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## Geotechnical Data Report HI-STORE CISF Phase 1 Site Characterization

Lea County, New Mexico

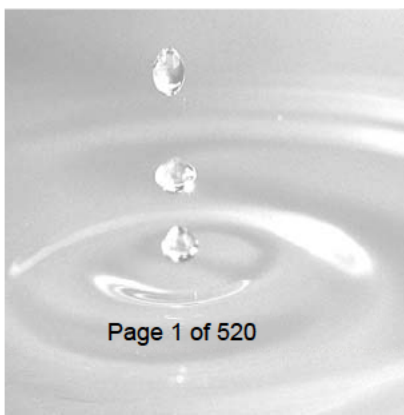
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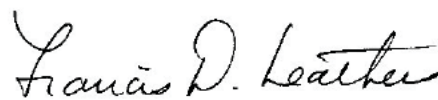
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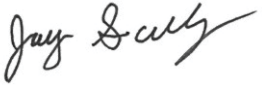
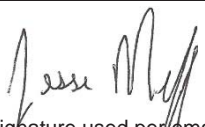
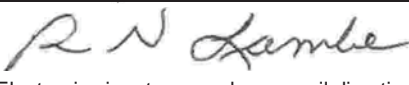
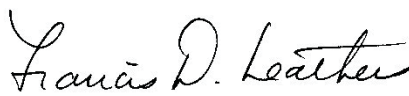




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# **1. Introduction**

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## **1.1 General**

The purpose of this report is to present the geotechnical field and laboratory data on soil and rock obtained for design of Phase 1 of the proposed HI-STORE Consolidated Interim Storage Facility (CISF) in Lea County, New Mexico (Fig. 1).

Our field explorations included borings and geophysical testing at the critical structures at the site, including the Independent Spent Fuel Storage Installation (ISFSI), the cask transfer building (CTB), and a portion of the heavy haul path (HHP) (Fig. 2).

## **1.2 Scope of Work**

We performed the following tasks for this report:

- Reviewed available subsurface information.
- Prepared field and laboratory work plan and procedures.
- Performed survey to layout borings prior to drilling and to determine as-build coordinates and ground surface elevations for as-drilled borings.
- Performed RadioDetection (RD) and Ground-Penetrating Radar (GPR) utility locating to support the drilling program.
- Performed Standard Penetration Test (SPT) and rock core borings and collected soil and rock samples.
- Installed groundwater monitoring wells in three borings.
- Performed a crosshole seismic velocity survey.
- Performed geotechnical laboratory tests to measure soil and rock properties.
- Performed chemical laboratory tests to measure soil corrosivity.
- Performed evaluation of liquefaction potential.
- Prepared this report.

## **1.3 Quality Assurance Program**

We performed the work for this project under the GEI Nuclear Quality Assurance (QA) program (10 CFR Part 50, Appendix B, ASME NQA-1-1994 compliant). The GEI Work Plan, which includes a list of QA procedures used for this project, is presented in Attachment A.

Our personnel, subconsultants, and subcontractors (with the exceptions of Cooper Testing Labs and GeoTesting Express) were trained on applicable GEI work plans and procedures prior to performing any work on the project. The services provided by GeoTesting Express were accepted under our Commercial Grade Dedication program based in part on its current American Association for Laboratory Accreditation (A2LA) accreditation encompassing ISO/IEC-17025:2005. The services provided by Cooper Testing Labs were accepted under our Commercial Grade Dedication based on the results of a Commercial Grade Survey.

We maintained training records that documented completed training for each person working on the project. GEI QA personnel conducted surveillances of subcontractor field activities.

Our personnel maintained sample inventory records and chain-of-custody records to track the soil samples from the field, to the storage facility, and to the testing laboratory.

## **2. Project and Site Information**

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### **2.1 Site and Project Description**

The proposed HI-STORE CISF site is located about halfway between Hobbs and Carlsbad in Lea County, New Mexico, approximately ½ mile north of U.S. Highway 62/180. The site is on a portion of land owned by the Eddy-Lea Energy Alliance (ELEA). A site location map is provided in Fig. 1.

The site of the proposed CISF is currently undeveloped land with sparse scrub-brush vegetation. The topography is relatively flat, with a gradual slope to the north. There is an existing cellular transmission tower located adjacent to the west side of the site, and remnants of historic drilling and potash operations on and near the site. Two roads run along the east and south sides of the proposed ISFSI area. To the east of the ISFSI area is Laguna Road, also known as Route 55, a gravel road running north-south. To the south of the proposed ISFSI area is Hydra Lane, a gravel road running west from Laguna Road.

There is an existing electric transmission line running east-west between the site and U.S. Highway 62/180. There are buried gas and water lines running east-west just south of the site, on the opposite side of Hydra Lane. There is also a gas main running north-south about 1,000 feet east of Laguna Road. There are also various underground utilities trending northeast-southwest through the site.

Holtec is proposing to develop a multi-phase CISF at the site. Phase 1 will consist of constructing an ISFSI, a CTB, a rail spur, ancillary buildings including an office building and security building, and upgraded access road in the southeast corner of the site, as shown in Fig. 2. The Phase 1 ISFSI will consist of two cask storage units (Holtec UMAX design), each about 250 by 500 feet in plan and about 25 feet deep below grade. The CTB will be a one-story, high bay industrial building about 100 by 300 feet in plan with slab on grade and two below-grade cask transfer pits about 17 feet deep.

### **2.2 Horizontal and Vertical Survey and Datum**

Souder, Miller & Associates (SMA) of Albuquerque, New Mexico surveyed the boring locations at the site. The horizontal survey was referenced to the North American Datum of 1983 (NAD83), State Plane New Mexico East. The vertical survey elevations are based on the North American Vertical Datum of 1988 (NAVD88). All measurements were in U.S. survey feet.

The as-drilled boring locations are shown in Fig. 2. The coordinates and ground surface elevations of the borings are presented in Table 1. The SMA as-built survey is presented in Attachment B.

## 2.3 Regional Geology

The geologic literature reports that in southeastern New Mexico, Quaternary and Upper Tertiary formations are the only Cenozoic rocks preserved. Rocks of the early Cenozoic and late Mesozoic (Jurassic and Cretaceous) are notably absent. It is believed all of southeastern New Mexico has been above sea level and subjected to erosion since the Cretaceous (Bachman, 1971). Deposition occurred subsequently in southeastern New Mexico during the Pleistocene and Holocene, creating the existing surficial materials, including the Gatuna Formation, caliche, terrace, channel and playa deposits, and windblown sand in some areas [Powers et al, 1978]. The geologic literature indicates that the bedrock strata dip regionally to the east and thicken to the south, with a gradient of approximately 35 feet per mile (Lowry et al, 2015).

Near the site, the upper strata of rock are Triassic age rocks consisting of a sequence of red beds known as the Dockum Group. The Upper Triassic Dockum Group consists of up to approximately 1,500 feet of moderate-reddish-brown to yellow-brown conglomeratic sandstones, mudstones and siltstones, and shales (Powers et al., 1978).

Within the Dockum Group are two members, the Chinle Formation and the underlying Santa Rosa Sandstone. However, due to lithological similarities of the formations, the formations have historically been identified as undivided and some literature has characterized them as lithologically indistinguishable. According to Bachman there are intricate facies changes and varying lithologies within the Dockum Group of eastern New Mexico which lead to problems of correlation (1971). Further efforts to differentiate members of the lower Dockum Group were made by Lucas and Hunt (1987). For the purposes of this report, we divided the Dockum Group into the Chinle and Santa Rosa formations based upon a visual stratigraphic change from predominant mudstone to predominant sandstone, and an apparent and measured difference in strength of rock core of the two units.

The Dockum Group rests unconformably on deeper, older Permian rocks which include a sequence of the Dewey Lake Red Beds underlain by the Rustler Formation. All borings for this subsurface exploration were terminated in the Dockum Group indicating this formation extends to a depth of at least 400 feet. The Dewey Lake Red Beds and the Rustler Formation were not encountered. The Chinle and Santa Rosa formations encountered in our subsurface exploration are discussed in detail in Sections 3, 4, and 5 and shown in Figs. 3 through 8.

## **3. Subsurface Explorations and Field Testing**

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### **3.1 Subsurface Explorations**

The purpose of the borings was to identify the soil and bedrock units at the HI-STORE CISF site and obtain geotechnical data for design of the ISFSI, CTB and other structures and roads. The planned boring locations and depths were chosen by Holtec and are shown in the GEI Work Plan (Attachment A).

Prior to drilling, GEI used RadioDetection (RD 7000+) and Ground Penetrating RADAR (GPR) to identify possible buried obstructions at the boring locations. No obstructions were detected within 25 feet of each boring location.

The borings were generally drilled as planned except that two borings (B105 and B106) were drilled deeper than estimated in the GEI Work Plan. The as-drilled boring depths are presented in Table 3 and ranged from about 60 to 400 feet.

The borings were drilled by Geomechanics Southwest, Inc. (GSI) of Albuquerque, New Mexico from September 25, 2017 through November 1, 2017 under subcontract to GEI. GSI used a CME-75 and a CME-85 drill rig to drill the borings.

The nine boring locations were numbered B101 through B109 (Fig. 2). Six offset borings were performed, identified with the boring number followed by a suffix A or B, to accommodate inclinometer casing installation, monitoring well installation, or to collect hammer energy measurements.

When performing Standard Penetration Tests (SPT) and collecting split spoon samples, GSI advanced the borings with hollow-stem augers without drilling fluid since the drilling was above the groundwater level. In general, the borings were advanced to a depth of about 60 feet with hollow stem augers, except that B101 and B106 were advanced to depths of 100 and 30 feet respectively with augers. We did not encounter typical auger refusal, but rather observed a transitional increase of resistance with depth. The upper portion of the Chinle formation could be drilled by either advancing hollow stem augers or rock coring. In our first boring (B106), we began rock coring at the top of the Chinle at a depth of about 30 feet. In B106, the core recovery and RQD were low for the first 30 feet of rock coring. Therefore, in the remainder of the borings, we drilled with hollow stem augers to a depth of 60 feet or more, and then began rock coring with generally good recovery and RQD values.

Below the depth of auger drilling, the borings were advanced by rock coring using HQ wireline tooling with water as the drilling fluid. Rock was cored in B101, B102, B105, B106, B107, and B109 to depths of 100 to 400 feet. Rock coring times ranged from about

1 to 10 minutes per foot. GSI used various drill bits, downward pressures, rotation speeds, and water pressures while attempting to improve the quality of the rock core samples. The range in coring times were likely due to the various drilling methods, and do not necessarily correlate with the hardness of the rock.

The offset borings were advanced with open-hole roller bit drilling using air (i.e., without the use of water or other drilling fluid).

The boring logs are presented in Attachment C. The as-drilled boring locations are shown in Fig. 2.

A GEI engineer or geologist was present during all drilling, sampling, and testing activities. GEI conducted quality assurance surveillances during surveying activities.

### **3.1.1 Soil and Rock Samples**

We collected standard split spoon samples from the borings (B101 through B109) in accordance with GEI Procedure 127, Boring Advancement, Split Spoon Sampling, and Logging in Soil.

We collected thick-walled split spoon samples at selected depths in accordance with GEI Procedure 128, Thick-Walled, Split-Barrel Driven Soil Samples, by using a Modified California split spoon sampler fitted with six 2.5-inch-OD by 1-inch-long liner rings.

We collected bulk soil samples in B101, B102, B105, B107, B108, and B109 in accordance with GEI Procedure 138, Bulk Soil Samplings from Borings. The samples were obtained from auger cuttings at a depth range of 0 to 10 feet.

We were unable to obtain thin-walled tube samples because the soil at the site was too dense or hard to push the tubes.

We classified the soil samples in the field in accordance with GEI Procedure 127, Boring Advancement, Split Spoon Sampling, and Logging in Soil. Soil descriptions shown on the boring logs in Attachment C represent the field classification modified, if required, based on laboratory classification and test results in accordance with GEI Procedure 150, Final Boring Log Preparation. Photographs of representative soil samples are presented in Attachment D.

We cored rock in B101, B102, B105, B106, B107, and B109 in accordance with GEI Procedure 136, Rock Coring. We placed the rock cores in wooden or waxed cardboard boxes for storage. We labeled the core boxes in accordance with GEI Procedure 122, Packing and Labeling of Rock Core Samples. The GEI field representative described the rock cores in the field on the boring logs. Rock core descriptions shown on the boring logs in Attachment C represent the field classification modified, if required, in accordance with GEI Procedure 148, Review of Field Boring Logs and in accordance with GEI Procedure



150, Final Boring Log Preparation. Photographs of representative rock core samples as well as a photo compilation of B101 are presented in Attachment D.

We temporarily stored the soil and rock samples in the field storage container (Conex box) on site. After the sampling field work was complete, we shipped the soil samples and selected rock core samples to GEI's office in Woburn, Massachusetts, and we transported the remainder of the rock core samples to a storage trailer at the Center of Excellence for Hazardous Materials Management (CEHMM) office in Carlsbad, New Mexico. Transport and storage of samples were performed in accordance with GEI Procedure 124, Transportation and Tracking of Soil and Rock Samples.

### **3.1.2 Borehole Completion**

In B102A, B103, and B104, we installed 2.75-inch-OD Slope Indicator inclinometer casing to the bottom of the borehole for crosshole seismic testing in the soil and bedrock in accordance with GEI Procedure 163, Inclinometer Casing Installation. Each casing was grouted in place with a cement-bentonite grout.

In B101B, B106A, and B107A, we installed monitoring wells, to measure groundwater elevation, in accordance with GEI Procedure 131, Installation of Groundwater Monitoring Wells. The wells consisted of a 20-foot-long section of slotted 2-inch-ID PVC screen surrounded with filter sand, and then a 2-inch-ID Schedule 40 PVC riser pipe surrounded by a bentonite chip seal above the filter sand and cement-bentonite grout to the ground surface. The wells were finished with a steel protective standpipe, and a concrete pad around the standpipe at the ground surface.

We backfilled the other borings with a cement-bentonite grout in accordance with GEI Procedure 135, Backfilling Boreholes by Grouting.

Inclinometer casing installation, monitoring well installation, and borehole grouting forms are presented in Attachment E.

## **3.2 In-Situ Soil Testing**

### **3.2.1 Standard Penetration Testing**

We performed Standard Penetration Tests (SPTs) to obtain soil samples for visual classification, laboratory testing, and to measure the penetration resistance of the soil.

SPTs were performed in accordance with GEI Procedure 127, Boring Advancement, Split Spoon Sampling, and Logging in Soil, using 2-inch-OD by 24-inch-long split spoon samplers without liners. The split spoon samplers had a 1.5-inch-ID. SPT blowcounts are presented in the boring logs in Attachment C.

GSI used CME-75 and CME-85 drill rigs each with an automatic hammer for all SPTs. Energy measurements of the automatic hammer were taken by GRL, a subcontractor of GSI. Energy measurements were collected during sampling of B101A and B105A.

Results of the hammer energy measurements are presented in Attachment F. The measured energy was 94 and 97% of the theoretical energy for the CME-75 and CME-85, respectively. During the performance of the SPTs, we spot-checked the drop height of the drive weights through a slot on the side of the automatic hammer. The spot checks confirmed that the drive weights were dropping 30 inches  $\pm$  1 inch in accordance with ASTM D 1586, Section 7.4.1.

### **3.2.2 Permeability Testing**

We performed water pressure tests, in B101, B106, B107, and B109, in accordance with GEI Procedure 132, Packer Testing. The tests provided a measurement of the permeability of the rock.

We performed the packer tests during rock coring at selected depths by coring the test zone, removing the core barrel and HQ drill rods to expose the test zone, lowering down a single packer assembly, inflating the packer to seal off the top of the test zone, pumping water into the test zone until the water pressure reached the specified test pressure, and recording flow readings. We performed tests at multiple water pressures, typically 15, 30, and 45 psi, at each test zone. We typically recorded flow readings for 5 to 20 minutes. After packer testing of a zone was complete, we resumed rock coring to the next test zone.

Occasionally, we observed water returning to the ground surface when attempting packer tests, indicating the packers were not able to seal off the test zones in the soft mudstone. Testing was discontinued at intervals where a seal could not be achieved.

Packer test results are presented in Table 2 and packer test data are presented in Attachment G.

### **3.2.3 Crosshole Seismic Shear Wave Velocity Survey**

We performed seismic shear wave velocity testing at one array location (B102A, B103, and B104) and measured the shear wave velocity of the soil and bedrock at the site. The crosshole shear wave velocity testing procedures and results are discussed in Section 6.1 below.

## **4. Laboratory Testing**

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### **4.1 Geotechnical Laboratory Testing of Soil and Rock**

#### **4.1.1 *GEI Laboratory Testing of Soil***

Selected soil samples from the borings were tested for:

- GEI Procedure 101, Water Content Measurement
- GEI Procedure 103, Specific Gravity Measurement
- GEI Procedure 104, Grain Size Analysis: Sieve and Hydrometer
- GEI Procedure 108, Atterberg Limits Measurement
- GEI Procedure 242, Unit Weight of Soil

Soil index properties are presented in Table 3. Laboratory testing data sheets are in Attachment H. Atterberg Limits results are presented in Figure 9.

#### **4.1.2 *GEI Laboratory Testing of Rock***

Selected rock samples from the borings were tested for:

- GEI Procedure 238, Unconfined Compressive Strength of Cohesive Soil and Soft Rock
- GEI Procedure 239, 1-D Consolidation Test
- GEI Procedure 244, Swell Test on One-Dimensional Consolidation Test Specimen

Rock properties are presented in Table 4. Laboratory testing data sheets are in Attachment I. Pending consolidation and swell tests will be included in a future revision of this report.

#### **4.1.3 GeoTesting Express Laboratory Testing of Soil**

We sent bulk samples of the caliche from B101, B105, B107, and B108 to GeoTesting Express (GTX). GTX created two composite samples for testing by combining B101 with B107 and B105 with B108. GTX tested the composite samples for:

- Compaction characteristics (modified proctor), ASTM D1557
- California Bearing Ratio (CBR), ASTM D1883
- Particle Size Analysis, ASTM D422

Particle size analysis were performed on the composite samples for soil classification purposes and performed after compaction testing for degradation. Laboratory test results are contained in Attachment J.

#### **4.1.4 GeoTesting Express Laboratory Testing of Rock**

We sent selected rock core samples from B101 to GTX for rock compressive strength and moduli testing per ASTM D7012.

Rock properties are presented in Table 4. Laboratory test results are contained in Attachment K.

### **4.2 Corrosivity Testing**

We sent three soil samples to Cooper Testing Labs of Palo Alto, California for corrosivity testing. Selected samples from B101, B105, and B108 were tested for the following parameters:

- Resistivity (100% saturation) in accordance with ASTM G57
- pH in accordance with ASTM G51
- Oxidation-Reduction Potential (ORP) in accordance with ASTM G200
- Sulfide in accordance with qualitative method by lead acetate paper
- Percent moisture in accordance with ASTM D2216

Corrosivity test results are contained in Attachment L.

## **5. Subsurface Conditions**

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### **5.1 Subsurface Profiles**

The soil strata encountered in the borings at the site were generally less than 40 feet thick in total, and consisted primarily of a thin layer of top soil underlain by caliche caprock and clayey sand/sandy clay residual soil. Beneath the soil, bedrock consisting of Chinle mudstone underlain by Santa Rosa sandstone was encountered to the bottom of the borings, at depths up to about 400 feet.

Three subsurface profiles at the site are shown in Figs. 3 through 5. The locations of the profiles are shown on Fig. 2. These profiles are depicted at true scale, except that there are breaks in the left side of Subsurface Profile C in Fig. 5. The approximate location and depth of the proposed CISF structures are shown on these profiles.

Additional boring profiles are shown in Figs. 6 to 8, presenting SPT results and rock core recovery and RQD results with depth. These profiles do not have any horizontal scale, and are shown to facilitate comparison of subsurface conditions versus depth at the various borings on each profile.

### **5.2 Soil and Rock Descriptions**

#### **5.2.1 Soil**

Soils ranging in thickness from 27.5 to 40.5 feet were encountered at the surface. Subsurface soil encountered in all the borings consisted of top soil, a caprock or caliche, and an underlying residual soil.

##### **5.2.1.1 Top Soil**

Top soil was encountered at the ground surface. The top soil was generally 3 to 4 inches thick, except in B109 where it was 8.1 feet thick. The top soil consisted of varying amounts of sand and clay. SPT N-values ranged from 5 to 14 blows per foot, indicating loose to medium dense soil.

During our exploration program, the top soil was observed to become soft and muddy when exposed to rain. When wet, the top soil rutted easily.

##### **5.2.1.2 Caliche**

Caliche was encountered beneath the top soil in all the borings. The caliche, referred to in literature as the Mescalero, was generally about 4.4 to 13.5 feet thick and represents a

continuous mantle in the area. The caliche consisted of a light gray to white deposit with varying amounts of sand and gravel with silt.

SPT N-values in the caliche ranged from 20 blows per foot to split spoon refusal (more than 100 blows per foot) with a median of 43 blows per foot, indicating dense to very dense soil.

Laboratory test results indicated specific gravities of 2.65 and 2.67. Unit weight tests performed on Modified California split spoon samples indicated total unit weights of 84.5 and 94.2 pounds per cubic foot (pcf). The fines in the caliche were generally nonplastic or low plasticity silt. The results of GEI laboratory tests on the caliche are presented in Attachment H.

Grain size, compaction, and California Bearing Ratio (CBR) tests were performed on two composite bulk samples of the caliche. Grain size tests were performed before and after compaction, and indicate that there was little to no breakdown of the material during compaction. The CBR tests show a consistent increase in CBR value with increasing density, as is normally the case. The samples prepared with 25 blows per layer were compacted to about 95% of maximum compaction and had CBR values of 78 and 82. The results of GTX laboratory tests on the caliche are presented in Attachment J.

#### 5.2.1.3 Residual Soil

Residual soil was encountered beneath the caliche. The top of the residual soil was encountered from El. 3518 to El. 3528 and ranged in thickness from 17 to 28 feet. Residual soil is a weathering product of the underlying Chinle Formation. Residual soil typically consisted of clayey sand or sandy clay with trace gravel. We distinguished the residual soil from the underlying Chinle Formation based on SPT refusal-values, difficulty in advancing augers, and visual and gradational changes in the stratigraphy. The contact between residual soil and the Chinle generally coincided with a transition to a poorly to moderately indurated mudstone of the Chinle Formation.

Typical N-values in the residual soil ranged from 37 blows per foot to split spoon refusal (more than 100 blows per foot) with N-values typically more than 100 blows per foot, indicating a very hard or very dense soil.

Laboratory test results indicated specific gravity of 2.74. Unit weight tests performed on Modified California split spoon samples indicated total unit weights of 98.6 and 126.4 pcf. The fines were generally a moderately plastic clay with liquid limits ranging from 40 to 42 and plasticity indexes ranging from 22 to 28. Natural water contents in the residual soil ranged from 8.3 to 10.7%, significantly below the plastic limit. The results of GEI laboratory tests on the residual soil are presented in Attachment H.

## **5.2.2 Bedrock**

The top of the bedrock encountered in the borings varied between El. 3499 and El. 3502. The bedrock formations encountered in the borings were the Chinle mudstone and the Santa Rosa sandstone.

Photos of representative core samples of bedrock are shown in Attachment D. In addition, a full-depth photo profile of the core from B101, extending to a depth of 400 feet, is shown in Attachment D.

### **5.2.2.1 Chinle Formation**

The Chinle Formation underlies residual soil on the site and is the upper member of the Dockum Group. The Chinle consists of a poorly indurated mudstone with interbedded lenses of moderately to well indurated siltstones and conglomerate. The Chinle was encountered at depths ranging from 27.5 to 40.5 feet, or El. 3499 to El. 3502. In borings B101 and B105, the bottom of the Chinle (top of Santa Rosa) was encountered at depths of 213 to 214 feet respectively. All other borings were terminated in the Chinle.

We collected split spoon samples, before switching to coring, in the poorly indurated mudstone of the Chinle Formation. The material was described on the boring logs as a sandy lean clay or clayey sand. The SPT N-values indicate a transition from very dense or very hard soil to soft rock.

Rock Quality Designation (RQD) in the Chinle Formation ranged from 0 to 100, with a median of 74. Lower RQD values and recoveries were typically observed in the very poorly indurated mudstones of the upper Chinle.

The laboratory test results of the unconfined compression tests indicated strengths in the range of 5.3 to 25.7 kips per square foot (ksf) with an average value of 16.1 ksf.

Laboratory test results of rock core of the Chinle Formation indicated that the unit weight ranged from 127 to 138 pounds per cubic foot (pcf) with an average value of 134 pcf. Unit weight tests performed on Modified California split spoon samples indicated total unit weights of 123.9 and 124.2 pcf.

The laboratory test results of split spoon samples of the Chinle Formation indicated specific gravities of 2.78, 2.81, and 2.81.

The results of eight in-situ permeability tests performed in the Chinle ranged from  $3.2 \times 10^{-7}$  cm/sec to  $7.7 \times 10^{-6}$  cm/sec with an average of about  $2.1 \times 10^{-6}$  cm/sec, indicating very low permeability material.

#### 5.2.2.2 Santa Rosa Formation

The Santa Rosa Formation is the lower member of the Dockum Group and is the known water-bearing unit in the region. The Santa Rosa ranges from fine- to coarse-grained sandstone, with minor reddish-brown siltstones and conglomerate. Borings B101 and B105 the Santa Rosa was encountered at El. 3322 and El. 3321, respectively. B101 and B105 were terminated in the Santa Rosa at depths of 401 and 222 feet, or El. 3135 and El. 3313, respectively.

RQD values in the Santa Rosa Formation ranged from 33 to 100, with a median of 98. However, RQD values in the Santa Rosa Formation were typically greater than 80%. Lower RQD values were observed at the transition from the Chinle to the Santa Rosa and within the Santa Rosa in zones of interbedded mudstone.

The results of two in-situ permeability tests performed in the Santa Rosa indicated permeabilities in the range of  $3.4 \times 10^{-7}$  cm/sec to  $9.2 \times 10^{-7}$  cm/sec with an average of about  $6.3 \times 10^{-7}$  cm/sec, indicating very low permeability material.

Laboratory test results indicated the bulk unit weight of the Santa Rosa Formation ranged from 156 to 164 pcf with an average value of 160 pcf. The results of the unconfined compression tests indicated strengths in the range of 293 to 1,003 kips per square foot (ksf) with an average value of 718 ksf.

### 5.3 Groundwater

We generally did not observe groundwater during drilling because water was used for rock coring, and the rock was relatively low permeability. We also did not observe groundwater during drilling of the offset borings which were advanced with air rotary techniques.

We measured depth to groundwater in the monitoring wells periodically during the subsurface exploration. Groundwater levels are presented in Table 5.

Two monitoring wells, B106(MW) and B107(MW), were screened in the Chinle Formation. Groundwater was not encountered in B106(MW) after water introduced during drilling and well installation was removed from the well. Groundwater was observed in B107(MW) from a depth range of 93.1 to 100.0 feet, or about El. 3437 to El. 3430.

One monitoring well, B101(MW), was screened in the Santa Rosa Formation. Groundwater was observed in B101(MW) from a depth range of 253.4 to 263.7, or about El. 3272 to El. 3282.

We also measured depth to groundwater in a monitoring well installed as part of the Global Nuclear Energy Partnership (GNEP) Eddy Lea Siting Study, submitted in April 2007. According the GNEP Siting Study, ELEA-2 was installed in March 2007 and screened



entirely within the Dockum Group, likely within the upper Chinle. Groundwater was observed in ELEA-2 from a depth range of 37.6 to 37.7 feet, or about El. 3496.

The geologic literature reports that the Santa Rosa Formation is the principal aquifer in the region in the western third of southern Lea County. However, discontinuous aquifers are present in the Chinle (Nicholson and Clebsch, 1961) where isolated layers and lenses of sandy material are present.

Based on the available information, it is our interpretation that the deep groundwater level measured in B101 is indicative of the primary groundwater aquifer at the site, at about 253 to 263 feet below the ground surface. We interpret the groundwater observed in B107(MW) and ELEA-2 as indicating the presence of limited water in discontinuous aquifers above lower permeability zones in the Chinle.

## **6. Discussion of Results and Recommendations**

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### **6.1 Crosshole Seismic Shear Wave Velocity Survey**

We performed seismic shear wave velocity testing at one array location (B102A, B103, and B104) and measured the shear wave velocity of the soil and bedrock at the site. Shear wave velocities are presented in Table 6 and Figure 10.

#### **6.1.1 Methodology – Crosshole Seismic Testing**

The crosshole seismic survey was conducted in accordance with GEI QA Procedure 166 which incorporates ASTM D-4428 and ASTM D6230-12 by reference. This method provides a means of measuring in-situ shear-wave velocity (VS). GEI employed an SE&G mechanical, reversible downhole hammer as the S-wave acoustic source. Operation of the source consisted of securing the hammer to the source borehole with an inflatable bladder. When activated in an arbitrary direction (either up or down), this source produces directionally distorted energy into the surrounding materials to produce repeatable and identifiable S-waves. When the source is activated in the opposite direction, the energy produces S-waves with reversed polarity. By stacking multiple hammer strikes on the recording instrument (seismograph), S-waves are typically enhanced, whereas other seismic waves and random noise are theoretically out-of-phase and diminished.

#### **6.1.2 Field Design – Inclinometer Cased Holes**

The three crosshole seismic survey cased holes at the test location (B102A, B103 and B104) were installed in a collinear alignment by GSI. B102A was selected as the acoustic source borehole and B103 and B104 were designated to be receiver boreholes R1 and R2, respectively. At the surface, the source borehole (B102A) was positioned approximately 15 feet from the near receiver borehole (B103). The far receiver borehole (B104) was approximately 15 feet beyond B103. Inclinometer measurements were collected in each cased hole at 2-foot depth intervals from 2 to 110 feet below ground surface (bgs), and completed in each of the test holes. Inclinometer-corrected distance measurements were used to calculate final seismic wave velocities.

#### **6.1.3 Data Analysis/Correlation to Boring Logs**

Crosshole seismic testing is recognized as the most reliable way to get discrete shear-wave interval velocities versus depth through a soil and rock section. In general, measured velocities increased with depth as shown in Fig. 10.

At the borehole array, shear wave velocity testing was performed on 5-foot intervals starting at 2 feet below ground surface (bgs), and continuing to 105 feet bgs (maximum depth tools can be operated in borehole due to tool length). Table 6 shows the calculated shear wave velocities for the crosshole tests. The near-surface fill and overburden sediments had measured shear-wave velocities ranging from 1,019 to 1,087 feet per second (ft/s). Velocities in the hard, dry lean clay varied from 1,703 to 2,041 ft/s. Below 60 feet, velocities were measured at 1,812 to 2,761 ft/s in the interbedded lean clays and mudstones layers. The 100-foot average shear wave velocity ( $V_{s100}$ ) is 1,765 ft/s which corresponds to a Class C per the IBC Seismic Site Classification.

## **6.2 Liquefaction Potential**

The soils encountered at the site were evaluated for liquefaction potential using the procedure described in Youd, et al., 2001. This procedure is identified in Regulatory Guide 1.198 (U.S. NRC, 2003). Based on the data from the borings and our analyses, the soils at the site are not susceptible to liquefaction.

As stated in Youd et al., corrected N-values greater than 30 blows per foot are too dense to liquefy in an earthquake of any size, and are therefore classified as non-liquefiable. In addition, soils above the groundwater table are not susceptible to liquefaction.

## **6.3 Swell Potential**

We are running consolidation and swell tests to evaluate whether the Chinle mudstone at the site may be susceptible to swell and heave in the presence of an increase in soil moisture. We will include those results in a future revision of this report.

## 7. References

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References for GEI work plans and procedures are contained in Attachment A. Other references are listed below.

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6. Powers, D. W., Lambert, S. J., Shaffer, S., Hill, L. R., & Weart, W. D. (1978). Geological Characterization Report Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico. Waste Management Technology, Sandia Laboratories.
7. U.S. Nuclear Regulatory Commission (NRC), 2003. Regulatory Guide 1.198, Procedures and Criteria for Assessing Seismic Liquefaction at Nuclear Power Plant Sites.
8. Youd, T.L, et al. (2001). "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils." American Society of Civil Engineers Journal of Geotechnical and Geoenvironmental Engineering. October, 2001. pp. 817-833.

## Tables

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**Table 1. Boring Exploration Data**

HI-STORE CISF Phase 1

Site Characterization

Lea County, New Mexico

Boring Number	As-Drilled Coordinates		Ground Surface Elevation (feet)	Boring Depth (feet)	Drilling, Sampling, and Field Test Notes (1)	Purpose
	Northing (feet)	Easting (feet)				
B101	571,880.4	731,795.0	3535.5	400.6	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B101A	571,899.0	731,779.8	NM	30.9	SPT	Hammer energy measurement.
B101B	571,906.7	731,791.6	3535.1	414.4	Not sampled	Installed monitoring well B101(MW).
B102	572,097.9	731,585.2	3531.7	112.0	Bulk Sampling, SPT, Rock Coring	Characterize soil and rock for ISFSI Pad.
B102A	572,088.4	731,581.4	3531.4	107.9	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B103	572,091.3	731,567.4	3531.2	107.6	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B104	572,094.6	731,552.0	3531.6	107.8	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B105	571,879.9	731,356.8	3535.0	221.7	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B105A	571,865.2	731,338.5	3534.9	30.4	SPT	Hammer energy measurement.
B106	572,280.0	731,356.3	3530.6	152.0	SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B106A	572,270.0	731,364.2	3531.4	203.0	Not sampled	Installed monitoring well B106(MW).
B107	572,282.3	731,792.4	3529.6	102.0	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B107A	572,282.4	731,782.1	3530.0	107.5	Not sampled	Installed monitoring well B107(MW).
B108	571,660.2	731,344.9	3536.7	60.9	SPT	Characterize soil for HHP.
B109	570,681.2	730,773.3	3539.6	102.0	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for CTB.

**Notes:**

1. Modified California samples were collected as appropriate in SPT borings.
2. Northing and Easting are based on the Modified U.S. State Plane of 1983 (NAD83), New Mexico East Zone 3001.
3. Elevations are based on the North American Vertical Datum of 1988 (NAVD88).
4. "SPT" indicates Standard Penetration Test.
5. "NM" indicates not measured.

**Table 2. Water Pressure Test Results**

HI-STORE CISF Phase 1

Site Characterization

Lea County, New Mexico

Formation	Boring Number	Ground Surface Elevation (feet)	Test Interval		USBR Pressure Permeability, Single Packer, Test Zone (*)	Applied Pressure at Ground Surface (psi)	Coefficient of Permeability (K)		Representative Permeability (K) at Test Interval	
			Depth Below Ground Surface (feet)	Elevation Range (feet)			(cm/sec)	(feet/yr)	(cm/sec)	(feet/yr)
Chinle	B107	3529.55	67.7 - 77	3461.9 - 3452.6	Zone 1	17	1.5E-06	1.6	1.05E-06	1.1
						32	5.4E-07	0.6		
						45	1.1E-06	1.2		
Chinle	B106	3530.6	75.7 - 102	3454.9 - 3428.6	Zone 1	17	4.0E-07	0.4	3.2E-07	0.3
						31	3.2E-07	0.3		
						46	2.5E-07	0.3		
Chinle	B107	3529.55	77.8 - 87	3451.8 - 3442.6	Zone 1	15	8.1E-06	8.4	7.7E-06	8.0
						30	8.3E-06	8.6		
						45	6.8E-06	7.1		
Chinle	B106	3530.6	80.5 - 102	3450.1 - 3428.6	Zone 1	34	6.3E-07	0.7	4.5E-07	0.5
						46	2.7E-07	0.3		
						28	8.9E-07	0.9		
Chinle	B106	3530.6	85.5 - 102.0	3445.1 - 3428.6	Zone 1	37	9.9E-07	1.0	9.4E-07	1.0
						17	1.2E-06	1.2		
						31	4.0E-07	0.4		
Chinle	B107	3529.6	88.1 - 102.0	3441.5 - 3427.6	Zone 1	45	1.3E-06	1.4	2.5E-06	2.6
						15	1.8E-06	1.9		
						29	2.2E-06	2.3		
Chinle	B109	3539.6	93.0 - 102.0	3446.6 - 3437.6	Zone 1	45	3.6E-06	3.7	2.6E-06	2.6
						16	2.8E-06	2.9		
						30	2.5E-06	2.6		
Chinle	B106	3530.6	117.5 - 127.0	3413.1 - 3403.6	Zone 1	45	2.4E-06	2.4	9.2E-07	1.0
						16	5.4E-07	0.6		
						32	4.8E-07	0.5		
Santa Rosa	B101	3535.5	237.4 - 250.6	3298.1 - 3284.9	Zone 2	44	1.8E-06	1.8	3.4E-07	0.4
Santa Rosa	B101	3535.5	337.4 - 400.6	3198.1 - 3134.9	Zone 3	16	5.9E-07	0.6		
						32	2.6E-07	0.3		
						45	1.8E-07	0.2		

**Table 3. Soil Index Properties**

HI-STORE CISF Phase 1

Site Characterization

Lea County, New Mexico

Sample Identification			Index Properties				Unit Weight							
Boring Number	Sample Number	Sample Depth (ft)	Formation	Water Content (%)	Grain Size Tests			Atterberg Limits Tests			Specific Gravity	Unit Weight		
					Water Content (%)	Gravel (%)	Sand (%)	Fines (%)	Water Content (%)	Liquid Limit		Plastic Limit	Plasticity Index	Water Content (%)
B101	MC1	10.0 - 11.0	Residual Soil	--	--	--	--	--	--	--	--	15.8	--	--
B101	MC2	20.0 - 21.0	Residual Soil	--	--	--	--	--	--	--	--	9.4	--	--
B101	MC3	30.0 - 30.4	Residual Soil	--	--	--	--	--	--	--	--	15.4	126.4	109.5
B101	S11	35.0 - 36.8	Chinle	--	8.7	0.0	3.6	96.4	--	--	--	--	--	--
B101	S13	45.0 - 46.8	Chinle	--	15.0	0.0	46.8	53.2	--	--	--	--	--	--
B101	S15	55.0 - 56.4	Chinle	--	13.0	0.0	35.2	64.8	--	--	--	--	--	--
B101	S19	75.0 - 76.2	Chinle	10.4	10.2	0.0	30.6	69.4	--	33	16	17	--	--
B101	S20	80.0 - 81.3	Chinle	10.4	10.8	0.0	19.4	80.6	--	--	--	--	--	--
B101	S22	90.0 - 91.4	Chinle	--	14.2	0.0	29.3	70.7	--	--	--	--	--	--
B101	S23	95.0 - 96.8	Chinle	15.9	13.9	0.0	42.1	57.9	--	40	20	20	--	--
B102	G1	0.0 - 10.0	Caliche	--	--	--	--	--	5.0	NP	NP	NP	2.67	--
B102	S13(5-17")	30.0 - 32.0	Chinle	13.6	8.6	0.0	27.6	72.4	--	--	--	--	--	--
B102	S14	35.0 - 36.3	Chinle	9.9	--	--	--	--	--	--	--	2.78	--	--
B102	S15	40.0 - 41.4	Chinle	8.0	6.6	0.0	14.7	85.3	--	--	--	--	--	--
B102	S16	45.0 - 45.9	Chinle	14.6	--	--	--	--	--	--	--	2.81	--	--
B105	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	16.0	--	--
B105	MC2	20.0 - 20.9	Residual Soil	--	--	--	--	--	--	--	--	10.3	--	--
B105	S9	25.0 - 26.8	Residual Soil	11.5	--	--	--	--	--	--	--	2.74	--	--
B105	MC3	40.0 - 41.0	Chinle	--	--	--	--	--	--	--	--	15.8	124.2	107.3
B105	S14	50.0 - 51.4	Chinle	15.7	--	--	--	--	--	--	--	2.81	--	--
B105	S15	55.0 - 56.4	Chinle	15.0	12.9	0.0	48.8	51.2	--	--	--	--	--	--
B106	S5	10.0 - 12.0	Caliche	12.7	13.0	49.2	42.0	8.8	--	43	34	9	--	--
B106	S7(6-24")	15.0 - 17.0	Residual Soil	11.5	10.7	0.3	80.2	19.5	--	40	15	25	--	--
B106	S9	20.0 - 21.9	Residual Soil	9.6	9.2	0.0	38.3	61.7	--	40	12	28	--	--
B106	S10	22.5 - 24.5	Residual Soil	10.8	9.2	0.0	55.9	44.1	--	41	14	27	--	--
B106	S13	30.0 - 31.1	Chinle	11.0	9.9	0.0	34.3	65.7	--	40	18	22	--	--
B107	G1	0.0 - 10.0	Caliche	--	--	--	--	--	--	NP	NP	NP	2.65	--
B107	S7	15.0 - 16.9	Residual Soil	--	8.3	0.0	60.1	39.9	10.9	42	20	22	--	--
B107	S13	30.0 - 32.0	Chinle	--	11.6	0.0	10.5	89.5	12.1	45	18	27	--	--
B107	S15	40.0 - 42.0	Chinle	--	10.9	0.0	31.8	68.2	16.5	41	20	21	--	--
B107	S17	50.0 - 51.3	Chinle	--	13.3	0.0	42.7	57.3	14.9	40	21	19	--	--
B108	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	13.3	94.2	83.2
B108	MC2	40.0 - 40.9	Chinle	--	--	--	--	--	--	--	--	14.7	123.9	108.1
B108	S14	45.0 - 47.0	Chinle	5.5	14.1	0.0	47.0	53.0	--	--	--	15.9	84.5	72.9
B109	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	7.5	98.6	91.7
B109	MC2	20.0 - 20.3	Residual Soil	--	--	--	--	--	--	--	--	--	--	--

**Notes**

1. "--" Indicates test was not assigned or performed.
2. "NP" Indicates the sample is nonplastic.
3. Total Unit Weight and Dry Unit Weights from modified california samples.
4. "ft" Indicates feet.
5. "pcf" Indicates pounds per cubic foot.
6. MC = Modified california sample; S = Standard SP T; G = Bulk sample.



**Table 4. Rock Core Test Results**

HI-STORE CISF Phase I

Site Characterization

Lea County, New Mexico

Sample Identification			Formation	Test No.	Water Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (ksf)	Strain at Failure (%)	Elastic Modulus (ksf)
Boring Number	Sample Number	Sample Depth (ft)								
B107	C6	84.0 - 85.0	Chinle	UC-1	15.2	126.5	109.8	17.4	0.75 <sup>(6)</sup>	2,727
B107	C6	84.0 - 85.0	Chinle	UC-2	16.8	136.9	117.2	5.3	0.90	900
B107	C4	73.9 - 74.6	Chinle	UC-3	15.4	137.8	119.5	25.7	0.80	4,545
B101	C28	226.3 - 226.7	Santa Rosa	NA	NM	159	NM	293	1.50	28,800
B101	C31	244.5 - 244.9	Santa Rosa	NA	NM	163	NM	938	0.45	227,500
B101	C39	283.4 - 283.8	Santa Rosa	NA	NM	160	NM	696	0.74	128,300
B101	C45	309.8 - 310.2	Santa Rosa	NA	NM	156	NM	699	0.62	95,040
B101	C48	324.5 - 325.9	Santa Rosa	NA	NM	163	NM	594	0.60	124,560
B101	C55	360.7 - 361.4	Santa Rosa	NA	NM	157	NM	766	0.56	181,440
B101	C63	399.8 - 400.3	Santa Rosa	NA	NM	164	NM	1003	0.50	263,520

**Notes:**

1. "ft" Indicates feet.
2. "pcf" Indicates pounds per cubic foot.
3. "ksf" indicates kips per square foot
4. NM indicates not measured.
5. NA indicated not applicable.
6. Strain at failure for UC-1 adjusted to remove initial seating strain

**Table 5. Groundwater Elevation Data from Monitoring Wells**

HI-STORE CISF Phase 1  
Site Characterization  
Lea County, New Mexico

Monitoring Well Number	B101 (MW)		B106 (MW)		B107 (MW)		ELEA-2	
	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
Sanded and Screened Interval <sup>1</sup>	377.7 - 414.4	3157.78 - 3121.08	174.3 - 203	3357.08 - 3328.38	82.4 - 107.5	3447.56 - 3422.46	53 - 98	3480.49 - 3435.49
Water Level Measurements	10/15/2017	NA	199.5	3331.9	102.6	3427.4	NM	NM
	10/16/2017	NA	199.5	3331.9	102.0	3428.0	NM	NM
	10/18/2017	NA	199.5	3331.9	100.8	3429.2	NM	NM
	10/19/2017	NA	199.5	3331.9	100.5	3429.5	NM	NM
	10/24/2017	NA	199.4	3332.0	98.0	3432.0	NM	NM
	10/26/2017	263.7	NM	NM	NM	NM	NM	NM
	10/31/2017	253.4	NE	NE	100.0	3430.0	NM	NM
	11/1/2017	253.4	NE	NE	99.6	3430.4	37.6	3495.9
	11/16/2017	253.6	NE	NE	93.1	3436.9	37.7	3495.8

**Notes:**

1. The sanded and screened interval corresponds to the upper and lower limits of the sanded zone.
2. Depth refers to depth below the ground surface.
3. Elevations are based on the North American Vertical Datum of 1988 (NAVD88).
4. "NA" indicates Not Applicable. Monitoring well was not installed by those dates.
5. "NM" indicates Not Measured.
6. "NE" indicates Not Encountered.
7. B107(MW) was bailed dry after 10/24/2017 water level measurement.
8. Data for B106(MW) from Oct15 to Oct24 indicate water levels below bottom of screen section, within the silt trap. These readings indicate groundwater at this
9. ELEA-2 sanded and screened interval information is based on the Drillhole Log ELEA-2 from the GNEP Eddy Lea Siting Study (2007).

**Table 6. Shear Wave Velocities**

HI-STORE CISF Phase I

Site Characterization

Lea County, New Mexico

Depth	Measurement Elevation	Shear Wave Velocity	Formation
(ft)	(ft)	(ft/sec)	
2	3529.4	1092	Caliche
5	3526.4	1057	Caliche
10	3521.4	1019	Caliche
15	3516.4	1087	Residual Soil
20	3511.4	1906	Residual Soil
25	3506.4	1703	Residual Soil
30	3501.4	2005	Residual Soil
35	3496.4	1243	Chinle
40	3491.4	1500	Chinle
45	3486.4	1588	Chinle
50	3481.4	1637	Chinle
55	3476.4	2041	Chinle
60	3471.4	2274	Chinle
65	3466.4	2240	Chinle
70	3461.4	1867	Chinle
75	3456.4	1849	Chinle
80	3451.4	1831	Chinle
85	3446.4	1877	Chinle
90	3441.4	1812	Chinle
95	3436.4	2220	Chinle
100	3431.4	2539	Chinle
105	3426.4	2761	Chinle

Note: Shear wave velocities were measured by crosshole testing at B102A, B103, and B104.

## Figures

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0 1000 2000 4000 6000  
SCALE, FEET

This Image from U.S.G.S. Topographic 7.5 Minute Series  
Laguna Gatuna, NM Quadrangle 2017.  
Datum is North American Vertical Datum of 1988 (NAVD88).  
Contour Interval is 10 Feet.



HI-STORE CISF Phase 1  
Site Characterization  
Lea county, New Mexico  
Holtec International  
Camden, New Jersey

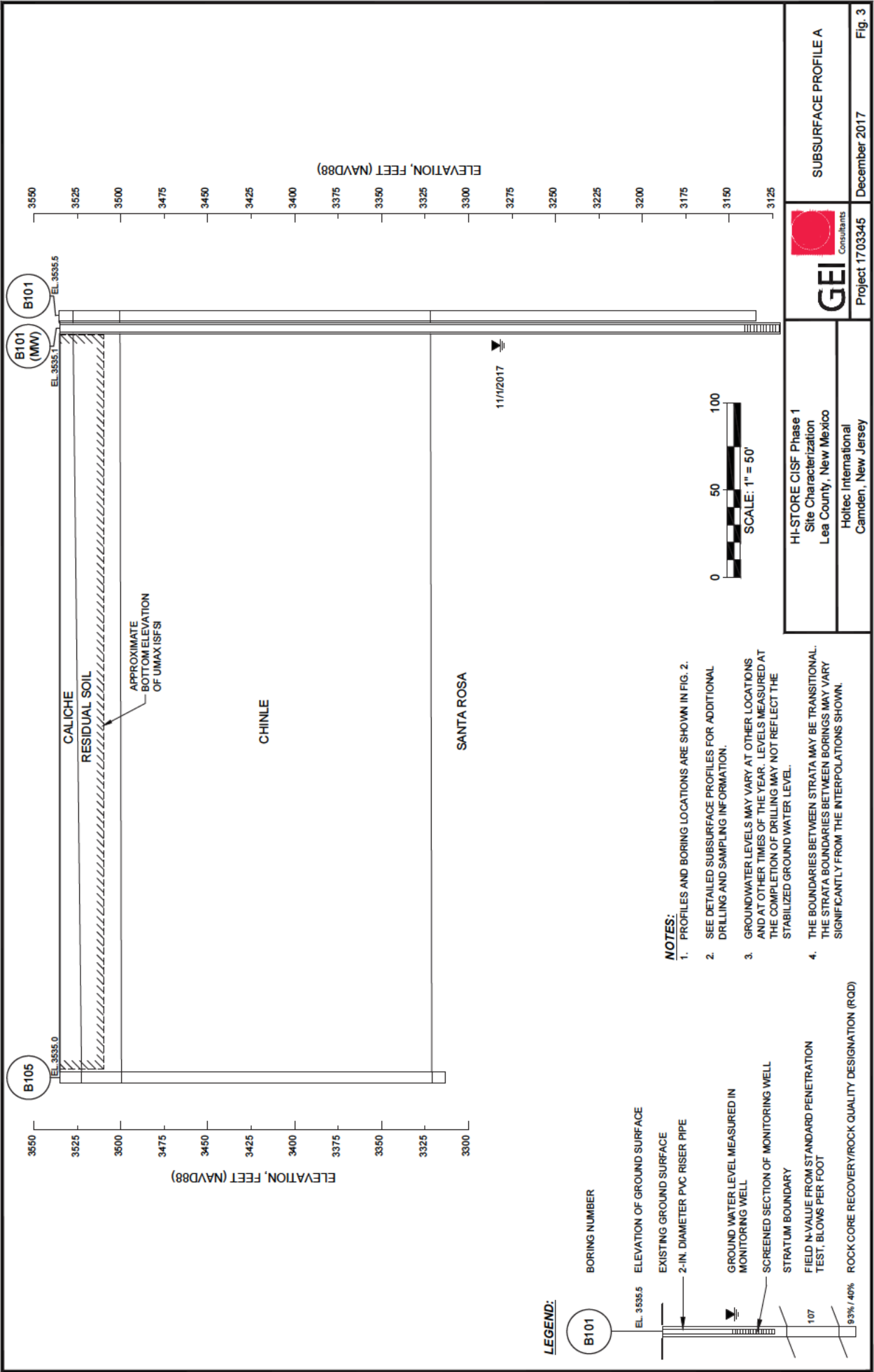
**GEI** Consultants  
Project 1703345

SITE LOCATION MAP

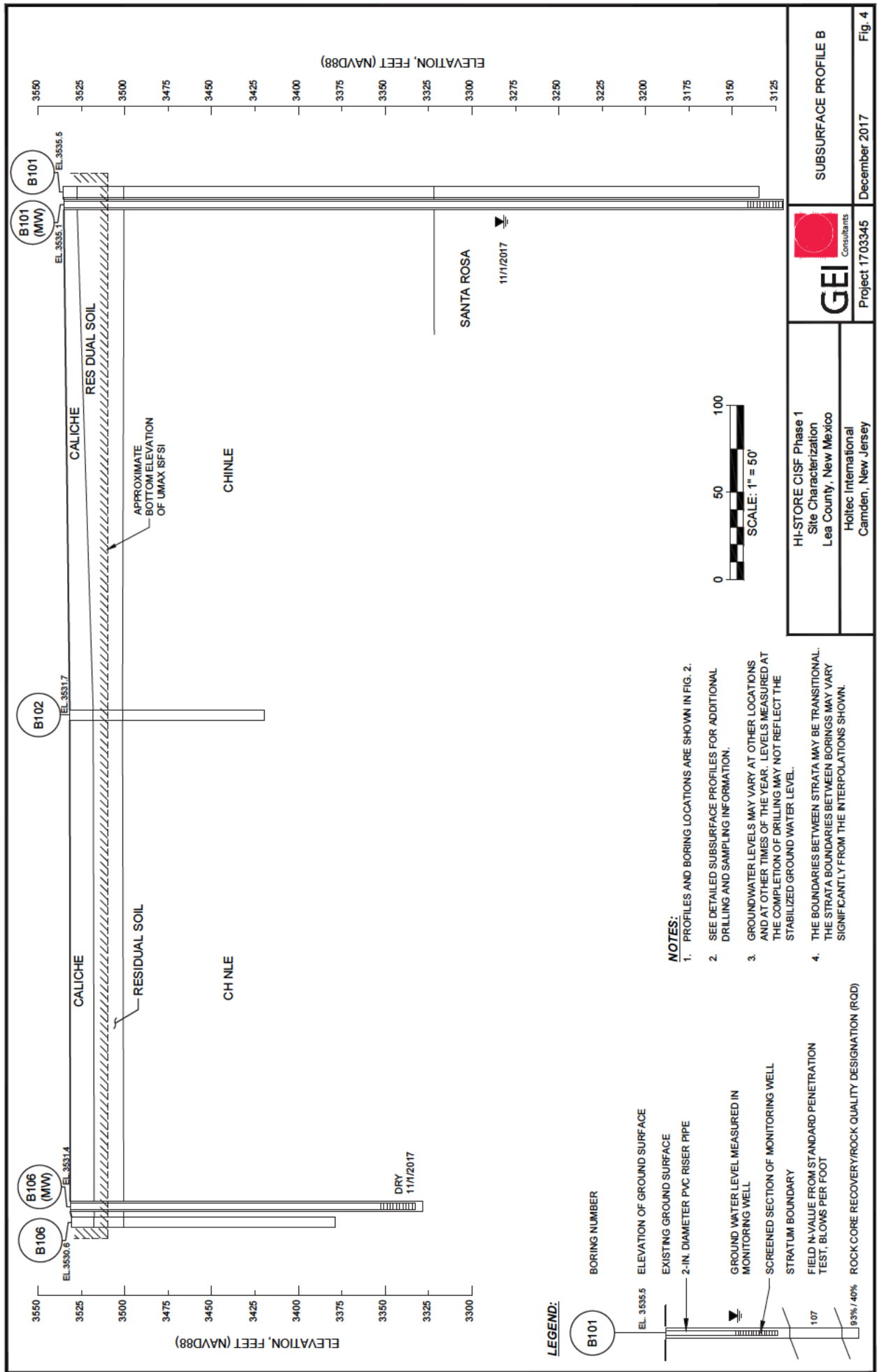
December 2017

Fig. 1

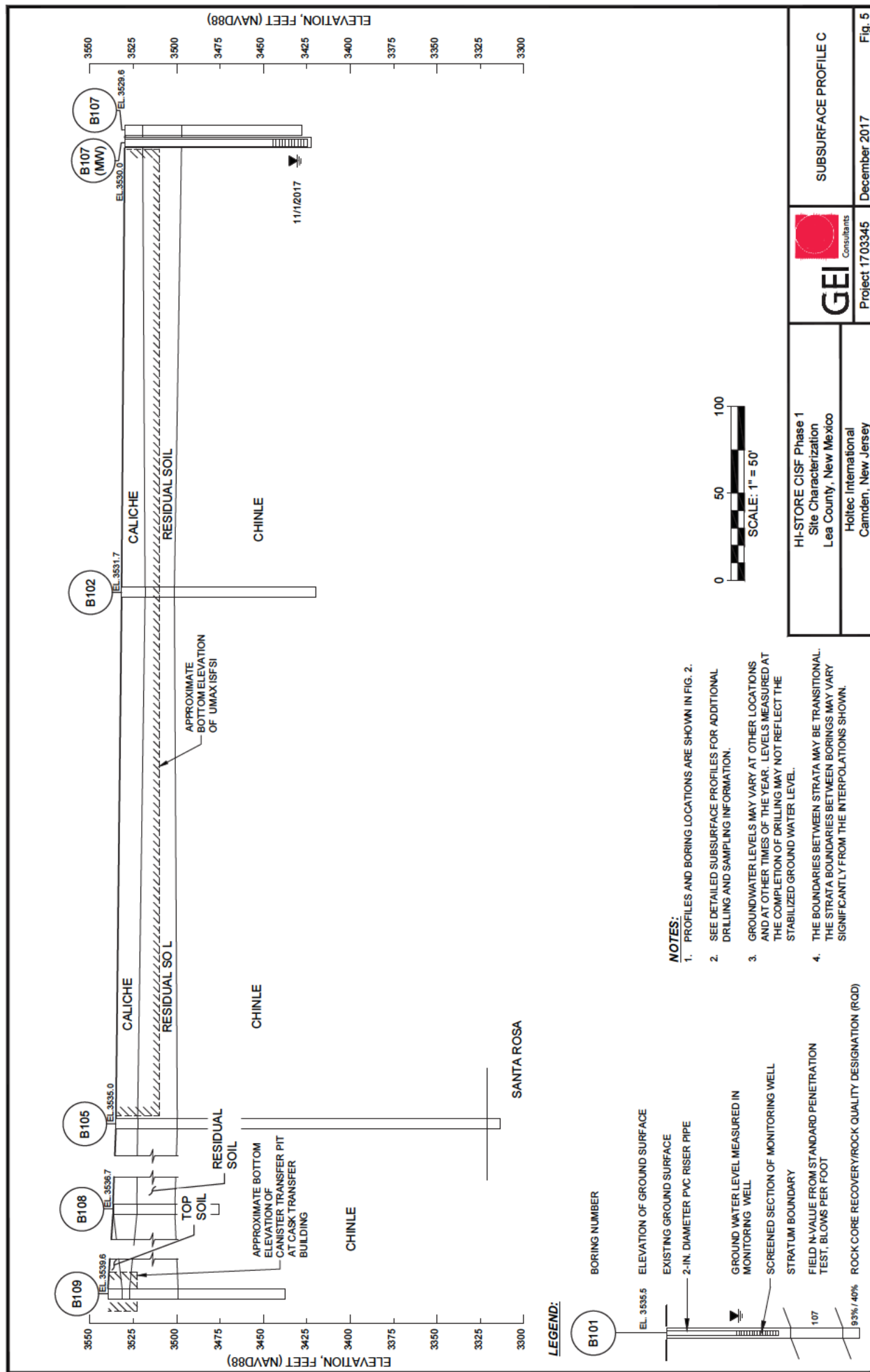
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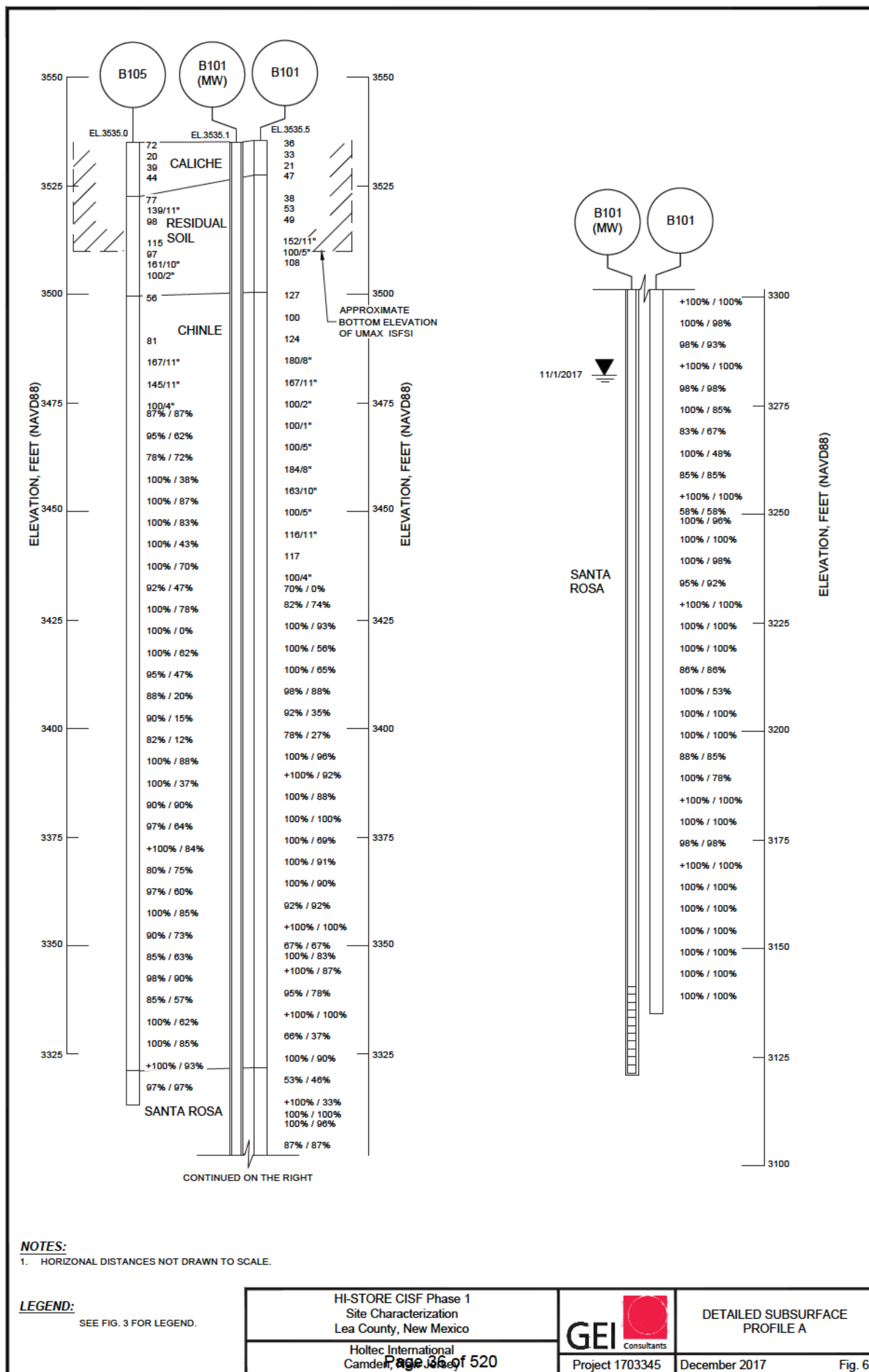


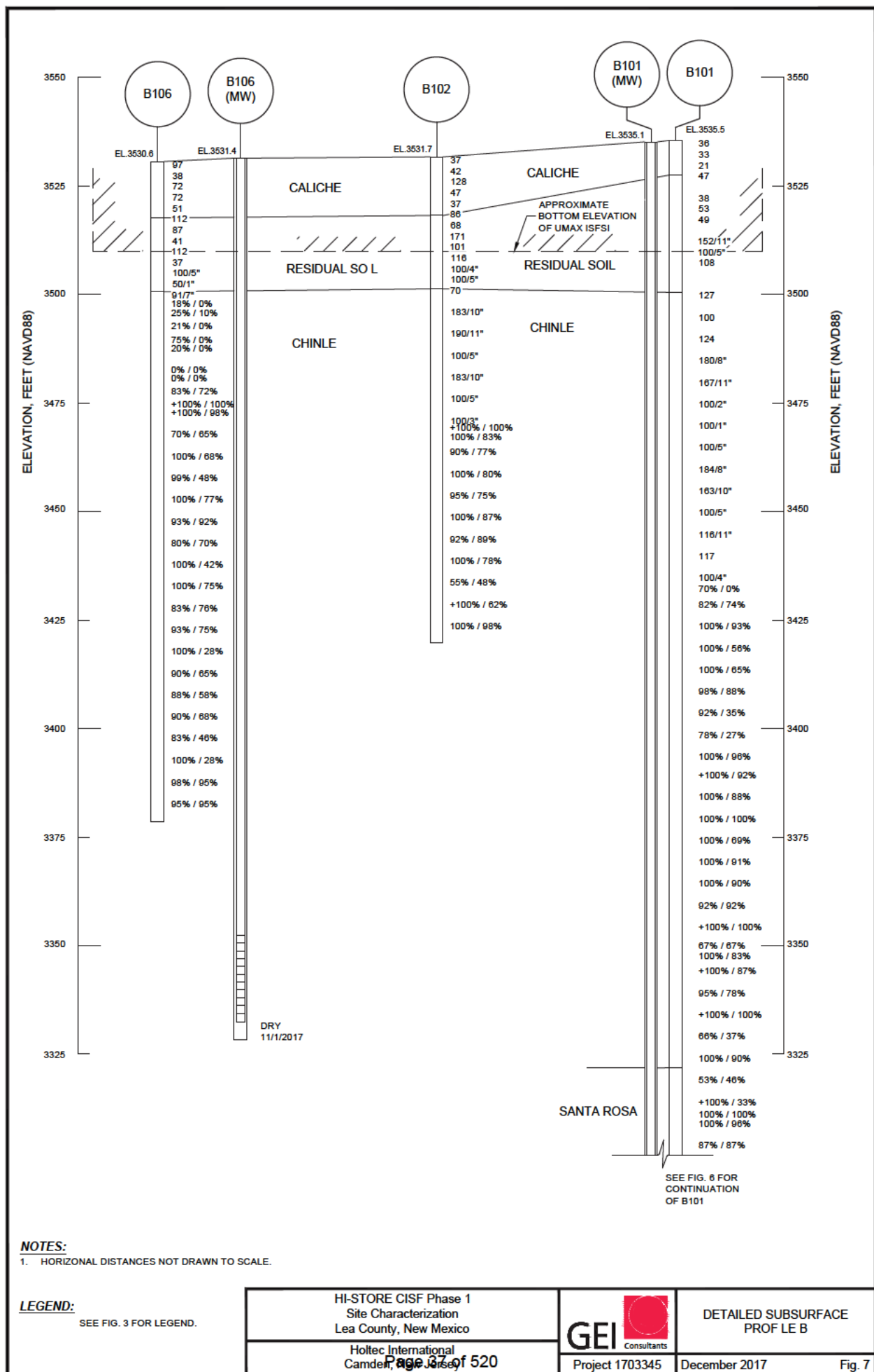


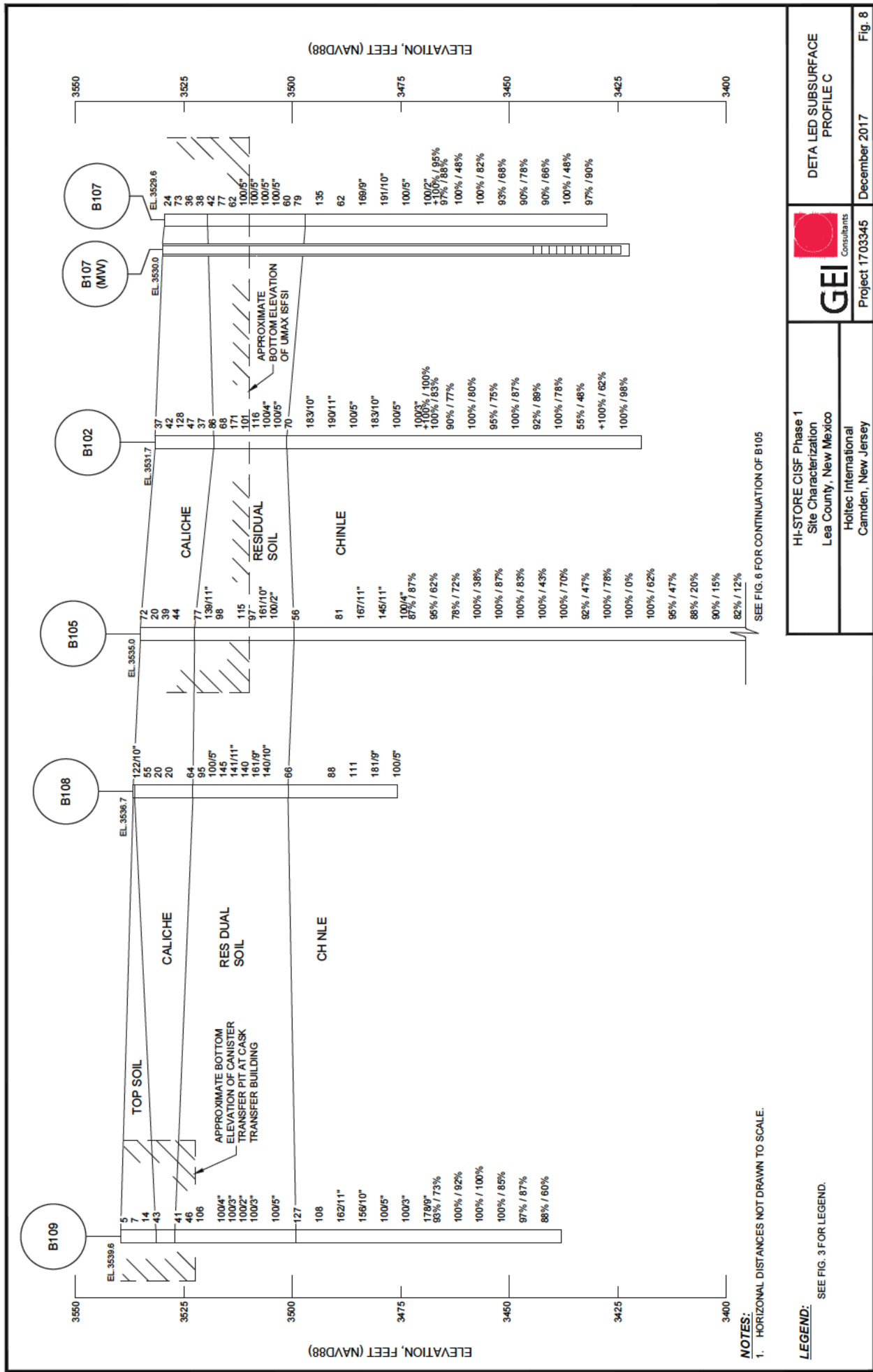


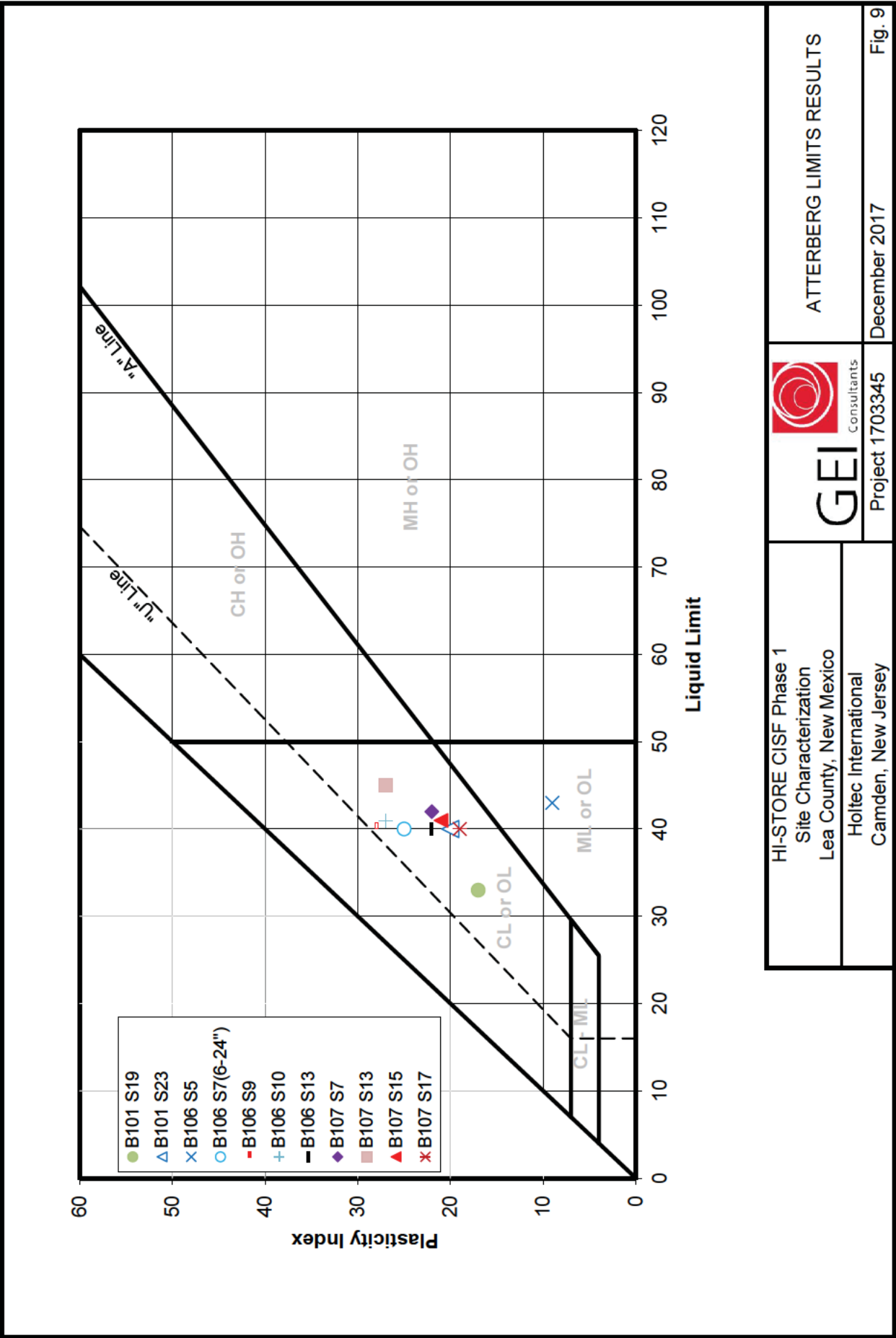
HI-STORE CISF Phase 1 Site Characterization Lea County, New Mexico		 <b>GEI</b> Consultants	SUBSURFACE PROFILE C
Holtec International Camden, New Jersey			December 2017
		Project 1703345	Fig. 5

Project 1703345  
December 2017  
Fig. 5









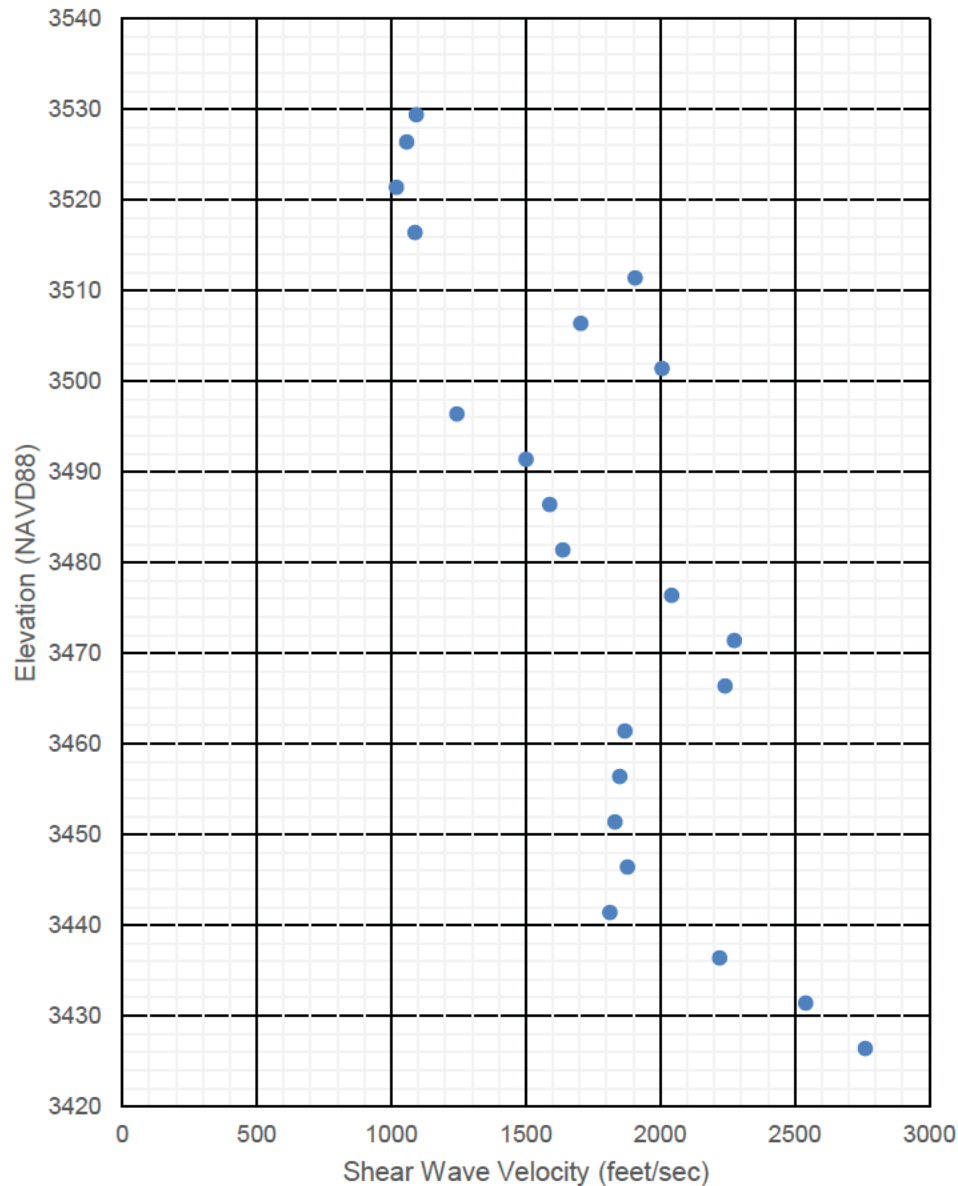
HI-STORE CISF Phase 1  
Site Characterization  
Lea County, New Mexico  
Holtec International  
Camden, New Jersey



ATTERBERG LIMITS RESULTS

Project 1703345  
December 2017  
Fig. 9

## Shear Wave Velocities



B102 Stratigraphy

El. 3532

Caliche

El. 3518

Residual Soil

El. 3501

Chinle

### Notes:

1. Shear wave velocities were measured by crosshole testing at B102A, B103, and B104.
2. See Table 6 for shear wave velocity measurements.

