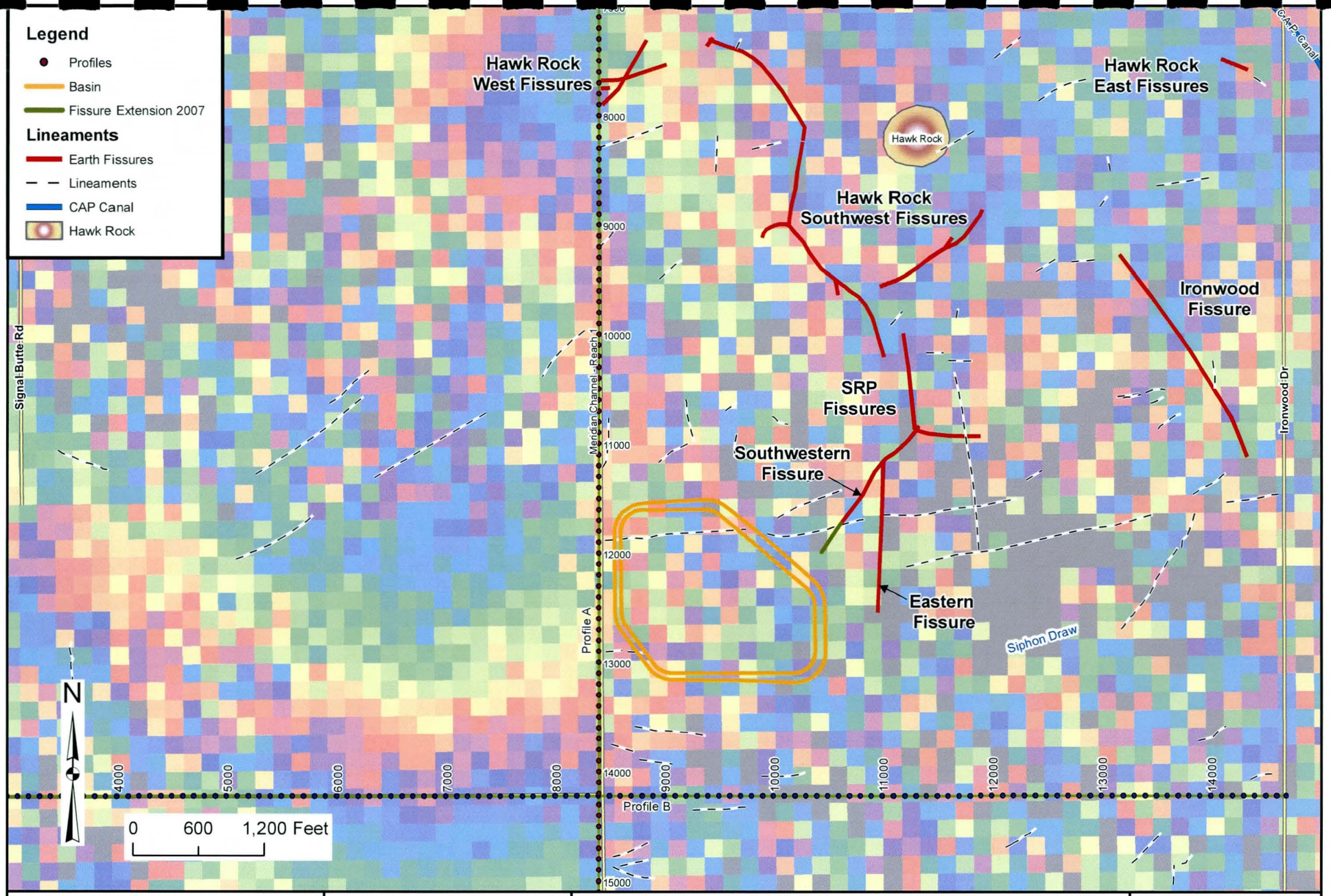
Southwest Fissure – 2007 extension and TT07-01. View to the southwest.



Southern extent of Eastern Fissure. View to the north.

APPENDIX B

INSAR



InSAR for the Period from October 2002 to December 2006
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

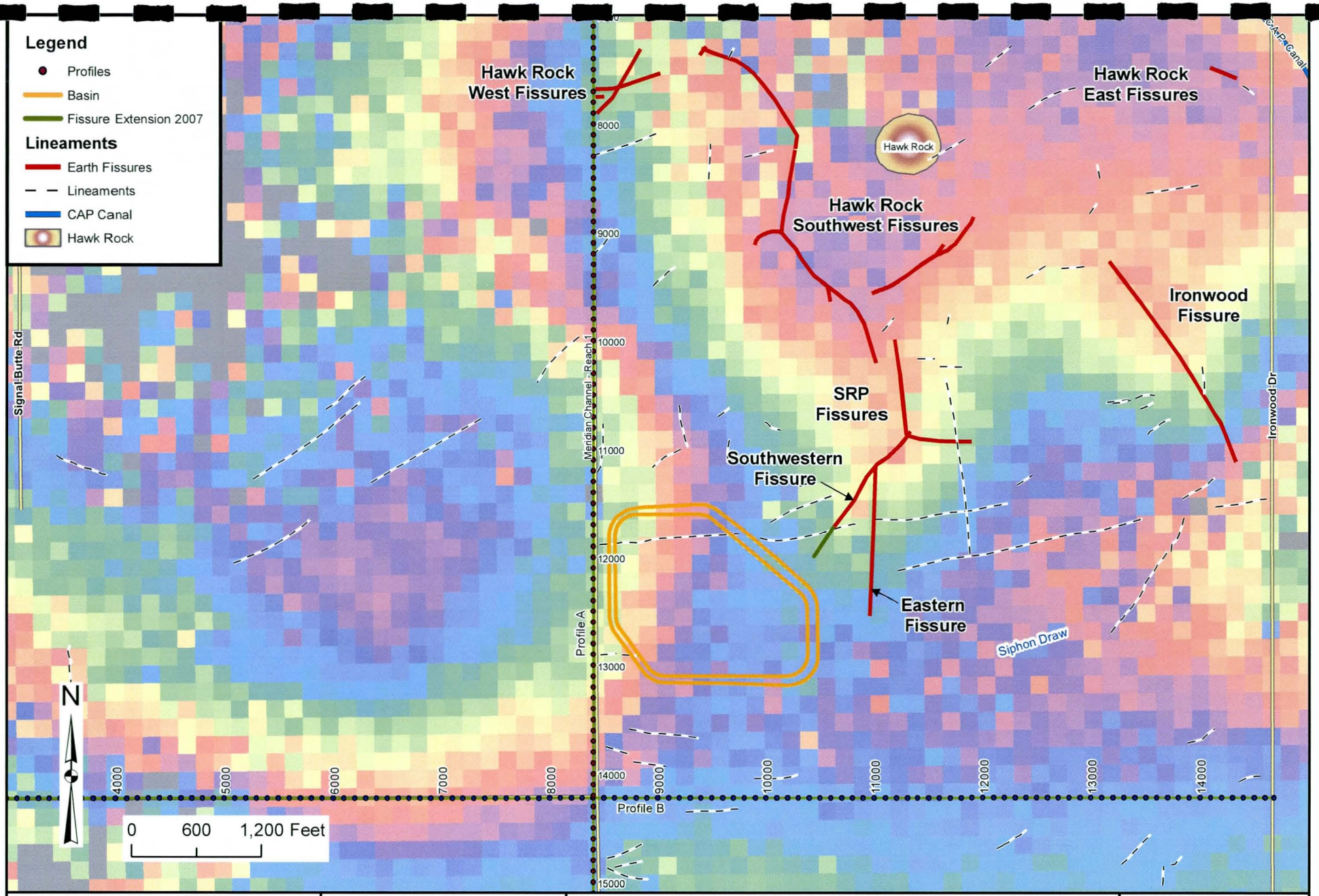
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2002 - 2006

FIGURE
B-1

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2002_2006.mxd)
7/10/2008 -- 4:12:02 PM



InSAR for the Period from October 2004 to January 2007
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

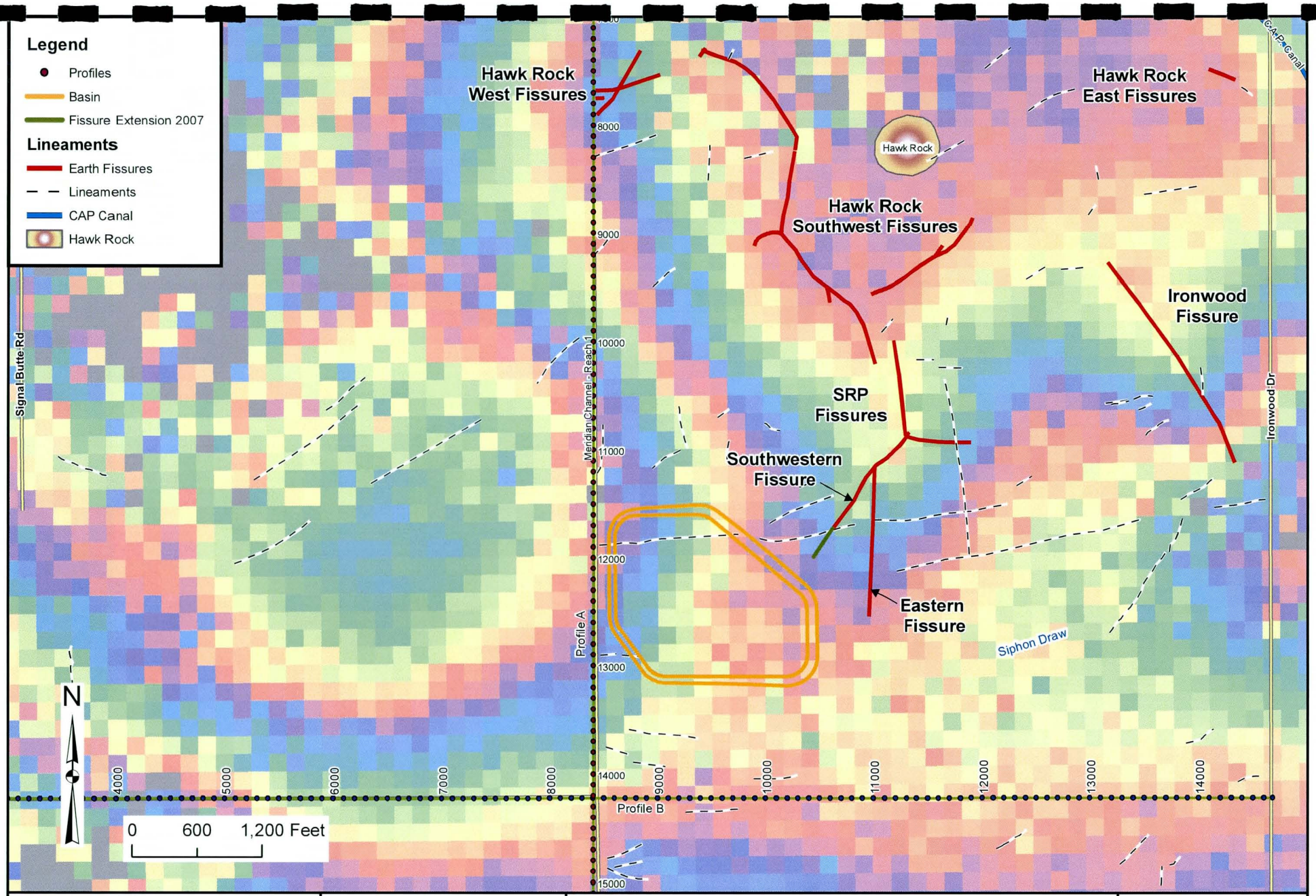
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2004 - 2007

FIGURE
B-2

amec

Map Document (X:\Projects\7-117-001080\MXD\InSAR_2004_2007.mxd)
7/10/2008 -- 3:45:18 PM



InSAR for the Period from October 2004 to April 2008
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

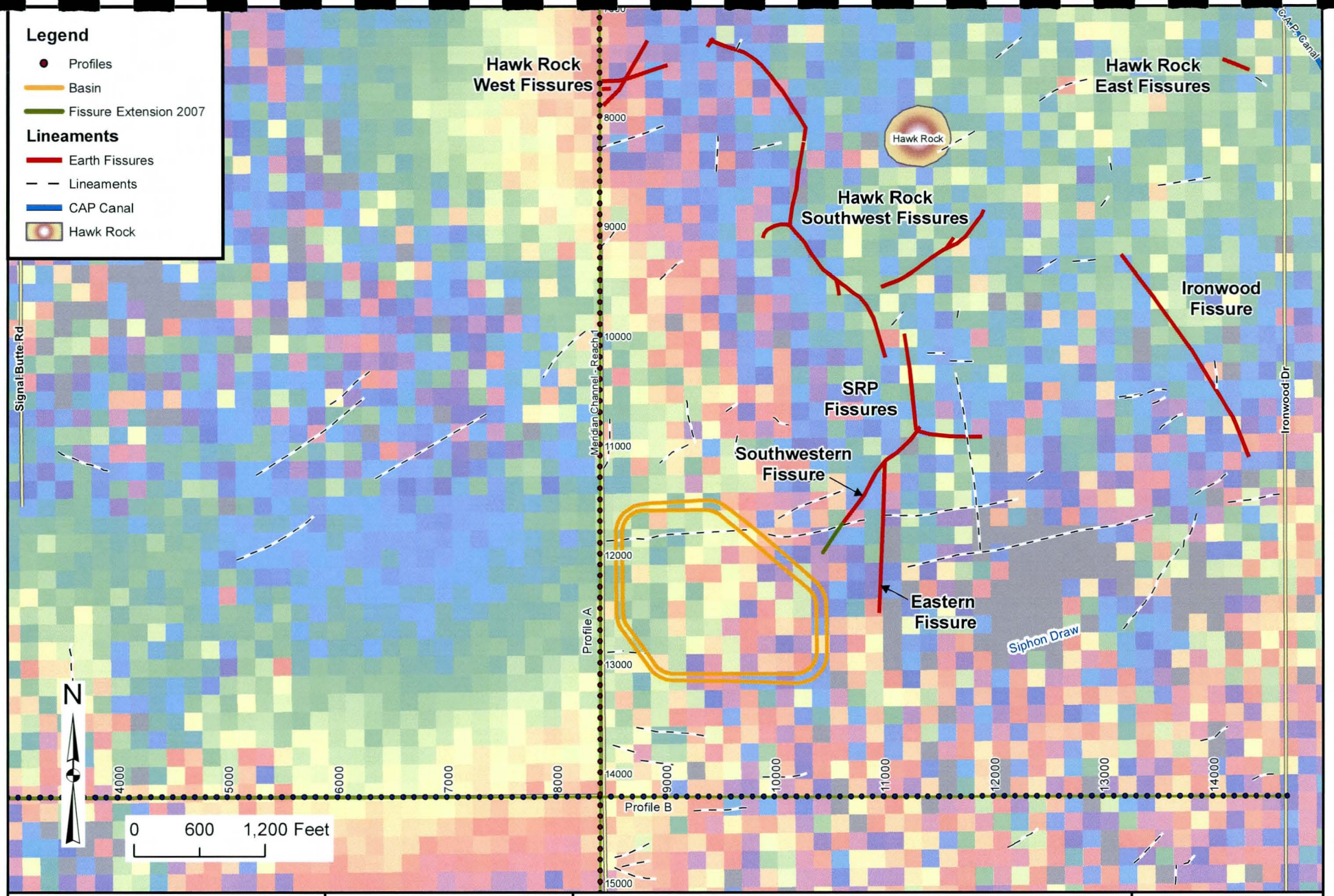
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2004 - 2008

FIGURE
B-3

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2004_2008.mxd)
7/10/2008 -- 4:33:50 PM



InSAR for the Period from February 2005 to December 2006
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

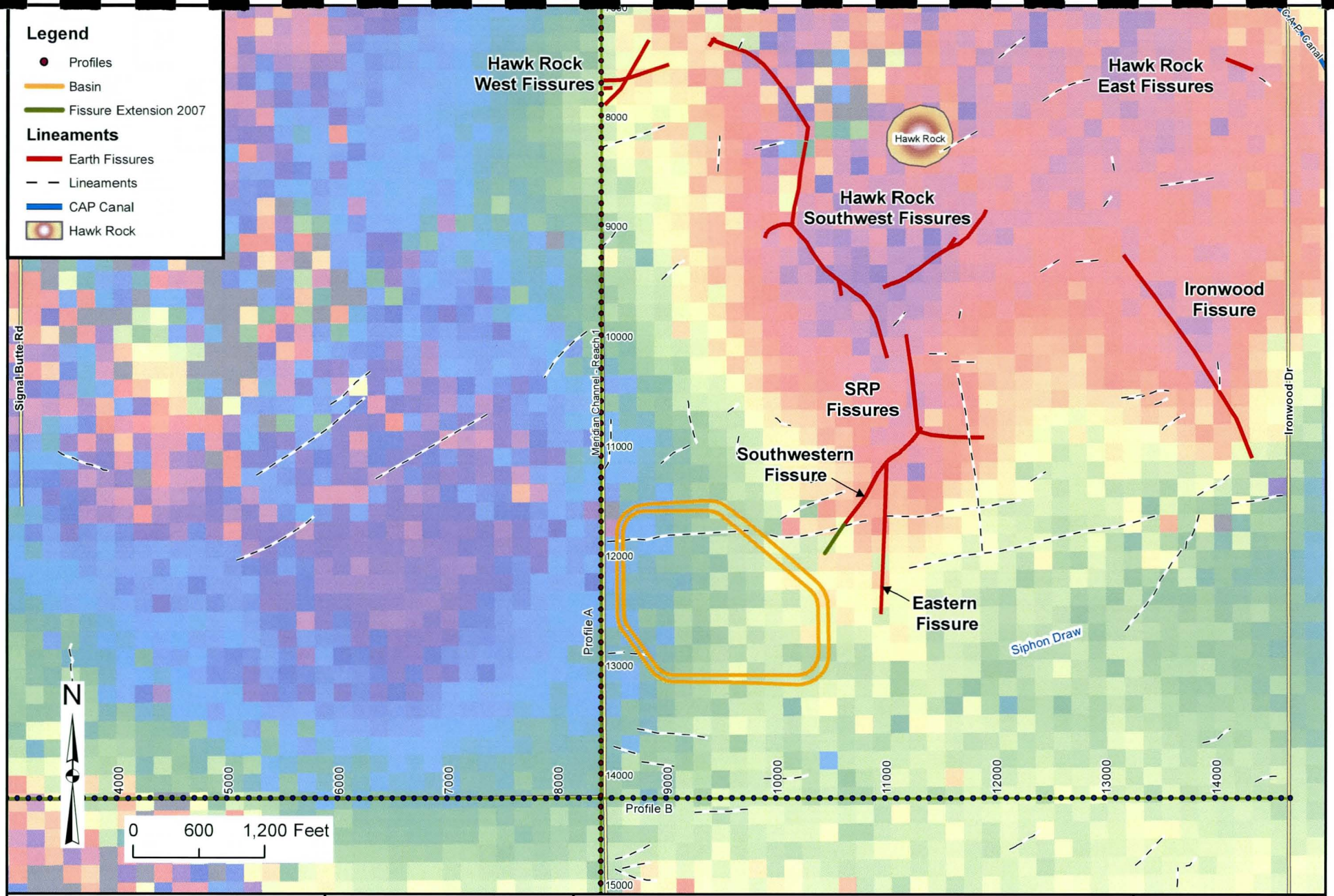
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2005 - 2006

FIGURE
B-4

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2005_2006.mxd)
7/10/2008 -- 4:00:33 PM



InSAR for the Period from November 2005 to January 2007
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

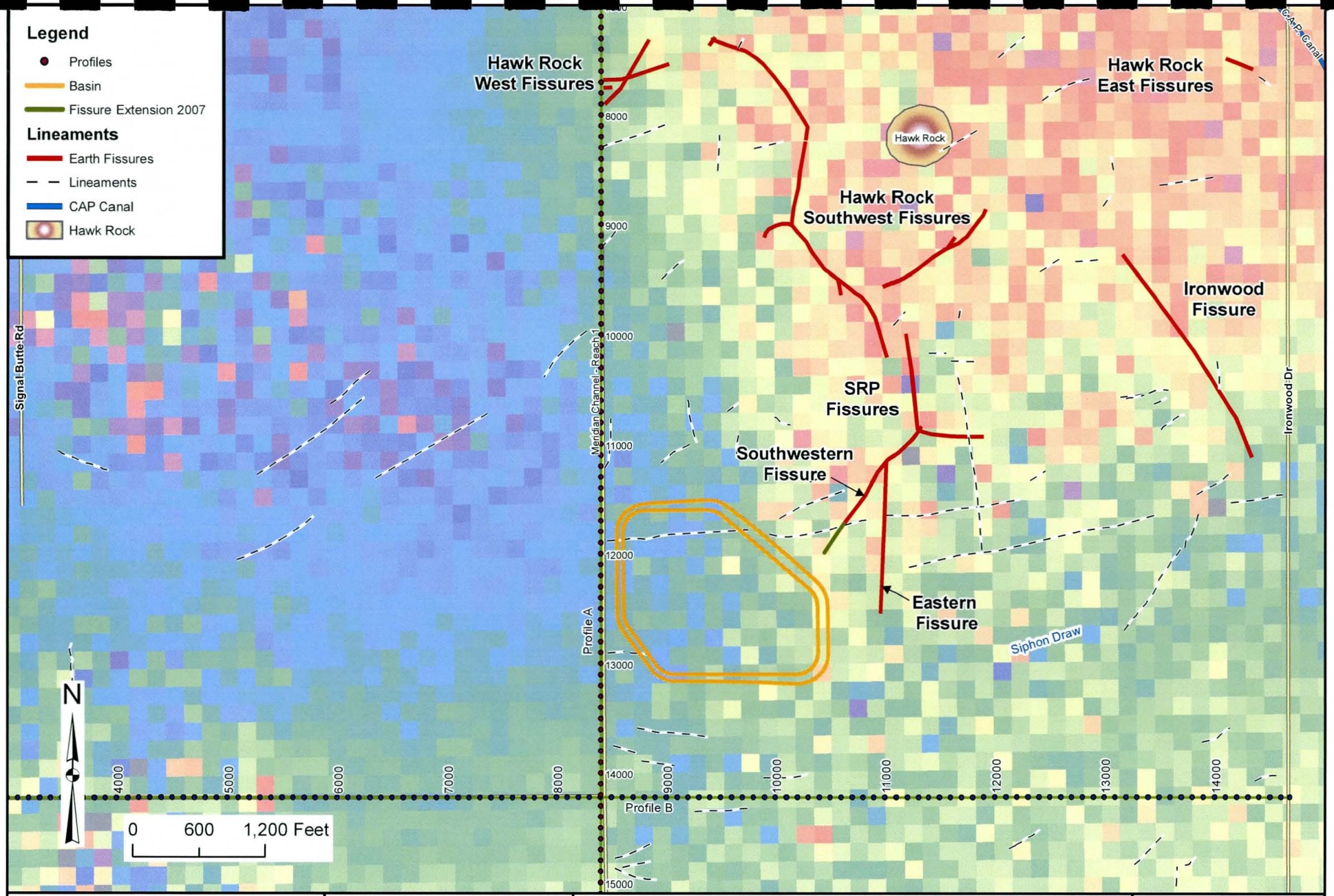
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2005 - 2007

FIGURE
B-5

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2005_2007.mxd)
7/10/2008 -- 4:07:11 PM



InSAR for the Period from January 2006 to December 2006
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

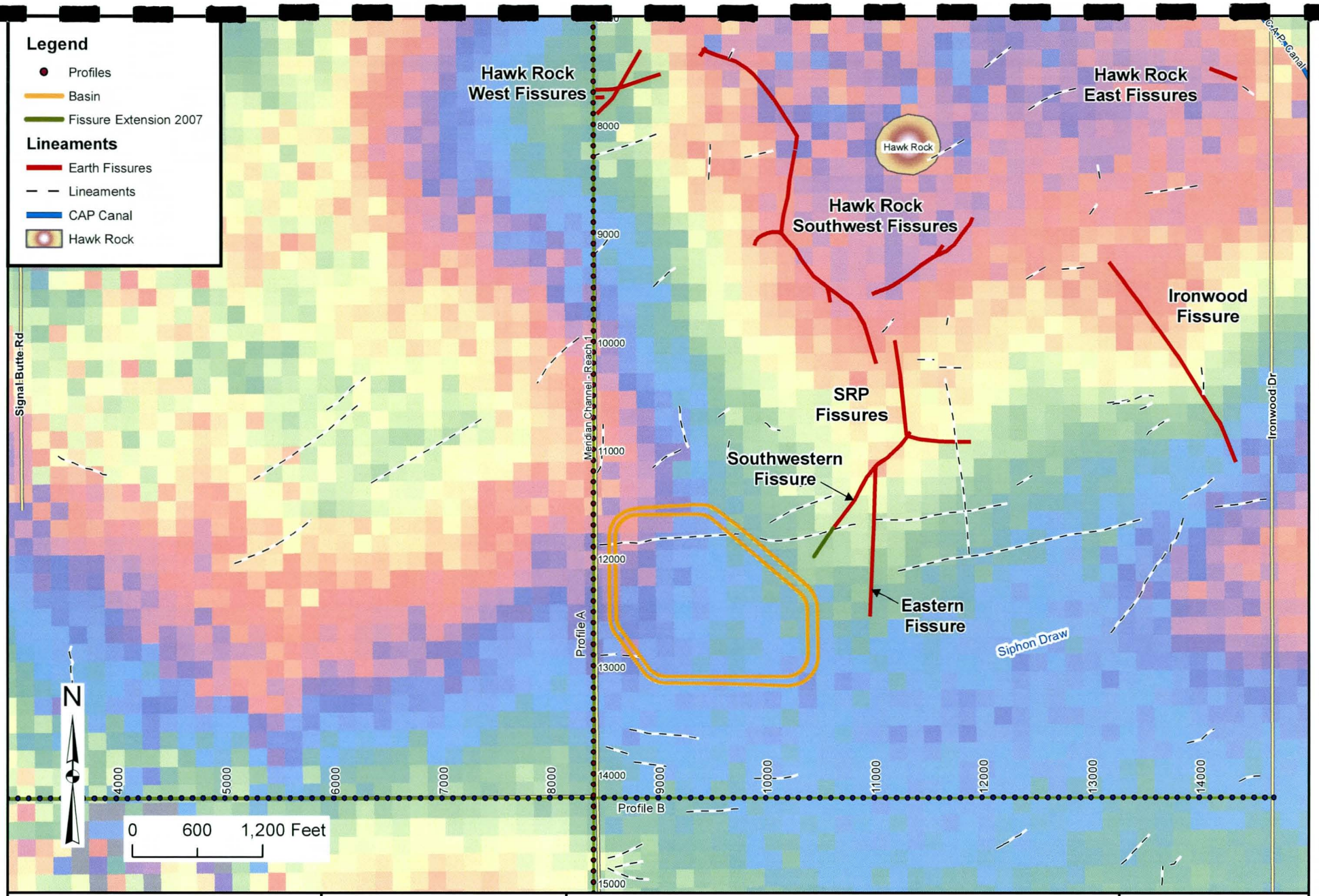
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2006

FIGURE
B-6

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2006.mxd)
7/10/2008 -- 4:18:34 PM



InSAR for the Period from June 2006 to April 2008
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

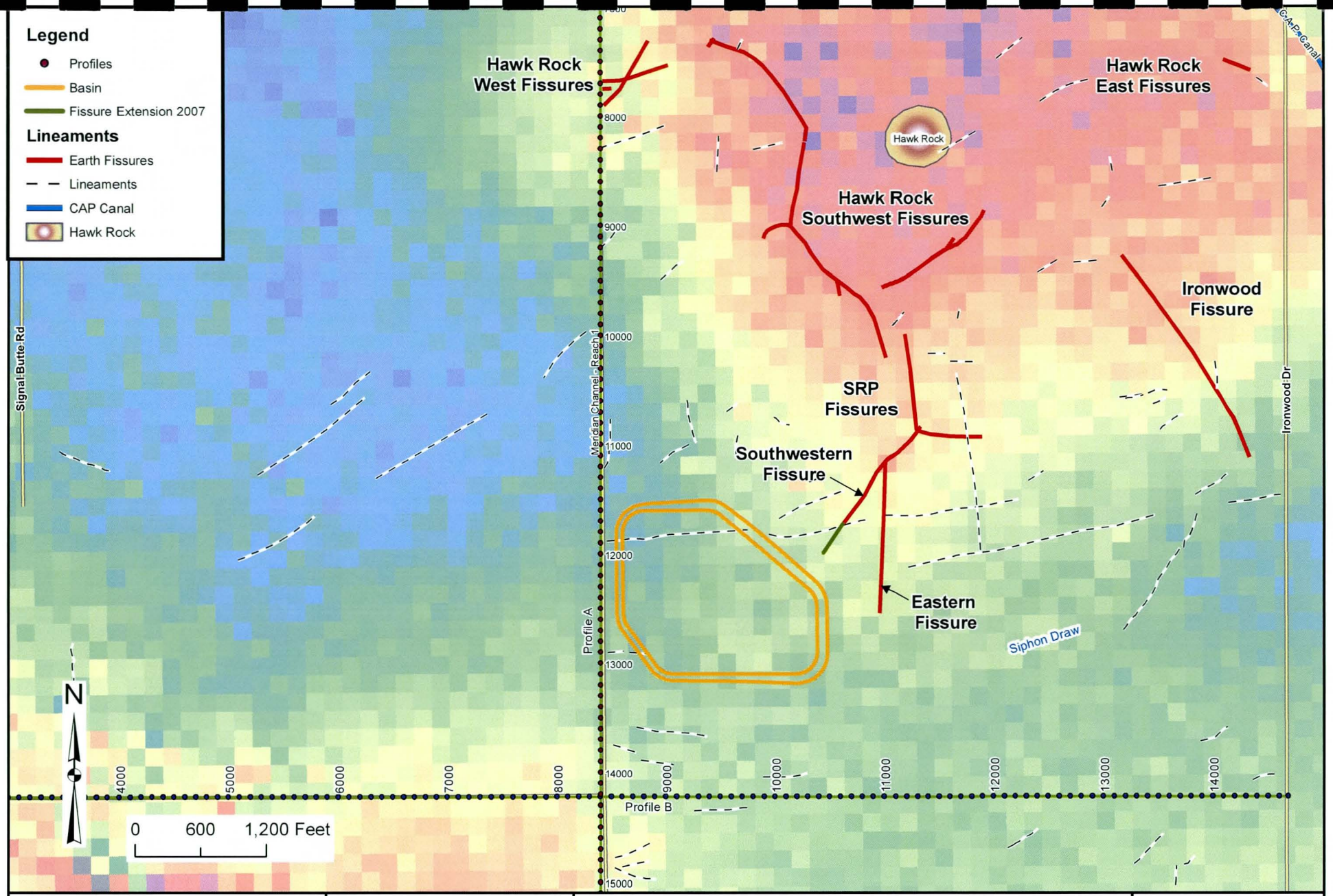
INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2006 - 2008

FIGURE
B-7

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2006_2008.mxd)
7/10/2008 -- 4:21:34 PM



InSAR for the Period from February 2007 to April 2008
One color cycle represents approximatley 9 cm of elevation change

Color aerial Imagery from AirPhoto USA, taken in April, 2007

JOB NO.:	7-117-001080
DESIGN:	KCF
DATE:	06/05/08
SCALE:	1" = 1200'

INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW IMPROVEMENTS PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
Contract FCD 2007C012.

InSAR 2007 - 2008

FIGURE
B-8

amec

Map Document: (X:\Projects\7-117-001080\MXD\InSAR_2007_2008.mxd)
7/10/2008 -- 4:25:24 PM

APPENDIX C

SEISMIC REFRACTION RESULTS

REFRACTION SEISMIC EQUIPMENT AND PROCEDURES

Refraction seismic surveys are performed in general conformance with the guidelines presented in ASTM D5777-95 Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation for refraction surveys using compression waves (p-waves). ASTM D5777 does not address shear wave (s-wave) surveys; standard practice is followed for refraction surveys using s-waves. In some investigations, such as seeking and tracing earth fissures or other significant discontinuities (Rucker and Keaton, 1998), non-standard procedures and analyses, such as signal amplitude analysis, are used as part of the investigation process.

Seismic Equipment - Refraction seismic surveys are performed using a Geometrics Smartseis SE-12 or SE-24 signal enhancement seismograph. These instruments have the capability to simultaneously record 12 or 24 channels of geophone data and produce hard copies of that data. The Smartseis also has the capability of digitally storing geophone data. Signal enhancement capability permits the use of a sledgehammer as the seismic energy source. A timing sensor is attached to the hammer, and for p-waves, a metal plate is set securely on the ground surface and struck. Generating horizontally polarized s-waves typically involves setting the plate against the end of a wooden plank or railroad tie oriented perpendicular to the axis of the geophone array and striking with a horizontal motion of the sledgehammer. A truck is usually driven onto the plank or tie to effectively couple the plank or tie to the ground.

Because of the signal enhancement capability, signals from several or many strikes can be added together to increase the total signal available relative to noise to obtain the seismic record. Although explosives can also be used as a p-wave seismic energy source, a sledgehammer does not require licenses or permits, or involve special limitations, regulations and liabilities. Explosive energy sources may be needed for long geophone arrays. Geophone cables with 12 geophone takeouts at 10-foot, 25-foot or 20-meter spacings are presently used. Vertical geophones are used to obtain p-wave data and horizontal geophones are used to obtain s-wave data. The seismograph system is extremely portable. In areas where vehicular access is not possible, the equipment can be mobilized by various means, including backpacking, packhorse, helicopter and canoe.

Field Procedures - The field operations are directed by our experienced engineer or geologist, who operates the equipment, prepares the records and examines the data in the field. Refraction seismic lines are generally laid out using the standard spacings on the geophone cables. A maximum depth of investigation of about 75 to 100 feet may be possible using a 300-foot array. For shorter lines with improved near-surface resolution, 10-foot spacings between geophones with a 120-foot array have a maximum depth of investigation of about 30 to 40 feet, and with a 240-foot array have a maximum depth of investigation of about 60 to 80 feet. Other geophone spacings can also be used. To improve the resolution of near-surface interfaces, energy source positions generally are set at 12.5 feet from the ends of a 25-foot spacing geophone array or at 5 feet from the ends of a 10-foot geophone spacing array. Several shots locations are utilized along the length of an array. When three shots are obtained, there is a foreshot and a backshot at the array ends and a midshot at the array center. The midshot is usually placed midway between the two centermost geophones. When five shots are obtained, the additional shotpoints are located midway between the foreshot-midshot and the midshot-backshot. For 240-foot 24-channel arrays, shotpoints are arrayed at 30-foot intervals along the array. These multiple shot points permit interpretation of near-surface interfaces at various locations along the array as well as near the endpoints for variable subsurface profiles, and permits more refined overall interpretations of shallow and mid-depth subsurface velocities and interfaces. In cases when both enhanced depth of investigation and improved shallow resolution are needed, multiple geophone arrays are completed end to end and combined into longer composite geophone arrays with greater depths of investigation. Additional energy shotpoints are then, at a minimum, performed at the midpoint and far endpoint of each adjacent geophone array to provide seismic energy travel path coverage over the extended array.