HI-STORE CISF Phase 1  
Site Characterization  
Lea County, New Mexico

Holtec International  
Camden, New Jersey



Project 1703345

SHEAR WAVE VELOCITIES

December 2017

Fig. 10

# Attachment A


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## GEI Work Plan



Consulting  
Engineers and  
Scientists



	Issued for use.
	Verify Current Revision.
CIS - WP 001 - 03	

### Revision 3

## GEI Work Plan 1




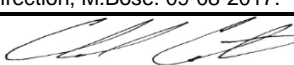
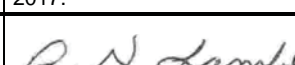
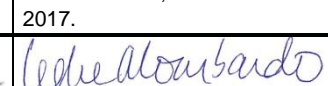

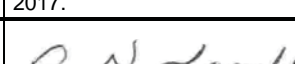
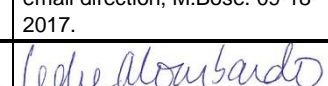

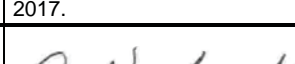
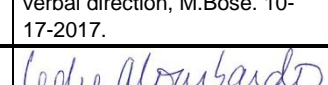
HI-STORE CISF Site Characterization – Phase 1  
Lea County, New Mexico

#### Submitted by:

GEI Consultants, Inc.  
400 Unicorn Park Drive  
Woburn, MA 01801  
781-721-4000

November 2017  
Project 1703345

## Work Plan Approval

Rev	Date	Prepared by	Checked By	Approved by
0	9/8/2017	 Chad Conti Electronic signature used per email direction, M.Bose. 09-08-2017.	 Robert Lambe Electronic signature used per email direction, M.Bose. 09-07-2017.	 Leslie Lombardo Electronic signature used per email direction, M.Bose. 09-08-2017.
1	9/19/2017	 Chad Conti Electronic signature used per email direction, M.Bose. 09-18-2017.	 Robert Lambe Electronic signature used per email direction, M.Bose. 09-19-2017.	 Leslie Lombardo Electronic signature used per email direction, M.Bose. 09-18-2017.
2	10/17/2017	 Chad Conti Electronic signature used per email direction, M.Bose. 10-17-2017.	 Robert Lambe Electronic signature used per verbal direction, M.Bose. 10-17-2017.	 Leslie Lombardo Electronic signature used per verbal direction, M.Bose. 10-17-2017.
3	11/14/2017	 Chad Conti Electronic signature used per email direction, M.Bose. 11-14-2017.	 Robert Lambe Electronic signature used per email direction, M.Bose. 11-14-2017.	 Leslie Lombardo Electronic signature used per email direction, M.Bose. 11-14-2017.

Work Plan Revision	Section	Description
0	All	New Work Plan
1	4.2.2, Table 2, Fig. 2	Revised inclinometer spacing from 10 feet to 15 feet.
2	4.3.1, 4.3.3, Table 1, Table 2	Clarified core box type, added Pitcher Sampler option, clarified monitoring well installation if no water is encountered. Added Pitcher Sampler procedure.
3	4.4.1, Table 1	Added Swell Testing and X-Ray Diffraction to list of lab tests. Added Swell Test procedure to table of procedures.

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2. Proposed Boring Locations

CRC/JVS/RNL/LAL:mrh

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# 1. Introduction

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This Work Plan describes the work activities and methods to be performed by GEI Consultants, Inc., and its team members under contract to Holtec International (PO #111995) as part of a site characterization for the construction of Holtec’s proposed HI-STORE Consolidated Interim Storage Facility (CISF) in Lea County, New Mexico. This work plan was prepared based on “[1] Technical Scope of Work – Geotech Investigation, HI-STORE CISF” provided by Holtec on August 29, 2017. GEI will perform the activities outlined in the Holtec Scope of Work to characterize Phase 1 of the HI-STORE CISF.

The goal of the project is to determine various soil properties to be used in geotechnical calculations to support the seismic analysis of the design, provide input to the design regarding settlement and stability, and to provide site characterization data to support licensing.

This Work Plan addresses:

- Surveying and staking locations of boreholes.
- Conducting a geophysical survey to map potential underground structures and utilities in the area of each exploration.
- Performing boring activities including drilling, logging, and sampling using standard split spoons, Shelby tubes, Modified California Samplers, Pitcher Samplers, and rock core barrels.
- Installing inclinometer casing and performing cross-hole seismic shear wave velocity measurements.
- Properly abandoning completed borings.
- Performing geotechnical laboratory tests on select soil samples.
- Performing laboratory tests to determine soil corrosivity.
- Performing calculations and preparing a Geotechnical Data Report with recommendations.

## 2. Project Organization and Communication

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Lines of responsibility and communication have been defined as shown on Fig. 1. The responsibilities of the GEI Project Manager (PM) include: approving any changes in the scope of work; monitoring and directing technical progress; reviewing and approving work products; instituting corrective actions if necessary; and approving key staffing changes.

Assisting the GEI PM will be a Field Manager (FM). The FM is responsible for: directing daily technical work; communicating with the Holtec Engineer while in the field; directing subcontractors in the field; implementing corrective actions if necessary; regular reporting of field activity progress; training GEI staff in the areas of health and safety and appropriate technical skills; and reporting issues to the GEI PM and other appropriate parties. The GEI FM will manage the GEI field staff assigned to work with GEI's subcontractors.

GEI's project Quality Assurance Manager (QAM) will assure that all staff are properly trained in quality assurance. The QAM will monitor the QA program and assure that GEI is following appropriate procedures and policies. If a non-compliance is identified, the GEI QAM will enter the condition into the Corrective Action Program and track, review, and approve condition reports and corrective actions.

GEI will engage subcontractors who provide specialized services for certain aspects of the work. GEI subcontractors will report to GEI staff only. GEI will be supported by the following subcontractors:

Souder, Miller & Associates (SMA) – Surveyors establishing site control points, boring markout, and as-built boring location surveys.

Geomechanics Southwest, Inc. (GSI) – Drillers performing soil borings, sampling, installation of groundwater monitoring wells, installation of inclinometer casing for cross-hole seismic velocity measurements, and boring abandonment.

GeoTesting Express (GTX) – Laboratory performing select geotechnical testing.

Cooper Testing Labs, Inc. (COT) – Laboratory performing soil corrosivity testing.

### 3. Project Schedule

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This Work Plan will be executed in accordance with the latest version of the Holtec Project Schedule using the approved GEI activity schedule input.



## 4. Project Scope and Approach

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The design of the field and laboratory program is based on:

- Holtec International, “[1] Technical Scope of Work – Geotech Investigation, HI-STORE CISF,” August 29, 2017.
- U.S. Nuclear Regulatory Commission, “Site Investigations for Foundations of Nuclear Power Plants,” Regulatory Guide 1.132, Revision 1, October 2003.
- U.S. Nuclear Regulatory Commission, “Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants,” Regulatory Guide 1.138, Revision 3, December 2014.
- N. Torres, et al., “Field Investigations for Foundations of Nuclear Power Facilities,” NUREG/CR-5738, USNRC, 1999.

Our approach is to address the requirements for geotechnical and geological investigations for the proposed ISFSI as described in Appendix C of Regulatory Guide 3.73 (“Site Evaluations and Design Earthquake Ground Motion for Dry Cask Independent Spent Fuel Storage and Monitored Retrievable Storage Installations”) and NUREG-1567 (“Standard Review Plan for Spent Fuel Dry Storage Facilities”).

GEI will conduct a geotechnical exploration program to focus on critical structures at the Site, including the Phase 1 ISFSI, the cask transfer building (CTB), and a portion of the heavy haul path (HHP). These areas of the site have been identified to provide the NRC with site characterization data to support licensing.

The Phase 1 scope of work will include land survey, geophysical utility clearance, cross-hole seismic survey, soil and rock borings, and laboratory testing of soil and rock. Detailed descriptions of each scope of work item and our proposed costs are included below.

### 4.1 Surveying

#### 4.1.1 Land Survey

Land survey work includes establishing horizontal and vertical ground control, surveying the locations of the proposed borings, and surveying the as-drilled locations of the borings. Temporary or permanent benchmarks may also be installed as needed. Control will be referenced to North American Datum of 1983 (NAD83), State Plane New Mexico East, and to the North American Vertical Datum of 1988 (NAVD88). Coordinates and ground surface elevations will be measured to the nearest 0.25 feet or less.

The proposed boring locations shown in Figure 2 will be marked in the field prior to drilling and then surveyed after they have been completed to identify the as-drilled locations. Boring locations may be revised to avoid potential conflicts with existing utilities or underground obstructions.

## **4.2 Geophysics**

### **4.2.1 Utility Survey**

Due to minimal information regarding existing utilities on the site, GEI will conduct a geophysical survey at each boring location to screen for unknown utilities, objects, or other anomalies. GEI uses various geophysical techniques in combination to provide a comprehensive scan of buried utilities in advance of intrusive activities. Since survey areas vary in size, shape, depth of interest, and surface interferences, a specific survey methodology may not be determined until detailed discussions with Holtec or a site walk-through. GEI proposes to use a combination of Radio Detection (RD 8000), Ground Penetrating Radar (GPR), or Time-Domain Electromagnetic (EM-61).

GEI will establish a control grid around each exploration location. For borings, we will clear an area approximately 30 feet x 30 feet to provide flexibility to shift boring location, if necessary due to impediments. The Radio Detection utility locator will be employed to detect energized lines. Where feasible, an active radio-frequency signal may be induced on wires or conduits exposed at the surface for the purpose of tracing them. GPR profiles will be collected on an intersecting 5 x 5 feet grid to provide a three-dimensional view of subsurface features. Additional profiles are collected where necessary to delineate anomalous reflections. Our field personnel paint interpreted utility alignments and create a scaled field drawing prior to site demobilization.

Boring locations may be revised to avoid potential conflicts with the existing utilities or underground obstructions.

#### **4.2.1.1 RadioDetection (RD)**

RadioDetection® RD8000 is used to actively and/or passively locate certain utilities within a specific depth range. The handheld wand has two passive modes that can detect a 60Hz (AC power) frequency that is induced in energized wires and a radio-frequency (RF) detector that will pick up reflected or induced RF signal that sometimes propagates along metallic utility lines and conduits. The RD also has an active mode when used in conjunction with a transmitter whereby a direct electrical connection or induction coil loop can be used to induce a known frequency signal onto exposed portions of the utility. We will match the frequency channel on the handheld unit to the same frequencies generated by the transmitter, to trace and mark out the induced signal at the surface.

#### 4.2.1.2 Ground Penetrating Radar (GPR)

GEI will use a GSSI Sir-3000 with a 400 MHz antenna and a GSSI DF system with a 300/800 MHz combined antenna. GPR is a non-destructive, non-intrusive geophysical technique that involves the transmission of very high-frequency electromagnetic (radio) waves into the near-surface. Reflections are produced when the electromagnetic waves encounter a subsurface interface or discontinuity in electrical character. These reflections are recorded by the field instrumentation and provide continuous, high-resolution subsurface images that are output in real-time to a digital recorder.

GPR signal penetration is partially controlled by near-surface conditions. Electrically resistive Earth material such as unsaturated, coarse-grained sediments optimizes GPR signal penetration. In contrast, GPR exploration will be limited by relatively conductive materials such as saturated or fine-grained sediments, clay-rich soils, ash, or reinforced concrete. Typical signal penetration through soils (utilizing the SIR-3000) at Nuclear Plants varies from 3 to 6 feet depending on soil type and saturation. Penetration limitations may also exist in salted roadways.

#### 4.2.1.3 Time-Domain Electromagnetics (EM-61)

Time-domain electromagnetic induction (EM) is a non-intrusive exploration technique that provides several advantages for buried metal detection. First, the EM-61 system is designed to induce eddy currents in a near-vertical section. This permits data collection proximal to some surface features (such as buildings or vehicles) that generally would cause interference with magnetometers or frequency-domain EM instruments. Secondly, the vertical signal generated from a buried target stops responding to the primary signal once the square (1 x 0.5 m) coils have been towed past the vertical projection of the buried metallic feature. The vertical projection, combined with the high dynamic range, can provide high lateral resolution mapping of utilities, underground storage tanks, reinforced concrete, and other metallic targets. This device is capable of detecting metal targets to depths of 10 feet while remaining insensitive to conductivity changes related to soil and groundwater.

### **4.2.2 Cross-Hole Shear Wave Velocity**

Cross-hole seismic shear wave velocity determinations will be made in one array. The array will use boring B102 (approximately 110-foot depth) and two additional borings (B103 and B104) spaced at 15- and 30-feet. The additional borings adjacent to B102 will be also be drilled to depths of approximately 110 feet. Typically, due to the equipment size and inclinometer casing installation process, the bottom approximately 10 feet of the borings are not tested.

## **4.3 Borings**

### **4.3.1 Soil/Rock Borings**

The proposed Phase 1 program consists of drilling 9 borings (B101 through B109) at locations approved by Holtec. The borings will be drilled in the areas of the proposed Phase 1 ISFSI, the CTB, and the HHP.

We will perform Standard Penetration Tests (SPT) and HQ rock coring, to collect soil samples and rock core (if competent rock is encountered), at all of the boring locations, except B103 and B104. In general, soil sampling will be at about 2.5-foot vertical intervals for the top 30 feet, and at 5-foot intervals from 30 feet to refusal. All SPT soil samples retrieved will be saved in glass jars for subsequent examination and testing as needed. Shelby tube samples will be collected at depth intervals where clay or silt deposits are encountered. Modified California Samplers may be used in place of SPTs to collect samples for unit weight testing. The location and depths of the Modified California Samples will be based on the soil conditions encountered.

We may collect bulk soil samples at B101, B102, B105, B106, B107, and B108 from auger cuttings at depths of about 0 to 10 feet. The bulk samples may be composited for laboratory testing.

The boreholes will be drilled to the top of rock, where the hole can be further advanced using SPT or HQ coring depending on the competency of the rock. In competent rock, the boring will be advanced using HQ coring. A Pitcher Sampler may be used in place of HQ coring to sample softer rock (or clays that are too hard for thin-walled Shelby tubes). All rock core retrieved will be placed in core boxes and saved for subsequent examination and testing as needed. Wooden core boxes are preferred; however, cardboard core boxes are acceptable.

We will obtain at least one water level reading from each boring after the completion of the boring.

Borings not completed with inclinometer casing or an observation well will be abandoned by backfilling with a cement-bentonite grout.

We assume that no hazardous material (e.g., petroleum contamination) will be encountered in our subsurface explorations that would require additional disposal and handling. All drill spoils will be spread on the ground adjacent to the exploration locations. If petroleum contaminated soils are encountered during drilling operations, we will notify Holtec to discuss proper agency notification and material handling and disposal requirements.

### **4.3.2 Inclinator Casings**

B102, B103, and B104 will be completed by grouting in place 2.75-inch-OD inclinometer casing for cross-hole seismic testing. B102, B103, and B104 will be completed with standpipe surface casing.

B102, B103, and B104 will not be abandoned as part of the Phase 1 scope.

### **4.3.3 Groundwater Monitoring Wells**

B101, B105, B106, B107, and B109 will be completed as groundwater monitoring wells with standpipe surface casing. The wells will consist of 2-inch-diameter, Sch. 40 PVC. We anticipate installing up to 20 feet of 0.010-inch slotted well screen and a silica sand pack. B101 is intended to be screened in the deep aquifer. B105, B106, B107, and B109 are intended to be screened in the shallow aquifer. The actual screened intervals and length may be adjusted in the field based on the soil, rock, and groundwater conditions encountered. A bentonite chip seal will be used above the sand pack with the remainder of the borehole backfilled with a cement-bentonite grout.

GSI will acquire state well permits.

If groundwater is not encountered in a boring planned for monitoring well installation, the borehole may be backfilled with cement-bentonite grout with no monitoring well installed. This decision will be made in consultation with the Project Manager.

### **4.3.4 Permeability Testing**

Packer testing will be performed in borings that will be completed as groundwater monitoring wells. We may perform up to eight packer tests at B101 and up to four packer tests in each of the other boreholes. The actual packer test lengths and test zones will be adjusted in the field based on the rock conditions encountered. Permeability testing may also be performed in monitoring wells.

## **4.4 Laboratory Testing**

### **4.4.1 Geotechnical Laboratory Testing**

Soil samples will be collected and tested using appropriate ASTM procedures for the tests indicated in the table below. Geotechnical laboratory testing performed by GEI will be conducted in GEI's Woburn, Massachusetts laboratory. Geotechnical laboratory testing performed by GeoTesting Express (GTX) will be conducted in Acton, Massachusetts. GTX will perform sieve analyses and Atterberg limits on samples selected for compaction and CBR testing for classification purposes.

For sieve analyses performed by GEI, we will use ASTM D 6913 in addition to D 422, if appropriate based on the gradation of the material. For ASTM D 422 the following clarifications apply:

- If any particle sizes exceed 3 inches, the maximum size particle of the sample will be measured and reported.
- The material passing the No. 10 sieve will be washed over a No. 200 sieve in accordance with ASTM D 1140 to determine the amount of material passing the No. 200 sieve.
- The material retained on the No. 200 sieve will be sieved through a nest of sieves containing as a minimum the following sizes: 1-1/2 inch, 3/4 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200.

Lab Test Type	Quantity (1)	Standard	Lab (2)
Moisture Content	20	ASTM D 2216	GEI
Sieve Analysis	20	ASTM D 422 / D 6913	GEI/GTX
Atterberg Limits	8	ASTM D 4318	GEI/GTX
Unconfined Compressive Strength of Cohesive Soil	12	ASTM D 2166	GEI
California Bearing Ratio (CBR)	8	ASTM D 1883	GTX
Rock Compressive Strength and Moduli Test	4	ASTM D 7012	GTX
1-D Consolidation Test	4	ASTM D 2435	GEI
Consolidated-Undrained Tri-axial Testing	8	ASTM D 4767	GEI
Density (Unit Weight)	20	ASTM D 7263	GEI
Specific Gravity	4	ASTM D 854	GEI
Compaction (Modified Proctor)	4	ASTM D 1557	GTX
Consolidated Drained Strength	8	Bishop & Henkel	GEI
Petrographic Analysis	3	ISRM	GTX
Cyclic Triaxial Test	6	ASTM D3999	GTX
Swell Tests	4	ASTM D4546	GEI
X-ray Diffraction (XRD)	4	ICDD	GTX

(1) Test quantities may vary based on field conditions and samples retrieved.

(2) Laboratory testing will be performed at GEI's Woburn, MA lab or by GeoTesting Express (GTX).

#### **4.4.2 Corrosivity Laboratory Testing**

A total of up to three soil samples for corrosivity testing will be taken from borings within the approximate footprint of the proposed ISFSI. The samples will be submitted to Cooper Testing

Labs of Palo Alto, California and analyzed for resistivity, pH, ORP, sulfide, and percent moisture by the following ASTM Methods, or other standard industry procedures:

Parameter	Test Method
Resistivity	ASTM G57
pH	ASTM G51
ORP	ASTM G200
Sulfide	Qualitative by Lead Acetate paper
Percent Moisture	ASTM D2216

## 4.5 Calculations and Geotechnical Data Report

GEI will prepare a Geotechnical Data Report. The Geotechnical Data Report will document the site characterization studies and results, cross-hole seismic results, geotechnical analyses, and geotechnical design criteria for the basis of the design and construction of the ISFSI. A draft copy of the report will be submitted for review within 2 weeks after completion of the laboratory testing. The final report will be issued within two weeks after resolution of comments. The report will be provided electronically. The report will include:

- Description of the subsurface explorations implemented for this scope of work.
- Site plan illustrating the boring locations.
- Review of subsurface conditions including logs of test borings, cross-hole seismic survey, and soil profiles.
- Information regarding the type of SPT used and its hammer efficiency.
- Results of all in-situ, field, and laboratory measurements, testing performed.
- Identification and description of test procedures/methods performed.
- Narrative interpretation of the subsurface soil and groundwater conditions observed and their implications for the project.
- Description of the test procedures used in performing the cross-hole seismic survey testing.
- Description of data interpretations, assumptions, and the methods used to determine engineering properties of the soils. Applicable references will be identified.
- Digital records, including a description of how the data are formatted in the electronic files, containing all unedited field test data. Shear and compression wave data will be presented in a standard seismic digital format. The data will be provided in Microsoft Excel format, or as approved by Holtec.
- Evaluation of liquefaction potential and recommended engineering properties of the soil.



## **5. Documentation and Submittals**

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Required documentation is described in the individual GEI procedures (Table 1). Field notes will be clearly recorded in standard field books or in an electronic data recorder. No erasures will be made in these books. Field notes are not submitted, but provided on request.

### **5.1 Geophysical Utility Survey**

Anomalies will be located on the ground with spray-painted markings.

### **5.2 Cross-Hole Seismic Survey**

A description of the test procedures used in performing the cross-hole seismic survey testing and the final cross-hole seismic testing data sheets will be included in the Geotechnical Data Report.

### **5.3 Borings**

Final boring logs will be included in the Geotechnical Data Report.

### **5.4 Laboratory Testing**

Final laboratory data reports will be included in the Geotechnical Data Report.

## 6. Quality Assurance Program

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With the exception of the utility survey work, which we understand is not considered “Important to Safety,” our scope of work will be conducted in accordance with our 10 CFR 50 Appendix B compliant Nuclear Quality Assurance (NQA) Program. In addition to the procedures and policies established by Holtec, the applicable procedures listed in Table 1 will be used. The current version of the applicable procedure at the time the activity is conducted will be used. The preparation, issue, and change of documents that specify quality requirements or prescribe activities affecting quality will be controlled according to GEI Procedure 920, Document Control.

The drilling and surveying subcontractors will perform their work under the GEI NQA Program. GEI will perform surveillances of the surveyor’s field activities intermittently in accordance with GEI Procedure 915, Conducting Surveillances. GEI will perform continuous surveillance of the driller’s field activities in accordance with GEI Procedure 922, Surveillance Reports – Continuously Monitored Field Activities.

Outside laboratories will perform their work in accordance with a Commercial Grade Dedication (GEI Procedure 926). Upon request, we will provide the results of the Commercial Grade Dedication to Holtec for review.

## 7. Training

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All GEI staff working on the project will be trained according to GEI Procedure 904, QA Training. GEI maintains a master training matrix identifying each employee and their training requirements based on their role in the project. Training requirements for subcontractors and subconsultants will be identified by the PM with input from the QAM. The QAM will verify that staff, subcontractors, and subconsultants have completed their required training.

## **8. Reporting of Deviations and Non-Conformances**

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If any GEI employees identify a Deviation or Non-Conformance in a quality-related activity or item, they will follow GEI Procedures 910, Corrective Action Program, and 917, Control of Nonconforming Items, as applicable.

## **9. Tracking the Status of Work Plan Elements**

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Significant work plan elements, such as field activities, laboratory testing, and submittals, will be tracked on the Work Plan Elements Tracking Form (Form 901.1). The form will be updated as elements are completed.

## Tables

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Table 1 – Applicable Procedures and Work Instructions

Table 2 – Boring Specifications

**Table 1. Applicable Procedures and Work Instructions**

GEI Work Plan 001 Rev 3

HI-STORE CISF

Lea County, New Mexico

<b>Document Number</b>	<b>Description</b>
GEI-PR100	Calibration of Test Equipment
GEI-PR101	Water Content Measurement
GEI-PR103	Specific Gravity Measurement
GEI-PR104	Grain Size Analysis: Sieve and Hydrometer
GEI-PR106	Sieve Analysis of Soil
GEI-PR108	Atterberg Limits Measurement
GEI-PR117	Surveying Using Survey Grade Global Positioning System Methods
GEI-PR120	Packing and Labeling of Split-Spoon Soil Samples
GEI-PR122	Packing and Labeling of Rock Core Samples
GEI-PR124	Transportation and Tracking of Soil and Rock Samples
GEI-PR126	Utility Clearance for Subsurface Exploration
GEI-PR127	Boring Advancement, Split Spoon Sampling, and Logging in Soil
GEI-PR128	Thick-Walled, Split-Barrel Driven Soil Samples
GEI-PR129	Soil Sampling for Corrosivity Testing
GEI-PR131	Well Installation
GEI-PR132	Packer Testing
GEI-PR135	Backfilling Boreholes by Grouting
GEI-PR136	Rock Coring
GEI-PR138	Bulk Soil Sampling from Borings
GEI-PR148	Review of Field Boring Logs
GEI-PR150	Final Boring Log Preparation
GEI-PR162	Well Level Measurement
GEI-PR163	Inclinometer Casing Installation
GEI-PR165	Thin-walled Tube Samples
GEI-PR166	Determining the Compressional Wave and Shear Wave Velocity in rock and soil using the Crosshole Seismic Testing Method
GEI-PR167	Pitcher Sampler
GEI-PR238	Unconfined Compressive Strength of Cohesive Soil and Soft Rock
GEI-PR239	1-D Consolidation Test
GEI-PR240	Consolidated Undrained Triaxial Test
GEI-PR241	Direct Shear Test
GEI-PR242	Unit Weight of Soil
GEI-PR243	Consolidated Drained Strength
GEI-PR244	Swell Test on One-Dimensional Consolidation Test Specimen
GEI-PR901	Preparation of Work Plans
GEI-PR902	Preparation of Work Instructions



**Table 1. Applicable Procedures and Work Instructions**

GEI Work Plan 001 Rev 3

HI-STORE CISF

Lea County, New Mexico

<b>Document Number</b>	<b>Description</b>
GEI-PR903	Technical Report and Calculation Preparation
GEI-PR904	QA Training
GEI-PR907	Transmittals
GEI-PR908	Procurement Documents
GEI-PR909	Processing Subcontractor Technical Documents
GEI-PR910	Corrective Action Program
GEI-PR911	Reporting of Defects and Non-Compliance
GEI-PR912	Stop Work
GEI-PR913	Computer Backup
GEI-PR914	Software Acquisition, Operation Verification, and Validation
GEI-PR915	Conducting Surveillances
GEI-PR916	Conducting Audits
GEI-PR917	Control of Nonconforming Items
GEI-PR918	Calibration
GEI-PR919	Reviewing and Storing Quality Assurance Records
GEI-PR920	Document Control
GEI-PR922	Surveillance Reports – Continuously Monitored Field Activities
GEI-PR924	Screening Suppliers
GEI-PR925	Qualifications for Inspection and Test Personnel
GEI-PR926	Commercial Grade Dedication
GEI-PR927	Identifying and Controlling Pending and Outstanding Work
ASTM D4633 – 10	Standard Test Method for Energy Measurement for Dynamic Penetrometers

Note: The current revision of the Procedure or Work Instruction will be used at the time the activity is conducted.

**Table 2 - Boring Specifications**  
 GEI Work Plan 001 Rev 3  
 HI-STORE CISE Site Characterization  
 Lea County, New Mexico

Boring Number	Coordinates		Estimated Depth in Soil (ft)	Estimated Depth in Rock (ft)	Estimated Total Depth (ft)	Sampling and Field Tests	Rationale for Hole Location, Depth, Samples and Tests
	Northing (ft)	Eastng (ft)					
B101	571,881	731,796	15	385	400	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Perform up to 8 Packer Tests.	Observe stratigraphy and collect samples beneath the proposed ISFSI. Install groundwater monitoring well.
B102	572,098	731,585	15	95	110	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Cross-hole seismic velocity testing.	Observe stratigraphy and collect samples beneath the proposed ISFSI.
B103	Offset 15 feet from B102 <sup>2</sup>		15	95	110	No Sampling Required; Cross-hole seismic velocity testing.	Cross-hole seismic velocity testing.
B104	Offset 15 feet from B103 <sup>2</sup>		15	95	110	No Sampling Required; Cross-hole seismic velocity testing.	Cross-hole seismic velocity testing.
B105	571,879	731,358	15	85	100	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Perform up to 4 Packer Tests.	Observe stratigraphy and collect samples beneath the proposed ISFSI. Install groundwater monitoring well.
B106	572,280	731,355	15	85	100	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Perform up to 4 Packer Tests.	Observe stratigraphy and collect samples beneath the proposed ISFSI. Install groundwater monitoring well.
B107	572,282	731,783	15	85	100	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Perform up to 4 Packer Tests.	Observe stratigraphy and collect samples beneath the proposed ISFSI. Install groundwater monitoring well.
B108	571,661	731,345	15	45	60	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring.	Observe stratigraphy and collect samples beneath the proposed HHP.
B109	570,681	730,774	15	85	100	Depths 0 ft to 30 ft SPTs performed at 2.5-ft intervals, Depths 30 ft to refusal. SPTs performed at 5-ft intervals. Collect up to 3 thin-walled Shelby tube samples where clay or silt is encountered; Rock coring; Perform up to 4 Packer Tests.	Observe stratigraphy and collect samples beneath the proposed CTB. Install groundwater monitoring well.

**NOTES:**

- Coordinates referenced to North American Datum of 1983, State Plane New Mexico East (NAD83).
- Offset locations of B103 and B104 are to be determined in field. B102, B103, and B104 will be in alignment for cross-hole seismic array.
- If water is not encountered before Estimated Total Depth, the boring may be advanced deeper until water is encountered (with approval from the Project Manager).  
Alternatively, if water is not encountered in a boring planned for monitoring well installation, the boring may be grouted with no monitoring well installed (with approval from the Project Manager).
- If the borehole used for sampling is not viable for well or inclinometer installation, an offset boring may be advanced within 20 feet of the sampled location with the inclinometer/well installed in the offset boring.

**ABBREVIATIONS:**

ft - Feet  
 SPT - Standard Penetration Tests

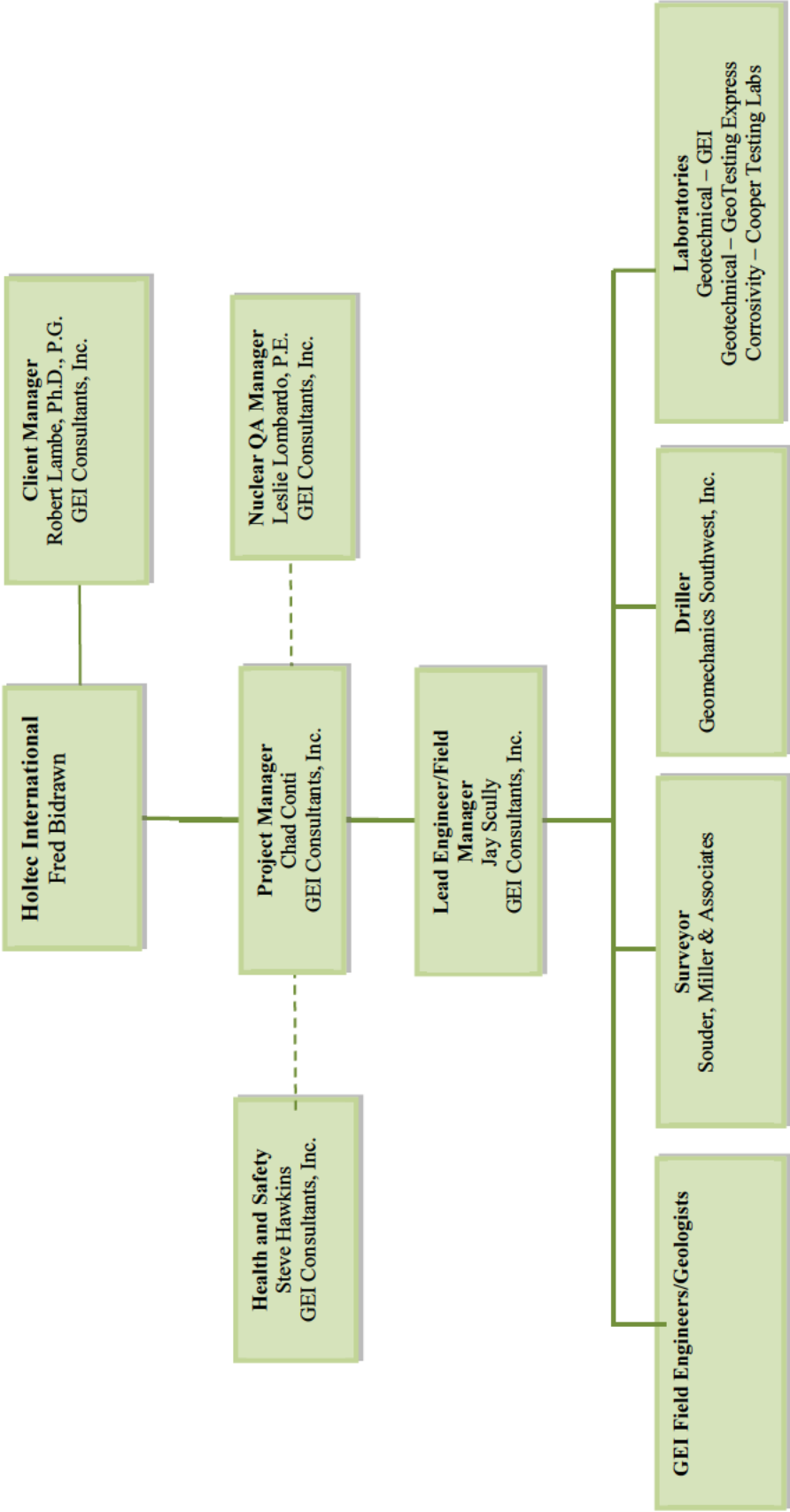
## Figures

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Figure 1 – Organizational Chart

Figure 2 – Location of Proposed Borings

**Figure 1. Organizational Chart**  
 GEI Work Plan 001 Rev 3  
 HI-STORE CISF  
 Lea County, New Mexico



# Security-Related Information Withheld under 10 CFR 2.390

## **Attachment B**

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### **As-Built Survey by Souder, Miller & Associates (SMA)**

**Subcontractor Document Approval**
 Issued for use.  
 Verify Current Revision.

CIS - SMA 03 - 00

Project Name: HI-STORE CISFProject Location: Lea County, New MexicoGEI Project No.: 173345Subcontractor: Souder, Miller & Associates (SMA)
 Document Title: .pdf file of drawing "Holtec HI-STORE CISF Facilities, Lea County, New Mexico, Borehole As Built Report," prepared by Souder, Miller & Associates, dated November 2017. Stamped November 6, 2017.
**Technical Reviewer**
 Signature:  Date: 11/8/2017
Printed Name: Jay Scully

Electronic signature used per verbal direction, M.Bose. 11/8/2017.

**QA Manager**
 Signature:  Date: 11/8/2017
Printed Name: Leslie Lombardo

Electronic signature used per email direction, M.Bose. 11/8/2017.





## Attachment C

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### Boring Logs

**Boring Information**

Northing : 571880.4      Easting : 731795.0  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3535.5  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 85

Date Start - End: 10/16/2017 - 10/22/2017  
 Driller Name: M. Shelquist  
 Logged By : A. McDonald/J. Neff/J. Scully  
 Drilling Company : GSI  
 Total Depth (ft) : 400.6

**Final Boring Log**

Boring No.  
**B101**  
 Page 1 of 16

**Drilling Information**

Hammer Type: Automatic  
 Auger I.D.: 4.25 in.  
 Auger Head Length: 3.875 in.  
 Drilling Method: Hollow stem augers 0-100.8 ft. Wireline rock coring 100.8-400.6 ft.

Casing I.D.: NA  
 Drill Rod O.D.: 3.5 in.

Core Barrel Type: HQ3  
 Core Barrel I.D./O.D.: 2.5 in. / 3.75 in.  
 Core Barrel Length: 8.6 ft

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3530	5		S1	18/24	9 15 21 28	NA	Collected bulk sample G1 from 0 to 10 ft. from auger cuttings.	CALICHE	S1(0 5"): CLAYEY SAND WITH GRAVEL (SC); ~60% fine sand, ~25% gravel up to 1 1/4", ~15% low plasticity fines, dark brown, moist.
			S2	12/24	8 15 18 18	NA			S1(5 18"): SILTY SAND WITH GRAVEL (SM); ~45% fine to coarse sand, ~40% gravel up to 1 1/4", ~15% nonplastic fines, light tan, gray, dry.
			S3	14/24	3 11 10 12	NA			S2: SILTY SAND WITH GRAVEL (SM); Same as to S1(5 18").
			S4	13/24	4 19 28 25	NA			S3: SILTY SAND WITH GRAVEL (SM); Same as to S1(5 18").
3520	10		MC1	12/12	18 38	NA		RESIDUAL SOIL	S4(0 6"): SILTY SAND WITH GRAVEL (SM); Same as to S1(5 18").
									S4(6 13"): CLAYEY SAND (SC); ~55% mostly fine sand, ~40% low plasticity fines, ~5% gravel up to 1/2", red, dry.
			S5	16/24	11 20 18 20	NA			MC1: CLAYEY SAND (SC); Same as to S4(6 13").
			S6	22/24	15 27 26 29	NA			S5: CLAYEY SAND (SC); Same as to S4(6 13").
	15		S7	21/24	14 23 26 29	NA			S6: CLAYEY SAND (SC); ~60% mostly fine sand, ~35% low plasticity fines, ~5% gravel up to 1/2", red, dry.
									S7: CLAYEY SAND (SC); Same as to S6.

**Notes:**

Project Name: HI-STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 2 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3510		MC2	12/12		15 28	NA		RESIDUAL SOIL	MC2: CLAYEY SAND (SC); S m ar to S6.
		S8	17/17		8 52 100/5"	NA			S8: SANDY LEAN CLAY (CL); ~55% ow p ast c ty f nes, ~45% f ne to med um sand, red, dry.
	25	S9	11/11		17 100/5"	NA			S9: SANDY LEAN CLAY (CL); S m ar to S8.
		S10	21/21		5 27 81 100/3"	NA			S10: SANDY LEAN CLAY (CL); S m ar to S8.
	30	MC3	5/5		50/5"	NA			MC3: SANDY LEAN CLAY (CL); ~55% ow p ast c ty f nes, ~40% most y f ne sand, ~5% grave up to 1/2", red, dry.
3500	35	S11	22/22		22 51 76 100/4"	NA		CHINLE	S11: LEAN CLAY (CL); 96% ow p ast c ty f nes, 4% f ne sand, redd sh brown, green sh gray. [Gra n S ze Test]
	40	S12	24/24		25 38 62 100	NA			S12: LEAN CLAY (CL); S m ar to S11.
	45	S13	22/22		15 38 86	NA			S13: SANDY LEAN CLAY (CL); 53% ow p ast c ty f nes, 47% f ne to med um sand, brown, purp e, tan. [Gra n S ze Test]

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 3 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
		X			100/4"				
	50	X	S14	14/14	31 80 100/2"	NA			S14: SANDY LEAN CLAY (CL); S m ar to S13.
	55	X	S15	17/17	32 67 100/5"	NA			S15: SANDY LEAN CLAY (CL); 65% ow p ast c ty f nes, 35% f ne to med um sand, brown, purp e, tan. [Gra n S ze Test]
3480							Dr chatter from ~59 to ~61 ft.	CHINLE	
	60	X	S16	8/8	32 100/2"	NA			S16: SANDY LEAN CLAY (CL); ~55% ow p ast c ty f nes, ~45% f ne to med um sand, brown, purp e, tan.
	65	X	S17	7/7	66 100/1"	NA			S17: SANDY LEAN CLAY (CL); S m ar to S16.
3470									
	70	X	S18	11/11	37 100/5"	NA			S18: SANDY LEAN CLAY (CL); S m ar to S16.

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3460	75	X	S19	14/14	22 84 100/2"	NA			S19: SANDY LEAN CLAY (CL); 69% ow p ast c ty f nes, 31% f ne to med um sand, brown, purp e, tan. [Gra n S ze Test], (LL = 33, PI = 17) [Atterberg L m ts Test]
	80	X	S20	16/16	34 63 100/4"	NA			S20: LEAN CLAY WITH SAND (CL); 81% ow p ast c ty f nes, 19% f ne to med um sand, brown, purp e, tan. [Gra n S ze Test]
3450	85	X	S21	11/11	35 100/5"	NA		CHINLE	S21: LEAN CLAY WITH SAND (CL); S m ar to S20.
	90	X	S22	17/17	29 16 100/5"	NA			S22: LEAN CLAY WITH SAND (CL); 71% ow p ast c ty f nes, 29% f ne to med um sand, purp e w th ye ow and gray sh green, dry. [Gra n S ze Test]
3440	95	X	S23	21/21	20 44 73 100/3"	NA			S23: SANDY LEAN CLAY (CL); 58% ow p ast c ty f nes, 42% f ne to med um sand, purp e w th ye ow and gray sh green, dry. [Gra n S ze Test], (LL = 40, PI = 20) [Atterberg L m ts Test]

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 5 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
	100	X	S24	10/10	29 100/4"	NA	Sp t spoon refusal at ~100.8 ft. Switched to wire ne rock coring. Washed out to ~101 ft prior to coring.	CHINLE	S24: SANDY LEAN CLAY (CL); Similar to S23.
			C1	42/60	0	7, 7, 11, 9, 11			C1: MUDSTONE; Brown sh red and gray, soft, weakly amnar, severely weathered. Fractures spaced 1 to 5", highly irregular and mostly mechanical fractures, highly fractured zone from 0 to 20".
3430	105		C2	49/60	74	6, 6.5, 13, 8.5, 10			C2: MUDSTONE; Brown sh red and gray, soft, amnar bedding, moderately weathered. Fractures spaced 1 to 26 1/2", generally planar and typically 0 to 10° from horizontal, moderately fractured zone from 3 to 4". Possible tstone from 9 to 25", gray, soft.
	110		C3	60/60	93	16.5, 6, 10.5, 10, 8			C3: MUDSTONE; Similar to C2. Fractures spaced 1 to 16", typically 0 to 30° from horizontal, approximately 30° fractures at 10", 14", 50", and 56", highly fractured zone from 45 to 46". Incus ons from 8 to 10", 21 to 27", 60".
3420	115		C4	60/60	56	5, 6.5, 4, 4.5, 6			C4: MUDSTONE; Similar to C2. Fractures spaced 1 to 7", typically 0 to 10° from horizontal, irregular fractures and highly fractured zones from 6 to 8", 11 to 13", 26 to 32", moderately fractured zones from 36 to 38" and 42 to 44", approximately 30° fracture at 54". Incus ons throughout from 26 to 32", 36 to 44", 60". Contains fine sand from 0 to 48".
	120		C5	60/60	65	3.5, 6, 2.5, 4, 5.5	Lost drill return at ~111 ft.		C5: MUDSTONE; Similar to C2. Fractures spaced 1 to 12", highly fractured zones from 9 to 11", 32 to 37", approximately 60° fractures at 25" and 58", approximately 30° fracture at 30". Incus ons throughout from 10 to 21", 29 to 44". Brown sh red and gray from 0 to 44", redd sh brown from 44 to 60".

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3410	125								
			C6	59/60	88	5, 6.5, 4.5, 6, 8.5			C6: MUDSTONE; S m ar to C2, redd sh brown. Fractures spaced 1 to 37", typ ca y 0 to 30° from hor zonta , approx mate y 30° fractures at 17", 40", and 49", h gh y fractured zone from 0 to 2". Inc us ons throughout from 0 to 2" and 39 to 42".
	130								
			C7	55/60	35	5, 7, 10, 12, 11			C7: MUDSTONE; S m ar to C2, conta ns green sh gray c ay. Fractures spaced 1 to 7", typ ca y 0 to 30° from hor zonta . Moderate y weathered/fractured sandstone from 42 to 48", brown and gray, med um hardness, rough fracture surfaces, conta ns ca c te ve ns.
	135								
3400			C8	47/60	27	5, 6, 6, 7, 14			C8: MUDSTONE; S m ar to C2. Fractures spaced 1 to 7", h gh y fractured zones from 0 to 3", 21 to 23", 41 to 47". Moderate y weathered sandstone from 31 to 34", brown and gray, med um hardness, rough fracture surfaces, conta ns ca c te ve ns. Poss b e cong omerate nc us ons from 10 to 12" and 41 to 47".
	140								
			C9	53/53	96	4, 6.5, 4, 4, 5.5			C9: S m ar to C2. Fractures spaced 2 1/2 to 21 1/2".
	145								
3390			C10	63/60	92	6, 5, 7, 5, 7.5			C10: MUDSTONE; S m ar to C2. Fractures spaced 1 1/2 to 15", typ ca y 0 to 30° from hor zonta , redd sh brown and gray. Poss b e c aystone from 57 to 63", gray, soft.
	150								
						5, 8.5,			

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 7 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
			C11	60/60	88	5, 6, 7			C11: MUDSTONE; S m ar to C2. Fractures spaced 3 1/2 to 6 1/2", h gh y fractured zone from 8 to 14". Poss b e c aystone from 0 to 9", gray, soft. Inc us ons from 36 to 48".
3380	155		C12	60/60	100	6, 5, 4.5, 7.5, 7.5			C12: MUDSTONE; S m ar to C2, redd sh brown. Fractures spaced 3 1/4 to 24".
	160		C13	60/60	69	6, 6, 6, 7.5, 12			C13: MUDSTONE; S m ar to C2, redd sh brown. Fractures spaced 3 1/2 to 15", h gh y fractured zone from 0 to 3".
3370	165		C14	60/60	91	4.5, 8, 5, 6, 11		CHINLE	C14: MUDSTONE; S m ar to C2, redd sh brown and gray. Fractures spaced 2 to 24". Approx mate y 30° fractures at 5" and 49".
	170		C15	60/60	90	6, 8, 10.5, 6.5, 8.5			C15: MUDSTONE; S m ar to C2, redd sh brown, gray, and tan. Fractures spaced 3 to 16". Approx mate y 30° fracture at 10". Poss b e cong omerate nc us ons from 6 to 12" and 35 to 36".
3360	175		C16	55/60	92	9, 6, 6, 8, 9			C16: MUDSTONE; S m ar to C2, redd sh brown. Fractures spaced 5 to 27". Inc us ons from 43 to 45".

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 8 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
	180								
			C17	62/53	100	6, 7, 5, 9, 6.5			C17: MUDSTONE; S m ar to C2, redd sh brown, gray, and tan. Fractures spaced 4 to 12", h gh y fractured zone from 0 to 9". Approx mate y 30° fracture at 21". Moderately weathered sandstone from 43 to 47", brown and gray, med um hardness, rough fracture surfaces, conta ns ca c te ns.
	185		C18	6/9	67	2			C18: MUDSTONE; S m ar to C2, redd sh brown.
3350			C19	60/60	83	13, 7, 6, 8, 19			C19: MUDSTONE; S m ar to C2 redd sh brown and gray. Fractures spaced 2 to 33", h gh y fractured zones from 11 to 16" and 58 to 60". Inc us ons from 58 to 60".
	190		C20	63/60	87	4.5, 5.5, 6.5, 3.5, 6.5		CHINLE	C20: MUDSTONE; S m ar to C2, brown sh red, tan, and gray. Fractures spaced 1 1/2 to 14". Approx mate y 30° at 20".
	195		C21	57/60	78	6.5, 7, 8.5, 7.5, 6.5			C21: MUDSTONE; S m ar to C2, brown sh red and tan. Fractures spaced 2 to 19", h gh y fractured zones from 9 to 11" and 55 to 57". Inc us ons from 9 to 11" and 32". Conta ns f ne tan sand from 44 to 57".
3340			C22	63/60	100	8.5, 9, 7.5, 9.5, 9.5			C22: MUDSTONE; S m ar to C2, redd sh brown, and tan. Fractures spaced 1 to 26 1/2", h gh y fractured zones from 7 to 10" and 23 to 31", moderate y fractured zone w th nc us ons from 49 to 51". Approx mate y 45° fracture at 16".
	200								

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 9 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3330	205								
		C23	40/60	37	7.5, 8.5, 8, 8, 8			CHINLE	C23: MUDSTONE; red, purple, gray and tan. Fractures spaced 1 to 13", highly fractured zones with irregular fractures from 5 to 8" and 21 to 26". Moderately weathered sandstone from 26 to 28", gray and brown, medium hardness, contains calcite veins. Approximately 30° fractures at 32 and 36". Mudstone contains fine tan sand, poorly indurated.
	210								
		C24	60/60	90	6.5, 9, 6.5, 4.5, 18				C24(0-36"): MUDSTONE; Similar to C2, purple from 0 to 2", reddish brown and tan from 11 to 36" with fine sand.
3320	215								
		C25	32/60	46	4.5, 3, 5, 5.5, 4.5		Core shoe was replaced.		C24(36-60"): SANDSTONE; medium hardness, red to gray, fine grained, cross stratified, well sorted, slightly weathered, fractures spaced 2 to 13", fractures generally planar and typically 0 to 10° from horizontal, rough fracture surfaces.  C25: SANDSTONE; Similar to C24(36-60"). Fractures spaced 1 to 12". Approximately 30° fracture at 15".
	220								
		C26	61/36	33	5, 6, 6			SANTA ROSA	C26: SANDSTONE; Similar to C24(36-60"). Fractures spaced 4 to 31", highly fractured zone from 0 to 6" with highly irregular, blocky fractures. Near vertical fracture from 8 to 13".
	225								
		C27	24/24	100	5, 5.5				C27: SANDSTONE; Similar to C24(36-60"). Possibly conglomerate from 19 to 21".
3310									
		C28	60/60	96	4, 5, 5, 4.5, 6				C28: SANDSTONE; Similar to C24(36-60"). Fractures spaced 2 to 24". Approximately 30° fractures at 14", 38", and 57".

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 10 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
	230								
			C29	52/60	87	4, 4, 4.5, 5, 5			C29: SANDSTONE; Similar to C24(36 60"). Fractures spaced 12 to 30".
	235								
3300			C30	64/60	100	5, 4, 3.5, 4, 8			C30: SANDSTONE; Similar to C24(30 60"). Fractures spaced 1 to 28", highly fractured zones from 0 to 15" and 41 to 42". Possible conglomerate from 36 to 64", reddish brown casts, well rounded, ~0.25 to 1.0 cm.
	240								
			C31	60/60	98	5, 6.5, 4, 6.5, 5			C31: SANDSTONE; Similar to C24(36 60"). Fractures spaced 11 to 26". Possible conglomerate throughout, reddish brown to gray casts, well rounded, ~0.25 to 1.0 cm
	245								
3290			C32	59/60	93	3.5, 3, 3.5, 4.5, 4			C32: SANDSTONE; Similar to C24(36 60"). Fractures spaced 2.5 to 27". Possible conglomerate from 29 to 36", reddish brown and gray casts, subrounded, ~0.5 to 1.5 cm.
	250								
			C33	61/60	100	2.5, 3, 2.5, 4.5, 5			C33: SANDSTONE; Similar to C24(36 60"). Fractures spaced 8 to 31 1/2". Possible conglomerate from 40 54" and 58 61", reddish brown and gray casts, well rounded, ~0.25 to 1.0 cm. Massive sandstone from 35 to 40" and 54 to 58", gray, fine grained, medium hardness.
	255								

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 11 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
			C34	59/60	98	6, 4, 4, 6, 6			C34(0 57"): SANDSTONE; S m ar to C24(36 60"). Fractures spaced 23 to 36". Poss b e cong omerate from 0 to 2", 5 to 6" and 33 to 36", redd sh brown and gray c asts, we rounded, ~0.5 cm. Sandstone from 6 to 16", med um to coarse gra ned, red and gray, med um hardness. Poss b e cong omerate from 51 to 57", soft, p nk and gray c asts, ~0.25 to 1.0 cm, subrounded, gray matr x.  C34(57 59"): MUDSTONE; Brown sh red, soft, am nar bedd ng, moderate y weathered.
	260								
			C35	61/60	85	7.5, 4.5, 6, 7, 7			C35: MUDSTONE; Brown sh red and gray, soft, am nar bedd ng, s ght y weathered, fractures spaced 1/2 to 9 1/2", genera y p anar and typ ca y 0 to 10° from hor zonta , h gh y fractured zones from 1 to 3" and 48 to 60 1/2".
	265								
3270			C36	50/60	67	6.5, 6, 4, 4, 6			C36: MUDSTONE; S m ar to C35. Brown sh red and gray.
	270							SANTA ROSA	
			C37	60/60	48	6, 5.5, 6, 4, 5.5			C37: MUDSTONE; S m ar to C35. Fractures spaced 2 to 12", h gh y fractured zones from 24 to 30" and 42 to 49". Approx mate y 30° fractures at 14", 17", and 19 1/2". Poss b e enses of c aystone at 39", 44 to 46", and 53 to 54", gray, soft.
	275								
3260			C38	51/60	85	6, 6, 3.5, 4, 3.5			C38: MUDSTONE; S m ar to C35.
	280								
			C39	63/48	100	3.5, 4, 4, 5			C39(0 19"): MUDSTONE; S m ar to C35. Fractures spaced 1 to 4", h gh y fractured zone from 0 to 8", vert ca fracture from 8 to 19".

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
									C39(19 to 63"): SANDSTONE; med um hardness, red and gray, fine grained, cross stratified, well sorted, slightly weathered, fractures spaced 1 to 13", fractures generally planar and typically 0 to 10° from horizontal, rough fracture surfaces.
	285		C40	7/12	58	5			C40: MUDSTONE; Brown sh red and gray, soft, amnar bedding, slightly weathered.
3250			C41	60/60	96	4, 7, 5.5, 5, 6			C41: MUDSTONE; Brown sh red and gray, soft, amnar bedding, slightly weathered, fractures spaced 2 to 11", generally planar and typically 0 to 30° from horizontal. Approximate 10° fractures at 19" and 28", approximate 30° fractures at 40" and 56".
	290		C42	60/60	100	7, 3.5, 5.5, 4, 4.5			C42: MUDSTONE; Similar to C41. Fractures spaced 3 to 13 1/2". Approximate 20° fractures at 9 1/2" and 49". Possible conglomerate from 0 to 19".
	295								
3240			C43	60/60	98	5, 5, 5, 5, 5		SANTA ROSA	C43: MUDSTONE; Similar to C41. Fractures spaced 2 to 28". Approximate 20° fractures at 8", 18 1/2", and 40".
	300		C44	57/60	92	3, 4, 4, 4, 4			C44: MUDSTONE; Similar to C41.
	305								
3230			C45	62/60	100	4, 3, 2.5, 4, 3			C45(0 9"): MUDSTONE; Similar to C41.  C45(9 62"): SANDSTONE; med um hardness, red and brown, fine grained, cross stratified, well sorted, slightly weathered, fractures spaced 13 to 25", fractures generally planar and typically 0 to 10° from horizontal, rough fracture surfaces.

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
	310								
			C46	60/60	100	5.5, 6, 5, 5, 5.5			C46: SANDSTONE; S m ar to C45(9 62").
	315								
3220			C47	60/60	100	3, 3, 3, 3.5, 3			C47: SANDSTONE; S m ar to C45(9 62").
	320								
			C48	52/60	86	3.5, 2.5, 3.5, 2.5, 2.5		SANTA ROSA	C48(0 25"): SANDSTONE; S m ar to C45(9 62"), green sh gray from 13 to 22 1/2". Fractures spaced 14 to 37 1/2". Poss b e conglomerate from 22 to 26".  C48(25 52"): MUDSTONE; Redd sh brown and gray, soft, am nar bedding, s ght y weathered, fractures spaced 5 to 47", genera y planar and typ ca y 0 to 10° from hor zonta .
	325								
3210			C49	60/60	53	4.5, 4, 4.5, 5.5, 5			C49: MUDSTONE; S m ar to C48(25 52"). Fractures spaced 2 to 12". Moderately fractured zone from 0 to 4", h gh y fractured zones from 33 to 37", 47 to 53", and 57 to 60". Vert ca fracture from 4 to 9", approx mate y 20° fractures at 5", 10", 24", 30" and 45".
	330								
			C50	60/60	100	5, 4, 5, 4, 5			C50: CLAYEY SANDSTONE; f ne gra ned, med um hardness, cross strat f ed, we sorted, s ght y weathered, red.

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 14 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
3200	335								
			C51	60/60	100	5, 4, 4.5, 5, 5			C51: CLAYEY SANDSTONE; S m ar to C50. R pp e am nated.
	340								
			C52	53/60	85	4.5, 4.5, 3.5, 4.5, 5.5			C52(0 4"): S m ar to C50.  C52(4 29"): SANDSTONE; f ne gra ned, cross strat f ed, s ght y weathered, med um hardness, we sorted, red w th green sh gray zones from 9 to 13" and 15 to 29", fractures spaced 1/2 to 24 1/2", fractures genera y p anar and typ ca y 0 to 10° from hor zonta . Approx mate y 10° fracture at 28 1/2".  C52(29 53"): CLAYEY SANDSTONE; f ne gra ned, med um hardness, cross strat f ed, we sorted, s ght y weathered, fractures spaced 1 to 9", fractures genera y p anar and typ ca y 0 to 30° from hor zonta , smooth fracture surfaces. Approx mate y 30° fractures at 38", 44", 47", and 56". C53: CLAYEY SANDSTONE; S m ar to C52(29 53"). Fractures spaced 1 1/2 to 16". Approx mate y 20 to 30° fractures at 9", 25", 30" and 59".
3190	345								
			C53	60/60	78	4.5, 6.5, 5.5, 4, 5		SANTA ROSA	
	350								
			C54	61/60	100	2.5, 4, 10, 2.5, NM			C54(0 9"): CLAYEY SANDSTONE; S m ar to C52(29 53").  C54(9 61"): SANDSTONE; f ne gra ned, cross strat f ed, s ght y weathered, med um hardness, we sorted, red w th green sh gray , fractures spaced 5 to 13", fractures genera y p anar and typ ca y 0 to 10° from hor zonta .
	355								
3180			C55	60/60	100	3.5, 2.5, 3, 4, 3			C55: CLAYEY SANDSTONE; A ternat ng med um to coarse gra ned and f ne gra ned sandstone, red and gray, med um hardness, s ght y weathered, fractures spaced 13 to 47", fractures genera y p anar and typ ca y hor zonta , smooth fracture surfaces. Med um to coarse gra ned sandstone, mass ve. F ne gra ned, cayey sandstone from 5 to 16" and 47 to 60", crossbedded.
	360								

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345


**GEI** Consultants

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/16/2017 - 10/22/2017

Total Depth (ft) : 400.6

## Final Boring Log

Boring No.

**B101**

Page 15 of 16

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil-Sample Description Rock-Lithological Description
		Type	Sample No	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min/ft)			
			C56	59/60	98	3.5, 4, 2, 5, 5			C56: CLAYEY SANDSTONE; S m ar to C55, fractures spaced 17 1/2 to 41 1/2". F ne gra ned c ayey sandstone from 44 to 61".
3170	365		C57	61/60	100	4, 2, 3, 4, 8			C57: CLAYEY SANDSTONE; S m ar to C55. F ne gra ned, c ayey sandstone from 44 to 61".
370			C58	60/60	100	5.5, 7.5, 7, 7, 6			C58: CLAYEY SANDSTONE; S m ar to C55. F ne gra ned, c ayey sandstone from 0 to 52".
3160	375		C59	60/60	100	6.5, 3, 4, 4, 5.5			C59: CLAYEY SANDSTONE; S m ar to C55. F ne gra ned, c ayey sandstone from 0 to 4".
380			C60	60/60	100	4.5, 6, 7, 4, 5.5			C60: CLAYEY SANDSTONE; S m ar to C55. Med um to coarse gra ned.
3150	385		C61	60/60	100	4.5, 3,			C61: CLAYEY SANDSTONE; S m ar to C55. F ne gra ned, c ayey sandstone from 58 to 60".

## Notes:

Project Name: HI-STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJEC BOR NG LOG 11/30/17



**Date Start / End:** 10/16/2017 - 10/22/2017  
**Total Depth (ft) :** 400.6

**Notes:**

**Project Name:** HI-STORE CISF Phase 1 Site Characterization  
**City/State:** Lea County, New Mexico  
**GEI Project Number:** 1703345



**Boring Information**

Northing : 571899.0      Easting : 731779.8  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3535.5  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 85

Date Start - End: 10/18/2017 10/18/2017  
 Driller Name: M. Shequst  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 30.9

**Final Boring Log**

Boring No.  
**B101A**  
 Page 1 of 2

**Drilling Information**

Hammer Type: Automat c  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Ro erb t to 30.9 ft.

Casing I.D.: NA  
 Drill Rod O.D.: 1.75 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 in. or RQD	Coring Time (min/ft)			
							Advanced ro erb t to 10 ft.		
	5								
3530									
	10	X	S1	11/18	14 18 28		Corrected hammer energy measurements.		S1: CLAYEY SAND (SC); ~60% fine to coarse sand, ~35% low plasticity fines, ~5% gravel up to 1/2", light red, dry.
	15	X	S2	15/18	31 69 65		Corrected hammer energy measurements.		S2: CLAYEY SAND (SC); Similar to S1.
3520									
	20	X	S3	14/15	35 95 100/3"		Corrected hammer energy measurements.		S3: SANDY LEAN CLAY (CL); ~55% low plasticity fines, ~40% fine to medium sand, ~5% gravel up to 1/2", red, dry.

**Notes:** GRL attached accelerometers to a 2 foot AWJ rod at top of the  
 drilling string for hammer energy measurements.  
 Evaluated based on B101.

Project Name: HI STORE CFS Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

Ground Surface Elev. (ft): 3535.5

Vertical Datum : NAVD 88

Date Start / End: 10/18/2017 10/18/2017

Total Depth (ft) : 30.9

## Final Boring Log

Boring No.

B101A

Page 2 of 2

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min)			
3510	25	X	S4	11/11	30 100/5"		Collected hammer energy measurements.	RESIDUAL SOIL	S4: SANDY LEAN CLAY (CL); Similar to S3, possible mestone fragments.
	30	X	S5	11/11	30 100/5"		Collected hammer energy measurements.		S5: SANDY LEAN CLAY (CL); ~55% low plasticity fines, ~40% fine to medium sand, 5% gravel up to 1/2", red, dry. Bottom of boring at depth 30.9 ft (E. 3504.6 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See Form 135.1.
3500	35								
	40								
3490	45								
	50								
	55								

**Notes:** GRL attached accelerometers to a 2 foot AWJ rod at top of the drilling for hammer energy measurements.  
Elevation based on B101.

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Form 150.2 rev 1

**Boring Information**

Northing : 571906.7      Easting : 731791.6  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3535.1  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 85

Date Start - End: 10/22/2017 10/26/2017  
 Driller Name: M. Shequst  
 Logged By : A. McDona d/J. Neff  
 Drilling Company : GSI  
 Total Depth (ft) : 414.4

**Final Boring Log**

Boring No.  
**B101B**  
 Page 1 of 4

**Drilling Information**

Hammer Type: NA  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Robert to 414.4 ft.

Casing I.D.: 6 n.  
 Drill Rod O.D.: 3.5 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 n. or RQD	Coring Time (m n/ft)			
3530	5						Borehole advanced with Robert to 414.4 ft. without sampling.		Soil Descriptions based on drill cuttings.  Red
3520	15								
3510	25								
3500	35								
3490	45								
3480	55								
3470	65								
3460	75								
3450	85								
3440	95								
									Gray green.

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.1  
Vertical Datum : NAVD 88

Date Start / End: 10/22/2017 10/26/2017  
Total Depth (ft) : 414.4

## Final Boring Log

Boring No.  
**B101B**  
Page 2 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Coring Time (min/ft)			
3430	105								Purple.
	110								
3420	115								
	120								
3410	125								
	130								
3400	135								
	140								
3390	145								
	150								
3380	155								
	160								
3370	165								
	170								
3360	175								
	180								
3350	185								
	190								
3340	195								
	200								
3330	205								
	210								
3320	215								
	220								
3310	225								
	230								

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535.1

Vertical Datum : NAVD 88

Date Start / End: 10/22/2017 10/26/2017

Total Depth (ft) : 414.4

## Final Boring Log

Boring No.

**B101B**

Page 3 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bows per 6 in. or RQD	Coring Time (min/ft)			
3300	235								Gray sh red to brown sh red. Brown.
	240								
3290	245						Drill chatter ~242 ft.		Possible mestone fragments in cuttings from ~240 to ~245 ft. Redd sh brown. Gray sh tan.
	250								
3280	255								Gray. Redd sh brown.
	260								
3270	265								Brown.
	270								
3260	275								Redd sh brown.
	280								Gray sh brown. Brown sh red to tan. Gray sh brown.
3250	285								Redd sh brown.
	290								
3240	295						Drill chatter from ~291 to 292 ft.		Brown.
	300								
3230	305								Redd sh brown to brown.
	310								Brown. Gray sh red.
3220	315								Brown.
	320								
3210	325								Gray. Redd sh brown to gray. Gray to brown. Redd sh brown.
	330								
3200	335								Redd sh brown with gray.
	340								
3190	345								Redd sh gray. Gray sh brown with red.
	350								Redd sh gray. Brown sh red.
3180	355								Redd sh brown to brown. Light brown to gray. Redd sh brown with gray.
	360								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

Ground Surface Elev. (ft): 3535.1

Vertical Datum : NAVD 88

Date Start / End: 10/22/2017 10/26/2017

Total Depth (ft) : 414.4

## Final Boring Log

Boring No.

**B101B**

Page 4 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bowls per 6 in. or RQD	Coring Time (min/ft)			
3170	365								Light brown to gray. Reddish brown. Light brown to gray.
	370								
3160	375								Gray. Reddish gray. Reddish brown.
	380								Gray. Reddish gray.
3150	385								
	390								
3140	395								
	400								Brownish red. Grayish brown.
3130	405								Gray.
	410						No return of cuttings at ~407 ft.		
3120	415								Bottom of boring at depth 414.4 ft (Elev. 3120.7 ft). Installed monitoring well B101(MW). See Form 131.1.
	420								
3110	425								
	430								
3100	435								
	440								
3090	445								
	450								
3080	455								
	460								
3070	465								
	470								
3060	475								
	480								
3050	485								
	490								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

**Boring Information**

Northing : 572097.9      Easting : 731585.2  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3531.7  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 9/30/2017 10/4/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 112.0

**Final Boring Log**

Boring No.  
**B102**  
 Page 1 of 4

**Drilling Information**

Hammer Type: Automat c      Casing I.D.: NA      Core Barrel Type: HQ  
 Auger I.D.: 4.25 n.      Drill Rod O.D.: 1.75 n.      Core Barrel I.D./O.D.: 2.5 n. / 3.75 n.  
 Auger Head Length: 3.875 n.      Core Barrel Length: 8.6 ft  
 Drilling Method: Ho ow stem augers 0 60.3 ft. W re ne rock cor ng 60.3 112.0 ft.

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

E lev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Eng neer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Samp e Descr pt on Rock L tho og ca Descr pt on
		Type	Sample No	Rec./ Pen. (n)	B ows per 6 n. or RQD	Cor ng T me (m n/ft)			
3530	5	X	S1	10/24	1 3 34 40	NA	Co ected bu k samp e G1 from 0 to 10 ft. from auger cutt ngs.	CALICHE	S1(0 4"): LEAN CLAY WITH SAND (CL); ~80% ow p ast c ty f nes, ~20% most y f ne sand, brown, mo st.
		X	S2	14/24	15 21 21 31	NA			S1(4 10"): SILTY SAND WITH GRAVEL (SM); ~70% most y f ne sand, ~15% nonp ast c f nes, ~15% grave up to 1/2", ght p nk, dry.
		X	S3	17/24	10 54 74 72	NA			S2: SILTY SAND WITH GRAVEL (SM); ~50% f ne to coarse sand, ~30% grave up to 1 1/4", ~20% nonp ast c f nes, ght tan, p nk, dry.
		X	S4	16/24	12 23 24 24	NA			S3: SILTY SAND WITH GRAVEL (SM); ~65% f ne to coarse sand, ~20% nonp ast c f nes, ~15% grave up to 1", ght tan, p nk, dry.
		X	S5	15/24	11 13 24 36	NA			S4: SILTY SAND WITH GRAVEL (SM); S m ar to S3.
		X	S6	19/24	30 34 52 75	NA			S5(0 11"): SILTY SAND WITH GRAVEL (SM); ~60% most y f ne sand, ~20% nonp ast c f nes, ~20% grave up to 1", brown and red, dry.
		X	S7	19/24	24 41 27 56	NA			S5(11 15"): SILTY SAND WITH GRAVEL (SM); ~65% f ne to coarse sand, ~20% nonp ast c f nes, ~15% grave up to 1", ght tan and p nk, dry.
		X	S8	20/24	24 75 96 72	NA			S6(0 12"): SILTY SAND WITH GRAVEL (SM); S m ar to S5(11 15").
		X	S9	21/21	19 30 71 100/3"	NA			S6(12 19"): CLAYEY SAND (SC); ~70% most y f ne sand, ~30% ow p ast c ty f nes, red, dry.
		X	S10	22/22	16 42 74	NA			S7: CLAYEY SAND (SC); ~60% most y f ne sand, ~35% ow p ast c ty f nes, ~5% grave up to 1/2", red, dry.
3510	20	X	S8	20/24	24 75 96 72	NA		RESIDUAL SOIL	S8: SANDY LEAN CLAY (CL); ~70% ow p ast c ty f nes, ~30% most y f ne sand, red, dry.
		X	S9	21/21	19 30 71 100/3"	NA			S9: SANDY LEAN CLAY (CL); S m ar to S8.
3510	20	X	S8	20/24	24 75 96 72	NA		RESIDUAL SOIL	S10(0 6"): SANDY LEAN CLAY (CL); S m ar to S8.
		X	S10	22/22	16 42 74	NA			S10(6 22"): CLAYEY SAND (SC); ~60% most y f ne sand, ~35% ow p ast c ty f nes, ~5% grave up to 1/2", red and ght p nk, dry.