Surface wave data is also typically collected for each seismic line setup and interpreted for vertical shear wave profiles using the Refraction Microtremor method. This procedure is described separately. To facilitate the collection of low frequency surface wave data, 4.5 Hz geophones are typically used for surface seismic work.

REFRACTION SEISMIC EQUIPMENT AND PROCEDURES (Cont.)

P-wave data are recorded for general exploration work. S-wave data are also recorded when dynamic subsurface material properties are desired. An s-wave arrival is verified by obtained two sets of horizontal data that are 180 degrees out of phase. The phase reversal is obtained by either reversing the horizontal geophone orientation or reversing the hammer impact direction. Hard copy printouts of all field data are made and inspected as the information is collected. Field notes, including line number and orientation, topographic variations and other notes as appropriate are made on the hard copy printout. Locations and other notes are made on site maps and in notebooks as appropriate. Initial first arrival picks are made in the field and array endpoint arrival times are checked for immediate data adequacy verification as part of the quality control process.

Interpretation - Although preliminary or quality control initial refraction seismic data interpretations may sometimes be performed in the field, full interpretations are completed in the office. At the present time, two interpretation methods are being used; the intercept time method (ITM) and an optimization software routine based on finite difference optimization software. ITM breaks an interpretation into several distinct layers. It is simple, can be performed with a calculator, and can provide excellent interpretations of near surface layer depths and velocities. Optimization provides a continuously variable velocity interpretation through a discrete grid. Interpretations using optimization also indicate zones where interpretation has occurred, thus providing quality control on the depths to which the interpretation can be relied upon. However, the discrete grid used by optimization results in a low resolution near surface interpretation. The combination of both ITM and, when appropriate, optimization methods provides two separate interpretations with complimentary strengths and cross-checking capability. These interpretation methods are applied as appropriate to a particular project.

Refraction seismic data interpretation using the intercept time method is detailed by Mooney (1973). A personal computer spreadsheet is used to perform the necessary calculations to obtain depths and layer velocities, and print out time-distance plots and depth interpretations. This method is used for interpretations of up to three layers. It is considered that more than three layers cannot be effectively interpreted using twelve geophone data points. Interpretations are then completed manually to produce a final interpreted geologic profile and layer depths.

Refraction seismic data interpretation using optimization is performed using the SeisOpt2D (presently Version 4.0) software package by Optim, L.L.C., 1999-2007, of Reno, Nevada. Energy source and geophone receiver locations and elevations, and first arrival times are entered into the software package, and first arrival travel times are optimized through a process of repeated (typically 10,000 to 100,000) iterations. Multiple seismic lines combined end to end into a longer composite line can be effectively interpreted using this software. Model grid dimensions and element sizes are selected, with larger grids containing smaller elements providing greater potential resolution. However, very large grids containing small elements may become unstable, and several runs may need to be made to obtain stable, robust interpretations. Once a robust interpretation has been obtained, the resulting seismic velocity profile is printed out with varying colors indicating the interpreted velocities.

References:

Mooney, H.M., 1973, Engineering Seismology Using Refraction Methods, Bison Instruments, Inc., Minneapolis, Minnesota.

Rucker, M.L. and Keaton, J.R., 1998, Tracing an Earth Fissure Using Seismic-Refraction Methods with Physical Verification, in Land Subsidence Case Studies and Current Research: Proceedings of the Dr. Joseph F. Poland Symposium on Land Subsidence, Edited by Borchers, J.W., Special Publication No. 8, Association of Engineering Geologists, Star Publishing Company, Belmont, California, p. 207-216.

REFRACTION MICROTREMOR (ReMi) SHEAR WAVE EQUIPMENT AND PROCEDURES

Refraction microtemor or ReMi surveys are performed in general accordance with the method described by Louie (2001) to develop vertical one-dimensional shear wave (s-wave) velocity profiles. The same equipment used for ReMi is also used for refraction seismic. When appropriate, both p-wave and s-wave data can be collected with the same physical seismic line setup.

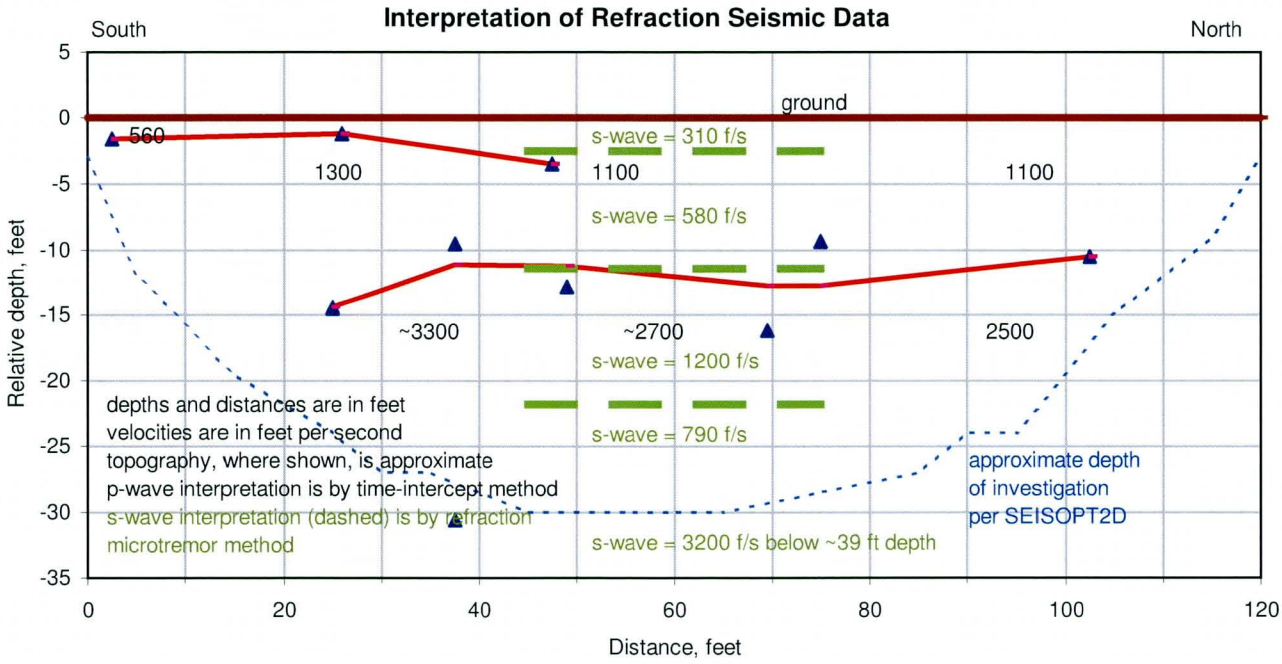
ReMi Seismic Equipment - ReMi surveys are performed using a Geometrics SE-12 or SE-24 Smartseis signal enhancement seismograph. These instruments have the capability to digitally record and store up to 12 or 24 channels of geophone data in SEG2 format. Up to 16,384 samples can be acquired for each geophone channel at sample intervals as long as 0.25, 0.5, 1 and 2 milliseconds. Sampling events to collect ReMi field data may typically last 6, 12 or 24 seconds. Geophone cables with 12 geophone takeouts at 10-foot or 20-meter spacings are presently used. Vertical geophones with resonant frequencies of 28 Hz and 4.5 Hz are used to obtain surface wave data for s-wave vertical profile analysis. High frequency geophones are used for shorter arrays with shallower depths of investigation, and low frequency geophones are used for longer arrays with greater depths of investigation. Broad band ambient site noise may be used as a surface wave energy source. Controlled surface wave energy sources include jogging alongside shorter geophone arrays and driving a field vehicle alongside longer geophone arrays. The seismograph system is extremely portable. In areas where vehicular access is not possible, the equipment can be mobilized by various means, including backpacking, packhorse, helicopter and canoe.

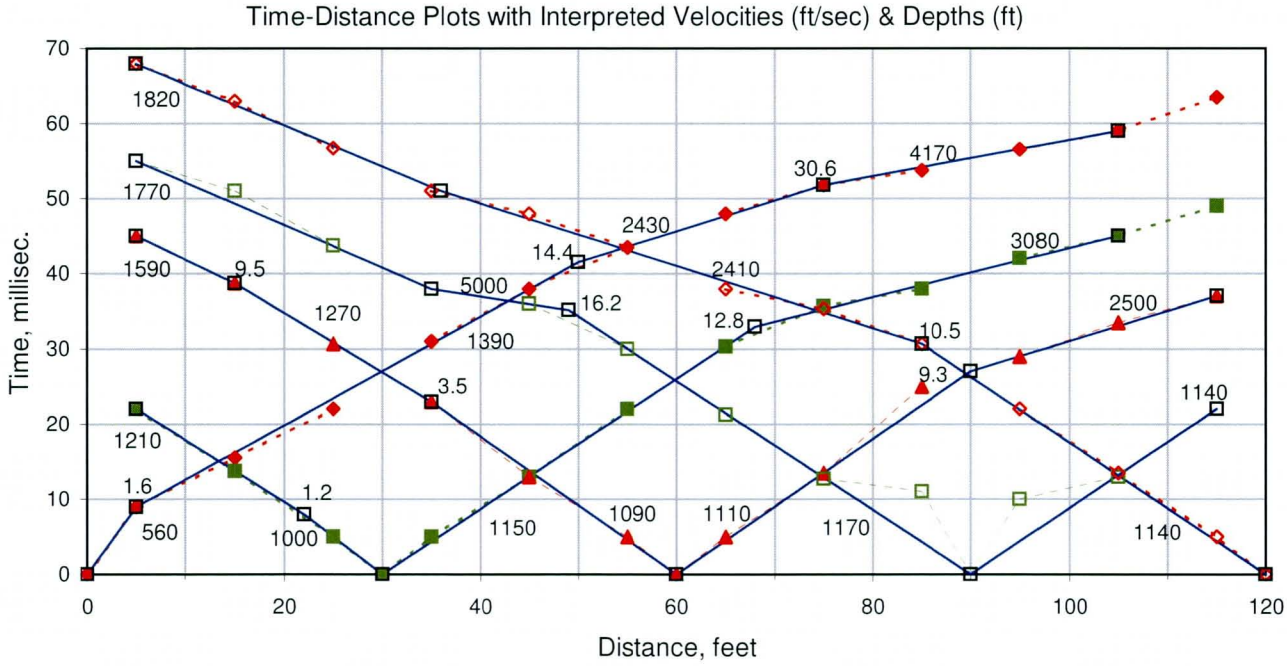
ReMi Field Procedures - The field operations are directed by our experienced engineer or geologist, who operates the equipment, prepares the records and examines the data in the field. ReMi seismic lines are generally laid out using the standard spacings on the geophone cables. A depth of investigation of about 100 meters or more may be possible using a 240 meter array. For shorter lines with improved near-surface resolution, 10-foot array spacings between geophones have a shallowr depth of investigation. Other geophone spacings can also be used.

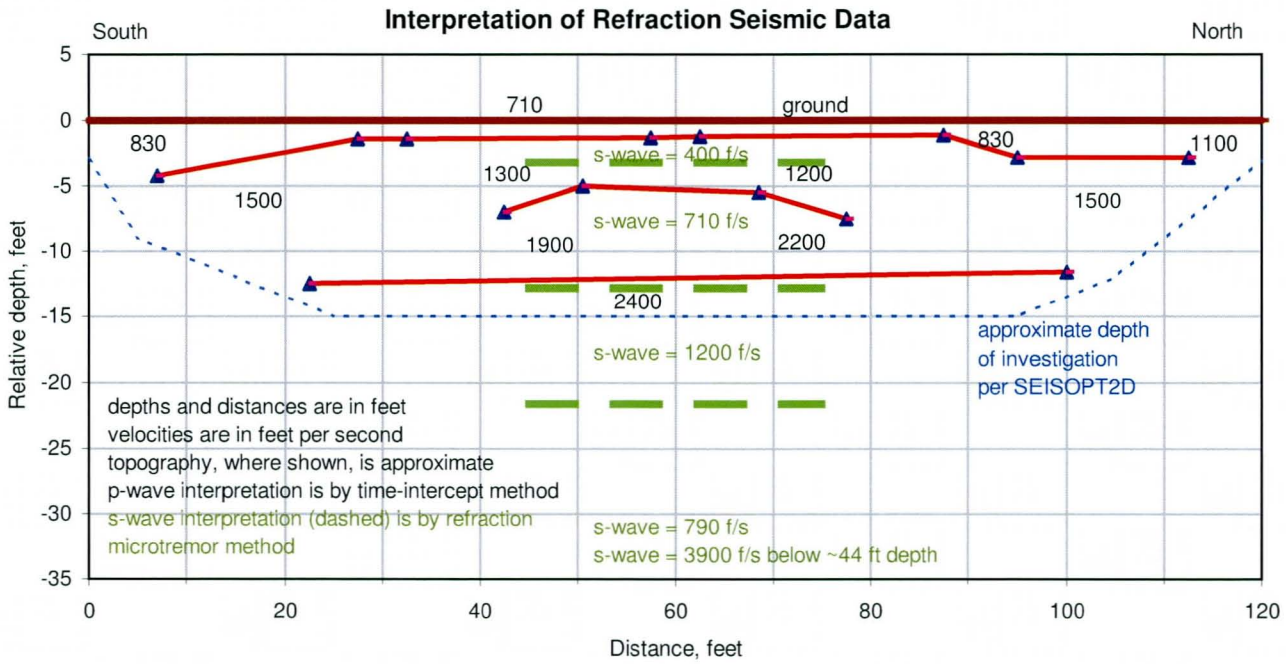
Data collection consists of the system sampling the ambient or generated surface waves (a sampling event) at the geophone array for several to many seconds. Typical sampling times and intervals for a sampling event may be 6 seconds at 0.5 milliseconds, 12 seconds at 1 millisecond and 24 seconds at 2 milliseconds for array lengths of 60 feet, 120 to 240 feet, and 240 meters, respectively. Several sampling events are collected at each ReMi setup. For shorter arrays where ReMi with surface wave energy generated by jogging is conducted in concert with seismic refraction data collection, four sampling events may typically be recorded. For longer arrays where urban ambient noise or a field vehicle generates the surface wave energy, six to ten sampling events may be recorded. Field notes, including line number and orientation, topographic variations and other notes as appropriate are made on hard copy of traces. Locations and other notes are made on site maps and in notebooks as appropriate. Sample data files may be transferred by 3.5-inch floppy to the laptop computer and preliminary interpretations made for immediate data adequacy verification as part of the quality control process.

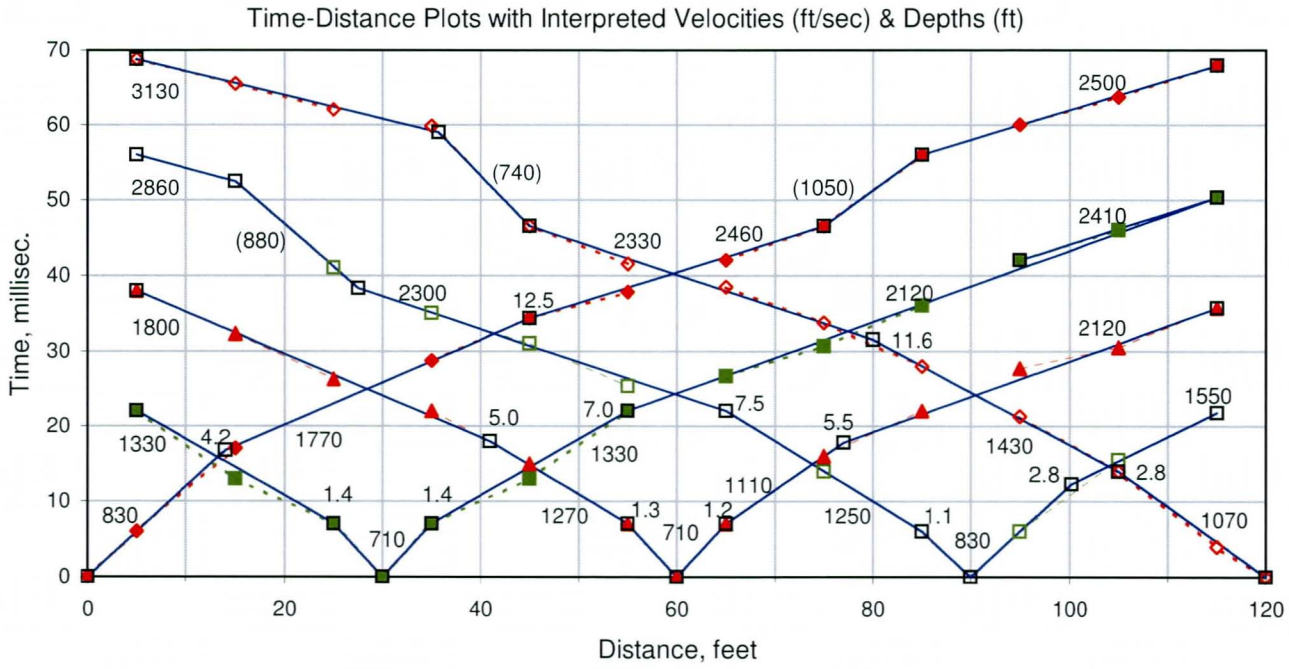
Interpretation - Although preliminary or quality control initial ReMi seismic data interpretations may sometimes be performed in the field, full interpretations are completed in the office. Data files, typically about 580kb each in size, are transferred from the seismograph to the laptop computer using 3.5-inch floppy disks. Interpretation is performed using the SeisOpt ReMi Version 3.0 (2004) software package by Optim, L.L.C., of Reno, Nevada. The software consists of two modules. The ReMiVsSpect module is used to convert the SEG2 files into a spectral energy shear wave frequency versus shear wave velocity presentation for a ReMi seismic setup. The interpreter then selects a dispersion curve consisting of the lower bound of the spectral energy shear wave velocity versus frequency trend, and that dispersion curve is saved to disk. Tracing the lower bound (slowest) of the shear wave velocity at each frequency selects the ambient energy propagating parallel to the geophone array, since energy propagating incident to the array will appear to have a faster propagating velocity. The second module, ReMiDisper, is then invoked. The interpreter models a dispersion curve with multiple layers and s-wave velocities to match the selected dispersion curve from the field data. An interpreted vertical s-wave profile is obtained through this process. It must be understood that this type of interpretation may not result in a unique solution.

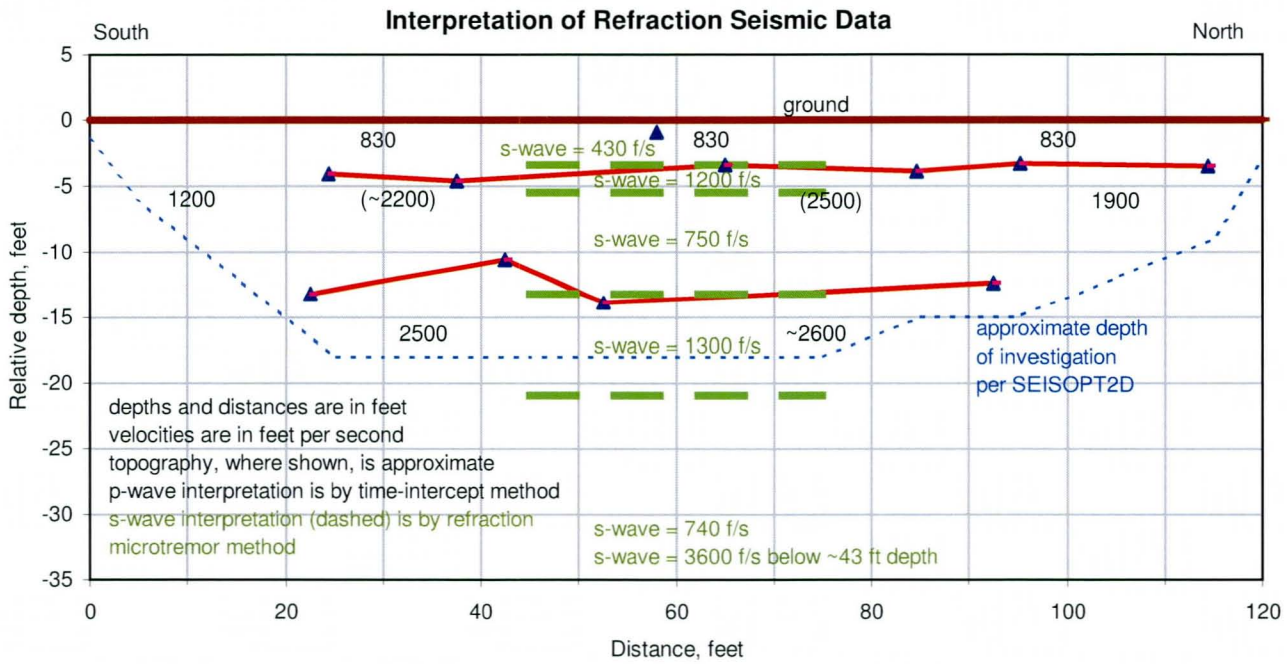
Louie, J.L., 2001, Faster, Better: Shear-wave velocity to 100 meters depth from refraction microtremor arrays, Bulletin of the Seismological Society of America, Vol. 91, 347-364.

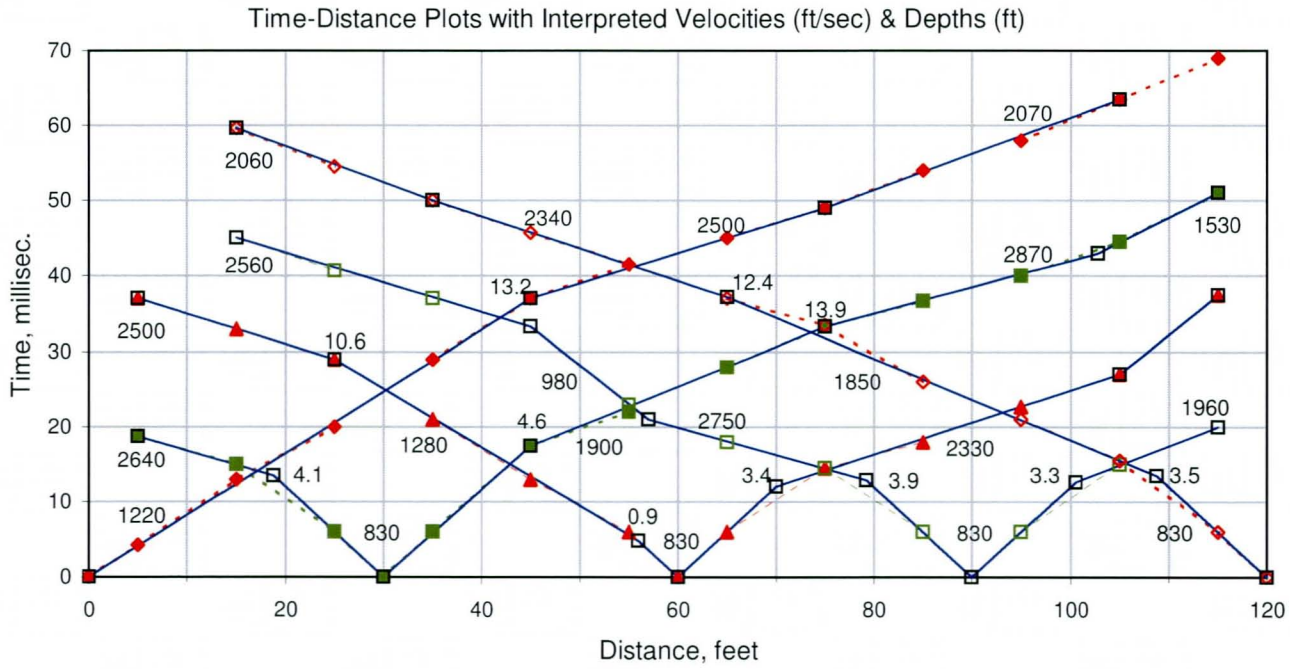

Interpretation of Refraction Seismic Data
South
North
ground
560
1300
1100
1100
s-wave = 310 f/s
s-wave = 580 f/s
~3300
~2700
2500
s-wave = 1200 f/s
s-wave = 790 f/s
s-wave = 3200 f/s below ~39 ft depth
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

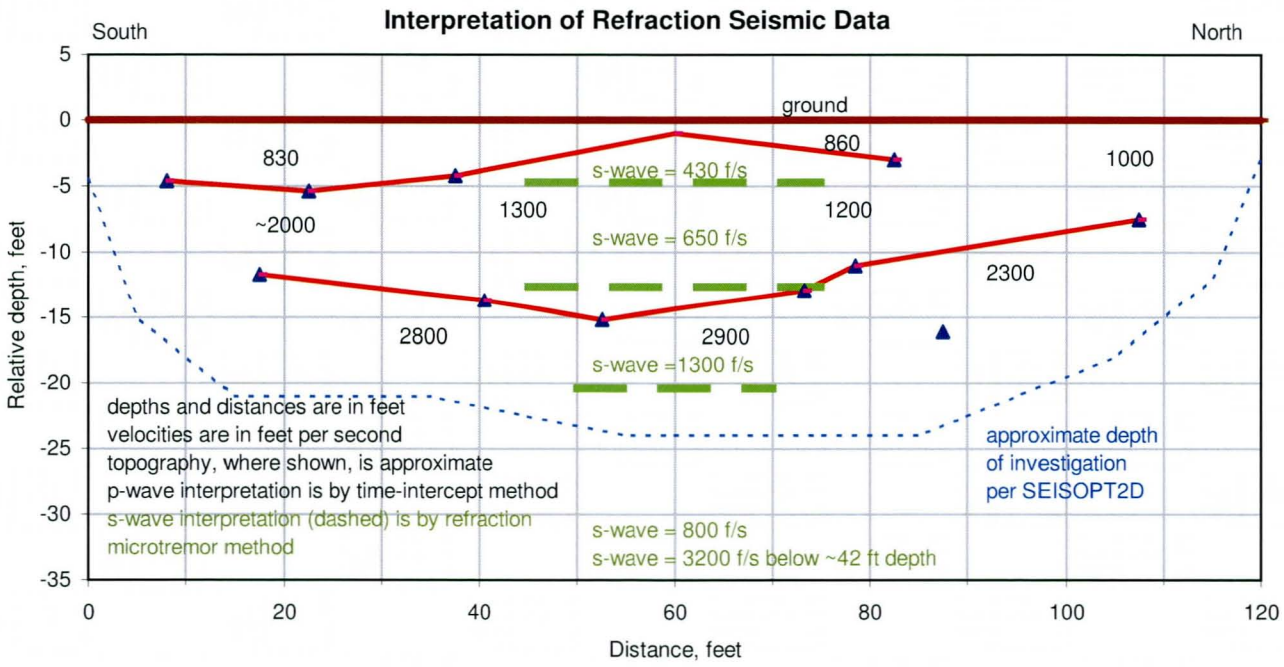

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
1820
1770
1590
9.5
1270
5000
14.4
2430
30.6
4170
2410
3080
2500
1390
16.2
12.8
10.5
9.3
3.5
1140
1210
1.6
560
1.2
1000
1150
1090
1110
1170
1140
Time, millisec.
Distance, feet

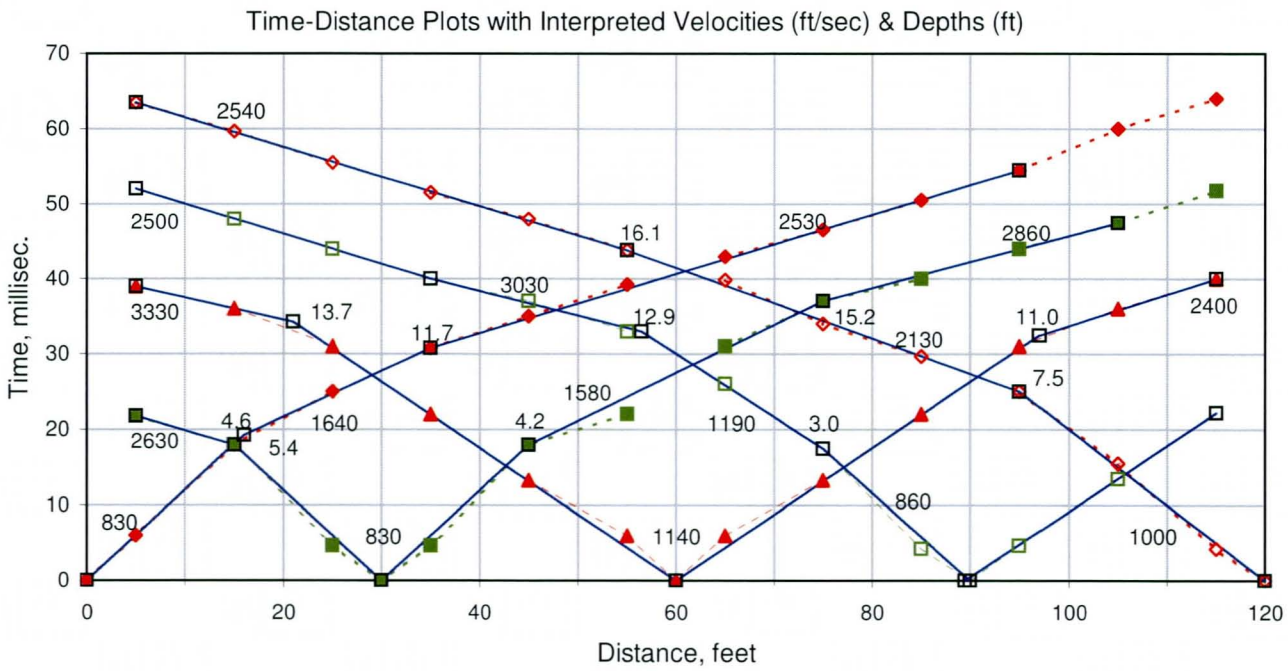

Interpretation of Refraction Seismic Data
South
North
ground
710
830
1500
1300
1200
1900
2200
2400
830
1100
1500
s-wave = 400 f/s
s-wave = 710 f/s
s-wave = 1200 f/s
s-wave = 790 f/s
s-wave = 3900 f/s below ~44 ft depth
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
Relative depth, feet
Distance, feet

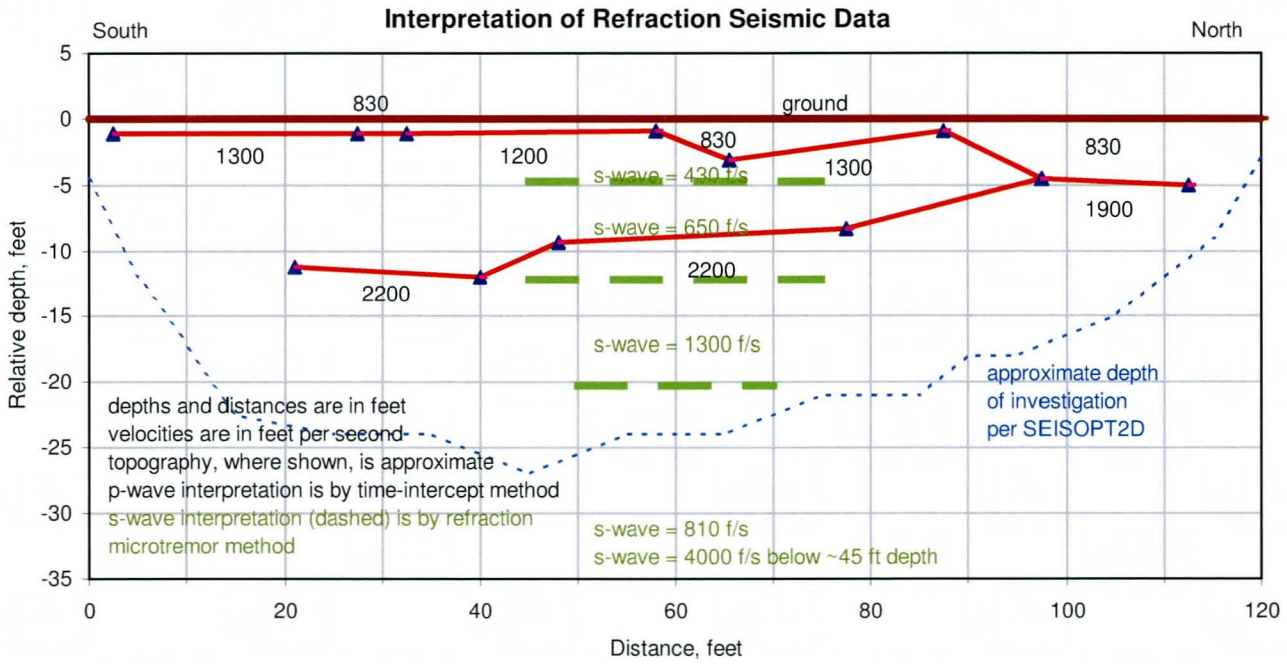

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3130
2860
(880)
(740)
2330
2460
(1050)
2500
2410
2300
12.5
2120
11.6
2120
1800
1330
4.2
1770
5.0
7.0
7.5
5.5
1330
1430
1550
1.4
1.4
1270
1.3
710
1.2
1110
1250
1.1
830
2.8
2.8
830
710
1070
Time, millisec.
Distance, feet

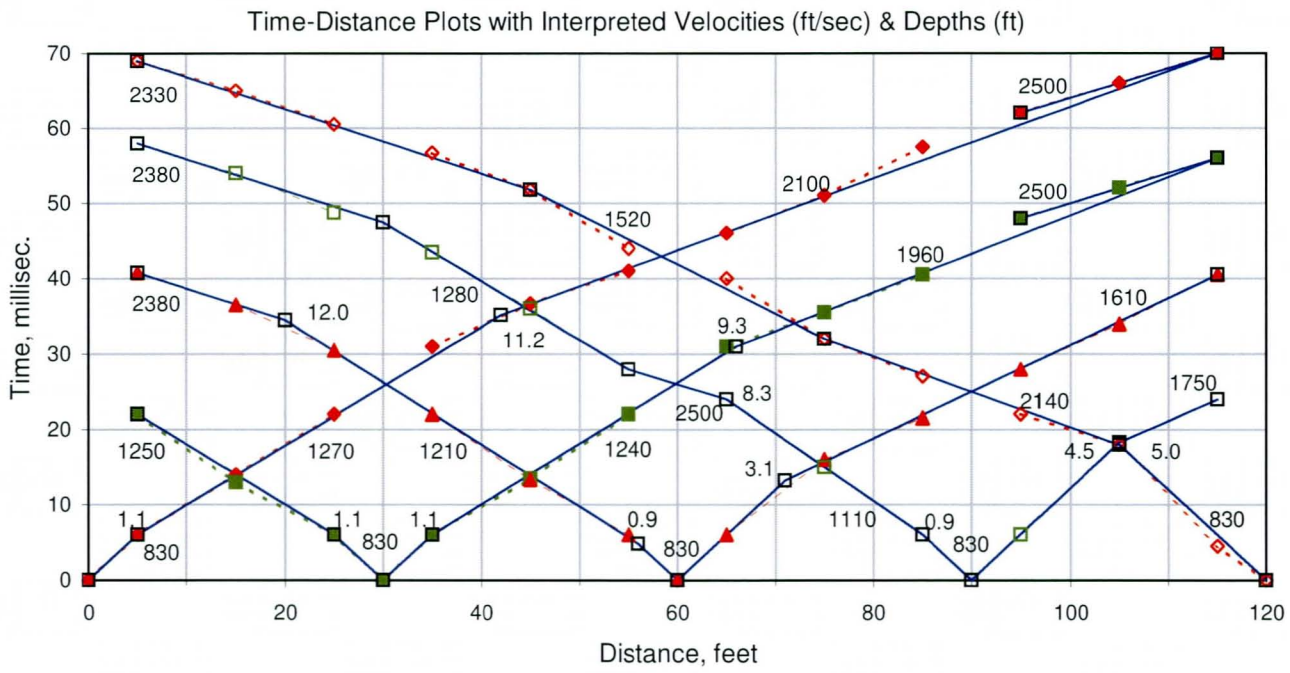

Interpretation of Refraction Seismic Data
South
North
ground
830
830
830
s-wave = 430 f/s
s-wave = 1200 f/s
1200
(~2200)
(2500)
1900
s-wave = 750 f/s
2500
s-wave = 1300 f/s
~2600
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
s-wave = 740 f/s
s-wave = 3600 f/s below ~43 ft depth
Relative depth, feet
Distance, feet

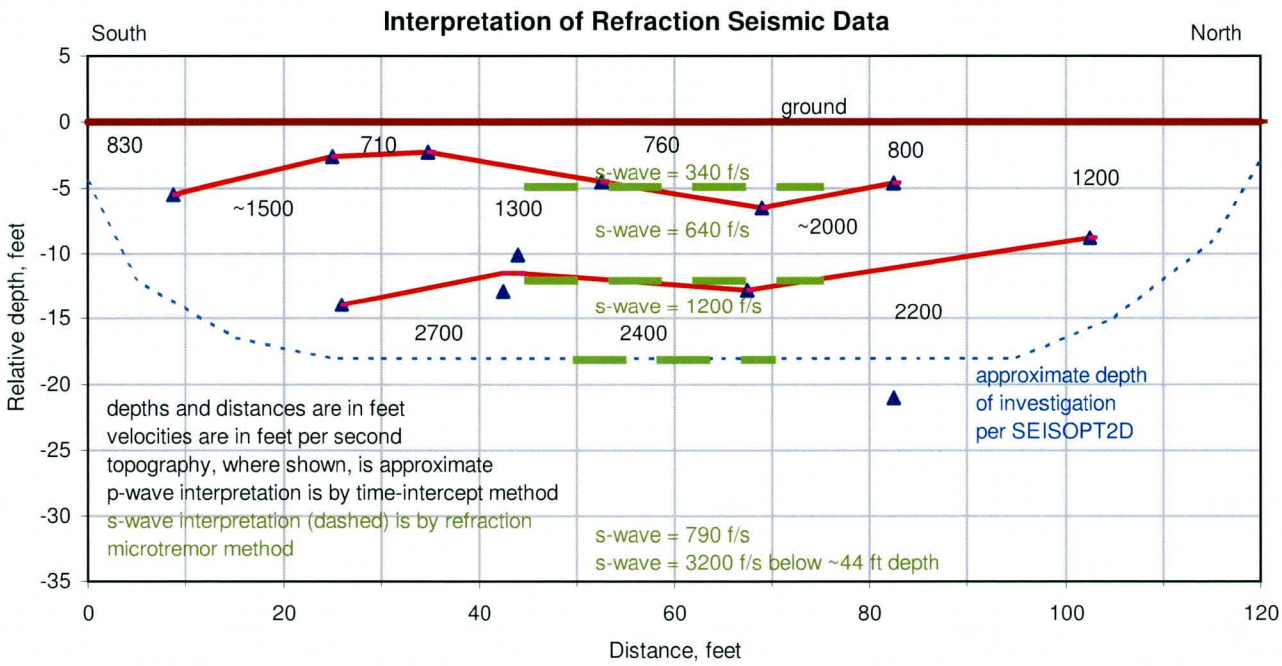

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2060
2070
2340
2500
2560
2870
1530
13.2
12.4
13.9
2500
10.6
980
1850
1960
4.6
2750
2640
1280
1900
2330
4.1
3.4
3.9
3.3
3.5
1220
830
0.9
830
830
830
Time, millisec.
Distance, feet

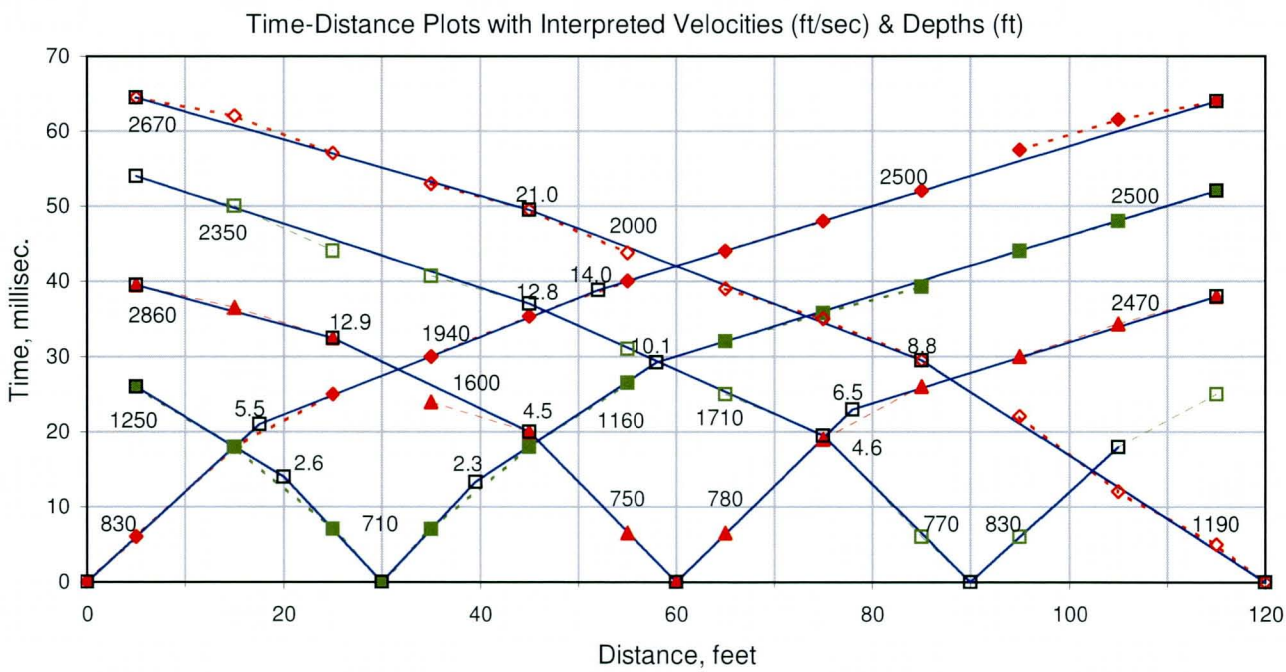

Interpretation of Refraction Seismic Data
South
North
ground
830
~2000
1300
860
1200
1000
2300
2800
2900
s-wave = 430 f/s
s-wave = 650 f/s
s-wave =1300 f/s
s-wave = 800 f/s
s-wave = 3200 f/s below ~42 ft depth
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
Relative depth, feet
Distance, feet

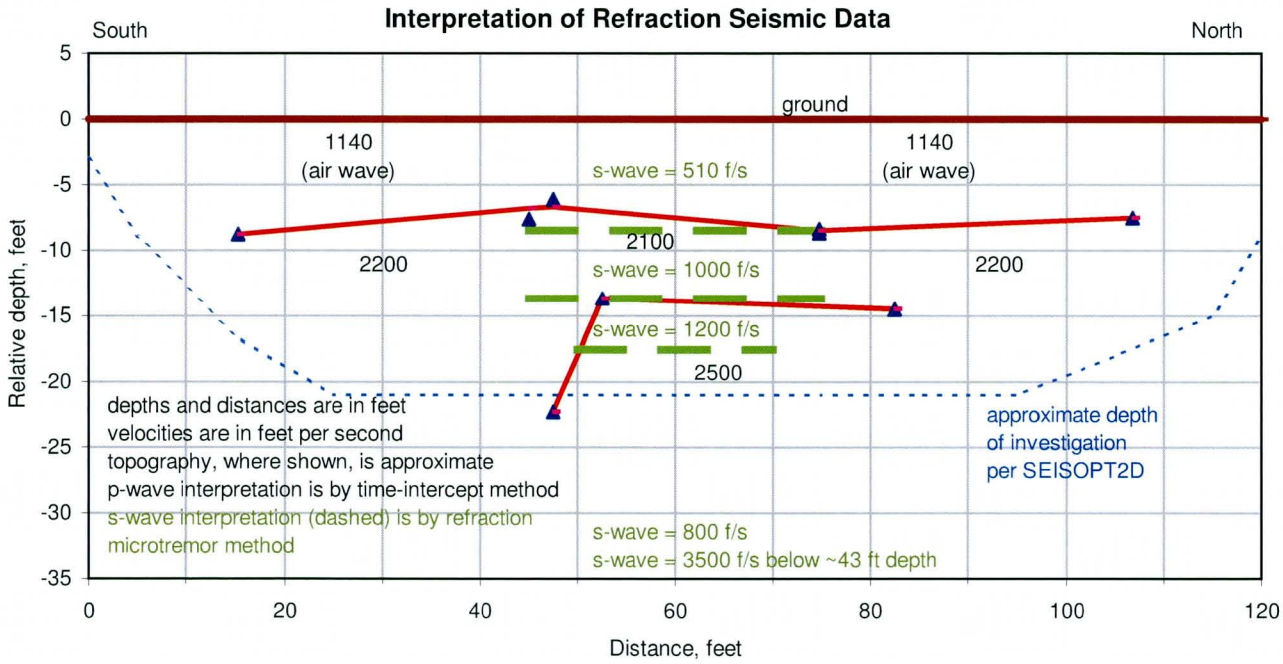

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2540
2500
3330
2630
830
4.6
5.4
13.7
1640
830
11.7
3030
4.2
1580
16.1
12.9
1190
1140
2530
15.2
3.0
860
2130
2860
11.0
7.5
2400
1000
Time, millisec.
Distance, feet

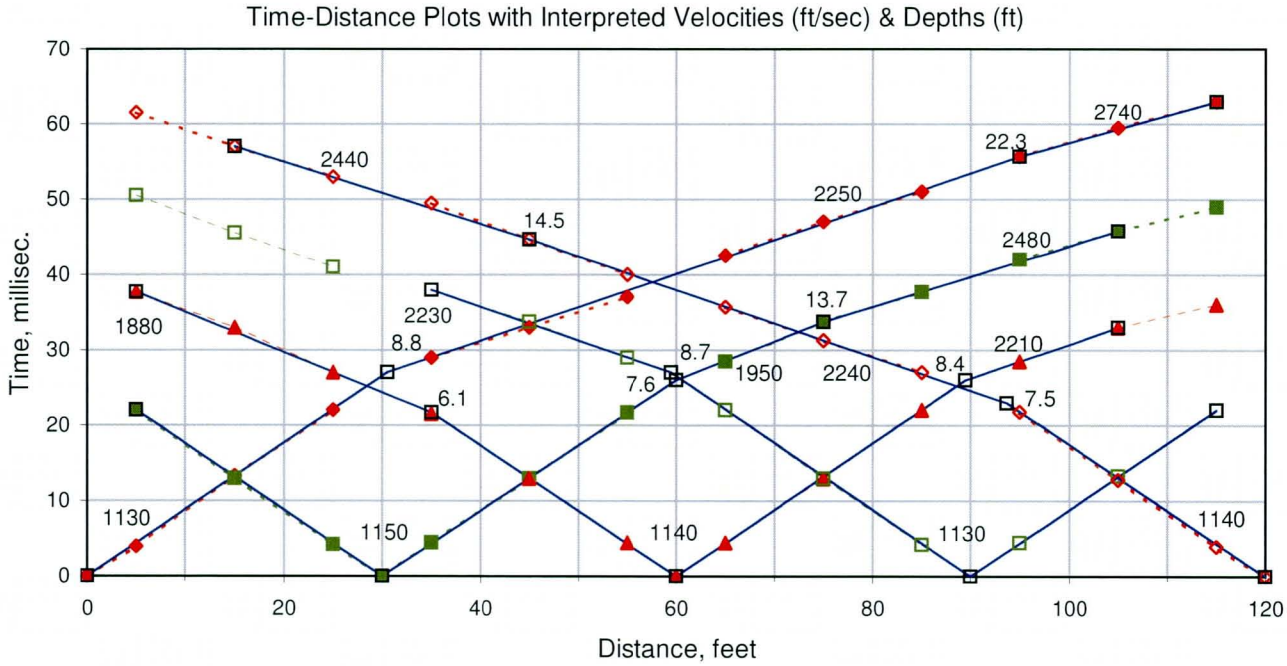

Interpretation of Refraction Seismic Data
South
North
ground
830
1300
1200
830
1300
830
1900
2200
2200
s-wave = 430 f/s
s-wave = 650 f/s
s-wave = 1300 f/s
s-wave = 810 f/s
s-wave = 4000 f/s below ~45 ft depth
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
Relative depth, feet
Distance, feet

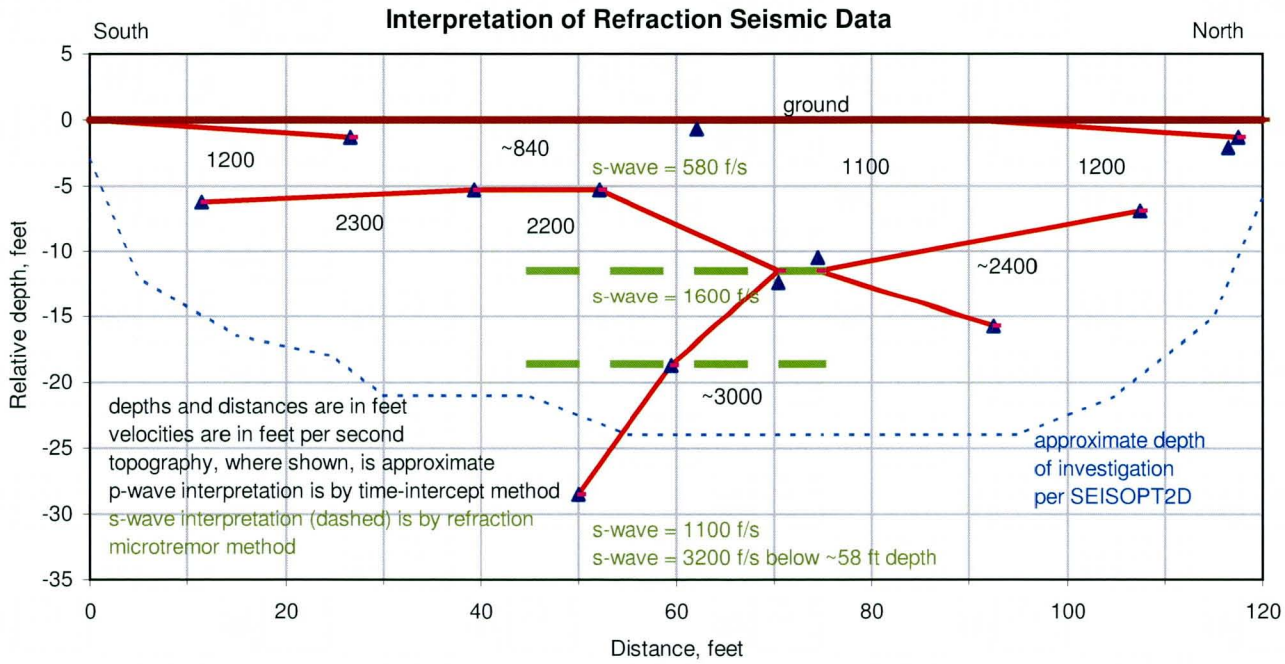

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
2330
2380
2380
2500
2100
2500
1520
1960
1280
12.0
11.2
9.3
1610
8.3
2500
2140
1750
1250
1270
1210
1240
3.1
4.5
5.0
1.1
830
1.1
830
1.1
0.9
830
1110
0.9
830
830

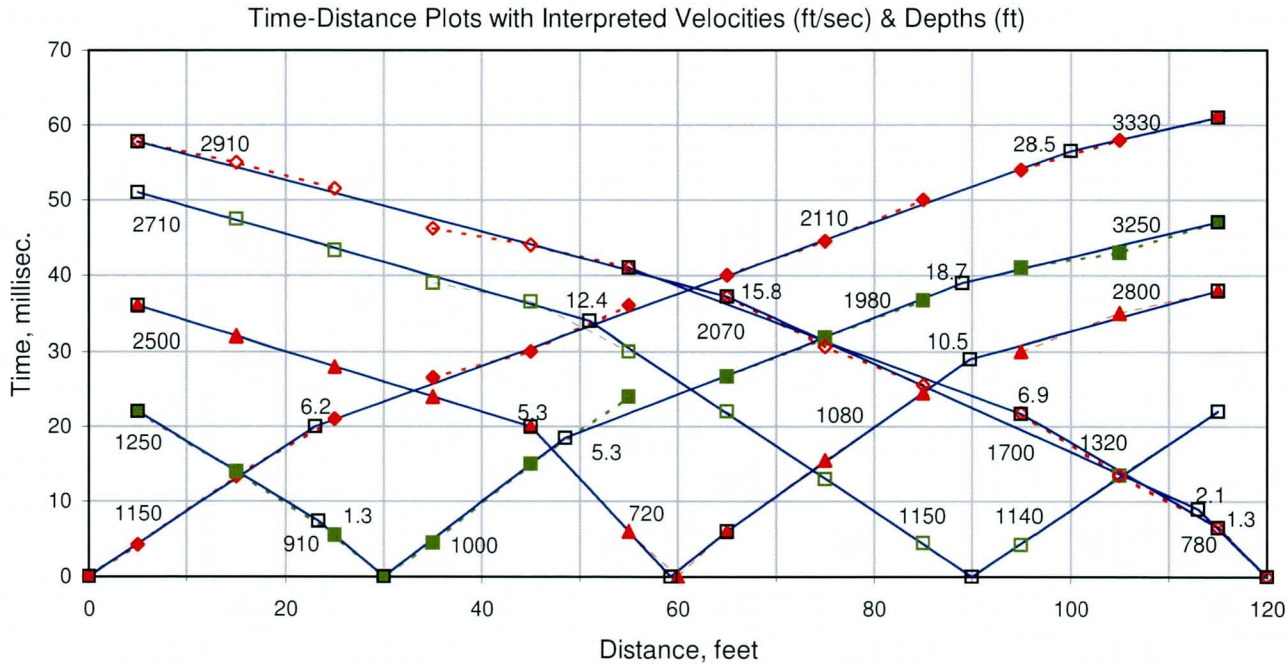

Interpretation of Refraction Seismic Data
South
North
ground
830
710
760
800
1200
~1500
1300
~2000
2700
2400
2200
s-wave = 340 f/s
s-wave = 640 f/s
s-wave = 1200 f/s
s-wave = 790 f/s
s-wave = 3200 f/s below ~44 ft depth
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
Relative depth, feet
Distance, feet

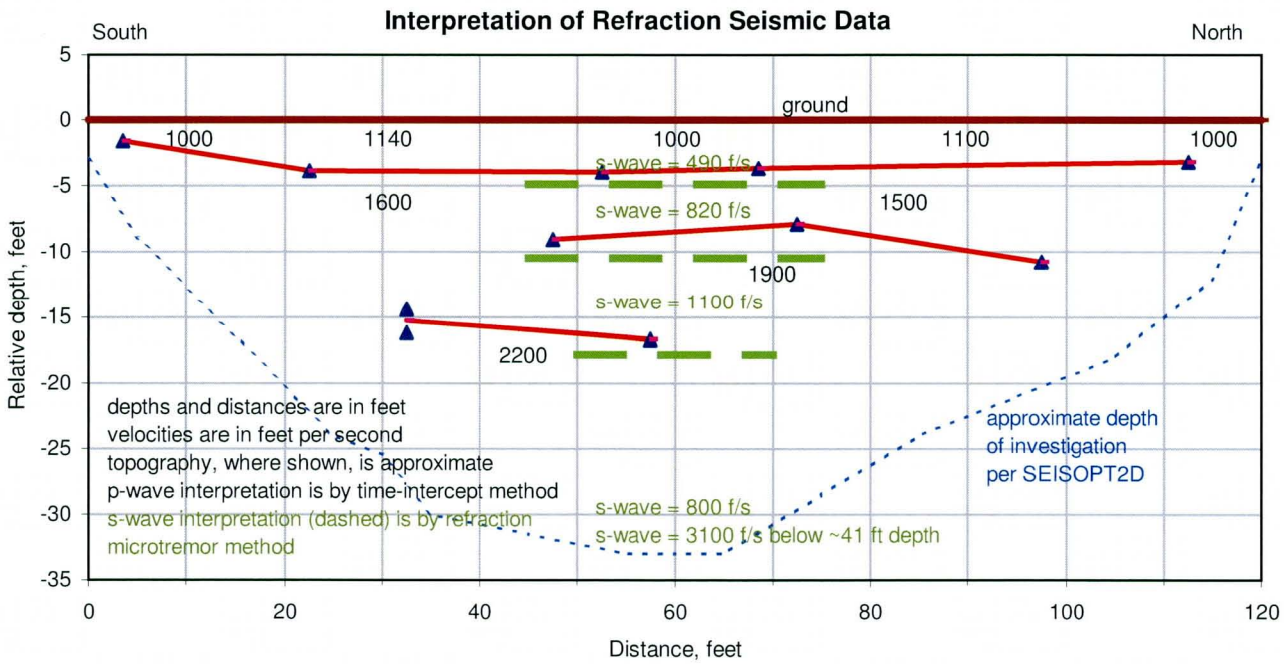

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2670
2350
2860
1250
830
21.0
2000
12.8
14.0
12.9
1940
1600
5.5
2.6
2.3
4.5
10.1
1160
750
1710
780
6.5
4.6
8.8
770
830
2500
2500
2470
1190
Time, millisec.
Distance, feet

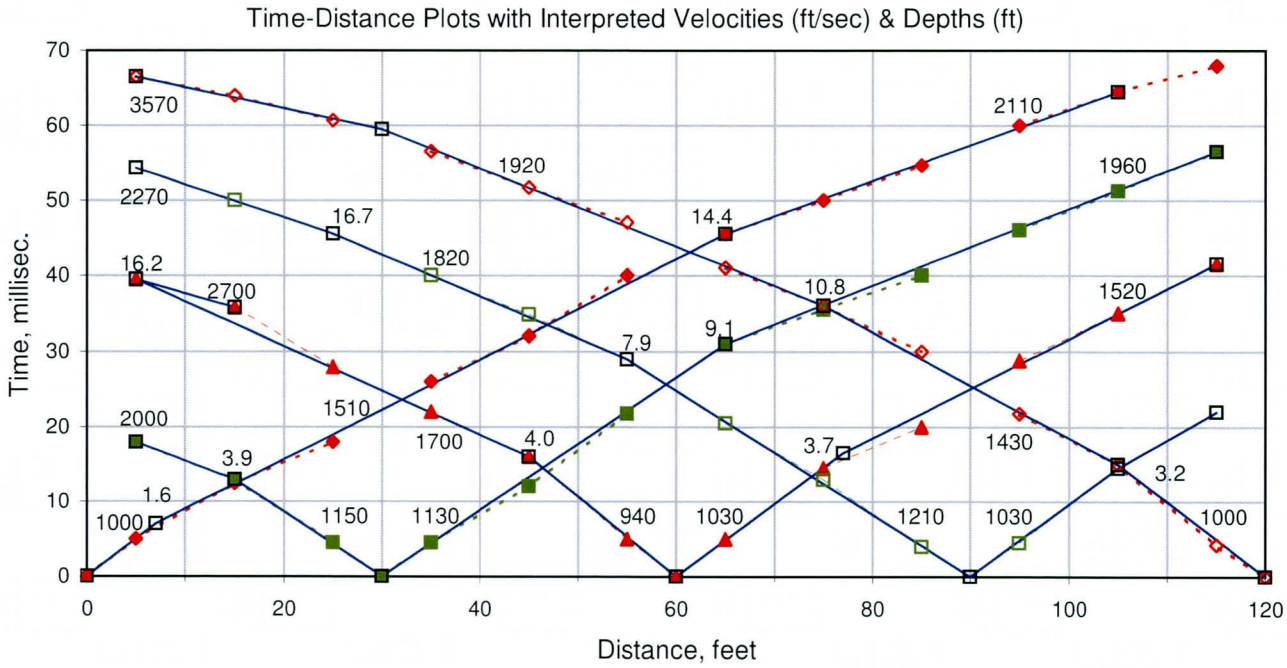

Interpretation of Refraction Seismic Data
South
North
ground
1140
(air wave)
1140
(air wave)
s-wave = 510 f/s
2100
2200
2200
s-wave = 1000 f/s
s-wave = 1200 f/s
2500
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
s-wave = 800 f/s
s-wave = 3500 f/s below ~43 ft depth
Relative depth, feet
Distance, feet

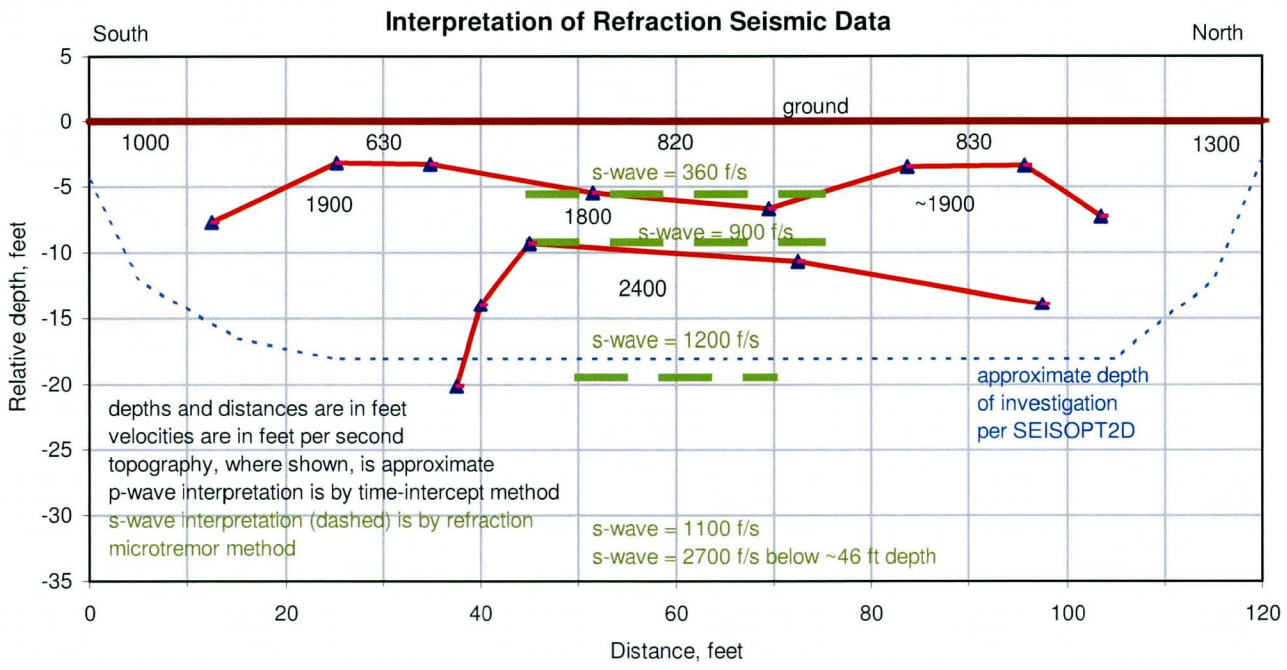

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2440
14.5
2250
22.3
2740
2480
13.7
1880
2230
8.8
8.7
1950
2240
8.4
2210
7.6
6.1
7.5
1130
1150
1140
1130
1140
Time, millisec.
Distance, feet

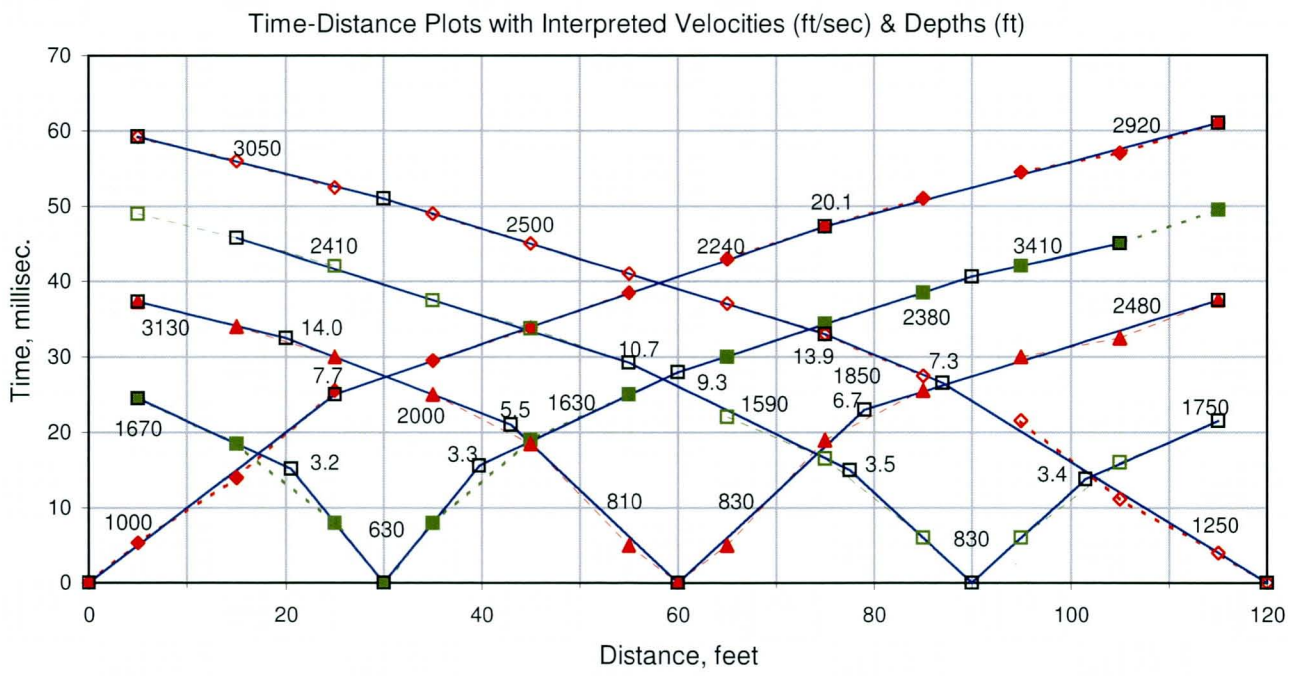

Interpretation of Refraction Seismic Data
South
North
ground
1200
~840
s-wave = 580 f/s
1100
1200
2300
2200
~2400
s-wave = 1600 f/s
~3000
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
s-wave = 1100 f/s
s-wave = 3200 f/s below ~58 ft depth
Relative depth, feet
Distance, feet

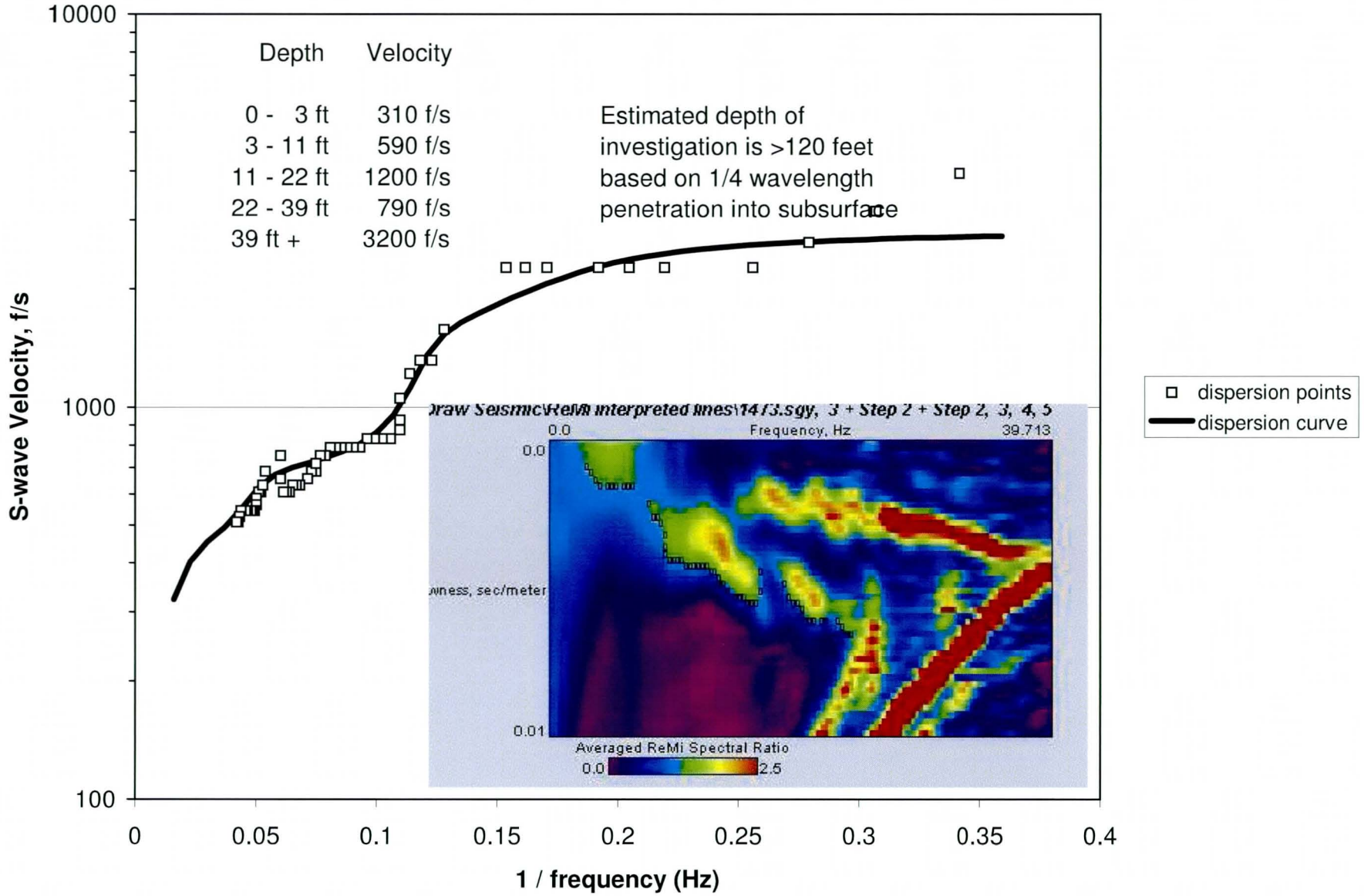

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
2910
2710
2500
1250
1150
910
1.3
6.2
1000
5.3
12.4
720
5.3
2070
15.8
2110
1080
1980
1150
10.5
18.7
1140
6.9
1700
28.5
3330
1320
3250
2800
2.1
1.3
780
Time, millisec.
Distance, feet