**Notes:**

Project Name: HI STORE CISF Phase 1 S te Character zat on  
 City/State: Lea County, New Mex co  
 GEI Project Number: 1703345





Ground Surface Elev. (ft): 3531.7

Vertical Datum : NAVD 88

Date Start / End: 9/30/2017 10/4/2017

Total Depth (ft) : 112.0

## Final Boring Log

Boring No.

**B102**

Page 2 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bows per 6 in. or RQD	Coring Time (min/ft)			
	25	X			100/4"				
		X	S11	10/10	35 100/4"	NA			S11: CLAYEY SAND (SC); ~85% fine to medium sand, ~15% ow past c ty f nes, red, dry.
		X	S12	5/5	100/5"	NA			S12: CLAYEY SAND (SC); ~70% most y f ne sand, ~25% ow past c ty f nes; ~5% grave up to 3/4", ght red, dry.
	30	X	S13	17/24	13 25 45 77	NA			S13(0 5"): CLAYEY SAND WITH GRAVEL (SC); ~70% most y f ne sand, ~15% ow past c ty f nes, ~15% angu ar grave up to 1", ght red, dry, conta ns angu ar rock fragments from 4 to 5".
3500		X							S13(5 17"): LEAN CLAY WITH SAND (CL); 72% ow past c ty f nes, 28% most y f ne sand, redd sh brown, dry. [Gra n S ze Test]
	35	X	S14	14/16	27 83 100/4"	NA			S14: LEAN CLAY WITH SAND (CL); S m ar to S13(5 17").
	40	X	S15	13/17	39 90 100/5"	NA	Dr chatter from ~40.0 to ~44.0 ft.		S15: LEAN CLAY WITH SAND (CL); 85% ow past c ty f nes, 15% most y f ne sand, redd sh brown, dry, some green sh gray c ay. [Gra n S ze Test]
3490		X							
	45	X	S16	11/11	46 100/5"	NA			S16: SANDY LEAN CLAY (CL); ~65% ow past c ty f nes, ~35% most y f ne sand, red w th green sh gray, dry.
		X					Dr chatter from ~47.0 to ~50.0 ft.		
	50	X	S17	14/16	49 83 100/4"	NA	Dr chatter from ~50.0 to ~60.0 ft.		S17: SANDY LEAN CLAY (CL); S m ar to S16.
3480		X							
	55	X							

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Form 150.2 rev. 1

Ground Surface Elev. (ft): 3531.7

Vertical Datum : NAVD 88

Date Start / End: 9/30/2017 10/4/2017

Total Depth (ft) : 112.0

## Final Boring Log

Boring No.

**B102**

Page 3 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (in/ft)			
		S18	5/5	100/5"	NA				S18: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% mostly fine sand, reddish greenish gray, dry.
	60	S19 C1	3/3 28/20	100/3"	NA	1, 2	Spit spoon refusal at ~60.3 ft. Switched to wireline rock coring.		S19: LEAN CLAY WITH SAND (CL); ~80% low plasticity fines, ~20% mostly fine sand, reddish, dry.
3470		C2	60/60		83	1, 1.5, 1.5, 2, 1			C1: MUDSTONE; reddish brown and gray, soft, moderately weathered, fractures spaced 2 to 2 1/2", fractures generally parallel and typically 0 to 10° from horizontal, highly fractured zone from 0 to 2". C2: MUDSTONE; similar to C1, reddish brown and greenish gray. Fractures spaced 1 to 25", fractures typically 0 to 30° from horizontal, highly fractured zones from 27 to 29" and 52 to 54". Greenish gray zones at 22" and from 51 to 56".
	65	C3	54/60		77	0.5, 2.5, 1.5, 2, 2			C3: MUDSTONE; similar to C1. Fractures spaced 1/2 to 23", fractures typically 0 to 30° from horizontal.
	70								
3460		C4	60/60		80	1, 2, 2, 2, 2.5		CHINLE	C4: MUDSTONE; similar to C1. Fractures spaced 1 to 12", fractures typically 0 to 30° from horizontal, highly fractured zone from 3 to 7".
	75								
		C5	57/60		75	1, 1, 1.5, 2, 2			C5: MUDSTONE; similar to C1. Fractures spaced 1 to 12". Approximately 60° fracture from horizontal at 17", highly fractured zone from 0 to 5".
	80								
3450		C6	60/60		87	1.5, 2, 2, 3, 3			C6: MUDSTONE; similar to C1. Fractures spaced 1 to 20", highly fractured zone from 22 to 26".
	85								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

Ground Surface Elev. (ft): 3531.7

Vertical Datum : NAVD 88

Date Start / End: 9/30/2017 10/4/2017

Total Depth (ft) : 112.0

## Final Boring Log

Boring No.

**B102**

Page 4 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Bows per 6 in. or RQD	Core Length (m n/ft)			
3440	90		C7	55/60	89	2, 1.5, 1.5, 1.5, 2		CHINLE	C7: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 1 to 12", fractures typically 0 to 30° from horizontal. Possible slickensides at 46", smooth fracture surfaces.
			C8	60/60	78	1, 2, 1.5, 2, 2.5			C8: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 2 to 14", highly fractured zones from 20 to 23" and 58 to 60".
	95		C9	33/60	48	1.5, 2, 5, 3, 4			C9: MUDSTONE; Similar to C1, brownish red, gray, and tan. Fractures spaced 2 to 12", highly fractured zone from 0 to 3".
	100		C10	64/60	62	1, 1.5, 1, 1.5, 1.5			C10: MUDSTONE; Similar to C1, brownish red and gray. Fractures spaced 1 to 14 1/2", fractures typically 0 to 30° from horizontal, highly fractured zones from 9 to 10" and 27 to 29". Possible calcarenite from 0 to 10", greenish gray, very stiff.
	105		C11	60/60	98	1, 1.5, 1.5, 1, 1.5			C11: MUDSTONE; Similar to C1, brownish red and gray. Fractures spaced 1 to 11", fractures typically 0 to 30° from horizontal, highly fractured zone from 0 to 3".
3420	110								
	115								Bottom of boring at depth 112 ft (Elev. 3419.7 ft). Measured ~109 ft depth to water at end of drilling, key influenced by drilling water used during coring. Borehole backfilled with grout upon completion. See form 135.1. Offset to B102A to install inclinometer casing.

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



**Boring Information**

Northing : 572088.4      Easting : 731581.4  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3531.4  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/10/2017 10/10/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 107.9

**Final Boring Log**

Boring No.  
**B102A**  
 Page 1 of 1

**Drilling Information**

Hammer Type: NA  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Rollerbit to 107.9 ft.

Casing I.D.: 6 in.  
 Drill Rod O.D.: 3.5 in.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Blows per 6 in. or RQD	Coring Time (min)			
3530	5						Advanced hollow stem augers to ~7 ft. Removed hollow stem augers. Set temporary steel surface casing to ~7 ft. Rollerbit to ~107.9 ft.  No samples collected.		Soil Descriptions based on drill cuttings.  Light gray, pink.  Red.   Pink to light gray.  Red with pink.      Red.       Brown with purple.
	10								
	15								
	20								
	25								
	30								
	35								
	40								
	45								
	50								
	55								
	60								
	65								
	70								
	75								
	80								
	85								
	90								
	95								
	100								
	105								
	110								
3420									Bottom of boring at depth 107.9 ft (El. 3427.5 ft). Groundwater not encountered. Installed inclinometer casing. See form 163.1.

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



**Boring Information**

Northing : 572091.3      Easting : 731567.4  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3531.2  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/11/2017 10/11/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 107.6

**Final Boring Log**

Boring No.  
**B103**  
 Page 1 of 1

**Drilling Information**

Hammer Type: NA  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Ro erb t to 107.6 ft.

Casing I.D.: 6 n.  
 Drill Rod O.D.: 3.5 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 n. or RQD	Coring Time (m n/ft)			
3530	5						Advanced hollow stem augers to ~7 ft. Removed hollow stem augers. Ro erb t to ~107.6 ft. Dr chatter from 0 to ~5 ft. Set temporary steel surface casing to ~7 ft. Ro erb t to ~107.6 ft. No samples collected.		Soil Descriptions are based on drill cuttings.  Light gray and white.   Drill cuttings color change to red at ~20 ft.
3520	10								
3510	15								
3500	20								
3490	25								
3480	30								
3470	35								
3460	40								
3450	45								
3440	50								
3430	55								
3420	60						Dr chatter at ~103 ft.		Purple/brown drill cuttings at ~106 ft. Bottom of boring at depth 107.6 ft (E. 3423.6 ft). Groundwater not encountered. Installed inclinometer casing. See form 163.1.
	65								
	70								
	75								
	80								

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



**Boring Information**

Northing : 572094.6      Easting : 731552.0  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3531.6  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/11/2017 10/11/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 107.8

**Final Boring Log**

Boring No.  
**B104**  
 Page 1 of 1

**Drilling Information**

Hammer Type: NA  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Ro erb t to 107.8 ft.

Casing I.D.: 6 n.  
 Drill Rod O.D.: 3.5 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 n. or RQD	Coring Time (m n/ft)			
3530	5						Advanced hollow stem augers to ~7 ft. Removed hollow stem augers. Ro erb t to ~107.8 ft. Dr chatter from ~2 to ~8 ft. Set temporary steel surface casing to ~7 ft. Ro erb t to ~107.8 ft. No samples collected.		Soil Descriptions based on drill cuttings.
3520	10								
	15								
3510	20								
	25							Red.	
3500	30								
	35							Red.	
3490	40								
	45								
3480	50								
	55						Dr chatter at ~50 ft.		Green sh gray.  Red and purple.        Green sh gray.        Purple.  Bottom of boring at depth 107.8 ft (E. 3423.8 ft). Groundwater not encountered. Installed inclinometer casing. See form 163.1.
3470	60								
	65						Dr chatter from ~65 to ~70 ft.		
3460	70								
	75								
3450	80								
	85								
3440	90								
	95								
3430	100								
	105								
3420	110								

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



**Boring Information**

Northing : 571879.9      Easting : 731356.8  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3535.0  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/15/2017 10/23/2017  
 Driller Name: G. Sanders  
 Logged By : M. Hernandez Caba /A. McDona d  
 Drilling Company : GSI  
 Total Depth (ft) : 221.7

**Final Boring Log**

Boring No.  
**B105**  
 Page 1 of 8

**Drilling Information**

Hammer Type: Automat c      Casing I.D.: NA      Core Barrel Type: HQ  
 Auger I.D.: 4.25 n.      Drill Rod O.D.: 1.75 n.      Core Barrel I.D./O.D.: 2.5 n. / 3.75 n.  
 Auger Head Length: 3.875 n.      Core Barrel Length: 8.6 ft  
 Drilling Method: Ho ow stem augers 0 61.7 ft. W re ne rock cor ng 61.7 221.7 ft.

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen. %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	So Sample Description on Rock Lithology Description
		Type	Sample No	Rec./ Pen. (n)	Blows per 6 n. or RQD	Cor ng Time (m n/ft)			
3530	5	X	S1	19/24	3-22-50-45	NA	Collected bulk sample G1 from 0 to 10 ft. from auger cuttings.	CALICHE	S1(0-4"): CLAYEY SAND WITH GRAVEL (SC); ~60% fine sand, ~25% gravel up to 1", ~15% low plasticity fines, dark brown, moist.
							Drill chatter at ~2 ft.		S1(4-19"): SILTY SAND WITH GRAVEL (SM); ~50% mostly fine sand, ~25% nonplastic fines, ~25% gravel up to 3/4", brown to light yellow, pink, moist.
		X	S2	11/24	5-10-10-12	NA			S2: SILTY SAND WITH GRAVEL (SM); ~55% mostly fine sand, ~25% nonplastic fines, ~20% gravel up to 1", light gray, pink, dry.
		X	S3	22/24	15-18-21-6	NA			S3: SILTY SAND WITH GRAVEL (SM); ~45% fine to coarse sand, ~40% gravel up to 1", ~15% nonplastic fines, light gray, pink, dry.
		X	S4	7/24	9-24-20-25	NA	Drill chatter at ~7 ft.		S4: NARROWLY GRADED GRAVEL WITH SAND (GP); ~60% gravel up to 1/2", ~35% fine to coarse sand, ~5% nonplastic fines, light gray, pink, dry.
3520	10	X	MC1	12/12	17-33	NA	Drill chatter at ~8.5 ft.	RESIDUAL SOIL	MC1: NARROWLY GRADED GRAVEL WITH SAND (GP); Similar to S4.
		X	S5	18/24	17-32-45-47	NA			S5: CLAYEY SAND (SC); ~60% mostly fine sand, ~30% low plasticity fines, ~10% gravel up to 1/2", pink and red, clayey fines increase toward bottom, dry.
		X	S6	16/17	34-39-100/5"	NA	Drill chatter at ~15 ft.		S6: CLAYEY SAND (SC); ~65% mostly fine sand, ~30% low plasticity fines, ~5% gravel up to 1/4", red and pink, slightly moist.
		X	S7	24/24	48-51-47-97	NA			S7: CLAYEY SAND (SC); ~70% fine to medium sand, ~30% low plasticity fines, red and pink, moist, sand content increases towards bottom.
		X	MC2	11/11	40-100/5"	NA			MC2: CLAYEY SAND (SC); ~70% fine to medium sand, ~30% low plasticity fines, red and pink, slightly moist.
		X	S8	21/21	21-35-80-	NA	Drill chatter at ~22 ft.		S8: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% mostly fine sand, red and pink, slightly moist, very stiff.

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization  
 City/State: Lea County, New Mexico  
 GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
Page 2 of 8

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Core Length (in/ft)			
3510	25	X	S9	21/21	15-33- 64- 100/3"	NA		RESIDUAL SOIL	S9: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% mostly fine sand, red and some gray, moist, very stiff.
		X	S10	16/16	54-61- 100/4"	NA			S10: CLAYEY SAND (SC); ~85% fine to coarse sand, ~15% low plasticity fines, red, moist.
	30	X	S11	8/8	79- 100/2"	NA			S11: CLAYEY SAND (SC); ~70% fine to medium sand, ~30% low plasticity fines, red and light gray, dry.
3500	35	X	S12	24/24	16-24- 32-42	NA	Drill chatter from ~30 to ~35 ft.		S12(0-7"): SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% fine sand, red, dry. S12(7-24"): LEAN CLAY (CL); ~90% low plasticity fines, ~10% fine sand, yellow, gray, purple, dry, very stiff.
	40	X	MC3	12/12	43-100	NA		CHINLE	MC3: LEAN CLAY (CL); Similar to S12(7-24").
3490	45	X	S13	24/24	16-27- 54-100	NA	Drill chatter from ~45 to ~50 ft.		S13: SANDY LEAN CLAY (CL); ~70% low plasticity fines, ~30% fine sand, red, brown, yellow, purple, gray, stiff.
	50	X	S14	17/17	20-67- 100/5"	NA	Drill chatter from ~50 to ~55 ft.		S14: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% fine sand, red, dry.
3480	55	X							

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345





Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Bows per 6 in. or RQD	Coring Time (min/ft)			
		X	S15	17/17	33-45-100/5"	NA	Drill chatter from ~55 to ~60 ft.		S15: SANDY LEAN CLAY (CL); 51% low plasticity fines, ~49% fine sand, red, brown, yellow, purple, gray, very stiff. [Grain Size Test]
	60	X	S16	10/10	51-100/4"	NA	Switched to wireline rock coring. Washed out to 61.7 ft. prior to coring.		S16: SANDY LEAN CLAY (CL); ~65% low plasticity fines, ~35% fine sand, red, purple, some greenish gray, slightly moist.
3470	65		C1	52/60	87	0.5, 1, 1, 1, 1.5		CHINLE	C1: MUDSTONE; reddish-brown and gray with some greenish clay, soft, laminated, moderately weathered, fractures spaced 11 to 36", fractures generally planar and typically 0 to 10° from horizontal.
			C2	57/60	62	0.5, 1, 1, 1.5, 2			C2: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 19", highly fractured zone from 53 to 60".
	70		C3	47/60	72	1, 1.5, 1.5, 1, 2.5			C3: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 26", highly fractured zone from 32 to 36". Approximately 30° fracture at 12".
3460	75		C4	60/60	38	1.5, 1, 1.5, 1.5, 2.5			C4: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 7", highly fractured zones from 15 to 17" and 51 to 52". Vertical fracture from 38 to 41".
	80		C5	60/60	87	1, 1.5, 1.5, 1.5, 2.5			C5: MUDSTONE; Similar to C1, reddish-brown, gray, and tan. Fractures spaced 1 to 15-1/2", highly fractured zone from 50 to 51". Approximately 30° fracture at 38".
3450	85								

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (in/ft)			
	90		C6	60/60	83	1.5, 1, 3.5, 3.5, 2.5			C6: MUDSTONE; Similar to C1, reddish-brown, gray, and tan. Fractures spaced 1 to 24", highly fractured zone from 12 to 13". Approximately 30° fractures at 52" and 54".
	95		C7	60/60	43	3, 3, 2, 1.5, 2.5			C7: MUDSTONE; Similar to C1, brownish-red, gray, and tan. Fractures spaced 1 to 10", highly fractured zones from 24 to 26", 36 to 37" and 46 to 48". Approximately 30° fractures at 51", 53" and 56".
3440	95		C8	60/60	70	1, 1.5, 1.5, 1.5, 1.5			C8: MUDSTONE; Similar to C1, brownish-red and gray. Fractures spaced 1 to 13", highly fractured zone from 28 to 30". Approximately 30° fracture at 49".
	100								
	105		C9	55/60	47	1.5, 1, 1.5, 2, 1.5		CHINLE	C9: MUDSTONE; Similar to C1, brownish-red and gray. Moderately fractured zone from 2 to 5", highly fractured zones from 15 to 16" and 37 to 38". Possible siltstone from 47 to 55", gray, soft.
3430	105		C10	60/60	78	1, 1.5, 1, 1.5, 2			C10: MUDSTONE; Similar to C1, brownish-red and gray. Fractures spaced 1 to 7", highly fractured zone from 11 to 13". Possible siltstone from 0 to 8", gray, soft.
	110								
	115		C11	60/60	0	1, 1, 1, 1, 2			C11: MUDSTONE; Similar to C1, brownish-red and gray. Fractures spaced 1 to 3-1/2", highly fractured zones from 7 to 11", 17 to 31", and 43 to 55". Shale-like from 7 to 15" and 23 to 31".
3420	115		C12	60/60	62	1, 1.5, 1.5, 2,			C12: MUDSTONE; Similar to C1, brownish-red and gray. Fractures spaced 1 to 13", highly fractured zones 3 to 5", 15 to 16" and 33 to 37". Approximately 30° fracture at 28".

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Core Length (m n/ft)			
	120					1.5			
			C13	57/60	47	1.5, 1.5, 2, 3, 3			C13: MUDSTONE; Similar to C1, brownish-red and gray. Fractures spaced 1 to 10", moderately fractured zone from 0 to 7", highly fractured zone from 12 to 15". Approximately 30° fracture at 10".
3410	125								
			C14	53/60	20	2, 2.5, 1.5, 2, 3.5			C14: MUDSTONE; Similar to C1. Moderately fractured zone from 0 to 9", highly fractured zones from 9 to 14" and 34 to 37", 42 to 43", and 51 to 53". Vertical fracture from 47 to 51".
	130								
			C15	54/60	15	5.5, 4.5, 2.5, 2, 2.5			C15: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 5", moderately fractured zones from 0 to 2" and 46 to 50", highly fractured zones from 12 to 15" and 22 to 24". Approximately 30° fractures at 26", 37", and 45".
3400	135								
			C16	49/60	12	1, 3.5, 1.5, 1.5, 3			C16: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 7", moderately fractured zone from 0 to 36". Possible conglomerate from 12 to 24", gray, medium hardness, rough fracture surfaces. Approximately 30° fractures at 40" and 46". Possible slickensides at 40" and 46", greenish-gray coat on fracture surface at 46".
	140								
			C17	60/60	88	2, 2, 2.5, 2.5, 3			C17: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 14". Approximately 30° fractures at 37" and 47". Possible slickenside at 47", greenish-gray coat on fracture surfaces.
3390	145								
			C18	60/60	37	3, 3.5, 4.5, 3, 3.5			C18: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 10", highly fractured zones from 11 to 17", 24 to 26", and 48 to 60". Possible siltstone from 17 to 20", gray, soft. Shale-like from 48 to 60".

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Core Length (in/ft)			
	150								
			C19	54/60	90	4, 3, 3.5, 5, 2			C19: MUDSTONE; Similar to C1, reddish-brown and gray. Mechanical fractures at 14" and 37".
3380	155								
			C20	58/60	64	NM, 4, 4, 4.5, 6			C20: MUDSTONE; Similar to C1. Fractures spaced 1 to 11", highly fractured zones from 20 to 24", 33 to 37" and 40 to 42". Fine brown sand on fracture surface at 55".
	160								
			C21	63/60	84	3.5, 4, 3.5, 5, 5			C21: MUDSTONE; Similar to C1, reddish-brown and gray. Highly fractured zones from 35 to 38" and 60 to 63". Approximately 30° fractures at 0" and 15". Possible slickenside at 15".
3370	165								
			C22	48/60	75	4, 6, 6, 3, 5			C22: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 2 to 12", highly fractured zone from 10 to 12".
	170								
			C23	58/60	60	1, 1, 1, 1, 1.5			C23: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 26", highly fractured zones from 0 to 4" and 9 to 17". Vertical fracture from 11 to 30", approximately 30° fracture at 53".
3360	175								
			C24	60/60	85	1, 1, 1.5, 4, 3			C24: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 3 to 10". Approximately 30° fractures at 12", 32" and 48", greenish-gray on fracture surfaces.
	180								

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
Page 7 of 8

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Bowls per 6 in. or RQD	Core Length (m n/ft)			
3350	185		C25	54/60	73	1, 2, 2.5, 3, 4		CHINLE	C25: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 18", highly fractured zones from 0 to 2" and 28 to 34". Approximately 30° fractures at 8 and 29", greenish-gray on fracture surfaces. Possible slickenside at 34".
			C26	51/60	63	2, 2.5, 2, 2, 3			C26: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 16", highly fractured zone from 0 to 5". Approximately 30° fractures at 27" and 49". Possible slickensides at 27" and 49".
			C27	59/60	90	2.5, 2, 3, 3, 4			C27: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 22", highly fractured zone from 8 to 11". Approximately 30° fractures at 2", 34" and 44". Possible slickensides at 2", 34", and 44".
			C28	51/60	57	3.5, 4.5, 3.5, 4, 4			C28: MUDSTONE; Similar to C1, reddish-brown and gray. Fractures spaced 1 to 14", highly fractured zone from 4 to 10". Approximately 30° fractures at 10", 20", 23", 49", 50" and 51". Possible slickensides at 10", 20", 23", and 49".
			C29	60/60	62	5, 5.5, 6.5, 4, 6			C29: MUDSTONE; Similar to C1, reddish-brown and tan. Fractures spaced 1 to 10", moderately fractured zone from 0 to 8". Approximately 30° fractures at 7", 14", 23", 43" and 44", approximately 60° fracture at 58". Possible conglomerate from 17 to 19", gray, medium hardness. Fine brown sand on fracture surfaces. Sand content increases with depth.
			C30	60/60	85	2.5, 5, 3.5, 6.5, 5			C30: MUDSTONE; Similar to C1, brownish-red and tan. Fractures spaced 1 to 26", highly fractured zone from 41 to 46". Approximately 30° fractures at 9" and 16", approximately 60° fracture at 41".
3330	205		C31	61/60	93	5, 2,			C31(0-26"): MUDSTONE; Similar to C1, brownish-red. Fractures

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



Ground Surface Elev. (ft): 3535  
Vertical Datum : NAVD 88

Date Start / End: 10/15/2017 10/23/2017  
Total Depth (ft) : 221.7

## Final Boring Log

Boring No.  
**B105**  
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Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per Section or RQD	Core Length (in/ft)			
3320	215					4.5, 4.5, 3.5	Switched drill bit to core harder material.	SANTA ROSA	spaced 1 to 16", highly fractured zone from 2 to 6".
									C31(26-61"): SANDSTONE, reddish-brown and tan with gray inclusions, thinly bedded, fine-grained, slightly weathered, medium hardness, crossbedded, slightly irregular fracture surfaces, planar and horizontal fracture at 39" with possible clay on fracture surface.
		C32	58/60	97	2, 2, 2, 2, 2.5				C32: SANDSTONE; Similar to C31(26-61"), greenish gray interbedding from 11 to 21".
3310	225								Bottom of boring at depth 221.7 ft (El. 3313.3 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See Form 135.1.
3300	235								
	240								

### Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization  
City/State: Lea County, New Mexico  
GEI Project Number: 1703345



**Boring Information**

Northing : 571865.2      Easting : 731338.5  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3534.9  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/18/2017 10/23/2017  
 Driller Name: G. Sanders  
 Logged By : M. Hernandez Caba /J. Neff  
 Drilling Company : GSI  
 Total Depth (ft) : 30.4

**Final Boring Log**

Boring No.  
**B105A**  
 Page 1 of 2

**Drilling Information**

Hammer Type: Automat c  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Ro erb t to 30.4 ft.

Casing I.D.: 6 n.  
 Drill Rod O.D.: 1.75 n.

Core Barrel Type: NA  
 Core Barrel I.D/O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 n. or RQD	Coring Time (m n/ft)			
3530	5						Advanced ro erb t to 10 ft.		
	10	X	S1	13/18	8 11 22		Collected hammer energy measurements.		S1: SILTY SAND (SM); ~60% most y f ne sand, ~30% nonp ast c f nes, ~10% grave up to 1", p nk, red, dry.
	15	X	S2	16/18	43 34 37		Collected hammer energy measurements.		S2: CLAYEY SAND (SC); ~60% most y f ne sand, ~40% ow p ast c ty f nes, red, p nk, dry.
3520	20	X	S3	16/16	20 76 100/4"		Collected hammer energy measurements.		S3: CLAYEY SAND (SC); ~70% most y f ne sand, ~30% ow p ast c ty f nes, red, s ght y mo st.
								RESIDUAL SOIL	

**Notes:** GRL attached accelerometer to a 2 foot AWJ rod at top of the drill string for hammer energy measurements.

**Project Name:** HI STORE CISF Phase 1 Site Characterization  
**City/State:** Lea County, New Mexico  
**GEI Project Number:** 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3534.9

Date Start / End: 10/18/2017 10/23/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 30.4

Boring No.

**B105A**

Page 2 of 2

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bows per 6 in. or RQD	Coring Time (min)			
3510	25	X	S4	17/17	32 47 100/5"		Collected hammer energy measurements.	RESIDUAL SOIL	S4: CLAYEY SAND (SC); ~60% mostly fine sand, ~40% low plasticity fines, red, slightly moist, fines increase towards bottom.
	30	X	S5	5/5	100/5"		Collected hammer energy measurements.		S5: CLAYEY SAND WITH GRAVEL (SC); ~60% mostly fine sand, ~20% low plasticity fines, ~20% gravel up to 1/2", pink, red, dry. Bottom of boring at depth 30.4 ft (E. 3504.5 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See Form 135.1.
3500	35								
	40								
3490	45								
	50								
3480	55								

**Notes:** GRL attached accelerometers to a 2 foot AWJ rod at top of the drill string for hammer energy measurements.

**Project Name:** HI STORE CISF Phase 1 Site Characterization

**City/State:** Lea County, New Mexico

**GEI Project Number:** 1703345





**Boring Information**

Northing : 572280.0      Easting : 731356.3  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3530.6  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 9/26/2017 10/13/2017  
 Driller Name: G. Sanders  
 Logged By : J. Neff/A. McDona d/M. H Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 152.0

**Final Boring Log**

Boring No.  
**B106**  
 Page 1 of 6

**Drilling Information**

Hammer Type: Automat c  
 Auger I.D.: 4.25 n.  
 Auger Head Length: 3.875 n.  
 Drilling Method: Ho ow stem augers 0 31.1 ft. W re ne rock cor ng 31.1 152.0 ft.

Casing I.D.: NA  
 Drill Rod O.D.: 1.75 n.

Core Barrel Type: HQ  
 Core Barrel I.D./O.D.: 2.5 n. / 3.75 n.  
 Core Barrel Length: 8.6 ft

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Engineer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Samp e Descr pt on Rock L tho oga Descr pt on
		Type	Sample No	Rec./ Pen. (n)	Blows per 6 n. or RQD	Cor ng T me (m n/ft)			
3530	5	X	S1	21/24	7 41 56 71	NA		CALICHE	S1(0 5"): LEAN CLAY WITH SAND (CL); ~80% ow p ast c ty f nes, ~20% f ne sand, brown, mo st.
		X	S2	17/24	13 20 18 14	NA			S1(5 21"): SILTY SAND WITH GRAVEL (SM); ~45% f ne to coarse sand, ~40% grave up to 1/2", ~15% nonp ast c f nes, ght gray, p nk, dry. S2: SILTY SAND WITH GRAVEL (SM); S m ar to S1(5 21").
		X	S3	19/24	10 26 46 59	NA			S3: SILTY SAND WITH GRAVEL (SM); S m ar to S1(5 21"), grave up to 1 1/2", p nk.
		X	S4	22/24	8 30 42 39	NA			S4: SILTY SAND WITH GRAVEL (SM); S m ar to S1(5 21"), p nk.
	10	X	S5	20/24	12 26 25 26	NA			S5: WIDELY GRADED GRAVEL WITH SILT AND SAND (GW GM); 49% grave up to 1", 42% most y f ne sand, 9% nonp ast c f nes, p nk, dry. [Gra n S ze Test], (LL = 43, PI = 9) [Atterberg L m ts Test]
		X	S6	20/23	24 43 69 100/5"	NA			S6(0 6"): NARROWLY GRADED GRAVEL (GP); ~100% subangu ar grave up to 1 1/4", ght gray, p nk, dry. S6(6 19.5"): CLAYEY SAND (SC); ~60% most y f ne sand, ~35% ow p ast c ty f nes, ~5% grave up to 1/2", red, mo st.
		X	S7	24/24	24 33 54 67	NA			S7(0 6"): CLAYEY SAND (SC); S m ar to S6(6 19.5"). S7(6 24"): CLAYEY SAND (SC); 80% f ne sand, 20% ow p ast c ty f nes, red, mo st. [Gra n S ze Test], (LL = 40, PI = 25) [Atterberg L m ts Test]
	15	X	S8	24/24	8 16 25 57	NA			S8(0 4"): CLAYEY SAND (SC); ~60% most y f ne sand, ~35% ow p ast c ty f nes, ~5% grave up to 1/2", red, mo st. S8(4 24"): CLAYEY SAND (CL); ~60% most y f ne sand, ~40% ow p ast c ty f nes, red, mo st, poss b e ca c um carbonate and gypsum, b ack mott ng.
		X	S9	23/23	16 35 77 100/5"	NA			S9: SANDY LEAN CLAY (CL); 62% ow p ast c ty f nes, 38% most y f ne sand, red, mo st, c ayey f nes ncrease w th depth, poss b e ca c um carbonate, b ack mott ng. [Gra n S ze Test], (LL = 40, PI = 28) [Atterberg L m ts Test]
		X	S10	24/24	8 14 23 56	NA			S10: CLAYEY SAND (SC); 56% most y f ne sand, 44% ow p ast c ty f nes, very st ff, red, mo st. [Gra n S ze Test], (LL = 41, PI = 27) [Atterberg L m ts Test]

**Notes:**

**Project Name:** HI STORE CISF Phase 1 S te Character zat on

**City/State:** Lea County, New Mex co

**GEI Project Number:** 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3530.6

Date Start / End: 9/26/2017 10/13/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 152.0

Boring No.

**B106**

Page 2 of 6

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Core Length (m n/ft)			
	25	X					Drill chatter from ~27 to ~28 ft.	RESIDUAL SOIL	S11: CLAYEY SAND (SC); ~80% mostly fine sand, ~20% low plasticity fines, red, moist.  S12: No recovery.
		X	S11	11/11	18	NA			
		X			100/5"				
							Spit spoon refusal at ~31.1 ft. Switched to wireline rock coring.	CHINLE	S13: SANDY LEAN CLAY (CL); 66% low plasticity fines, 34% mostly fine sand, red, moist. Contains possible limestone fragments. [Grain Size Test], (LL = 40, PI = 22) [Atterberg Limits Test] C1: LIMESTONE, medium hardness, gray, likely a cobble fragment.  C2: MUDSTONE; reddish brown, soft, severely weathered, fractures spaced 1 to 6", fractures generally planar and typically 0 to 10° from horizontal, highly fractured zone from 0 to 9". Possibly conglomerate from 9 to 15", greenish gray.  C3: MUDSTONE; red, soft, severely weathered, highly fractured, fractures spaced 0 to 1/2", fractures generally planar.  C4: MUDSTONE; similar to C3. C5: MUDSTONE; similar to C3.  C6: No recovery.  C7: No recovery.  C8: MUDSTONE; reddish brown, soft, moderately weathered, fractures spaced 2 to 13", fractures generally planar and typically 0 to 30° from horizontal.
			S12	0/1	50/1"	NA			
3500	30	X	S13	13/13	15 41	NA			
			C1	2/11	0	7			
			C2	15/60	10	3.5, 3.5, 4, 4, 4			
	35								
			C3	10/48	0	3, 2.5, 3, 3.5			
3490	40								
			C4	9/12	0	4.5			
			C5	12/60	0	2, 2, 2.5, 2, 2			
	45								
			C6	0/24	0	2, 2			
			C7	0/36	0	2, 2, 3.5			
3480	50								
			C8	30/36	72	1, 1, 1			
	55								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3530.6

Date Start / End: 9/26/2017 10/13/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 152.0

Boring No.

**B106**

Page 3 of 6

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (m n/ft)			
			C9	30/24	100	1.5, 3			C9: MUDSTONE; Similar to C8. Fractures spaced 1/2 to 16". Possible gray siltstone from 2 to 5" and 15 to 18".
			C10	62/60	98	1.5, 1.5, 1, 1.5, 1.5			C10: MUDSTONE; Similar to C8, reddish brown and gray. Fractures spaced 2 1/2 to 17", fractures typically 0 to 10° from horizontal, highly fractured zone from 28 to 31"
3470	60								
			C11	42/60	65	1, 1, 1.5, 1.5, 1.5			C11: MUDSTONE; Similar to C8, reddish brown and gray. Fractures spaced 3 to 19 1/2", fractures typically 0 to 10° from horizontal. Possible gray siltstone lenses from 12 to 29". Possible gray siltstone from 30 to 32".
	65								
			C12	60/60	68	3, 2, 1.5, 2.5, 3.5			C12: MUDSTONE; Similar to C8, reddish brown and gray. Fractures spaced 1 to 14", highly fractured zones from 50 to 52" and 56 to 60". Possible siltstone lenses from 0 to 5".
3460	70							CHINLE	
			C13	60/60	48	1, 1.5, 1, 2.5, 3			C13: MUDSTONE; Similar to C8, brown sh red. Fractures spaced 1 to 8", highly fractured shale from 7 to 15", fractures typically 0 to 10° from horizontal.
	75								
			C14	60/60	77	2, 1.5, 1.5, 2.5, 2.5			C14: MUDSTONE; Similar to C8, reddish brown. Fractures spaced 3 1/2 to 26", fractures typically 0 to 10° from horizontal.
3450	80								
			C15	56/60	92	2.5, 3, 2.5, 2, 4			C15: MUDSTONE; Similar to C8, reddish brown, gray, and tan. Fractures spaced 1 to 28".
	85								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

## Final Boring Log

**Ground Surface Elev. (ft):** 3530.6

**Date Start / End:** 9/26/2017 10/13/2017

**Vertical Datum :** NAVD 88

**Total Depth (ft) :** 152.0

**Boring No.**

**B106**

Page 4 of 6

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (m/n/ft)			
3440  <									

**Notes:**

**Project Name:** HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mex co

**GEI Project Number:** 1703345



GEI  Consultants

## Final Boring Log

Ground Surface Elev. (ft): 3530.6

Date Start / End: 9/26/2017 10/13/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 152.0

Boring No.

**B106**

Page 5 of 6

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (m/ft)			
3410	120								
		C23	53/60	58	1, 1.5, 2, 1.5, 2.5				C23: MUDSTONE; Similar to C8, brown sh red, gray, and tan. Fractures spaced 1 to 11", highly fractured zone from 30 to 33". Possible slickensides at 24 and 26". Smooth fracture surface at 60".
	125								
		C24	54/60	68	1.5, 1, 1, 1.5, 2.5				C24: MUDSTONE; Similar to C8, brown sh red, gray, and tan. Fractures spaced 1 to 16 1/2", highly fractured zone from 0 to 4". Possible slickensides at 20", 30", 38" and 54".
3400	130								
		C25	50/60	46	3.5, 2, 1.5, 1.5, 3				C25: MUDSTONE; Similar to C8, brown sh red and gray. Fractures spaced 1 to 10", highly fractured from 0 to 16". Approximately 30° fracture at 16". Possible conglomerate from 2 to 6" and 40 to 42", gray, medium hardness. Possible slickensides at 19" and 23" with green sh gray oxidation on fracture surfaces.
	135								
		C26	60/60	28	1, 1.5, 2, 1.5, 3				C26: MUDSTONE; Similar to C8, brown sh red. Fractures spaced 1 to 18 1/2", highly fractured zone from 18 to 20". Possible conglomerate from 0 to 2" and 43 to 45". Possible slickensides at 18", 32", 35", 37", 41", 42", 45", 48", 50", 54", and 57" with green sh gray oxidation on fracture surfaces. Approximately 30° fractures at 32", 37", 49" and 58".
3390	140								
		C27	59/60	95	1.5, 2.5, 2, 1.5, 3.5				C27: MUDSTONE; Similar to C8, brown sh red, gray, and tan. Fractures spaced 2 to 24". Approximately 30° fractures at 32" and 35". Possible slickenside at 18". Possible gray siltstone from 40 to 60".
	145								
		C28	57/60	95	2.5, 2.5, 1.5, 2, 1.5				C28: MUDSTONE; Similar to C8, brown sh red and gray. Fractures spaced 2 to 18 1/2". Approximately 30° fractures at 26" and 35". Possible slickensides at 8", 26", and 40".

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

## Final Boring Log

Ground Surface Elev. (ft): 3530.6

Date Start / End: 9/26/2017 10/13/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 152.0

Boring No.

**B106**

Page 6 of 6

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bowls per 6 in. or RQD	Coring Time (min/ft)			
3380	150							CHINLE	
									Bottom of boring at depth 152 ft (Elev. 3378.6 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See form 135.1. Offset to B106A to install monitoring well.
	155								
	160								
3370									
	165								
	170								
3360									
	175								
	180								
3350									

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



**Boring Information**

Northing : 572270.0      Easting : 731364.2      Date Start - End: 10/4/2017 10/10/2017  
 Horizontal Datum : NAD 83      Driller Name: G. Sanders  
 Ground Surface Elev. (ft): 3531.4      Logged By : J. Neff/A. McDona d/M. H Caba  
 Vertical Datum : NAVD 88      Drilling Company : GSI  
 Rig Type: Truck Mounted CME 75      Total Depth (ft) : 203.0

**Final Boring Log**

Boring No.  
**B106A**  
 Page 1 of 2

**Drilling Information**

Hammer Type: NA      Casing I.D.: 6 n.      Core Barrel Type: NA  
 Auger I.D.: NA      Drill Rod O.D.: 3.5 n.      Core Barrel I.D/O.D.: NA / NA  
 Auger Head Length: NA      Core Barrel Length: NA  
 Drilling Method: Ro erb t to 203.0 ft.

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (n)	Blows per 6 n. or RQD	Coring Time (m n/ft)			
3530	5						Advanced hollow stem augers to ~7 ft. Removed hollow stem augers. No samples collected. Set temporary steel surface casing to ~7 ft. Ro erb t to ~203.0 ft. No samples collected.		Soil Descriptions based on drill cuttings.  Red.
	10								
	15								
	20								
	25								
	30								
	35								
	40								
	45								
	50								
	55								
	60								
	65								
	70								
	75								
	80								
	85								
	90								Green sh gray.
	95								
	100								

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Ground Surface Elev. (ft): 3531.4

Date Start / End: 10/4/2017 10/10/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 203.0

## Final Boring Log

Boring No.

**B106A**

Page 2 of 2

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Coring Time (min/ft)			
3420	110								Purple.
3410	120								
3400	130								
3390	140								Red.
3380	150								Sand content increased.
3370	160								Purple with greenish gray.
3360	170								
3350	180								Red.
3340	190						Drill chatter at ~187 ft.		
3330	200								
3320	210								Bottom of boring at depth 203 ft (Elev. 3328.4 ft). Borehole capped to ~199.5 ft. Installed monitoring well B106(MW). See Form 131.1.
3310	220								
3300	230								
3290	240								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345





**Boring Information**

Northing : 572282.3      Easting : 731792.4  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3529.6  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 9/28/2017 10/3/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 102.0

**Final Boring Log**

Boring No.  
**B107**  
 Page 1 of 4

**Drilling Information**

Hammer Type: Automat c      Casing I.D.: NA      Core Barrel Type: HQ  
 Auger I.D.: 4.25 n.      Drill Rod O.D.: 1.75 n.      Core Barrel I.D./O.D.: 2.5 n. / 3.75 n.  
 Auger Head Length: 3.875 n.      Core Barrel Length: 8.6 ft  
 Drilling Method: Ho ow stem augers 0 60.2 ft. W re ne rock cor ng 60.2 102.0 ft.

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Eng neer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Samp e Descr pt on Rock L tho og ca Descr pt on
		Type	Sample No	Rec./ Pen. (n)	Blows per 6 n. or RQD	Cor ng T me (m n/ft)			
3520	5	X	S1	16/24	1 6 18 28	NA	Co ected bu k samp e G1 from 0 to 10 ft. from auger cutt ngs.	CALICHE	S1(0 7"): LEAN CLAY WITH SAND (CL); ~65% ow p ast c ty f nes, ~25% f ne sand, ~10% grave up to 1", brown, mo st.
		X	S2	17/24	15 40 33 33	NA			S1(7 16"): SILTY SAND WITH GRAVEL (SM); ~60% f ne to coarse sand, ~20% nonp ast c f nes, ~20% subangu ar grave up to 1/2", p nk, ght gray, dry.
		X	S3	20/24	12 18 18 23	NA			S2: WIDELY GRADED SAND WITH SILT AND GRAVEL (SW SM); ~50% f ne to coarse sand, ~40% grave, ~10% nonp ast c f nes, p nk, ght gray, dry.
		X	S4	6/24	14 18 20 25	NA			S3: WIDELY GRADED SAND WITH SILT AND GRAVEL (SW SM); S m ar to S2.
	10	X	S5	15/24	11 19 23 29	NA		RESIDUAL SOIL	S4: WIDELY GRADED SAND WITH SILT AND GRAVEL (SW SM); S m ar to S2.
		X	S6	23/24	18 38 39 49	NA			S5: CLAYEY SAND (SC); ~70% most y f ne sand, ~25% ow p ast c ty f nes, ~5% grave up to 1/2", red, mo st.
		X	S7	23/23	14 23 39 100/5"	NA			S6: CLAYEY SAND (SC); ~60% f ne sand, ~40% ow p ast c ty f nes, red, mo st.
		X	S8	10/11	29 100/5"	NA			S7: CLAYEY SAND (SC); 60% f ne sand, 40% ow p ast c ty f nes, red, mo st. [Gra n S ze Test], (LL = 42, PI = 22) [Atterberg L m ts Test]
		X	S9	5/5	100/5"	NA			S8: CLAYEY SAND (SC); ~70% most y f ne sand, ~30% ow p ast c ty f nes, red, mo st.
		X	S10	5/5	100/5"	NA			S9: CLAYEY SAND (SC); S m ar to S8.
3510	20	X	S9	5/5	100/5"	NA			S10: CLAYEY SAND (SC); ~65% most y f ne sand, ~35% ow p ast c ty f nes, very st ff, ght gray, p nk, dry.
		X	S10	5/5	100/5"	NA			

**Notes:**

**Project Name:** HI STORE CISF Phase 1 S te Character zat on

**City/State:** Lea County, New Mex co

**GEI Project Number:** 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3529.6

Date Start / End: 9/28/2017 10/3/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 102.0

Boring No.

**B107**

Page 2 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Borings per 6 in. or RQD	Core Length (in/ft)			
	25	X	S11	5/5	100/5"	NA		RESIDUAL SOIL	S11: CLAYEY SAND (SC); Similar to S10.
		X	S12	15/24	11 22 38 60	NA			S12: SANDY LEAN CLAY (CL); ~70% low plasticity fines, ~30% fine sand, red, greenish gray, moist, piece of gravel from 0.1".
3500	30	X	S13	14/24	13 30 49 67	NA			S13: LEAN CLAY (CL); 89% low plasticity fines, 11% fine sand, red, moist. Contains possible limestone fragments. [Grain Size Test], (LL = 45, PI = 27) [Atterberg Limits Test]
	35	X	S14	12/23	21 52 83 100/5"	NA			S14: LEAN CLAY (CL); Similar to S13.
3490	40	X	S15	11/24	14 30 32 52	NA		CHINLE	S15: SANDY LEAN CLAY (CL); 68% low plasticity fines, 32% fine sand, red with greenish gray from 0.1", moist. [Grain Size Test], (LL = 41, PI = 21) [Atterberg Limits Test]
	45	X	S16	12/15	21 69 100/3"	NA			S16: SANDY LEAN CLAY (CL); ~70% low plasticity fines, ~30% fine sand, red, moist.
							Drill chatter at ~47.5 ft.		
3480	50	X	S17	12/16	33 91 100/4"	NA			S17: SANDY LEAN CLAY (CL); 57% low plasticity fines, ~43% fine sand, red, moist. [Grain Size Test], (LL = 40, PI = 19) [Atterberg Limits Test]
							Drill chatter at ~52 ft.		
							Drill chatter from ~54 to ~56.5 ft.		
	55	X							

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



NUCLEAR PROJECT BORING LOG 11/30/17

## Final Boring Log

Ground Surface Elev. (ft): 3529.6

Date Start / End: 9/28/2017 10/3/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 102.0

Boring No.

**B107**

Page 3 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Bows per 6 in. or RQD	Coring Time (min/ft)			
		S18	5/5	100/5"	NA				S18: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% fine to medium sand, red, moist.
3470	60	S19 C1	2/2 26/22	100/2"	NA 95	2.5, 2	Spit spoon refusal at ~60.2 ft. Switched to wireline rock coring.	CHINLE	S19: SANDY LEAN CLAY (CL); Similar to S18. C1: MUDSTONE; moderately weathered, reddish brown and gray, soft, fractures spaced 1 to 9", fractures generally planar and typically 0 to 10° from horizontal. Gray seam from 20 to 40" and 40 to 54". C2: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 3 to 19", highly fractured at 57".
		C2	58/60		88	2, 1, 1.5, 1, 1.5			C3: MUDSTONE; Similar to C1, reddish brown and tan. Fractures spaced 1 to 9", fractures typically 0 to 30° from horizontal.
3460	70	C3	60/60		48	1.5, 2.5, 1.5, 1.5, 2.5			C4: MUDSTONE; Similar to C1, reddish brown. Fractures spaced 1 to 13", highly fractured zones at 3", 12", 25" and 36", fractures typically 0 to 30° from horizontal.
		C4	60/60		82	2.5, 2, 2.5, 1.5, 2.5			C5: MUDSTONE; Similar to C1. Fractures spaced 1 to 16".
3450	80	C5	56/60		68	3.5, 3, 2.5, 1.5, 3.5			C6: MUDSTONE; Similar to C1, reddish brown. Fractures spaced 1 to 24", highly fractured zone from 6 to 10".
		C6	54/60		78	1, 1.5, 2.5, 2.5, 3			

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



## Final Boring Log

**Ground Surface Elev. (ft):** 3529.6

**Date Start / End:** 9/28/2017 10/3/2017

**Vertical Datum :** NAVD 88

**Total Depth (ft) :** 102.0

**Boring No.**

**B107**

Page 4 of 4

E lev. (ft)	Depth (ft)	Sample Information				Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No	Rec./ Pen. (in)	Bowls per 6 in. or RQD			
3440	90		C7	54/60	66	2, 2.5, 3.5, 3, 2	CHINLE	C7: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 1 to 10", highly fractured zones at 24" and 46 to 48".
			C8	60/60	48	1.5, 1, 1, 1, 2		C8: MUDSTONE; Similar to C1, brownish red and gray. Fractures spaced 1/4 to 10", typically 0 to 30° from horizontal, approximately 80° fractures from horizontal at 23 to 25" and 50 to 54".
			C9	58/60	90	1.5, 1, 2, 1.5, 1.5		C9: MUDSTONE; Similar to C1, brownish red, gray, and tan. Fractures spaced 1 1/2 to 23", fractures typically 0 to 30° from horizontal.
3430	100						CHINLE	Bottom of boring at depth 102 ft (Elev. 3427.6 ft). At end of drilling, observed ~1.5 ft of water above ground surface, keydrill water used during coring. Borehole backfilled with grout upon completion. See form 135.1. Offset to B107A to install monitoring well.
3420	110						CHINLE	
	115						CHINLE	

**Notes:**

**Project Name:** HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mex co

**GEI Project Number:** 1703345



**Boring Information**

Northing : 572282.4      Easting : 731782.1  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3530.0  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/2/2017 10/2/2017  
 Driller Name: G. Sanders  
 Logged By : J. Neff/A. McDona d/M. H Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 107.5

**Final Boring Log**

Boring No.  
**B107A**  
 Page 1 of 1

**Drilling Information**

Hammer Type: NA  
 Auger I.D.: NA  
 Auger Head Length: NA  
 Drilling Method: Ro erb t to 107.5 ft.

Casing I.D.: 6 n.  
 Drill Rod O.D.: 3.5 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O D  
 split spoon sampler

Pen = Penetration Length  
 Rec = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA NM = Not Applicable Not Measured  
 LL = Liquid Limit  
 P = Plasticity Index  
 NV NP = No value Non-plastic

E lev. (ft)	Depth (ft)	Sample Information					Dr ing Remarks and Eng neer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Sample Descr pt on Rock L tho og ca Descr pt on
		Type	Sample No	Rec./ Pen. (n)	B ows per 6 n. or RQD	Cor ng T me (m n/ft)			
3520	5					Advanced ho ow stem augers to ~7 ft. Removed ho ow stem augers. Set temporary stee surface cas ng to ~7 ft. Ro erb t to ~107.5 ft.		No samp es co ected.	
	10								
	15								
	20								
	25								
	30								
	35								
	40								
	45								
	50								
	55								
3470	60								
65									
70									
75									
80									
85									
90									
95									
100									
105									
3420	110								

**Notes:**

**Project Name:** HI STORE CISF Phase 1 Site Characterization

**City/State:** Lea County, New Mexico

**GEI Project Number:** 1703345



**Boring Information**

Northing : 571660.2      Easting : 731344.9  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3536.7  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/12/2017 10/12/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 60.9

**Final Boring Log**

Boring No.  
**B108**  
 Page 1 of 3

**Drilling Information**

Hammer Type: Automat c  
 Auger I.D.: 4.25 n.  
 Auger Head Length: 3.875 n.  
 Drilling Method: Ho ow stem augers 0 60.9 ft.

Casing I.D.: NA  
 Drill Rod O.D.: 1.75 n.

Core Barrel Type: NA  
 Core Barrel I.D./O.D.: NA / NA  
 Core Barrel Length: NA

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	So Sample Description Rock Lithology Description
		Type	Sample No	Rec./ Pen. (n)	Blows per 6 n. or RQD	Cor ng Time (m n/ft)			
3530	5	X	S1	10/16	3 22 100/4"	NA	Dr chatter at ~2.5 ft.	CALICHE	S1(0 4") CLAYEY SAND (SC); ~75% most y f ne sand, ~20% ow p ast c ty f nes, ~5% grave up to 1/2", dark brown, mo st.
		X	S2	11/24	12 35 20 14	NA			S1(4 10"): SILTY SAND WITH GRAVEL (SM); ~50% f ne to coarse sand, ~25% nonp ast c f nes, ~25% grave up to 1", ght tan, p nk, dry.
		X	S3	19/24	9 8 12 8	NA			S2: SILTY SAND WITH GRAVEL (SM); S m ar to S1(4 10").
		X	S4	21/24	12 12 8 11	NA			S3: SILTY SAND WITH GRAVEL (SM); ~50% most y f ne sand, ~30% grave up to 1 1/2", ~20% nonp ast c f nes, ght gray, p nk, dry.
		X	S4	21/24	12 12 8 11	NA			S4: SILTY SAND WITH GRAVEL (SM); S m ar to S3, changes from p nk to red at 12".
3520	10	MC	MC1	12/12	20 26	NA	Dr chatter at ~22 ft.	RESIDUAL SOIL	MC1: SILTY SAND WITH GRAVEL (SM); S m ar to S3.
		X	S5	24/24	15 26 38 70	NA			S5(0 15"): SILTY SAND WITH GRAVEL (SM); S m ar to S3.
		X	S6	21/21	30 36 59 100/3"	NA			S5(15 24"): CLAYEY SAND (SC); ~65% most y f ne sand, ~30% ow p ast c ty f nes, ~5% grave up to 1/2", ght gray, p nk and red, dry.
		X	S7	11/11	5 100/5"	NA			S6: CLAYEY SAND (SC); ~65% most y f ne sand, ~30% ow p ast c ty f nes, ~5% grave up to 1/2", p nk and red, dry.
		X	S8	24/24	27 57 88 54	NA			S7: CLAYEY SAND (SC); S m ar to S6, changes from red to ght gray, p nk at 6".
	20	X	S9	17/17	22 41 100/5"	NA			S8: CLAYEY SAND (SC); S m ar to S6, red and p nk from 6 to 9", c ayey f nes ncrease towards bottom.
		X	S9	17/17	22 41 100/5"	NA			S9: SANDY LEAN CLAY (CL); ~70% ow p ast c ty f nes, ~30% most y f ne sand, red, p nk, s ght y mo st.

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterizat on  
 City/State: Lea County, New Mex co  
 GEI Project Number: 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3536.7

Date Start / End: 10/12/2017 10/12/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 60.9

Boring No.

**B108**

Page 2 of 3

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Coring Time (min/ft)			
3510	25	X	S10	19/19	22 40 100 100/1"	NA	Drill chatter at ~26 ft.	RESIDUAL SOIL	S10: CLAYEY SAND (SC); ~60% mostly fine sand, ~40% ow past c ty f nes, red, p nk, mo st.
		X	S11	15/15	26 61 100/3"	NA			S11: CLAYEY SAND (SC); S m ar to S10.
	30	X	S12	16/16	11 40 100/4"	NA			S12: CLAYEY SAND WITH GRAVEL (SC); ~60% mostly fine sand; ~25% ow p ast c ty f nes; ~15% grave up to 1", red, p nk, mo st.
	35	X	S13	24/24	21 29 37 46	NA			S13(0 8"): CLAYEY SAND WITH GRAVEL (SC); S m ar to S12.
3500		X					Drill chatter from ~40 ft. to ~45 ft.	CHINLE	S13(8 24"): LEAN CLAY WITH SAND (CL); ~85% ow p ast c ty f nes, ~15% mostly fine sand, tan, gray, purp e, mo st, st ff.
	40	X	MC2	11/11	34 100/5"	NA			MC2: LEAN CLAY WITH SAND (CL); S m ar to S13(8 24"), very st ff.
	45	X	S14	24/24	18 32 56 70	NA			S14: SANDY LEAN CLAY (CL); 53% ow p ast c ty f nes, 47% mostly fine sand, very st ff, red, mo st. [Gran S ze Test]
	50	X	S15	22/22	19 36 75 100/4"	NA			S15: SANDY LEAN CLAY (CL); ~65% ow p ast c ty f nes, ~35% f ne to med um sand, very st ff, red, purp e, mo st.
55		X							

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



**Final Boring Log**

Ground Surface Elev. (ft): 3536.7

Date Start / End: 10/12/2017 10/12/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 60.9

Boring No.

**B108**

Page 3 of 3

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./ Pen. (in)	Bows per 6 in. or RQD	Coring Time (min)			
3480		X	S16	15/15	28 81 100/3"	NA	Drill chatter from ~55 ft. to ~60 ft.	CHINLE	S16: SANDY LEAN CLAY (CL); ~65% low plastic fines, ~35% fine to medium sand, very stiff, red, purple, moist.
60		X	S17	11/11	21 100/5"	NA			S17: SANDY LEAN CLAY (CL); ~70% low plastic fines, ~30% fine to medium sand, stiff, red, purple, moist, greenish gray clay from 5 to 8".
									Bottom of boring at depth 60.9 ft (Elev. 3475.8 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See Form 135.1.
3470									
	65								
	70								
	75								
3460									
	80								
	85								

**Notes:**

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345





**Boring Information**

Northing : 570681.2      Easting : 730773.3  
 Horizontal Datum : NAD 83  
 Ground Surface Elev. (ft): 3539.6  
 Vertical Datum : NAVD 88  
 Rig Type: Truck Mounted CME 75

Date Start - End: 10/13/2017 10/14/2017  
 Driller Name: G. Sanders  
 Logged By : A. McDona d/M. Hernandez Caba  
 Drilling Company : GSI  
 Total Depth (ft) : 102.0

**Final Boring Log**

Boring No.  
**B109**  
 Page 1 of 4

**Drilling Information**

Hammer Type: Automat c  
 Auger I.D.: 4.25 n.  
 Auger Head Length: 3.875 n.  
 Drilling Method: Ho ow stem augers 0 71.3 ft. W re ne rock cor ng 71.3 102.0 ft.

Casing I.D.: NA  
 Drill Rod O.D.: 1.75 n.

Core Barrel Type: HQ  
 Core Barrel I.D./O.D.: 2.5 n. / 3.75 n.  
 Core Barrel Length: 8.6 ft

**ABBREVIATIONS:**

Blows per 6 in.: 140 lb  
 hammer falling 30 inches  
 to drive a 2 inch O.D.  
 split spoon sampler.

Pen. = Penetration Length  
 Rec. = Recovery Length  
 RQD = Length of Sound Cores > 4 in / Pen., %  
 HSA = Hollow-Stem Auger

WOR = Weight of Rods  
 WOH = Weight of Hammer  
 S = Split Spoon Sample  
 C = Core Sample

NA, NM = Not Applicable, Not Measured  
 LL = Liquid Limit  
 PI = Plasticity Index  
 NV, NP = No value, Non-plastic

Elev. (ft)	Depth (ft)	Sample Information					Dr ng Remarks and Eng neer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Sample Descr pt on Rock L tho g ca Descr pt on
		Type	Sample No	Rec./ Pen. (n)	Blows per 6 n. or RQD	Cor ng T me (m n/ft)			
3530	5	X	S1	12/24	2 3 2 3	NA	Co ected bu k samp e G1 from 0 to 10 ft. from auger cutt ngs.	TOP SOIL	S1: LEAN CLAY WITH SAND (CL); ~60% ow p ast c ty f nes, ~25% most y f ne sand, ~15% grave up to 1/2", dark brown, dry.
		X	S2	13/24	8 4 3 3	NA			S2: SANDY LEAN CLAY WITH GRAVEL (CL); ~50% ow p ast c ty f nes, ~25% f ne sand, ~25% grave up to 1", dark brown to ght brown, dry.
		X	S3	7/24	3 6 8 8	NA			S3: SANDY LEAN CLAY WITH GRAVEL (CL); S m ar to S2.
		X	S4	17/24	9 20 23 20	NA			S4(0 7"): SANDY LEAN CLAY WITH GRAVEL (CL); S m ar to S2.
	10	X	MC1	12/12	12 49	NA	MC1: SILTY SAND WITH GRAVEL (SM); S m ar to S4(7 17").	CALICHE	S4(7 17"): SILTY SAND WITH GRAVEL (SM); ~60% f ne to coarse sand, ~25% grave up to 1/2", ~15% nonp ast c f nes, ght red, dry.
		X	S5	19/24	24 20 21 20	NA			S5: CLAYEY SAND (SC); ~60% f ne to med um sand, ~40% ow p ast c ty f nes, ght red, dry.
	15	X	S6	24/24	14 20 26 48	NA	S6: CLAYEY SAND (SC); S m ar to S5.	RESIDUAL SOIL	S6: CLAYEY SAND (SC); S m ar to S5.
		X	S7	24/24	11 28 78 90	NA			S7: CLAYEY SAND (SC); S m ar to S5.
		X	MC2	4/4	100/4"	NA			MC2: CLAYEY SAND (SC); S m ar to S5.
		X	S8	10/10	18 100/4"	NA			S8: CLAYEY SAND (SC); ~60% f ne to coarse sand, ~40% ow p ast c ty f nes, red, dry.

**Notes:**

Project Name: HI STORE CISF Phase 1 S te Character zat on  
 City/State: Lea County, New Mex co  
 GEI Project Number: 1703345



## Final Boring Log

**Ground Surface Elev. (ft):** 3539.6

Date Start / End: 10/13/2017 10/14/2017

**Vertical Datum :** NAVD 88

**Total Depth (ft) :** 102.0

**Boring No.**

**B109**

Page 2 of 4

E lev. (ft)	Depth (ft)	Samp e Informat on				Dr ng Remarks and Eng neer ng Geo ogy Descr pt on of Rock Cores and Fractures	Layer Name	So Samp e Descr pt on Rock L tho g ca Descr pt on
		Type	Sample No	Rec./ Pen. ( n)	B ows per 6 n. or RQD			
3510	25	X	S9	9/9	54 100/3"	NA	RESIDUAL SOIL	S9: CLAYEY SAND (SC); ~60% f ne to coarse sand, ~40% ow p ast c ty f nes, red, dry.
		X	S10	8/8	64 100/2"	NA		S10: CLAYEY SAND (SC) ~80% f ne to coarse sand, ~20% ow p ast c ty f nes, red, dry.
	30	X	S11	9/9	38 100/3"	NA		S11: SANDY LEAN CLAY (CL); ~60% ow p ast c ty f nes, ~40% most y f ne sand, red, dry.
	35	X	S12	4/11	90 100/5"	NA		Dr chatter at ~35 ft.  S12: CLAYEY SAND (SC); ~60% f ne to coarse sand, ~40% ow p ast c ty f nes, red, dry.
	40	X	S13	15/22	16 50 77 100/4"	NA		S13(0 5"): CLAYEY SAND (SC); S m ar to S12. S13(5 15"): SANDY LEAN CLAY (CL); ~70% ow p ast c ty f nes, ~25% f ne sand, ~5% grave up to 1 1/2", red, dry.
	45	X	S14	14/24	24 44 64 80	NA		S14(0 3"): CLAYEY SAND (SC); ~70% f ne to med um sand, ~30% ow p ast c ty f nes, red, dry. S14(3 14"): SANDY LEAN CLAY (CL); ~65% ow p ast c ty f nes, ~35% f ne sand, red, dry.
	50	X	S15	12/17	20 62 100/5"	NA		Dr chatter at ~49 ft.  S15: SANDY LEAN CLAY (CL); S m ar to S14(3 14").
	55	X						Dr chatter from ~52 to ~55 ft.

**Notes:**

**Project Name:** HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mex co

**GEI Project Number:** 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3539.6

Date Start / End: 10/13/2017 10/14/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 102.0

Boring No.

**B109**

Page 3 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Borings per 6 in. or RQD	Core Length (m n/ft)			
		X	S16	11/16	26 56 100/4"	NA			S16: SANDY LEAN CLAY (CL); Similar to S14(3 14").
3480	60	X	S17	11/11	35 100/5"	NA	Drill chatter from ~60 to ~65 ft.		S17: LEAN CLAY WITH SAND (CL); ~75% low plasticity fines, ~25% fine sand, red, dry, changes from red to gray at 5".
	65	X	S18	9/9	38 100/3"	NA			S18: SANDY LEAN CLAY (CL); ~60% low plasticity fines, ~40% fine sand, dark red, dry.
3470	70	X	S19	15/15	27 78 100/3"	NA			S19: SANDY LEAN CLAY (CL); Similar to S18, changes from gray to red at 2".
			C1	56/60	73	3, 3.5, 5.5, 6, 8.5	Switched to wireline rock coring. Washed out to 72 ft. prior to coring. Drill return is red throughout coring 72 102 ft.	CHINLE	C1: MUDSTONE; moderately weathered, reddish brown, soft, fractures spaced 1 to 16", fractures generally planar and typically horizontal, shale like from 0 to 32".
	75		C2	60/60	92	4.5, 4, 9, 9, 6			C2: MUDSTONE; Similar to C1, reddish brown and gray. Fractures spaced 1 to 36", fractures typically 0 to 10° from horizontal.
3460	80		C3	60/60	100	2, 4.5, 5.5, 5, 6.5			C3: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 4 to 30", approximately 30° fractures at 12 1/2" and 17".
	85								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



## Final Boring Log

Ground Surface Elev. (ft): 3539.6

Date Start / End: 10/13/2017 10/14/2017

Vertical Datum : NAVD 88

Total Depth (ft) : 102.0

Boring No.

**B109**

Page 4 of 4

Elev. (ft)	Depth (ft)	Sample Information					Drilling Remarks and Engineering Geology Description of Rock Cores and Fractures	Layer Name	Soil Sample Description Rock Lithology Description
		Type	Sample No.	Rec./Pen. (in)	Bows per 6 in. or RQD	Coring Time (min/ft)			
3450	90		C4	60/60	85	3.5, 6, 6, 6.5, 9.5		CHINLE	C4: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Highly fractured zone from 0 to 6".
			C5	58/60	87	9.5, 6, 5.5, 4, 7			C5: MUDSTONE; Similar to C1, reddish brown, gray, and tan. Fractures spaced 1 to 12". Light gray mudstone from 0 to 41".
3440	100		C6	53/60	60	5, 6, 5.5, 5.5, 9			C6: MUDSTONE; Similar to C1, brownish red, gray, and tan. Fractures spaced 1 to 9 1/2", highly fractured zone from 0 to 14". Shale like from 30 to 38".
3430	110								Bottom of boring at depth 102 ft (Elev. 3437.6 ft). Groundwater not encountered. Borehole backfilled with grout upon completion. See Form 135.1.
	115								

## Notes:

Project Name: HI STORE CISF Phase 1 Site Characterization

City/State: Lea County, New Mexico

GEI Project Number: 1703345



Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment D**

---

### **Representative Sample Photos**

#### **D.1 - Soil Sample Photos**

#### **D.2 - Rock Sample Photos**

#### **D.3 - B101 Rock Core Photo Compilation**

Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **D.1 – Soil Sample Photos**



Photo #1: Representative soil (caliche) from B102



Photo #2: Representative soil (caliche) from B102

HI-STORE CISF Phase 1 Site Characterization Lea County, New Mexico Holtec International Camden, New Jersey	 <b>GEI</b> Consultants	REPRESENTATIVE SOIL SAMPLE PHOTOS (1 of 2)	December 2017	Att. D.1





Photo #3: Representative soil (residual) from B102



Photo #4: Representative soil (residual) from B102

HI-STORE CISF Phase 1 Site Characterization Lea County, New Mexico Holtec International Camden, New Jersey	 <b>GEI</b> Consultants	REPRESENTATIVE SOIL SAMPLE PHOTOS (2 of 2)	December 2017	Att. D.1



Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **D.2 – Rock Sample Photos**



Photo #1: Representative rock (Chinle) from B105



Photo #2: Representative rock (Chinle) from B105

HI-STORE CISF Site Characterization Lea County, New Mexico  Holtec International Camden, New Jersey	 <b>GEI</b> Consultants	REPRESENTATIVE ROCK SAMPLE PHOTOS (1 of 2)
	1703345	December 2017      Att. D.2



CORE RUN	DATE	DEPTH INTERVAL (ft.)	RECOVERY (in.)	PENETRATION (in.)	REC. PEN (%)	RQD (%)
C31	10-20-17	240.6 - 245.6	60	60	100	98
C32	10-21-17	245.6 - 250.6	58.5	60	98	93
C33	10-21-17	250.6 - 255.6	60.8	60	100	100

HI-STORE CISF  
1703345  
B101  
C31 - C33  
Box 11 of 22

Photo #3: Representative rock (Santa Rosa) from B101

CORE RUN	DATE	DEPTH INTERVAL (ft.)	RECOVERY (in.)	PENETRATION (in.)	REC. PEN (%)	RQD (%)
C60	10-21-17	380.6 - 385.6	59.8	60	100	100
C61	10-22-17	385.6 - 390.6	60	60	100	100
C62	10-22-17	390.6 - 395.6	60	60	100	100

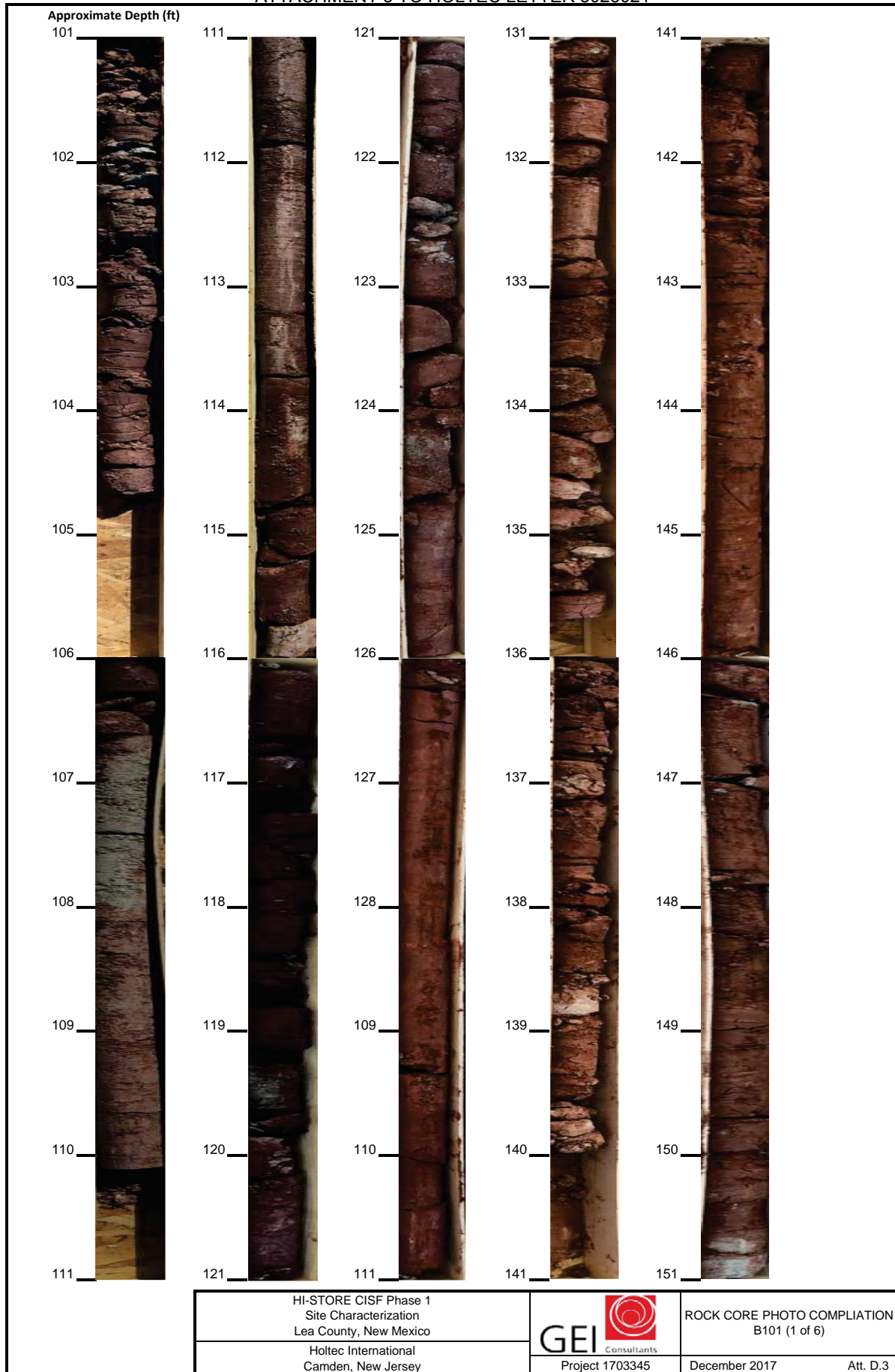
HI-STORE CISF  
Site Characterization  
1703345  
B101  
C60 - C62  
Box 21 of 22

Photo #4: Representative rock (Santa Rosa) from B101

HI-STORE CISF Site Characterization Lea County, New Mexico  Holtec International Camden, New Jersey		REPRESENTATIVE ROCK SAMPLE PHOTOS (2 of 2)
	GEI Consultants 1703345	
		December 2017      Att. D.2

Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **D.3 – B101 Rock Core Photo Compilation**

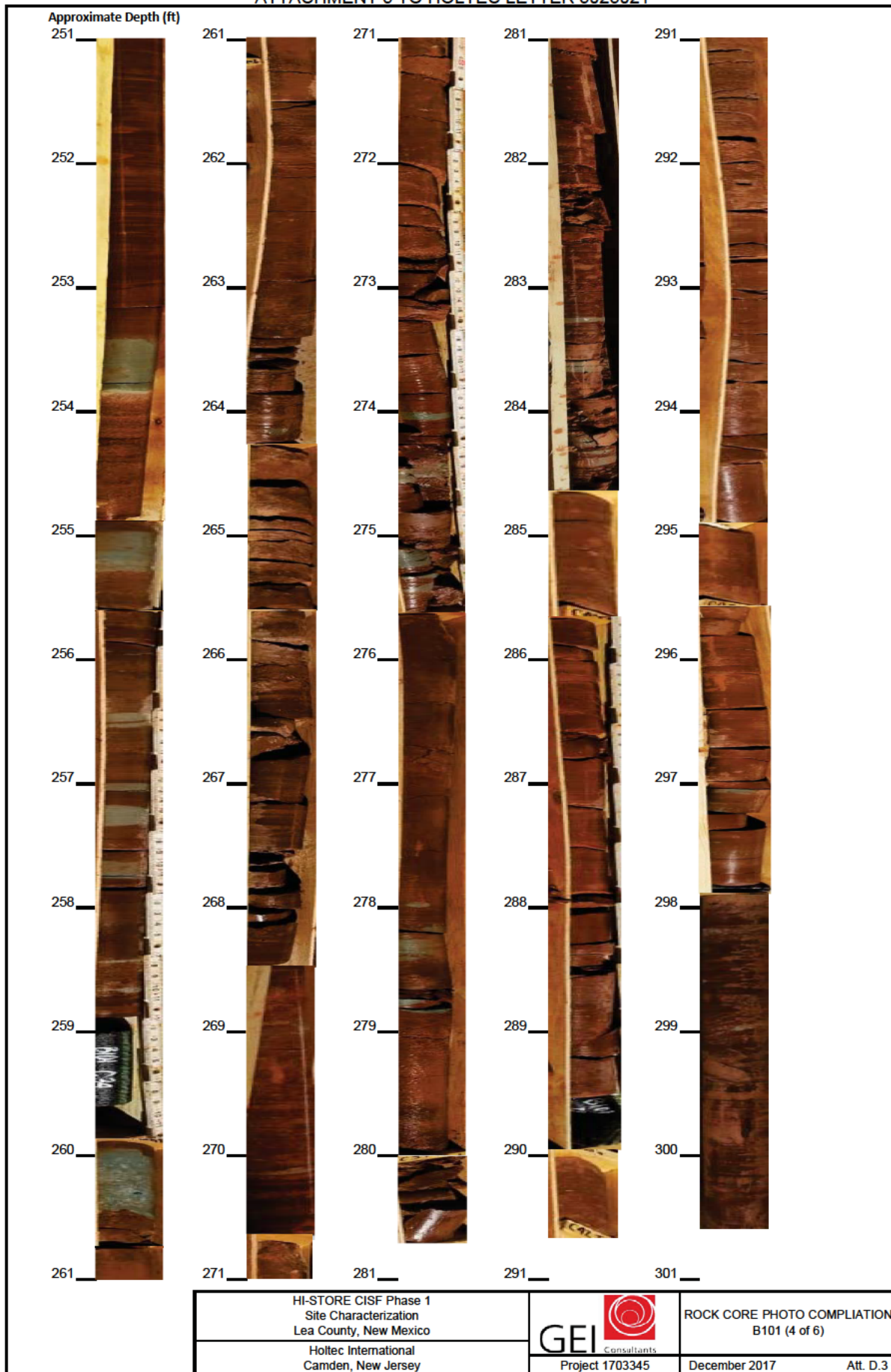




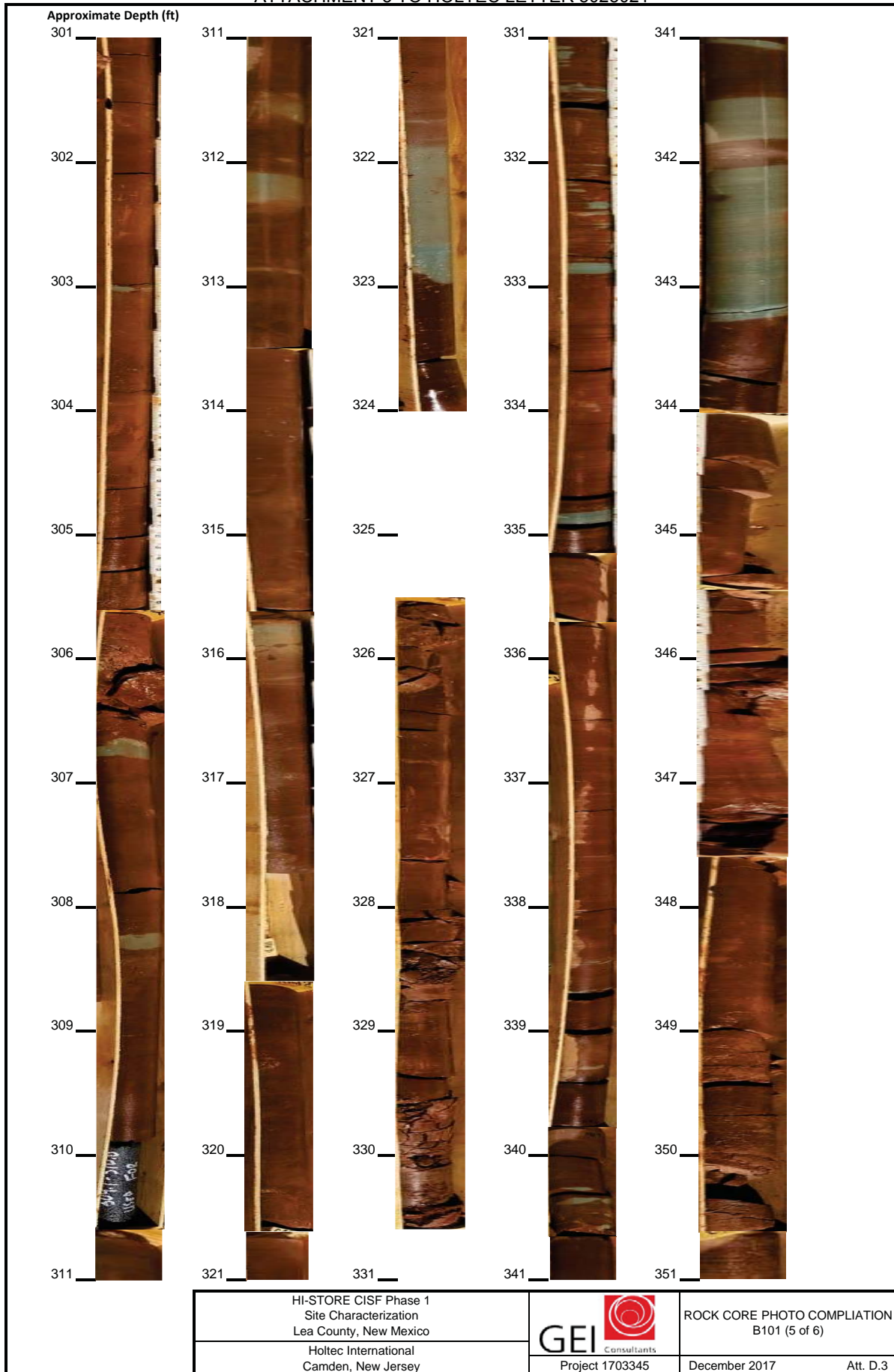
# ATTACHMENT 5 TO HOLTEC LETTER 5025021

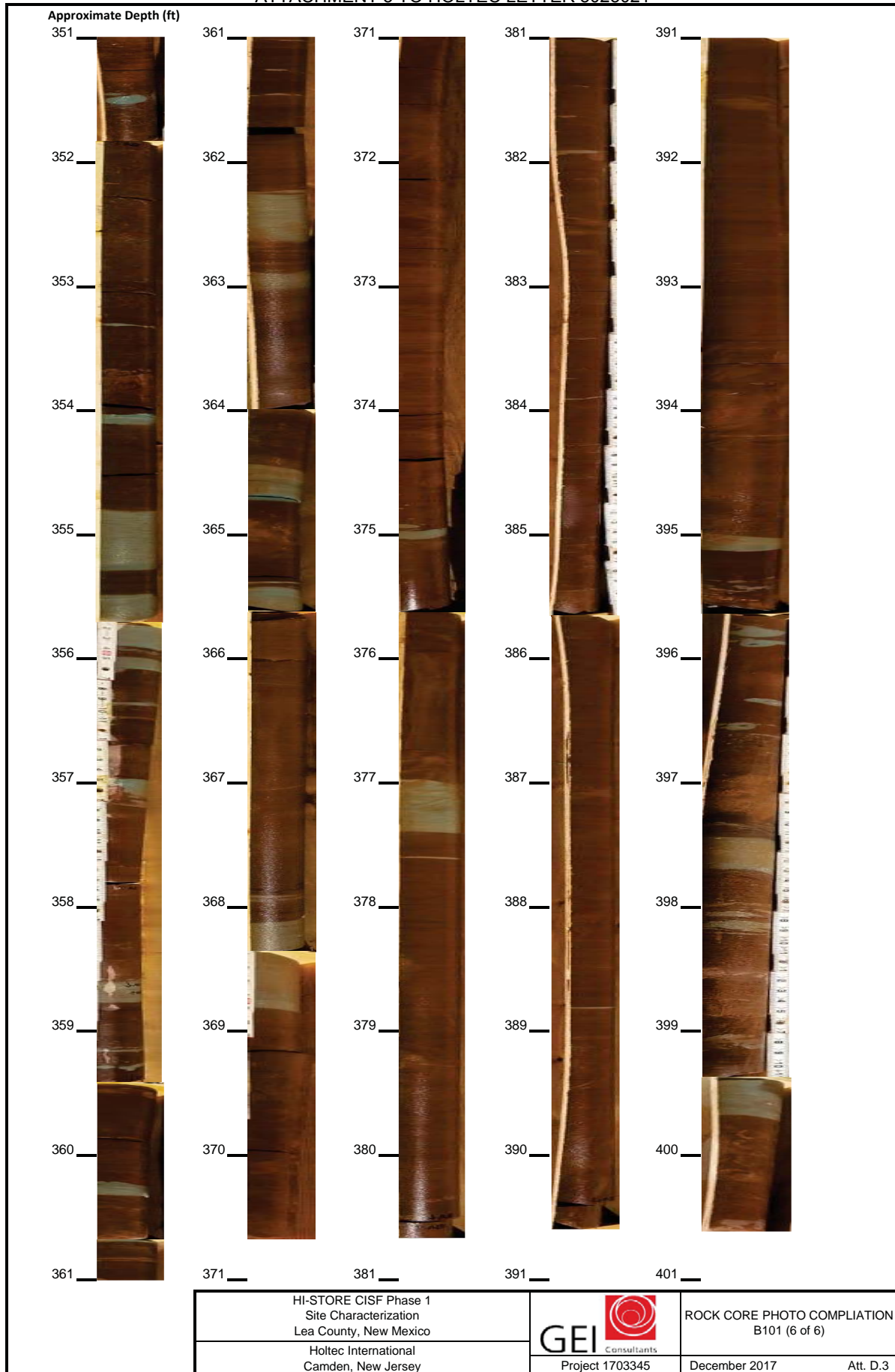












Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment E**

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### **Inclinometer, Grouting, and Well Installation Forms**

# Groundwater Well Installation Log

Well ID: B101(MW)

Project Name HI-STORE CISF Site Characterization

Project Location Lea County, New Mexico

Client Holtec

Contractor Geomechanics Southwest, Inc. (GSI)

Driller G. Sanders GEI Rep. A. McDonald

GEI Proj. No. 1703345

Location Description

SE Corner of ISFSI

Install Date 10/24/2017

Survey

Datum: NAVD 88

Ground

Elevation: 3535.13

Length of Surface Casing above Ground

~2.6 ft.

Dist. Top of Surf. Casing to Top of Riser Pipe

+0.05 ft.

Type and Thickness of Seal  
around Surface Casing

2 ft by 2 ft Concrete pad

ID of Surface Casing

4 in. by 4 in.

Type of Surface Casing

Square Standpipe

Depth Bottom of Surface Casing

~2.4 ft.

ID and OD of Riser Pipe

2 in./ 2-3/8 in.

Type of Riser Pipe

Sch. 40 PVC

Type of Backfill around Riser Pipe

Cement-Bentonite Grout

Diameter of Borehole

~6 in.

Depth Top of Seal

367.7 ft.

Type of Seal

Bentonite chips

Depth Bottom of Seal

377.7 ft.

Depth Top of Screened Section

393.9 ft.

Type of Screen

Sch. 40 PVC

Description of Screen Openings

10 slot.

ID and OD of Screened Section

2 in./ 2-3/8 in.

Type of Filter Material

Colorado 10 x 20  
Silica Sand

Depth Bottom of Screened Section

413.9 ft.

Depth Bottom of Silt Trap/Cap

414.4 ft.

Depth Bottom of Filter Material

414.4 ft.

Depth Top of Seal

NA

Type of Seal

NA

Depth Bottom of Seal

NA

Type of Backfill below Filter Material

NA

Bottom of Borehole

414.4 ft.

10/25/2017	8:00	331.8 ft.
Date	Time	Distance to ▾ below top of riser pipe

General Soil Conditions (Not to Scale)

Santa Rosa

**Notes:** 10/25/2017: Top of PVC surveyed at El. 3537.97 ft.  
 11/1/2017: Cut off 0.15 ft of PVC. New top of PVC elevation calculated at El. 3537.82 ft.  
 Water level measurements will be adjusted accordingly.

Completed form reviewed by: J. Scully Date: 11/28/2017



Form 131.1 rev 1

# Groundwater Well Installation Log

ATTACHMENT 5 TO HOLTEC LETTER 5025021

Well ID: B106(MW)

Project Name HI-STORE CISF Site Characterization

Project Location Lea County, New Mexico

Client Holtec

Contractor Geomechanics Southwest, Inc. (GSI)

Driller G. Sanders

GEI Rep. A. McDonald;  
M. Hernandez Cabal

GEI Proj. No. 1703345

Location Description

NW Corner ISFSI

Install Date 10/10/2017

Survey

Datum: NAVD 88

Ground

Elevation: 3531.38

Length of Surface Casing above Ground ~2.5 ft.

Dist. Top of Surf. Casing to Top of Riser Pipe 0 ft.

Type and Thickness of Seal around Surface Casing 2 ft by 2 ft Concrete pad

ID of Surface Casing 4 in. by 4 in.

Type of Surface Casing Square Standpipe

Depth Bottom of Surface Casing ~2.5 ft.

ID and OD of Riser Pipe 2 in./ 2-3/8 in.

Type of Riser Pipe Sch. 40 PVC

Type of Backfill around Riser Pipe Cement-Bentonite Grout

Diameter of Borehole ~6 in.

Depth Top of Seal 162.1 ft.

Type of Seal Bentonite chips

Depth Bottom of Seal 174.3 ft

Depth Top of Screened Section 179.3 ft.

Type of Screen Sch. 40 PVC

Description of Screen Openings 10 slot.

ID and OD of Screened Section 2 in./ 2-3/8 in.

Type of Filter Material Colorado 10 x 20 Silica Sand

Depth Bottom of Screened Section 199.3 ft.

Depth Bottom of Silt Trap/Cap 199.6 ft.

Depth Bottom of Filter Material 199.6 ft.

Depth Top of Seal NA

Type of Seal NA

Depth Bottom of Seal NA

Type of Backfill below Filter Material See Notes

Bottom of Borehole 203 ft.

General Soil Conditions (Not to Scale)

Chinle

Date	Time	Distance to ▾ below top of riser pipe
10/12/2017	7:50	NE
10/11/2017	7:35	NE

## Notes:

Borehole collapsed from ~199.6 to ~203 ft.

Completed form reviewed by: J. Scully

Date: 11/28/2017



Form 131.1 rev 1



# Groundwater Well Installation Log

ATTACHMENT 5 TO HOLTEC LETTER 5025021

Well ID: B107(MW)

Project Name HI-STORE CISF Site Characterization  
 Project Location Lea County, New Mexico  
 Client Holtec  
 Contractor Geomechanics Southwest, Inc. (GSI)  
 Driller G. Sanders  
 GEI Rep. A. McDonald;  
 M. Hernandez Cabal

GEI Proj. No. 1703345  
 Location Description NE Corner ISFSI  
 Install Date 10/2/2017


Survey Datum: NAVD 88	Length of Surface Casing above Ground	~2.5 ft.
Ground Elevation: 3529.96	Dist. Top of Surf. Casing to Top of Riser Pipe	0.1 ft.
<div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">General Soil Conditions (Not to Scale)</div> <div style="margin-left: 10px;">Chinle</div> </div>	Type and Thickness of Seal around Surface Casing	2 ft by 2 ft Concrete pad
	ID of Surface Casing	4 in. by 4 in.
	Type of Surface Casing	Square Standpipe
	Depth Bottom of Surface Casing	~2.5 ft.
	ID and OD of Riser Pipe	2 in./ 2-3/8 in.
	Type of Riser Pipe	Sch. 40 PVC
	Type of Backfill around Riser Pipe	Cement-Bentonite Grout
	Diameter of Borehole	~6 in.
	Depth Top of Seal	70 ft.
	Type of Seal	3/8 in. Bentonite chips
	Depth Bottom of Seal	82.4 ft.
	Depth Top of Screened Section	85.5 ft.
	Type of Screen	Sch. 40 PVC
	Description of Screen Openings	10 slot.
	ID and OD of Screened Section	2 in./ 2-3/8 in.
Type of Filter Material	Colorado 10 x 20 Silica Sand	
Depth Bottom of Screened Section	105.6 ft.	
Depth Bottom of Silt Trap/Cap	105.9 ft.	
Depth Bottom of Filter Material	107.5 ft.	
Depth Top of Seal	NA	
Type of Seal	NA	
Depth Bottom of Seal	NA	
Type of Backfill below Filter Material	NA	
Bottom of Borehole	107.5 ft.	


## Notes:

Completed form reviewed by: J. Scully Date: 11/28/2017





Form 131.1 rev 1


<b>Borehole Grouting</b>		Boring No.: B101
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>J. Neff</u>	Date: <u>10/31/17-11/1/17</u>
Completed Form Reviewed By:	<u>C. Conti</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>3.875/ 8</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:
Borehole Depth (L)	<u>400.6</u> ft	
Approx. Borehole Volume (V)	<u>59.5</u> cu. ft	<u>0-100 ft. HSA, ~8 in. diameter</u>
		<u>100-400.6 ft. HQ 3.75 in. diameter</u>
		<u>Reamed out with 3.875 in. roller bit.</u>
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>2-3/8" ID/3.5"OD and NJW Steel/ 1" PVC</u>	
Max. Depth Tremie Pipe Inserted:	<u>395</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>38</u>	
Approx. grout volume mixed:	<u>57</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>57</u> cu. ft	per batch <u>0</u> lbs
Notes:		
 Form 135.1, Rev. 0		


<b>Borehole Grouting</b>		Boring No.: B101A
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>J. Neff/A. McDonald</u>	Date: <u>10/26/2017</u>
Completed Form Reviewed By:	<u>C. Conti</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>4</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-30.9 ft. 3-7/8 in. roller bit.</u>  _____  _____
Borehole Depth (L)	<u>30.9</u> ft	
Approx. Borehole Volume (V)	<u>3</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" PVC</u>	
Max. Depth Tremie Pipe Inserted:	<u>10</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>1</u>	
Approx. grout volume mixed:	<u>3</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>3</u> cu. ft	per batch <u>0</u> lbs
Notes:		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0




<b>Borehole Grouting</b>		Boring No.: B102
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>A. McDonald/M. Hernandez-Cabal</u>	Date: <u>10/4/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>8</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-60.3 ft. 8 in. diameter HSA.</u> <u>60.3-112 ft. 3.75 in diameter HQ core barrel.</u>  
Borehole Depth (L)	<u>112.0</u> ft	
Approx. Borehole Volume (V)	<u>25</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" hose</u>	
Max. Depth Tremie Pipe Inserted:	<u>60</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>12.25</u>	
Approx. grout volume mixed:	<u>18.37</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>18.37</u> cu. ft	per batch <u>0</u> lbs
Notes:		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0


<b>Borehole Grouting</b>		Boring No.: B105
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>A. McDonald</u>	Date: <u>10/23/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>8/ 3.75</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-60 ft. 8 in. diameter HSA.</u>  <u>60-221 ft. 3.75 in diameter HQ core barrel.</u>  _____
Borehole Depth (L)	<u>196.0</u> ft	
Approx. Borehole Volume (V)	<u>32</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" hose</u>	
Max. Depth Tremie Pipe Inserted:	<u>~180</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>20</u>	
Approx. grout volume mixed:	<u>30</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>30</u> cu. ft	per batch <u>0</u> lbs
Notes:		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0

<b>Borehole Grouting</b>		Boring No.: B105A
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>A. McDonald</u>	Date: <u>10/23/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>4</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-30.9 ft. 3-7/8 in. roller bit.</u>  _____  _____
Borehole Depth (L)	<u>30.9</u> ft	
Approx. Borehole Volume (V)	<u>3</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" hose</u>	
Max. Depth Tremie Pipe Inserted:	<u>10</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>1</u>	
Approx. grout volume mixed:	<u>3</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>3</u> cu. ft	per batch <u>0</u> lbs
Notes:		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0

<b>Borehole Grouting</b>		Boring No.: B106
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Gallegos</u>	
Performed By:	<u>M. Hernandez-Cabal</u>	Date: <u>10/13/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d) <u>8/ 3.75</u> inch Borehole Depth (L) <u>152.0</u> ft Approx. Borehole Volume (V) <u>19.9</u> cu. ft $V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$ Type / Nom. Dia. Tremie Pipe: <u>1" hose</u> Max. Depth Tremie Pipe Inserted: <u>~140</u> ft	Describe depth of borehole in soil and rock, depth and diameter of casing or augers: <u>0-31.1 ft., ~8 in. diameter HSA.</u> <u>31.1-152 ft., ~3.75 in. wireline rock coring HQ</u>	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed: <u>17.5</u> Approx. grout volume mixed: <u>27</u> cu. ft Approx. grout volume pumped: <u>26.25</u> cu. ft	Approx. weight calcium chloride per batch <u>0</u> lbs	
Notes:		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0



<b>Borehole Grouting</b>		Boring No.: B108
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Gallegos</u>	
Performed By:	<u>M. Hernandez-Cabal</u>	Date: <u>10/13/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>8</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-60.9 ft., ~8 in. diameter HSA.</u>  _____  _____
Borehole Depth (L)	<u>60.9</u> ft	
Approx. Borehole Volume (V)	<u>21.3</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" hose</u>	
Max. Depth Tremie Pipe Inserted:	<u>~55</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>12</u>	
Approx. grout volume mixed:	<u>18</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>18</u> cu. ft	per batch <u>0</u> lbs
<p>Notes:</p> <p>Borehole collapsed to ~55 ft. Approx. borehole volume: 19.2 cu. ft.</p>		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0

<b>Borehole Grouting</b>		Boring No.: B109
Project Name	<u>HI-STORE CISF Site Characterization</u>	
Project Location	<u>Lea County, New Mexico</u>	
GEI Project No.	<u>1703345</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Performed By:	<u>M. Hernandez-Cabal/A. McDonald</u>	Date: <u>10/15/2017</u>
Completed Form Reviewed By:	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Borehole Diameter (d)	<u>8/ 3.75</u> inch	Describe depth of borehole in soil and rock, depth and diameter of casing or augers:  <u>0-70 ft., ~8 in. diameter HSA.</u>  <u>70-102 ft., 3.75 in. diameter HQ core barrel.</u>  _____
Borehole Depth (L)	<u>102.0</u> ft	
Approx. Borehole Volume (V)	<u>26.9</u> cu. ft	
$V = \frac{\pi d^2 L}{144 * 4} \text{ cu. ft}$		
Type / Nom. Dia. Tremie Pipe:	<u>1" hose</u>	
Max. Depth Tremie Pipe Inserted:	<u>~70</u> ft	
<p style="text-align: center;">Standard Grout Mix Proportions (One Batch):</p> <ul style="list-style-type: none"> <li>- One 94-lb (nominal) bag of Type I or Type II Portland cement.</li> <li>- 3 to 5 lbs of powdered bentonite. The weight of bentonite used may be adjusted in the field.</li> <li>- 7 to 10 gallons of water.</li> <li>- Optional: Up to 2 lbs of calcium chloride may be added per 94-lb bag of cement at the discretion of the GEI field representative to accelerate the set-up time of the grout.</li> <li>- One batch at these proportions will make approximately 1.5 cubic feet of grout, which will fill a 3-inch diameter borehole approximately 30 feet.</li> </ul>		
Number of batches mixed:	<u>14</u>	
Approx. grout volume mixed:	<u>21</u> cu. ft	Approx. weight calcium chloride
Approx. grout volume pumped:	<u>21</u> cu. ft	per batch <u>0</u> lbs
<p>Notes:</p> <p>Borehole collapsed to ~55 ft. Approx. borehole volume: 19.2 cu. ft.</p>		
		 <b>GEI</b> Consultants Form 135.1, Rev. 0

<b>Inclinometer Casing Installation</b>		Boring: B102A
Project Name:	<u>HI-STORE CISF Site Characterization</u>	GEI Project No. <u>1703345</u>
Project Location:	<u>Lea County, New Mexico</u>	
Drilling Co.	<u>GSI</u>	
Driller	<u>G. Sanders</u>	
Casing installation performed in accordance with Proc 163 Rev <u>3</u>		
Casing Installation Observed By	<u>M. Hernandez-Cabal/A. McDonald</u>	Date: <u>10/10/2017</u>
Completed Form Reviewed By	<u>J. Neff</u>	Date: <u>11/15/2017</u>
Inclinometer casing type and diameter: <u>Grooved slope indicator PVC casing</u> <u>10 ft., 2.75 in. OD/ 2.375 in. ID</u> Depth of Bottom of Inclinometer Casing <u>107.9</u> ft Inclinometer Casing length above Ground Surface <u>~1.94</u> ft Type / Nom. Dia. Tremie Pipe: <u>1" polypipe</u> Max. Depth Tremie Pipe Inserted: <u>107.9</u> ft	Describe depth of borehole in soil and rock, depth and diameter of drill bits, rock core bits, etc.: <u>0-107.9 ft., ~5-7/8 in. roller bit.</u> <u>Soil from 0 to 67 ft., rock from 67 ft. to 107.9 ft.</u>	
<b>Notes:</b>		



<b>Inclinometer Casing Installation</b>		Boring: B103
Project Name:	HI-STORE CISF Site Characterization	GEI Project No. 1703345
Project Location:	Lea County, New Mexico	
Drilling Co.	GSI	
Driller	G. Sanders	
Casing installation performed in accordance with Proc 163 Rev ____3__		
Casing Installation Observed By	M. Hernandez-Cabal/A. McDonald	Date: 10/11/2017
Completed Form Reviewed By	J. Neff	Date: 11/15/2017
Inclinometer casing type and diameter: <u>Grooved slope indicator PVC casing</u> 10 ft., 2.75 in. OD/ 2.375 in. ID Depth of Bottom of Inclinometer Casing <u>107.7 ft</u> Inclinometer Casing length above Ground Surface <u>2.3 ft</u> Type / Nom. Dia. Tremie Pipe: <u>1" polypipe</u> Max. Depth Tremie Pipe Inserted: <u>107.1 ft</u>	Describe depth of borehole in soil and rock, depth and diameter of drill bits, rock core bits, etc.: 0-107.64 ft., ~5-7/8 in. roller bit. Soil from 0 to 60 ft, rock from 60 ft. to 107.6 ft.	
<b>Notes:</b>		

<b>Inclinometer Casing Installation</b>		Boring: B104
Project Name:	HI-STORE CISF Site Characterization	GEI Project No. 1703345
Project Location:	Lea County, New Mexico	
Drilling Co.	GSI	
Driller	G. Sanders	
Casing installation performed in accordance with Proc 163 Rev ____3__		
Casing Installation Observed By	M. Hernandez-Cabal/A. McDonald	Date: 10/11/2017
Completed Form Reviewed By	J. Neff	Date: 11/15/2017
Inclinometer casing type and diameter: <u>Grooved slope indicator PVC casing</u> <u>10 ft., 2.75 in. OD/ 2.375 in. ID</u> Depth of Bottom of Inclinometer Casing <u>107.8 ft</u> Inclinometer Casing length above Ground Surface <u>2.15 ft</u> Type / Nom. Dia. Tremie Pipe: <u>1" polypipe</u> Max. Depth Tremie Pipe Inserted: <u>107.8 ft</u>	Describe depth of borehole in soil and rock, depth and diameter of drill bits, rock core bits, etc.: <u>0-107.82 ft., ~5-7/8 in. roller bit.</u> <u>Soil from 0 to 60 ft, rock from 60 ft. to 107.82 ft.</u>	
<b>Notes:</b>		


Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## Attachment F

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### Hammer Energy Report

**Subcontractor Document Approval**

	Issued for use. Verify Current Revision.
	CIS - GSI 02 - 00

Project Name: HI-STORE CISF Site CharacterizationProject Location: Lea County, New MexicoGEI Project No.: 1703345Subcontractor: Geomechanics Southwest, Inc. (Prepared by GRL engineers, inc.)

Document Title: Energy Measurement for Dynamic Penetrometers  
HI-STORE CISF  
GEI Project No. 1703345  
Lea County, New Mexico  
GRL Job No. 172056-1  
October 23, 2017

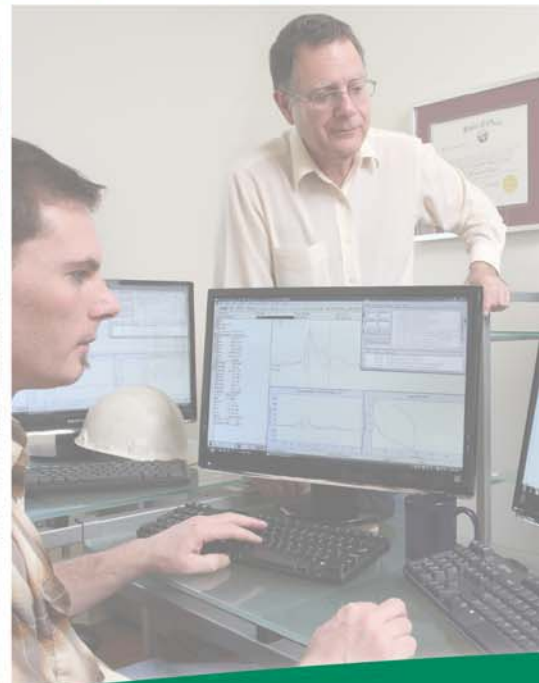
submitted on November 3, 2017 by Geomechanics Southwest, Inc. (via email)

**Technical Reviewer**Signature:  Date: 11/20/2017Printed Name: Jay Scully

Electronic signature inserted by J.Scully 11/20/2017.

**QA Manager**Signature:  Date: 11/21/2017Printed Name: Leslie Lombardo

Electronic signature used per email direction, M.Bose. 11/21/2017.



**GRL** Dynamic  
Measurements  
and Analyses  
**engineers, inc.**

### Job No. 172056-1

Report on: Energy Measurement for Dynamic  
Penetrometers  
HI-STORE CISF  
GEI Project No. 1703345  
Lea County, New Mexico

Prepared for Geomechanics Southwest, Inc.  
By Camilo Alvarez, MSCE, P.E. and  
Anna M. Klesney, MSCE, E.I.T.

October 23, 2017





October 23, 2017

Steve Bradshaw, Operations Manager - Tucson  
Geomechanics Southwest, Inc.  
5839 South Belvedere Avenue  
Tucson, Arizona 85706

Re: Energy Measurement for Dynamic Penetrometers  
HI-STORE CISF  
GEI Project No. 1703345  
Lea County, New Mexico

GRL Job No. 172056-1

Dear Mr. Steve Bradshaw:

This report transmits our findings from energy measurements and related data analysis conducted by GRL Engineers, Inc. (GRL) for two drill rigs located on the HI-STORE CISF project in Lea County, New Mexico. Two automatic hammer and penetrometer systems were monitored during Standard Penetration Tests. Dynamic testing summarized in this report was conducted on Wednesday, October 18, 2017.

A Pile Driving Analyzer® Model 8G recorded, processed and displayed the dynamic data to meet the objectives of the hammer system calibration. Discussions on the test methods, limitations and implementation are provided in Appendix A. The energy measurement results are summarized in Tables 1A and 1B, with the average and standard deviation provided in Appendix B. Representative plots of force and normalized velocity are provided in Appendix C and certificates of calibration are provided in Appendix D.

## EQUIPMENT

### *Hammer and Penetrometer System*

Energy measurements were recorded during standard penetration tests conducted for two automatic hammers and the following drill rig types and serial numbers.

Rig Number (Reference)	Drill Rig Type	Drill Rig Serial Number
62 (A)	CME 75	224607
118 (B)	CME 85	381236

Measurements were recorded for one boring location for each drill rig. Geomechanics Southwest, Inc. (GSI) advanced the penetrometer to a depth of 10.0 feet prior to energy measurements. The instrumented subassembly was connected to the top of the drill rod string and measurements recorded at intervals of 5.0 feet for no less than three depths of data.

Measurements were recorded for every blow required to advance the sampler 18 inches. Results are provided for the final 12 inches or less of the sampler advancement alone (i.e., excluding the initial 6 inches of advancement). ASTM Standard D4633-10 states that tests for energy evaluation should be limited to SPT N-values between 10 and 50. Energy measurements of all samples are included in the reported averages.

The following drill rod dimensions, of rod size AWJ, were employed during testing.

For Drill Rigs A, B

Drill Rod Area		Outside Diameter		Inside Diameter	
sq. inch		Inch		inch	
1.21		1.75		1.25	
Depth of Penetrometer *		Drill Rod Section Lengths *		Transducer to Penetrometer Length *	
feet		feet		feet	
A	B	A	B	A	B
10.0	10.0	10	10	13.8	13.8
15.0	15.0	15	15	18.8	18.8
20.0	20.0	20	20	23.8	23.8
25.0	25.0	25	25	28.8	28.8
30.0	30.0	30	30	33.8	33.8

\* A (CME 75 Serial Number 224607); B (CME 85 Serial Number 381236).

### **Instrumentation**

A Pile Driving Analyzer was employed for recording, processing, and displaying the dynamic data. An instrumented subassembly, inserted at the top of the drill rod string below the hammer and anvil system and above the drill rods, was employed to record force and acceleration data. The subassembly was instrumented with two foil strain gages in a full bridge circuit and two piezoresistive accelerometers attached on diametrically opposite sides of the subassembly. Data sampling frequency was 50.0 kHz.



Figure 1: Drilling Operations, Facing Southwest

The Model 8G utilizes a digital system, and with the employed sampling frequency of 50.0 kHz, the signal conditioning conforms to ASTM D4633-10. Results for the maximum hammer operating rate, rod top force and velocity, and transferred energy are provided in Appendix B and summarized in the appended tables. Discussions on the test method and its limitations can be found in Appendix A.

## MEASUREMENTS AND CALCULATIONS

The primary objective of testing was the measurement of the energy transmitted from the hammer impact through the anvil into the instrumented subassembly and drill rods. Strain transducers and accelerometers were employed for calculation of the transferred energy using force,  $F(t)$  and velocity  $v(t)$ , records as follows:

$$EMX = \int_b^a F(t)v(t)dt$$

where time "b" is to the beginning of the energy transfer and time "a" is the time at which the energy transfer reaches a maximum. Force is calculated as the product of the measured strain, elastic modulus and cross-sectional area, and measured acceleration is integrated to velocity.



Integrated over the complete impact event and calculated from measured force and velocity, the energy transferred to the top of the drill rod was calculated as a function of time. The maximum transferred energy (i.e., EMX, also referred to as EFV) is used as an indicator of the energy content of the event. The described method is the only theoretically correct method of measuring energy transfer and automatically corrects for rod non-uniformities such as connector masses or loose joints. The EF2 method results included in Appendix B are inherently incorrect and included in Appendix B for reference alone.

## TEST RESULTS

### ***Result Discussion***

Dynamic data was evaluated for the hammer operating rate, rod top force and velocity, and transferred energy. Appendix B provides the evaluated quantities for blows making up the SPT N-value, with their averages and standard deviation, plotted and printed as a function of depth for the monitored sequences of the standard penetration tests.

The plots in Appendix B include:

- FMX – the maximum measured rod top force
- VMX – the maximum measured rod top velocity
- BPM – the hammer operating rate in blows per minute
- BLC – the equivalent penetration resistance or count of impacts per each 6 inches set
- EFV – the maximum calculated energy (EMX) transferred to the rod top
- EF2 – the maximum of the integral of the square of force, theoretically incorrect energy transfer calculation

The corresponding tables also include:

- ETR – ratio of transferred energy (EFV) to the maximum theoretical potential energy
- CSX – the maximum measured rod top compressive stress, averaged over the cross-sectional area

The maximum theoretical potential energy is the product of the standard 140 lb hammer impact mass dropped the standard 30 inches. If the calculated energy transferred exceeds the maximum theoretical potential energy, it generally implies that the drop height is higher than the standard 30 inches.

A representative plot of force and normalized velocity versus time for a typical blow from each data set is provided in Appendix C to demonstrate the data quality.

### **Summary of Results**

- I. Two automatic hammers were monitored during standard penetration tests conducted on October 18, 2017. The average energy transfer ratio calculated with the EFV method for the monitored sequences for all drill rigs are tabulated below together with the corresponding, average hammer operating rates.

Rig Number (Reference)	Energy Transfer Ratio percent	Operating Rate bpm
62 (A)	94	58
118 (B)	97	55

For select impacts, the calculated energy transferred exceeded the maximum theoretical potential energy, suggesting most possibly that the drop height trip, in these cases, was slightly higher than 30 inches.

- II. The uncorrected N-values encountered during monitored sequences ranged from 33 blows to refusal conditions.
- III. To convert the uncorrected N-values for the employed hammer and penetrometer system and operator(s), the Schmertman correction for adjustment to 60 percent transfer efficiency is

$$N_{60} = \left( \frac{e_m}{60} \right) N_m$$

where  $N_{60}$  is the corrected hammer N-value,  $e_m$  is the percent energy transfer efficiency (i.e.,  $e_m = 100 \times \text{ETR}$ ) and  $N_m$  is the measured SPT N-value provided by GSI during drilling operations.  $N_{60}$  values for all measurements and monitored depths are presented in the appended tables. The measured overall energy transfer ratios tabulated above for the respective drill rigs produce an  $N_{60}$  equivalent of roughly  $1.6N_m$  for both rigs. Further corrections due to overburden stresses in the soil, etc., have not been considered.

Geomechanics Southwest, Inc.  
Energy Measurement for Dynamic Penetrometers  
GRL Job No. 172056-1

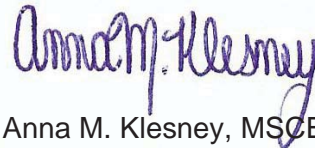
Page 6

We appreciate the opportunity to be of assistance to you on this project. Please contact our offices if you have any questions regarding the contents of this report, or if we may be of further service.

Respectfully,  
GRL ENGINEERS, INC.



Camilo Alvarez, P.E. New Mexico  
Senior Engineer



Anna M. Klesney, MSCE, E.I.T.  
Project Engineer

**TABLE 1A: Summary of Field Results**  
**Energy Measurement for Dynamic Penetrometers**

Rig Serial No.	Depth(s)	Uncorrected N value	Corrected N value	Hammer Operating Rate (BPM)	Average Transferred Energy (EFV) ft-lbs	Energy Transfer Ratio (ETR) %	Maximum Compressive	
							Measured Top Stress (CSX) ksi	Impact Top Force (FMX) kips
	ft	(1) blows	(2) N <sub>60</sub>	bpm	(3) ft-lbs	(3) %	(4) ksi	(5) kips
<b>Rig Number 62, CME 75 Serial Number 224607</b>								
	10.0 - 11.5	33	53	58	335	96	26	32
	15.0 - 16.5	71	109	58	323	92	26	32
	20.0 - 21.3	176 for 10"	---	58	328	94	27	32
	25.0 - 26.4	147 for 11"	---	58	324	93	27	32
	30.0 - 30.4	---	---	---	---	---	---	---
	Overall System Performance			58	328	94	27	32
	Standard Deviation			0	5	2	0	0

ATTACHMENT 5 TO HOLTEC LETTER 5025021

### Notes

1. Uncorrected N-value, number of hammer blows required to advance sampler the final 12 inches, unless noted otherwise.
2. Corrected N-value, number of hammer blows required to advance sampler the final 12 inches, corrected for calculated energy transfer ratio (ETR).
3. Average transferred energy at transducer location; ratio of transferred energy to theoretical potential energy of hammer.
4. Average, measured Compressive driving Stress averaged over the drill rod cross section at transducer location.
5. Average, measured Compressive driving Force at transducer location.

**TABLE 1B: Summary of Field Results**  
**Energy Measurement for Dynamic Penetrometers**

Rig Serial No.	Depth(s)	Uncorrected N value	Corrected N value	Hammer Operating Rate (BPM)	Average Transferred Energy (EMX)	Energy Transfer Ratio (ETR)	Maximum Compressive	
							Measured Top Stress (CSX)	Impact Top Force (FMX)
	ft	(1) blows	(2) N <sub>60</sub>	bpm	(3) ft-lbs	(3) %	(4) ksi	(5) kips
<b>Rig Number 118, CME 85 Serial Number 381236</b>								
	10.0 - 11.5	46	76	56	347	99	26	31
	15.0 - 16.5	134	222	55	348	100	26	32
	20.0 - 21.3	195 for 9"	---	55	338	97	27	33
	25.0 - 25.9	100 for 5"	---	55	332	95	27	33
	30.0 - 30.9	100 for 5"	---	55	337	96	27	33
	Overall System Performance			55	340	97	27	32
	Standard Deviation			0	7	2	1	1

### Notes

1. Uncorrected N-value, number of hammer blows required to advance sampler the final 12 inches, unless noted otherwise.
2. Corrected N-value, number of hammer blows required to advance sampler the final 12 inches, corrected for calculated energy transfer ratio (ETR).
3. Average transferred energy at transducer location; ratio of transferred energy to theoretical potential energy of hammer.
4. Average, measured Compressive driving Stress averaged over the drill rod cross section at transducer location.
5. Average, measured Compressive driving Force at transducer location.

# **APPENDIX A**

## APPENDIX A

### AN INTRODUCTION INTO SPT DYNAMIC TESTING

The following has been written by GRL Engineers, Inc. and may only be copied with its written permission.

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#### 1. BACKGROUND

The Standard Penetration Test is frequently conducted as an in-situ assessment of soil strength. This test requires that a 140 lb weight is dropped 30 inches onto a drive rod at whose bottom a sampler is usually installed. The sampler is driven for 18 inches; the number of blows required for the last 12 inches of driving is the so-called N-value. The N-value may be used as a strength indicator for foundation design or as a means of assessing the liquefaction potential of soils.

Obviously, the SPT hammer efficiency is an important consideration when using the N-values for design purposes. Measurements have indicated that the energy in the drive rod is sometimes only 30% and may reach 90% of the potential or rated energy of the SPT hammer (E-rated = 0.35 kip-ft or 0.475 kJ). The type of hammer used to drive the rod is the main reason for these variations. On the average, the energy in the drive rod is 60% of the standard rated energy.

Because of the variability of energy, methods based on N-values are considered unreliable. However, measurements during SPT testing using the Case Method can be done on a routine basis and these measurements yield the transferred energy values. With measured energy, EMX, known, an adjustment of the measured N-value,  $N_m$ , can be made as follows.

$$N_{60} = N_m [E_m / (0.6E_r)] \quad (1)$$

Thus, if the measured energy value is equal to the normally expected transferred energy of 60% of E-rated then the adjusted and measured N-values are identical. On the other hand, if the measured energy is only 30% then the adjusted blow count will be reduced by 50%.

#### 2. DYNAMIC TESTING AND ANALYSIS METHODS APPLIED TO SPT

The Case Method of dynamic pile testing, named after the Case Institute of Technology where it was

developed between 1964 and 1975, requires that a substantial ram mass (e.g. a pile driving hammer) impacts the pile top such that the pile undergoes at least a small permanent set. Thus, the method is also referred to as a "High Strain Method". The Case Method requires dynamic measurements on the pile or shaft under the ram impact and then a calculation of various quantities. Conveniently, for SPT applications, the measurements and analyses are done by a single piece of equipment: the SPT Analyzer. The Pile Driving Analyzer® (PDA) is also suitable to perform these measurements and data processing.

A related analysis method is the "Wave Equation Analysis" which calculates a relationship between bearing capacity, pile stresses, transferred energy and field blow count. The GRLWEAP™ program performs this analysis and provides a complete set of helpful information and input data. This program can be used very effectively to simulate the SPT driving process.

#### 3. MEASUREMENTS

GRL uses equipment manufactured by Pile Dynamics, Inc. The system includes either an SPT-Analyzer™ (SPTA) or a Pile Driving Analyzer® (PDA), an instrumented rod section and two accelerometers. SPT energy testing is very closely related to and borrows procedures from dynamic pile testing. Those interested in the basis of the SPT energy testing method may obtain extensive literature on dynamic pile testing from GRL Engineers, Inc.

##### 3.1 SPT Analyzer or Pile Driving Analyzer

The basis for the results calculated by the SPTA or PDA are strain and acceleration measured in an instrumented rod section. These signals are converted to rod top force,  $F(t)$ , and rod top velocity,  $v(t)$ . The SPTA or PDA conditions, calibrates and displays these signals and immediately computes average pile force and velocity thereby eliminating bending effects. The product of these two

measurements is then integrated over time which yields the energy transferred to the instrumented section as a function of time (see Section 4.1).

For convenience and accuracy, strain measurements are usually taken on an instrumented section of SPT drive rod. Ideally, the section properties of the instrumented rod and those of the drive rod are the same, however, using subs, other sections can also be utilized.

For the instrumented section, PDI provides a force calibration in such a way that the output of the instrumented rod is directly calculated without the need for an accurate elastic modulus or cross sectional area of the rod section.

The acceleration measurements are often demanding in the SPT environment, because of high frequency and high acceleration motion components. An experienced measurement engineer, therefore, has to evaluate the quality of this data before final conclusions are drawn from the numerical results calculated by SPTA or PDA.

SPTA or PDA records are taken while the standard N-value is acquired in the conventional manner. This then allows a direct correlation between N-value and average transferred energy.

### 3.2 HPA

The SPT hammer's ram velocity may be directly obtained using radar technology in the Hammer Performance Analyzer™. The impact velocity results can be automatically processed with a PC or recorded on a strip chart. HPA measurements yield a hammer kinetic energy, but not the energy transferred to the drive rod.

## 4 RECORD EVALUATION BY SPTA OR PDA

### 4.1 HAMMER PERFORMANCE

The PDA calculates the energy transferred to the pile top from:

$$E(t) = \int_0^t F(\tau)v(\tau) d\tau \quad (2)$$

The maximum of the  $E(t)$  curve is often called **ENTHRU** or **EMX**; it is the most important quantity for an overall evaluation of the performance of a hammer

and driving system. **EMX** allows for a classification of the hammer's performance when presented as,  $e_T$ , the rated transfer efficiency, also called energy transfer ratio (**ETR**) or global efficiency.

$$e_T = EMX/E_R \quad (3)$$

where  $E_R$  is the hammer manufacturer's rated energy value or 0.35 kip-ft (0.475 kJ) in the case of the SPT hammer.

Often in the SPT literature one finds also reference to the EF2 energy. This evaluation is based on assumed proportionality between force and velocity (see also Section 5):

$$v(t) = F(t) / Z \quad (4)$$

where  $Z = EA/c$  is the pile impedance,  $E$  is the elastic modulus,  $A$  is the cross sectional area and  $c$  is the speed of the stress wave in the pile material..

Combining equations 2 and 4 leads to

$$EF(t) = \int_0^t F(\tau)^2 / Z d\tau \quad (5)$$

The EF2 transferred energy value is the EF-value at the time  $t = 2L/c$ , where  $L$  is the drive rod length and  $c$  is the stress wave speed in steel (16,800 ft/s or 5,124 m/s). Since the force is easier to measure than both force and velocity, Equation 5 is preferred by some test engineers. However, the EF method is fraught with errors and certain correction factors have to be applied to make it approximately correct. Among the error sources are the following:

- Proportionality is often violated prior to time  $2L/c$ . The proportionality between force and velocity in a downward traveling wave only holds if the wave does not encounter a disturbance prior to reflecting off the pile toe. Such disturbances include a change in cross sectional area, an open or loose splice or joint, or resistance along the shaft.
- Using only one force measurement precludes a data quality check based on the proportionality between force and velocity. Thus, a force measurement that is for some reason in error may not be detectable, which will lead to errors in the EF2 value. Data quality checks will be discussed further in Section 5.



The use of EF2 is therefore not recommended but it is often included in result presentations for the sake of completeness.

## 4.2 STRESSES

During SPT monitoring, it is also of interest to monitor compressive stresses at both the top of the drive rod and at its bottom.

At the pile top (location of sensors) the maximum compression stress averaged over the rod's cross section, **CSX**, is directly obtained from the measurements. Note that this stress value refers to the instrumented section. If the rod has a different cross sectional area then the stress in the rod will be different from CSX.

The SPTA or PDA can also calculate, in an approximate manner, the force at the rod bottom, **CFB**. To obtain the corresponding stress, this force value should be divided by the appropriate cross sectional area, e.g. by the rod area just above the sampler or by the sampler area itself. Of course, non-uniform stress components as they might occur at the sampler tip due to a sloping rock are not considered in this calculation.

## 5. DATA QUALITY CHECKS

Quality data is the first and foremost requirement for accurate dynamic testing results. It is therefore important that the measurement engineer performing SPTA or PDA tests has the experience necessary to recognize measurement problems and take appropriate corrective action should problems develop. Fortunately, dynamic pile testing allows for certain data quality checks because two independent measurements are taken that have to conform to the so-called proportionality relationship.

As long as there is only a wave traveling in one direction, as is the case during impact when only a downward traveling wave exists in the rod, force and velocity measured at its top are proportional

$$F = v Z \quad (5)$$

where Z is again the pile impedance,  $Z = EA/c$ . This relationship can also be expressed in terms of stress

$$\sigma = F/A = v (E/c) \quad (6)$$

or strain

$$\epsilon = \sigma/E = v / c \quad (7)$$

This means that the early portion of strain times wave speed must be equal to the velocity unless the proportionality is affected by high friction near the pile top or by a pile cross sectional change not far below the sensors. Checking the proportionality is an excellent means of assuring meaningful measurements but is only truly meaningful for perfectly uniform rods. Open or loose splices, for example, will lead to a non-proportionality. For SPT rods it is fortunate that usually no soil resistance acts along the shaft and for that reason, proportionality can exist until the stress wave returns from sampler top or rod bottom unless connectors are not sufficiently tightened or have a significant mass.

Velocity data quality can also be checked by looking at the final displacement, DFN, which is calculated from the acceleration by double integration. If the calculated final displacement is much higher or lower than indicated by the N-value, the accelerometer attachment may be loose or the sensor may be faulty. If major drift in the velocity is observed, the EMX value may be in error, even though proportionality from impact to time  $2L/c$  exists. In this case, it may be useful to evaluate the energy transferred to the drill rod at time  $2L/c$ , which is calculated by the PDA or SPTA as the E2E quantity.

# **APPENDIX B**

## **ENERGY MEASUREMENT RESULTS**

Rig Number 62



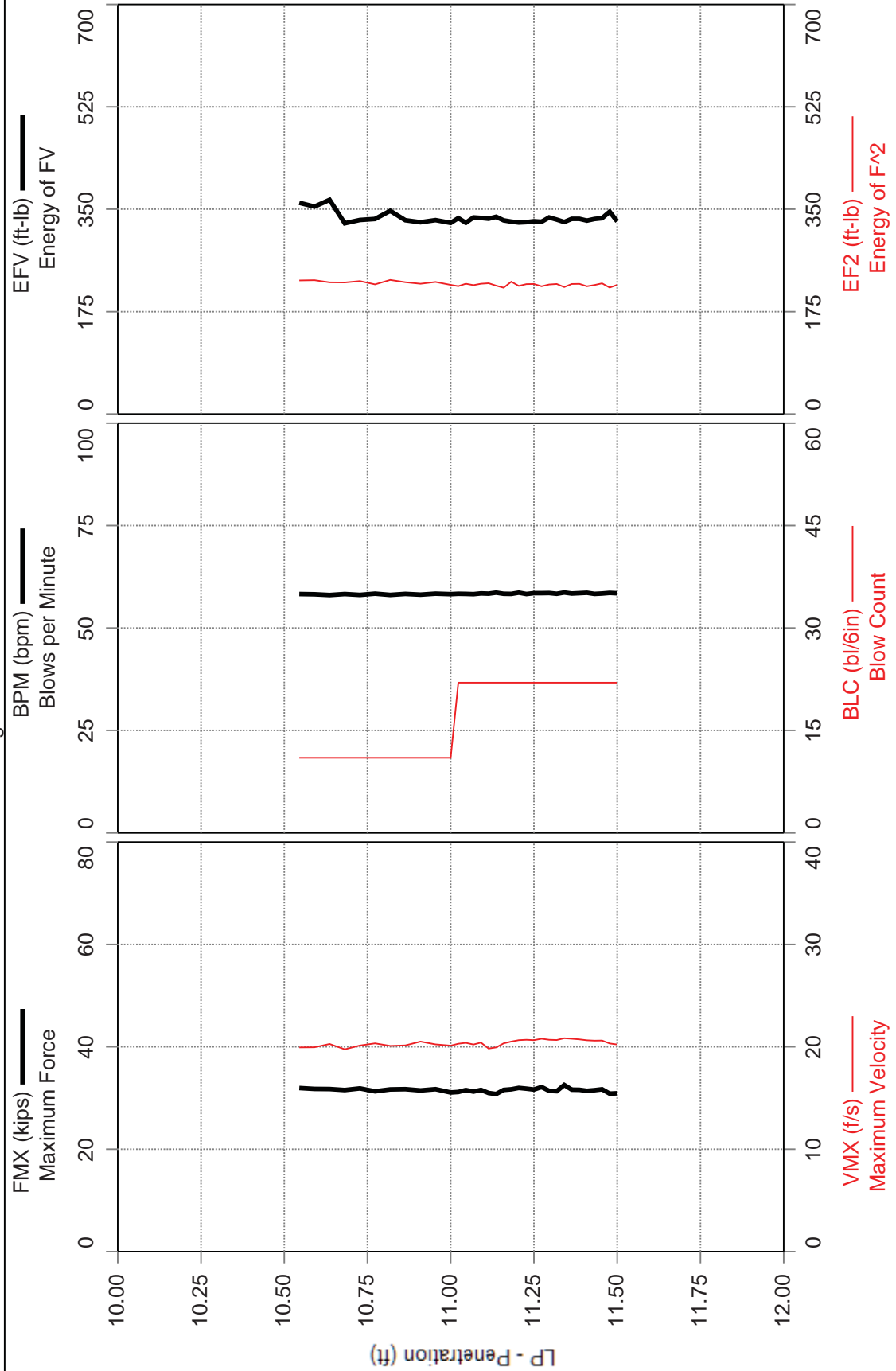
GRL Engineers, Inc. - PDIPILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 21-October-2017

Test started: 18-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 10.0 feet

Boring No. B105A



GRL Engineers, Inc.  
Case Method & iCAP® Results

Page 1  
PDILOT2 2016.1.56.5 - Printed 21-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 10.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 13.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
9	10.55	11	26.4	32	19.9	58	361	228	103
10	10.59	11	26.3	32	19.9	58	355	229	101
11	10.64	11	26.2	32	20.3	58	366	225	105
12	10.68	11	26.1	32	19.8	58	326	225	93
13	10.73	11	26.3	32	20.1	58	332	227	95
14	10.77	11	25.9	31	20.3	58	333	221	95
15	10.82	11	26.2	32	20.1	58	347	229	99
16	10.86	11	26.2	32	20.1	58	331	225	95
17	10.91	11	26.0	31	20.5	58	328	223	94
18	10.95	11	26.2	32	20.2	58	331	226	95
19	11.00	11	25.7	31	20.1	58	327	221	93
20	11.02	22	25.8	31	20.3	58	335	218	96
21	11.05	22	26.1	32	20.4	58	327	223	93
22	11.07	22	25.8	31	20.2	58	336	220	96
23	11.09	22	26.1	32	20.4	58	335	223	96
24	11.11	22	25.6	31	19.8	58	334	223	95
25	11.14	22	25.4	31	19.9	59	337	219	96
26	11.16	22	26.1	32	20.3	58	331	216	95
27	11.18	22	26.2	32	20.5	58	329	226	94
28	11.20	22	26.4	32	20.6	59	327	219	93
29	11.23	22	26.3	32	20.7	58	328	222	94
30	11.25	22	26.2	32	20.7	59	329	222	94
31	11.27	22	26.6	32	20.8	59	328	218	94
32	11.30	22	25.9	31	20.7	59	336	221	96
33	11.32	22	25.9	31	20.7	58	332	222	95
34	11.34	22	26.9	33	20.8	59	328	217	94
35	11.36	22	26.1	32	20.8	58	334	222	95
36	11.39	22	26.1	32	20.7	59	334	222	95
37	11.41	22	26.0	31	20.6	59	330	218	94
38	11.43	22	26.1	32	20.6	58	333	220	95
39	11.45	22	26.2	32	20.6	58	335	223	96
40	11.48	22	25.5	31	20.3	59	346	216	99
41	11.50	22	25.6	31	20.2	58	329	221	94
Average			26.1	32	20.4	58	335	222	96
Std. Dev.			0.3	0	0.3	0	9	3	3
Maximum			26.9	33	20.8	59	366	229	105
Minimum			25.4	31	19.8	58	326	216	93

Total number of blows analyzed: 33

Sensors

GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 21-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 10.0 feet  
OP: AK

Boring No. B105A  
Date: 18-October-2017

Blows: 9-11; 14-15; 20-40

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4819	420.0	1.00

Blows: 12-13; 16-19; 41

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	off
A4	PR Accel	K4819	420.0	1.00

Time Summary

Drive 41 seconds 10:21 AM - 10:21 AM BN 1 - 41



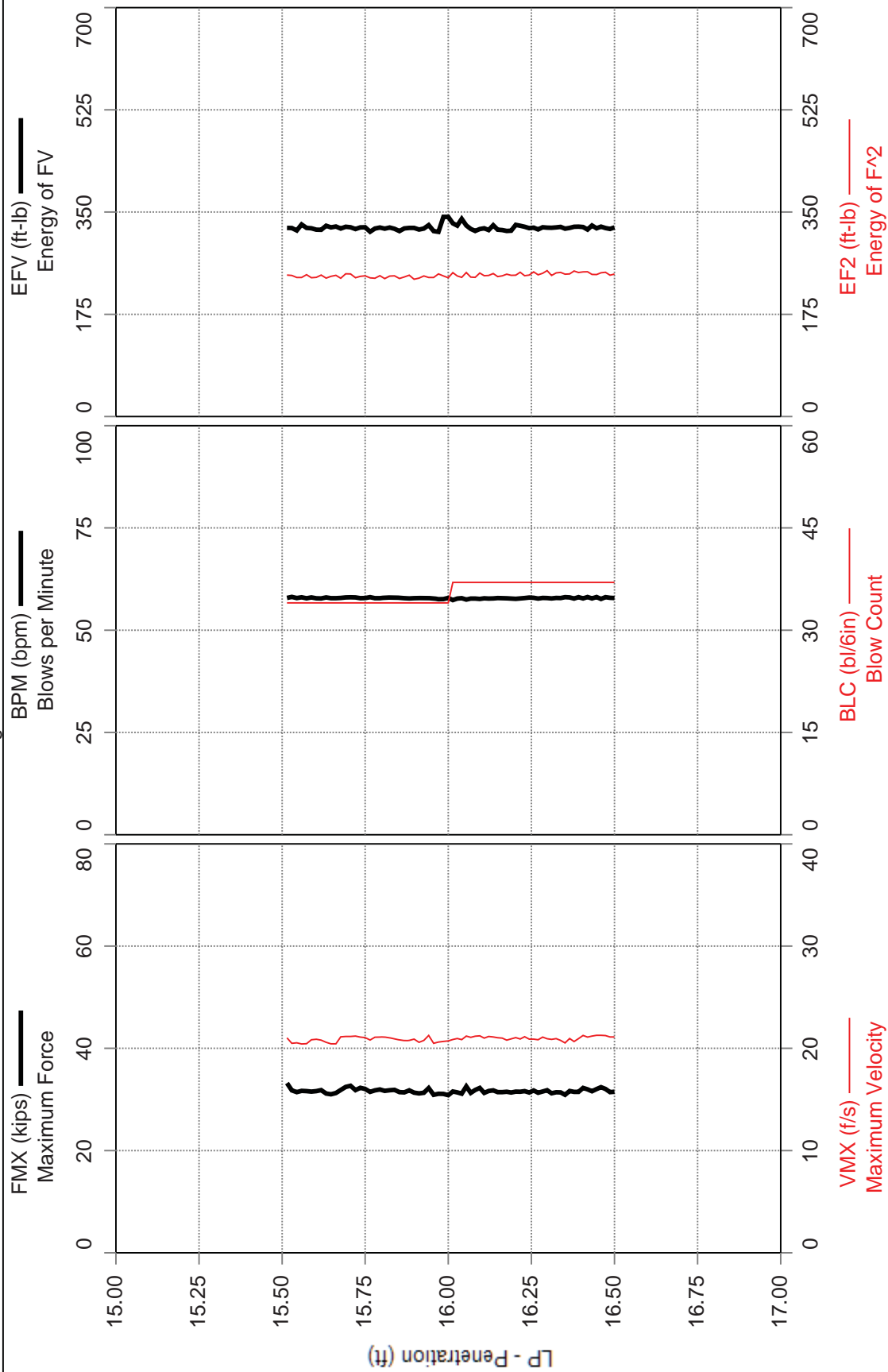
GRL Engineers, Inc. - PDI PLOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 21-October-2017

Test started: 18-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 15.0 feet

Boring No. B105A



GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 21-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 15.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 18.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
44	15.51	34	27.4	33	21.0	58	323	242	92
45	15.53	34	26.3	32	20.5	58	323	241	92
46	15.54	34	26.0	31	20.5	58	319	238	91
47	15.56	34	26.2	32	20.4	58	329	238	94
48	15.57	34	26.1	32	20.5	58	323	243	92
49	15.59	34	26.1	32	20.8	58	322	238	92
50	15.60	34	26.1	32	20.9	58	320	238	91
51	15.62	34	26.3	32	20.8	58	320	242	91
52	15.63	34	25.8	31	20.6	58	327	237	93
53	15.65	34	25.6	31	20.4	58	324	240	92
54	15.66	34	25.8	31	20.4	58	325	242	93
55	15.68	34	26.3	32	21.1	58	322	237	92
56	15.69	34	26.8	32	21.2	58	325	244	93
57	15.71	34	27.0	33	21.2	58	324	244	93
58	15.72	34	26.3	32	21.2	58	321	238	92
59	15.74	34	26.7	32	21.1	58	324	240	92
60	15.75	34	26.5	32	21.0	58	324	241	93
61	15.76	34	26.0	31	20.8	58	316	237	90
62	15.78	34	26.3	32	21.1	58	322	237	92
63	15.79	34	26.4	32	21.1	58	324	241	92
64	15.81	34	26.2	32	21.1	58	322	236	92
65	15.82	34	26.3	32	21.0	58	323	240	92
66	15.84	34	26.3	32	20.9	58	321	241	92
67	15.85	34	26.0	31	20.8	58	317	236	91
68	15.87	34	25.9	31	20.8	58	322	239	92
69	15.88	34	26.3	32	20.8	58	323	242	92
70	15.90	34	25.9	31	20.9	58	323	235	92
71	15.91	34	25.8	31	20.6	58	320	237	91
72	15.93	34	25.9	31	20.8	58	322	241	92
73	15.94	34	26.6	32	21.3	58	328	238	94
74	15.96	34	25.5	31	20.5	58	317	238	91
75	15.97	34	25.7	31	20.6	58	316	244	90
76	15.99	34	25.7	31	20.7	58	342	241	98
77	16.00	34	25.5	31	20.7	58	342	238	98
78	16.01	37	26.1	32	20.9	57	331	246	94
79	16.03	37	25.9	31	21.0	58	327	241	93
80	16.04	37	25.7	31	20.9	58	338	238	97
81	16.05	37	26.9	33	21.2	57	327	247	93
82	16.07	37	25.9	31	21.1	58	321	239	92
83	16.08	37	26.3	32	21.2	58	318	238	91
84	16.09	37	26.7	32	21.2	58	321	246	92
85	16.11	37	25.9	31	21.0	58	322	241	92
86	16.12	37	26.2	32	21.2	58	319	242	91
87	16.14	37	26.3	32	21.1	58	327	245	94
88	16.15	37	26.0	31	21.0	58	320	240	91
89	16.16	37	26.0	31	21.0	58	319	241	91



GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 21-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 15.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
90	16.18	37	26.0	32	20.8	58	318	244	91
91	16.19	37	25.9	31	20.9	58	318	242	91
92	16.20	37	26.1	32	21.0	58	328	242	94
93	16.22	37	26.0	31	20.9	58	327	247	93
94	16.23	37	26.1	32	21.1	58	325	241	93
95	16.24	37	25.9	31	20.9	58	322	242	92
96	16.26	37	26.2	32	20.9	58	323	248	92
97	16.27	37	25.9	31	20.8	58	320	243	92
98	16.28	37	26.1	32	21.1	58	324	245	93
99	16.30	37	26.3	32	20.9	58	323	250	92
100	16.31	37	25.8	31	20.9	58	323	241	92
101	16.32	37	25.9	31	21.0	58	324	246	92
102	16.34	37	25.9	31	20.8	58	325	247	93
103	16.35	37	25.5	31	20.5	58	322	244	92
104	16.36	37	26.2	32	21.0	58	323	244	92
105	16.38	37	26.0	31	20.7	58	325	249	93
106	16.39	37	26.0	31	21.0	58	325	246	93
107	16.41	37	26.6	32	21.3	58	324	248	93
108	16.42	37	26.4	32	21.1	58	320	248	91
109	16.43	37	26.1	32	21.2	58	327	243	93
110	16.45	37	26.5	32	21.3	58	322	243	92
111	16.46	37	26.8	32	21.3	58	325	246	93
112	16.47	37	26.5	32	21.2	58	323	247	92
113	16.49	37	26.0	31	21.1	58	321	242	92
114	16.50	37	26.0	32	21.1	58	324	244	92
Average			26.1	32	20.9	58	323	242	92
Std. Dev.			0.4	0	0.2	0	5	4	1
Maximum			27.4	33	21.3	58	342	250	98
Minimum			25.5	31	20.4	57	316	235	90

Total number of blows analyzed: 71

#### Sensors

Blows: 44-114

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4819	420.0	1.00

#### Time Summary

Drive 1 minute 57 seconds 10:30 AM - 10:32 AM BN 1 - 114



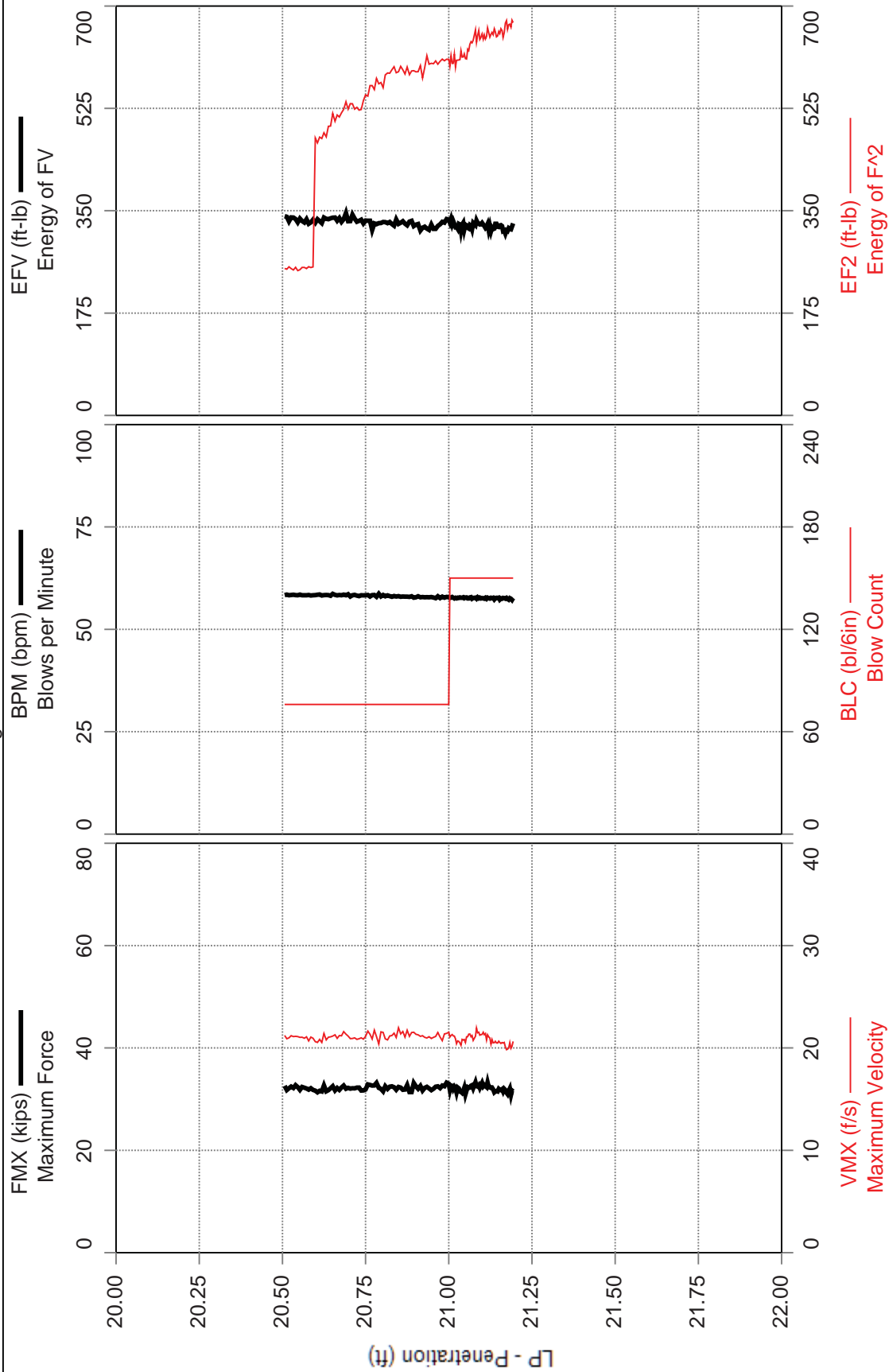
GRL Engineers, Inc. - PDI PLOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 22-October-2017

Test started: 18-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 20.0 feet

Boring No. B105A



GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 22-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 20.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 23.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
21	20.51	76	26.9	33	21.2	58	341	251	97
22	20.51	76	26.3	32	20.9	58	340	250	97
23	20.52	76	26.6	32	21.0	58	332	254	95
24	20.53	76	26.8	32	21.2	58	339	251	97
25	20.53	76	26.6	32	21.1	58	338	249	97
26	20.54	76	27.0	33	21.1	58	336	253	96
27	20.55	76	26.7	32	21.1	58	330	248	94
28	20.55	76	26.3	32	21.0	58	337	249	96
29	20.56	76	26.8	32	21.1	58	332	253	95
30	20.57	76	26.6	32	21.0	58	330	253	94
31	20.57	76	26.5	32	21.1	58	336	251	96
32	20.58	76	26.3	32	20.7	58	328	254	94
33	20.59	76	26.6	32	21.1	58	330	253	94
34	20.59	76	26.3	32	20.9	58	335	254	96
35	20.60	76	26.2	32	20.6	58	329	474	94
36	20.61	76	25.9	31	20.5	58	335	466	96
37	20.61	76	26.1	32	20.8	59	332	476	95
38	20.62	76	26.0	32	20.5	58	329	473	94
39	20.63	76	27.0	33	21.4	58	338	483	97
40	20.63	76	26.0	32	20.8	58	336	476	96
41	20.64	76	26.2	32	21.0	58	335	494	96
42	20.64	76	26.6	32	21.1	58	337	495	96
43	20.65	76	26.9	33	21.2	59	338	516	97
44	20.66	76	26.2	32	21.3	58	338	503	97
45	20.66	76	26.6	32	20.9	58	333	514	95
46	20.67	76	26.3	32	21.2	58	337	510	96
47	20.68	76	26.7	32	21.2	58	331	517	95
48	20.68	76	27.0	33	21.6	58	336	523	96
49	20.69	76	26.5	32	21.4	58	346	536	99
50	20.70	76	26.6	32	21.2	59	332	524	95
51	20.70	76	26.5	32	20.9	58	332	533	95
52	20.71	76	26.6	32	20.9	58	343	533	98
53	20.72	76	26.5	32	21.0	58	337	524	96
54	20.72	76	26.7	32	20.8	58	331	527	95
55	20.73	76	26.7	32	20.9	58	333	522	95
56	20.74	76	26.2	32	21.0	58	335	523	96
57	20.74	76	26.2	32	20.9	58	328	538	94
58	20.75	76	26.3	32	21.1	58	333	548	95
59	20.76	76	27.2	33	21.6	58	333	546	95
60	20.76	76	27.1	33	21.3	58	333	564	95
61	20.77	76	27.0	33	20.9	58	317	564	91
62	20.78	76	27.0	33	21.7	58	328	557	94
63	20.78	76	27.4	33	21.1	58	327	576	93
64	20.79	76	26.6	32	20.4	59	329	567	94
65	20.80	76	26.4	32	21.6	58	329	569	94
66	20.80	76	26.1	32	21.5	58	331	560	94

GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 22-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 20.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
67	20.81	76	26.9	33	20.9	58	330	582	94
68	20.82	76	26.5	32	20.8	58	329	585	94
69	20.82	76	26.8	32	21.2	58	331	585	95
70	20.83	76	26.9	32	21.2	58	327	591	93
71	20.84	76	26.7	32	21.4	58	324	596	93
72	20.84	76	26.3	32	21.0	58	335	586	96
73	20.85	76	26.8	32	22.0	58	327	588	94
74	20.86	76	26.7	32	21.4	58	329	597	94
75	20.86	76	26.3	32	21.6	58	332	591	95
76	20.87	76	26.4	32	21.1	58	328	584	94
77	20.88	76	27.1	33	21.7	58	325	596	93
78	20.88	76	25.9	31	21.1	58	331	583	95
79	20.89	76	25.9	31	21.5	58	333	589	95
80	20.89	76	27.4	33	21.5	58	324	589	92
81	20.90	76	26.9	32	21.3	58	326	587	93
82	20.91	76	26.5	32	21.3	58	327	588	93
83	20.91	76	26.9	33	21.1	58	316	598	90
84	20.92	76	26.2	32	21.2	58	321	577	92
85	20.93	76	26.6	32	21.0	58	323	595	92
86	20.93	76	26.8	32	21.0	58	319	615	91
87	20.94	76	26.5	32	21.1	58	317	600	91
88	20.95	76	26.2	32	20.9	58	326	602	93
89	20.95	76	26.5	32	21.0	58	319	601	91
90	20.96	76	26.8	32	21.1	58	319	606	91
91	20.97	76	26.9	33	21.5	58	324	601	93
92	20.97	76	26.6	32	21.1	58	327	605	93
93	20.98	76	27.0	33	20.7	58	331	609	95
94	20.99	76	26.9	33	21.4	58	330	606	94
95	20.99	76	27.5	33	21.4	58	336	609	96
96	21.00	76	27.3	33	21.5	58	335	609	96
97	21.00	150	26.3	32	21.1	58	330	597	94
98	21.01	150	27.0	33	21.2	58	336	615	96
99	21.01	150	26.9	33	21.3	58	327	602	93
100	21.01	150	26.4	32	21.2	58	332	602	95
101	21.02	150	26.8	32	21.2	58	327	618	94
102	21.02	150	26.5	32	20.9	58	322	596	92
103	21.02	150	25.9	31	20.4	58	322	607	92
104	21.03	150	26.7	32	20.7	58	319	607	91
105	21.03	150	26.5	32	20.6	58	328	608	94
106	21.03	150	26.0	31	20.5	58	326	608	93
107	21.04	150	26.0	31	20.3	58	315	623	90
108	21.04	150	25.8	31	20.8	58	326	613	93
109	21.04	150	26.2	32	20.8	58	329	613	94
110	21.05	150	26.6	32	20.8	58	318	618	91
111	21.05	150	25.6	31	20.5	58	326	610	93
112	21.05	150	26.2	32	21.1	58	325	609	93
113	21.06	150	26.7	32	21.1	58	321	626	92
114	21.06	150	26.6	32	21.3	58	320	624	91
115	21.06	150	26.7	32	21.4	58	325	635	93
116	21.07	150	27.0	33	21.1	58	324	639	92
117	21.07	150	27.0	33	21.2	57	318	637	91
118	21.07	150	26.5	32	20.7	58	329	641	94
120	21.08	150	27.5	33	21.1	58	325	659	93

GRL Engineers, Inc.  
Case Method & iCAP® Results

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CME 75 Serial Number 224607 - Rig Number 62 at 20.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
121	21.08	150	26.9	33	21.9	57	333	638	95
122	21.09	150	26.8	32	21.5	58	329	650	94
123	21.09	150	27.0	33	21.5	58	328	658	94
124	21.09	150	26.6	32	21.3	58	327	643	93
125	21.10	150	27.0	33	21.3	58	327	647	93
126	21.10	150	27.4	33	21.3	58	329	652	94
127	21.10	150	26.9	33	21.5	58	326	643	93
128	21.11	150	27.1	33	21.3	57	324	651	93
129	21.11	150	26.9	33	21.4	58	321	644	92
130	21.11	150	26.7	32	20.8	57	323	648	92
131	21.12	150	27.5	33	21.3	58	327	663	93
132	21.12	150	26.7	32	21.1	58	316	655	90
133	21.12	150	26.8	32	21.0	58	324	647	93
134	21.13	150	26.6	32	20.4	58	315	652	90
135	21.13	150	26.7	32	20.8	58	321	655	92
136	21.13	150	26.4	32	20.5	58	318	651	91
137	21.14	150	25.9	31	20.5	57	319	661	91
138	21.14	150	26.0	32	20.6	58	328	656	94
139	21.14	150	26.1	32	20.5	58	328	647	94
140	21.15	150	26.0	32	20.5	58	323	649	92
141	21.15	150	26.4	32	20.7	58	322	656	92
142	21.15	150	26.3	32	20.5	57	325	653	93
143	21.16	150	26.2	32	20.4	58	325	661	93
144	21.16	150	26.4	32	20.5	57	324	658	92
145	21.16	150	26.0	31	20.5	58	315	646	90
146	21.17	150	26.4	32	20.5	58	316	654	90
147	21.17	150	26.3	32	20.1	57	311	671	89
148	21.17	150	25.8	31	19.8	58	316	675	90
149	21.18	150	25.6	31	19.9	57	315	660	90
150	21.18	150	26.1	32	20.0	57	320	668	91
151	21.18	150	26.5	32	20.5	58	319	669	91
152	21.19	150	25.5	31	20.0	57	318	664	91
153	21.19	150	26.2	32	20.2	57	323	676	92
154	21.19	150	26.0	31	20.6	58	328	672	94
Average			26.6	32	21.0	58	328	561	94
Std. Dev.			0.4	0	0.4	0	7	118	2
Maximum			27.5	33	22.0	59	346	676	99
Minimum			25.5	31	19.8	57	311	248	89

Total number of blows analyzed: 133

#### Sensors

Blows: 21-36; 38; 40; 42-43; 45; 47; 50-51; 64; 67-69; 72; 93; 135; 137

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4819	420.0	1.00

GRL Engineers, Inc.  
Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 22-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 20.0 feet  
OP: AK

Boring No. B105A  
Date: 18-October-2017

Blows: 37; 39; 41; 44; 46; 48-49; 52-63; 65-66; 70-71; 73-92; 94-134; 136; 138-154

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4819	420.0	off

#### Time Summary

Drive 2 minutes 38 seconds 10:43 AM - 10:45 AM BN 1 - 154



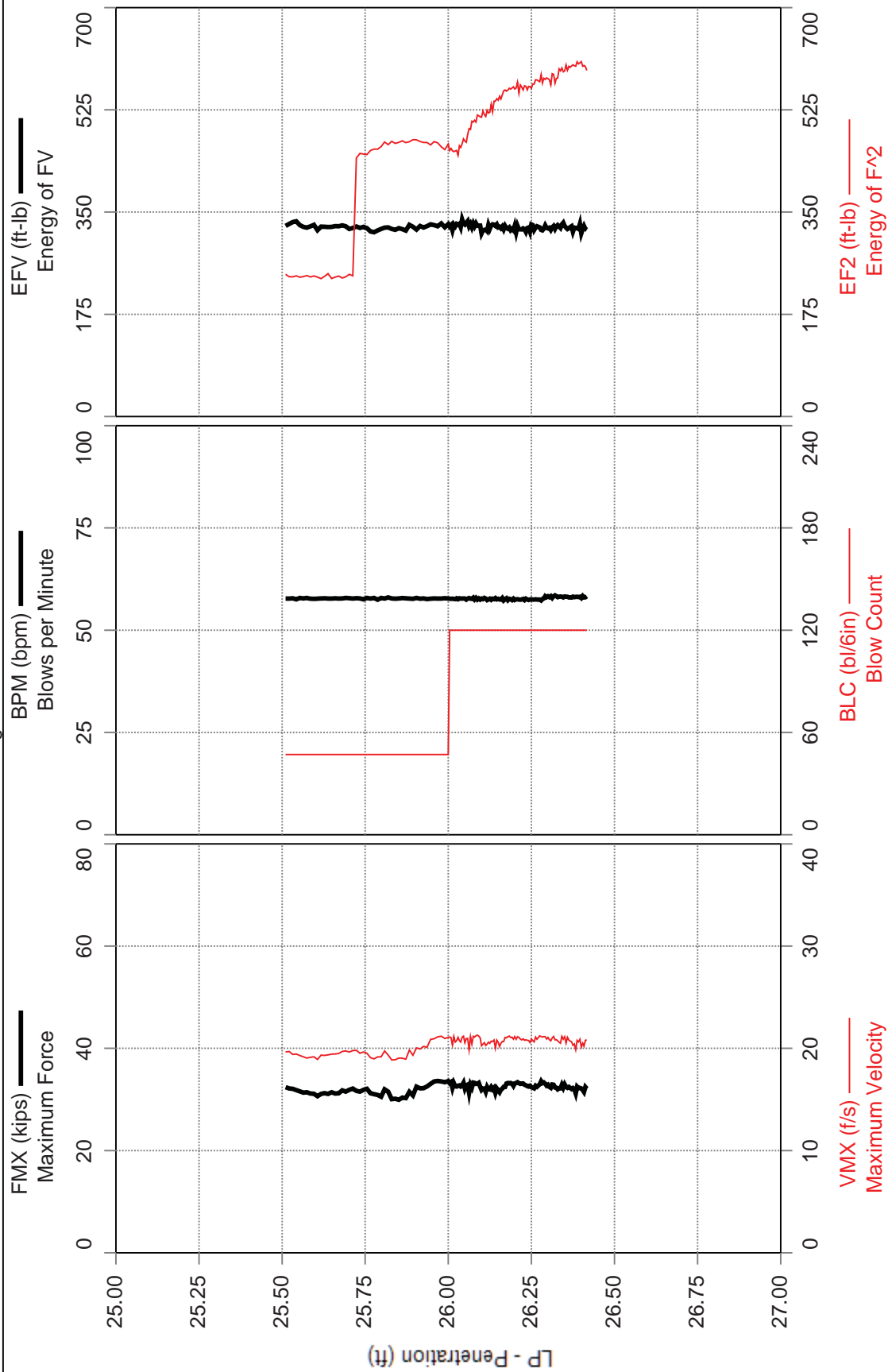
GRL Engineers, Inc. - PDIPLOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 22-October-2017

Test started: 18-October-2017

CME 75 Serial Number 224607 - Rig Number 62 at 25.0 feet

Boring No. B105A



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Case Method & iCAP® Results

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CME 75 Serial Number 224607 - Rig Number 62 at 25.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 28.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
33	25.51	47	26.8	32	19.6	58	326	244	93
34	25.52	47	26.6	32	19.7	58	330	239	94
35	25.53	47	26.5	32	19.4	58	333	239	95
36	25.54	47	26.3	32	19.4	58	334	241	95
37	25.55	47	26.1	32	19.3	58	328	238	94
38	25.56	47	25.9	31	19.2	58	325	240	93
39	25.57	47	26.0	31	19.1	58	323	241	92
40	25.59	47	25.7	31	19.1	58	326	239	93
41	25.60	47	25.7	31	19.2	58	328	241	94
42	25.61	47	25.3	31	18.9	58	319	239	91
43	25.62	47	25.7	31	19.3	58	325	236	93
44	25.63	47	25.8	31	19.3	58	325	240	93
45	25.64	47	25.7	31	19.4	58	324	245	93
46	25.65	47	26.0	31	19.4	58	325	236	93
47	25.66	47	25.7	31	19.4	58	326	239	93
48	25.67	47	25.8	31	19.5	58	326	240	93
49	25.68	47	26.3	32	19.7	58	327	237	93
50	25.69	47	26.1	32	19.7	58	326	239	93
51	25.70	47	26.4	32	19.6	58	321	243	92
52	25.71	47	26.6	32	19.8	58	323	241	92
53	25.72	47	26.2	32	19.8	58	325	443	93
54	25.73	47	26.1	32	19.5	58	323	450	92
55	25.74	47	26.3	32	19.6	58	325	449	93
56	25.76	47	26.5	32	19.5	58	322	448	92
57	25.77	47	25.8	31	19.1	58	317	455	90
58	25.78	47	25.6	31	19.0	58	315	458	90
59	25.79	47	25.5	31	19.2	57	319	457	91
60	25.80	47	25.2	31	19.2	58	321	462	92
61	25.81	47	26.4	32	19.7	58	323	470	92
62	25.82	47	26.1	32	19.4	58	324	465	92
63	25.83	47	24.8	30	18.9	58	321	471	92
64	25.84	47	24.9	30	18.9	58	320	468	91
65	25.85	47	24.7	30	19.1	58	322	469	92
66	25.86	47	25.1	30	19.0	58	321	472	92
67	25.87	47	25.0	30	18.9	58	318	469	91
68	25.88	47	26.0	31	19.8	58	328	470	94
69	25.89	47	25.4	31	19.3	58	325	474	93
70	25.90	47	26.9	32	20.0	58	320	474	91
71	25.91	47	26.6	32	19.9	58	326	471	93
72	25.93	47	26.6	32	20.2	58	323	469	92
73	25.94	47	26.9	33	20.1	58	326	469	93
74	25.95	47	27.3	33	20.9	58	329	465	94
75	25.96	47	27.7	34	20.9	58	328	471	94
76	25.97	47	27.8	34	21.1	58	326	468	93
77	25.98	47	27.7	34	21.2	58	330	462	94
78	25.99	47	27.6	33	21.0	58	324	457	93



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Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
79	26.00	47	27.8	34	21.1	58	329	466	94
80	26.00	120	27.4	33	21.1	58	325	455	93
81	26.01	120	27.6	33	21.0	58	328	459	94
82	26.01	120	26.7	32	20.3	58	319	455	91
83	26.02	120	27.4	33	21.2	58	328	453	94
84	26.02	120	26.9	33	20.6	58	325	455	93
85	26.03	120	26.9	33	20.7	58	330	455	94
86	26.03	120	27.0	33	21.1	58	328	447	94
87	26.03	120	27.1	33	20.7	58	330	463	94
88	26.04	120	26.9	33	20.6	58	324	461	93
89	26.04	120	27.1	33	21.1	58	337	467	96
90	26.05	120	27.5	33	21.2	58	330	475	94
91	26.05	120	26.5	32	20.6	58	329	471	94
92	26.05	120	27.1	33	21.0	57	332	470	95
93	26.06	120	27.2	33	21.0	58	335	483	96
94	26.06	120	25.9	31	19.9	58	326	493	93
95	26.07	120	27.2	33	21.1	58	330	492	94
96	26.07	120	26.7	32	20.4	58	324	505	93
97	26.08	120	27.5	33	21.2	58	331	504	94
98	26.08	120	27.5	33	21.1	58	326	507	93
99	26.08	120	27.3	33	21.2	58	331	504	94
100	26.09	120	27.3	33	21.3	57	327	516	93
101	26.09	120	27.5	33	21.2	58	327	515	93
102	26.10	120	26.9	33	21.0	57	327	513	93
103	26.10	120	26.3	32	20.3	58	313	512	90
104	26.10	120	26.5	32	20.4	58	319	523	91
105	26.11	120	26.5	32	20.5	58	319	517	91
106	26.11	120	26.0	31	20.3	58	320	514	91
107	26.12	120	26.8	32	20.4	57	318	524	91
108	26.12	120	26.5	32	20.6	58	328	519	94
109	26.13	120	26.4	32	20.5	58	321	521	92
110	26.13	120	26.8	32	20.7	57	327	534	94
111	26.13	120	26.4	32	20.7	58	329	522	94
112	26.14	120	26.7	32	20.8	58	328	540	94
113	26.14	120	25.9	31	20.0	58	326	540	93
114	26.15	120	26.6	32	20.8	58	329	544	94
115	26.15	120	26.3	32	20.6	58	324	541	93
116	26.15	120	26.0	31	20.2	58	325	548	93
117	26.16	120	26.4	32	20.5	57	322	543	92
118	26.16	120	26.5	32	20.7	58	325	550	93
119	26.17	120	26.8	32	20.7	57	320	557	92
120	26.17	120	26.8	32	21.1	58	326	559	93
121	26.18	120	27.4	33	21.0	58	323	557	92
122	26.18	120	27.4	33	21.1	57	321	559	92
123	26.18	120	27.4	33	21.2	58	324	562	92
124	26.19	120	27.5	33	21.1	58	319	560	91
125	26.19	120	27.3	33	21.1	57	321	562	92
126	26.20	120	27.0	33	20.9	58	319	564	91
127	26.20	120	27.4	33	21.2	57	326	561	93
128	26.20	120	27.4	33	20.9	58	315	562	90
129	26.21	120	27.6	33	21.1	58	326	572	93
130	26.21	120	27.4	33	21.1	57	320	554	92
131	26.22	120	27.3	33	20.9	57	320	568	92

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Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
132	26.22	120	27.4	33	20.8	58	320	564	92
133	26.23	120	27.4	33	20.9	58	322	559	92
134	26.23	120	27.2	33	20.8	57	320	566	92
135	26.23	120	27.1	33	20.8	58	316	565	90
136	26.24	120	26.9	33	20.8	58	323	559	92
137	26.24	120	26.9	33	20.8	57	324	565	92
138	26.25	120	27.0	33	20.6	58	317	564	90
139	26.25	120	26.8	32	20.9	58	329	562	94
140	26.25	120	26.7	32	20.8	57	328	569	94
141	26.26	120	26.6	32	20.6	57	319	569	91
142	26.26	120	27.0	33	21.1	58	323	576	92
143	26.27	120	26.8	32	20.9	57	326	576	93
145	26.28	120	27.3	33	21.2	57	324	573	92
146	26.28	120	27.7	34	21.1	57	319	585	91
147	26.28	120	27.4	33	21.1	58	319	571	91
148	26.29	120	27.5	33	21.1	58	322	579	92
149	26.29	120	27.3	33	21.1	58	327	577	93
150	26.30	120	27.0	33	20.9	58	323	580	92
151	26.30	120	27.2	33	21.1	58	322	578	92
152	26.30	120	26.8	32	20.8	58	323	576	92
153	26.31	120	26.7	32	20.7	58	319	568	91
154	26.31	120	27.2	33	21.0	58	324	587	93
155	26.32	120	27.2	33	21.2	58	326	586	93
156	26.32	120	26.7	32	20.8	59	321	571	92
157	26.33	120	26.7	32	20.8	58	325	578	93
158	26.33	120	26.4	32	20.7	58	328	579	94
159	26.33	120	26.6	32	20.6	58	325	595	93
160	26.34	120	26.6	32	20.5	58	323	592	92
161	26.34	120	27.2	33	21.2	58	329	597	94
162	26.35	120	26.7	32	20.9	58	332	590	95
163	26.35	120	27.2	33	21.1	58	326	592	93
164	26.35	120	26.8	32	20.5	58	323	602	92
165	26.36	120	26.7	32	21.1	58	321	593	92
166	26.36	120	26.8	32	20.8	58	322	599	92
167	26.37	120	26.7	32	20.7	58	324	598	93
168	26.37	120	26.5	32	20.7	58	326	600	93
169	26.38	120	26.6	32	20.3	58	316	602	90
170	26.38	120	26.4	32	20.4	58	323	600	92
171	26.38	120	25.8	31	19.9	58	323	600	92
172	26.39	120	26.9	32	20.8	58	322	607	92
173	26.39	120	26.6	32	20.6	58	321	604	92
174	26.40	120	26.7	32	20.9	58	330	606	94
175	26.40	120	26.6	32	20.1	58	314	607	90
176	26.40	120	26.3	32	20.5	58	321	600	92
177	26.41	120	26.0	31	20.2	58	326	601	93
178	26.41	120	26.8	32	20.8	58	321	599	92
179	26.42	120	26.5	32	20.8	58	319	593	91
Average			26.7	32	20.4	58	324	490	93
Std. Dev.			0.7	1	0.7	0	4	111	1
Maximum			27.8	34	21.3	59	337	607	96
Minimum			24.7	30	18.9	57	313	236	90

Total number of blows analyzed: 146

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#### Sensors

Blows: 33-179

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

#### Time Summary

Drive 3 minutes 9 seconds 11:00 AM - 11:03 AM BN 1 - 179

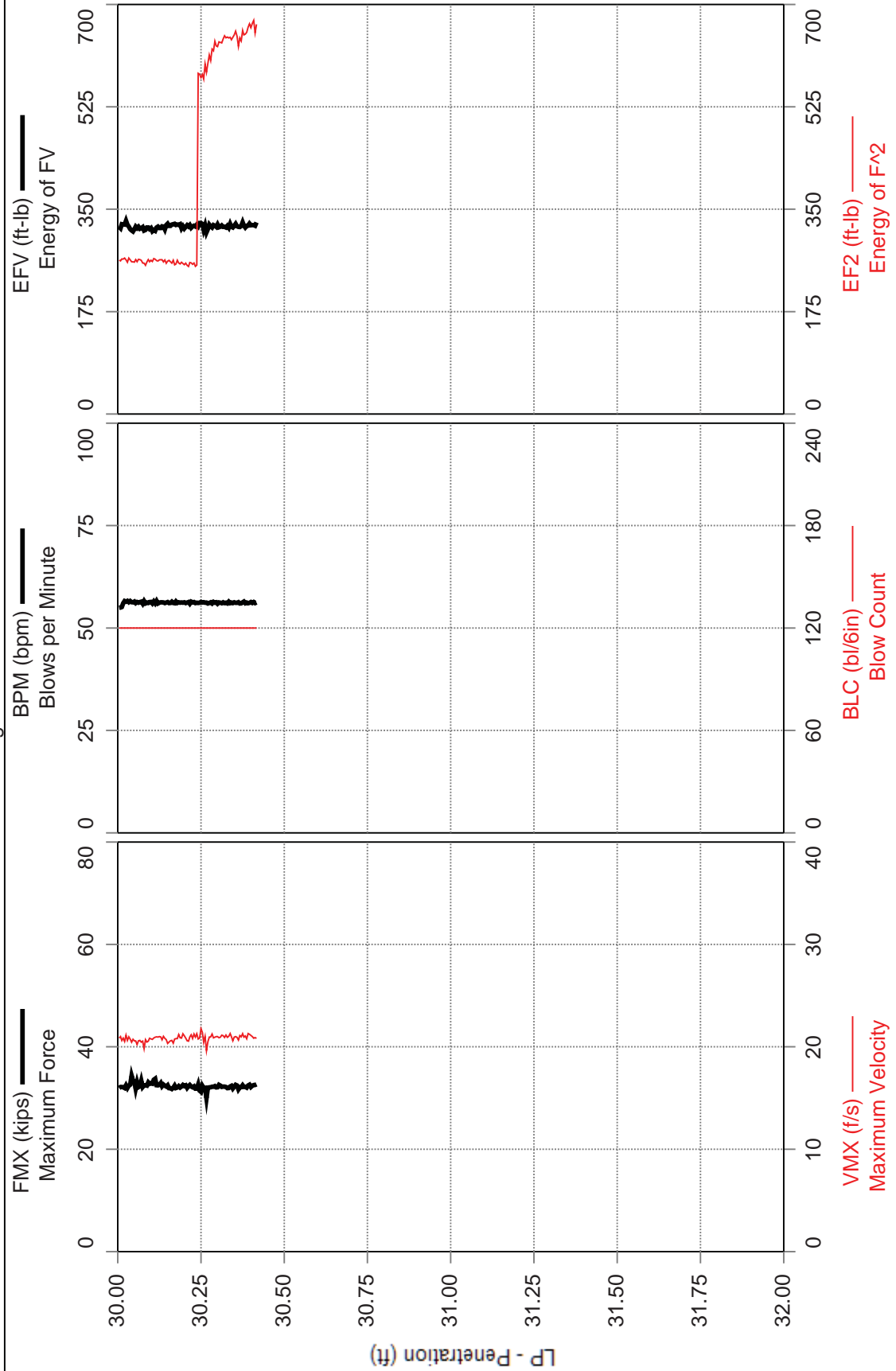


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CME 75 Serial Number 224607 - Rig Number 62 at 30.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 33.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
1	30.00	120	26.4	32	20.9	55	320	263	91
2	30.01	120	26.6	32	21.0	55	317	262	91
3	30.01	120	26.6	32	20.6	55	324	265	93
4	30.02	120	26.5	32	20.8	56	324	265	93
5	30.02	120	26.4	32	20.5	57	324	266	92
6	30.03	120	26.8	32	21.1	56	330	264	94
7	30.03	120	26.4	32	20.6	57	323	259	92
8	30.03	120	26.8	32	21.0	56	320	266	91
9	30.04	120	26.9	33	20.7	57	316	264	90
10	30.04	120	28.4	34	20.5	56	314	260	90
11	30.05	120	27.6	33	20.7	56	312	260	89
12	30.05	120	27.4	33	20.6	56	316	260	90
13	30.05	120	26.3	32	20.6	56	320	264	92
14	30.06	120	27.3	33	20.2	56	318	260	91
15	30.06	120	26.5	32	20.6	56	320	264	91
16	30.07	120	26.7	32	20.6	56	317	264	90
17	30.07	120	27.6	33	20.5	56	318	263	91
18	30.08	120	26.6	32	20.5	56	319	258	91
19	30.08	120	26.8	32	19.8	57	314	258	90
20	30.08	120	26.9	33	20.7	56	315	254	90
21	30.09	120	26.8	32	20.5	56	319	260	91
22	30.09	120	27.3	33	20.5	56	319	264	91
23	30.10	120	27.1	33	20.8	56	316	260	90
24	30.10	120	27.2	33	20.8	56	318	263	91
25	30.10	120	27.1	33	20.7	56	312	261	89
26	30.11	120	27.7	34	20.9	56	315	266	90
27	30.11	120	27.9	34	20.9	56	313	265	89
28	30.12	120	26.9	32	21.0	57	319	262	91
29	30.12	120	26.8	32	21.0	56	320	262	91
30	30.13	120	26.9	33	21.0	56	318	263	91
31	30.13	120	27.2	33	21.0	56	318	264	91
32	30.13	120	26.7	32	20.7	56	321	264	92
33	30.14	120	27.0	33	21.0	56	320	260	91
34	30.14	120	26.8	32	20.8	56	315	263	90
35	30.15	120	26.7	32	20.7	56	323	258	92
36	30.15	120	26.8	32	20.3	56	325	261	93
37	30.15	120	26.4	32	20.5	56	322	263	92
38	30.16	120	26.4	32	20.6	56	322	260	92
39	30.16	120	26.2	32	20.6	56	324	258	92
40	30.17	120	26.4	32	20.4	56	324	263	93
41	30.17	120	26.8	32	20.8	56	325	255	93
42	30.18	120	26.4	32	20.8	56	323	256	92
43	30.18	120	26.5	32	20.8	56	324	263	92
44	30.18	120	26.7	32	21.2	56	323	258	92
45	30.19	120	26.5	32	20.9	56	324	257	93
46	30.19	120	26.7	32	20.9	56	317	259	91

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BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
47	30.20	120	26.9	33	21.3	56	321	257	92
48	30.20	120	26.7	32	21.1	56	317	255	91
49	30.20	120	26.8	32	20.8	56	320	258	91
50	30.21	120	26.4	32	20.6	56	323	254	92
51	30.21	120	26.7	32	20.5	56	321	252	92
52	30.22	120	26.9	33	21.0	56	323	259	92
53	30.22	120	26.6	32	21.2	56	318	258	91
54	30.23	120	26.5	32	20.8	56	321	256	92
55	30.23	120	26.7	32	21.3	56	322	258	92
56	30.23	120	26.3	32	20.9	56	321	252	92
57	30.24	120	26.3	32	21.3	56	323	254	92
58	30.24	120	27.0	33	20.8	56	321	582	92
59	30.25	120	26.0	31	20.8	56	326	581	93
60	30.25	120	25.8	31	21.8	56	326	575	93
61	30.25	120	26.8	32	21.4	56	325	580	93
62	30.26	120	26.4	32	20.4	56	315	573	90
63	30.26	120	26.4	32	21.0	56	322	598	92
64	30.27	120	24.8	30	19.6	56	310	584	89
65	30.27	120	26.4	32	20.5	56	316	599	90
66	30.28	120	26.5	32	21.0	56	324	613	93
67	30.28	120	26.5	32	21.0	56	321	604	92
68	30.28	120	26.6	32	21.2	56	319	623	91
69	30.29	120	26.6	32	20.9	56	323	621	92
70	30.29	120	26.7	32	20.9	56	322	637	92
71	30.30	120	26.5	32	21.0	56	320	629	91
72	30.30	120	26.5	32	21.0	56	324	628	93
73	30.30	120	26.9	33	20.9	56	319	636	91
74	30.31	120	26.8	32	20.9	56	320	635	91
75	30.31	120	26.6	32	21.1	56	322	634	92
76	30.32	120	26.6	32	21.1	56	320	641	91
77	30.32	120	26.6	32	20.9	56	320	646	91
78	30.33	120	26.6	32	21.1	56	319	643	91
79	30.33	120	26.4	32	20.9	56	321	644	92
80	30.33	120	26.4	32	21.0	56	318	643	91
81	30.34	120	26.7	32	21.3	56	325	644	93
82	30.34	120	26.8	32	21.0	56	320	640	91
83	30.35	120	26.3	32	20.6	56	319	644	91
84	30.35	120	26.6	32	20.9	56	322	648	92
85	30.35	120	26.9	33	21.0	56	325	654	93
86	30.36	120	26.8	32	20.9	56	321	646	92
87	30.36	120	26.2	32	20.7	56	320	628	91
88	30.37	120	26.5	32	21.1	56	320	643	91
89	30.37	120	26.5	32	21.0	56	321	638	92
90	30.38	120	26.9	33	21.3	56	328	655	94
91	30.38	120	26.6	32	20.9	56	322	648	92
92	30.38	120	26.6	32	21.1	56	319	649	91
93	30.39	120	26.5	32	20.8	56	322	652	92
94	30.39	120	26.8	32	21.3	56	322	661	92
95	30.40	120	26.9	33	21.2	56	326	667	93
96	30.40	120	26.6	32	21.1	56	323	660	92
97	30.40	120	26.8	32	21.0	56	323	668	92
98	30.41	120	26.9	33	20.8	56	323	673	92
99	30.41	120	26.9	33	20.9	56	322	651	92

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CME 75 Serial Number 224607 - Rig Number 62 at 30.0 feet

Boring No. B105A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
100	30.42	120	27.0	33	20.8	56	327	666	94
		Average	26.7	32	20.8	56	320	420	92
		Std. Dev.	0.4	1	0.3	0	4	185	1
		Maximum	28.4	34	21.8	57	330	673	94
		Minimum	24.8	30	19.6	55	310	252	89
Total number of blows analyzed: 100									

#### Sensors

Blows: 1-100

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

#### Time Summary

Drive 1 minute 45 seconds 11:19 AM - 11:21 AM BN 1 - 100

Rig Number 118





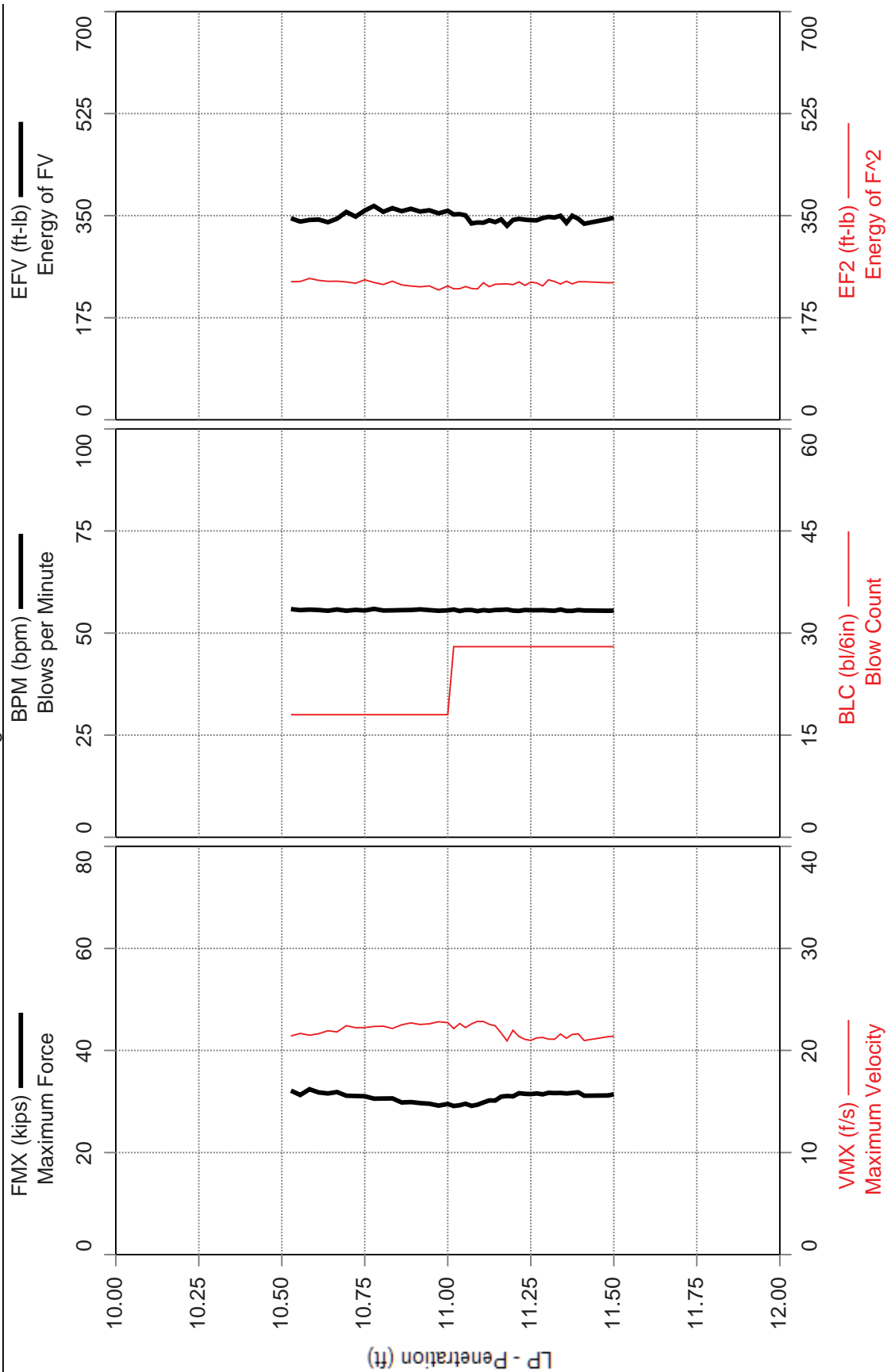
GRL Engineers, Inc. - PDIPILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 23-October-2017

Test started: 18-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 10.0 feet

Boring No. B101A



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Case Method & iCAP® Results

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CME 85 Serial Number 381236 - Rig Number 118 at 10.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 13.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
15	10.53	18	26.5	32	21.4	56	345	237	99
16	10.56	18	25.9	31	21.7	56	340	237	97
17	10.58	18	26.8	32	21.5	56	343	242	98
18	10.61	18	26.3	32	21.6	56	343	239	98
19	10.64	18	26.1	32	21.9	55	339	237	97
20	10.67	18	26.3	32	21.8	56	345	238	99
21	10.69	18	25.7	31	22.4	55	356	236	102
22	10.72	18	25.7	31	22.2	56	348	234	100
23	10.75	18	25.6	31	22.2	56	359	240	103
24	10.78	18	25.3	31	22.4	56	367	235	105
25	10.81	18	25.3	31	22.4	56	357	232	102
26	10.83	18	25.3	31	22.2	56	363	238	104
27	10.86	18	24.6	30	22.5	56	358	231	102
28	10.89	18	24.7	30	22.7	56	362	229	103
29	10.92	18	24.5	30	22.5	56	357	228	102
30	10.94	18	24.4	30	22.6	56	359	229	103
31	10.97	18	24.1	29	22.8	55	354	223	101
32	11.00	18	24.4	30	22.7	56	358	229	102
33	11.02	28	24.1	29	22.1	56	352	225	101
34	11.04	28	24.2	29	22.6	55	353	225	101
35	11.05	28	24.4	30	22.2	56	351	229	100
36	11.07	28	24.1	29	22.6	56	337	225	96
37	11.09	28	24.3	29	22.8	55	338	224	97
38	11.11	28	24.6	30	22.8	56	338	235	97
39	11.13	28	25.0	30	22.6	55	342	228	98
40	11.14	28	24.9	30	22.4	56	339	232	97
41	11.16	28	25.6	31	21.7	56	343	233	98
42	11.18	28	25.7	31	20.9	56	333	233	95
43	11.20	28	25.6	31	22.0	56	343	232	98
44	11.21	28	26.1	32	21.4	55	344	236	98
45	11.23	28	26.0	31	21.1	56	343	230	98
46	11.25	28	26.0	31	21.0	56	342	236	98
47	11.27	28	26.1	32	21.2	56	342	235	98
48	11.29	28	26.0	31	21.3	56	346	230	99
49	11.30	28	26.2	32	21.1	56	348	240	99
50	11.32	28	26.2	32	21.1	55	347	237	99
51	11.34	28	26.2	32	21.6	56	350	233	100
52	11.36	28	26.1	32	21.2	55	338	238	96
53	11.38	28	26.2	32	21.6	55	350	233	100
54	11.39	28	26.3	32	21.6	56	345	237	98
55	11.41	28	25.7	31	21.0	56	336	237	96
59	11.48	28	25.8	31	21.3	55	344	235	98
60	11.50	28	25.9	31	21.4	56	347	235	99
Average			25.5	31	21.9	56	347	233	99
Std. Dev.			0.8	1	0.6	0	8	5	2
Maximum			26.8	32	22.8	56	367	242	105

GRL Engineers, Inc.  
Case Method & iCAP® Results

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CME 85 Serial Number 381236 - Rig Number 118 at 10.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in Minimum	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
			24.1	29	20.9	55	333	223	95

Total number of blows analyzed: 43

#### Sensors

Blows: 15; 17-53; 55-60

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

Blows: 16; 54

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	off

#### Time Summary

Drive 1 minute 3 seconds 1:33 PM - 1:34 PM BN 1 - 60



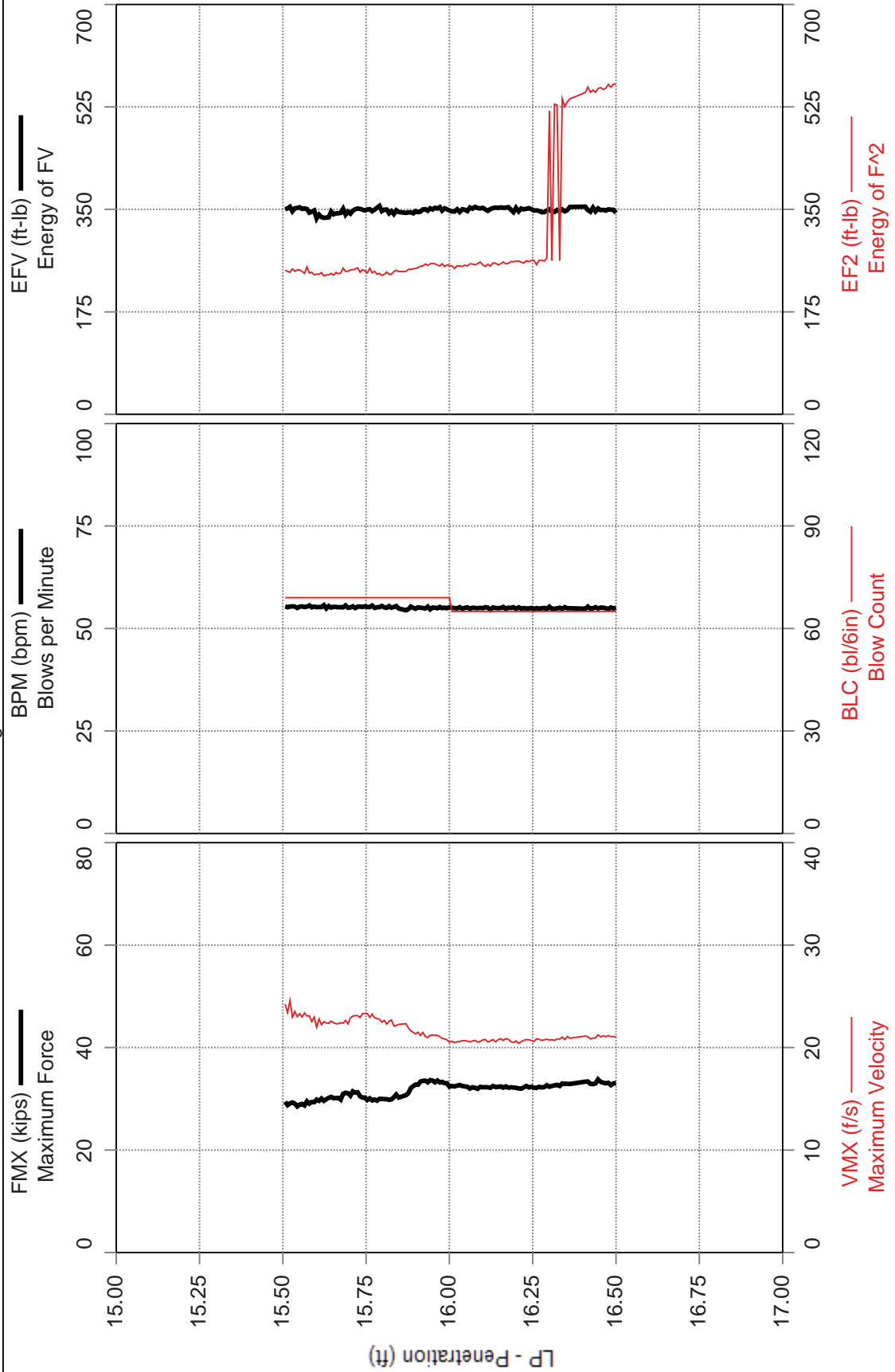
GRL Engineers, Inc. - PDIPILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 23-October-2017

Test started: 18-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 15.0 feet

Boring No. B101A



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Case Method & iCAP® Results

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PDILOT2 2016.1.56.5 - Printed 23-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 15.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 18.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
32	15.51	69	24.3	29	24.2	55	350	246	100
33	15.51	69	23.8	29	23.4	55	352	244	100
34	15.52	69	24.0	29	24.6	55	354	243	101
35	15.53	69	24.2	29	23.0	55	347	248	99
36	15.54	69	24.0	29	23.5	55	352	244	101
37	15.54	69	23.6	29	23.0	55	352	247	101
38	15.55	69	23.8	29	23.3	55	353	247	101
39	15.56	69	24.0	29	23.0	55	351	244	100
40	15.57	69	23.7	29	23.4	55	352	241	100
41	15.57	69	24.4	30	23.1	55	350	252	100
42	15.58	69	24.0	29	23.1	56	344	241	98
43	15.59	69	24.3	29	22.5	55	346	242	99
44	15.59	69	24.3	29	23.0	55	348	238	99
45	15.60	69	24.6	30	22.0	55	334	240	96
46	15.61	69	24.5	30	22.8	55	341	239	97
47	15.62	69	24.8	30	22.2	55	337	242	96
48	15.62	69	24.5	30	22.5	56	336	237	96
49	15.63	69	24.7	30	22.4	55	336	238	96
50	15.64	69	25.0	30	22.4	55	336	238	96
51	15.64	69	25.1	30	22.6	55	346	241	99
52	15.65	69	24.9	30	22.4	55	342	238	98
53	15.66	69	24.9	30	22.3	55	343	242	98
54	15.67	69	25.0	30	22.3	55	343	240	98
55	15.67	69	24.7	30	22.4	55	344	241	98
56	15.68	69	25.6	31	22.4	55	351	250	100
57	15.69	69	25.8	31	22.7	56	341	244	97
58	15.70	69	25.7	31	22.3	55	346	244	99
59	15.70	69	25.3	31	22.9	55	343	246	98
60	15.71	69	26.0	31	23.1	55	348	247	99
61	15.72	69	25.8	31	23.1	55	350	248	100
62	15.72	69	25.9	31	23.1	55	351	250	100
63	15.73	69	25.2	30	22.9	55	351	243	100
64	15.74	69	25.0	30	23.3	55	350	247	100
65	15.75	69	25.0	30	23.3	55	348	245	99
66	15.75	69	24.6	30	23.3	55	350	241	100
67	15.76	69	24.9	30	22.9	55	350	250	100
68	15.77	69	24.5	30	23.3	56	347	242	99
69	15.78	69	24.7	30	22.9	55	349	244	100
70	15.78	69	24.5	30	22.8	55	353	239	101
71	15.79	69	24.8	30	22.8	55	356	241	102
72	15.80	69	24.8	30	22.5	56	347	237	99
73	15.80	69	24.7	30	22.7	55	349	239	100
74	15.81	69	24.7	30	22.3	55	350	243	100
75	15.82	69	24.6	30	22.6	55	343	239	98
76	15.83	69	24.7	30	22.7	55	347	239	99
77	15.83	69	25.0	30	22.1	55	342	244	98

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Case Method & iCAP® Results

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CME 85 Serial Number 381236 - Rig Number 118 at 15.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
78	15.84	69	25.5	31	22.1	55	348	246	100
79	15.85	69	25.0	30	22.3	55	346	244	99
82	15.87	69	25.4	31	22.3	54	344	244	98
83	15.88	69	25.7	31	21.9	55	345	247	99
84	15.88	69	26.5	32	21.6	55	345	248	99
85	15.89	69	26.8	32	21.5	55	343	248	98
86	15.90	69	27.1	33	21.3	55	347	249	99
87	15.91	69	27.1	33	21.5	55	345	250	99
88	15.91	69	27.6	33	21.2	55	346	253	99
89	15.92	69	27.7	33	21.5	55	350	253	100
90	15.93	69	27.7	34	21.1	55	350	257	100
91	15.93	69	27.5	33	21.0	55	348	254	99
92	15.94	69	27.8	34	21.2	55	352	257	101
93	15.95	69	27.7	34	21.2	55	350	258	100
94	15.96	69	27.5	33	21.2	55	353	257	101
95	15.96	69	27.7	34	21.2	55	351	255	100
96	15.97	69	27.4	33	21.1	55	354	253	101
97	15.98	69	27.5	33	20.9	55	348	257	99
98	15.99	69	27.3	33	20.8	55	352	252	101
99	15.99	69	27.3	33	20.8	55	350	255	100
100	16.00	69	26.7	32	20.5	55	348	254	99
101	16.01	65	26.9	32	20.6	55	346	253	99
102	16.02	65	26.8	32	20.5	55	346	249	99
103	16.02	65	26.9	33	20.6	55	350	254	100
104	16.03	65	27.0	33	20.6	55	345	253	99
105	16.04	65	26.9	32	20.7	55	350	253	100
106	16.05	65	26.8	32	20.7	55	349	255	100
107	16.05	65	26.7	32	20.6	55	347	253	99
108	16.06	65	26.4	32	20.6	55	353	257	101
109	16.07	65	26.7	32	20.6	55	351	257	100
110	16.08	65	26.6	32	20.7	55	354	255	101
111	16.08	65	26.4	32	20.5	55	352	257	101
112	16.09	65	26.7	32	20.6	55	352	260	100
113	16.10	65	26.6	32	20.8	55	353	255	101
114	16.11	65	26.7	32	20.8	55	350	253	100
115	16.12	65	26.6	32	20.6	55	347	256	99
116	16.12	65	26.6	32	20.6	55	350	253	100
117	16.13	65	26.9	33	20.8	55	352	259	101
118	16.14	65	26.7	32	20.6	55	353	258	101
119	16.15	65	26.7	32	20.8	55	352	255	101
120	16.15	65	26.8	32	20.9	55	353	257	101
121	16.16	65	26.6	32	20.7	55	353	260	101
122	16.17	65	26.8	32	20.9	55	353	257	101
123	16.18	65	26.6	32	20.8	55	354	258	101
124	16.18	65	26.6	32	20.6	55	349	261	100
125	16.19	65	26.6	32	20.5	55	345	261	99
126	16.20	65	26.6	32	20.6	55	353	261	101
127	16.21	65	26.5	32	20.4	55	347	262	99
128	16.22	65	26.4	32	20.6	55	351	260	100
129	16.22	65	26.6	32	20.7	55	350	258	100
130	16.23	65	26.9	33	20.8	55	351	262	100
131	16.24	65	26.6	32	20.8	55	352	261	101
132	16.25	65	26.7	32	20.7	55	350	263	100

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Case Method & iCAP® Results

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CME 85 Serial Number 381236 - Rig Number 118 at 15.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
133	16.25	65	26.6	32	20.6	55	348	263	99
134	16.26	65	26.6	32	20.9	55	348	255	99
135	16.27	65	26.7	32	20.8	55	347	263	99
136	16.28	65	26.6	32	20.7	55	345	263	99
137	16.28	65	26.7	32	20.8	55	345	262	99
138	16.29	65	27.0	33	20.8	55	348	267	99
139	16.30	65	26.7	32	20.7	55	350	518	100
140	16.31	65	26.9	33	20.8	55	346	263	99
141	16.32	65	27.0	33	20.7	55	345	529	99
142	16.32	65	27.0	33	20.9	55	349	528	100
143	16.33	65	26.9	32	20.8	55	347	263	99
144	16.34	65	27.3	33	21.0	55	350	539	100
145	16.35	65	27.2	33	20.8	55	347	526	99
146	16.35	65	27.2	33	21.1	55	349	534	100
147	16.36	65	27.2	33	20.9	55	354	539	101
153	16.41	65	27.6	33	21.1	55	355	549	101
154	16.42	65	27.6	33	21.1	55	349	559	100
155	16.42	65	27.2	33	20.9	55	346	550	99
156	16.43	65	27.2	33	20.9	55	353	554	101
157	16.44	65	27.3	33	20.9	55	346	550	99
158	16.45	65	27.9	34	21.2	55	352	556	100
159	16.45	65	27.5	33	21.0	55	349	558	100
160	16.46	65	27.4	33	21.1	55	349	555	100
161	16.47	65	27.3	33	21.1	55	348	557	99
162	16.48	65	27.4	33	21.2	55	350	563	100
163	16.48	65	27.0	33	21.1	55	350	559	100
164	16.49	65	27.3	33	21.1	55	349	564	100
165	16.50	65	27.3	33	21.0	55	344	564	98
Average			26.1	32	21.6	55	348	297	100
Std. Dev.			1.2	1	1.0	0	4	109	1
Maximum			27.9	34	24.6	56	356	564	102
Minimum			23.6	29	20.4	54	334	237	96

Total number of blows analyzed: 127

#### Sensors

Blows: 32-165

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

#### Time Summary

Drive 3 minutes 22 seconds 1:50 PM - 1:53 PM BN 1 - 165



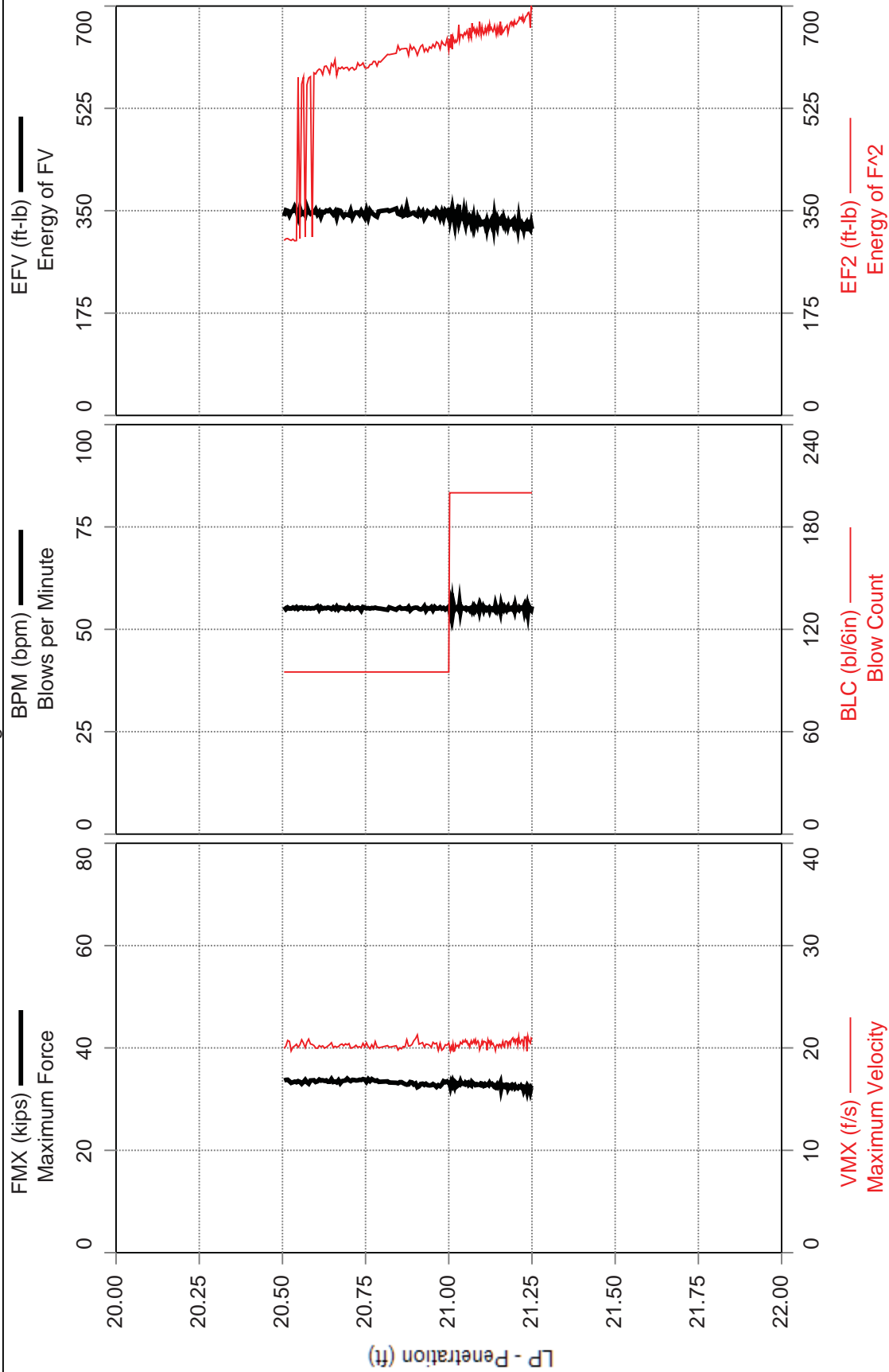
GRL Engineers, Inc. - PDIPILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 23-October-2017

Test started: 18-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet

Boring No. B101A





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Case Method & iCAP® Results

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CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 23.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
36	20.51	95	27.8	34	20.0	56	341	299	97
37	20.51	95	27.9	34	20.2	55	351	302	100
38	20.52	95	27.9	34	20.7	55	350	302	100
39	20.52	95	27.7	33	20.6	55	342	301	98
40	20.53	95	27.4	33	19.7	55	349	299	100
41	20.53	95	27.5	33	20.1	55	349	301	100
42	20.54	95	27.6	33	20.2	55	357	298	102
43	20.54	95	27.5	33	20.4	55	351	299	100
44	20.55	95	27.7	34	20.0	55	340	578	97
45	20.55	95	27.6	33	20.3	55	354	302	101
46	20.56	95	27.3	33	20.8	55	344	566	98
47	20.56	95	27.6	33	20.5	55	347	578	99
48	20.57	95	27.9	34	20.0	55	342	305	98
49	20.57	95	27.5	33	20.6	55	356	565	102
50	20.58	95	27.3	33	20.9	55	348	577	99
51	20.58	95	27.8	34	20.4	55	345	579	99
52	20.59	95	27.8	34	20.3	55	347	305	99
53	20.59	95	27.8	34	20.2	55	347	586	99
54	20.60	95	27.6	33	20.0	55	352	584	101
55	20.61	95	27.7	33	20.0	56	344	589	98
56	20.61	95	27.9	34	20.2	55	348	592	99
57	20.62	95	27.8	34	20.1	55	340	590	97
58	20.62	95	27.8	34	20.2	55	348	583	99
59	20.63	95	27.7	34	20.0	55	347	597	99
60	20.63	95	27.8	34	20.1	55	350	597	100
61	20.64	95	27.6	33	20.2	55	349	592	100
62	20.64	95	27.6	33	20.3	55	351	585	100
63	20.65	95	28.0	34	20.5	55	348	601	99
64	20.65	95	27.6	33	20.0	55	344	597	98
65	20.66	95	27.6	33	20.2	55	348	608	100
66	20.66	95	27.5	33	20.1	56	338	581	97
67	20.67	95	27.8	34	20.1	55	351	594	100
68	20.67	95	27.3	33	20.3	55	350	593	100
69	20.68	95	27.7	34	20.4	55	344	596	98
70	20.68	95	27.8	34	20.2	55	340	593	97
71	20.69	95	27.8	34	20.4	55	344	595	98
72	20.69	95	28.1	34	20.3	55	343	595	98
73	20.70	95	27.9	34	20.4	56	342	590	98
74	20.71	95	27.7	34	20.0	55	350	594	100
75	20.71	95	27.9	34	20.0	55	339	595	97
76	20.72	95	27.9	34	20.1	55	345	591	99
77	20.72	95	27.8	34	20.3	55	347	592	99
78	20.73	95	27.8	34	20.1	55	347	603	99
79	20.73	95	27.9	34	20.1	55	343	598	98
80	20.74	95	27.9	34	20.0	55	350	599	100
81	20.74	95	28.0	34	20.5	55	344	603	98

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CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
82	20.75	95	27.9	34	20.1	55	339	595	97
83	20.75	95	27.6	33	20.5	55	350	594	100
84	20.76	95	28.0	34	20.1	55	338	595	97
85	20.76	95	27.7	34	19.9	55	351	600	100
86	20.77	95	28.0	34	20.3	55	346	600	99
87	20.77	95	27.9	34	20.0	55	344	605	98
88	20.78	95	27.7	34	20.6	55	341	605	98
89	20.78	95	27.8	34	20.1	55	340	597	97
90	20.79	95	27.6	33	20.0	55	349	605	100
91	20.79	95	27.6	33	20.1	55	349	604	100
95	20.82	95	27.7	33	20.2	55	351	617	100
96	20.82	95	27.5	33	20.1	55	349	617	100
100	20.84	95	27.4	33	20.2	55	354	619	101
101	20.85	95	27.4	33	19.8	55	345	632	99
102	20.85	95	27.5	33	20.0	55	343	624	98
103	20.86	95	27.5	33	19.9	55	351	627	100
104	20.86	95	27.4	33	20.1	55	341	627	97
105	20.87	95	27.2	33	20.1	55	343	628	98
106	20.87	95	27.1	33	20.8	55	357	627	102
107	20.88	95	27.2	33	20.2	55	343	616	98
108	20.88	95	27.6	33	20.2	55	344	633	98
109	20.89	95	27.5	33	20.3	55	346	626	99
110	20.89	95	27.2	33	20.7	55	347	630	99
111	20.90	95	27.3	33	20.9	55	343	625	98
112	20.91	95	26.7	32	21.3	55	341	616	97
113	20.91	95	26.9	32	20.4	55	349	624	100
114	20.92	95	27.2	33	20.4	55	344	631	98
115	20.92	95	27.3	33	20.5	55	348	633	100
116	20.93	95	27.1	33	20.1	56	337	622	96
117	20.93	95	27.3	33	20.4	55	342	627	98
118	20.94	95	27.0	33	20.4	55	349	622	100
119	20.94	95	27.0	33	20.3	55	346	630	99
120	20.95	95	27.1	33	20.0	55	344	628	98
121	20.95	95	27.2	33	20.6	55	347	634	99
122	20.96	95	27.1	33	20.4	55	342	629	98
123	20.96	95	26.8	32	20.5	55	352	639	101
124	20.97	95	27.0	33	19.8	55	348	636	99
125	20.97	95	26.9	33	20.5	55	338	626	97
126	20.98	95	27.2	33	19.8	55	348	640	99
127	20.98	95	27.7	33	19.9	55	337	634	96
128	20.99	95	27.5	33	20.3	55	350	632	100
129	20.99	95	27.7	33	20.3	55	347	644	99
130	21.00	95	27.4	33	20.5	56	339	625	97
131	21.00	200	27.4	33	20.0	54	355	644	101
132	21.01	200	26.8	32	19.7	56	338	628	97
133	21.01	200	27.5	33	20.1	54	346	651	99
134	21.01	200	27.1	33	19.9	56	332	626	95
135	21.01	200	27.6	33	20.4	54	347	647	99
136	21.02	200	27.3	33	19.7	56	337	641	96
137	21.02	200	26.9	33	19.7	55	352	638	101
138	21.02	200	27.5	33	20.3	55	335	641	96
139	21.02	200	27.4	33	20.1	55	346	638	99
140	21.03	200	26.9	33	20.2	55	350	640	100

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CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
141	21.03	200	27.0	33	20.3	55	342	647	98
142	21.03	200	27.3	33	20.1	55	360	667	103
143	21.03	200	27.2	33	20.3	56	334	642	95
144	21.04	200	27.6	33	20.6	54	340	651	97
145	21.04	200	27.3	33	20.5	55	338	651	96
146	21.04	200	27.4	33	20.4	55	339	650	97
147	21.04	200	27.3	33	20.7	55	337	646	96
148	21.05	200	27.3	33	20.6	55	345	651	99
149	21.05	200	27.2	33	20.6	55	333	654	95
150	21.05	200	27.4	33	20.8	55	327	651	93
151	21.05	200	27.3	33	20.6	55	339	654	97
152	21.06	200	27.4	33	20.7	55	329	658	94
153	21.06	200	27.5	33	20.3	55	331	651	95
154	21.06	200	27.1	33	20.4	55	336	645	96
155	21.06	200	27.2	33	20.1	55	340	663	97
156	21.07	200	27.1	33	20.4	55	338	651	97
157	21.07	200	27.0	33	20.7	55	329	645	94
158	21.07	200	27.6	33	20.4	55	334	671	96
159	21.07	200	27.4	33	20.5	55	326	659	93
160	21.08	200	27.3	33	20.8	55	336	662	96
161	21.08	200	27.2	33	20.5	55	327	655	93
162	21.08	200	27.0	33	20.8	55	335	659	96
163	21.08	200	27.1	33	20.4	55	333	651	95
164	21.09	200	27.2	33	20.6	55	328	660	94
165	21.09	200	27.1	33	20.7	55	336	654	96
166	21.09	200	27.1	33	20.5	56	331	651	95
167	21.09	200	27.2	33	19.8	54	334	673	95
168	21.10	200	27.1	33	20.1	56	331	660	94
169	21.10	200	27.3	33	20.3	55	327	650	93
170	21.10	200	27.3	33	20.7	55	328	664	94
171	21.10	200	27.1	33	20.4	55	327	657	94
172	21.11	200	26.9	33	20.7	55	331	652	95
173	21.11	200	27.0	33	20.6	55	332	656	95
174	21.11	200	27.2	33	20.6	55	326	663	93
175	21.11	200	27.1	33	20.5	55	331	654	94
176	21.12	200	27.1	33	19.8	55	321	660	92
177	21.12	200	27.2	33	20.8	55	329	665	94
178	21.12	200	27.1	33	20.5	55	326	657	93
179	21.12	200	27.4	33	20.7	55	330	669	94
180	21.13	200	27.2	33	20.3	55	330	660	94
181	21.13	200	27.2	33	20.6	55	333	663	95
182	21.13	200	27.2	33	20.4	55	327	660	94
183	21.13	200	27.1	33	20.5	55	332	656	95
184	21.14	200	27.1	33	20.3	55	323	660	92
185	21.14	200	26.7	32	20.1	55	340	666	97
186	21.14	200	26.7	32	19.7	56	330	659	94
187	21.14	200	26.9	33	20.2	55	330	651	94
188	21.15	200	27.1	33	20.3	55	324	662	93
189	21.15	200	26.9	33	20.3	55	335	654	96
190	21.15	200	27.2	33	20.1	55	331	663	94
191	21.15	200	27.1	33	20.4	55	330	657	94
192	21.16	200	27.5	33	20.3	54	334	673	96
193	21.16	200	26.5	32	20.1	56	337	650	96

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CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
194	21.16	200	27.1	33	20.4	55	332	661	95
195	21.16	200	27.1	33	20.6	55	329	655	94
196	21.17	200	26.8	32	20.2	55	337	657	96
197	21.17	200	26.8	32	20.1	55	332	659	95
198	21.17	200	27.1	33	20.6	55	326	664	93
199	21.17	200	27.1	33	20.7	55	332	664	95
200	21.18	200	27.1	33	20.6	55	331	667	95
201	21.18	200	26.5	32	20.2	56	324	653	93
202	21.18	200	26.8	32	20.5	55	330	660	94
203	21.18	200	26.9	33	20.6	55	326	665	93
204	21.19	200	26.8	32	20.3	55	326	671	93
205	21.19	200	26.9	33	20.7	55	330	673	94
206	21.19	200	26.7	32	20.9	55	332	667	95
207	21.19	200	27.0	33	21.0	55	334	671	95
208	21.20	200	26.9	33	20.7	55	328	667	94
209	21.20	200	27.0	33	20.8	55	332	674	95
210	21.20	200	26.6	32	20.5	56	326	669	93
211	21.20	200	26.8	32	20.8	55	330	669	94
212	21.21	200	26.7	32	20.9	55	328	671	94
213	21.21	200	26.6	32	20.3	55	320	674	92
214	21.21	200	26.8	32	21.1	55	334	675	95
215	21.21	200	26.7	32	20.5	55	324	681	93
216	21.22	200	26.7	32	20.4	55	325	678	93
217	21.22	200	26.9	33	20.7	55	323	680	92
218	21.22	200	26.7	32	20.8	55	328	676	94
219	21.22	200	26.7	32	20.7	55	325	682	93
220	21.23	200	26.2	32	20.2	56	318	673	91
221	21.23	200	26.5	32	21.1	54	326	675	93
222	21.23	200	26.5	32	21.0	55	326	680	93
223	21.23	200	26.7	32	21.1	55	328	683	94
224	21.24	200	26.1	32	19.7	56	315	684	90
225	21.24	200	26.9	33	21.1	54	335	688	96
226	21.24	200	26.7	32	20.8	56	323	689	92
227	21.24	200	26.5	32	20.6	55	320	683	91
228	21.25	200	26.0	31	20.5	55	318	663	91
229	21.25	200	26.6	32	20.9	55	327	699	93
230	21.25	200	26.5	32	20.8	56	319	694	91
Average			27.3	33	20.4	55	338	618	97
Std. Dev.			0.4	1	0.3	0	10	84	3
Maximum			28.1	34	21.3	56	360	699	103
Minimum			26.0	31	19.7	54	315	298	90

Total number of blows analyzed: 189

#### Sensors

Blows: 36-230

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

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CME 85 Serial Number 381236 - Rig Number 118 at 20.0 feet  
OP: AK

Boring No. B101A  
Date: 18-October-2017

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#### Time Summary

Drive 4 minutes 13 seconds 2:05 PM - 2:10 PM BN 1 - 230

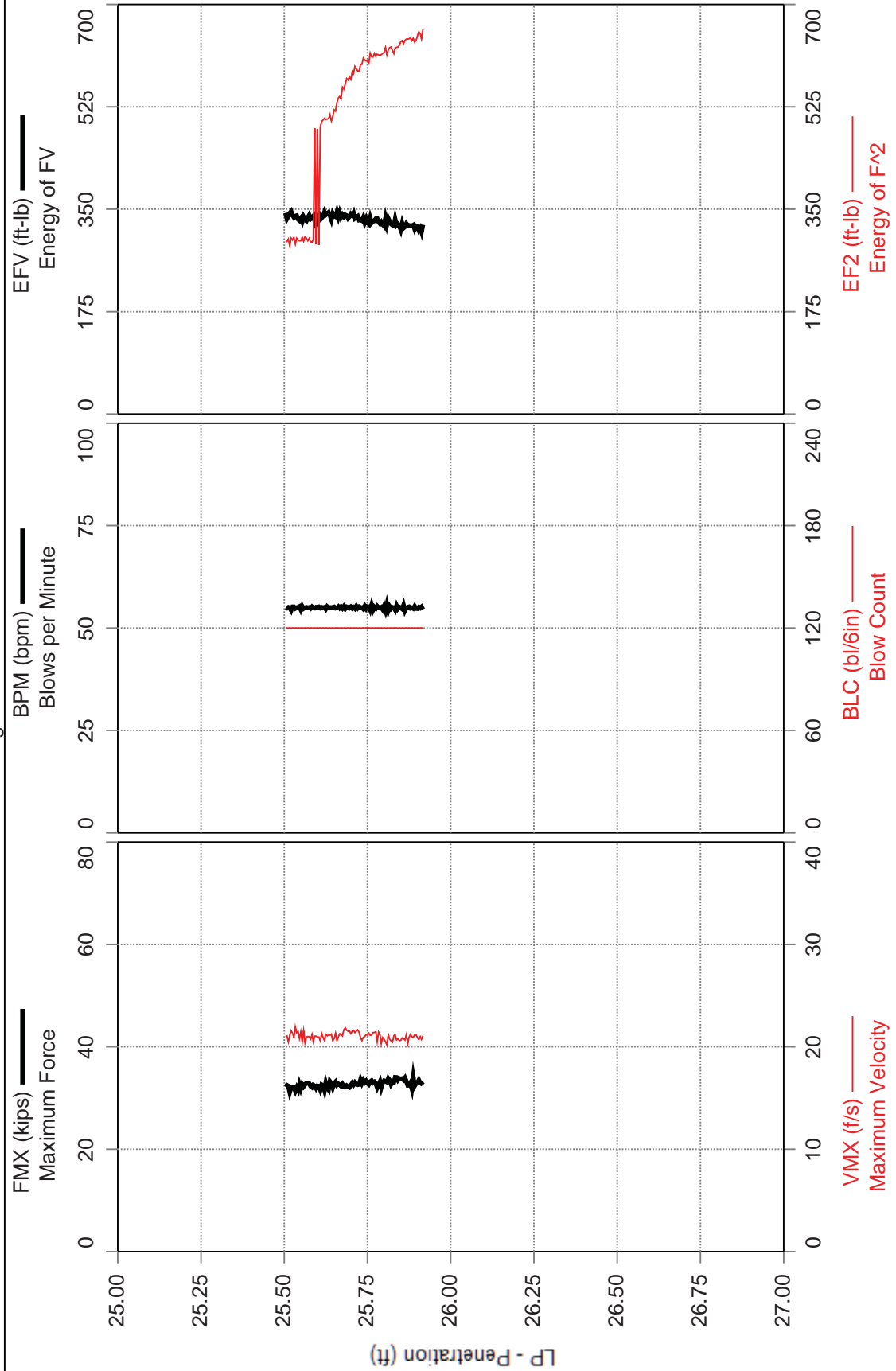


GRL Engineers, Inc. - PDILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 23-October-2017 Test started: 18-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 25.0 feet