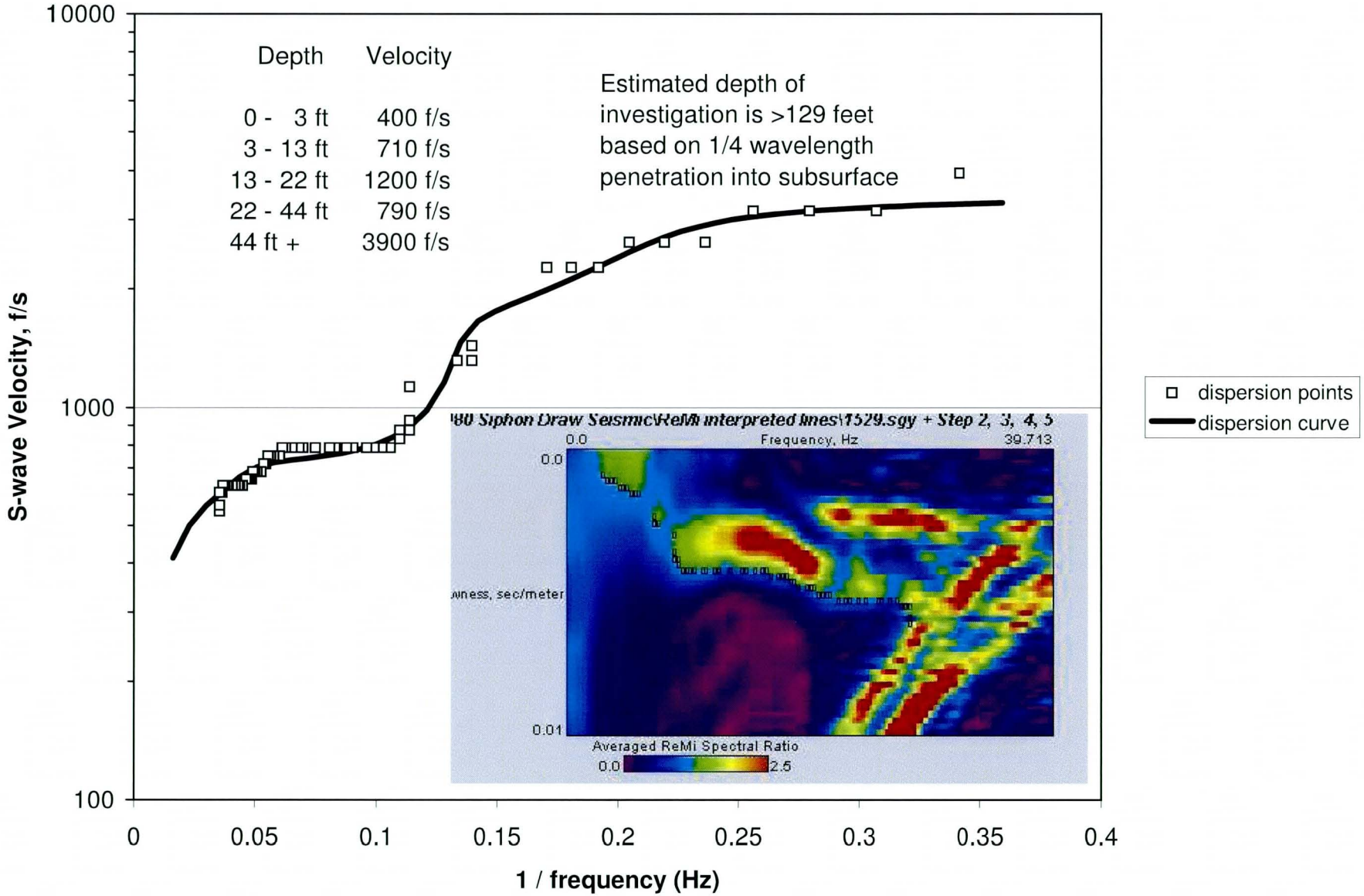

Interpretation of Refraction Seismic Data
South
North
ground
1000
1140
1000
1100
1000
s-wave = 490 f/s
1600
1500
s-wave = 820 f/s
1900
s-wave = 1100 f/s
2200
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
approximate depth of investigation per SEISOPT2D
s-wave = 800 f/s
s-wave = 3100 f/s below ~41 ft depth
Relative depth, feet
Distance, feet


Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
3570
2270
16.2
2700
2000
1.6
1000
3.9
16.7
1920
1820
1510
1150
1700
1130
4.0
7.9
14.4
9.1
940
1030
10.8
3.7
2110
1960
1520
1430
1210
1030
3.2
1000
Time, millisec.
Distance, feet

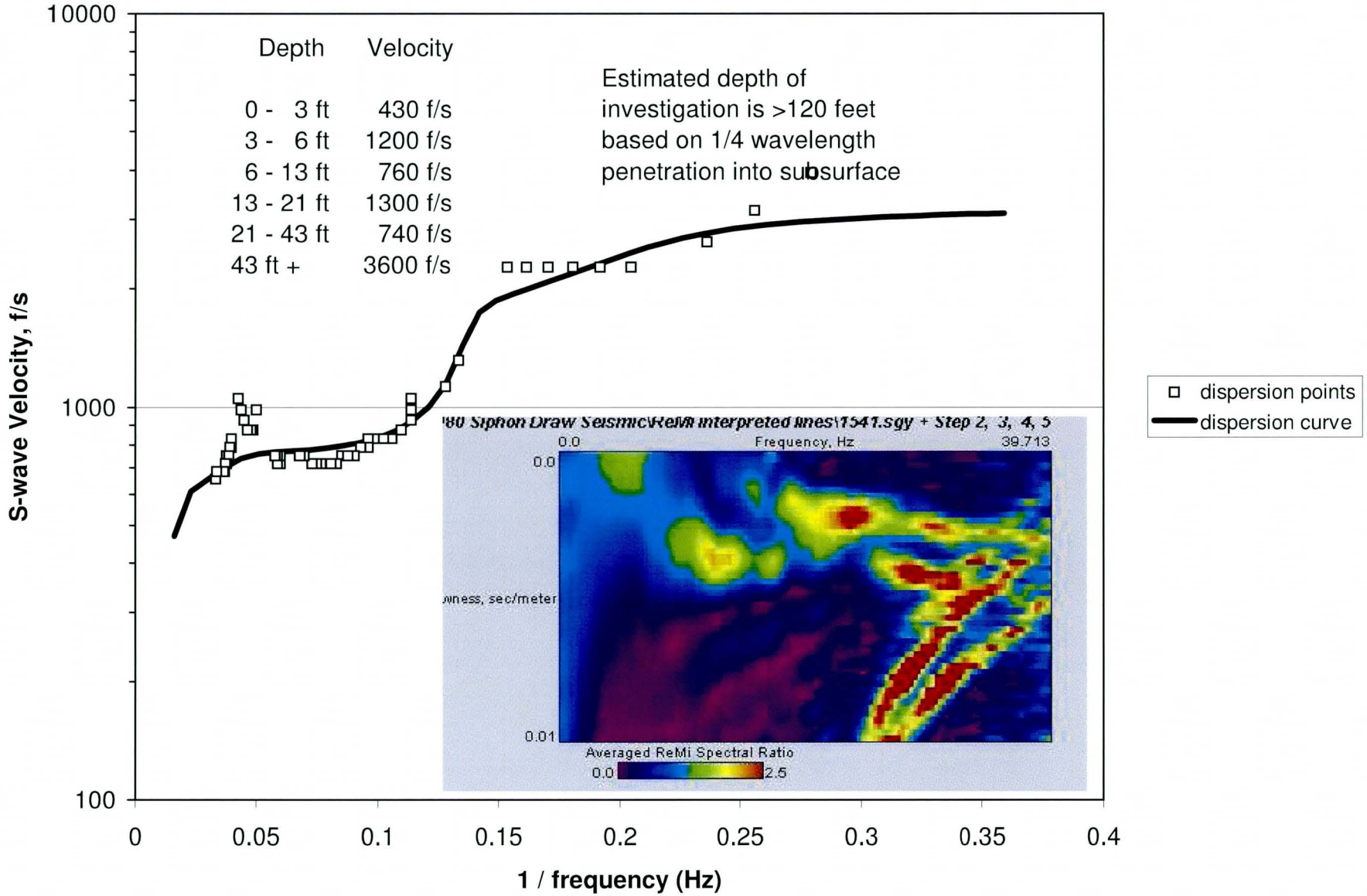

Interpretation of Refraction Seismic Data
South
North
ground
1000
630
820
830
1300
1900
1800
~1900
2400
s-wave = 360 f/s
s-wave = 900 f/s
s-wave = 1200 f/s
s-wave = 1100 f/s
s-wave = 2700 f/s below ~46 ft depth
approximate depth of investigation per SEISOPT2D
depths and distances are in feet
velocities are in feet per second
topography, where shown, is approximate
p-wave interpretation is by time-intercept method
s-wave interpretation (dashed) is by refraction microtremor method
Relative depth, feet
Distance, feet

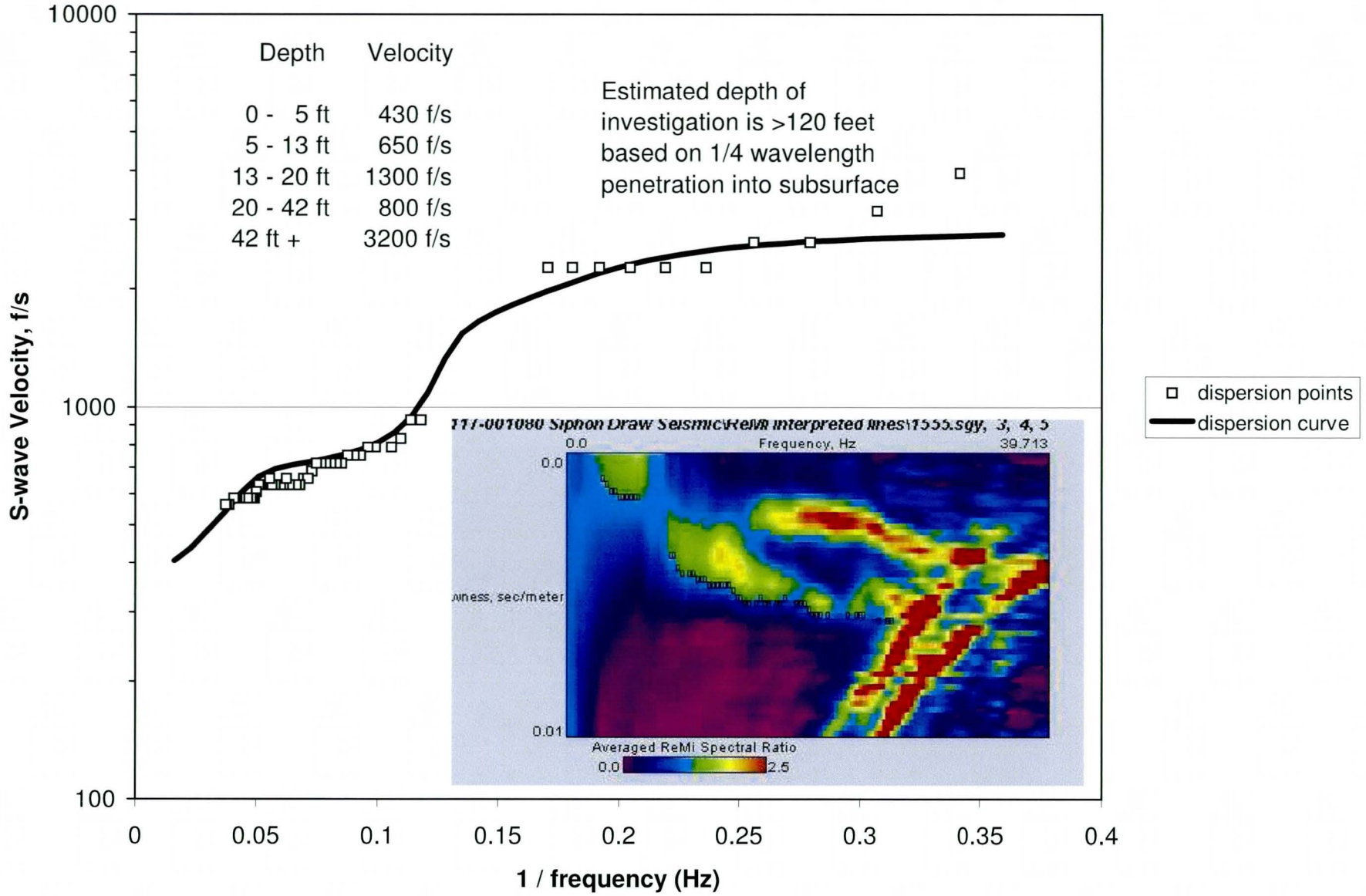

Time-Distance Plots with Interpreted Velocities (ft/sec) & Depths (ft)
Time, millisec.
Distance, feet
3050
2410
2500
2240
20.1
2920
3410
3130
14.0
7.7
2000
5.5
1630
10.7
9.3
1590
13.9
1850
6.7
7.3
2380
2480
1670
3.2
3.3
3.5
3.4
1750
1000
630
810
830
830
1250

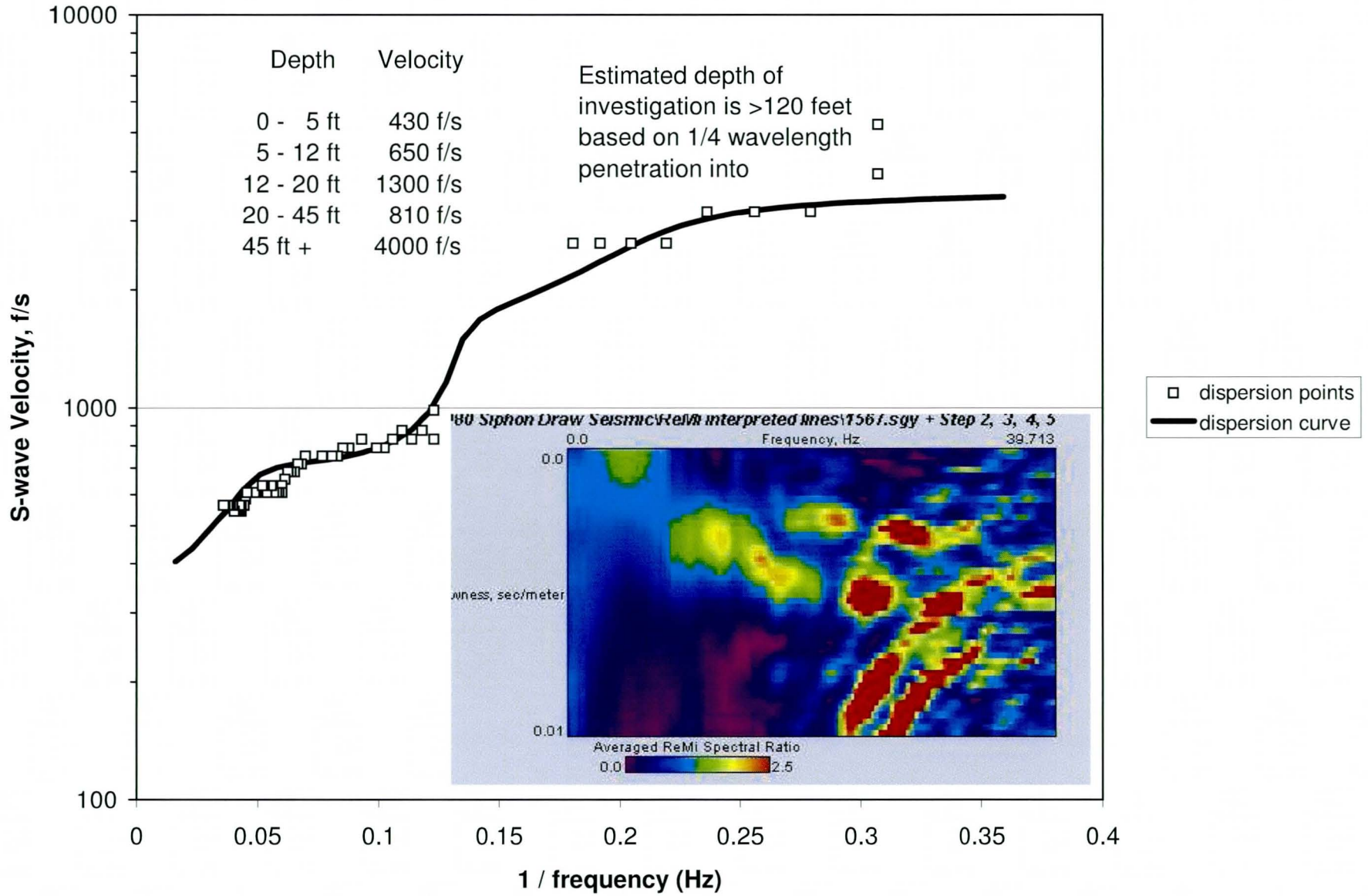

Depth Velocity
0 - 3 ft 310 f/s
3 - 11 ft 590 f/s
11 - 22 ft 1200 f/s
22 - 39 ft 790 f/s
39 ft + 3200 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve
S-wave Velocity, f/s
1 / frequency (Hz)
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5

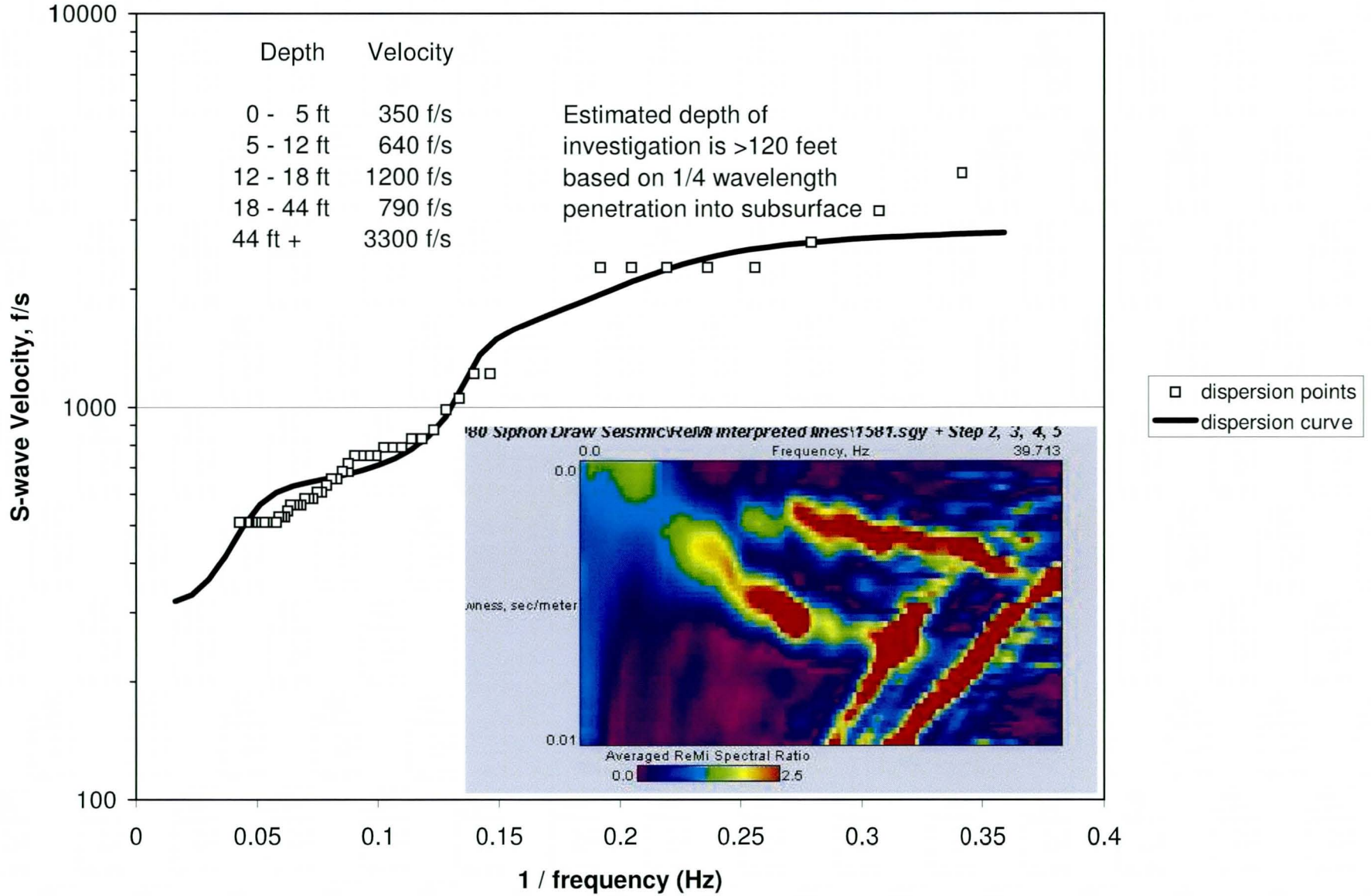

Depth Velocity
0 - 3 ft 400 f/s
3 - 13 ft 710 f/s
13 - 22 ft 1200 f/s
22 - 44 ft 790 f/s
44 ft + 3900 f/s
Estimated depth of investigation is >129 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5

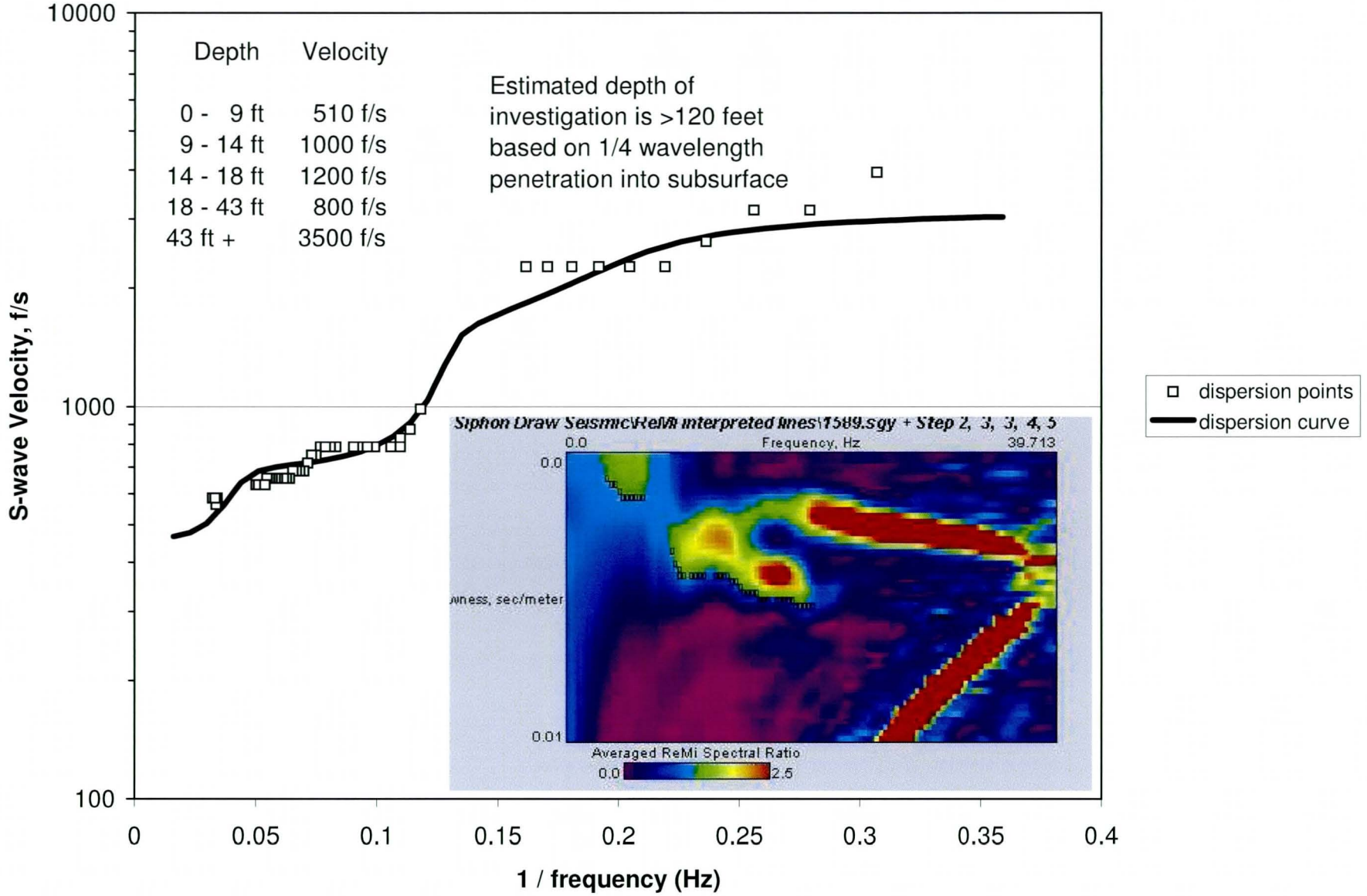
Refraction Microtremor S-wave Interpretation **Line 25** AMEC Job No. 7-117-001080

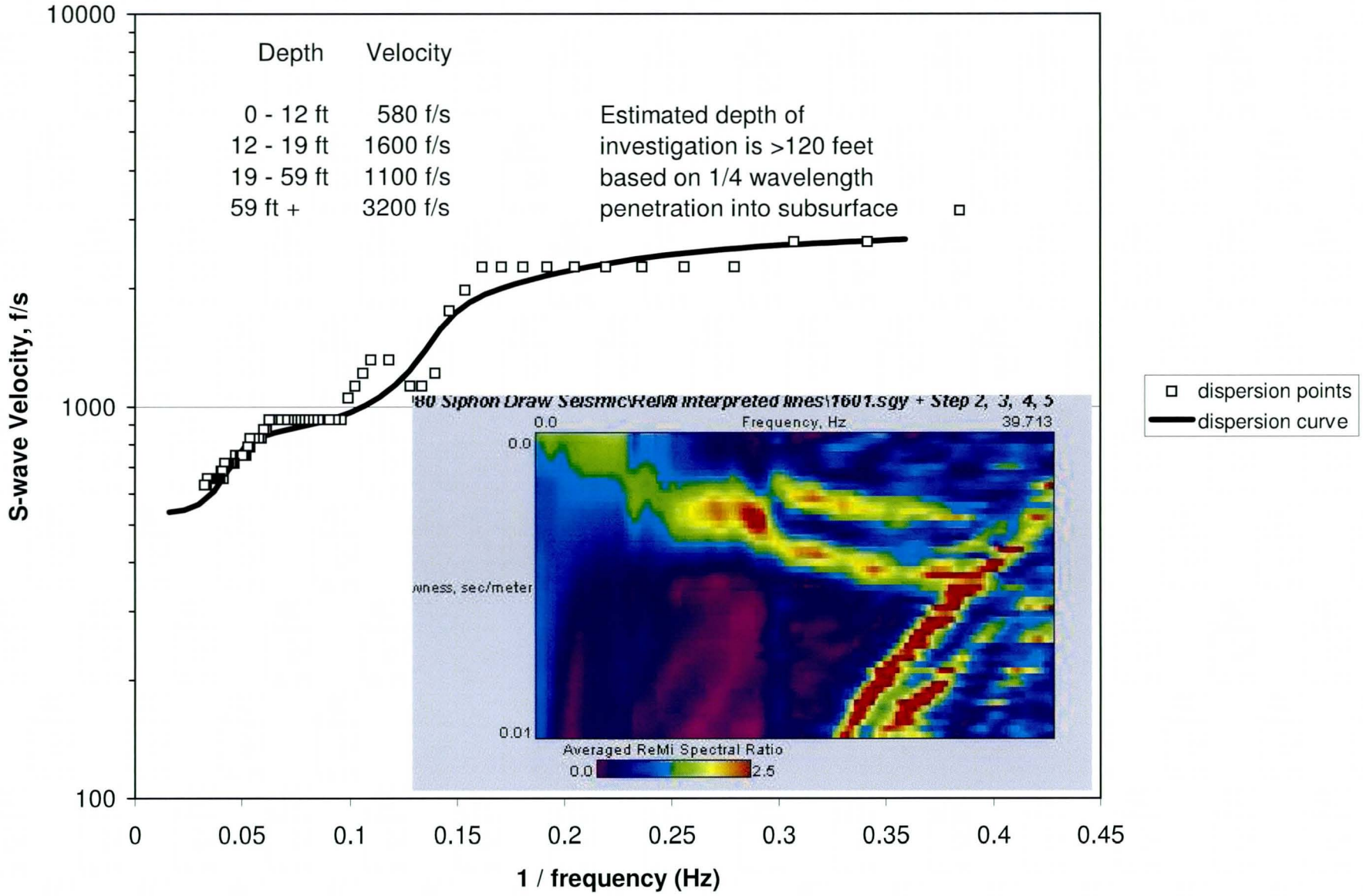


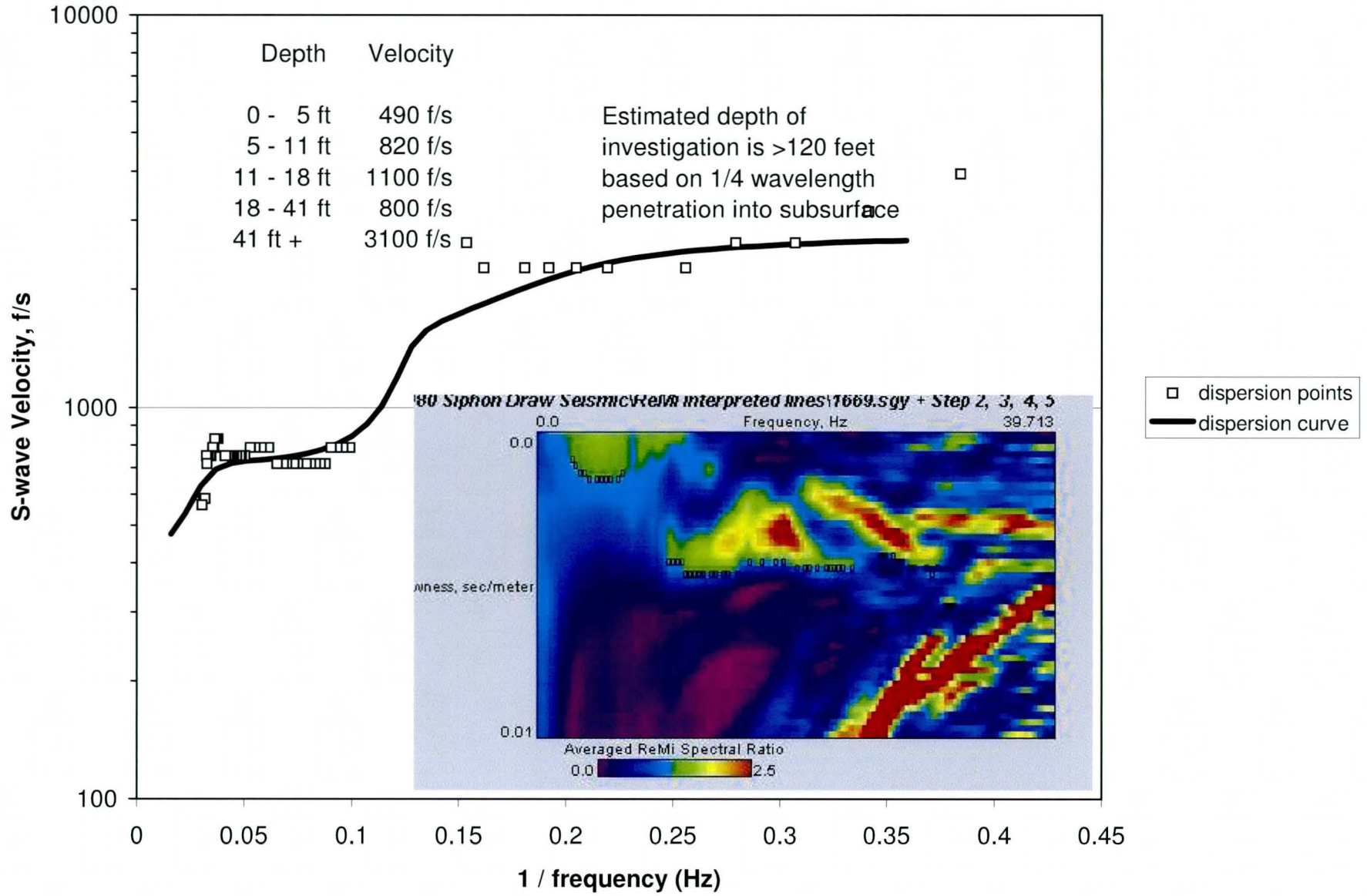

Depth Velocity
0 - 5 ft 430 f/s
5 - 13 ft 650 f/s
13 - 20 ft 1300 f/s
20 - 42 ft 800 f/s
42 ft + 3200 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5

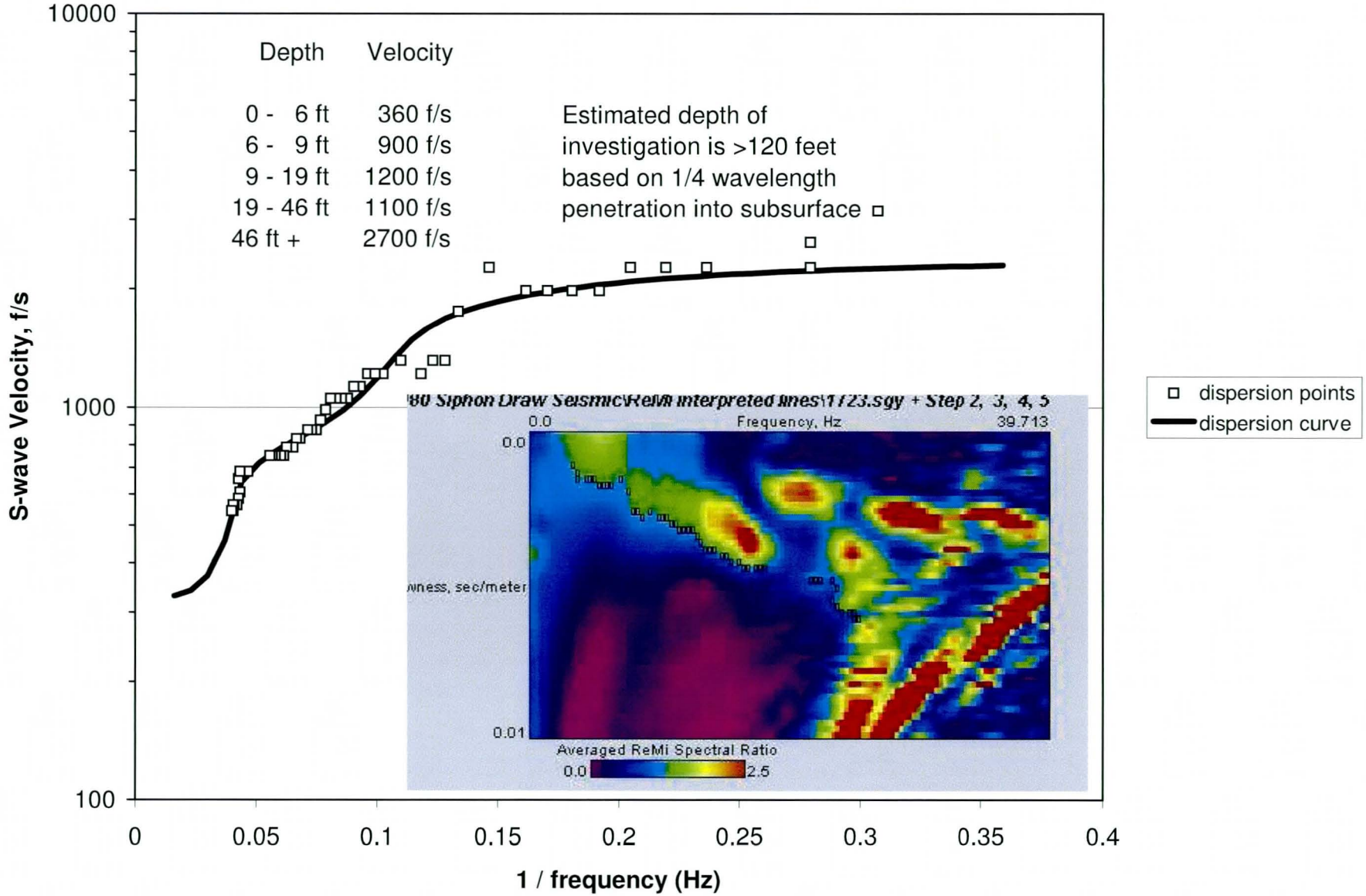

Depth Velocity
0 - 5 ft 430 f/s
5 - 12 ft 650 f/s
12 - 20 ft 1300 f/s
20 - 45 ft 810 f/s
45 ft + 4000 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5


Depth Velocity
0 - 5 ft 350 f/s
5 - 12 ft 640 f/s
12 - 18 ft 1200 f/s
18 - 44 ft 790 f/s
44 ft + 3300 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve
S-wave Velocity, f/s
1 / frequency (Hz)
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5


Depth Velocity
0 - 9 ft 510 f/s
9 - 14 ft 1000 f/s
14 - 18 ft 1200 f/s
18 - 43 ft 800 f/s
43 ft + 3500 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
Siphon Draw Seismic\ReMi interpreted lines\1589.sgy + Step 2, 3, 3, 4, 5
Frequency, Hz
39.713
0.0
0.01
Averaged ReMi Spectral Ratio
2.5
dispersion points
dispersion curve
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)

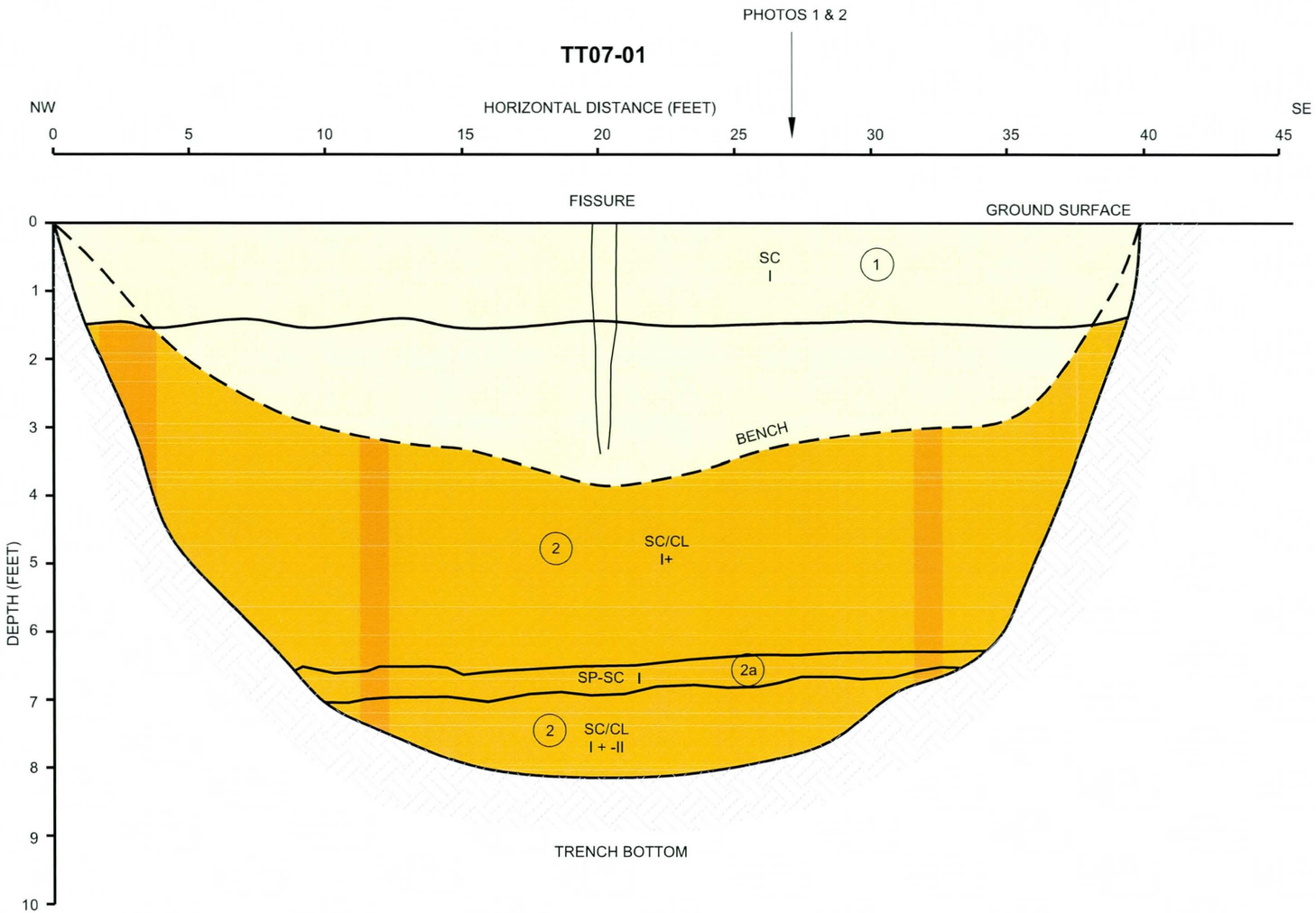

Depth Velocity
0 - 12 ft 580 f/s
12 - 19 ft 1600 f/s
19 - 59 ft 1100 f/s
59 ft + 3200 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
1 / frequency (Hz)
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5


Depth Velocity
0 - 5 ft 490 f/s
5 - 11 ft 820 f/s
11 - 18 ft 1100 f/s
18 - 41 ft 800 f/s
41 ft + 3100 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
1 / frequency (Hz)
dispersion points
dispersion curve
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
2.5


Depth Velocity
0 - 6 ft 360 f/s
6 - 9 ft 900 f/s
9 - 19 ft 1200 f/s
19 - 46 ft 1100 f/s
46 ft + 2700 f/s
Estimated depth of investigation is >120 feet based on 1/4 wavelength penetration into subsurface
dispersion points
dispersion curve
S-wave Velocity, f/s
10000
1000
100
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
1 / frequency (Hz)
Frequency, Hz
0.0
39.713
0.01
Averaged ReMi Spectral Ratio
0.0
2.5

APPENDIX D

TEST TRENCH LOGS



PROFILE - TEST TRENCH TT-01

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'

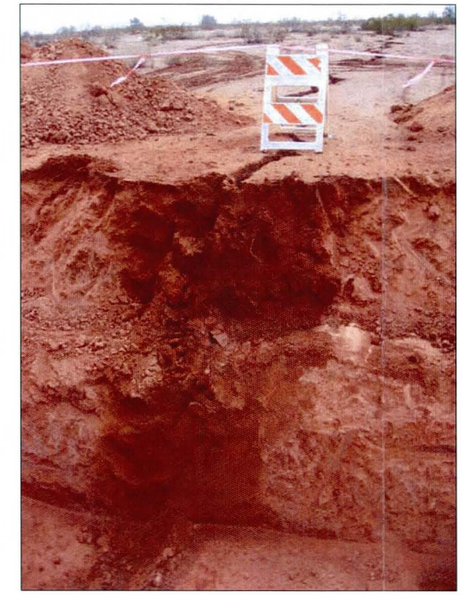


PHOTO - 1

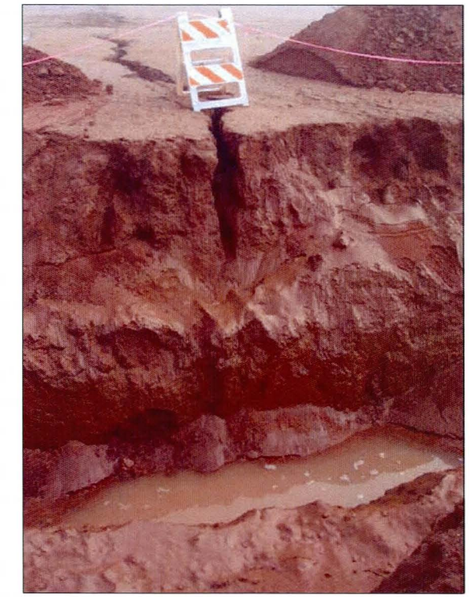


PHOTO - 2

KEY

- ALLUVIAL UNIT 1 HOLOCENE — SM (I,II) USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

(1) SC, CLAYEY SAND, TRACE GRAVEL , TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND
STAGE I, MEDIUM PLASTICITY, LIGHT REDDISH-BROWN

(2) SC/CL, CLAYEY SAND TO SANDY CLAY, TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND
STAGE I+ -II, WEAKLY CEMENTED, MEDIUM PLASTICITY, REDDISH-BROWN

(2a) SP-SC, SAND TO CLAYEY SAND, TRACE GRAVEL, WELL GRADED SAND, SUBANGULAR TO SUBROUNDED
STAGE I, NONPLASTIC TO LOW PLASTICITY, LIGHT BROWN

NOTE: TRENCH FILLED WITH WATER FROM RAIN/ RUNOFF,
PRIOR TO LOGGING- DISTRICT CLEAN OUT

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-01
TEST TRENCH LOG

INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
SIPHON DRAW DRAINAGE IMPROVEMENT PROJECT
CONTRACT FCD 2007C012

FIGURE
D-1

amec

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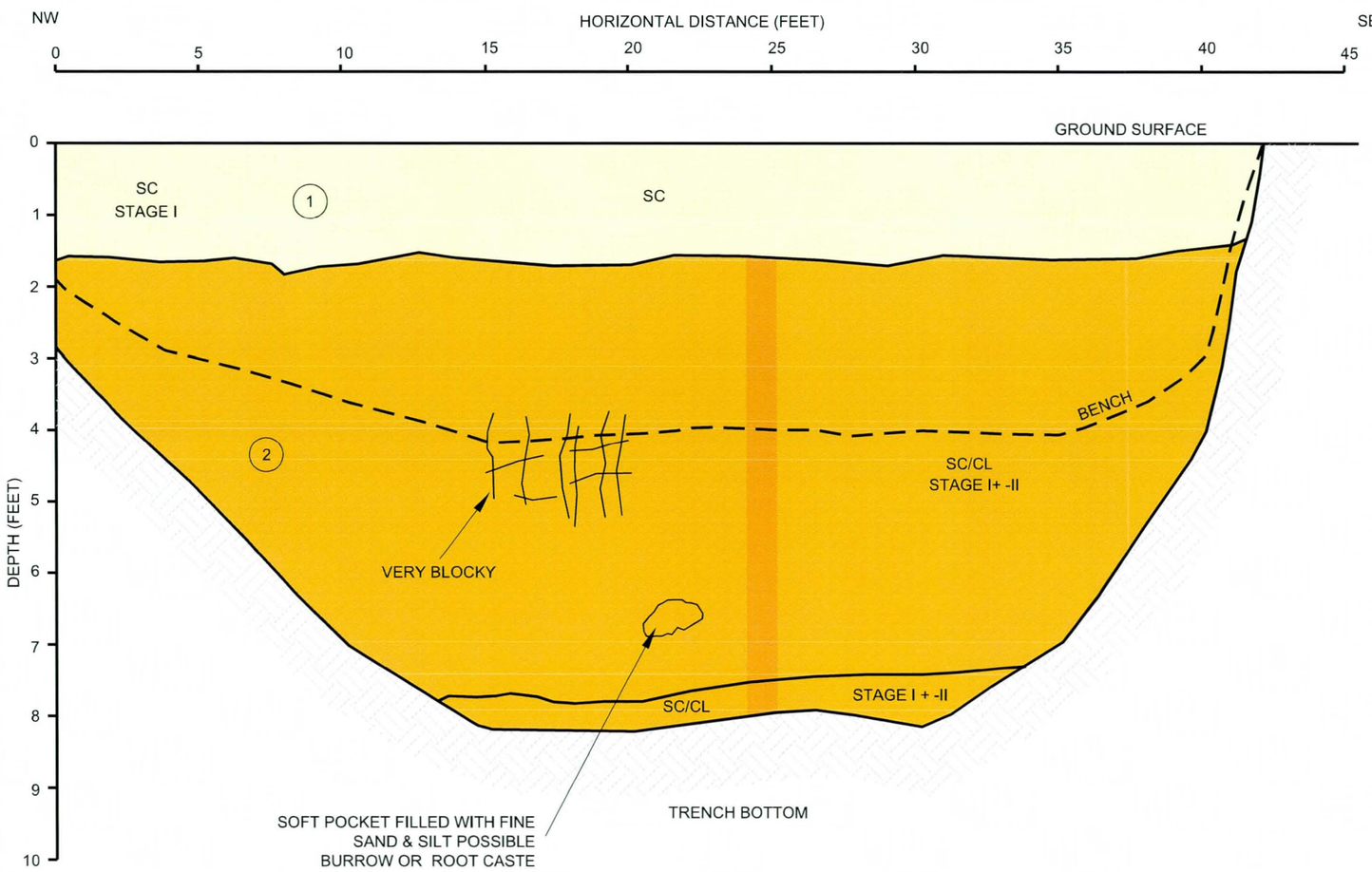
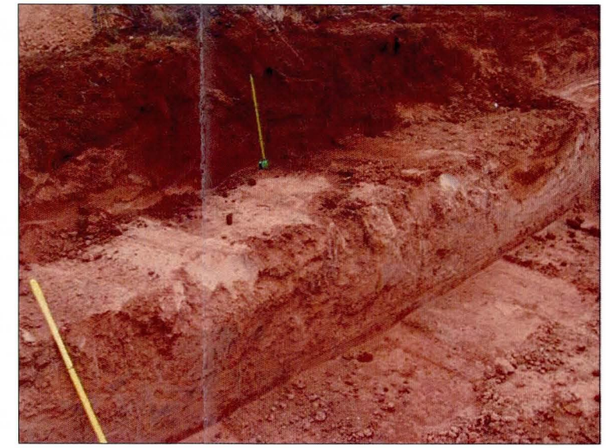
TT07-02



PROFILE - TEST TRENCH TT-02

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'



KEY

- ALLUVIAL UNIT 1 HOLOCENE
- SM (I,II) USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

1. SC, CLAYEY SAND, TRACE GRAVEL , TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND STAGE I, MEDIUM PLASTICITY, LIGHT REDDISH-BROWN
2. SC/CL, CLAYEY SAND TO SANDY CLAY, TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND STAGE I+ -II, WEAKLY CEMENTED, MEDIUM PLASTICITY, REDDISH-BROWN

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-02
TEST TRENCH LOG

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FIGURE D-2

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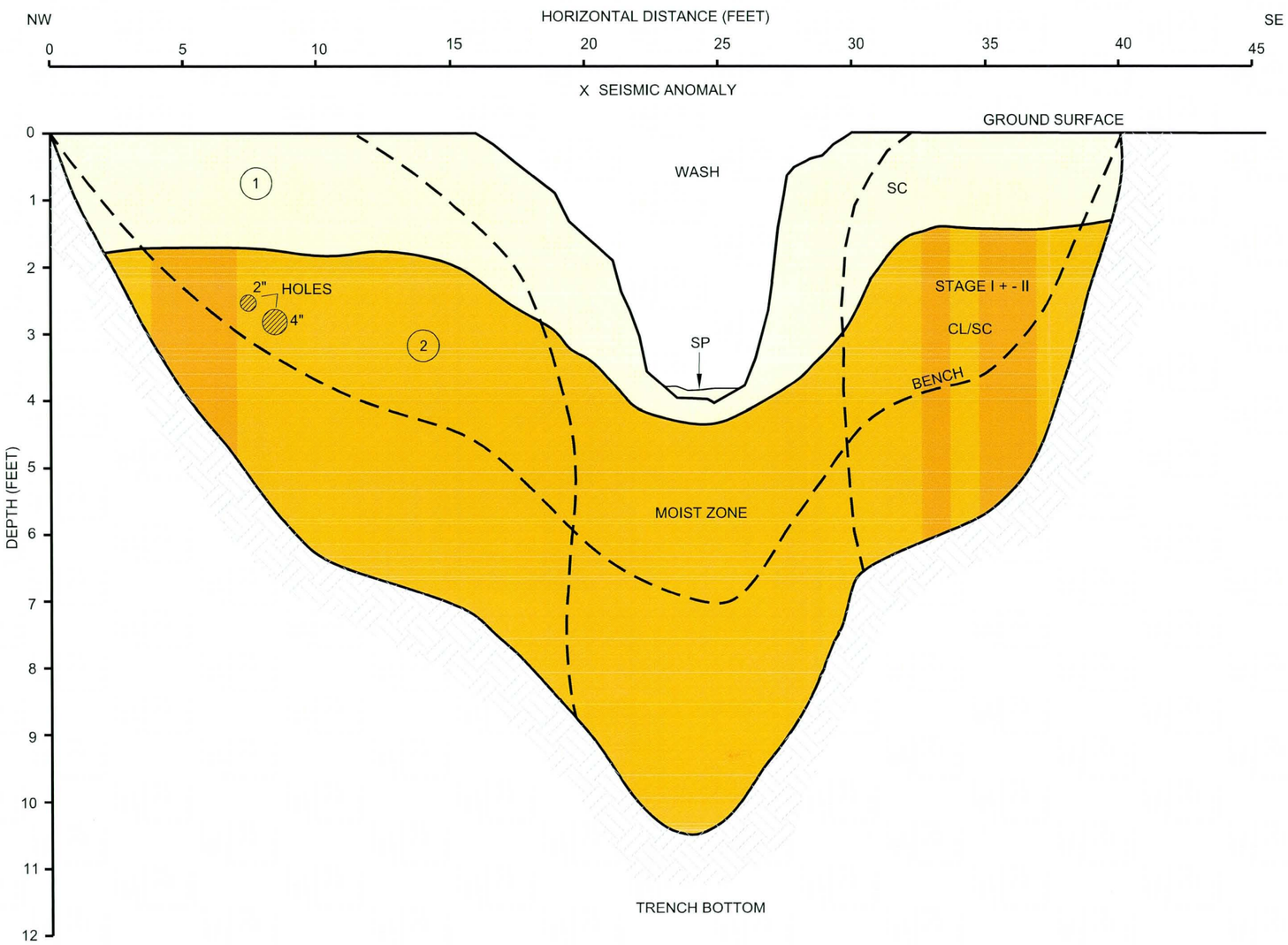
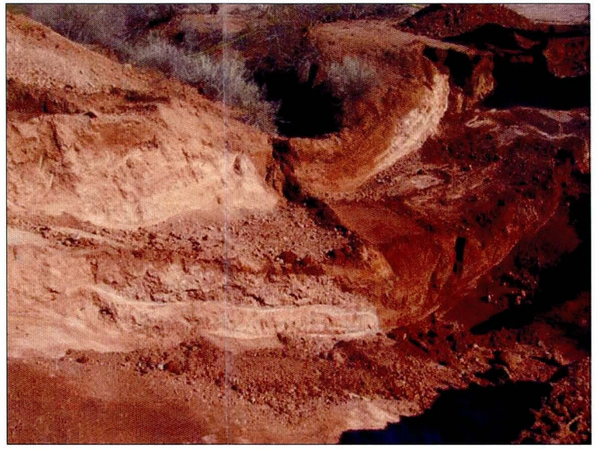


PROFILE - TEST TRENCH TT-03

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'



KEY

- ALLUVIAL UNIT 1 HOLOCENE — SM (I,II) USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

(1) SC, CLAYEY SAND, TRACE GRAVEL , TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND
STAGE I, MEDIUM PLASTICITY, LIGHT REDDISH-BROWN

(2) SC/CL, CLAYEY SAND TO SANDY CLAY, TRACE SILT, PREDOMINANTLY FINE TO MEDIUM SAND
STAGE I+ -II, WEAKLY CEMENTED, MEDIUM PLASTICITY, REDDISH-BROWN

NOTE: TRENCH FILLED WITH WATER FROM RAIN/ RUNOFF,
PRIOR TO LOGGING- DISTRICT CLEAN OUT

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-03
TEST TRENCH LOG

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FIGURE
D-3

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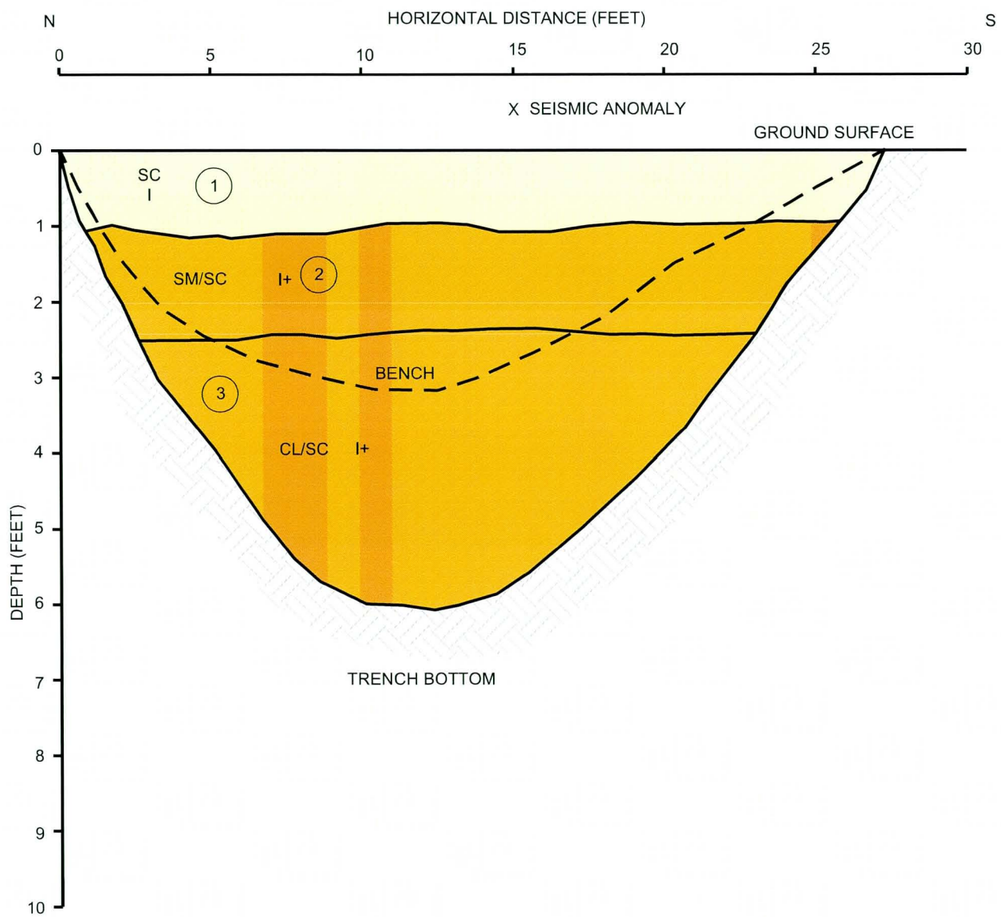

PROFILE - TEST TRENCH TT-04

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

1. SC, CLAYEY SAND, TRACE OF SILT, PREDOMINANTLY MEDIUM TO FINE SAND, STAGE I, LOW TO MEDIUM PLASTICITY, LIGHT REDDISH-BROWN
2. SM/ML, SILTY SAND TO SANDY SILT, TRACE OF CLAY, PREDOMINANTLY MEDIUM TO FINE SAND, WEAKLY CEMENTED, STAGE I+, LOW PLASTICITY, LIGHT BROWN
3. CL/ SC, CLAYEY SAND TO SANDY CLAY, PREDOMINANTLY MEDIUM TO FINE SAND, STAGE I+, WEAKLY CEMENTED, MEDIUM PLASTICITY, LIGHT REDDISH-BROWN, SLIGHTLY BLOCK STRUCTURE

KEY

- ALLUVIAL UNIT 1 HOLOCENE
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

SM (I,II) — USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

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FIGURE D-4

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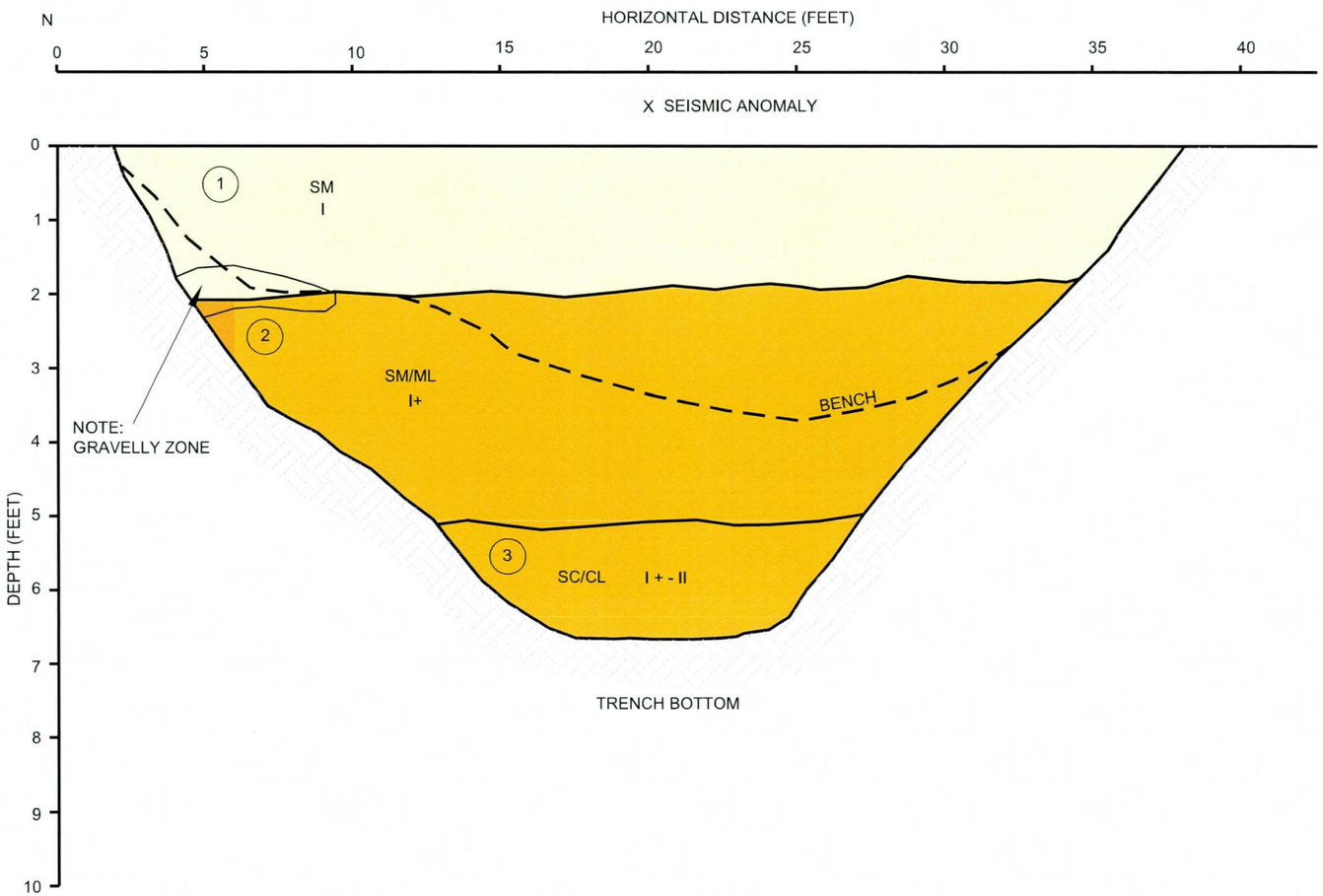

PROFILE - TEST TRENCH TT-05

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'

KEY

- ALLUVIAL UNIT 1 HOLOCENE — SM (I,II) USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

1. SM, SILTY SAND, TRACE OF CLAY, TRACE OF GRAVEL, PREDOMINANTLY FINE TO MEDIUM SAND, LOW PLASTICITY, LIGHT BROWN, STAGE I
2. SM/ML, SILTY SAND TO SANDY SILT, TRACE OF GRAVEL, TRACE OF CLAY, PREDOMINANTLY FINE TO MEDIUM SAND, WEAKLY CEMENTED, LOW PLASTICITY, LIGHT BROWN, STAGE I+
   NOTE; OCCASIONAL GRAVELLY LENSE
3. SC/CL, SANDY CLAY TO CLAYEY SAND, PREDOMINANTLY FINE TO MEDIUM SAND, WEAKLY CEMENTED, STAGE I+, LOW TO MEDIUM PLASTICITY, LIGHT REDDISH-BROWN, SLIGHTLY BLOCKY SOIL STRUCTURE

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-05
TEST TRENCH LOG

INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
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FIGURE D-5

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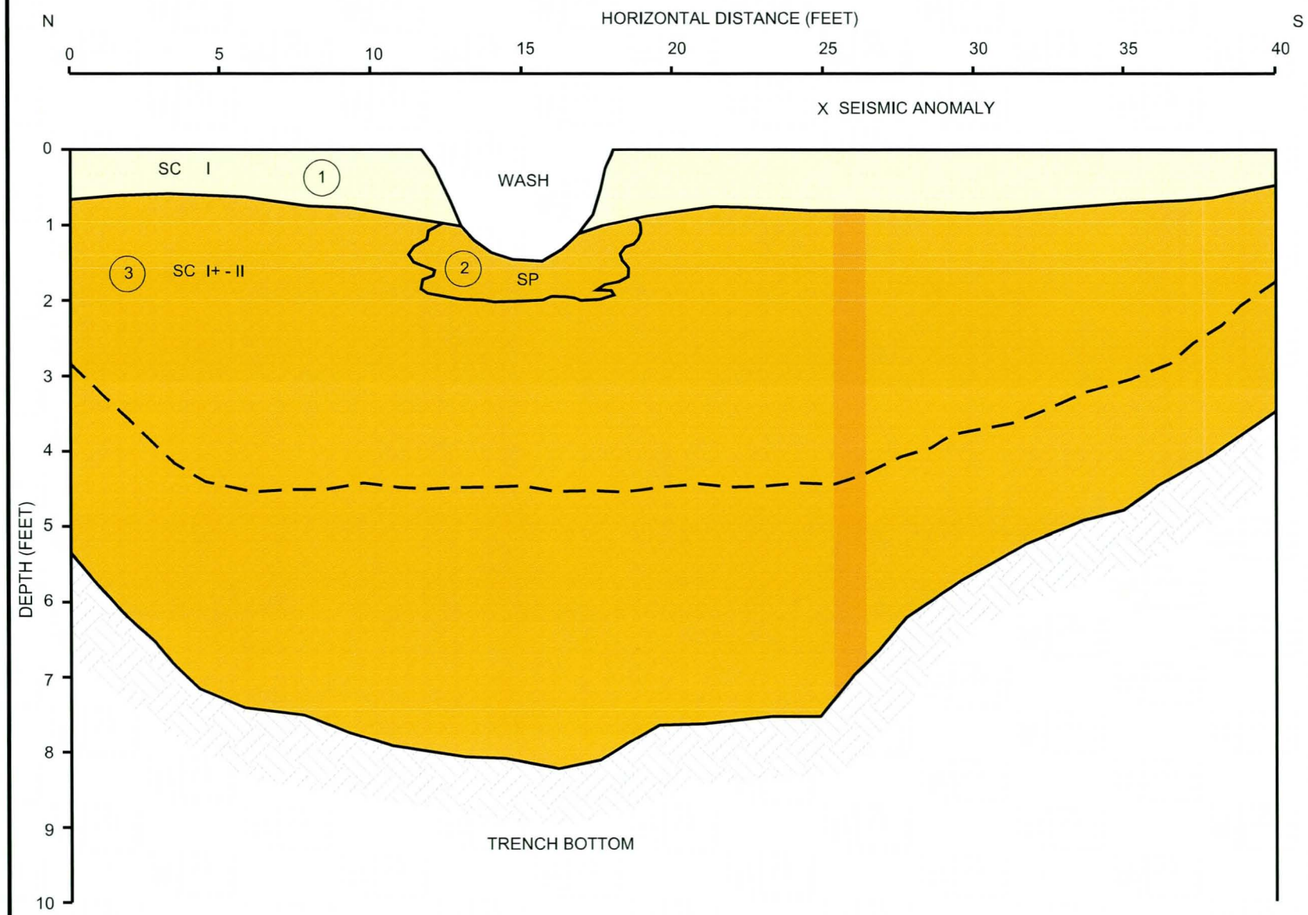

PROFILE - TEST TRENCH TT-06

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'

KEY

	ALLUVIAL UNIT 1 HOLOCENE	SM (I,II)	USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
	ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE		
	CONTACT		
	TEST TRENCH BENCH		
	SOIL DISCONTINUITY OR CRACK		

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

(1) SC, CLAYEY SAND, PREDOMINANTLY FINE TO MEDIUM SAND, NONCEMENTED, STAGE I, LOW PLASTICITY, LIGHT BROWN

(2) SP, SAND, TRACE SILT, PREDOMINANTLY MEDIUM TO FINE GRAINED, NONCEMENTED, NONPLASTIC, BROWN

(3) SC, CLAYEY SAND, RARE FINE GRAVEL, TRACE OF CONSIDERABLE SILT, PREDOMINANTLY MEDIUM TO FINE SAND, WEAKLY LIME CEMENTED, STAGE I+ -II, LOW TO MEDIUM PLASTICITY, LIGHT BROWN

NOTE: SLIGHTLY STRUCTURE, OCCASIONAL ZONE OF CL/ML, COARSE GRAINED SOUTH OF WASH

NOTE: TRENCH FILLED WITH WATER FROM RAIN/ RUNOFF, PRIOR TO LOGGING- DISTRICT CLEAN OUT

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-06
TEST TRENCH LOG

INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
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FIGURE
D-6