Boring No. B101A



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CME 85 Serial Number 381236 - Rig Number 118 at 25.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 28.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
31	25.50	120	26.6	32	21.0	55	344	294	98
32	25.51	120	26.9	32	21.1	55	334	295	95
33	25.51	120	26.7	32	20.5	55	338	299	96
34	25.52	120	25.8	31	21.1	55	343	287	98
35	25.52	120	26.5	32	21.6	54	346	301	99
36	25.53	120	26.5	32	21.3	55	340	297	97
37	25.53	120	26.5	32	20.9	55	336	302	96
38	25.53	120	25.9	31	21.9	55	338	290	97
39	25.54	120	26.5	32	21.4	55	339	300	97
40	25.54	120	26.1	32	21.5	55	333	297	95
41	25.55	120	27.0	33	20.8	55	331	296	95
42	25.55	120	26.3	32	21.5	54	334	296	95
43	25.55	120	27.0	33	20.5	55	329	302	94
44	25.56	120	26.7	32	21.6	55	337	295	96
45	25.56	120	27.0	33	20.4	55	332	303	95
46	25.57	120	27.2	33	20.9	55	330	301	94
47	25.57	120	27.2	33	21.0	55	335	296	96
48	25.58	120	27.1	33	21.0	55	340	300	97
49	25.58	120	26.7	32	20.7	55	333	294	95
50	25.58	120	26.5	32	21.2	55	336	293	96
51	25.59	120	26.9	33	20.5	55	338	299	97
52	25.59	120	26.8	32	21.0	55	330	488	94
53	25.60	120	26.4	32	21.0	55	339	290	97
54	25.60	120	26.8	32	21.0	55	327	487	93
55	25.60	120	26.7	32	20.9	55	331	289	95
56	25.61	120	26.1	32	20.6	55	339	491	97
57	25.61	120	26.9	33	21.3	55	335	500	96
58	25.62	120	26.8	32	20.9	55	338	503	97
59	25.62	120	26.0	32	20.6	55	345	505	99
60	25.63	120	27.2	33	21.2	55	340	503	97
61	25.63	120	26.5	32	21.1	55	342	504	98
62	25.63	120	26.1	32	21.1	55	344	505	98
63	25.64	120	27.5	33	21.1	55	339	512	97
64	25.64	120	27.2	33	21.2	55	332	501	95
65	25.65	120	26.5	32	20.6	55	343	508	98
66	25.65	120	27.2	33	20.8	55	338	520	97
67	25.65	120	27.4	33	21.3	55	337	518	96
68	25.66	120	26.9	33	20.6	55	345	532	99
69	25.66	120	27.1	33	21.0	55	337	540	96
70	25.67	120	27.0	33	21.3	55	344	543	98
71	25.67	120	26.7	32	21.2	55	336	539	96
72	25.68	120	27.1	33	21.1	55	340	558	97
73	25.68	120	26.6	32	21.7	55	337	555	96
74	25.68	120	26.6	32	21.9	55	340	564	97
75	25.69	120	26.8	32	21.6	55	339	573	97
76	25.69	120	26.7	32	21.5	55	335	571	96



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CME 85 Serial Number 381236 - Rig Number 118 at 25.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
77	25.70	120	26.5	32	21.5	55	337	576	96
78	25.70	120	26.9	32	21.3	55	342	572	98
79	25.70	120	27.2	33	21.5	55	339	585	97
80	25.71	120	26.9	33	21.6	55	344	582	98
81	25.71	120	27.3	33	21.4	55	335	594	96
82	25.72	120	27.0	33	21.5	55	337	590	96
83	25.72	120	26.9	33	21.7	55	338	586	97
84	25.73	120	27.0	33	21.4	55	331	585	95
85	25.73	120	27.8	34	20.9	55	332	597	95
86	25.73	120	27.2	33	20.6	55	331	598	94
87	25.74	120	27.7	33	20.9	55	336	608	96
88	25.74	120	27.3	33	21.0	55	327	605	94
89	25.75	120	27.6	33	21.2	55	333	604	95
90	25.75	120	27.2	33	21.1	55	327	604	93
91	25.75	120	27.0	33	21.3	55	325	599	93
92	25.76	120	27.4	33	21.1	54	335	617	96
93	25.76	120	27.6	33	21.1	56	327	611	93
94	25.77	120	27.3	33	21.4	54	329	610	94
95	25.77	120	27.4	33	21.4	55	330	616	94
96	25.78	120	27.1	33	21.5	55	334	611	95
97	25.78	120	26.5	32	20.5	55	334	615	95
98	25.78	120	27.0	33	21.4	55	328	614	94
99	25.79	120	27.4	33	21.2	55	325	613	93
100	25.79	120	26.5	32	20.3	55	328	614	94
101	25.80	120	27.3	33	20.9	55	324	616	93
102	25.80	120	27.6	33	20.7	55	321	618	92
103	25.80	120	27.5	33	20.5	54	335	626	96
104	25.81	120	27.4	33	20.2	56	324	614	92
105	25.81	120	28.0	34	21.2	54	334	622	96
106	25.82	120	27.7	33	20.7	55	329	626	94
107	25.82	120	27.0	33	20.6	55	325	627	93
108	25.83	120	27.3	33	20.5	55	323	621	92
109	25.83	120	27.4	33	21.1	55	322	616	92
110	25.83	120	28.1	34	21.2	54	333	626	95
111	25.84	120	28.1	34	20.7	55	322	627	92
112	25.84	120	27.7	34	20.8	55	325	627	93
113	25.85	120	28.0	34	20.6	55	322	630	92
114	25.85	120	27.9	34	20.6	55	315	636	90
115	25.85	120	27.9	34	20.9	55	326	638	93
116	25.86	120	27.7	34	20.8	56	318	633	91
117	25.86	120	28.0	34	20.7	54	320	638	91
118	25.87	120	27.5	33	21.2	55	325	641	93
119	25.87	120	26.8	32	20.3	55	322	641	92
120	25.88	120	26.8	32	20.9	55	322	641	92
121	25.88	120	27.2	33	21.2	55	322	643	92
122	25.88	120	26.4	32	21.0	55	322	638	92
123	25.89	120	28.2	34	20.9	55	323	642	92
124	25.89	120	26.8	32	21.2	55	316	635	90
125	25.90	120	27.1	33	21.2	55	321	638	92
126	25.90	120	27.2	33	20.9	55	320	646	91
127	25.90	120	27.7	33	20.7	55	314	653	90
128	25.91	120	27.2	33	21.0	55	318	650	91
129	25.91	120	27.2	33	20.7	55	311	641	89



GRL Engineers, Inc.  
Case Method & iCAP® Results

Page 3  
PDILOT2 2016.1.56.5 - Printed 23-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 25.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
130	25.92	120	26.9	33	21.1	55	324	657	92
		Average	27.0	33	21.0	55	332	523	95
		Std. Dev.	0.5	1	0.4	0	8	131	2
		Maximum	28.2	34	21.9	56	346	657	99
		Minimum	25.8	31	20.2	54	311	287	89
Total number of blows analyzed: 100									

#### Sensors

Blows: 31-130

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

#### Time Summary

Drive 2 minutes 20 seconds 2:31 PM - 2:34 PM BN 1 - 130



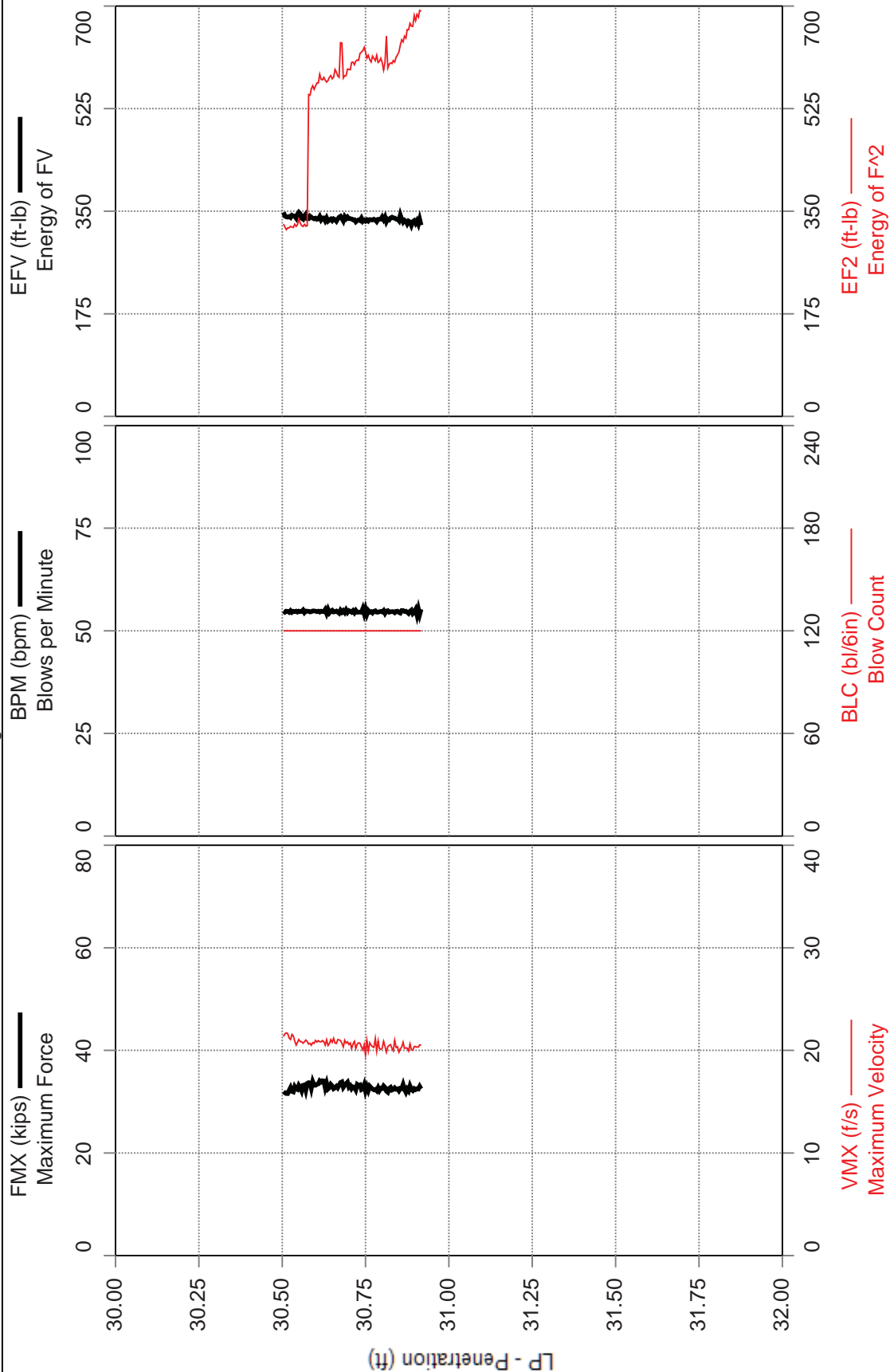
GRL Engineers, Inc. - PDIPILOT2 Ver 2016.1.56.5 - Case Method & iCAP® Results

Printed: 23-October-2017

Test started: 18-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 30.0 feet

Boring No. B101A



GRL Engineers, Inc.  
Case Method & iCAP® Results

Page 1  
PDILOT2 2016.1.56.5 - Printed 23-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 30.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

AR: 1.21 in<sup>2</sup>

SP: 0.492 k/ft<sup>3</sup>

LE: 33.83 ft

EM: 30,000 ksi

WS: 16,807.9 f/s

JC: 0.00 []

CSX: Max Measured Compr. Stress

EFV: Energy of FV

FMX: Maximum Force

EF2: Energy of F<sup>2</sup>

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows per Minute

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
28	30.50	120	26.4	32	21.3	55	348	328	99
29	30.51	120	26.2	32	21.6	55	342	323	98
30	30.51	120	26.1	32	21.7	55	340	319	97
31	30.52	120	26.1	32	21.6	55	340	321	97
32	30.52	120	26.6	32	21.2	54	341	322	97
33	30.53	120	27.1	33	21.1	55	339	324	97
34	30.53	120	26.4	32	21.6	54	343	323	98
35	30.53	120	26.4	32	21.4	55	342	322	98
36	30.54	120	27.2	33	20.9	55	341	328	98
37	30.54	120	26.9	33	20.5	55	338	324	97
38	30.55	120	26.8	32	20.8	55	345	327	98
39	30.55	120	27.4	33	21.1	55	348	337	99
40	30.55	120	27.1	33	20.9	55	346	330	99
41	30.56	120	26.5	32	20.8	55	338	326	97
42	30.56	120	27.4	33	20.7	55	336	324	96
43	30.57	120	27.5	33	20.8	54	342	328	98
44	30.57	120	26.6	32	21.0	55	345	324	99
45	30.58	120	27.8	34	20.8	55	337	325	96
46	30.58	120	27.9	34	20.6	55	337	549	96
47	30.58	120	27.8	34	20.7	55	341	548	98
48	30.59	120	26.9	33	20.5	55	340	559	97
49	30.59	120	28.0	34	20.8	55	338	564	97
50	30.60	120	27.5	33	20.7	55	337	558	96
51	30.60	120	27.4	33	21.0	55	338	563	97
52	30.60	120	27.6	33	20.8	55	336	569	96
53	30.61	120	27.7	33	20.9	55	337	569	96
54	30.61	120	28.2	34	20.8	55	341	584	97
55	30.62	120	28.0	34	20.8	55	335	575	96
56	30.62	120	28.2	34	21.0	55	338	574	97
57	30.63	120	28.1	34	20.8	55	338	578	97
58	30.63	120	27.0	33	20.5	55	334	573	95
59	30.63	120	27.8	34	21.0	54	339	570	97
60	30.64	120	26.8	32	20.5	55	333	573	95
61	30.64	120	27.0	33	20.6	54	335	579	96
62	30.65	120	27.6	33	21.0	55	337	581	96
63	30.65	120	27.3	33	20.8	55	334	576	95
64	30.65	120	26.9	33	21.2	55	337	579	96
65	30.66	120	27.0	33	20.7	55	336	592	96
66	30.66	120	27.3	33	20.7	55	333	587	95
67	30.67	120	27.0	33	21.0	55	336	581	96
68	30.67	120	27.4	33	21.0	54	340	578	97
69	30.68	120	27.9	34	21.0	55	341	637	98
70	30.68	120	28.0	34	20.7	55	338	637	96
71	30.68	120	27.1	33	20.3	55	333	577	95
72	30.69	120	27.4	33	21.0	54	341	581	97
73	30.69	120	27.7	34	20.7	55	337	581	96

GRL Engineers, Inc.  
Case Method & iCAP® Results

Page 2  
PDILOT2 2016.1.56.5 - Printed 23-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 30.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
74	30.70	120	28.0	34	20.8	54	340	592	97
75	30.70	120	27.1	33	20.6	55	337	592	96
76	30.70	120	27.3	33	20.7	55	337	591	96
77	30.71	120	26.9	33	20.2	55	337	604	96
78	30.71	120	27.2	33	20.6	55	335	604	96
79	30.72	120	27.1	33	20.9	54	336	600	96
80	30.72	120	26.7	32	20.2	55	332	606	95
81	30.73	120	27.6	33	20.6	55	334	608	95
82	30.73	120	27.4	33	20.7	55	335	607	96
83	30.73	120	27.5	33	20.7	55	334	619	95
84	30.74	120	26.7	32	20.3	54	338	621	97
85	30.74	120	26.9	33	20.1	55	333	624	95
86	30.75	120	27.5	33	20.6	54	335	629	96
87	30.75	120	26.5	32	19.6	55	333	622	95
88	30.75	120	27.2	33	20.9	54	335	611	96
89	30.76	120	26.6	32	19.9	55	333	616	95
90	30.76	120	27.3	33	20.7	55	336	609	96
91	30.77	120	27.1	33	20.5	55	335	605	96
92	30.77	120	26.8	32	20.4	54	335	614	96
93	30.78	120	26.7	32	20.3	55	336	611	96
94	30.78	120	26.8	32	21.2	55	335	607	96
95	30.78	120	26.5	32	19.9	55	332	616	95
96	30.79	120	27.0	33	20.9	55	336	604	96
97	30.79	120	26.6	32	20.2	55	336	605	96
98	30.80	120	27.0	33	20.1	55	336	611	96
99	30.80	120	26.9	33	20.2	55	340	604	97
100	30.80	120	27.3	33	20.9	55	336	591	96
101	30.81	120	27.1	33	20.4	54	340	604	97
102	30.81	120	26.5	32	19.8	55	332	648	95
103	30.82	120	26.3	32	20.4	55	337	594	96
104	30.82	120	26.9	33	20.5	55	335	601	96
105	30.83	120	27.1	33	20.6	55	339	603	97
106	30.83	120	26.7	32	20.2	55	340	602	97
107	30.83	120	26.8	32	20.0	55	339	607	97
108	30.84	120	27.0	33	21.0	54	338	604	97
109	30.84	120	26.8	32	20.3	55	337	613	96
110	30.85	120	26.9	32	20.3	55	337	617	96
111	30.85	120	26.5	32	19.8	54	334	621	95
112	30.85	120	26.9	33	20.1	54	344	633	98
113	30.86	120	26.9	33	20.3	55	336	642	96
114	30.86	120	27.6	33	20.8	55	331	639	95
115	30.87	120	26.8	32	20.2	55	335	649	96
116	30.87	120	26.3	32	20.2	55	333	645	95
117	30.88	120	26.8	32	20.2	55	329	660	94
118	30.88	120	26.5	32	19.9	54	333	659	95
119	30.88	120	27.3	33	20.6	55	332	670	95
120	30.89	120	26.8	32	20.1	55	326	666	93
121	30.89	120	26.6	32	20.0	54	332	665	95
122	30.90	120	26.9	33	20.4	55	334	684	95
123	30.90	120	26.7	32	20.4	55	329	675	94
124	30.90	120	26.9	33	20.3	54	334	686	95
125	30.91	120	26.8	32	20.3	55	328	681	94
126	30.91	120	27.2	33	20.5	54	336	693	96

GRL Engineers, Inc.  
Case Method & iCAP® Results

Page 3  
PDILOT2 2016.1.56.5 - Printed 23-October-2017

CME 85 Serial Number 381236 - Rig Number 118 at 30.0 feet

Boring No. B101A

OP: AK

Date: 18-October-2017

BL#	Depth ft	BLC bl/6in	CSX ksi	FMX kips	VMX f/s	BPM bpm	EFV ft-lb	EF2 ft-lb	ETR (%)
127	30.92	120	26.9	33	20.5	55	326	691	93
		Average	27.1	33	20.6	55	337	558	96
		Std. Dev.	0.5	1	0.4	0	4	114	1
		Maximum	28.2	34	21.7	55	348	693	99
		Minimum	26.1	32	19.6	54	326	319	93
Total number of blows analyzed: 100									

#### Sensors

Blows: 28-127

Sensor	Type	Serial Nr.	Calibration	Replay Factor
F1	Strain	215AWJ-1	212.8	1.00
F2	Strain	215AWJ-2	212.6	1.00
A3	PR Accel	K0069	310.0	1.00
A4	PR Accel	K4816	378.0	1.00

#### Time Summary

Drive 2 minutes 18 seconds 2:51 PM - 2:54 PM BN 1 - 127

# **APPENDIX C**

## **REPRESENTATIVE PLOTS**

Rig Number 62

GRL Engineers, Inc.  
SPT Analyzer Results

Page 1 of 1

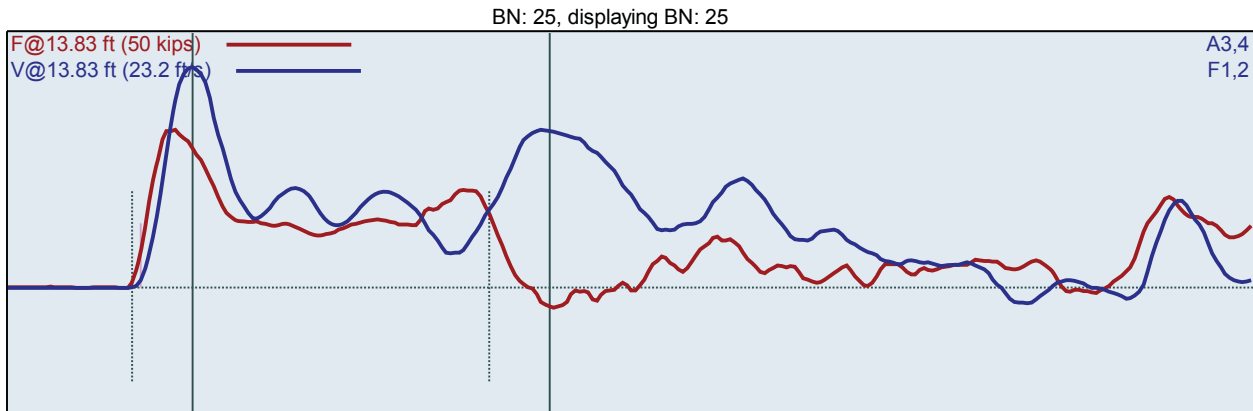
PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 75 Serial Number 224607  
AK

CME 75 at 10.0 feet  
Test date: 10/18/2017

AR: 1.21 in<sup>2</sup>  
LE: 13.83 ft  
WS: 16807.9 ft/s

SP: 0.492 k/ft<sup>3</sup>  
EM: 30000 ksi



CSX: Compression Stress Maximum  
FMX: Maximum Force  
VMX: Maximum Velocity  
BPM: Blows/Minute

EFV: Maximum Energy  
EF2: Energy of F<sup>2</sup> (ASTM D4633)  
ETR: Energy Transfer Ratio - Rated

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
25	11.14	25.4	31	19.9	59	337	219	96



GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 75 Serial Number 224607

AK

CME 75 at 15.0 feet

Test date: 10/18/2017

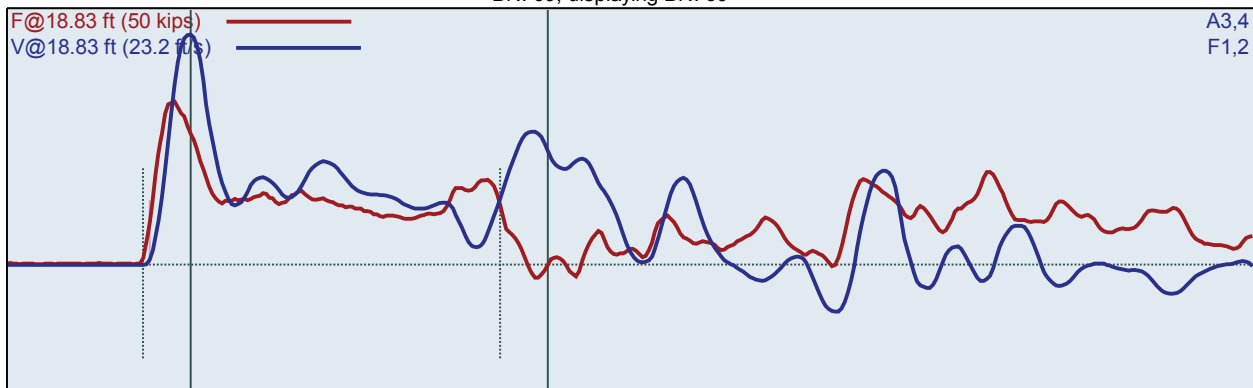
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 18.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 69, displaying BN: 69



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
69	15.88	26.3	32	20.8	58	323	242	92

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 75 Serial Number 224607

Rig Number 62 at 20.0 feet

AK

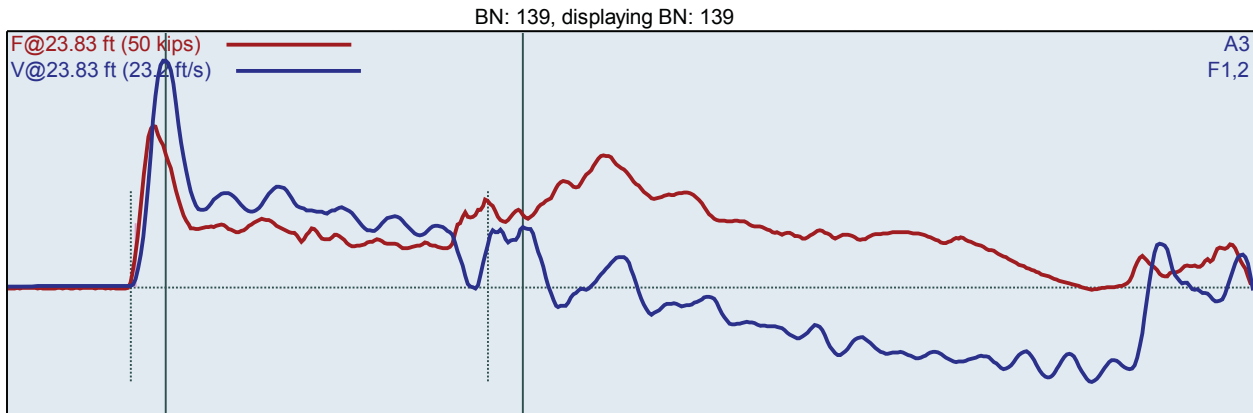
Test date: 10/18/2017

AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 23.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
139	21.14	26.1	32	20.5	58	328	647	94

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 75 Serial Number 224607

AK

CME 75 at 25.0 feet

Test date: 10/18/2017

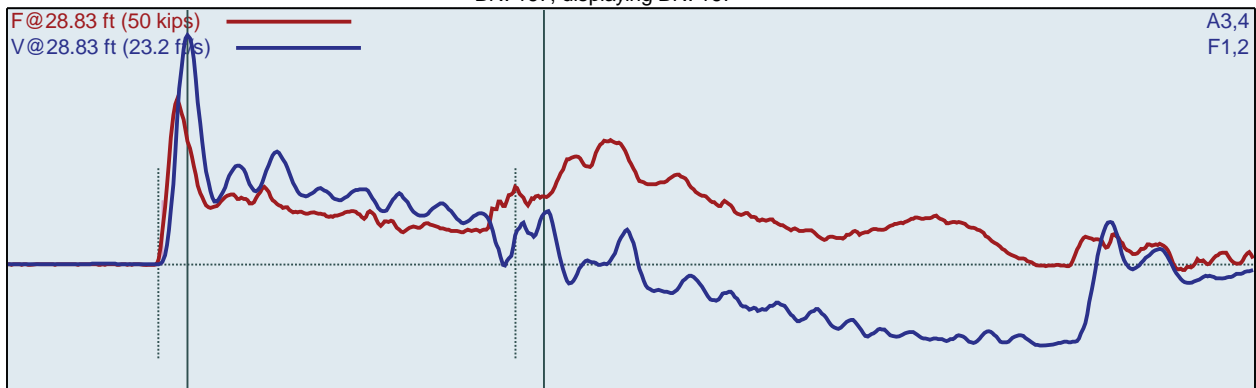
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 28.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 167, displaying BN: 167



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
167	26.37	26.7	32	20.7	58	324	598	93

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 75 Serial Number 224607

Rig Number 62 at 30.0 feet

AK

Test date: 10/18/2017

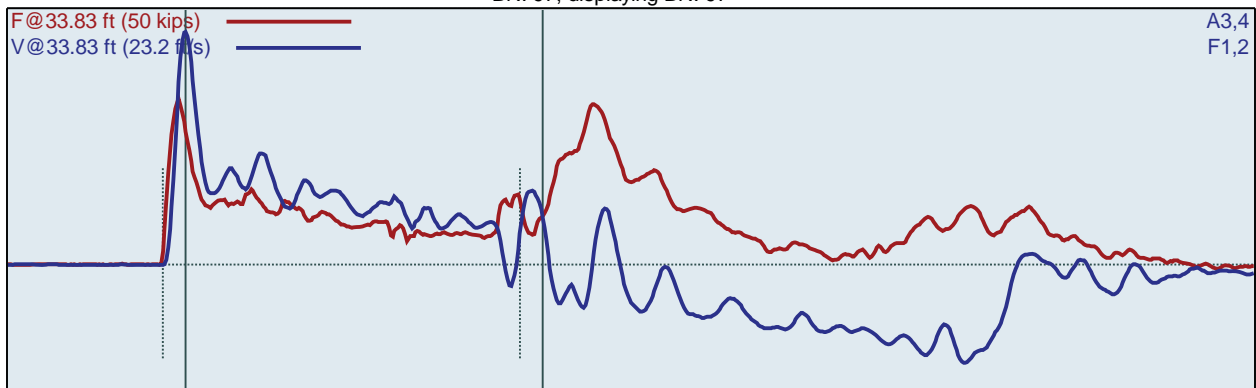
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 33.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 97, displaying BN: 97



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
97	30.40	26.8	32	21.0	56	323	668	92

Rig Number 118

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 85 Serial Number 381236

AK

CME 85 at 10.0 feet

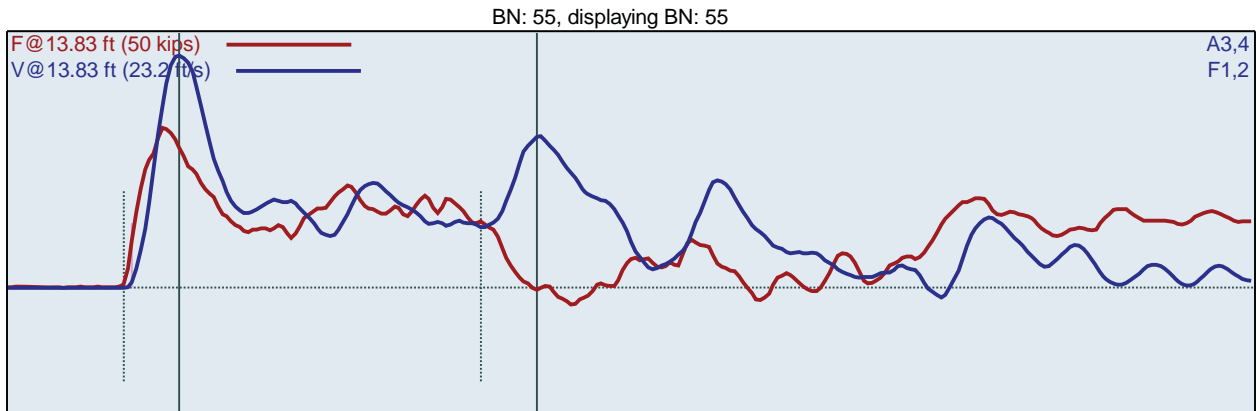
Test date: 10/18/2017

AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 13.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft- b	EF2 ft- b	ETR (%)
55	11.41	25.7	31	21.0	56	336	237	96

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 85 Serial Number 381236

AK

CME 85 at 15.0 feet

Test date: 10/18/2017

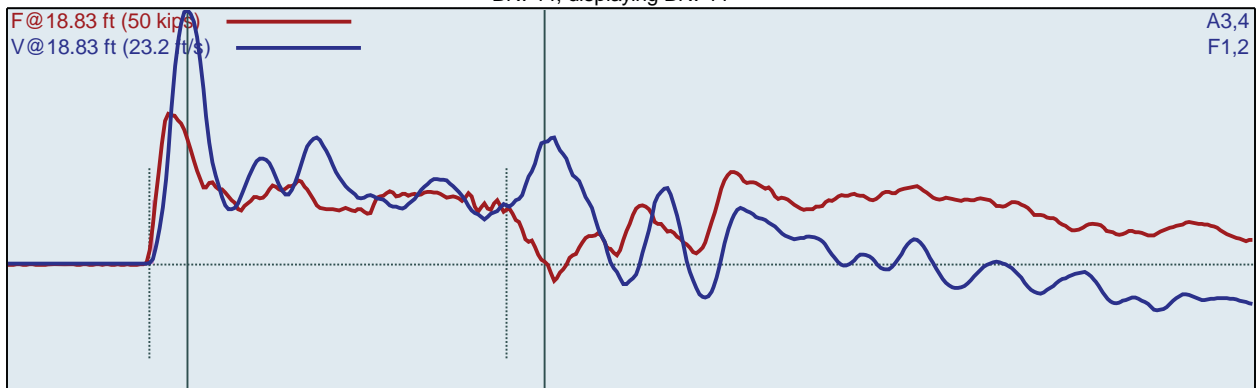
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 18.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 44, displaying BN: 44



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
44	15.59	24.3	29	23.0	55	348	238	99

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 85 Serial Number 381236

AK

CME 85 at 20.0 feet

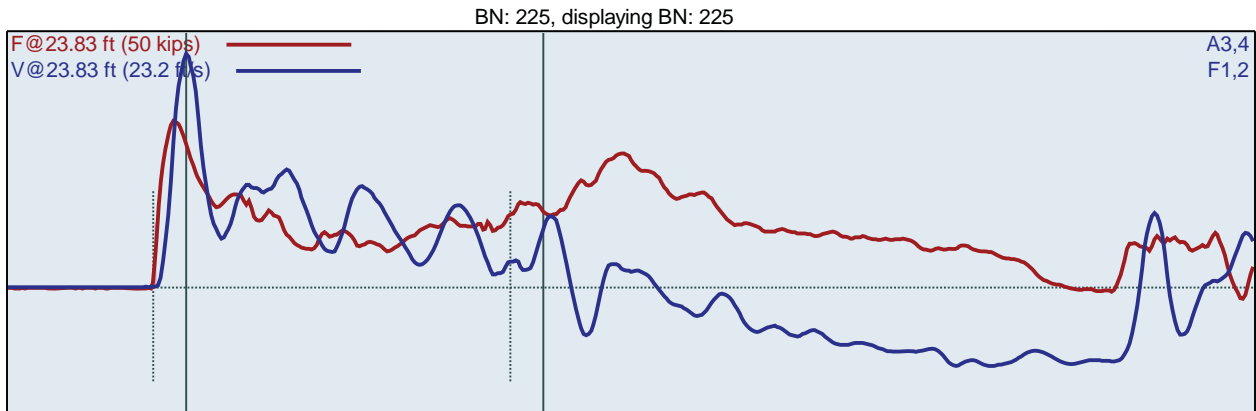
Test date: 10/18/2017

AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 23.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft- b	EF2 ft- b	ETR (%)
225	21.24	26.9	33	21.1	54	335	688	96



GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 85 Serial Number 381236

AK

CME 85 at 25.0 feet

Test date: 10/18/2017

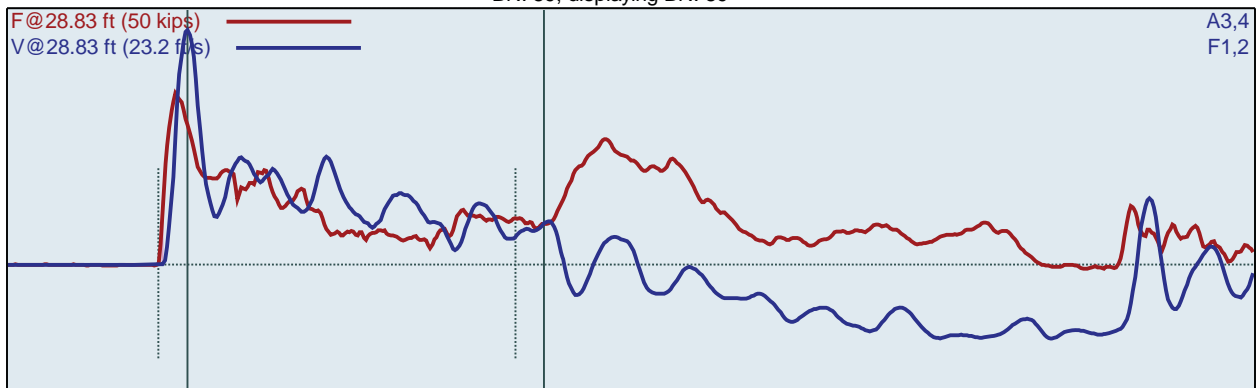
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 28.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 89, displaying BN: 89



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft- b	EF2 ft- b	ETR (%)
89	25.75	27.6	33	21.2	55	333	604	95

GRL Engineers, Inc.

SPT Analyzer Results

Page 1 of 1

PDA-S Ver. 2017.18 - Printed: 10/23/2017

CME 85 Serial Number 381236

AK

CME 85 at 30.0 feet

Test date: 10/18/2017

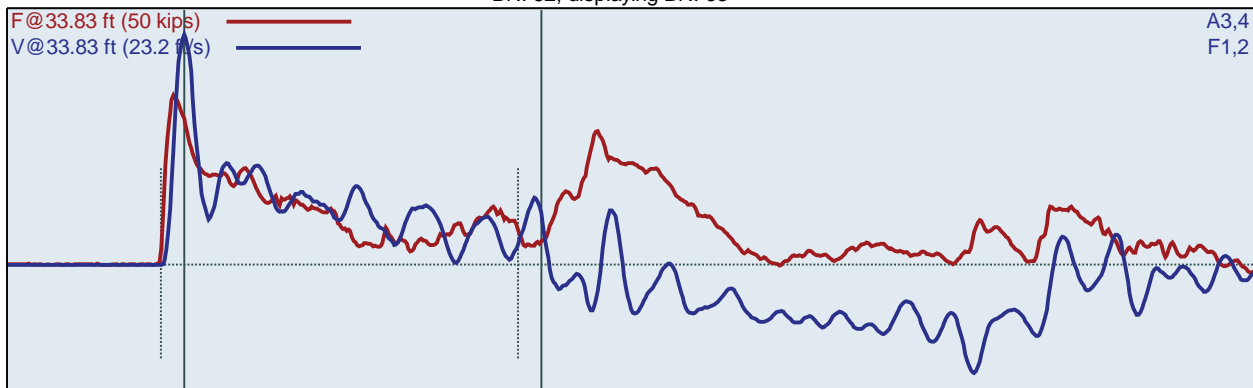
AR: 1.21 in<sup>2</sup>SP: 0.492 k/ft<sup>3</sup>

LE: 33.83 ft

EM: 30000 ksi

WS: 16807.9 ft/s

BN: 62, displaying BN: 63



CSX: Compression Stress Maximum

EFV: Maximum Energy

FMX: Maximum Force

EF2: Energy of F<sup>2</sup> (ASTM D4633)

VMX: Maximum Velocity

ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	LP ft	CSX ksi	FMX kips	VMX ft/s	BPM bpm	EFV ft-b	EF2 ft-b	ETR (%)
62	30.65	27.6	33	21.0	55	337	581	96

# **APPENDIX D**

## **SUPPLEMENTAL DOCUMENTS**



# *Certificate of Compliance*


**Pile Dynamics, Inc. certifies that the**

**Pile Driving Analyzer®, Model 8G**

**Serial Number: 4515 LE**

**has been tested and passed all final test procedures on 26 Feb 2015**

**and complies with the criteria as set forth in ASTM Standard D-4945**

Tested by 



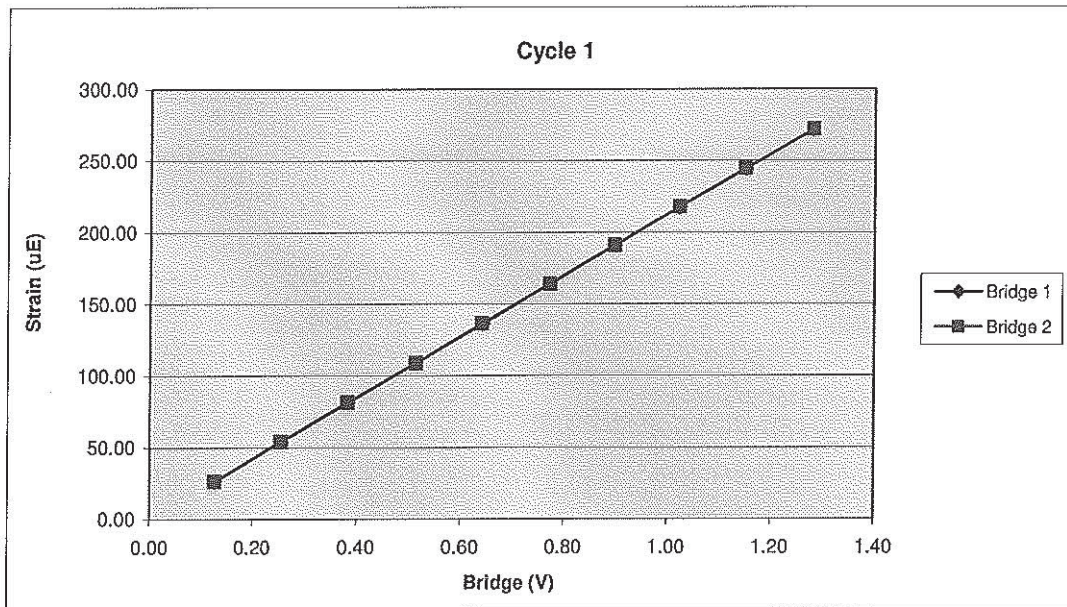
Pile Dynamics, Inc.  
30725 Aurora Road  
Cleveland, Ohio 44139 USA



215AWJ		Cycle 1		
Sample	Force (lb)	Strain ( $\mu$ E)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	977.02	26.73	0.13	0.13
3	1964.46	54.45	0.26	0.26
4	2953.09	81.81	0.38	0.38
5	3953.71	109.12	0.51	0.51
6	4955.52	136.61	0.64	0.64
7	5964.01	164.22	0.77	0.77
8	6930.60	191.08	0.90	0.90
9	7901.33	217.71	1.02	1.02
10	8896.25	244.61	1.15	1.15
11	9899.23	272.03	1.28	1.28

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7738.98	Force Calibration (lb/V)	7729.70
Offset	-17.93	Offset	-8.87
Correlation	0.999999	Correlation	0.999999
Strain Calibration ( $\mu$ E/V)	212.61	Strain Calibration ( $\mu$ E/V)	212.36
Offset	-0.10	Offset	0.15
Correlation	0.999997	Correlation	0.999997

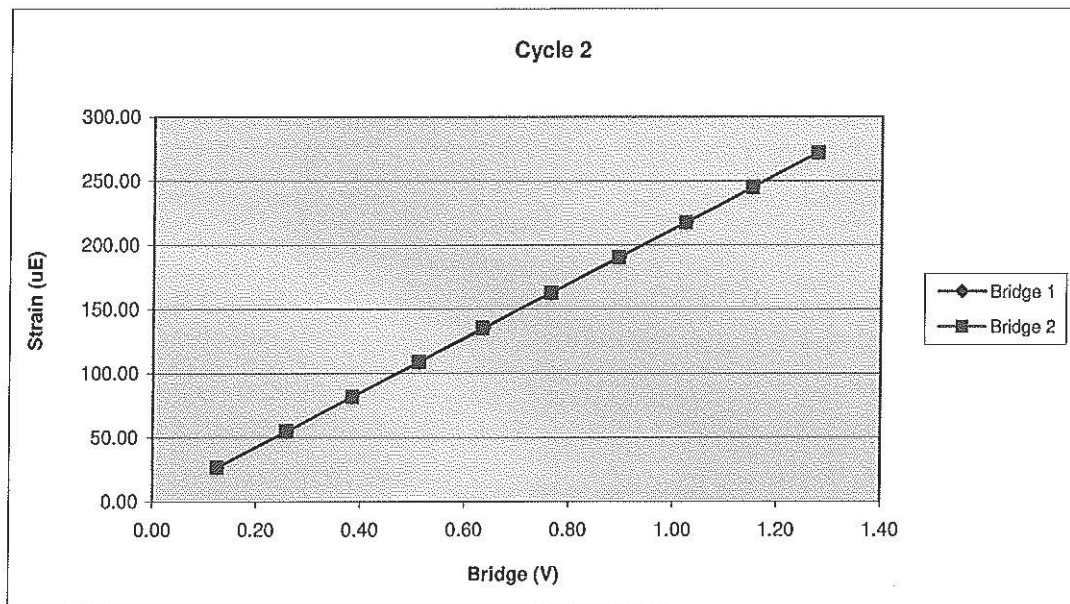
Force Strain Calibration	
EA (Kips)	36399.47
Offset	-14.42
Correlation	0.999995



215AWJ		Cycle 2		
Sample	Force (lb)	Strain ( $\mu$ E)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	960.50	26.94	0.13	0.12
3	1994.95	55.01	0.26	0.26
4	2971.78	81.98	0.38	0.39
5	3945.65	109.18	0.51	0.51
6	4908.90	135.48	0.64	0.63
7	5908.34	162.99	0.77	0.77
8	6918.21	190.72	0.90	0.90
9	7914.31	217.84	1.02	1.02
10	8886.61	245.23	1.15	1.15
11	9862.45	272.40	1.28	1.28

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7731.57	Force Calibration (lb/V)	7727.09
Offset	-6.40	Offset	-1.66
Correlation	0.999999	Correlation	0.999998
Strain Calibration ( $\mu$ E/V)	213.09	Strain Calibration ( $\mu$ E/V)	212.96
Offset	0.02	Offset	0.15
Correlation	0.999997	Correlation	0.999997

Force Strain Calibration	
EA (Kips)	36283.45
Offset	-7.20
Correlation	0.999995

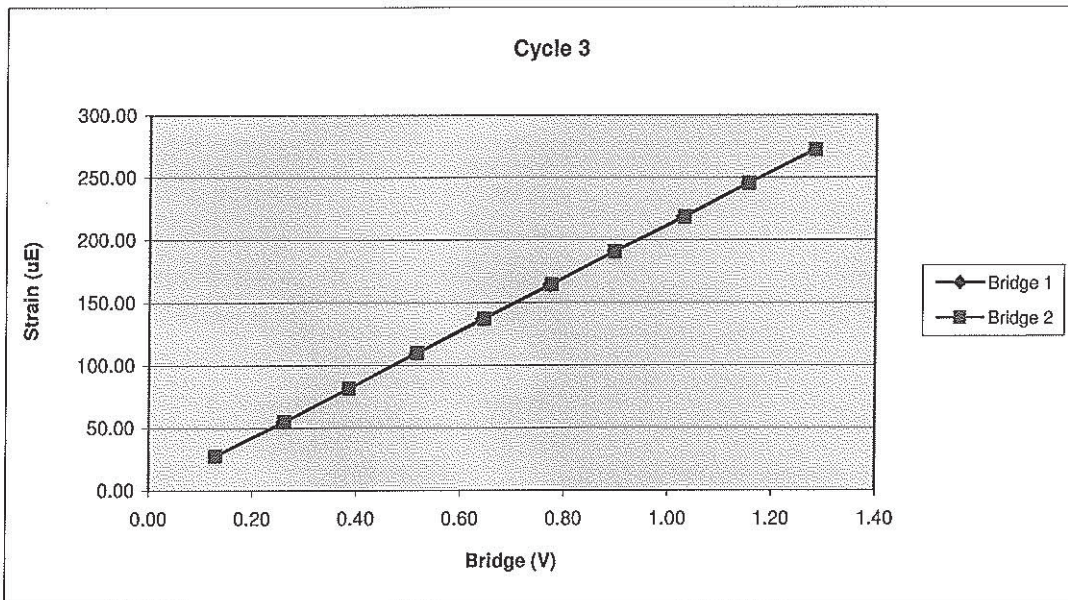




215AWJ		Cycle 3		
Sample	Force (lb)	Strain ( $\mu$ E)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	996.30	27.74	0.13	0.13
3	2001.64	55.10	0.26	0.26
4	2966.86	81.70	0.39	0.39
5	3977.71	109.94	0.51	0.52
6	4965.16	137.05	0.64	0.65
7	5970.30	164.33	0.77	0.78
8	6920.57	190.72	0.90	0.90
9	7942.24	218.64	1.03	1.03
10	8917.49	245.43	1.15	1.15
11	9905.72	272.23	1.28	1.28

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7741.62	Force Calibration (lb/V)	7736.97
Offset	-6.62	Offset	-21.06
Correlation	0.999999	Correlation	0.999997
Strain Calibration ( $\mu$ E/V)	212.71	Strain Calibration ( $\mu$ E/V)	212.58
Offset	0.18	Offset	-0.21
Correlation	0.999995	Correlation	0.999995

Force Strain Calibration	
EA (Kips)	36394.84
Offset	-13.25
Correlation	0.999997



Bridge Excitation (V) 5  
Shunt Resistor (ohm) 60.4k

Calibration Factors	215AWJ		
Bridge 1 ( $\mu\text{E}/\text{V}$ )	212.80	Bridge 2 ( $\mu\text{E}/\text{V}$ )	212.63
EA Factor (Kips)	36359.25	Area ( $\text{in}^2$ )	1.21

Calibrated by:

Calibrated Date:

6/5/2017

Pile Dynamics Inc  
30725 Aurora Rd  
Solon, OH 44139

Traceable to N.I.S.T.



SPT Rod Calibration		Pile Dynamics, Inc.	
		Made in USA	
	English	SI	
EA Product	36,359.25 kips	161.80 MN	
E	30,000 ksi	207,000 MPa	
A	1.21 in <sup>2</sup>	7.8 cm <sup>2</sup>	
Rod Serial #:		215 AWJ - 1	
Calibration Factor (meV):		212.80	
Calibration Date:		5-Jun-17	
Calibration Due:		5-Jun-19	

215 AWJ - 1  
215 AWJ - 2

36359.25  
212.8  
212.63  
5-Jun-17

Print to fit and it looks okay!

SPT Rod Calibration		Pile Dynamics, Inc.	
		Made in USA	
	English	SI	
EA Product	36,359.25 kips	161.80 MN	
E	30,000 ksi	207,000 MPa	
A	1.21 in <sup>2</sup>	7.8 cm <sup>2</sup>	
Rod Serial #:		215 AWJ - 2	
Calibration Factor (meV):		212.63	
Calibration Date:		5-Jun-17	
Calibration Due:		5-Jun-19	

215	Number
AWJ	type

Bridge 1	215 AWJ - 1
Bridge 2	215 AWJ - 2
EA Factor	36359.25
Calibration 1	212.80
Calibration 2	212.63
Date Cal	5-Jun-17

<--- enter

QBTA: ON [ALT-F1/BB=60]

File Dynamics, Inc.

TG F2 DPF

File Dynamics 03-Jun-17 02:55		FS — 10	BN 752 SL 712/ 3440/ 99	PJ: PN: HOPBAR	A 4 -- US F 2 3.3
LE 39.6 ft AR 1.7 in2 EM 30000 Ksi SP 0.492 K/ft3 WS 16810 ft/s WC 17043 ft/s					
JC 0.40 FM 1.00 UM 1.00					
EA/C 30.3 Ks/ft UN KIPS*0.1 FR 20000 MB 30					
DL -40 UT -1 PK 1 TM-PEAK					
F1/2 500/ 213 F3/4 213/ 213 A1/2 999/ 999 A3/4 999/ 310	TS 12 TB 8.0	E B PD: k0069 T1 9.5 2L/C 4.7	VA 1000	VE 1022	LP 0.00 ft LI 1.0
ACCEPT SQ-OFF FL-OFF PR-OFF		VMX= 4.5 FMX= 68 AMX= 139 EMX= 0.3 MEX= 133 FUP= 0.99			
		ACCELEROMETER CALIBRATION N.I.S.T. Traceable SERIAL NUMBER: K0069 CALIBRATION FACTOR: .062 MV/G PAK (*5000): 310 DATE: 6JUNE17 PDA OPERATOR: <i>JA</i>			
contact File Dynamics USA with your questions tel USA - 216 - 831- 6131 fax USA - 216 - 831- 0916		OP: laine lver:4.051 AT-PIEZOELECTRIC-			

Smart Sensor

Smart Chip Programmed By J.M.W. on 6JUNE17 CRC Value 5B72

QBTA: ON [ALT-F1/BB=60]

File Dynamics, Inc.

TG F2 DPF

<b>File Dynamics</b> 21-Jun-17 22:06		FS — 10	BN 1304 SL 922/ 3440/ 99	PJ: PN: HOPBAR	A 4 -- US F 2 3.3
LE 39.6 ft AR 1.7 in2 EM 30000 Ksi SP 0.492 K/ft3 WS 16810 ft/s WC 16862 ft/s  JC 0.40 FM 1.00 VM 1.00					
EA/C 30.3 Ks/ft UN KIPS*0.1 FR 20000 MB 30  DL -41 UT -1 PK 1 TM-PEAK  F1/2 500/ 213 F3/4 213/ 213 A1/2 999/ 999 A3/4 999/ 378		TS 12 E B PD: k4816 LP 0.00 ft TB 8.0 T1 9.5 2L/C 4.7 UA 1000 UE 1022 LI 1.0			
ACCEPT SQ-OFF FL-OFF PR-OFF		VMX= 4.5 FMX= 69 AMX= 139 EMX= 0.3 MEX= 135 FVP= 1.00			
		ACCELEROMETER CALIBRATION N.I.S.T. Traceable SERIAL NUMBER: K4816 CALIBRATION FACTOR: .0756 mV/g PAK (*5000): 378 DATE: 26JUNE17 PDA OPERATOR: [Signature]			
contact File Dynamics USA with your questions tel USA - 216 - 831- 6131 fax USA - 216 - 831- 0916		OP: laine [ver:4.05]			

Smart Sensor

Smart Chip Programmed By X.M.W. on 26JUNE17 CRC Value E501

QBTA: ON [ALT-F1/BB=60]		File Dynamics, Inc.		TG F2	DPF				
File Dynamics 03-Jun-17 02:48		FS — 10	BN 741 SL 708/ 3440/ 2	PJ: PN: HOPBAR	A 4 -- US F 2 3.3				
LE 39.6 ft AR 1.7 in2 EM 30000 Ksi SP 0.492 K/ft3 WS 16810 ft/s WC 17043 ft/s									
JC 0.40 FM 1.00 UM 1.00									
EA/C 30.3 Ks/ft UN KIPS*0.1 FR 20000 MB 30									
DL -37 UT -1 PK 1 TM-PEAK									
F1/2 500/ 213 F3/4 213/ 213 A1/2 999/ 999 A3/4 999/ 420									
TS 12 TB 8.0						E B PD: k4819 T1 9.5 2L/C 4.7	VA 1000	UE 1022	LI 1.0
UMX= 4.5 FMX= 71 AMX= 139 EMX= 0.3 MEX= 139 FUP= 1.02									
ACCEPT SQ-OFF FL-OFF PR-OFF									
contact File Dynamics USA with your questions tel USA - 216 - 831- 6131 fax USA - 216 - 831- 0916									
ACCELEROMETER CALIBRATION N.I.S.T. Traceable SERIAL NUMBER: K4819 CALIBRATION FACTOR: .084 mV/g PAK (*5000): 420 DATE: 6JUN617 PDA OPERATOR: [Signature]									
<-AT:PIEZORESISTIVE		OP: Iaine Iver:4.051		AT:PIEZOELECTRIC->					

Smart Sensor

Smart Chip Programmed By J.M.W. on 6JUN617 CRC Value DE76

Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment G**

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### **Packer Test Forms**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>		
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2a		
Project No.: 1703345				Ground Surface El.: 3535.48		
Location: Lea County, New Mexico				Datum: NAVD 1988		
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017		
Calculated By: J. Scully				Date: 11/10/2017		
Checked By: M. Hernandez-Cabal				Date: 11/20/2017		
<b>Packer Test Setup</b>						
Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.				
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>	<u>251</u>			
Gauge Height, ft.	<u>3.9</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>254.5</u>			
Depth to Top of Test Zone, ft.	<u>237.4</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>13.04</u>			
Depth to Bottom of Borehole, D, ft.	<u>250.6</u>	Head Loss, L, ft.	<u>0</u>			
Length of Test Zone, ℓ, ft.	<u>13.2</u>	<i>Ignored for flow less than 2 gpm</i>	<u>16</u>			
Reservoir, 55 gallon drum						
Drum Diameter, ft.	<u>1.85</u>	Applied Water Pressure, h <sub>2</sub> , psi	<u>36.9</u>			
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	h <sub>2</sub> , ft	<u>291.4</u>			
		Effective Head, H, ft.	<u>291.8</u>			
		Effective distance to water surface, T <sub>u</sub> , ft.	<u>291.8</u>			
		T <sub>u</sub> = U - D + H	<u>291.8</u>			
PACKER TEST METHOD: <u>Method 1 (Single Packer)</u>						
Fig. 17-6		Fig. 17-8				
Percent of unsaturated stratum, X	<u>100</u>	ℓ / r	<u>84</u>			
$X = \frac{H}{T_u} (100)$		Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>				
T <sub>u</sub> / ℓ	<u>22</u>	<u>110</u>				
		<u>Zone 2</u>				
PACKER TEST DATA						
Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
0.01	0.03	5	0.0001	(ft./sec)	(ft./yr)	(cm./sec)
				1.8E-08	0.56	5.4E-07
Check Applicability						
Q / a =	0.000007	≤	0.1	<u>Yes</u>		
ℓ (ft.) =	13.2	≥	10 r (ft.) =	1.6	<u>Yes</u>	
Notes:						
1. Water pressure was measured with a pressure gauge attached to the water line above ground.						
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.						
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.						
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.						
Method 1		Zone 2: $K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}$				





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

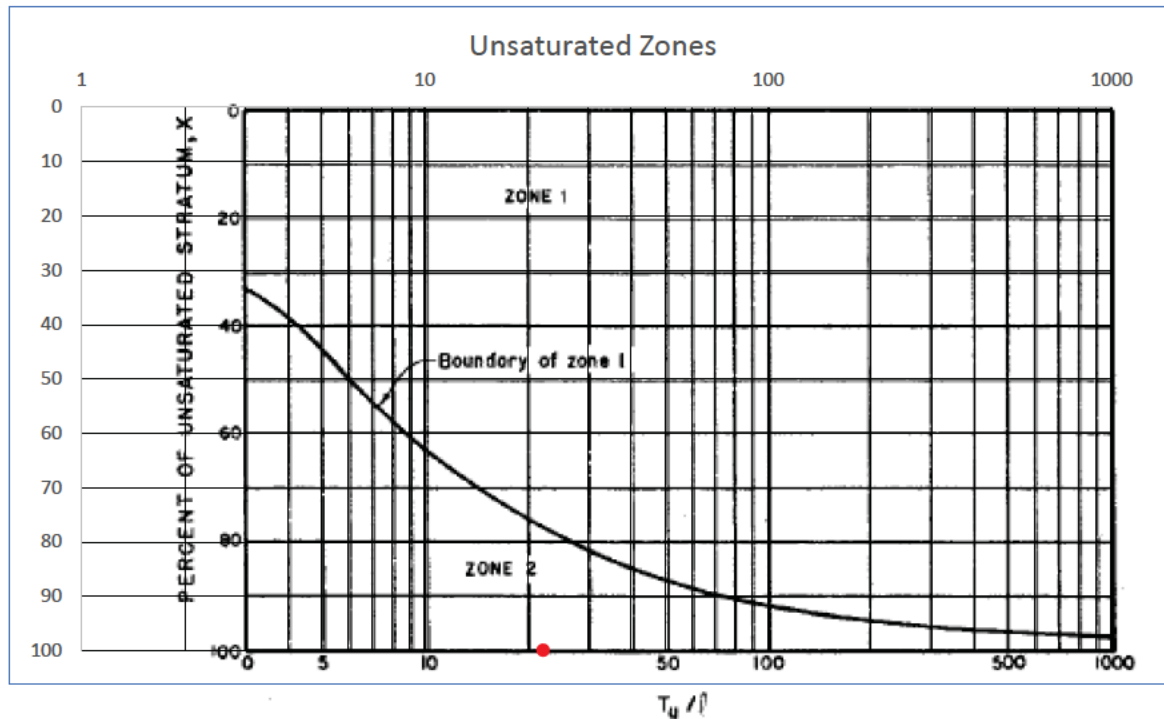
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

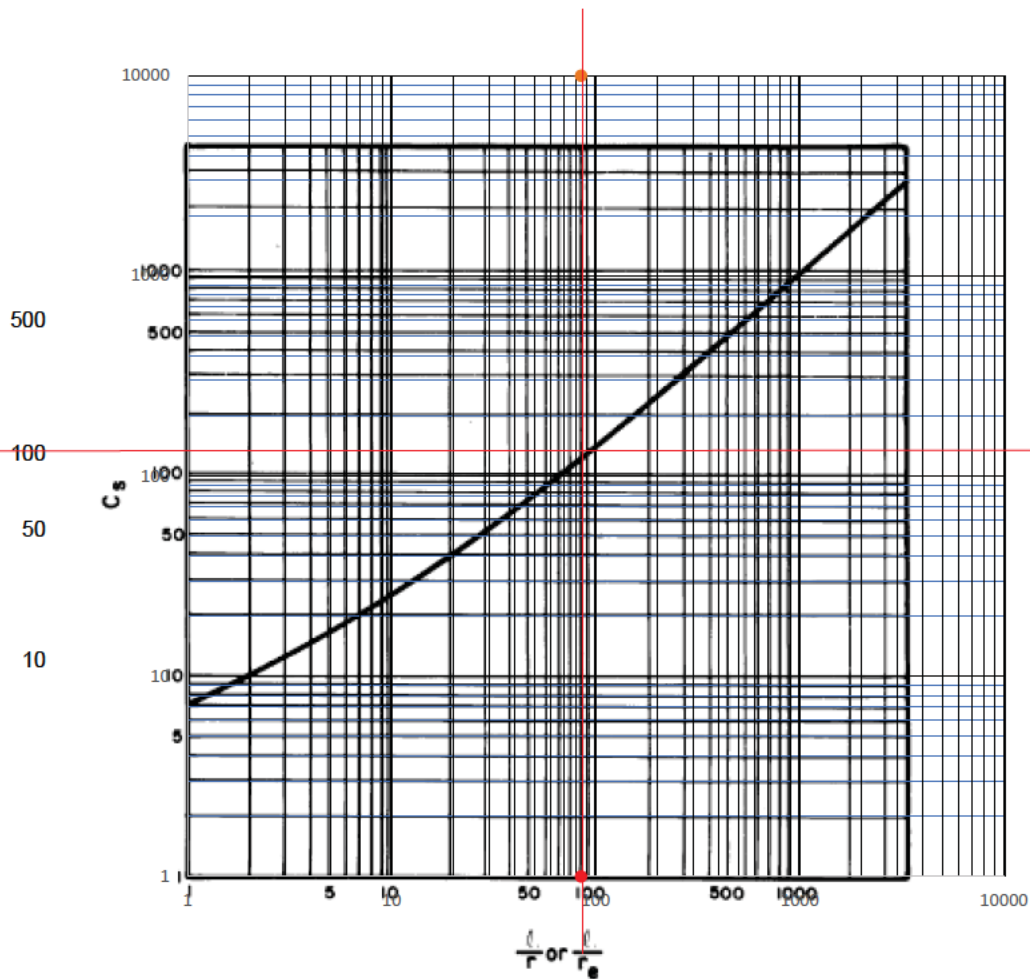
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>		
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2b		
Project No.: 1703345				Ground Surface El.: 3535.48		
Location: Lea County, New Mexico				Datum: NAVD 1988		
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017		
Calculated By: J. Scully				Date: 11/10/2017		
Checked By: M. Hernandez-Cabal				Date: 11/20/2017		
<b>Packer Test Setup</b>						
Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.				
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>	<u>251</u>			
Gauge Height, ft.	<u>3.9</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>254.5</u>			
Depth to Top of Test Zone, ft.	<u>237.4</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>13.04</u>			
Depth to Bottom of Borehole, D, ft.	<u>250.6</u>	Head Loss, L, ft.	<u>0</u>			
Length of Test Zone, ℓ, ft.	<u>13.2</u>	<i>Ignored for flow less than 2 gpm</i>	<u>32</u>			
Reservoir, 55 gallon drum						
Drum Diameter, ft.	<u>1.85</u>	Applied Water Pressure, h <sub>2</sub> , psi	<u>73.8</u>			
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	h <sub>2</sub> , ft	<u>328.3</u>			
		Effective Head, H, ft.	<u>328.7</u>			
		Effective distance to water surface, T <sub>u</sub> , ft.	<u>328.7</u>			
		T <sub>u</sub> = U - D + H	<u>328.7</u>			
PACKER TEST METHOD: <u>Method 1 (Single Packer)</u>						
Fig. 17-6		Fig. 17-8				
Percent of unsaturated stratum, X	<u>100</u>	ℓ / r	<u>84</u>			
$X = \frac{H}{T_u} (100)$		Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>				
T <sub>u</sub> / ℓ	<u>25</u>	<u>110</u>				
		<u>Zone 2</u>				
PACKER TEST DATA						
Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
0.01	0.03	5	0.0001	(ft./sec)	(ft./yr)	(cm./sec)
				1.6E-08	0.49	4.8E-07
Check Applicability						
Q / a =	0.000007	≤	0.1	<u>Yes</u>		
ℓ (ft.) =	13.2	≥	10 r (ft.) =	1.6	<u>Yes</u>	
Notes:						
1. Water pressure was measured with a pressure gauge attached to the water line above ground.						
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.						
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.						
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.						
Method 1		Zone 2: $K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}$				



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

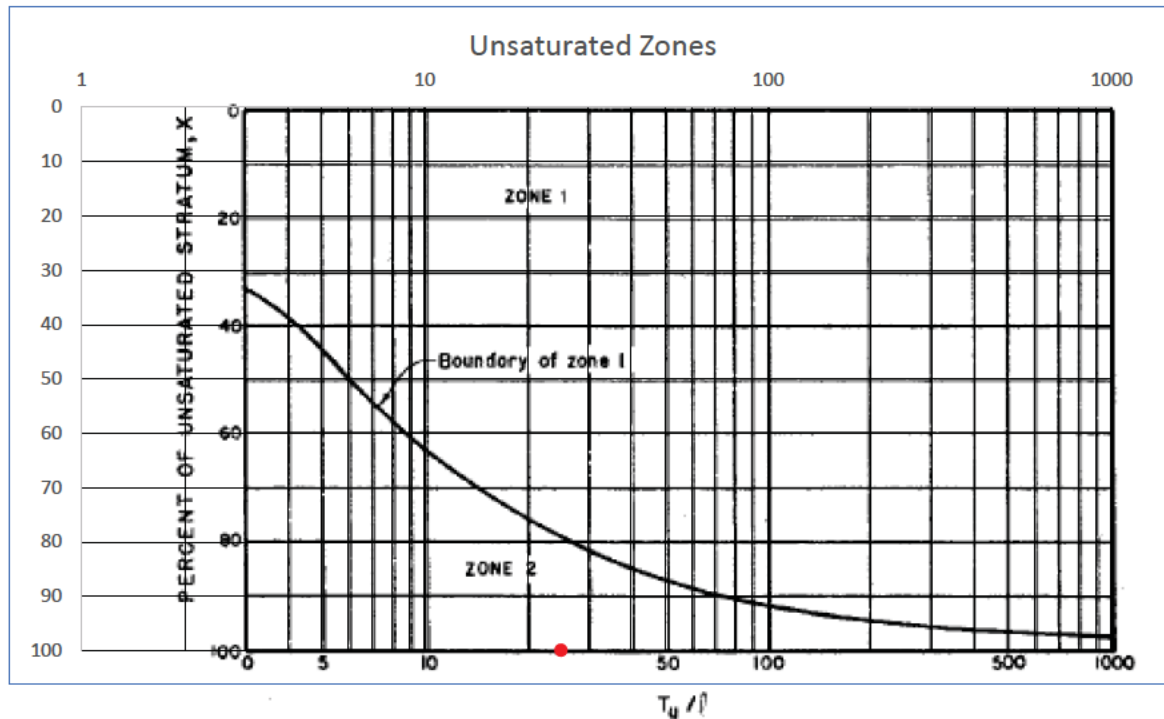
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

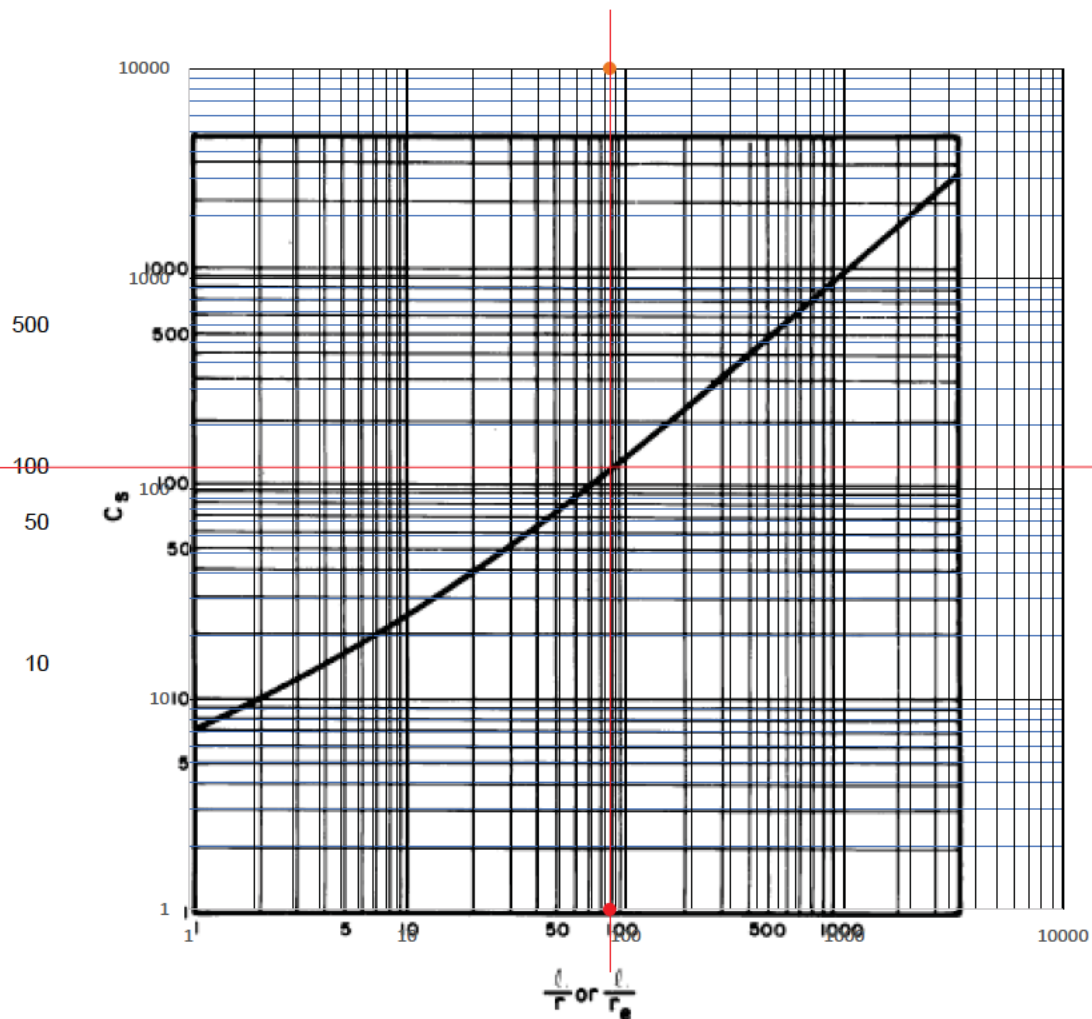
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>	
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2c	
Project No.: 1703345				Ground Surface El.: 3535.48	
Location: Lea County, New Mexico				Datum: NAVD 1988	
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017	
Calculated By: J. Scully				Date: 11/10/2017	
Checked By: M. Hernandez-Cabal				Date: 11/20/2017	

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	251
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	254.5
Depth to Top of Test Zone, ft.	237.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.04
Depth to Bottom of Borehole, D, ft.	250.6	Head Loss, L, ft.	0
Length of Test Zone, ℓ, ft.	13.2	<i>Ignored for flow less than 2 gpm</i>	
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	44
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	101.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	356.0
		Effective distance to water surface, T <sub>u</sub> , ft.	356.4
		T <sub>u</sub> = U - D + H	

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	100	Fig. 17-8	84
Percent of unsaturated stratum, X		ℓ / r	
$X = \frac{H}{T_u} (100)$		Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>	110
T <sub>u</sub> / ℓ	27		
	Zone 2		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.04	0.11	5	0.0004	5.8E-08	1.81	1.8E-06

Check Applicability

Q / a =	0.000027	≤	0.1	Yes
ℓ (ft.) =	13.2	≥	10 r (ft.) =	1.6
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 2:

$$K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}$$

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

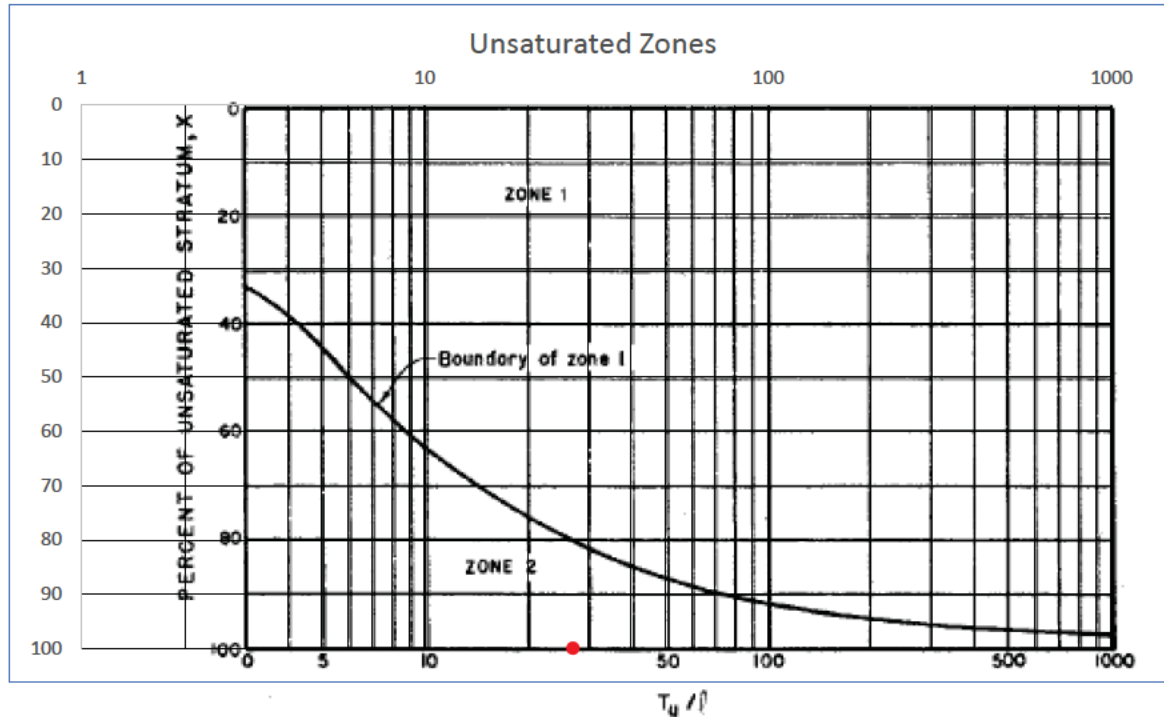
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower  
boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

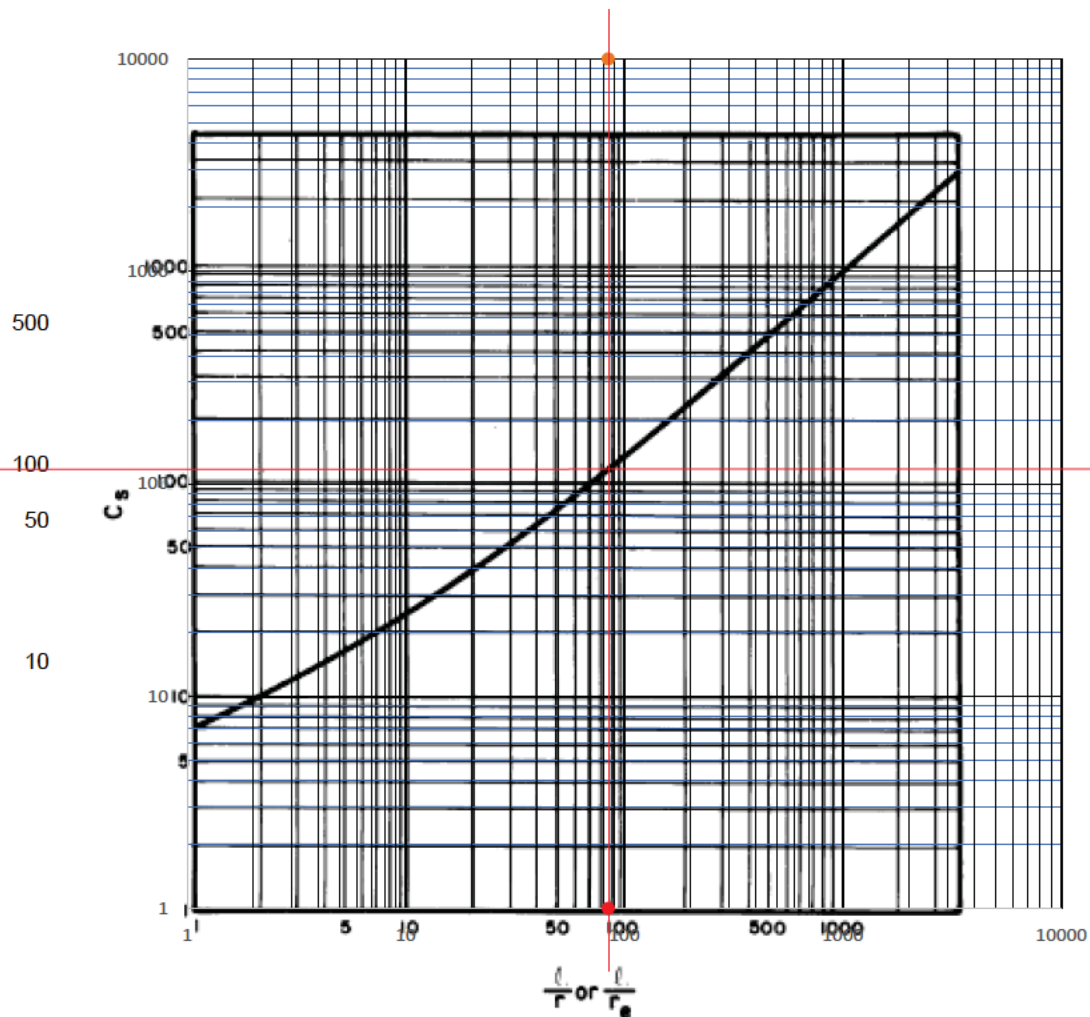
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**





<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	16
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	36.9
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	291.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	140.4

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-8 Zone 3

ℓ / r 404.5

Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.04	0.11	5	0.0004	2.0E-08	0.62	5.9E-07

Check Applicability

Q / a =	0.0000058	≤	0.1	Yes
ℓ (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes


  

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:

$$K = \frac{Q}{(C_s + 4)rH}$$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

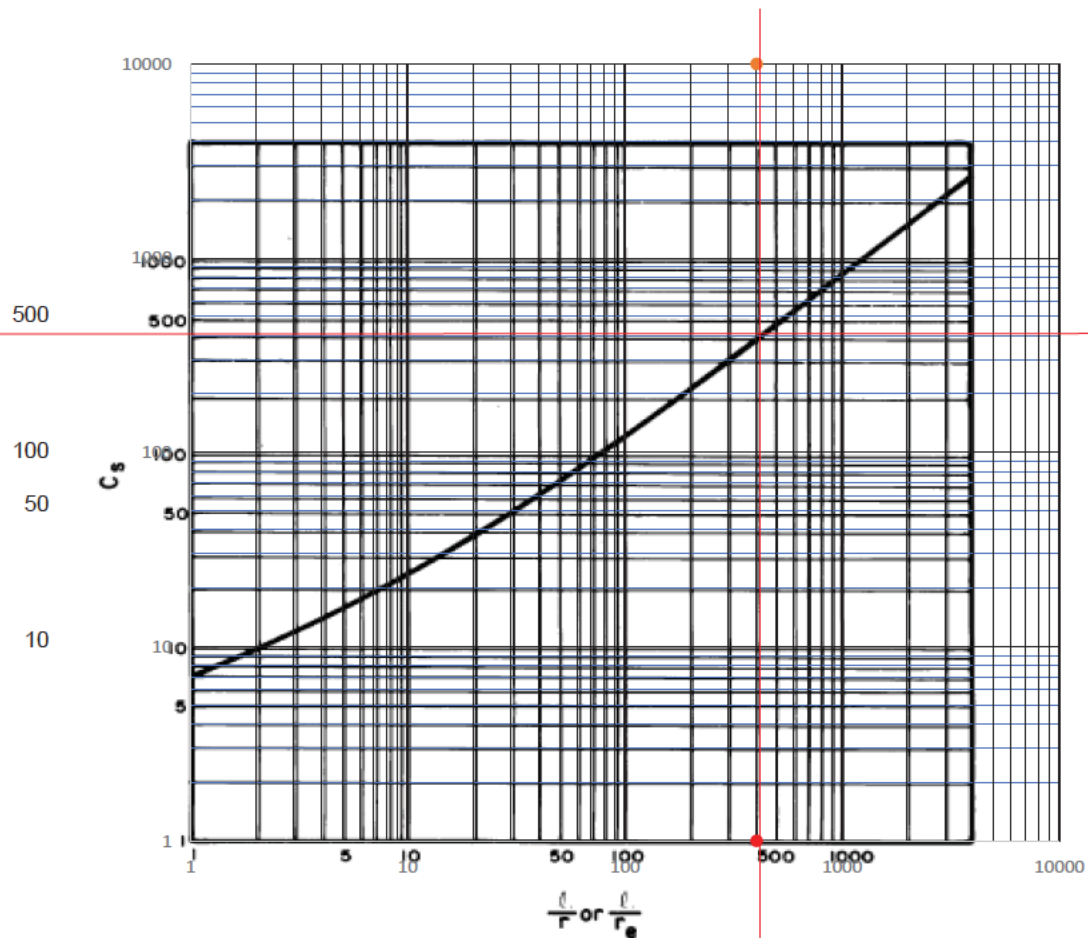
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, l, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	32
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	73.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	327.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	177.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-8 Zone 3

l / r 404.5

Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	8.7E-09	0.27	2.6E-07

Check Applicability

Q / a =	0.0000029	≤	0.1	Yes
l (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes


  

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:

$$K = \frac{Q}{(C_s + 4)rH}$$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

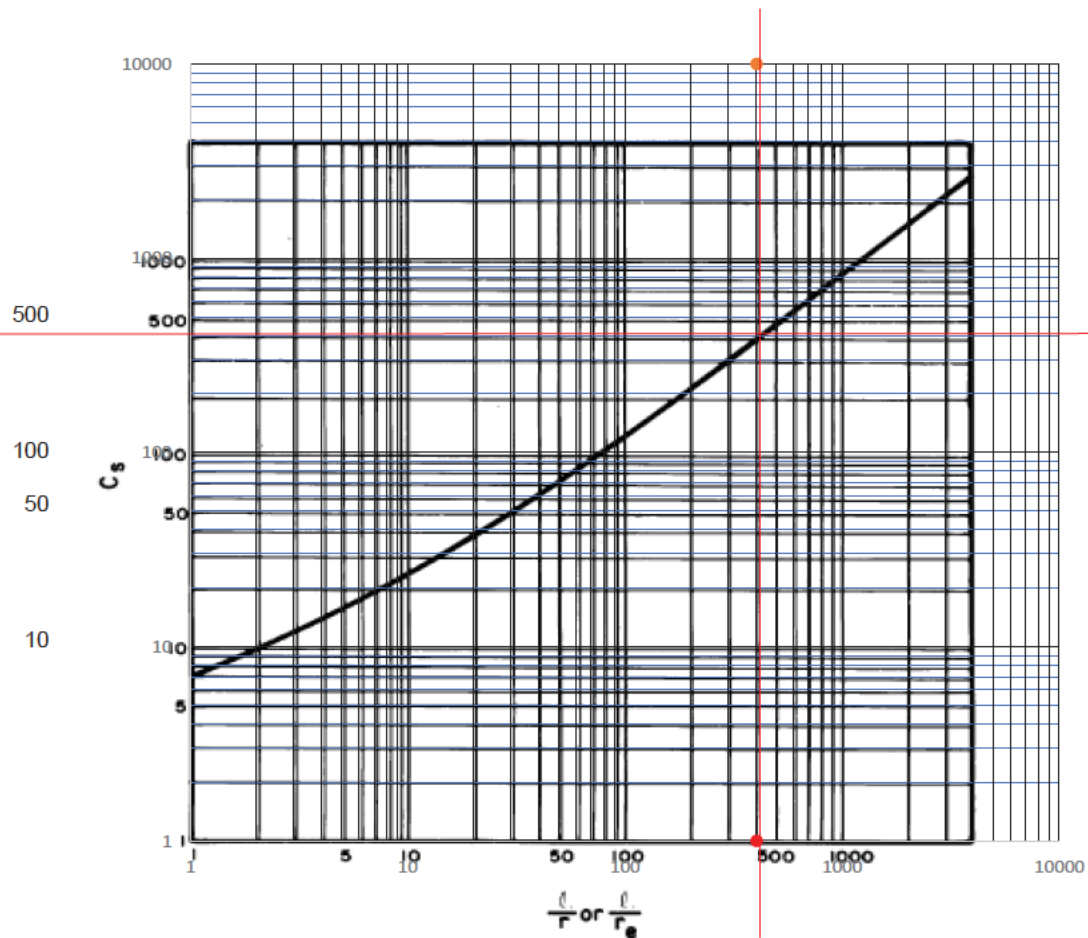
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3c
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	357.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	207.3

**PACKER TEST METHOD:** Method 1 (Single Packer)  
 Fig. 17-8 Zone 3  
 ℓ / r 404.5  
 Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	20	0.0001	5.9E-09	0.19	1.8E-07

  
 Check Applicability  


Q / a =	0.0000022	≤	0.1	Yes
ℓ (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:       $K = \frac{Q}{(C_s + 4)rH}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

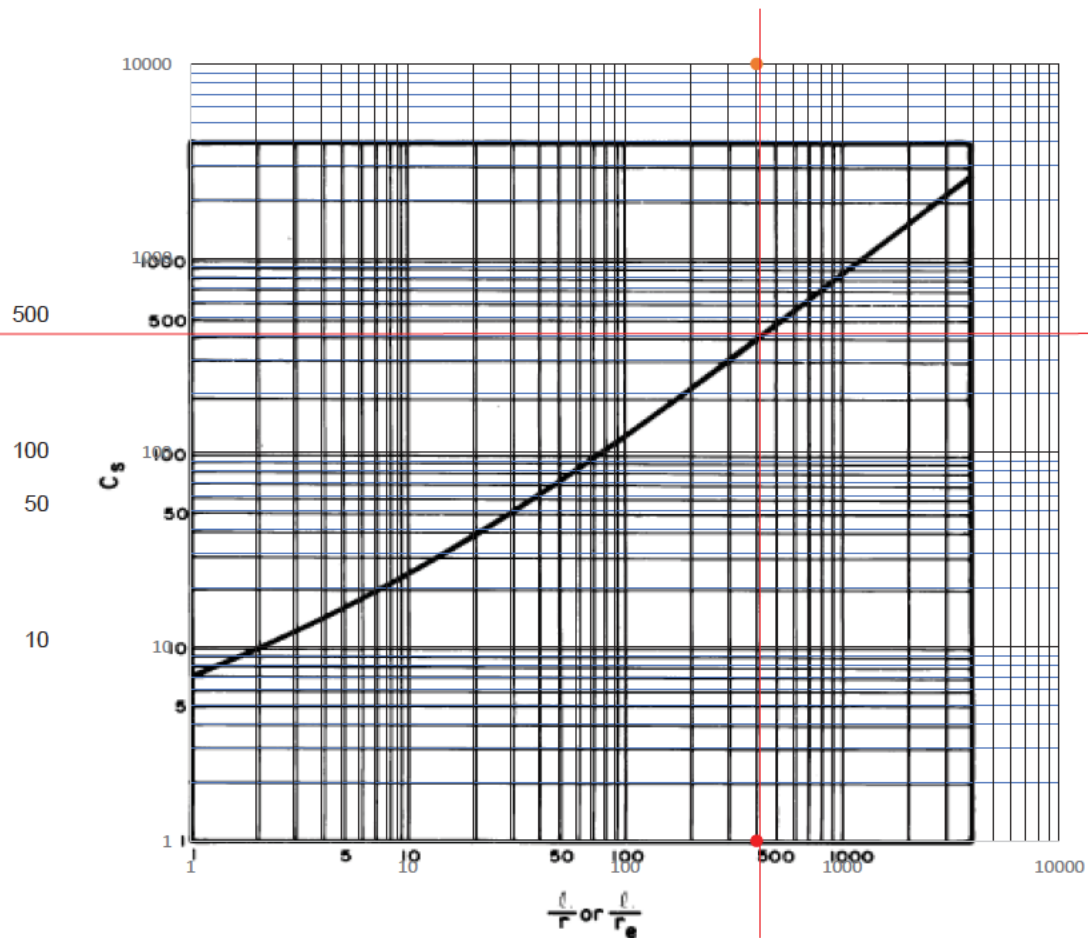
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/27/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	85.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	16.28
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	16.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	28
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	64.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	170.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	318.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6

Percent of unsaturated stratum, X

$$X = \frac{H}{T_u} (100)$$

T<sub>u</sub> / ℓ

19  
Zone 1

Fig. 17-7

H / r

ℓ / H

Saturated Conductivity Coefficient, C<sub>u</sub>

54	1094
0.10	230

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	2.9E-08	0.92	8.9E-07

Check Applicability


Q / a =	0.000011	≤	0.1	
ℓ (ft.) =	16.5	≥	10 r (ft.) =	1.6
				Yes <u>Yes</u>

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

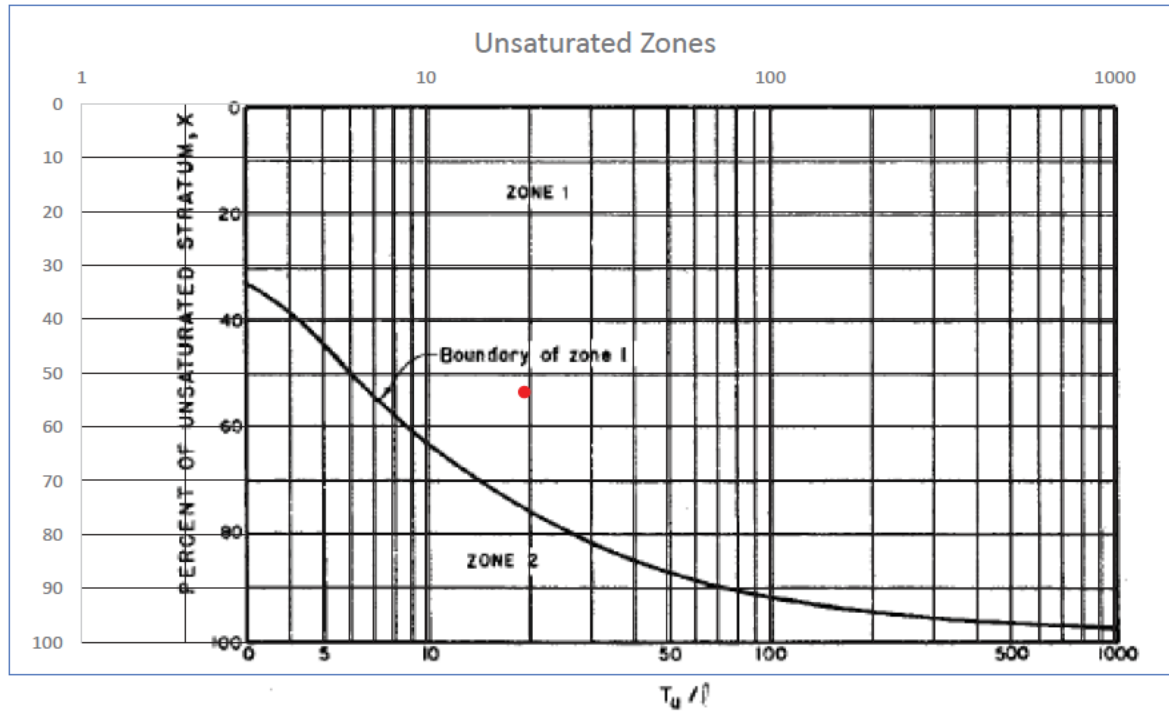
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

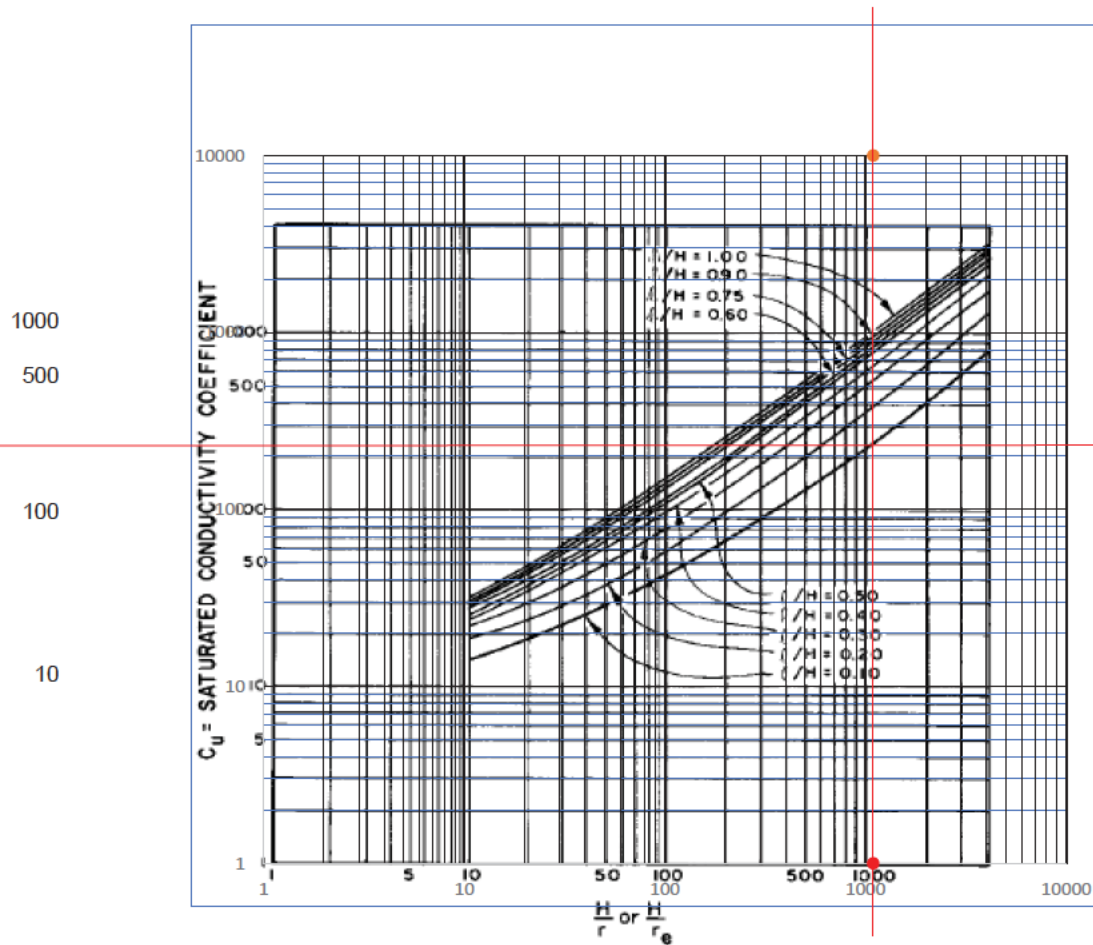
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/27/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	85.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	16.28
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	16.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	37
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	85.4
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	191.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	339.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	56
$X = \frac{H}{T_u} (100)$	1227
	0.09
T <sub>u</sub> / ℓ	21
	Zone 1
	275

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	3.3E-08	1.03	9.9E-07


Check Applicability

Q / a =	0.000017	≤	0.1	
ℓ (ft.) =	16.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

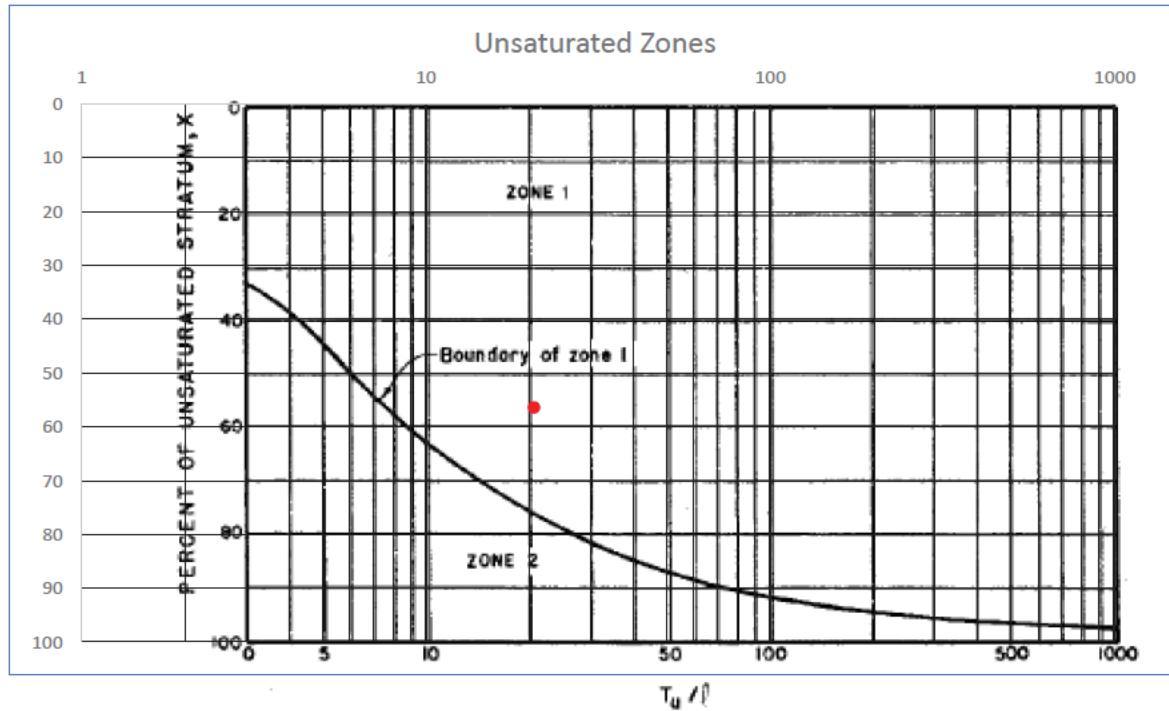
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

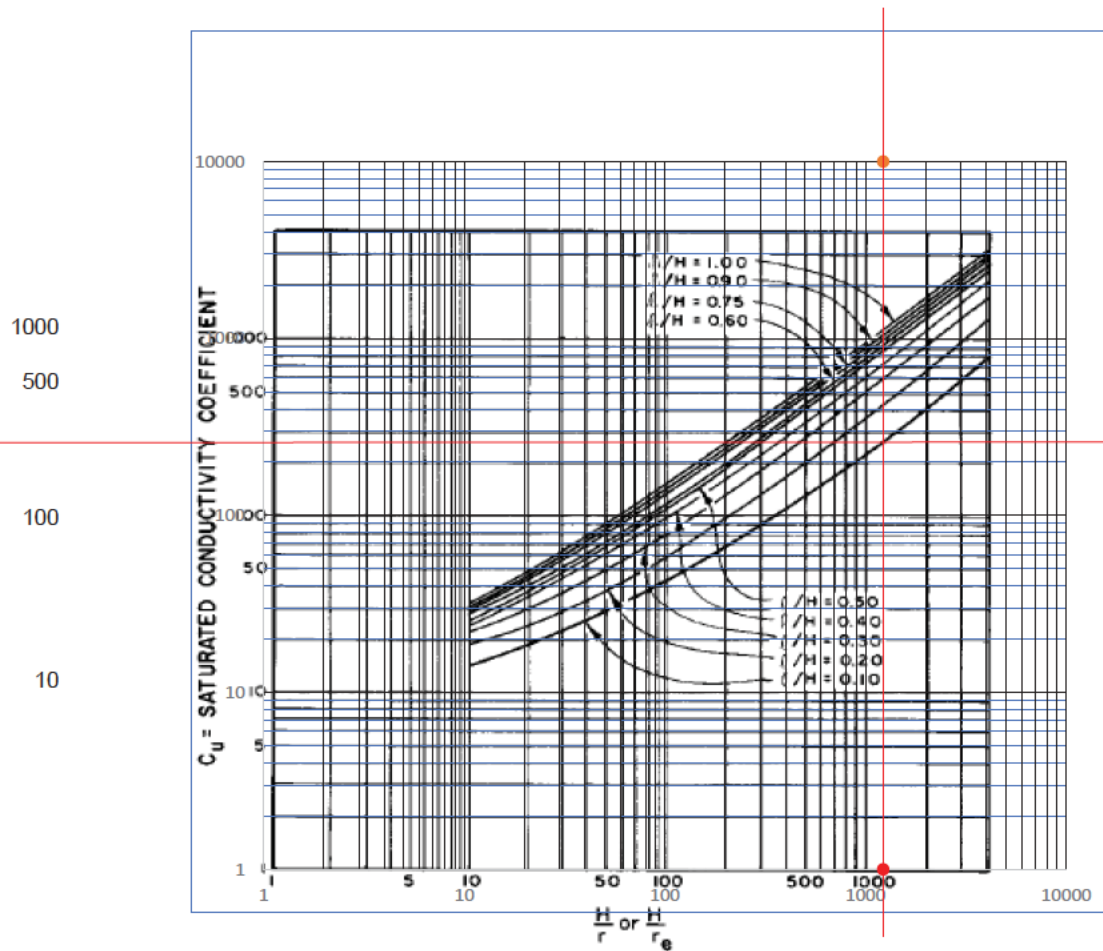
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	80.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	21.18
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	21.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	34
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	78.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	184.8
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	332.8

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	56
$X = \frac{H}{T_u} (100)$	1182
	0.12
	300
T <sub>u</sub> / ℓ	15
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	2.1E-08	0.65	6.3E-07

Check Applicability


Q / a =	0.000008	≤	0.1	Yes
ℓ (ft.) =	21.5	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

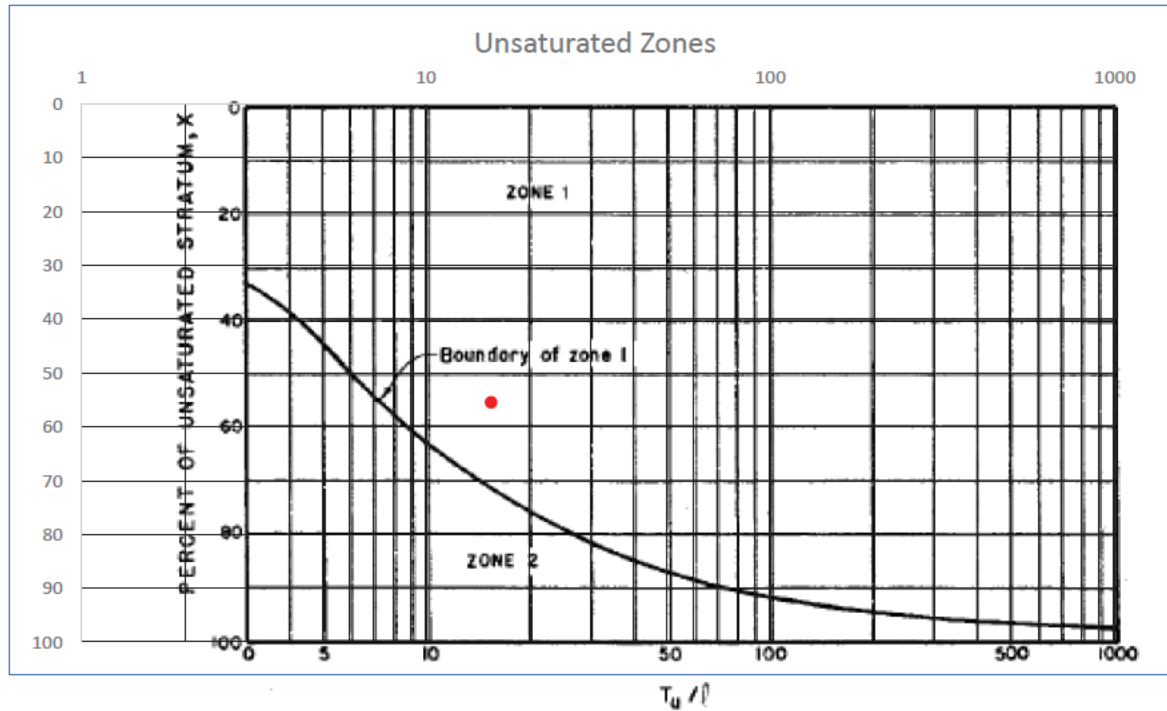
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

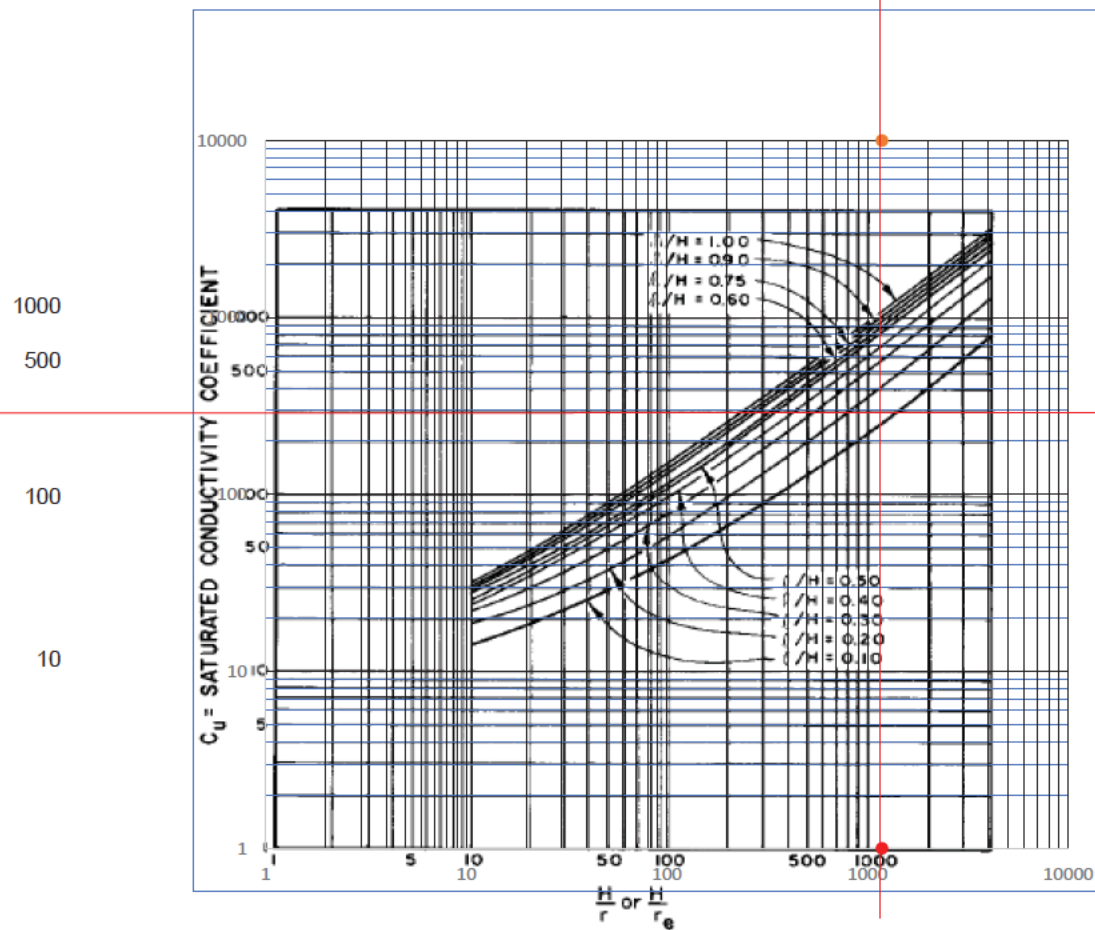
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	80.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	21.18
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	21.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	46
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	106.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	212.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	360.5

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	59	H / r	1360
$X = \frac{H}{T_u} (100)$		ℓ / H	0.10
T <sub>u</sub> / ℓ	17	Saturated Conductivity Coefficient, C <sub>u</sub>	300
	Zone 1		

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	9.0E-09	0.28	2.7E-07

  
**Check Applicability**


Q / a =	0.00000	≤	0.1	
ℓ (ft.) =	21.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

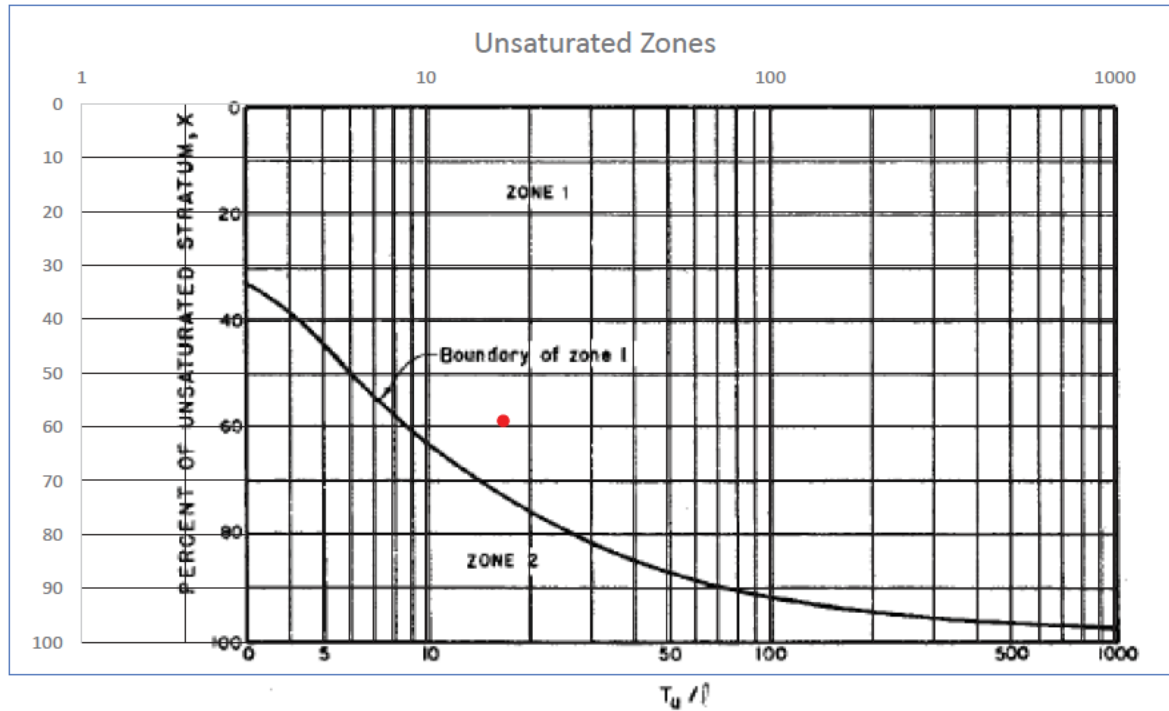
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

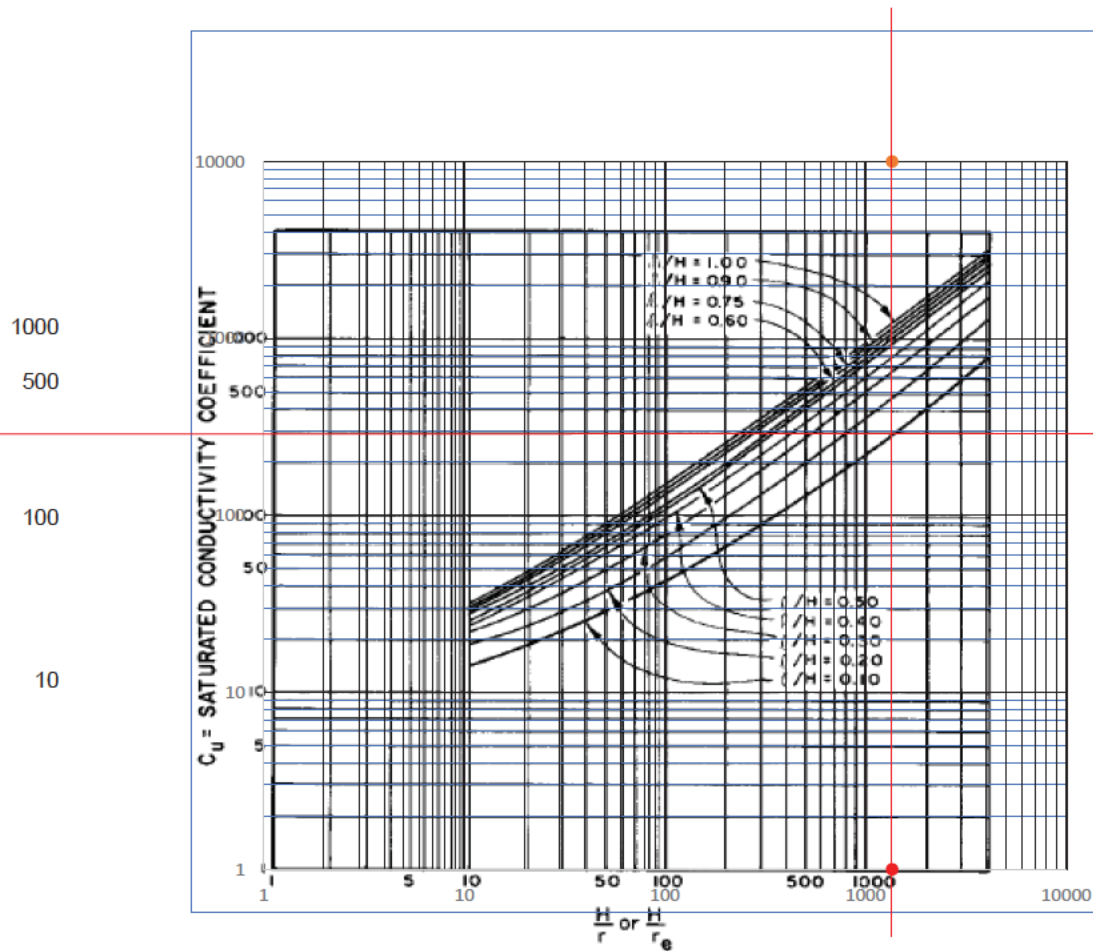
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106
Depth to Top of Test Zone, ft.	75.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	25.90
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	26.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	145.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	293.2

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	50
$X = \frac{H}{T_u} (100)$	929
	H / r
	ℓ / H
	0.18
	Saturated Conductivity Coefficient, C <sub>u</sub>
	300
T <sub>u</sub> / ℓ	11
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.3E-08	0.42	4.0E-07

Check Applicability


Q / a =	0.000003	≤	0.1	Yes
ℓ (ft.) =	26.3	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

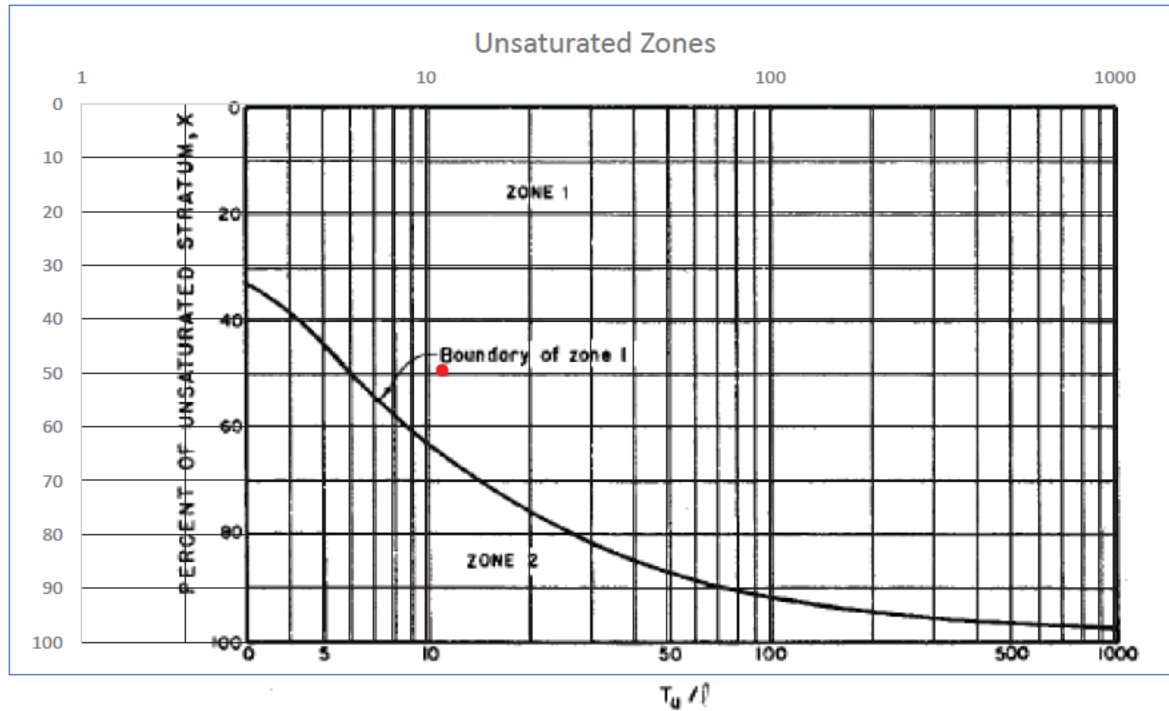
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

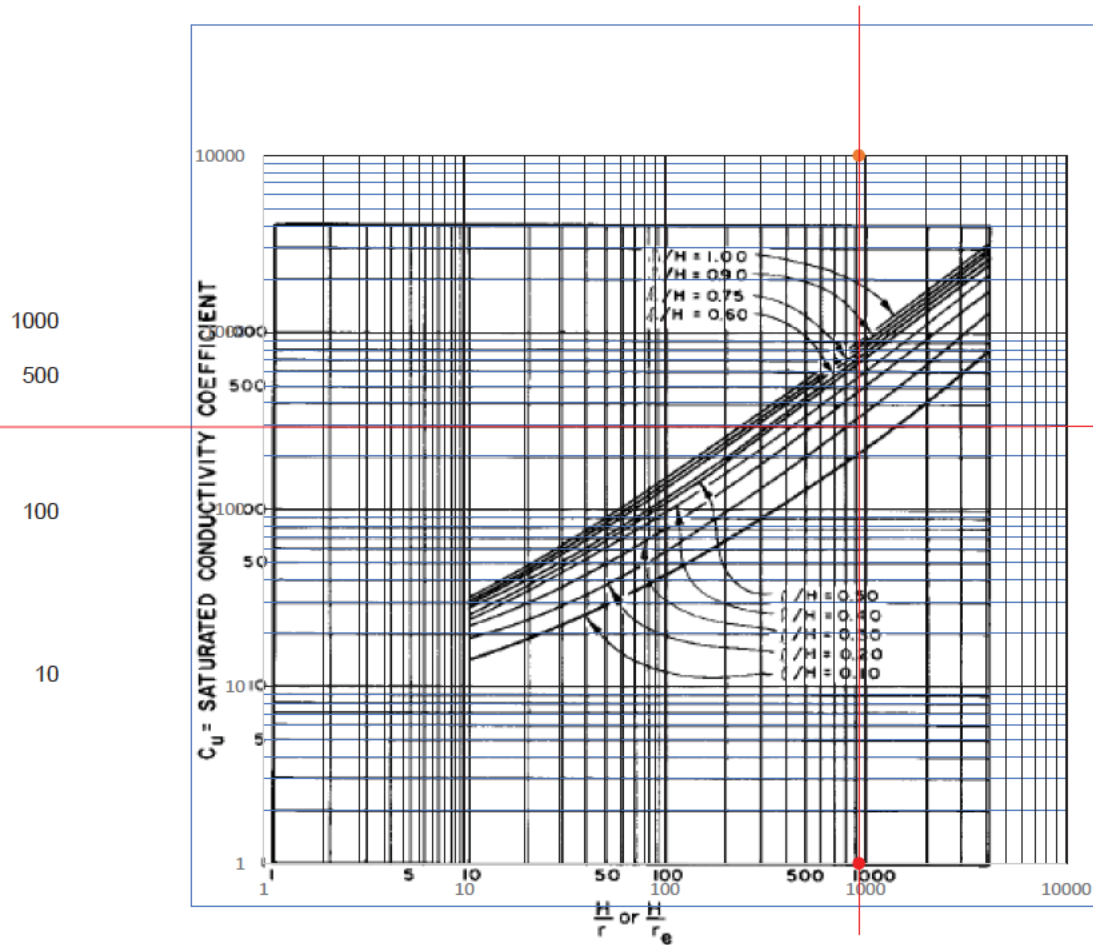
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106
Depth to Top of Test Zone, ft.	75.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	25.90
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	26.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	31
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	71.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	177.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	325.5

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	55	H / r	1136
$X = \frac{H}{T_u} (100)$		ℓ / H	0.15
T <sub>u</sub> / ℓ	12	Saturated Conductivity Coefficient, C <sub>u</sub>	310
	Zone 1		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
< 0.01	0.03	5	0.0001	1.0E-08	0.33	3.2E-07

Check Applicability


Q / a =	0.000003	≤	0.1	Yes
ℓ (ft.) =	26.3	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

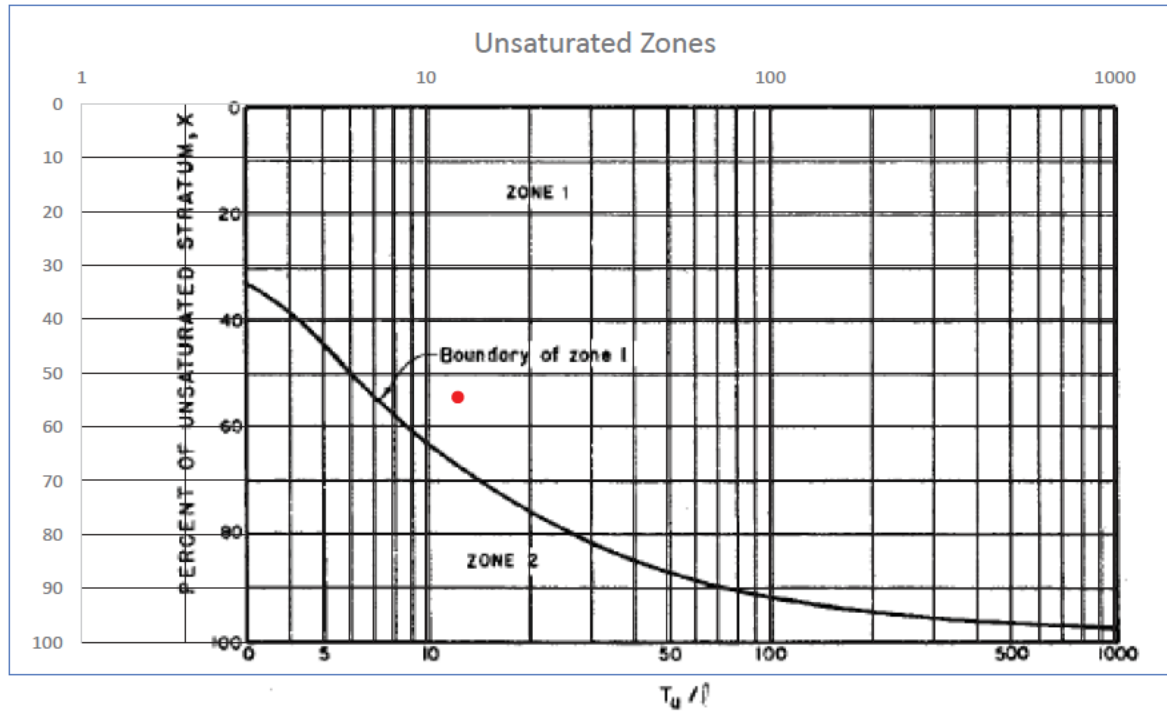
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

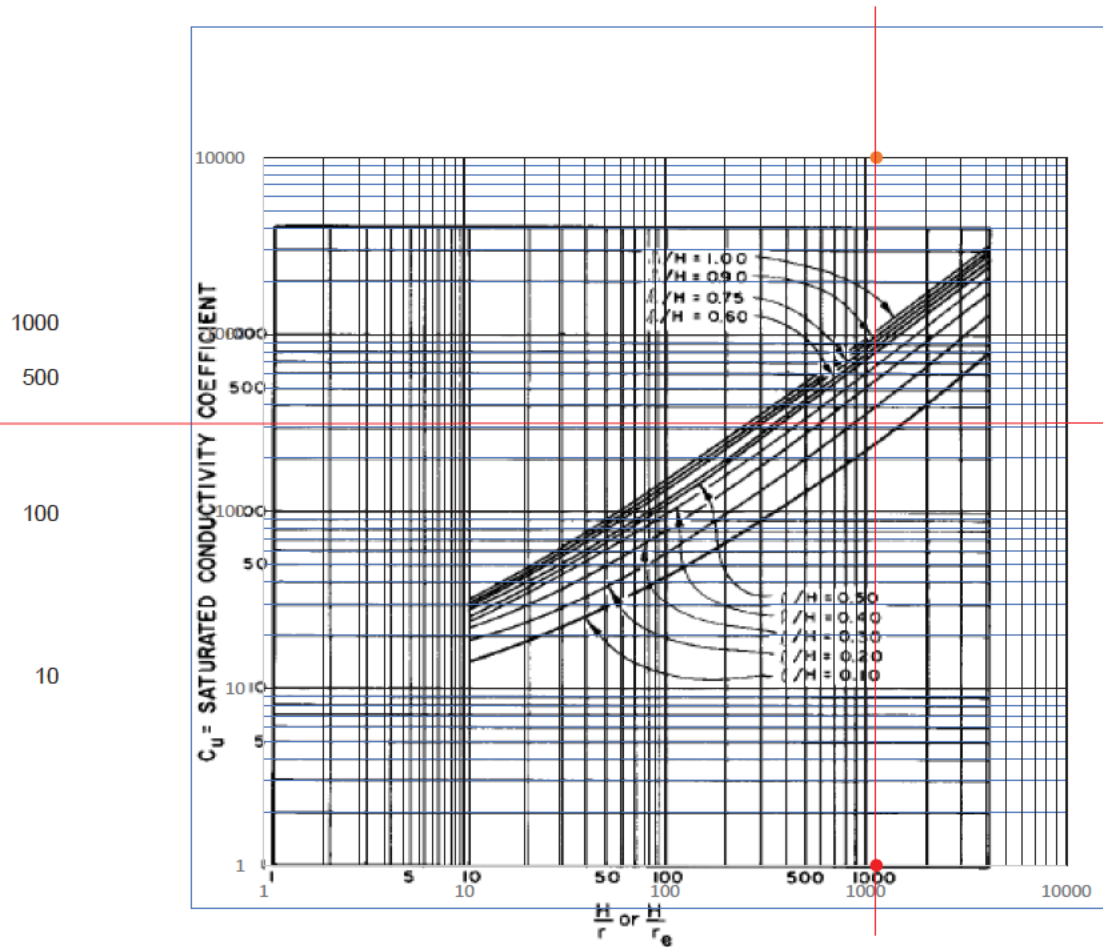
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3c
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.	<u>250</u>
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	<u>4</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>106</u>
Depth to Top of Test Zone, ft.	<u>75.7</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>25.90</u>
Depth to Bottom of Borehole, D, ft.	<u>102</u>	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	<u>26.3</u>	<i>Ignored for flow less than 2 gpm</i>	<u>0</u>
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	<u>46</u>
Drum Diameter, ft.	<u>1.85</u>	h <sub>2</sub> , ft	<u>106.2</u>
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	Effective Head, H, ft.	<u>212.2</u>
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	<u>360.2</u>

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	<u>59</u>
$X = \frac{H}{T_u} (100)$	<u>1358</u>
	<u>0.12</u>
T <sub>u</sub> / ℓ	<u>14</u>
	<u>Zone 1</u>
	<u>325</u>

Saturated Conductivity Coefficient, C<sub>u</sub>

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
< 0.01	<u>0.03</u>	5	<u>0.0001</u>	<u>8.3E-09</u>	<u>0.26</u>	<u>2.5E-07</u>

  
**Check Applicability**


Q / a =	<u>0.000003</u>	≤	0.1	
ℓ (ft.) =	<u>26.3</u>	≥	10 r (ft.) =	<u>1.6</u>
				<u>Yes</u>

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

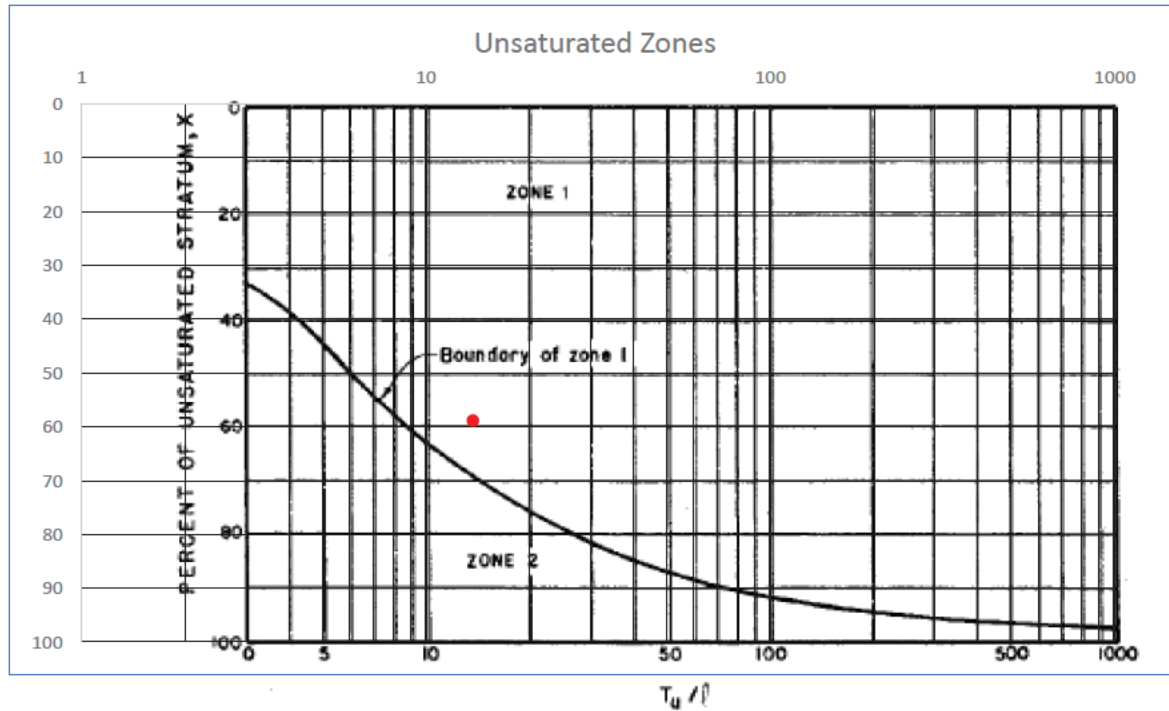
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

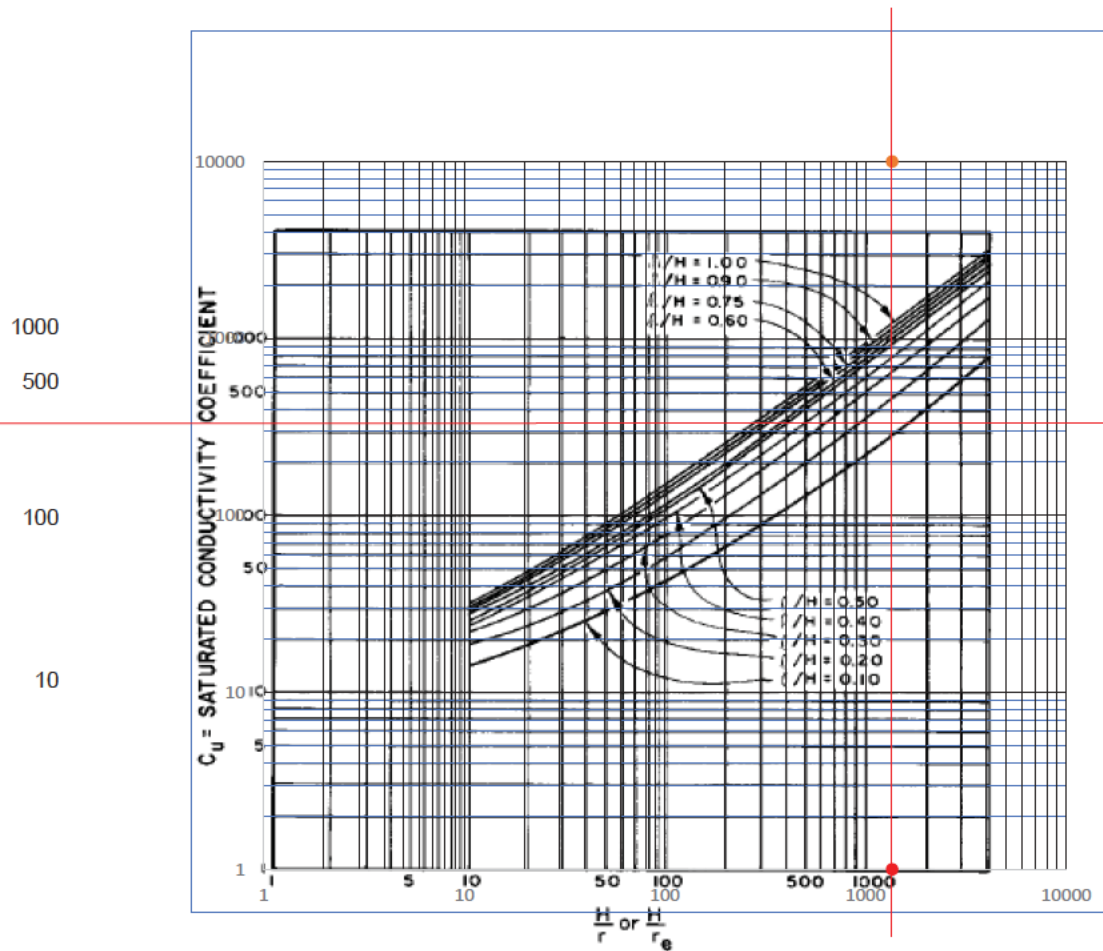
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	131.1
Depth to Top of Test Zone, ft.	117.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.40
Depth to Bottom of Borehole, D, ft.	127	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	16
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	36.9
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	168.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	291.0

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	58
$X = \frac{H}{T_u} (100)$	1075
	0.06
T <sub>u</sub> / ℓ	31
	Zone 1
	225

Saturated Conductivity Coefficient, C<sub>u</sub>

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	5	0.001	9.1E-08	2.87	2.8E-06


  
**Check Applicability**

Q / a =	0.00006	≤	0.1	
ℓ (ft.) =	9.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

  
**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

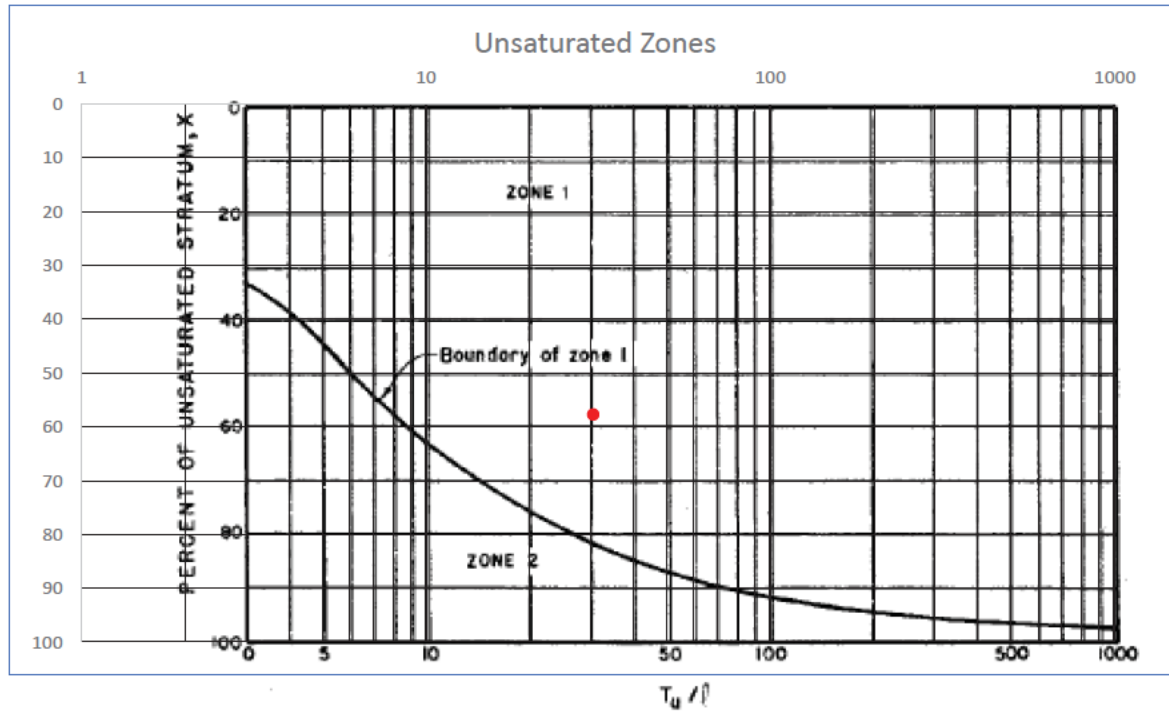
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

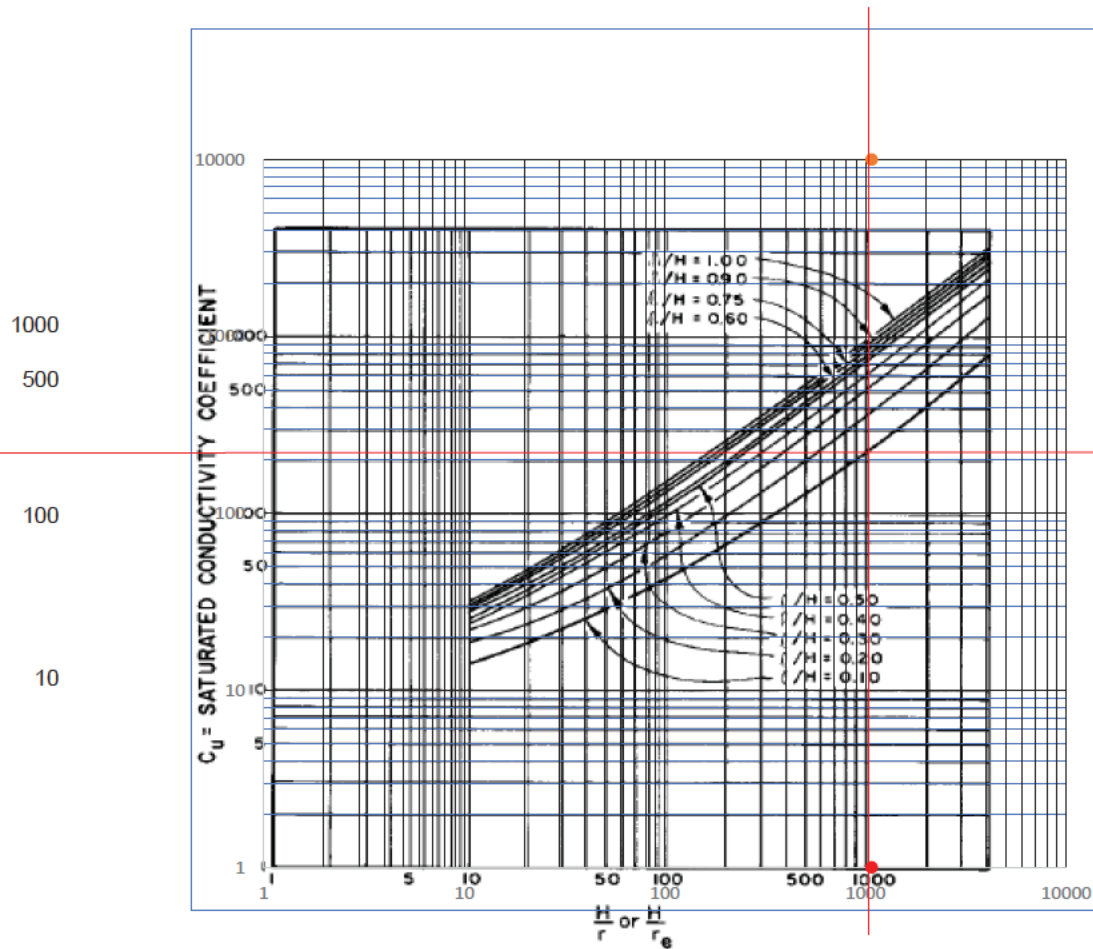
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	131.1
Depth to Top of Test Zone, ft.	117.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.40
Depth to Bottom of Borehole, D, ft.	127	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	30
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	69.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	200.3
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	323.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	62
$X = \frac{H}{T_u} (100)$	1282
	0.05
	275
T <sub>u</sub> / ℓ	34
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.08	0.22	5	0.001	8.3E-08	2.63	2.5E-06


Check Applicability

Q / a =	0.00008	≤	0.1	
ℓ (ft.) =	9.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

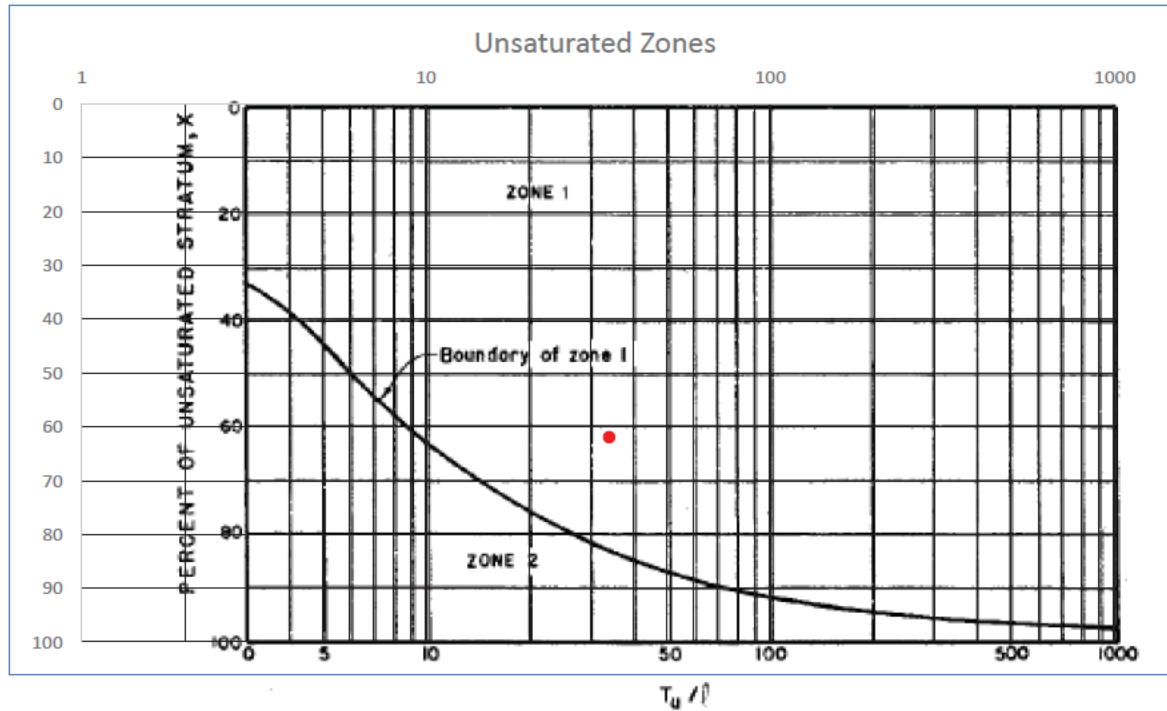
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

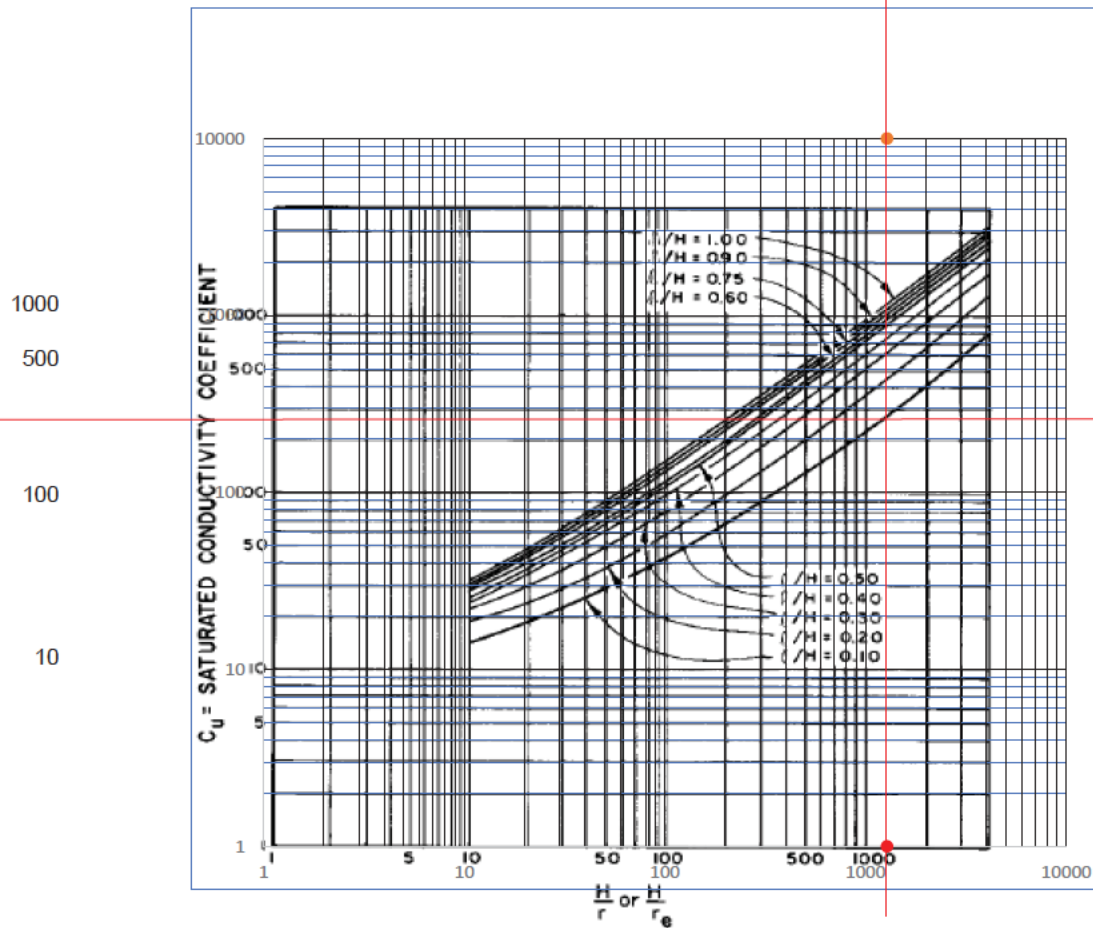
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4c
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	131.1
Depth to Top of Test Zone, ft.	117.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.40
Depth to Bottom of Borehole, D, ft.	127	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	234.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	66
$X = \frac{H}{T_u} (100)$	1504
	0.04
	300
T <sub>u</sub> / ℓ	38
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.38	1.02	20	0.001	7.7E-08	2.44	2.4E-06