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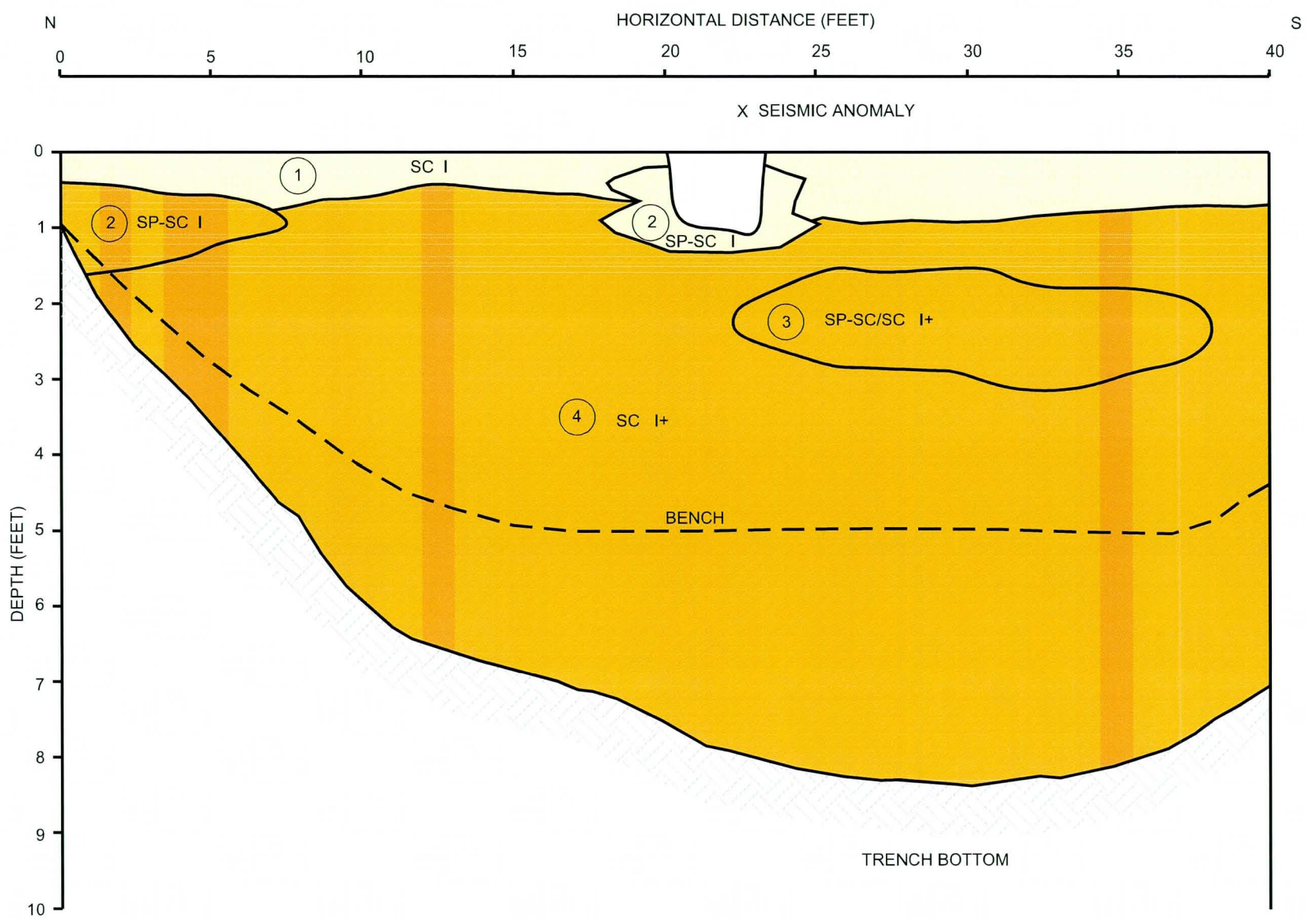

PROFILE - TEST TRENCH TT-07

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'

KEY

- ALLUVIAL UNIT 1 HOLOCENE
- SM (I,II) — USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

1. SC, CLAYEY SAND, TRACE OF SILT, PREDOMINANTLY MEDIUM TO FINE GRAINED SAND, NONCEMENTED, STAGE I, LOW PLASTICITY, LIGHT BROWN
2. SP-SC, INTERBEDDED SAND & CLAYEY SAND, PREDOMINANTLY MEDIUM TO FINE SAND, NONCEMENTED, NONPLASTIC BROWN
3. SP-SC/SC, CLAYEY SAND, TRACE OF FINE GRAVEL, WELL GRADED SAND, NONCEMENTED, STAGE I+, BROWN, NONPLASTIC
4. CLAYEY SAND, TRACE TO CONSIDERABLE SILT, PREDOMINANTLY MEDIUM TO FINE SAND, WEAKLY LIME CEMENTED, STAGE I+, LOW TO MEDIUM PLASTICITY, BROWN

NOTE: SLIGHTLY PRISMATIC STRUCTURE, OCCASIONAL ZONE OF CL/ML

NOTE: TRENCH FILLED WITH WATER FROM RAIN/ RUNOFF, PRIOR TO LOGGING- DISTRICT CLEAN OUT

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

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FIGURE D-7

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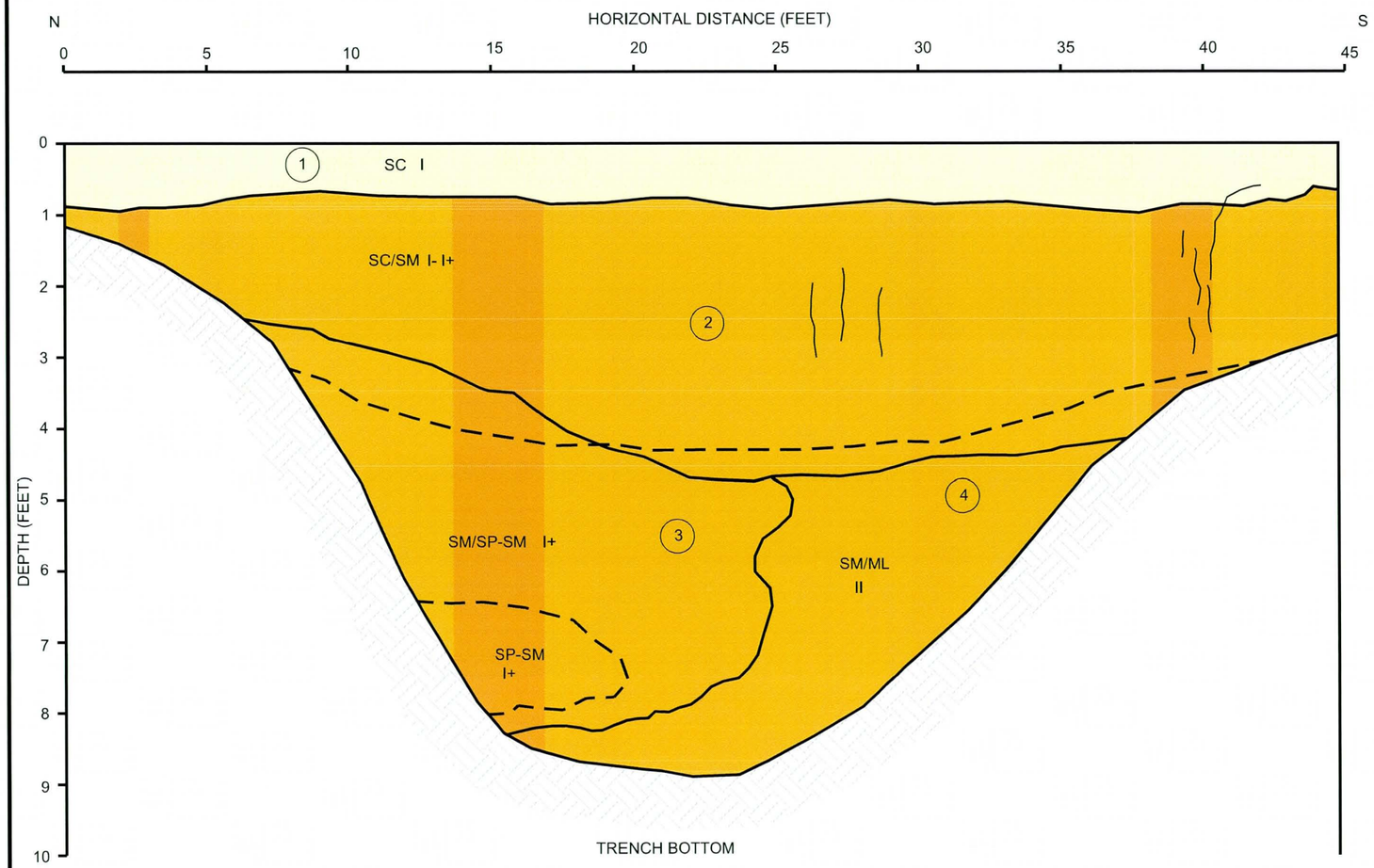
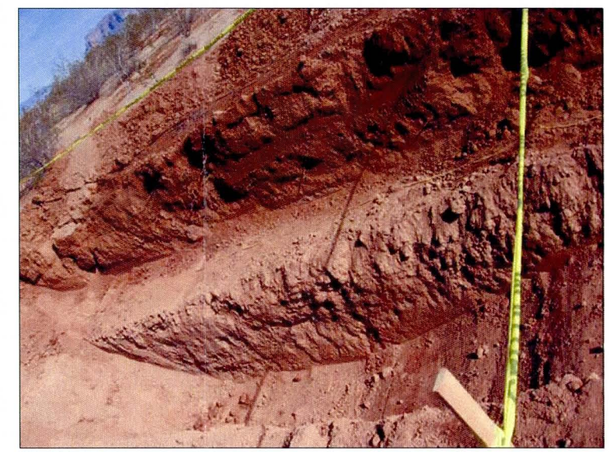


PROFILE - TEST TRENCH TT-08

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'



USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

1. SC, CLAYEY SAND, TRACE OF SILT, PREDOMINANTLY MEDIUM TO FINE GRAINED SAND, NONCEMENTED, STAGE I, LOW PLASTICITY, LIGHT BROWN
2. SC/SM, SILTY TO CLAYEY SAND, TRACE OF GRAVEL, PREDOMINANTLY MEDIUM TO FINE SAND, NONCEMENTED, STAGE I-I+, LOW PLASTICITY, LIGHT BROWN
3. SP-SM/SM, SILTY SAND TO SAND, TRACE TO CONSIDERABLE GRAVEL, WELL GRADED SAND, PREDOMINANTLY FINE GRAVEL, SUBANGULAR TO SUBROUNDED, NONCEMENTED, STAGE I+, NONPLASTIC TO LOW PLASTICITY, LIGHT BROWN

   NOTE: OCCASIONAL GRAVELLY LENSE
4. SILTY SAND TO SANDY SILT, PREDOMINANTLY MEDIUM TO FINE SAND, WEAKLY CEMENTED, STAGE II, LOW PLASTICITY, LIGHT BROWN

NOTE: TRENCH FILLED WITH WATER FROM RAIN/ RUNOFF,

KEY

- ALLUVIAL UNIT 1 HOLOCENE
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

SM (I,II) USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-08
TEST TRENCH LOG

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FIGURE D-8

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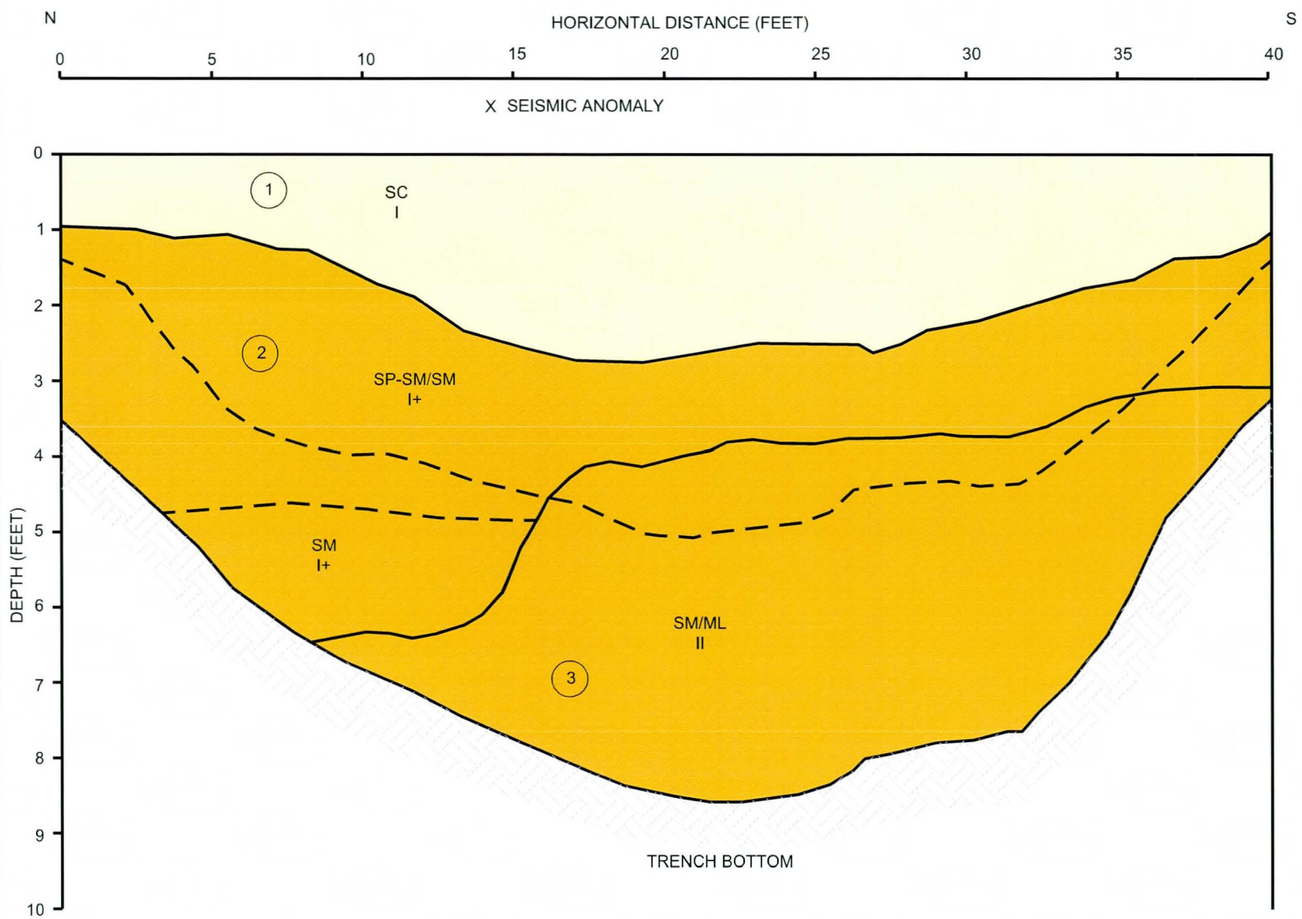
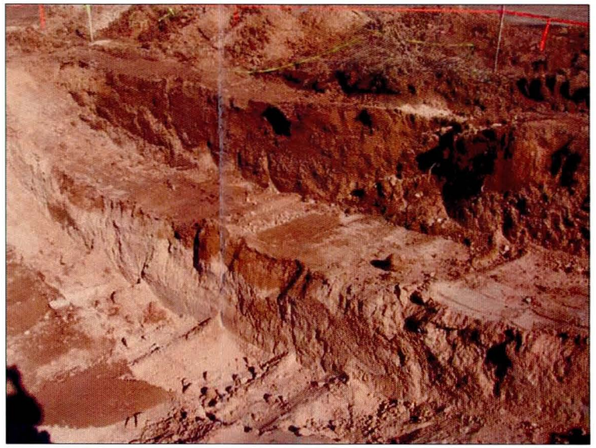


PROFILE - TEST TRENCH TT-09

SCALE: HORIZONTAL: 1" = 10', VERTICAL 1" = 2'



USCS DESIGNATIONS & GEOLOGIC DESCRIPTION

(1) SC, CLAYEY SAND, TRACE OF SILT, TRACE OF GRAVEL, PREDOMINANTLY MEDIUM TO FINE GRAINED SAND, NONCEMENTED, STAGE I, LOW PLASTICITY, LIGHT BROWN

(2) SP-SM/SM, SAND & GRAVEL TO SILTY SAND & GRAVEL, WELL GRADED SAND, PREDOMINANTLY FINE GRAVEL, SUBANGULAR TO SUBROUNDED NONCEMENTED, STAGE I+, NONPLASTIC, BROWN

(3) SM/ML, SILTY SAND TO SANDY SILT, TRACE OF FINE GRAVEL, PREDOMINANTLY MEDIUM TO FINE SAND, WEAKLY LIME CEMENTED, STAGE II, LOW PLASTICITY, LIGHT BROWN

NOTE: PREDOMINANTLY SM WITH ZONES OF ML

NOTE: OCCASIONAL ZONE WITH SLIGHT PRISMATIC STRUCTURE

KEY

- ALLUVIAL UNIT 1 HOLOCENE
- SM (I,II) — USCS SOIL CLASSIFICATION WITH STAGE OF CARBONATE MORPHOLOGY
- ALLUVIAL UNIT 2 HOLCCENE/ LATE PLEISTOCENE
- CONTACT
- TEST TRENCH BENCH
- SOIL DISCONTINUITY OR CRACK

JOB NO.	7-117-001080
DESIGN:	KLF
DRAWN:	VF
DATE:	7/2008
SCALE:	AS SHOWN

TT07-09
TEST TRENCH LOG

INITIAL GEOLOGIC HAZARD ASSESSMENT AND GEOTECHNICAL CHARACTERIZATION REPORT
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FIGURE D-9

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APPENDIX E

BORING LOGS

TEST DRILLING EQUIPMENT AND PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or "river-run" material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT AND PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

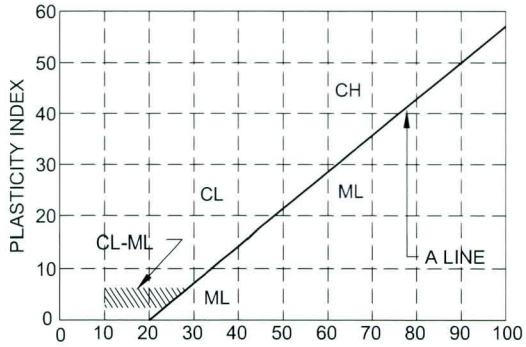
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the United Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see " The Unified Soil Classification System " ASTM Designation: D2487

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
					GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixture.
			Limits plot below "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot below "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid limit less than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid limit more than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid limit more than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1512'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist moderately firm	**SANDY SILT,** some predominantly, medium to coarse grained, subrounded to subangular sand, low plasticity, brown
				S	6-6-5					
								SC-SM	slightly moist firm	**CLAYEY SILTY SAND,** occasional fine grained, subangular gravel, predominantly fine to medium grained, subangular sand, low plasticity, brown
5				U	17	87	3			
								CL	slightly moist very firm	**CLAY,** trace of silt, weakly lime cemented to some calcium carbonate filaments, medium plasticity, brown note: increase in cementation below 9'
				S	11-15-23					
10				S	14-20-24		8			
								ML	slightly moist hard	**SILT,** some predominantly medium to coarse grained, subrounded to subangular sand, weakly lime cemented, calcium carbonate nodules, low plasticity, light brown
15				U	78	95	6			
										Stopped Auger at 14'6" Stopped Sampler at 15'6"
20										
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-1

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Channel

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1514'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	3-6-8			SM	slightly moist moderately firm	**SILTY SAND,** considerable silt, predominantly fine to medium grained, subangular to subrounded, low plasticity, brown
								ML	slightly moist firm	**SANDY SILT,** trace sand, weakly lime cemented with some calcium carbonate filaments, low to medium plasticity, brown
5				S	12-14-16					
								CL	slightly moist hard	**SANDY CLAY,** some silt, predominantly fine to medium grained sand, weakly lime cemented to medium lime cemented, medium plasticity, brown to dark brown note: rare to occasional fine grained, subangular to subrounded gravel, predominantly fine grained, subangular to angular sand, weakly lime cemented, low plasticity, brown below 9' note: very firm below 9' note: predominantly medium to coarse grained sand with trace fine grained gravel, moderately lime cemented, medium plasticity, light brown below 13'6" note: hard below 13'6"
				U	50/10"					
10				S	12-17-25					
15				S	22-30-44		6			
				U	100/5"					
20										Stopped Auger at 19'2" Sampler refused at 19'11"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-2

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Channel

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1513'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-4-6			SM	slightly moist moderately firm	**SILTY SAND,** well graded, subangular to angular sand, low plasticity, brown
								CL	slightly moist firm	**SANDY CLAY,** rare to occasional fine grained, subangular to subrounded gravel, predominantly fine grained, subangular to subrounded sand, weakly lime cemented with some calcium carbonate filaments, low plasticity, brown note: increasing calcium carbonate & low to medium plasticity below 6'
5				S	5-8-10					
				S	12-15-12					
								SC	slightly moist very firm	**CLAYEY SAND,** rare fine grained, subangular to subrounded gravel, predominantly fine to medium grained, high plasticity, reddish-brown
10				U	56	104	12			
								SM	slightly moist very firm to hard	**SILTY SAND,** predominantly medium to coarse grained sand, subangular to angular, low plasticity, brown note: clayey lenses 2" to 4" thick note: trace fine gravel below 16'
15				S	21-22-23					
20				S	27-50/5"		6			
										Stopped Auger at 19'6" Sampler refused 20'5"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-3

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Channel

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1510'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-3-5			SM	slightly moist soft to moderately firm	**SILTY SAND,** considerable silt, predominantly medium to coarse grained sand, subangular to subrounded, low plasticity, brown note: trace to some well graded gravel below 3'6"
5				U	15	111	3			
								SP-SC	slightly moist very firm	**SAND WITH CLAY & GRAVEL,** well graded, subangular to subrounded gravel, predominantly subangular to angular, medium to coarse grained sand, low plasticity to nonplastic, brown
				S	6-13-19		2			
10				S	10-16-20					note: predominantly fine grained gravel below 11'
								SC	slightly moist hard	**CLAYEY SAND,** occasional fine grained, subangular to subrounded gravel, predominantly fine to medium grained sand, subangular to subrounded, weakly lime cemented, medium plasticity, light brown
15				U	80	100	7			
								CL	slightly moist hard	**SANDY CLAY,** some medium to fine grained sand, medium lime cemented, low plasticity, brown
20				S	21-28-47					
										Stopped Auger at 19'6" Stopped Sampler at 21'
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-4

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Channel

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1507'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-4-8			SM	slightly moist moderately firm to firm	**SILT WITH SAND,** considerable well graded, subangular sand, low plasticity, brown note: trace fine grained gravel below 2'
5				S	8-9-10					
								SC	slightly moist firm to hard	**CLAYEY SAND,** rare fine grained, subangular to subrounded gravel, predominantly fine to medium grained sand, moderately lime cemented with calcium carbonate filaments, medium plasticity, brown
				U	30	94	9			
10				S	15-22-30		7			note: some well graded sand in zones note: increased cementation below 8'6"
										note: trace silt below 13'
15				S	17-18-18					
20				S	29-50/5"					
										Stopped Auger at 19'6" Sampler refused at 20'5"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-5

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Channel

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1505'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	4-4-3			ML	slightly moist soft	**CLAYEY SILT,** trace medium to fine grained sand, medium plasticity, brown
								CL	slightly moist firm to hard	**CLAY WITH SAND,** rare fine grained, subangular to subrounded gravel, some predominantly fine grained, subangular to subrounded sand, weakly lime cemented, some calcium carbonate filaments, medium plasticity, brown
5				S	9-12-16		7			
				S	8-12-18					
										note: some small diameter roots below 9'
10				U	32	93	7			
										note: trace to some well graded sand below 12'
15				S	21-18-16					
										note: gravelly sand zones below 17'6" alternating with silty clay zones
20				U	90					
										Stopped Auger at 19'6" Stopped Sampler at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-6

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1502'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-3-4			CL	moist soft to hard	**CLAY,** trace medium to fine grained sand, medium plasticity, dark brown note: considerable well graded sand on surface note: decrease in sand & weakly lime cemented below 3'6"
5				S	12-13-16					note: increase in sand below 7'
				U	63					note: moderately lime cemented, thin, alternating zones up to 2" to 4" thick of silt, clay & sand below 8'6"
10				S	20-24-33					
								SP-SC	slightly moist very firm	**SAND WITH CLAY,** trace of fine grained, subangular to subrounded gravel, predominantly medium grained, subangular to subrounded sand, medium plasticity, brown to light brown
15				U	56	105	3			
								SM	slightly moist hard	**SILTY SAND,** trace fine grained, subangular gravel, predominantly medium to coarse grained, subangular sand, weakly lime cemented, low plasticity, light brown
20				S	28-26-25		3			
								SP	slightly moist very dense	**SAND WITH GRAVEL,** trace silt, some predominantly fine grained gravel, predominantly medium to coarse grained, subangular sand, weakly lime cemented, nonplastic, light brown
25				S	17-38-50/5"					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-7

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1502'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25			X					SP		**SAND WITH GRAVEL,** continued
										Stopped Auger at 24'6" Sampler refused at 25'11"
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-7

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1502'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-4-7			ML	slightly moist moderately firm	**SILT,** some predominantly medium to coarse grained, subangular to subrounded sand, low plasticity to nonplastic, light brown note: small man-made fill piles in the area of the boring
								CL	slightly moist firm to hard	**SILTY CLAY,** trace predominantly fine grained, subangular to subrounded sand, weakly lime cemented, some calcium carbonate filaments, medium plasticity, brown
5				S	11-10-15		6			
				U	44	101	10			
10				U	57					note: increase in calcium carbonate cemented nodules & moderately lime cemented below 11'
15				S	20-30-43					note: increase in well grained sand, decrease in cementation below 17'
20				S	26-19-24					
25				U	100/8"	87	9			

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-8

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1502'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25										Stopped HSA at 24'6" Sampler refused at 25'2"
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-8

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1501'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	3-4-5			SM/ML	slightly moist soft	**SILTY SAND,** trace subangular fine grained gravel, predominantly medium to coarse grained sand, subangular, low plasticity, brown note: locally grading to sandy silt
								CL	slightly moist very firm to hard	**SILTY CLAY,** trace predominantly medium grained subangular sand, low to medium plasticity, weakly lime cemented, brown note: decrease in cementation below 6'6"
5				U	33					
				S	10-14-18					
10				S	12-18-26					
15				S	18-22-29		6			
								SC	slightly moist hard	**CLAYEY SAND,** rare fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded sand, medium plasticity, brown
20				U	100	91	7			
										Stopped Auger at 19'6" Sampler refused at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-9

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1500'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist moderately firm	**SILT,** some calcium carbonate filaments, low plasticity, brown
				S	5-6-7					
										note: increase calcium carbonate filaments & low to medium plasticity below 4'
5				S	6-7-8		6			
								SC	slightly moist very firm to hard	**CLAYEY SAND,** rare fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded, weakly lime cemented, some calcium carbonate filaments, medium to high plasticity, brown
				U	54	107	9			
										note: increase in calcium carbonate filaments below 8.5'
10				S	18-20-24					
										note: high plasticity below 11'
15				S	17-24-31					
										Stopped Auger at 14'6" Stopped Sampler at 16'
20										
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-10

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/2/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1500'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-3-5			ML	slightly moist soft to moderately firm	**SANDY SILT,** trace fine grained, subangular gravel, some predominantly medium coarse grained, subangular sand, low plasticity to nonplastic, brown note: decrease in sand below 2'
5				S	5-6-7					note: sandy zones with trace of fine gravel below 6'
				S	3-5-5					
								CL	slightly moist very firm	**CLAY,** rare to occasional fine grained, subangular to subrounded sand, weakly lime cemented with some calcium carbonate filaments, medium plasticity, brown
10				U	42	81	10			
								SW	slightly moist dense	**SAND,** trace fine grained, subangular gravel, well graded, subangular to subrounded sand,nonplastic, brown
15				S	15-18-19		3			
								ML	slightly moist very firm	**SANDY SILT,** trace of fine grained gravel, some calcium carbonate, low to nonplastic, predominantly medium to coarse grained, subangular sand, light brown
20				S	20-22-27					
										Stopped HSA at 19'6" Stopped sampler at 21'
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-11

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1499'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	slightly moist soft to moderately firm	**SILTY SAND,** trace fine grained, subrounded gravel, predominantly well graded, medium coarse grained, subangular to subrounded sand, low plasticity, light brown note: nonplastic to low plasticity below 4'
				S	3-4-4					
5				U	14					
								ML	slightly moist very firm	**SILT,** trace of subangular to subrounded, fine grained gravel, predominantly well graded, subangular to subrounded sand, nonplastic, light brown
10				S	11-15-18		5			
								SP-SC	slightly moist very firm	**SAND WITH CLAY,** trace fine grained gravel, predominantly medium to coarse grained, subangular, uncemented, low plasticity, brown
15				U	46	106	2			
								ML	slightly moist very firm to hard	**SILT,** moderately lime cemented, some fine grained, gravel size, lime cemented nodules, low plasticity, light brown
20				S	35-50/6"					
										Stopped Auger at 19'6" Sampler refused at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-12

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1498'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	4-4-2			ML	moist soft	**SILT,** occasional gravel, trace to some medium grained sand, low plasticity, brown
5				S	1-1-2					
				U	12	99	3			note: sandy lenses below 6'
								SP	slightly moist medium dense	**SAND WITH GRAVEL,** well graded, subangular to subrounded gravel, predominantly medium to coarse grained subangular to subrounded sand, nonplastic, light brown
10				S	10-8-9					
								SC	slightly moist hard	**CLAYEY SAND,** trace fine grained, subangular to subrounded gravel, predominantly well graded, subangular to subrounded sand, medium plasticity, light brown
15				S	28-40-44		4			
				U	100/11"	105	4			note: decrease in cementation, increase in coarse grained sand below 18'
20										Stopped HSA at 19'6" Sampler refused at 20'5"
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-13

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1497'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist moderately firm to firm	**SILT,** trace of clay, low plasticity, light brown note: trace of sand & gravel in zones
				S	6-9-13					
5				S	6-6-7		4			
										note: increase in sand at 7' note: no clay from 7' to 9' note: weakly lime cemented below 9'
				S	7-8-10					
10				U	23					note: trace of clay below 12'
15				S	13-11-15					
								SC	slightly moist hard	**CLAYEY SAND,** some well graded, subangular gravel, predominantly medium grained, subangular to subrounded sand, medium plasticity, brown
20				U	100/12"	108	4			
25										Stopped HSA at 19'6" Sampler refused at 20'6"

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-14

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1497'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	1-4-5			ML	slightly moist moderately firm	**SILT,** low plasticity to nonplastic, brown
								CL	slightly moist moderately firm to firm	**CLAY,** trace predominantly fine to medium grained, subangular to subrounded sand, weakly lime cemented, some calcium carbonate filaments, medium plasticity, brown
5				S	6-5-7					
				U	33	95	11			
								ML	slightly moist very firm	**SILT,** weakly lime cemented, low plasticity, brown
10				U	50					
								ML	slightly moist very firm to hard	**SILT WITH SAND,** some to considerable, medium to coarse grained, subrounded to subangular sand,
15				S	22-21-27		6			note: considerable calcium carbonate nodules below 13'
										note: moderately to strongly lime cemented below 18'
20				S	29-49-42					note: trace clay below 19'
										note: considerable sand & increase in gravel below 22'
25				U	100/10" NR					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-15

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1497'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25										
										Stopped Auger at 24'6" Sampler refused at 25'4"
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-15

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1499'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist moderately firm	**SILT,** trace fine grained, subangular gravel, trace predominantly medium to coarse grained, subangular sand, uncemented, low plasticity, brown note: small diameter roots note: decreased gravel, trace of calcium carbonate filaments below 2'
				S	3-4-5					
				S	6-5-6					
								CL	slightly moist firm to very firm	**CLAY WITH SAND,** rare fine grained, subangular to subrounded gravel, some to considerable predominantly fine to medium grained, subangular to subrounded sand, weakly cemented to uncemented, low plasticity, brown
5				S	14-19-24					
				U	55					
10				S	8-9-15		3			
								ML	slightly moist firm to hard	**SILT WITH SILTY SAND ZONES,** silt with strongly lime cemented, silty sand zones approximately 2"-4" thick, low plasticity, brown with very light brown & gray zones
15				U	31 NR					
20				S	30-50/5"					
25				S	33-41-47					note: trace clay, trace of fine grained, subangular gravel below 24'

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-16

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1499'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25										**SILT WITH SILTY SAND ZONES,**continued
										Stopped Auger at 24'6" Stopped Sampler at 26'
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-16

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1500'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist moderately firm	**SILT WITH SAND,** predominantly fine grained sand, trace of calcium carbonate filaments, low plasticity, brown
				S	6-6-8					
5				U	32	91	8	CL	slightly moist very firm to hard	**CLAY WITH SAND,** considerable predominantly fine grained, subangular to subrounded sand, gravel-sized calcium carbonate nodules, medium plasticity, brown note: moderately lime cemented below 6'
				S	19-29-43					
10				S	18-20-24		6	ML	slightly moist very firm to hard	**SILT,** some fine grained, gravel-sized calcium carbonate nodules, low plasticity, brown note: some predominantly medium grained, subangular sand, trace of calcium carbonate filaments below 13'
15				S	18-29-50					
20				U	53 NR					
										Stopped Auger at 19'6" Stopped Sampler at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-17

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1501'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	2-4-4			ML	slightly moist soft	**SILT,** trace of well graded, subangular to subrounded sand, low plasticity to nonplastic, light brown note: small diameter roots
								SC	slightly moist very firm to hard	**CLAYEY SAND,** occasional fine grained, subangular to subrounded gravel, predominantly well graded, subangular to subrounded sand, high plasticity, brown
5				S	11-15-25					note: weakly lime cemented below 6'
				U	41	98	6			
										note: decrease in sand grain size below 9'
10				S	21-37-50/5"					
										note: decrease in clay, predominantly medium to coarse grained sand below 13'
15				S	10-23-29		3			
										Stopped Auger at 14'6" Stopped Sampler at 16'
20										
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-18

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1504'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	1-3-5			ML	moist soft	**SILT,** some predominantly medium to coarse grained, subangular sand, low plasticity, brown
								SM	slightly moist firm	**SILTY SAND,** trace fine grained, subangular gravel, predominantly medium to coarse grained, subangular sand, weakly lime cemented, low plasticity, brown
5			X	S	5-8-8		5			
			X	S	5-4-8					note: decrease in sand below 7'
10				U	27	94	2			note: alternating zones of medium to coarse grained sand & silty clay lenses below 9'
								SP-SC	slightly moist very firm	**SAND WITH CLAY,** trace fine grained, subangular gravel, trace fine grained, predominantly medium coarse grained, subangular sand, gravel-sized calcium carbonate nodules, nonplastic, brown
15			X	S	18-18-17					
								SC	slightly moist hard	**CLAYEY SAND WITH GRAVEL,** some fine grained, subangular to subrounded gravel, predominantly well graded, subangular to subrounded sand, weakly cemented, low plasticity, brown
20				U	97	111	4			
										Stopped Auger at 19'6" Stopped Sampler at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-19

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1507'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								ML	slightly moist firm	**SILT WITH SAND,** trace fine grained, subangular gravel, predominantly medium to coarse grained, subangular sand, weakly lime cemented, trace calcium carbonate filaments, low plasticity, brown
				S	4-7-9					
								CL	slightly moist firm to moderately firm	**CLAY WITH SAND,** some to considerable predominantly fine grained, subangular to subrounded sand, weakly cemented, medium plasticity, dark brown
5				U	28	94	7			
				S	9-15-18					note: decrease in sand content below 7'6"
				S	12-17-23		6			note: increased clay below 9'
10										
								SP	slightly moist dense to very dense	**SAND,** trace silt, some well graded, subangular gravel, predominantly medium to coarse grained, subangular sand, nonplastic, brown
15				U	57					
20				S	11-19-25 NR					
25										Stopped Auger at 19'6" Stopped Sampler at 21'

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-20

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1508'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	1-3-4			ML	slightly moist soft to very firm	**SILT WITH SAND,** predominantly medium to coarse grained, subangular to subrounded sand, uncemented, low plasticity, brown note: small diameter roots note: decreased sand, trace fine grained, subangular gravel below 3'6"
5				S	9-7-7					
				U	42					note: trace calcium carbonate filaments & medium grained, sand-sized calcium carbonate nodules below 7'
10				S	14-18-27		5			note: increased cementation to moderately lime cemented below 9'
15				U	83 NR					
								SP-SM	slightly moist firm	**SAND WITH SILT & GRAVEL,** trace to some fine grained, subangular gravel, predominantly medium to coarse grained, subrounded to subangular sand, uncemented, low plasticity, light brown note: clay lenses below 21'
20				S	10-13-17					
25				U	60					

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-21

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/4/08

LOCATION Structure

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1508'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								SP-SM		**SAND WITH SILT & GRAVEL,** continued
										Stopped Auger at 24'6"
										Stopped Sampler at 25'6"
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-21

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1507'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL	slightly moist firm to very firm	**SANDY CLAY,** rare fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded sand, uncemented, brown
				S	7-8-8					
5				U	31	98	5			note: trace calcium carbonate filaments & moderately lime cemented below 4'6"
								SC	slightly moist moderately firm to firm	**CLAYEY SAND,** trace to some well graded, subangular gravel, well graded subangular to subrounded sand, low plasticity, light brown
				S	6-6-7					
10				S	6-11-16		3			note: increase silt below 9'6" note: trace clay below 9'6"
								ML	slightly moist very firm	**SILT,** occasional fine grained, subrounded gravel, trace clay, trace calcium carbonate
15				S	16-17-19					
								SW	slightly moist dense	**SAND WITH GRAVEL,** some well graded, subangular to subrounded gravel, well graded, subangular to subrounded sand, nonplastic, brown
20				U	60	106	6			
										Stopped Auger at 19'6" Stopped Sampler at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-22

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1504'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	6-4-6			SC	slightly moist moderately firm to very firm	**CLAYEY SAND,** occasional to trace fine grained, subangular to subrounded gravel, predominantly fine to medium grained sand, low plasticity, brown note: trace gravel, rare small cobble on the ground surface note: increase in clay content below 2'
5				S	4-6-8					
				S	13-17-23		5			
10				U	42	83	8	CL	slightly moist very firm	**SILTY CLAY,** weakly lime cemented with trace calcium carbonate filaments, medium plasticity, dark brown
15				S	20-16-24			ML	slightly moist very firm	**SANDY SILT,** trace fine grained gravel, predominantly medium grained, subangular sand weakly lime cemented, low plasticity, light brown
20										Stopped Auger at 14'6" Stopped Sampler at 16'
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-23

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1508'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SC	slightly moist moderately firm	**CLAYEY SAND,** some predominantly well graded, subangular gravel, some predominalty fine to medium grained, subangular sand, low plasticity, light brown
				S	7-7-5					
								SP	slightly moist firm	**SAND WITH GRAVEL,** some predominantly fine grained, subangular gravel, predominantly medium to coarse grained, subangular to subrounded sand
5				S	4-7-9					
								CL	slightly moist firm to very firm	**SANDY CLAY,** rare fine grained, subangular gravel, trace silt, considerable predominantly fine to medium grained, subangular to subrounded sand, weakly lime cemented with some calcium carbonate filaments, medium plasticity
				U	50	105	9			
10				S	11-11-15					
15				S	18-18-23		5			
20										Stopped Auger at 14'6" Stopped Sampler at 16'
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-24

PROJECT Siphon Draw Retention Basin

JOB NO. 7-117-001080 **DATE** 6/3/08

LOCATION Basin Edge

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1513'
DATUM NAD 83

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	4-5-7			CL	slightly moist moderately firm to hard	**SANDY CLAY,** rare fine grained, subangular gravel, considerable predominantly fine grained, subangular to subrounded sand, medium plasticity, brown
										note: no sand below 3'
5				U	33	93	6			
										note: increase clay, weakly lime cemented, occasional calcium carbonate filaments below 6'
				S	16-16-18					
10				S	10-11-19		5			
										note: no cementation below 14'
15				S	17-16-19					
										note: increase in cementation below 19' note: increase in medium to coarse grained sand below 19'
20				U	100					
										Stopped Auger at 19'6" Stopped Sampler at 20'6"
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - California-style tube sample
NR - No Recovery

LOG OF TEST BORING NO. BH-25

APPENDIX F

LABORATORY TEST RESULTS

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive 1-inch high 2.5-inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inch per minute. The machine is designed to receive one of the 1-inch high 2.42-inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

amec

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	6/10/08

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**

PERCENT PASSING BY WEIGHT

BH-17 @ 4.5-5.5'	CL	45	26	76	86	93	95	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100
BH-18 @ 7.5-8.5'	SC	53	33	36	44	50	54	59	70	78	81	94	97	99	100	100	100	100	100	100	100	100	107
BH-19 @ 19.5-20.5'	SC	34	15	17	23	31	36	43	55	63	65	75	79	85	88	95	100	100	100	100	100	100	115
BH-20 @ 4.5-5.5'	CL	46	26	69	82	91	94	95	97	98	99	100	100	100	100	100	100	100	100	100	100	100	117
BH-21 @ 19.5-21.0'	SP-SM	31	8	9.5	13	18	22	29	43	55	61	82	89	94	96	96	100	100	100	100	100	100	126
BH-22 @ 0.0-4.5'	CL	31	13	54	66	74	78	82	88	93	95	99	100	100	100	100	100	100	100	100	100	100	128
BH-22 @ 9.5-11.0'	SC	32	13	31	39	43	46	51	61	69	72	85	89	95	98	100	100	100	100	100	100	100	132
BH-23 @ 0.0-4.5'	SC	29	10	41	52	60	64	69	77	84	86	92	95	97	98	99	99	99	99	100	100	100	135
BH-24 @ 0.0-4.5'	SC	28	9	36	45	51	55	59	67	73	75	81	82	84	85	88	92	93	95	100	100	100	140
BH-24 @ 9.5-11.0'	CL	40	23	62	74	82	85	89	93	96	97	99	100	100	100	100	100	100	100	100	100	100	143
BH-25 @ 9.5-11.0'	CL	39	21	68	81	88	91	93	97	98	98	99	100	100	100	100	100	100	100	100	100	100	148

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PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	6/10/08

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**
													PERCENT PASSING BY WEIGHT										
BH-9 @ 19.5-20.5'	SC	49	25	49	63	71	75	79	87	93	94	98	100	100	100	100	100	100	100	100	100	100	55
BH-10 @ 7.5-8.5'	SC	50	31	33	47	63	70	76	86	92	94	99	100	100	100	100	100	100	100	100	100	100	58
BH-10 @ 14.5-16.0'	SC	65	41	43	57	66	71	76	84	91	93	98	100	100	100	100	100	100	100	100	100	100	60
BH-11 @ 9.5-10.5'	CL	44	24	97	99	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	64
BH-12 @ 2.5-4.0'	SM	22	3	29	36	43	48	54	65	75	78	91	95	98	100	100	100	100	100	100	100	100	67
BH-12 @ 14.5-15.5'	SP-SC	25	4	7.6	10	14	19	26	46	65	71	89	92	97	98	100	100	100	100	100	100	100	70
BH-13 @ 19.5-20.5'	SC	38	18	32	45	55	59	62	68	75	78	88	92	97	98	100	100	100	100	100	100	100	77
BH-14 @ 19.5-20.5'	SC	42	18	13	19	26	32	40	55	67	72	84	87	91	92	93	93	100	100	100	100	100	83
BH-15 @ 4.5-6.0'	CL	46	26	93	95	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	85
BH-16 @ 9.5-11.0'	CL	31	12	72	79	84	86	89	92	95	95	98	98	98	99	100	100	100	100	100	100	100	95

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PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	6/10/08

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**

PERCENT PASSING BY WEIGHT

BH-1 @ 4.5-5.5'	SC-SM	25	5	25	35	51	58	64	75	84	87	95	97	98	100	100	100	100	100	100	100	100	2
BH-2 @ 9.5-11.0'	CL	34	11	54	74	83	86	89	93	95	95	98	99	100	100	100	100	100	100	100	100	100	9
BH-3 @ 4.5-6.0'	CL	27	8	59	70	76	79	82	87	91	92	98	99	100	100	100	100	100	100	100	100	100	13
BH-3 @ 9.5-10.5'	SC	78	53	39	51	63	71	79	92	95	96	99	99	99	100	100	100	100	100	100	100	100	15
BH-4 @ 14.5-15.5'	SC	45	24	43	54	62	66	71	80	86	89	95	96	99	100	100	100	100	100	100	100	100	22
BH-5 @ 7.5-8.5'	SC	38	19	43	55	65	72	81	92	96	97	99	99	99	100	100	100	100	100	100	100	100	26
BH-6 @ 4.5-6.0'	CL	36	17	74	82	89	91	93	96	97	98	99	100	100	100	100	100	100	100	100	100	100	31
BH-6 @ 9.5-10.5'	CL	42	23	65	81	89	91	94	97	98	99	100	100	100	100	100	100	100	100	100	100	100	33
BH-7 @ 14.5-15.5'	SP-SC	37	20	6.0	9	13	16	23	46	65	71	89	94	98	100	100	100	100	100	100	100	100	40
BH-8 @ 4.5-6.0'	CL	37	19	83	89	93	95	97	99	100	100	100	100	100	100	100	100	100	100	100	100	100	44

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PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	SEE BELOW
SAMPLE SOURCE:	SEE BORING	**DATE ASSIGNED:**	6/10/08

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD(ASTM D2937)

LAB #	BORING	MOISTURE WET WT. (g)	MOISTURE DRY WT. (g)	MOISTURE MOISTURE CONTENT	NUMBER OF RINGS	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
2	BH-1 @ 4.5-5.5'	318.0	308.0	3.2%	5.0	759.3	219.0	86.7
5	BH-1 @ 14.5-15.5'	721.8	678.1	6.4%	5.0	820.1	207.6	95.3
15	BH-3 @ 9.5-10.5'	443.2	395.9	11.9%	5.0	903.9	202.5	103.8
19	BH-4 @ 4.5-5.5'	553.5	539.9	2.5%	4.0	721.6	171.4	111.1
22	BH-4 @ 14.5-15.5'	395.8	371.1	6.7%	6.0	1,013.0	242.7	99.7
26	BH-5 @ 7.5-8.5'	359.5	330.9	8.6%	5.0	819.5	206.3	93.5
33	BH-6 @ 9.5-10.5'	354.5	330.8	7.2%	5.0	817.5	218.6	92.5
40	BH-7 @ 14.5-15.5'	311.3	302.5	2.9%	4.0	704.6	181.4	105.2
45	BH-8 @ 7.5-8.5'	780.2	710.9	9.7%	5.0	885.5	215.5	101.1
49	BH-8 @ 24.5-25.2'	547.9	504.8	8.5%	4.0	632.8	179.5	86.5
55	BH-9 @ 19.5-20.5'	354.5	331.1	7.1%	5.0	803.1	216.9	90.7
58	BH-10 @ 7.5-8.5'	437.0	400.6	9.1%	5.0	909.9	205.3	107.0
64	BH-11 @ 9.5-10.5'	255.1	232.8	9.6%	4.0	590.5	160.9	81.2
70	BH-12 @ 14.5-15.5'	374.4	367.2	2.0%	5.0	869.7	218.2	105.8
74	BH-13 @ 7.0-8.0'	571.9	556.4	2.8%	4.0	654.3	162.5	99.0
77	BH-13 @ 19.5-20.5'	376.3	360.3	4.4%	5.0	870.7	207.3	105.2
83	BH-14 @ 19.5-20.5'	385.9	371.1	4.0%	5.0	897.3	220.8	107.7
86	BH-15 @ 7.5-8.5'	545.1	491.9	10.8%	4.0	673.2	166.1	94.7
100	BH-17 @ 4.5-5.5'	331.5	307.5	7.8%	6.0	982.4	273.5	90.7
107	BH-18 @ 7.5-8.5'	363.3	341.3	6.4%	5.0	837.6	208.8	97.8
113	BH-19 @ 9.5-10.5'	652.1	637.3	2.3%	5.0	784.2	203.3	94.0
115	BH-19 @ 19.5-20.5'	447.6	431.1	3.8%	6.0	1,071.2	236.4	111.0
117	BH-20 @ 4.5-5.5'	365.1	340.0	7.4%	6.0	994.2	265.3	93.7
130	BH-22 @ 4.5-5.5'	734.5	698.1	5.2%	5.0	840.3	216.5	98.2
134	BH-22 @ 19.5-20.5'	782.9	740.6	5.7%	5.0	878.7	205.1	105.5
138	BH-23 @ 9.5-10.5'	749.5	691.8	8.3%	6.0	907.5	257.1	82.8
142	BH-24 @ 7.5-8.5'	833.6	765.0	9.0%	6.0	1,075.3	250.4	104.5
146	BH-25 @ 4.5-5.5'	687.0	647.1	6.2%	5.0	810.1	215.4	92.8

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PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	See Below
SAMPLE SOURCE:	See Below	**DATE ASSIGNED:**	6/10/08

MOISTURE CONTENT OF SOIL (ASTM D2216)

LAB #	BORING & DEPTH	WET WT. (gram)	DRY WT. (gram)	MOISTURE CONTENT
4	BH-1 @ 9.5-11.0'	427.4	395.1	8.2%
10	BH-2 @ 14.5-16.0'	375.5	355.0	5.8%
17	BH-3 @ 19.5-20.4'	209.0	197.1	6.0%
20	BH-4 @ 7.5-9.0'	1012.8	991.4	2.2%
27	BH-5 @ 9.5-11.0'	416.8	388.7	7.2%
31	BH-6 @ 4.5-6.0'	291.8	273.9	6.5%
41	BH-7 @ 19.5-21.0'	359.0	348.9	2.9%
44	BH-8 @ 4.5-6.0'	308.0	290.3	6.1%
54	BH-9 @ 14.5-16.0'	497.0	470.9	5.5%
57	BH-10 @ 4.5-6.0'	660.7	626.2	5.5%
65	BH-11 @ 14.5-16.0'	774.7	751.7	3.1%
69	BH-12 @ 9.5-11.0'	554.8	530.3	4.6%
76	BH-13 @ 14.5-16.0'	679.4	654.0	3.9%
79	BH-14 @ 4.5-6.0'	472.4	455.6	3.7%
88	BH-15 @ 14.5-16.0'	626.8	590.2	6.2%
95	BH-16 @ 9.5-11.0'	268.7	261.8	2.6%
102	BH-17 @ 9.5-11.0'	623.1	589.7	5.7%
109	BH-18 @ 14.5-16.0'	819.3	798.6	2.6%
111	BH-19 @ 4.5-6.0'	593.6	564.5	5.2%
119	BH-20 @ 9.5-11.0'	519.5	491.7	5.7%
124	BH-21 @ 9.5-11.0'	669.5	639.7	4.7%
132	BH-22 @ 9.5-11.0'	472.8	460.6	2.6%
137	BH-23 @ 7.5-9.0'	604.4	578.0	4.6%
144	BH-24 @ 14.5-16.0'	449.7	427.1	5.3%
148	BH-25 @ 9.5-11.0'	326.4	309.9	5.3%

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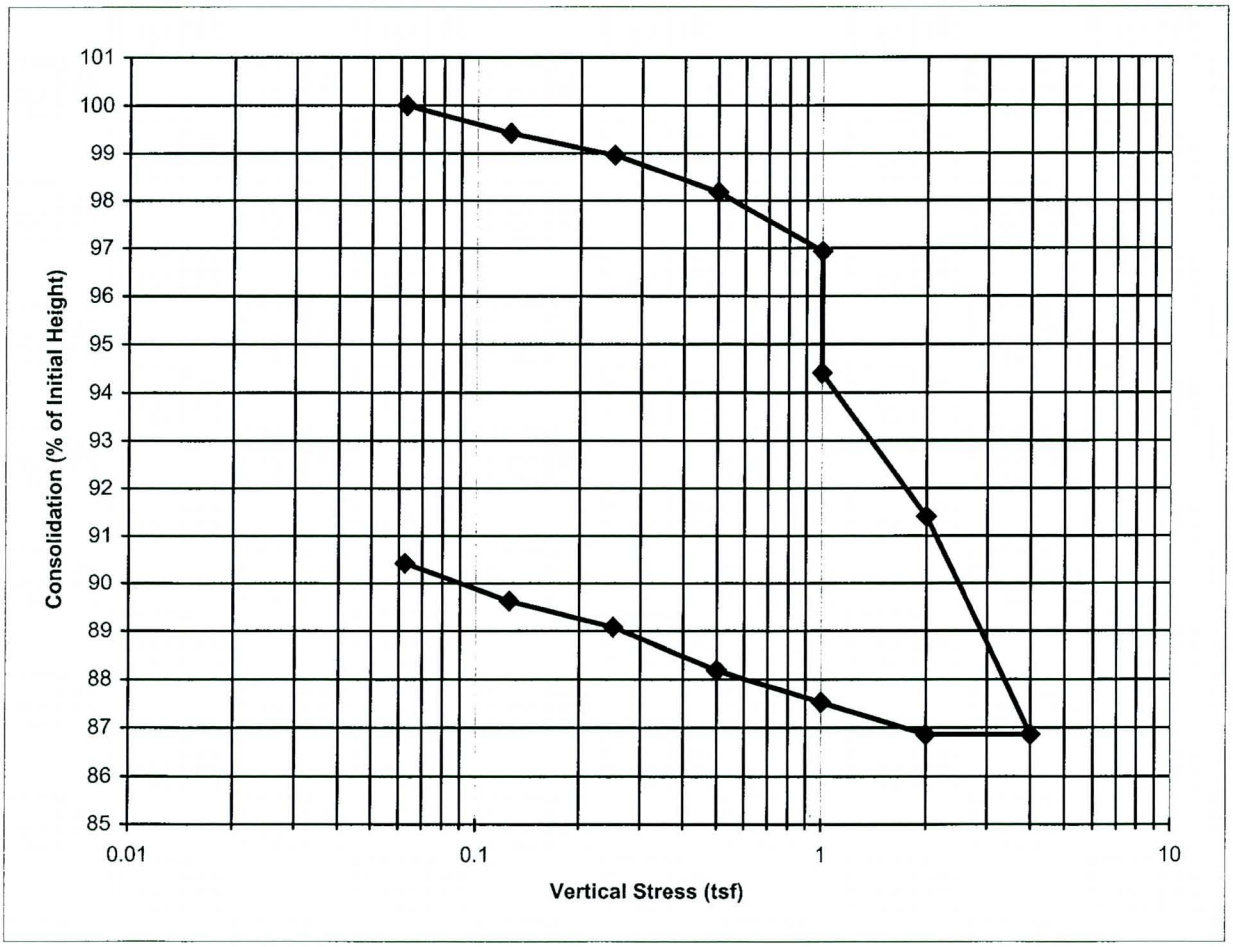
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	8
SAMPLE SOURCE:	BH-2 @ 7.5-8.3'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.00
INITIAL MOISTURE CONTENT	6.4%	FINAL MOISTURE CONTENT	18.8%
INITIAL DRY DENSITY(pcf)	106.6	FINAL DRY DENSITY(pcf)	122.3
INITIAL DEGREE OF SATURATION	25%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.77	FINAL VOID RATIO	0.54
		SATURATED AT	1 tsf



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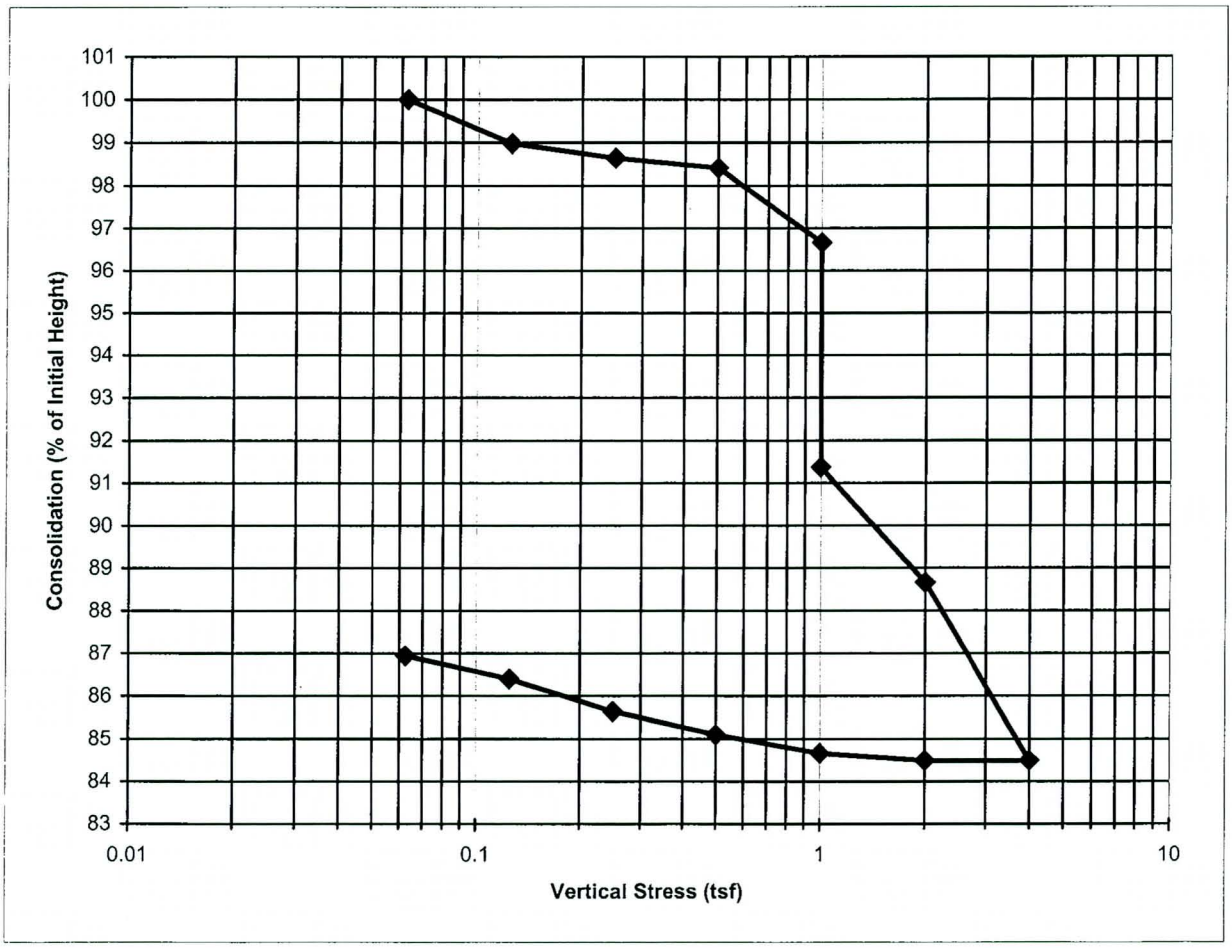
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	38
SAMPLE SOURCE:	BH-7 @ 7.5-8.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.89
INITIAL MOISTURE CONTENT	7.7%	FINAL MOISTURE CONTENT	20.8%
INITIAL DRY DENSITY(pcf)	94.8	FINAL DRY DENSITY(pcf)	111.8
INITIAL DEGREE OF SATURATION	25%	FINAL DEGREE OF SATURATION	104%
INITIAL VOID RATIO	0.85	FINAL VOID RATIO	0.56
		SATURATED AT	1 tsf



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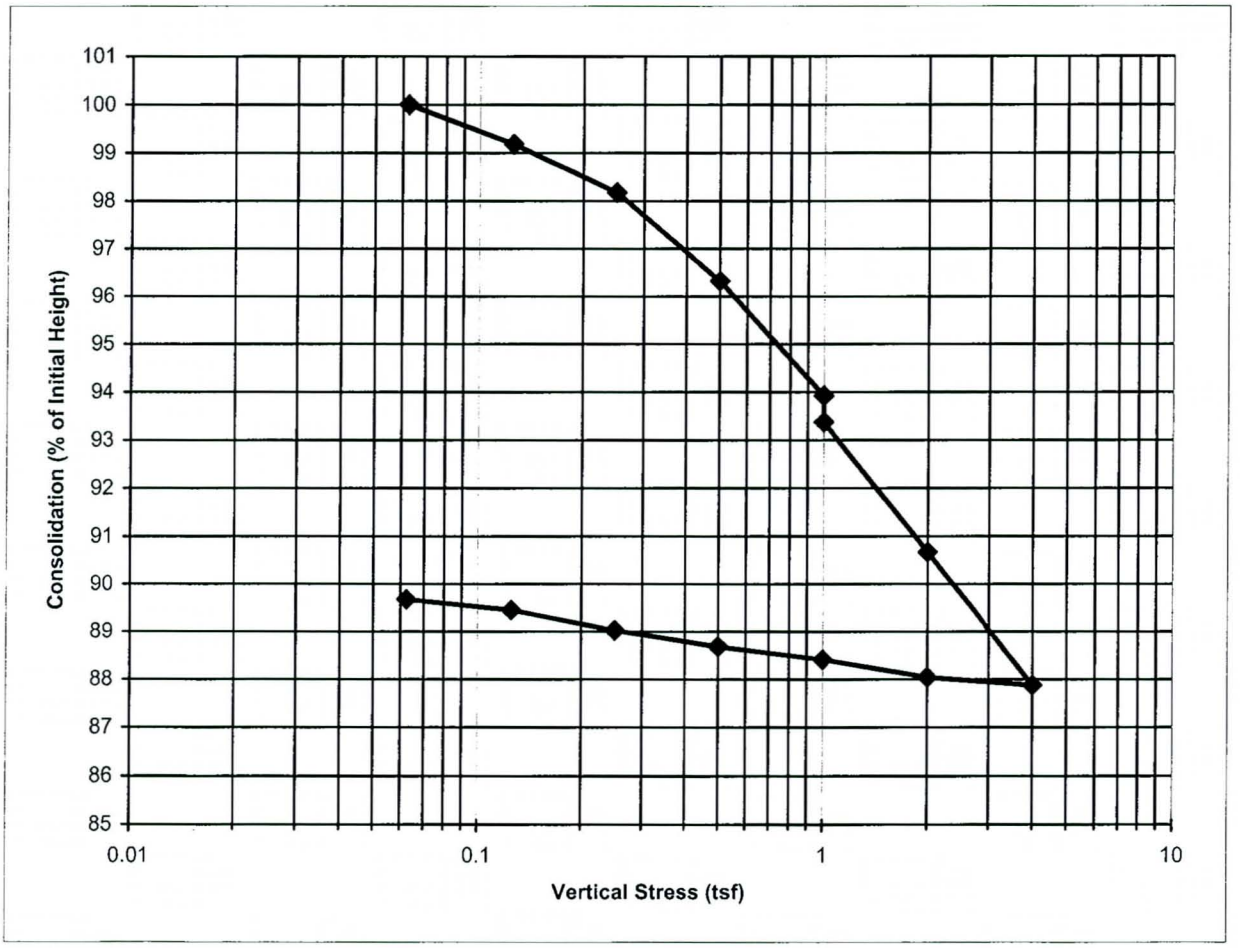
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	46
SAMPLE SOURCE:	BH-8 @ 9.5-10.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.04
INITIAL MOISTURE CONTENT	4.4%	FINAL MOISTURE CONTENT	19.3%
INITIAL DRY DENSITY(pcf)	99.5	FINAL DRY DENSITY(pcf)	112.8
INITIAL DEGREE OF SATURATION	17%	FINAL DEGREE OF SATURATION	102%
INITIAL VOID RATIO	0.73	FINAL VOID RATIO	0.52
		SATURATED AT	1 tsf



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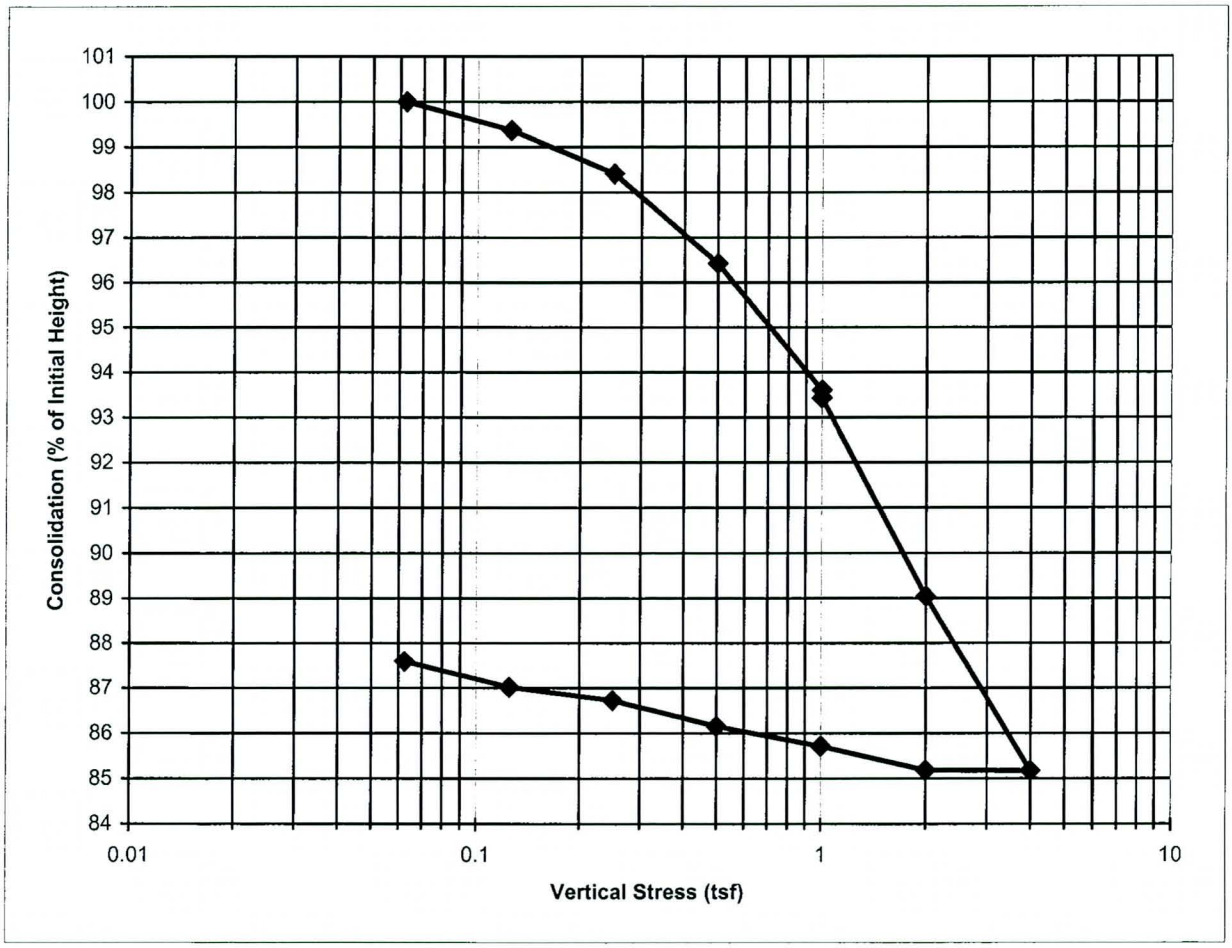
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	51
SAMPLE SOURCE:	BH-9 @ 4.5-5.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.92
INITIAL MOISTURE CONTENT	7.3%	FINAL MOISTURE CONTENT	20.4%
INITIAL DRY DENSITY(pcf)	97.2	FINAL DRY DENSITY(pcf)	113.7
INITIAL DEGREE OF SATURATION	25%	FINAL DEGREE OF SATURATION	103%
INITIAL VOID RATIO	0.84	FINAL VOID RATIO	0.57
		SATURATED AT	1 tsf



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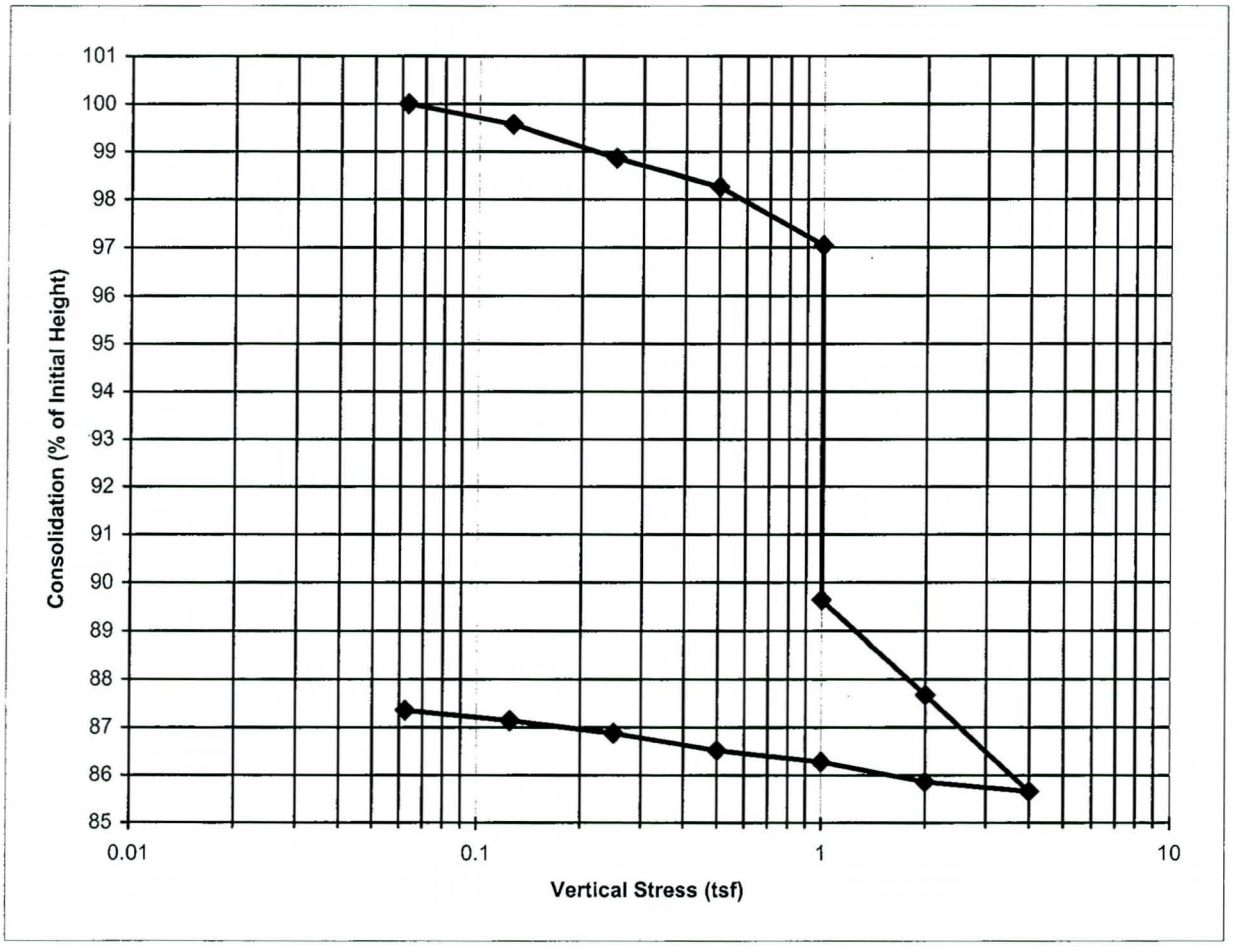
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	68
SAMPLE SOURCE:	BH-12 @ 4.5-5.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.94
INITIAL MOISTURE CONTENT	2.7%	FINAL MOISTURE CONTENT	12.5%
INITIAL DRY DENSITY(pcf)	109.9	FINAL DRY DENSITY(pcf)	127.8
INITIAL DEGREE OF SATURATION	13%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.57	FINAL VOID RATIO	0.34
		SATURATED AT	1 tsf



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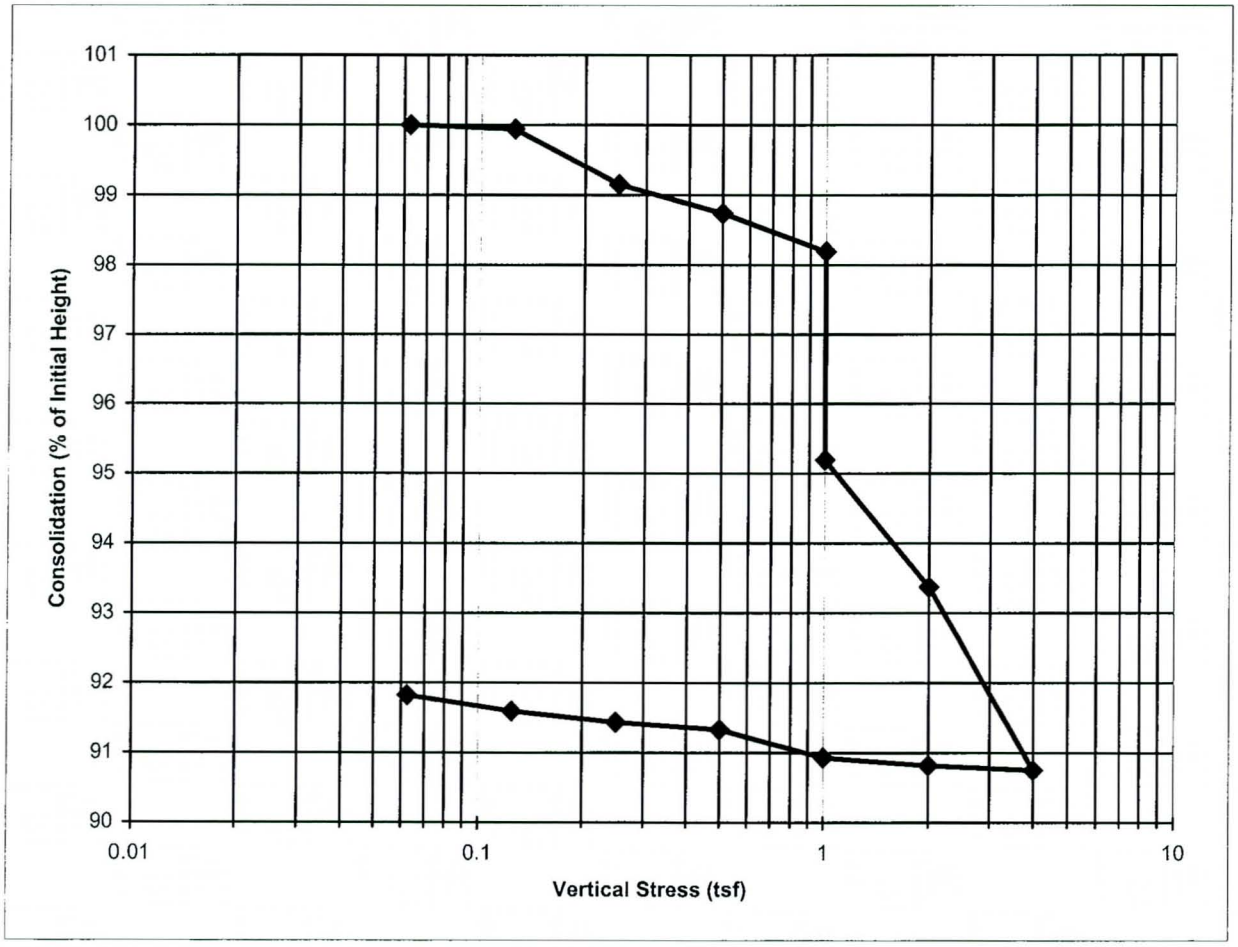
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	87
SAMPLE SOURCE:	BH-15 @ 9.5-10.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.17
INITIAL MOISTURE CONTENT	5.2%	FINAL MOISTURE CONTENT	23.2%
INITIAL DRY DENSITY(pcf)	94.9	FINAL DRY DENSITY(pcf)	104.2
INITIAL DEGREE OF SATURATION	18%	FINAL DEGREE OF SATURATION	104%
INITIAL VOID RATIO	0.75	FINAL VOID RATIO	0.59
		SATURATED AT	1 tsf



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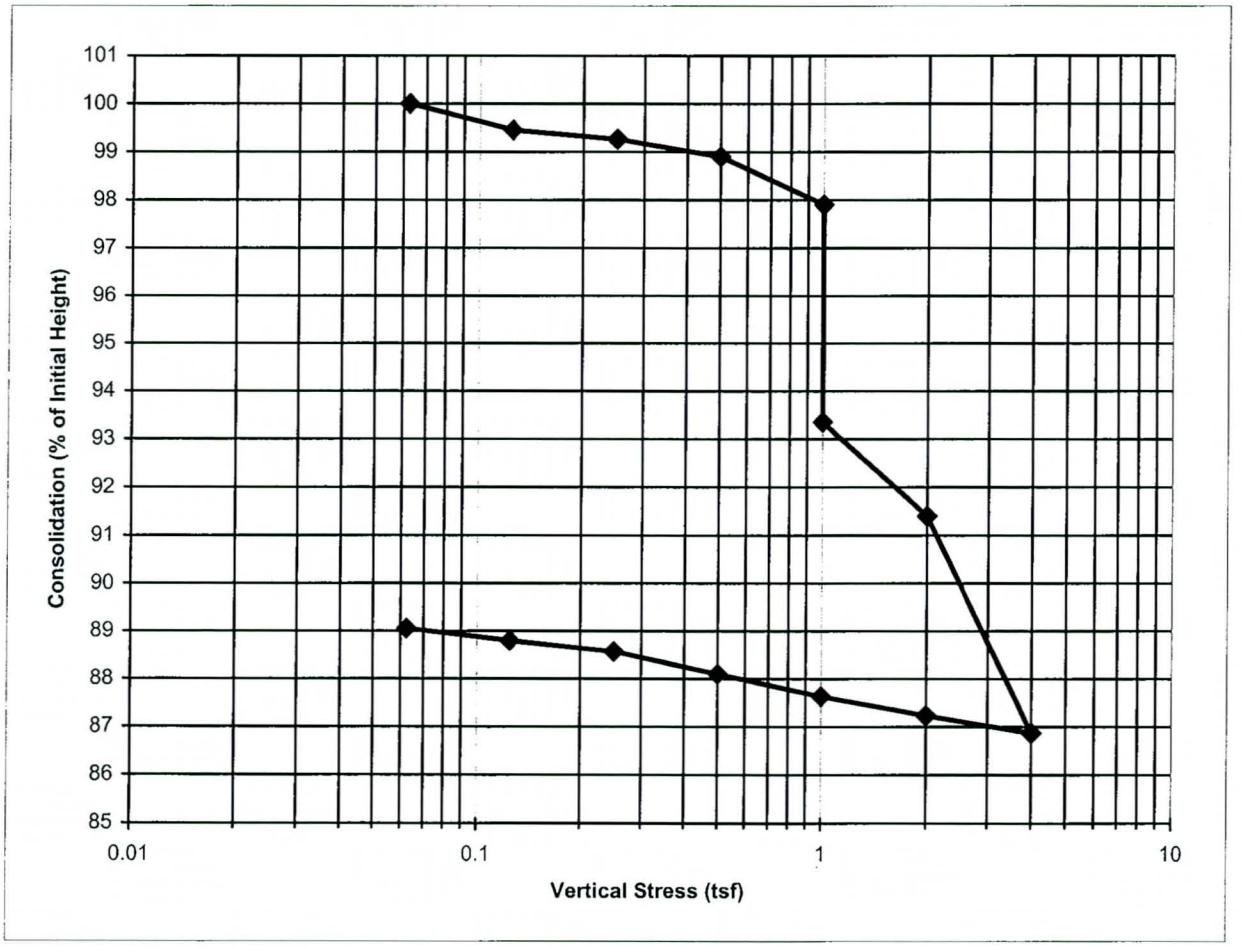
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	94
SAMPLE SOURCE:	BH-16 @ 7.5-8.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	4.00
INITIAL MOISTURE CONTENT	7.4%	FINAL MOISTURE CONTENT	24.8%
INITIAL DRY DENSITY(pcf)	90.8	FINAL DRY DENSITY(pcf)	104.1
INITIAL DEGREE OF SATURATION	23%	FINAL DEGREE OF SATURATION	105%
INITIAL VOID RATIO	0.90	FINAL VOID RATIO	0.65
		SATURATED AT	1 tsf



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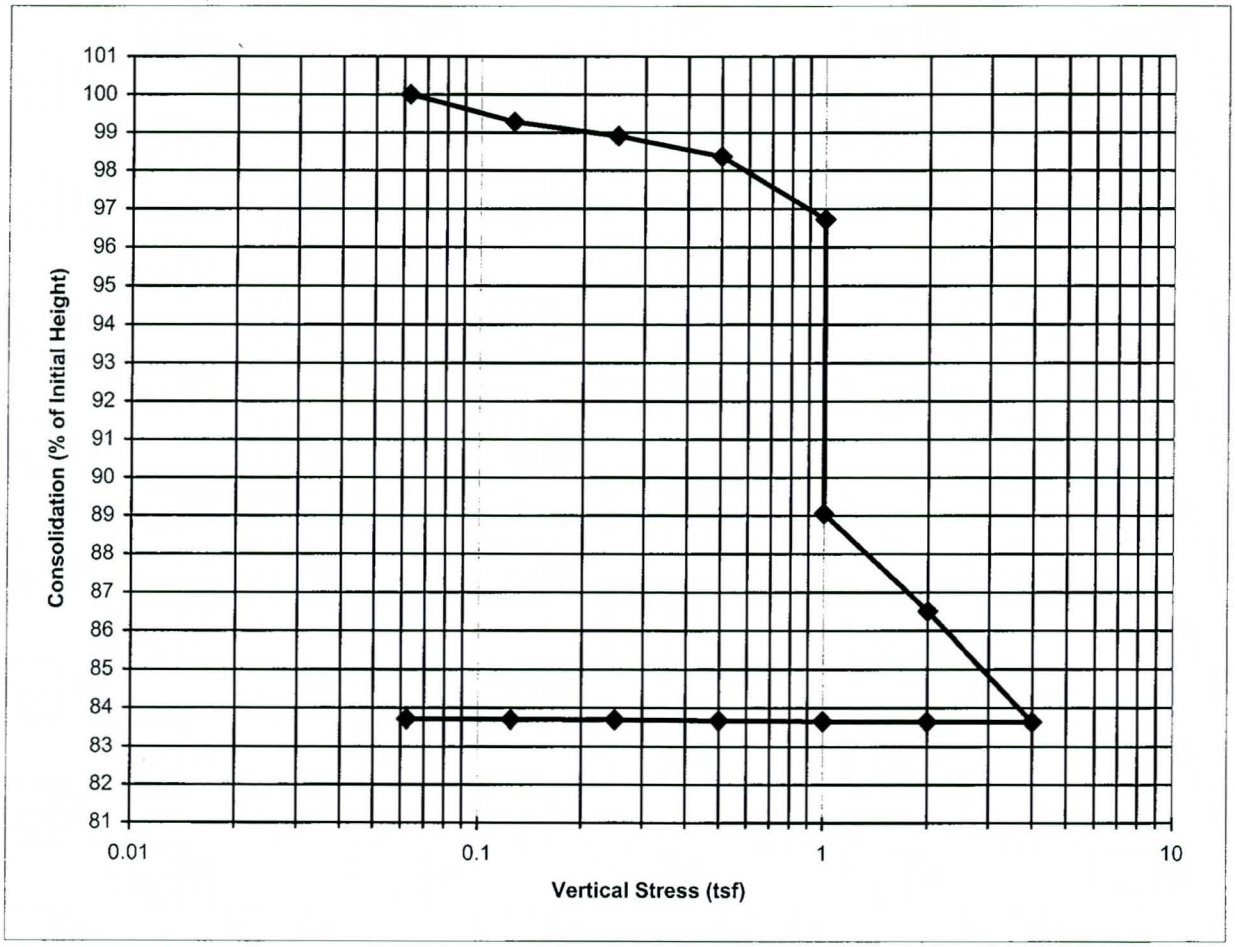
PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	120
SAMPLE SOURCE:	BH-20 @ 14.5-15.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.85
INITIAL MOISTURE CONTENT	4.3%	FINAL MOISTURE CONTENT	15.1%
INITIAL DRY DENSITY(pcf)	101.8	FINAL DRY DENSITY(pcf)	121.3
INITIAL DEGREE OF SATURATION	17%	FINAL DEGREE OF SATURATION	100%
INITIAL VOID RATIO	0.69	FINAL VOID RATIO	0.42
		SATURATED AT	1 tsf



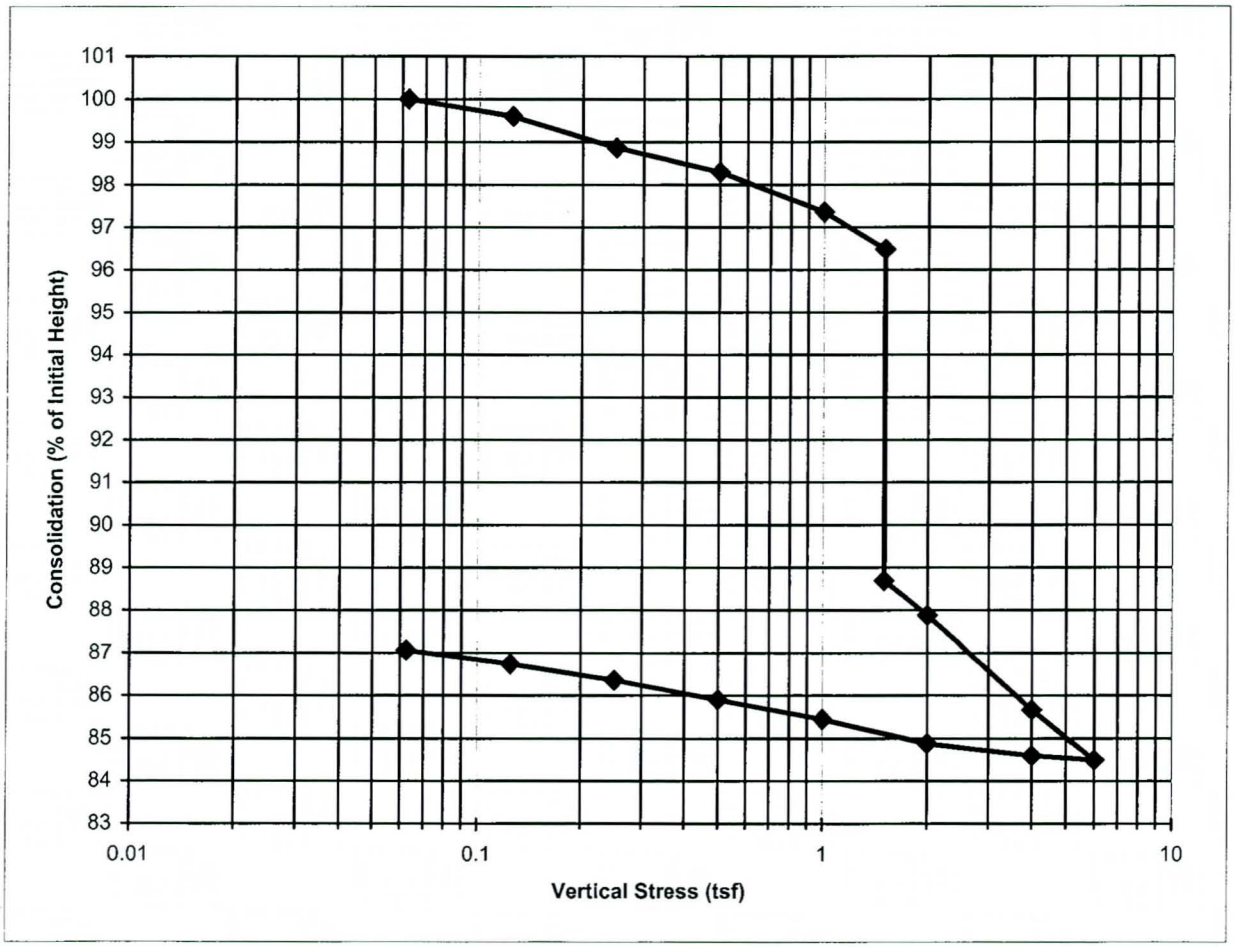
AASHTO R18

REVIEWED BY

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	127
SAMPLE SOURCE:	BH-21 @ 24.5-25.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.89
INITIAL MOISTURE CONTENT	3.5%	FINAL MOISTURE CONTENT	16.7%
INITIAL DRY DENSITY(pcf)	95.3	FINAL DRY DENSITY(pcf)	112.3
INITIAL DEGREE OF SATURATION	13%	FINAL DEGREE OF SATURATION	96%
INITIAL VOID RATIO	0.73	FINAL VOID RATIO	0.46
		SATURATED AT	1 tsf



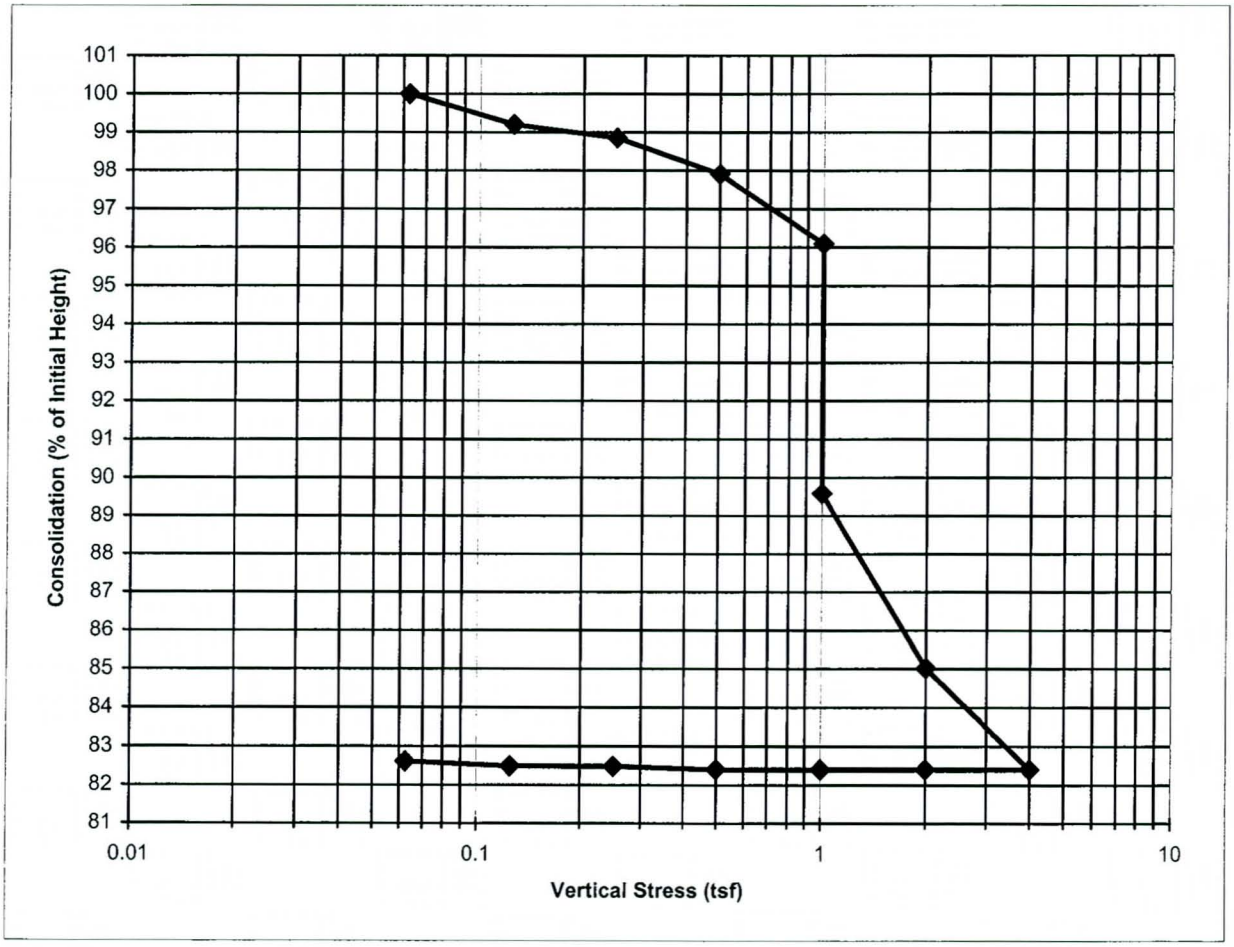
AASHTO R18

REVIEWED BY

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	150
SAMPLE SOURCE:	BH-25 @ 19.5-20.5'	**DATE ASSIGNED:**	6/10/08
SAMPLE PREP:	Insitu		

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES OF SOILS (ASTM D2435)

INITIAL VOLUME (cu.in)	4.60	FINAL VOLUME (cu.in)	3.79
INITIAL MOISTURE CONTENT	5.8%	FINAL MOISTURE CONTENT	24.6%
INITIAL DRY DENSITY(pcf)	85.5	FINAL DRY DENSITY(pcf)	103.4
INITIAL DEGREE OF SATURATION	16%	FINAL DEGREE OF SATURATION	102%
INITIAL VOID RATIO	1.01	FINAL VOID RATIO	0.66
		SATURATED AT	1 tsf



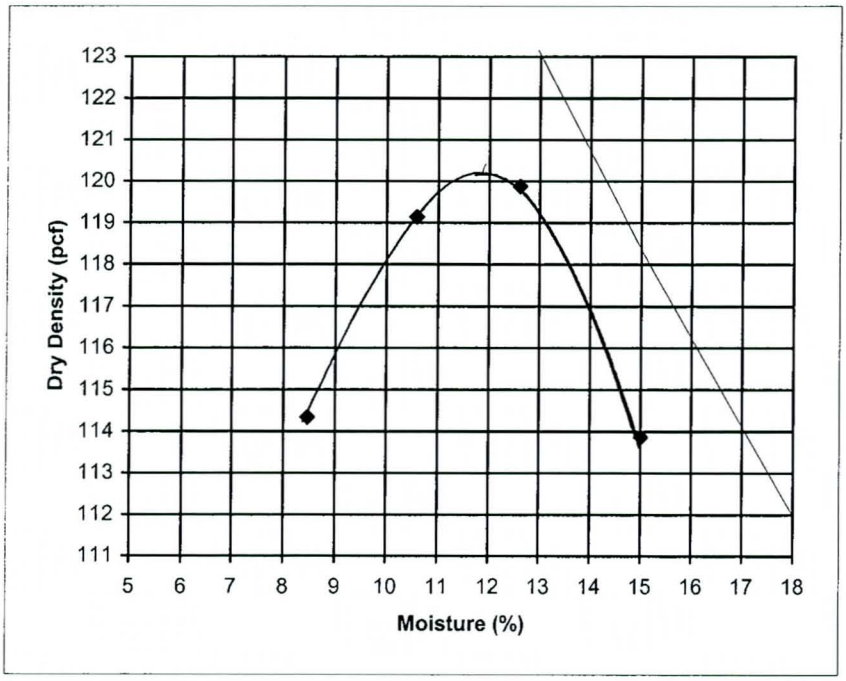
AASHTO R18

REVIEWED BY

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	128
SAMPLE SOURCE:	BH-22 @ 0.0-4.5'	**DATE SAMPLED:**	6/10/08

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	120.2
OPTIMUM MOISTURE (%):	11.9



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	100
1 1/4"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
1/4"	100
#4	99
#8	95
#10	93
#16	88
#30	82
#40	78
#50	74
#100	66
#200	54

ATTERBERG LIMITS

LL:	31
PL:	18
PI:	13
USCS:	CL

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

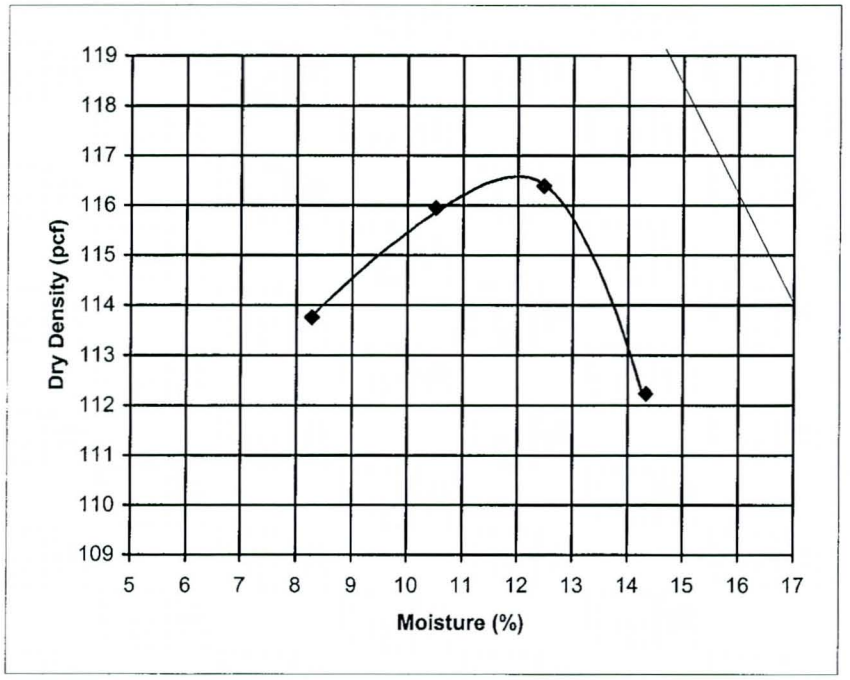
AASHTO R18

REVIEWED BY

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	135
SAMPLE SOURCE:	BH-23 @ 0.0-4.5'	**DATE SAMPLED:**	6/10/08

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	116.6
OPTIMUM MOISTURE (%):	11.8



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	99
1 1/4"	99
1"	99
3/4"	99
1/2"	98
3/8"	97
1/4"	95
#4	92
#8	86
#10	84
#16	77
#30	69
#40	64
#50	60
#100	52
#200	41

ATTERBERG LIMITS

LL:	29
PL:	19
PI:	10
USCS:	SC

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

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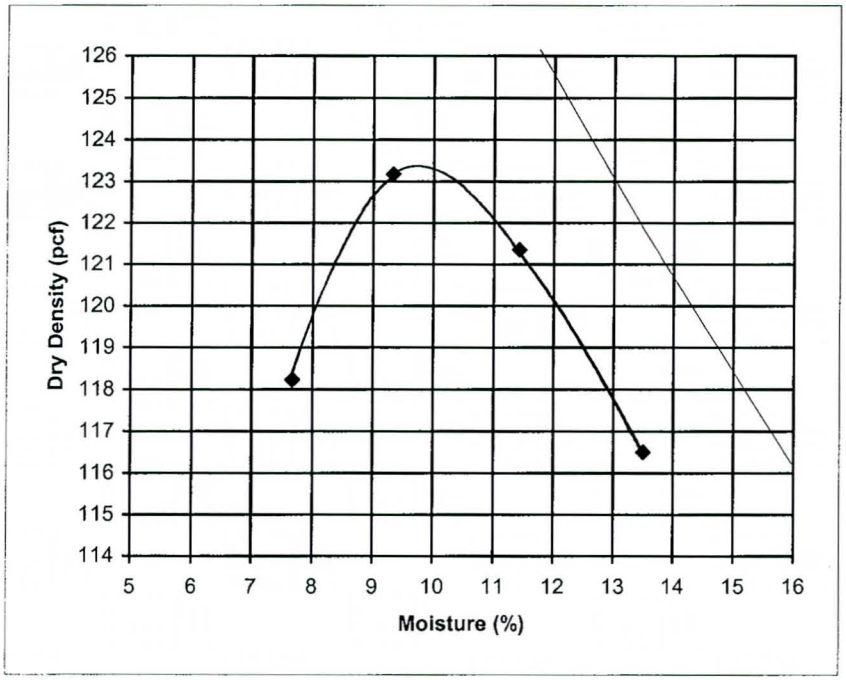
AASHTO R18

REVIEWED BY

PROJECT:	Siphon Draw Retention Basin	**JOB NO:**	7-117-001080ph1
LOCATION:	Arizona	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	140
SAMPLE SOURCE:	BH-24 @ 0.0-4.5'	**DATE SAMPLED:**	6/10/08

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
DETERMINING PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (AASHTO T89 & T90)

MAXIMUM DRY DENSITY (pcf):	123.3
OPTIMUM MOISTURE (%):	9.7



SIEVE SIZE	PERCENT PASSING
6"	100
4"	100
3"	100
2"	100
1 1/2"	95
1 1/4"	93
1"	92
3/4"	88
1/2"	85
3/8"	84
1/4"	82
#4	81
#8	75
#10	73
#16	67
#30	59
#40	55
#50	51
#100	45
#200	36

ATTERBERG LIMITS

LL:	28
PL:	19
PI:	9
USCS:	SC

NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: 2.651 ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

REVIEWED BY

SHEETS

N

KEY

BH-1 BORING IDENTIFIER AND LOCATION

L-16 SEISMIC IDENTIFIER AND LOCATION

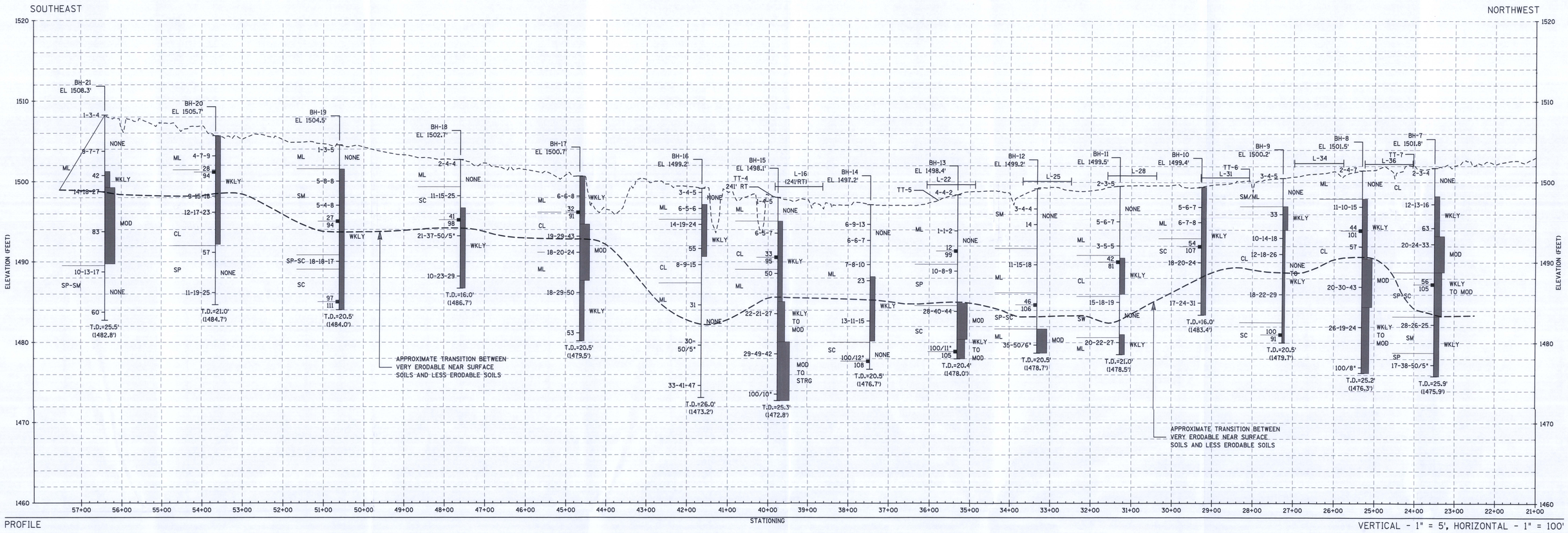
TT-1 TEST TRENCH IDENTIFIER AND LOCATION

0 200 400

Scale: 1" = 200'

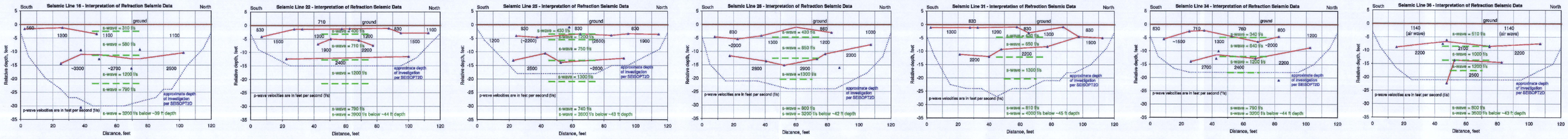
JOB NO. 7-117-001080	SIPHON DRAW	amec
DESIGN: BAH		
DRAWN: GWH		
DATE: 7/2008	SITE MAP GEOTECHNICAL INVESTIGATION LOCATIONS	SHEET 1
SCALE: 1" = 200'		

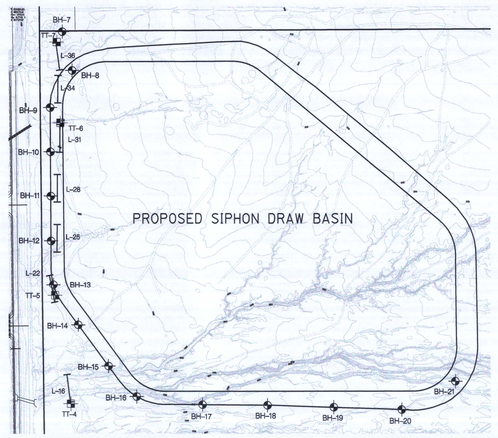
...\Pre-design Files\Sheet-1.dgn 05/11/2009 1:33:28 PM AMEC



PROFILE

VERTICAL - 1" = 5', HORIZONTAL - 1" = 100'





INVESTIGATION LOCATION MAP

N.T.S.

LEGEND

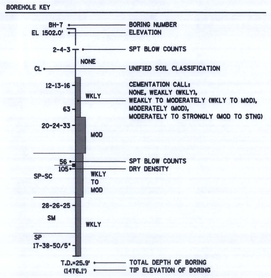
BH-7 — BOREHOLE LOCATION AND IDENTIFIER

TT-4 — TEST TRENCH LOCATION AND IDENTIFIER

L-16 — SEISMIC LINE LOCATION AND IDENTIFIER

NOTE: SEE APPENDIX D FOR TEST TRENCH (TT) LOGS.

BOREHOLE KEY



NO.	REVISION	MADE	CKD.	DATE
1				
2				
3				
4				

SCALE:	AS SHOWN
JOB NO.:	7-117-001080
DESIGNED:	BAH
DRAWN:	GWH
CHECKED:	
DATE:	

SIPHON DRAW DRAINAGE IMPROVEMENT PROJECT
MARICOPA AND PINAL COUNTIES, ARIZONA
CONTRACT FCD 2007C012

GEOLOGIC CHARACTERIZATION PROFILE

SHEET 2

amec