Check Applicability


Q / a =	0.00009	≤	0.1	Yes
ℓ (ft.) =	9.5	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

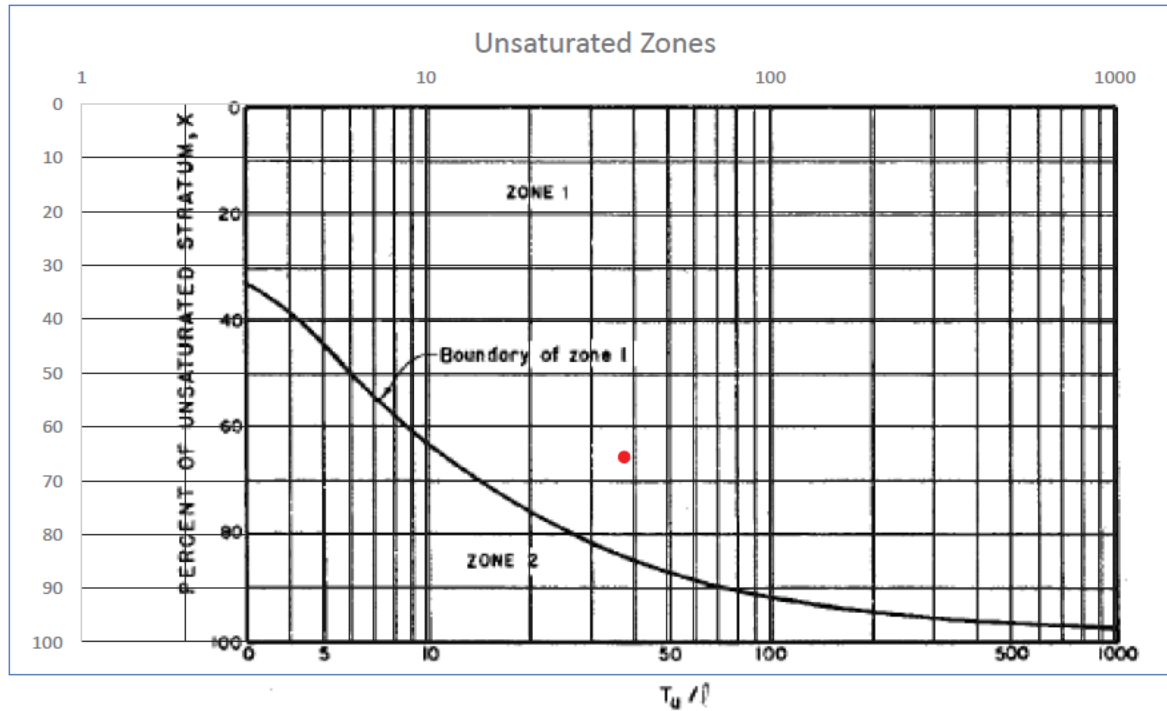
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

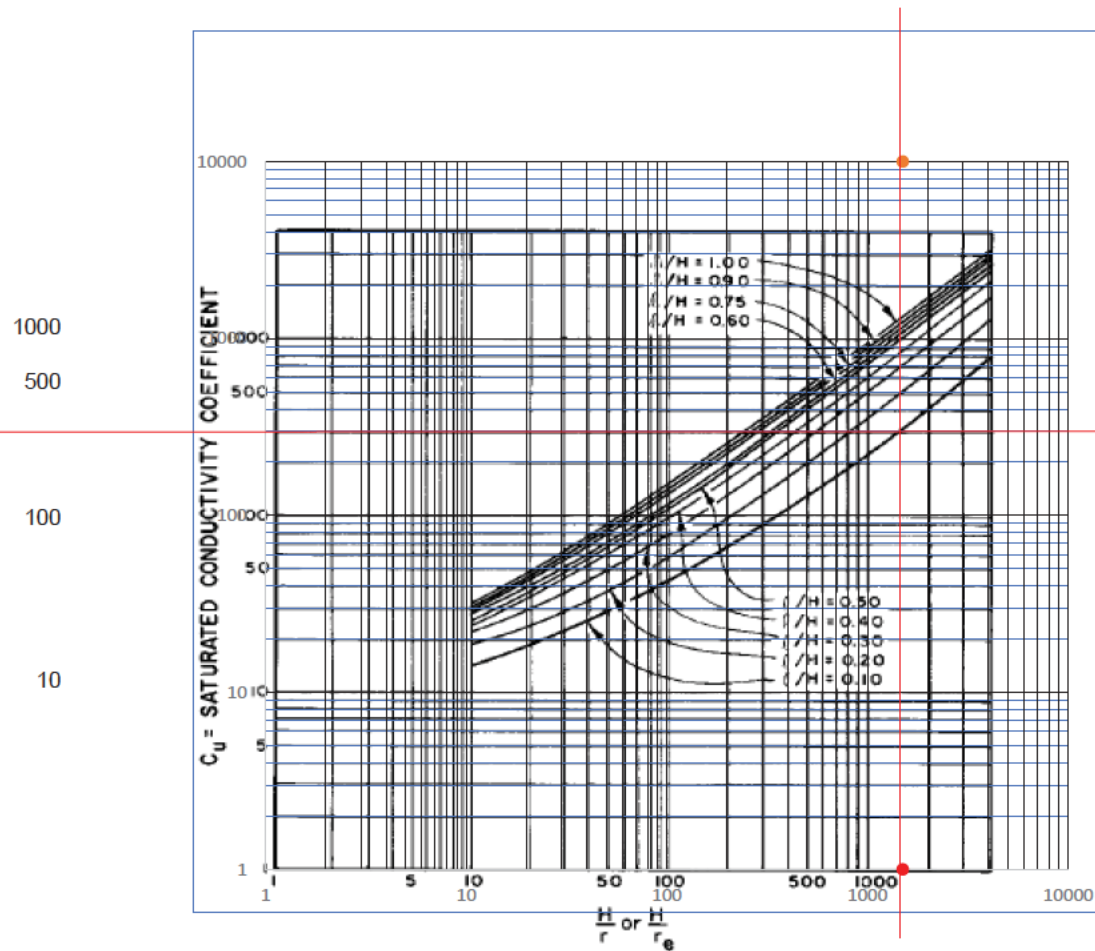
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	120.1
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	293.1

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	41
$X = \frac{H}{T_u} (100)$	769
	0.08
	190
T <sub>u</sub> / ℓ	32
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	5.0E-08	1.58	1.5E-06

Check Applicability


Q / a =	0.000019	≤	0.1	
ℓ (ft.) =	9.3	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

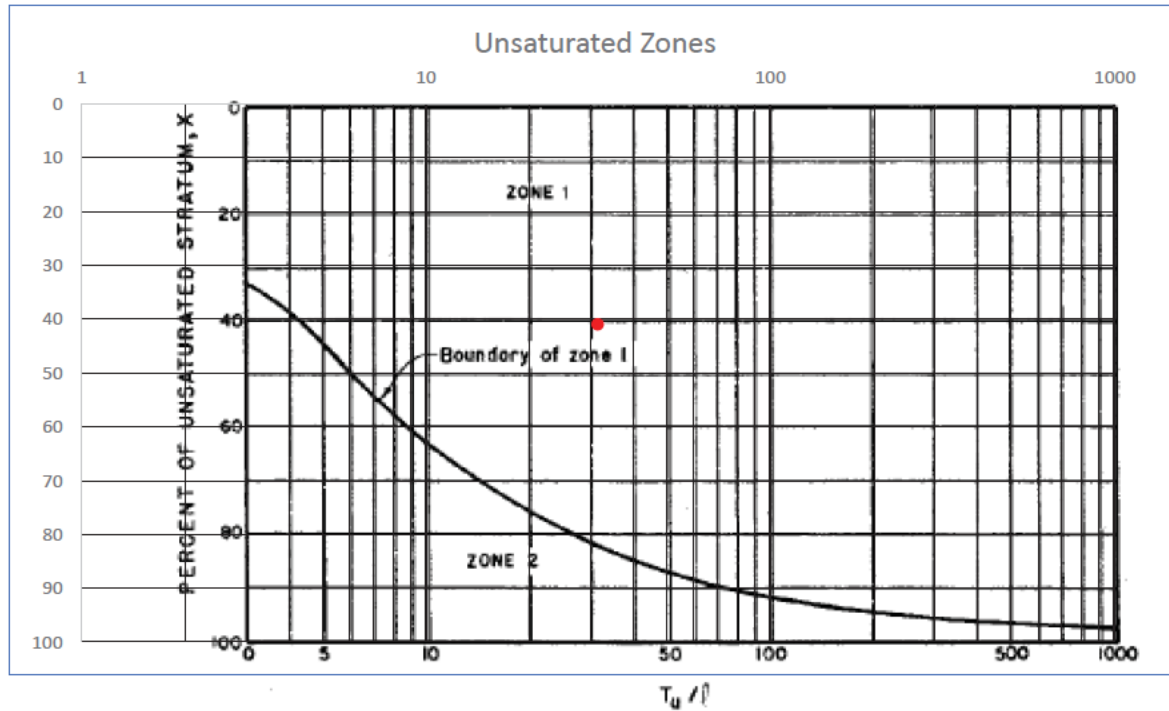
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

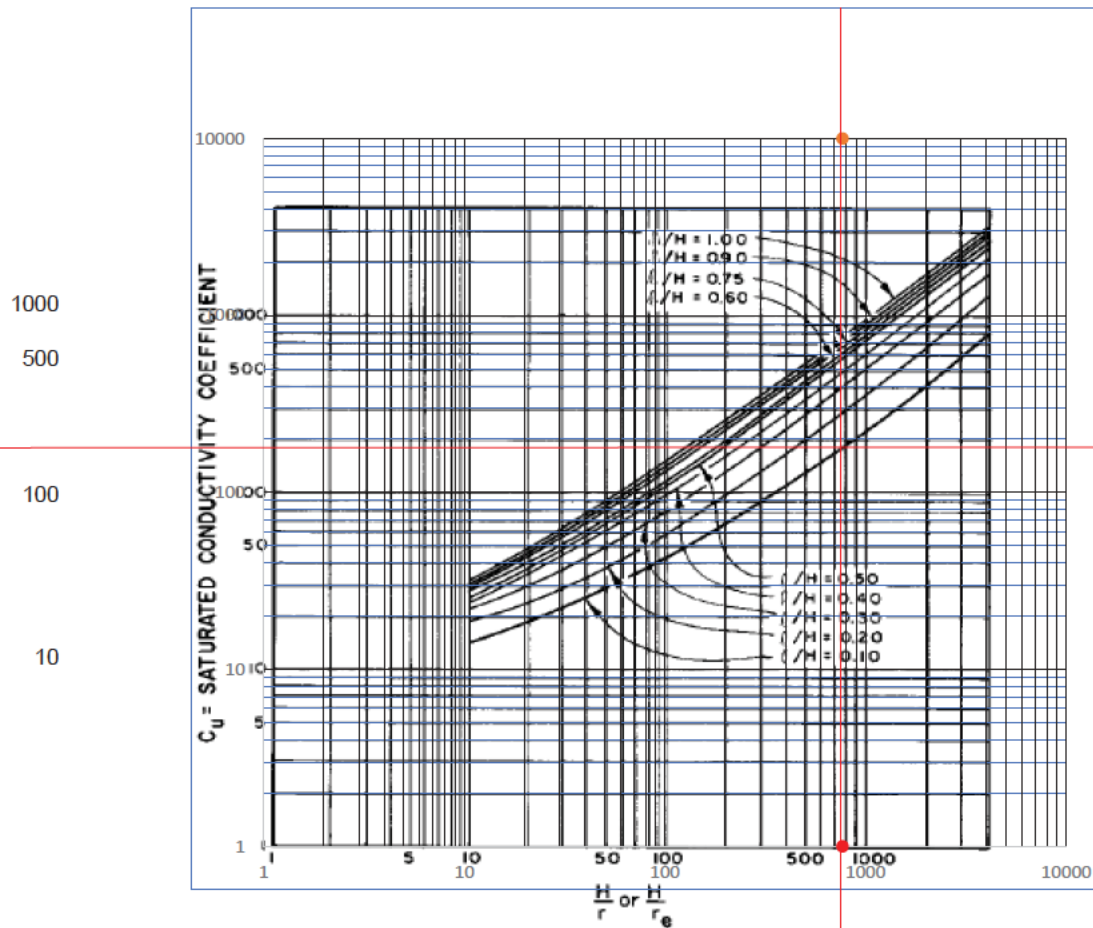
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	32
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	73.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	154.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	327.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	47	H / r	990
$X = \frac{H}{T_u} (100)$		ℓ / H	0.06
T <sub>u</sub> / ℓ	35	Saturated Conductivity Coefficient, C <sub>u</sub>	210
	Zone 1		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.8E-08	0.56	5.4E-07


Check Applicability

Q / a =	0.000010	≤	0.1	
ℓ (ft.) =	9.3	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

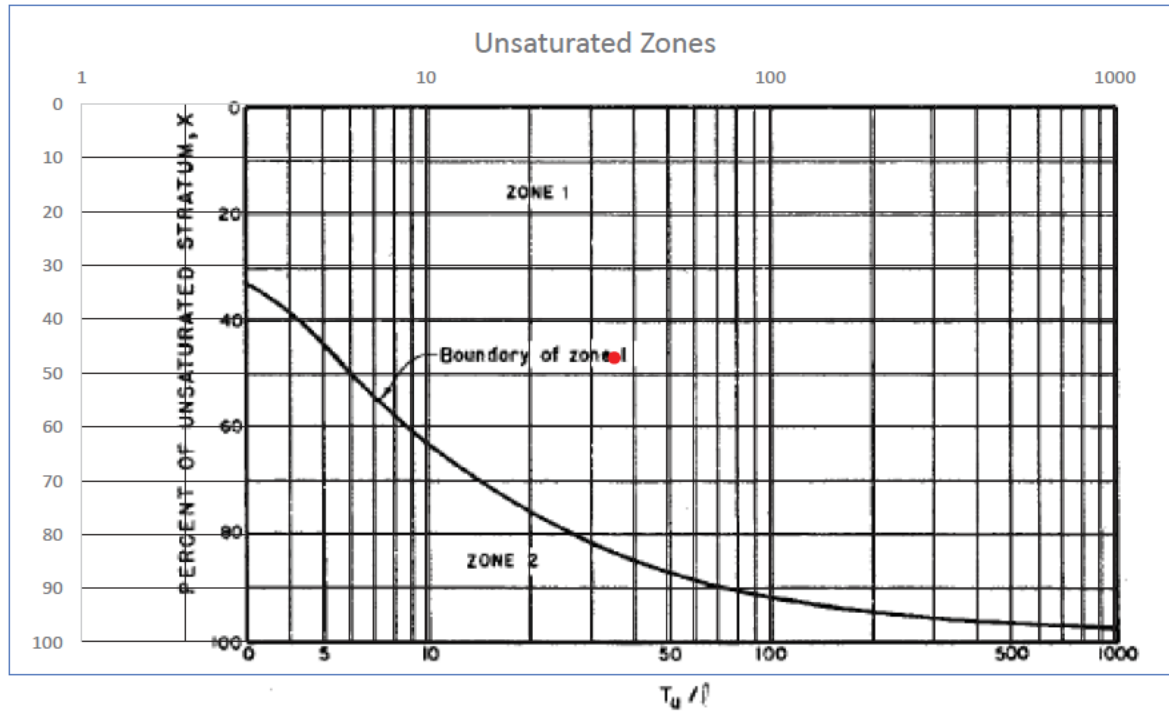
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

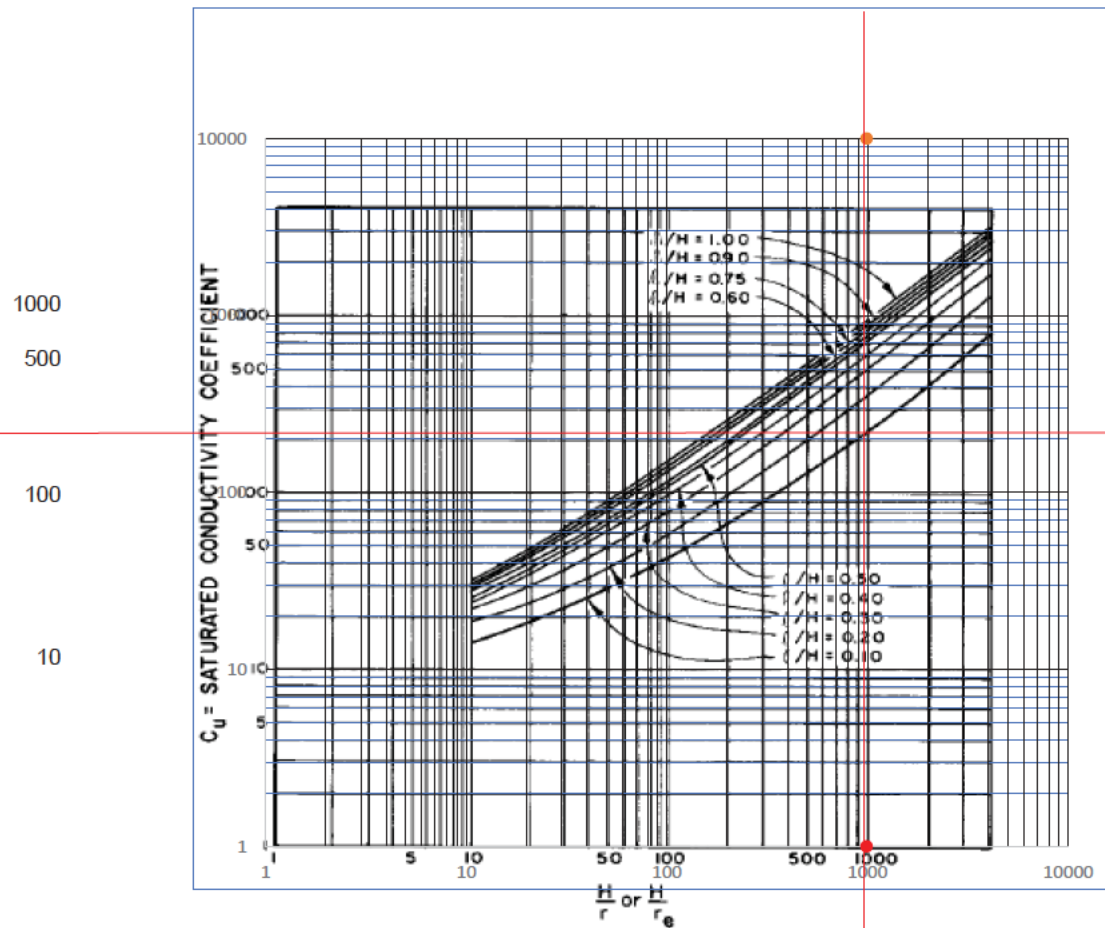
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	184.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	52
$X = \frac{H}{T_u} (100)$	1182
	0.05
	250
T <sub>u</sub> / ℓ	38
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	3.7E-08	1.17	1.1E-06


Check Applicability

Q / a =	0.000029	≤	0.1	
ℓ (ft.) =	9.3	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

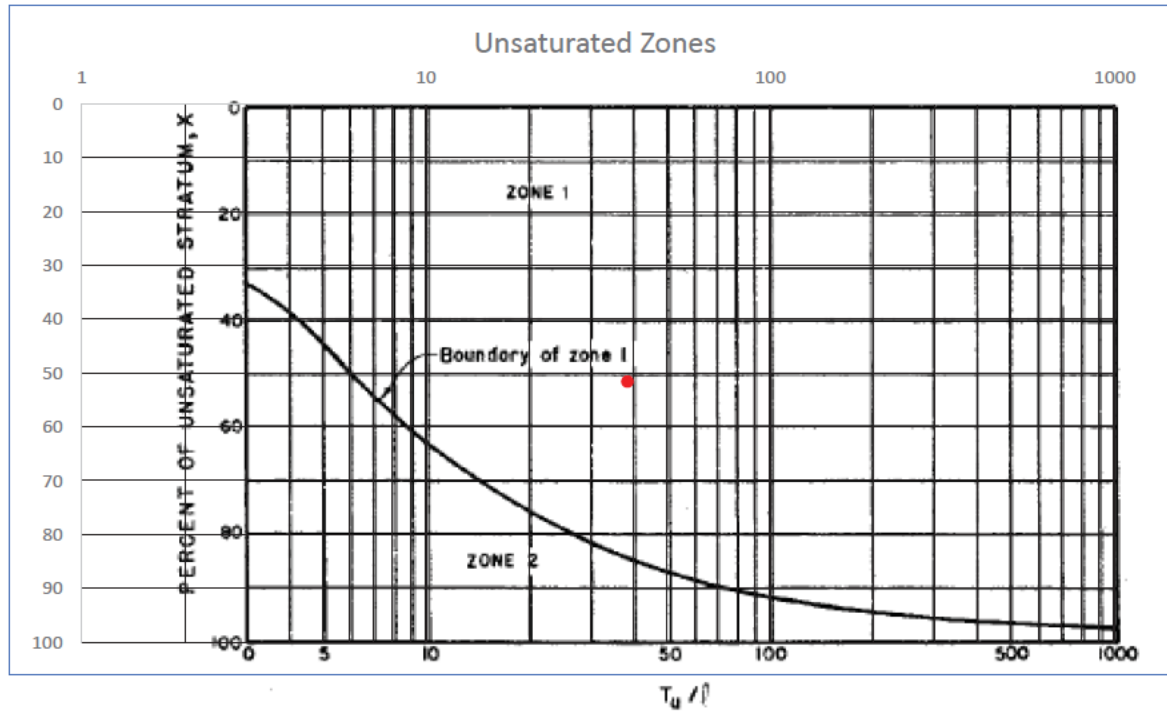
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

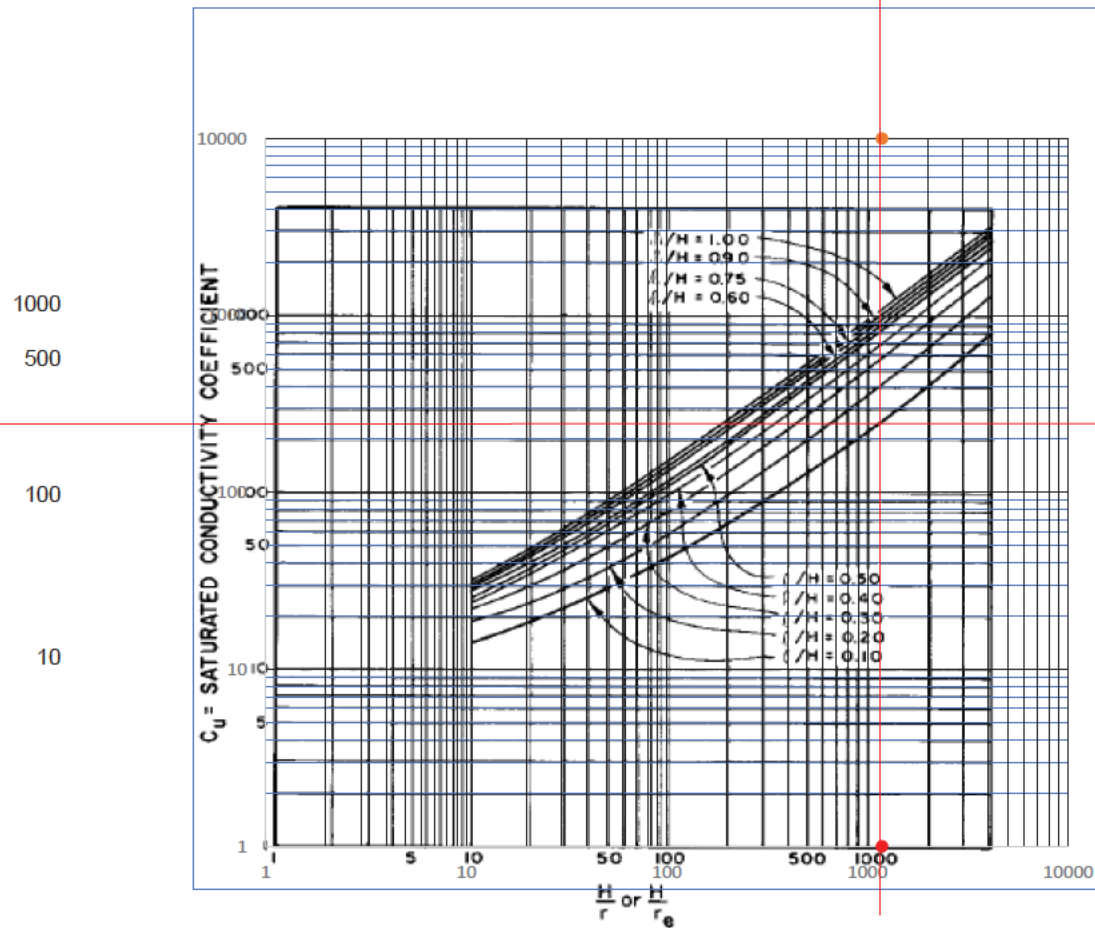
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	15
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	34.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	125.3
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	288.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	43
$X = \frac{H}{T_u} (100)$	802
	0.07
	190
T <sub>u</sub> / ℓ	31
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.11	0.30	5	0.0010	2.6E-07	8.35	8.1E-06

Check Applicability


Q / a =	0.000108	≤	0.1	Yes
ℓ (ft.) =	9.2	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

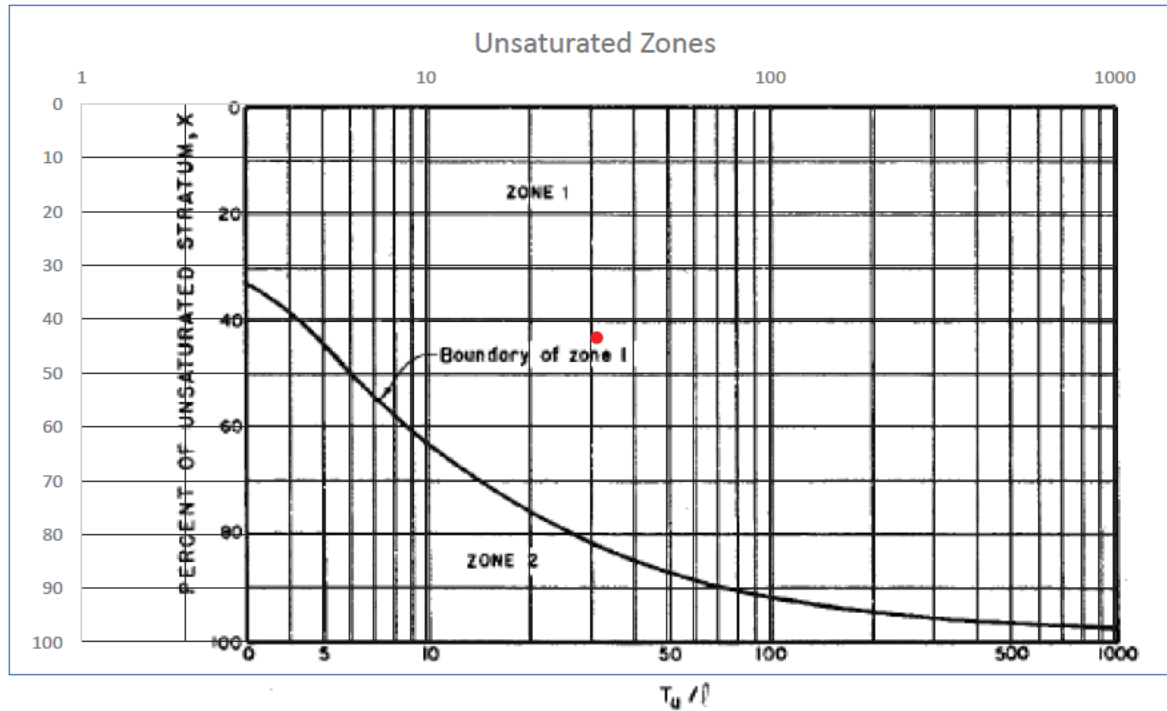
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

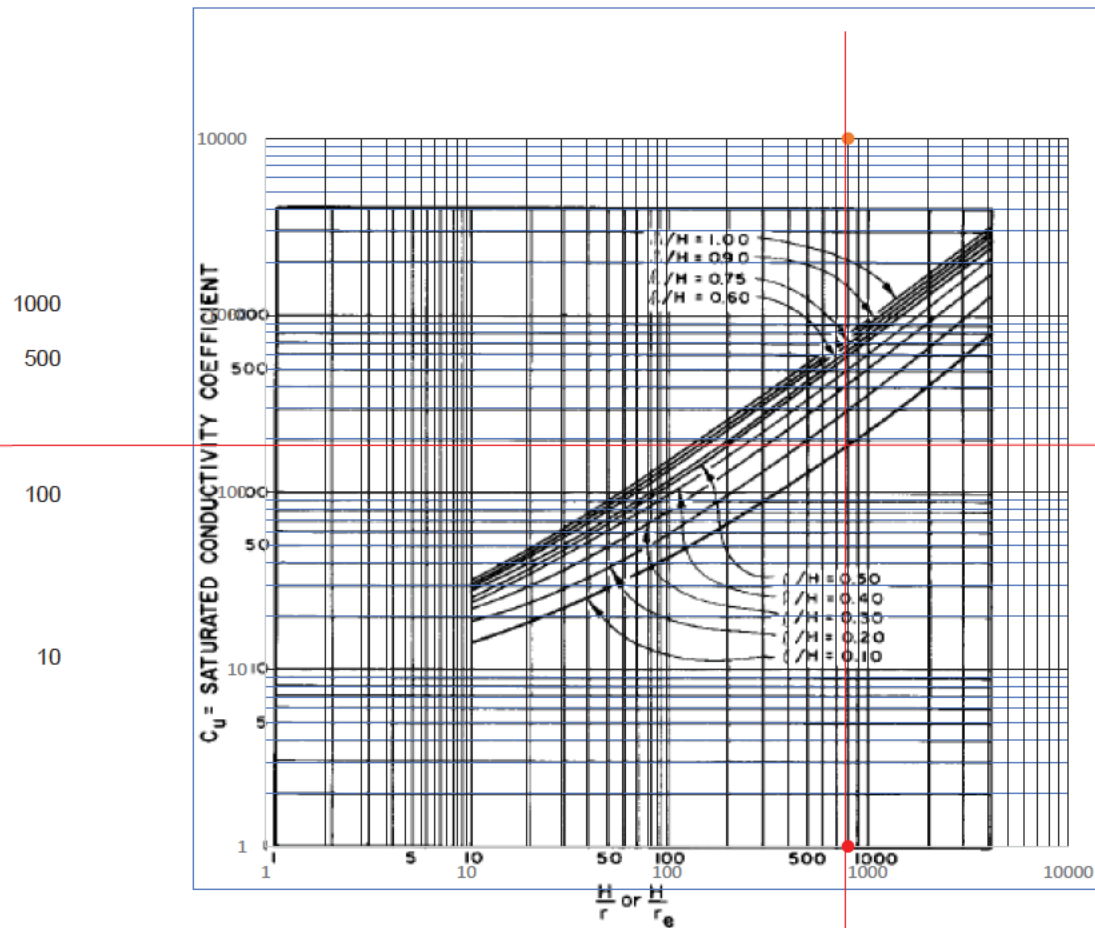
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	30
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	69.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	159.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	322.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	50
$X = \frac{H}{T_u} (100)$	1024
	0.06
	210
T <sub>u</sub> / ℓ	35
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.16	0.43	5	0.0014	2.7E-07	8.62	8.3E-06

Check Applicability


Q / a =	0.000157	≤	0.1	Yes
ℓ (ft.) =	9.2	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

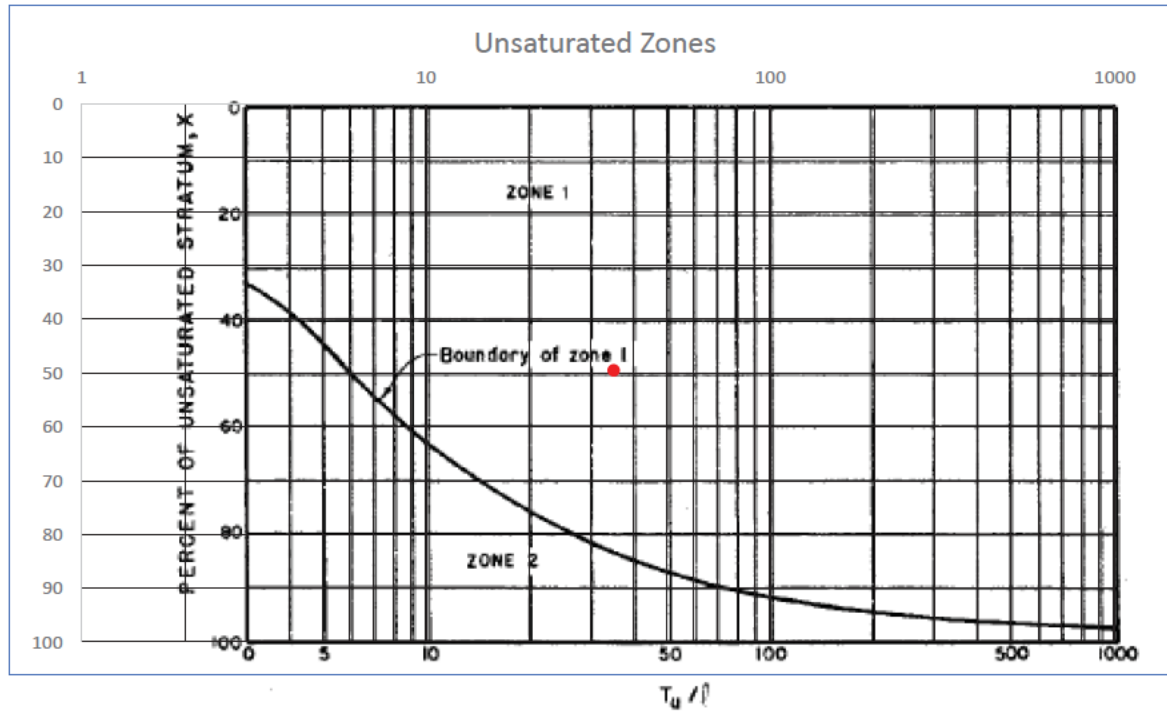
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

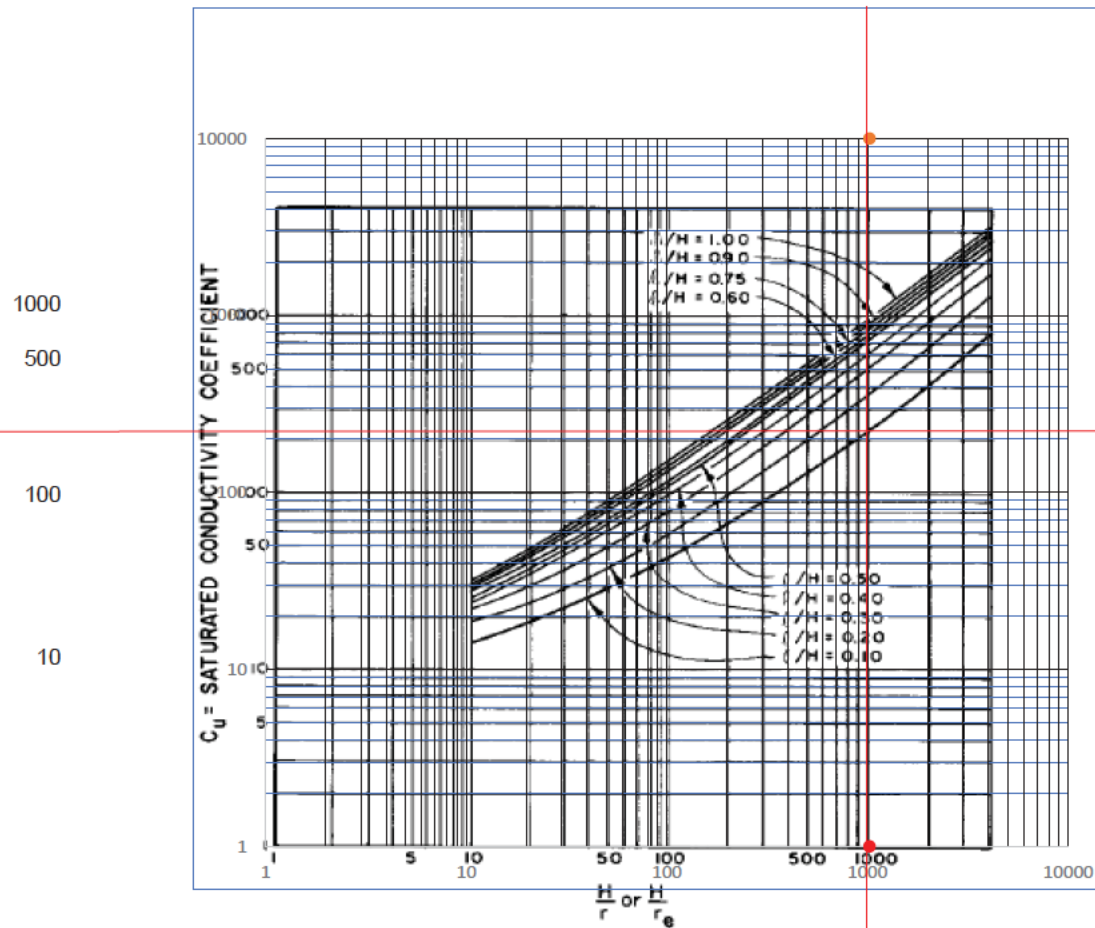
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By:		Date:

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	194.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.5

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	54	H / r	1245
$X = \frac{H}{T_u} (100)$		ℓ / H	0.05
T <sub>u</sub> / ℓ	39	Saturated Conductivity Coefficient, C <sub>u</sub>	250
	<u>Zone 1</u>		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.19	0.51	5	0.0017	2.2E-07	7.06	6.8E-06

Check Applicability


Q / a =	0.000187	≤	0.1	
ℓ (ft.) =	9.2	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

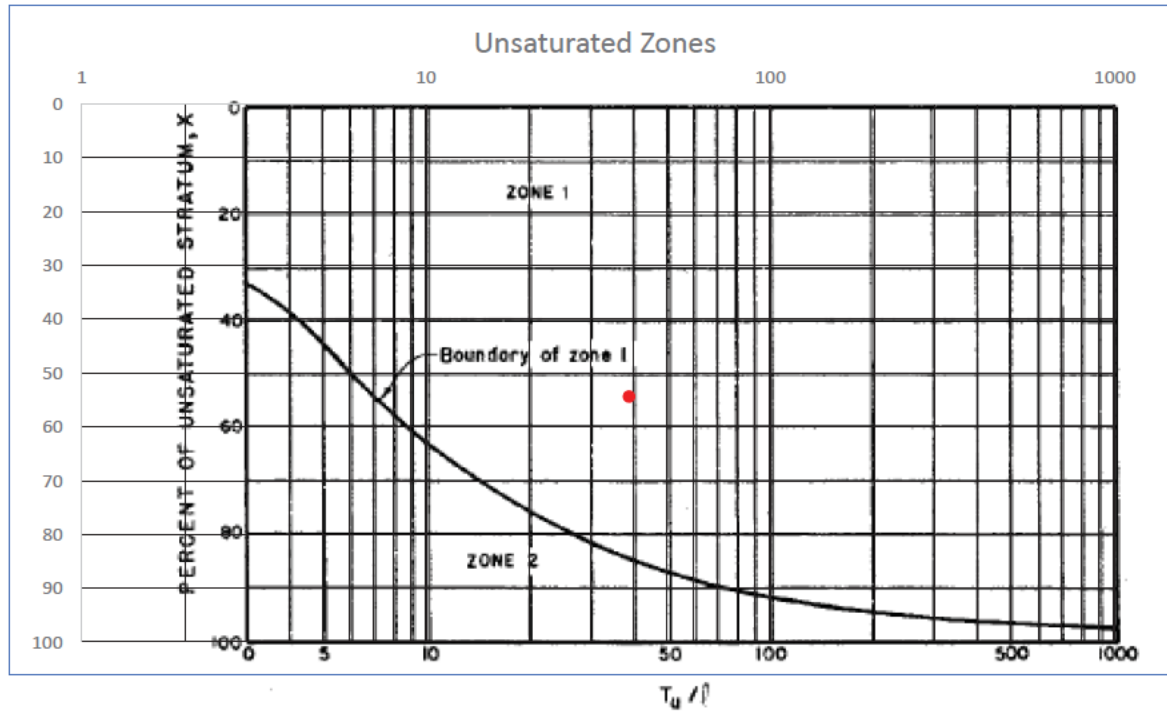
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

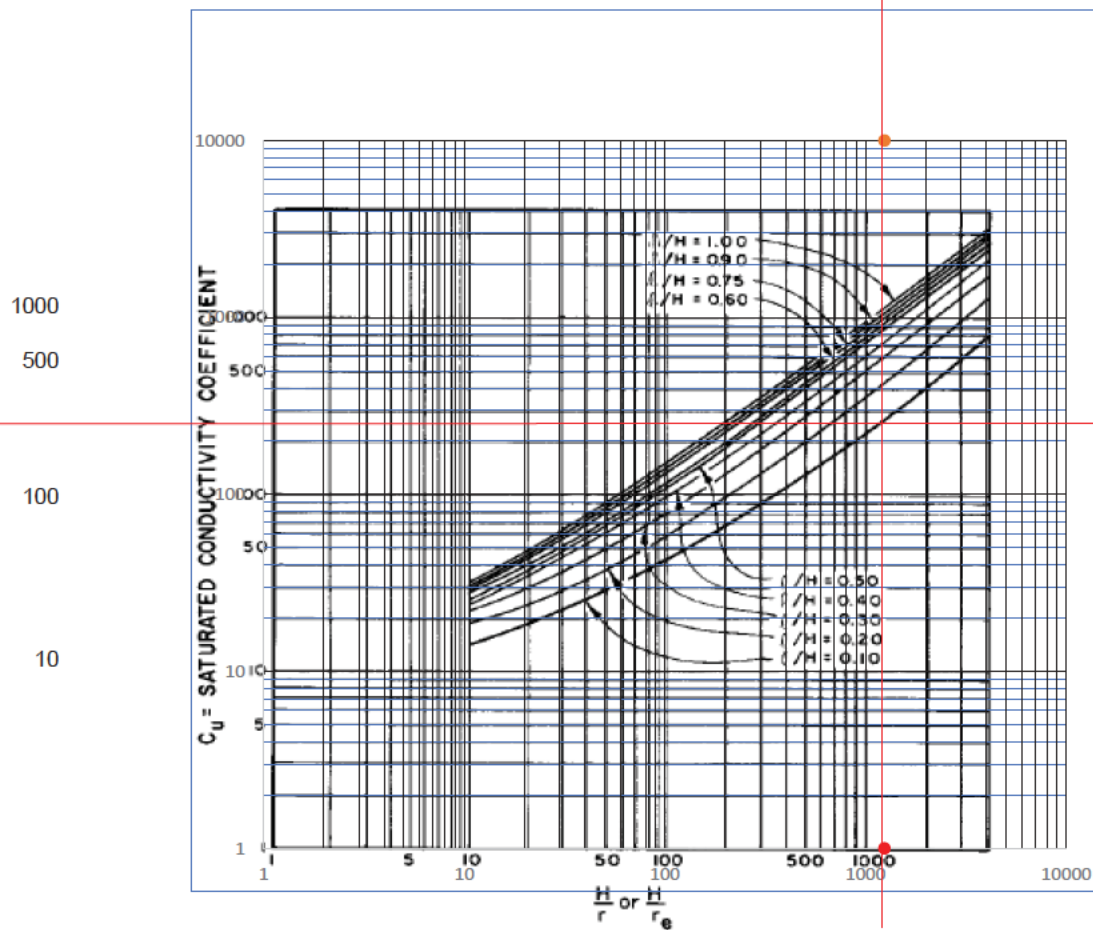
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	144.6
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	292.6

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7	
Percent of unsaturated stratum, X	49	H / r
$X = \frac{H}{T_u} (100)$		ℓ / H
		0.10
		Saturated Conductivity Coefficient, C <sub>u</sub>
		205
T <sub>u</sub> / ℓ	21	
	Zone 1	

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	3.9E-08	1.22	1.2E-06

Check Applicability


Q / a =	0.000013	≤	0.1	Yes
ℓ (ft.) =	13.9	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

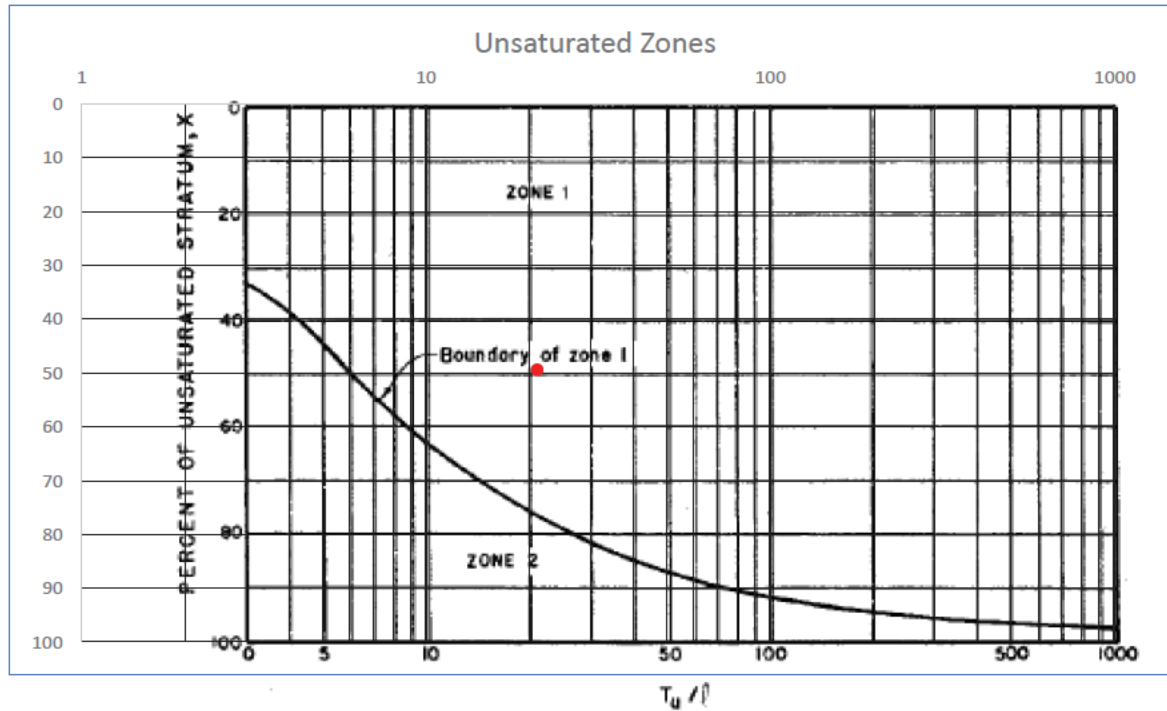
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

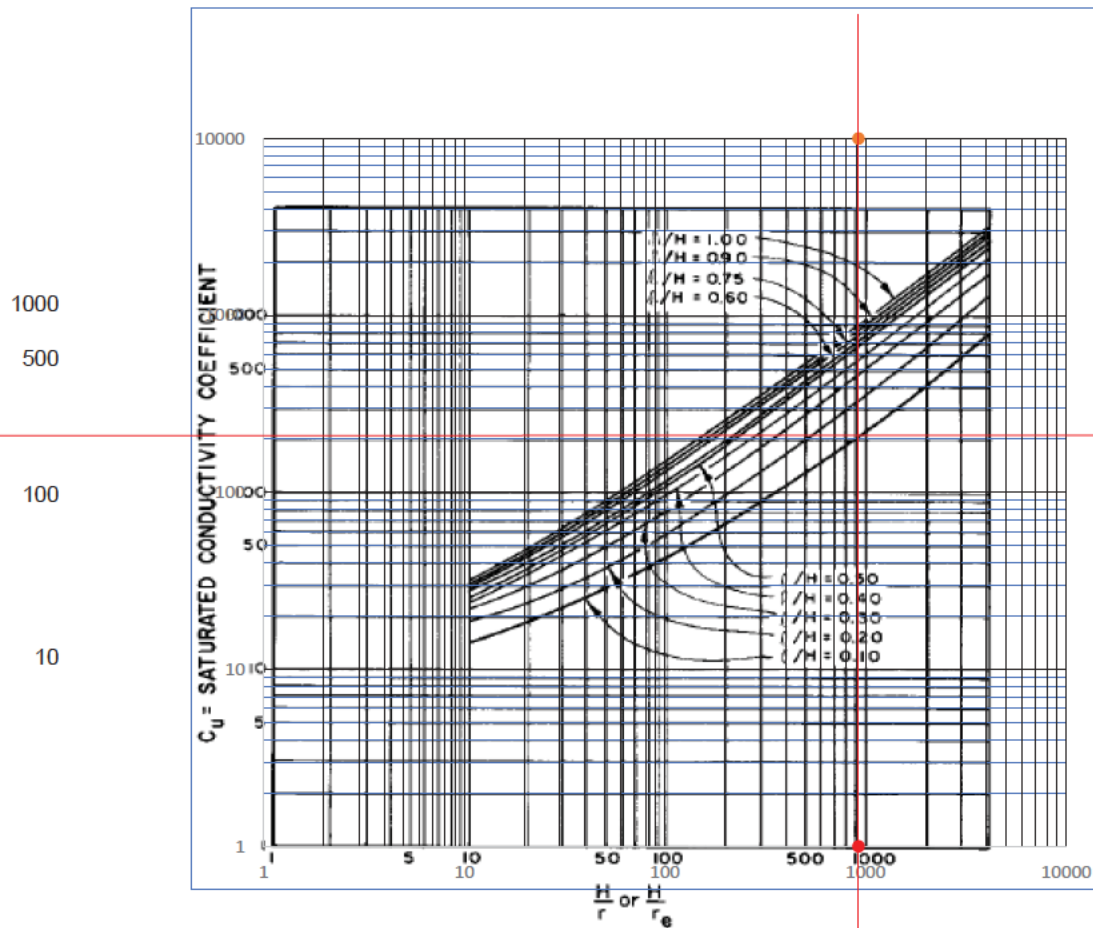
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	31
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	71.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	176.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	324.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	54	H / r	1132
$X = \frac{H}{T_u} (100)$		ℓ / H	0.08
T <sub>u</sub> / ℓ	23	Saturated Conductivity Coefficient, C <sub>u</sub>	250
	Zone 1		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.3E-08	0.41	4.0E-07

Check Applicability


Q / a =	0.000007	≤	0.1		Yes
ℓ (ft.) =	13.9	≥	10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

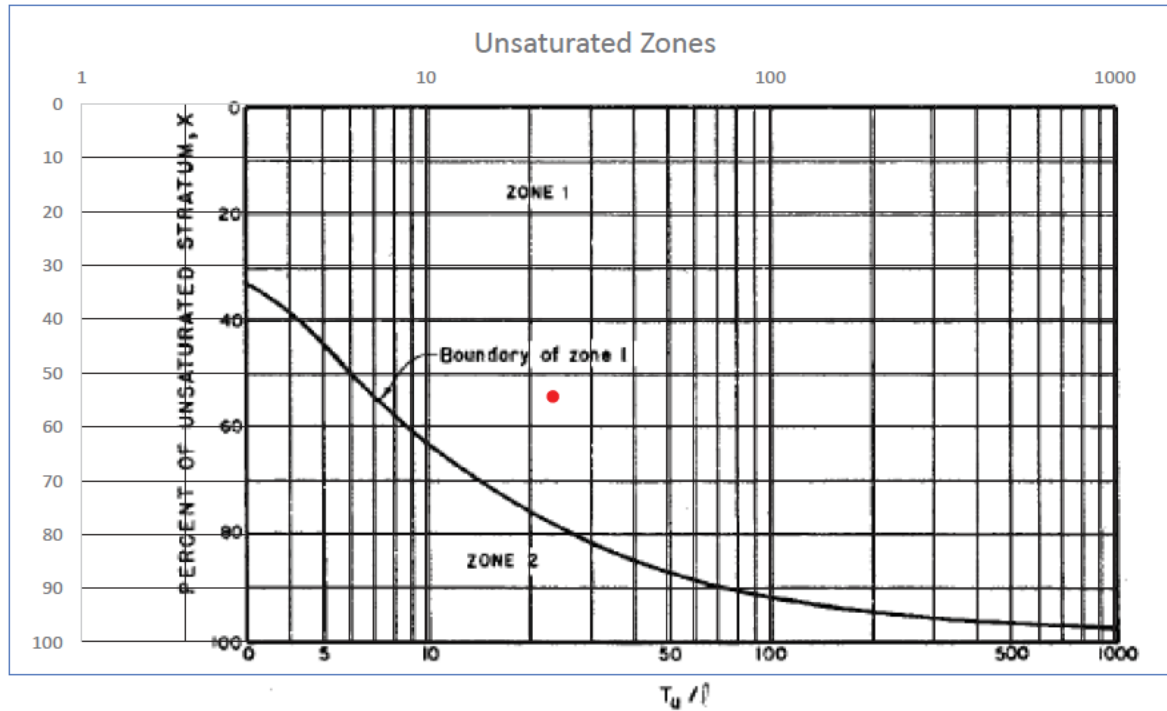
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

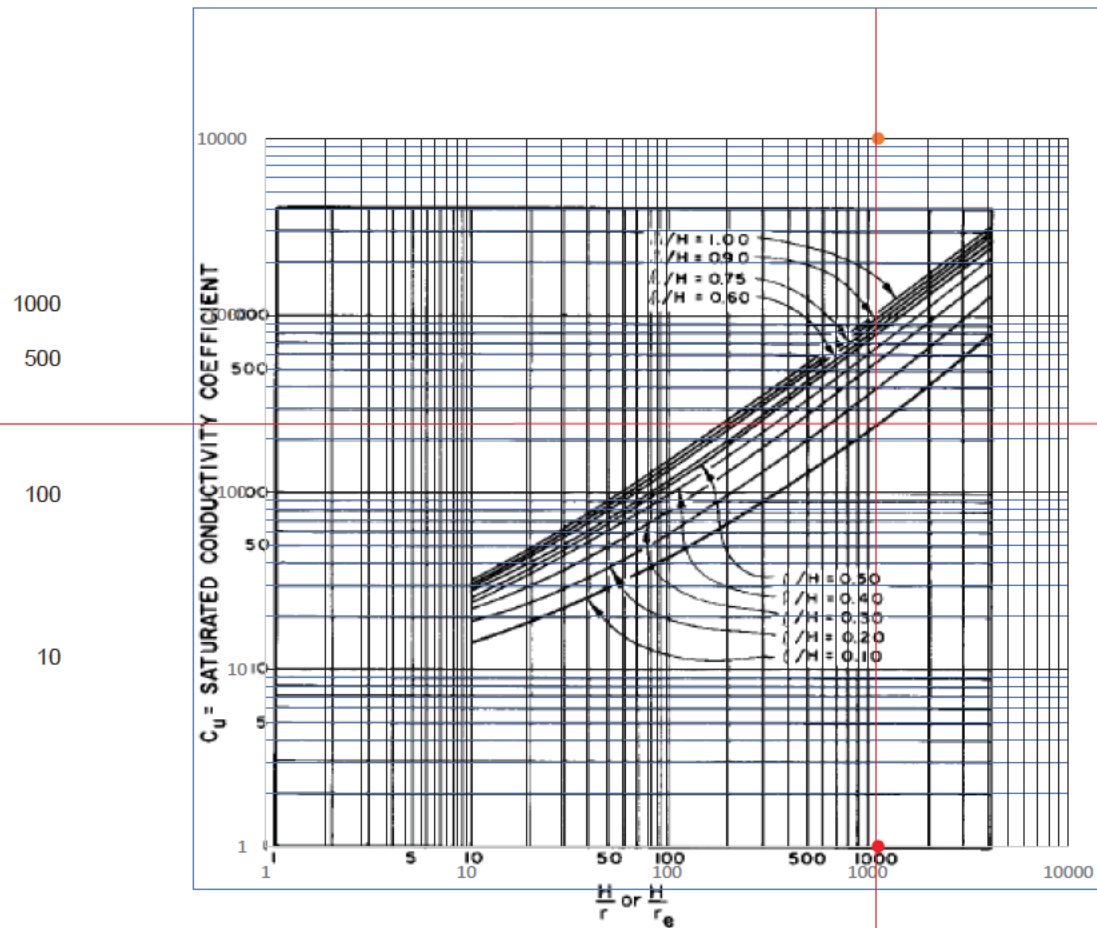
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	209.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.2

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	59
$X = \frac{H}{T_u} (100)$	1339
	ℓ / H
	0.07
	Saturated Conductivity Coefficient, C <sub>u</sub>
	275
T <sub>u</sub> / ℓ	26
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	7	0.0004	4.3E-08	1.35	1.3E-06


Check Applicability

Q / a =	0.000028	≤	0.1	
ℓ (ft.) =	13.9	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

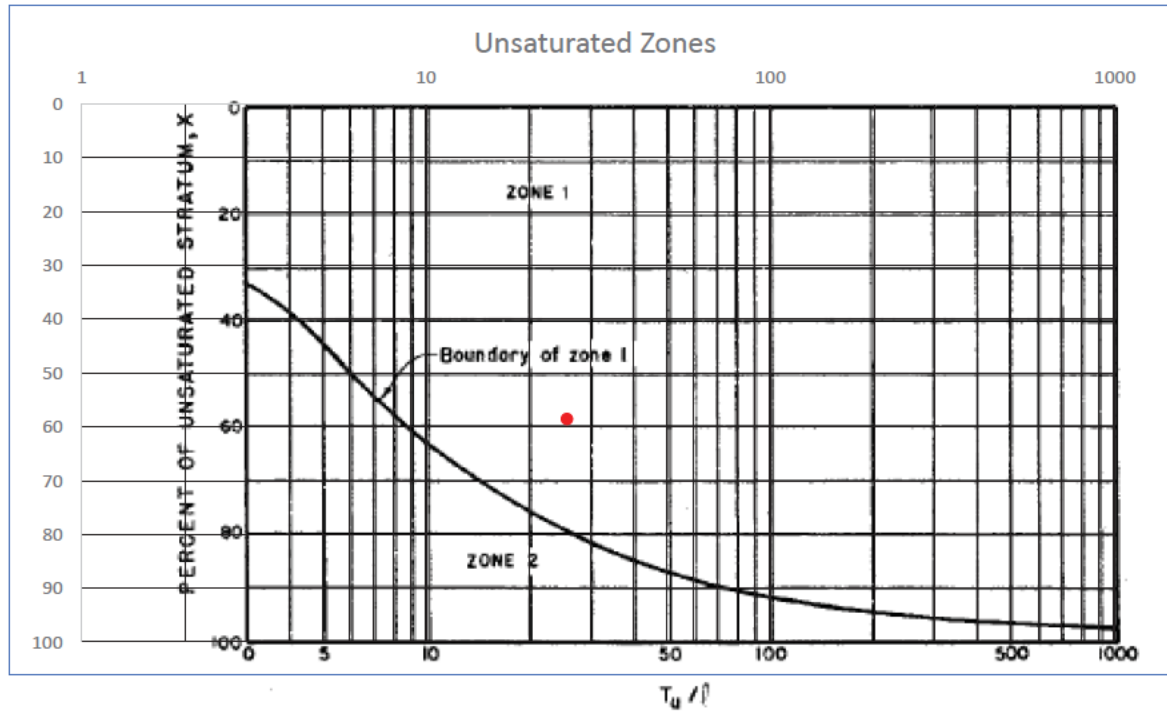
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

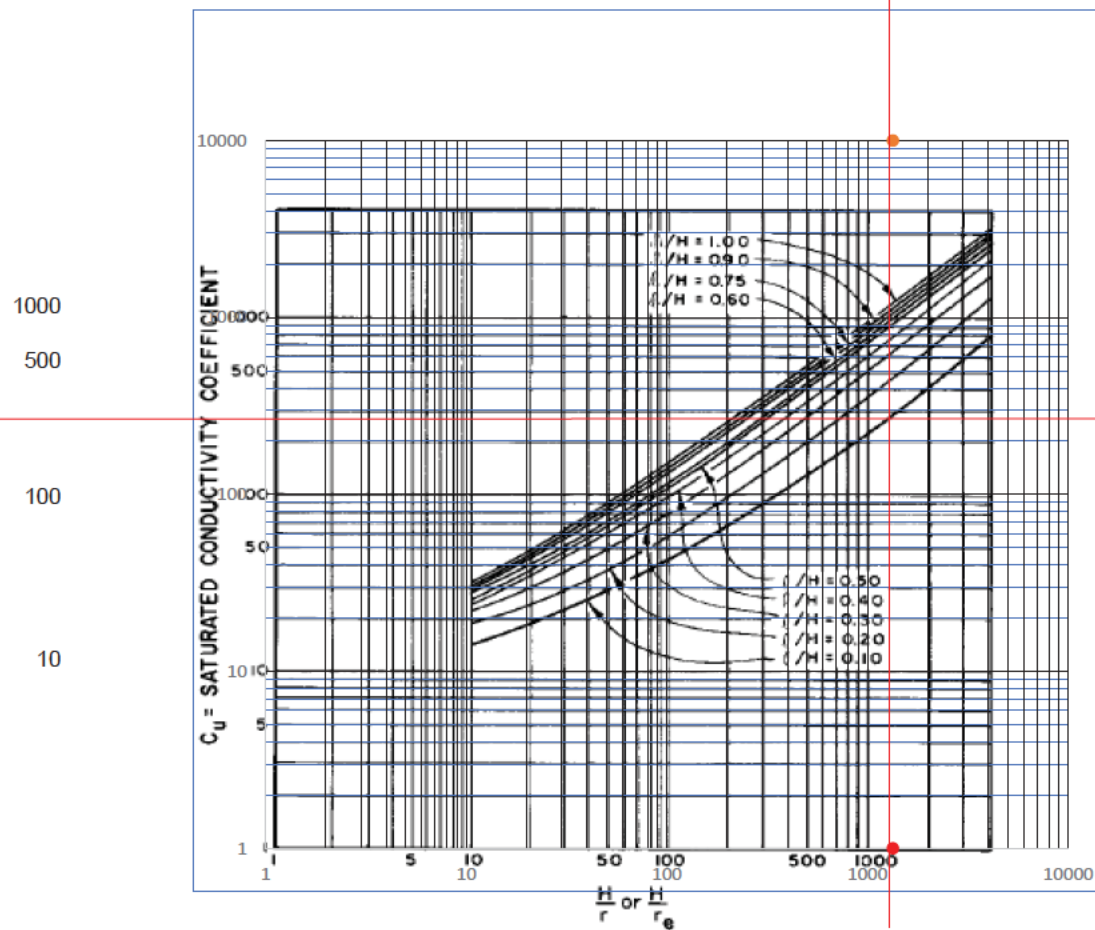
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B109</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3539.6
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/14/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	93	Exposed surface area of the test zone, a, ft. <sup>2</sup>	8.91
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.0	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	15
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	34.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	140.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	288.0

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	49	H / r	896
$X = \frac{H}{T_u} (100)$		ℓ / H	0.06
T <sub>u</sub> / ℓ	32	Saturated Conductivity Coefficient, C <sub>u</sub>	205
	Zone 1		

  
**PACKER TEST DATA**  
*Note: Observed slight leak at ground surface during testing.*

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	6.0E-08	1.89	1.8E-06

  
**Check Applicability**


Q / a =	0.000030	≤	0.1	
ℓ (ft.) =	9	≥	10 r (ft.) =	1.6
				Yes
				Yes

**Notes:**

1. Water pressure was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

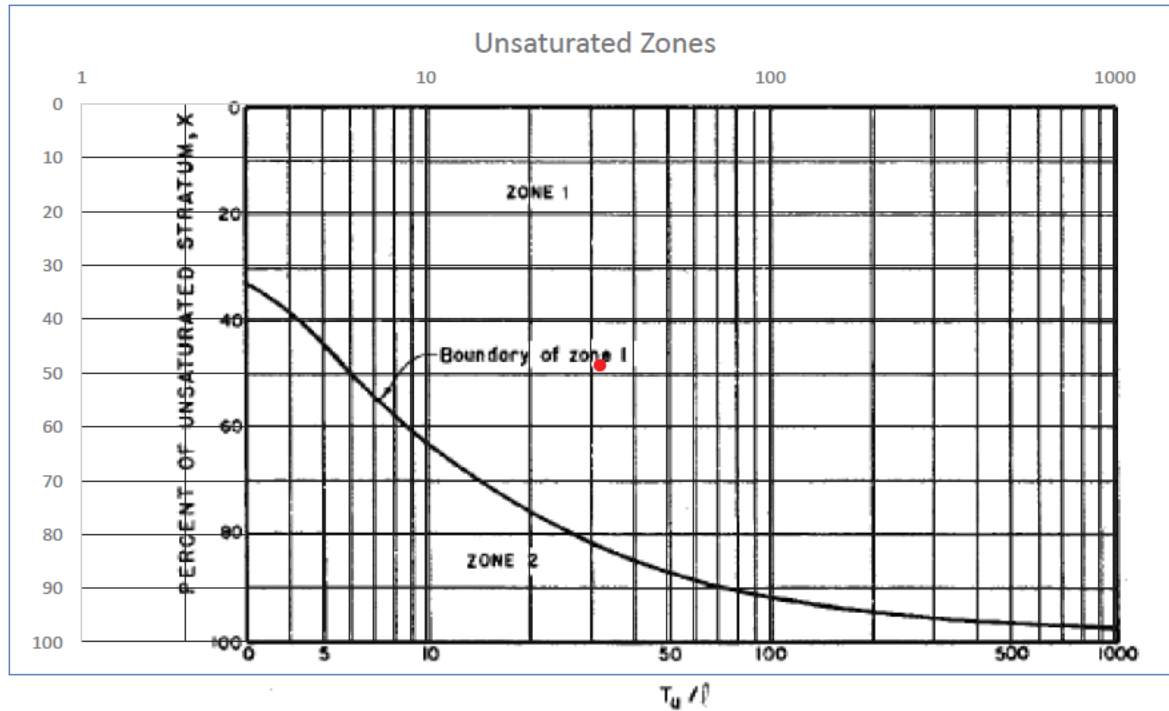
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

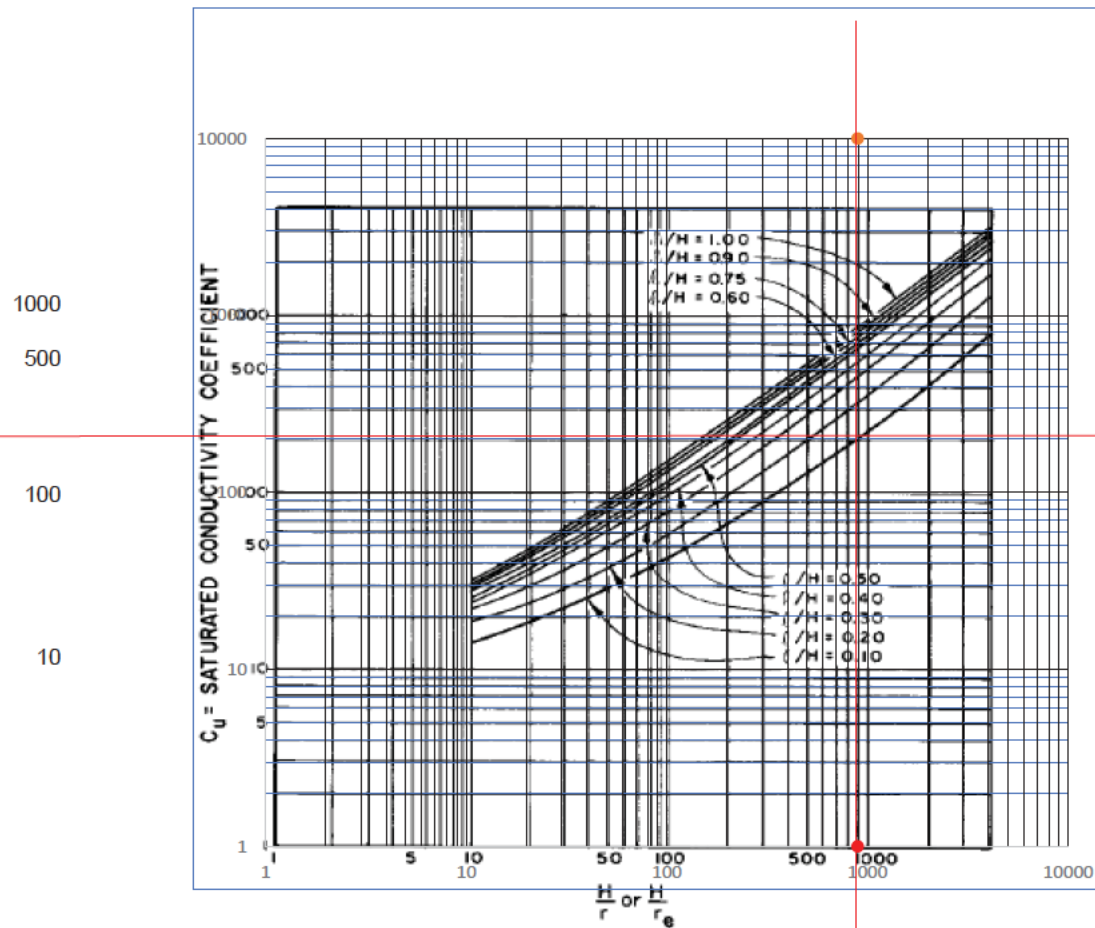
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				<b>Boring: B109</b>	
Project: HI-STORE CISF Site Characterization				Packer Test No.: 1b	
Project No.: 1703345				Ground Surface El.: 3539.6	
Location: Lea County, New Mexico				Datum: NAVD 1988	
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/14/2017	
Calculated By: J. Scully				Date: 11/10/2017	
Checked By: M. Hernandez-Cabal				Date: 11/20/2017	

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	93	Exposed surface area of the test zone, a, ft. <sup>2</sup>	8.91
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.0	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	29
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	66.9
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	172.3
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	320.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	54	H / r	1103
$X = \frac{H}{T_u} (100)$		ℓ / H	0.05
T <sub>u</sub> / ℓ	36	Saturated Conductivity Coefficient, C <sub>u</sub>	230
	Zone 1		

PACKER TEST DATA

*Note: Observed slight leak at ground surface during testing.*

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.05	0.13	5	0.0004	7.2E-08	2.28	2.2E-06

Check Applicability


Q / a =	0.000050	≤	0.1	Yes
ℓ (ft.) =	9	≥	10 r (ft.) =	1.6
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

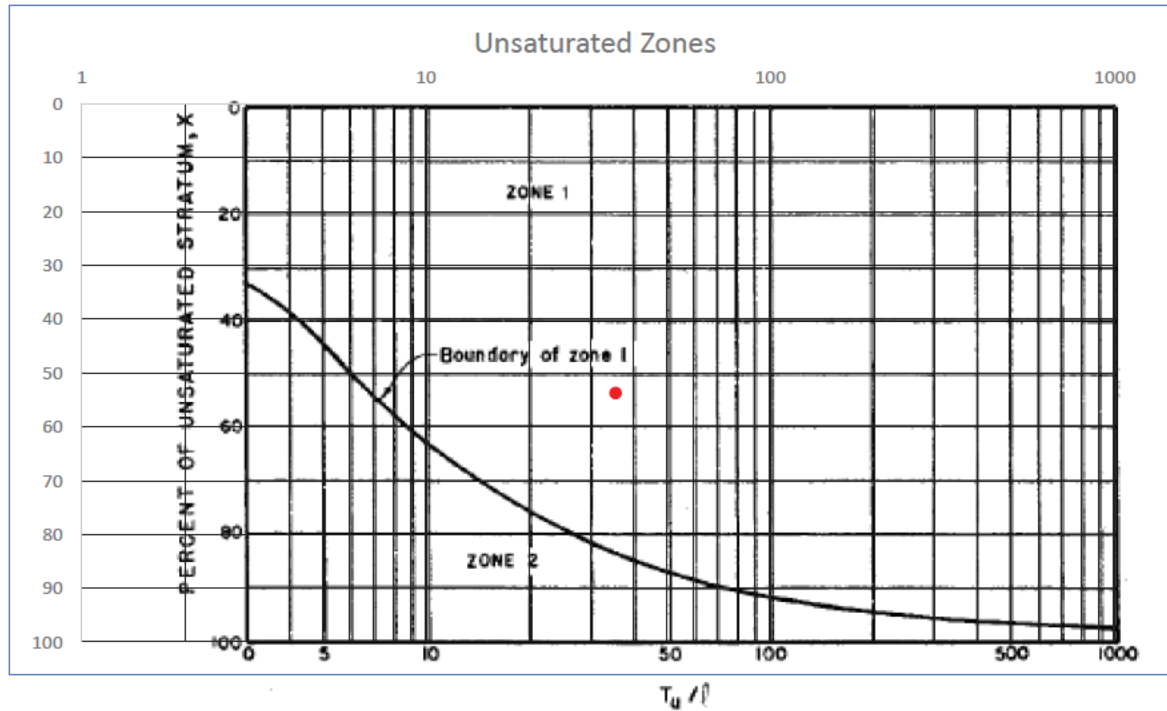
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

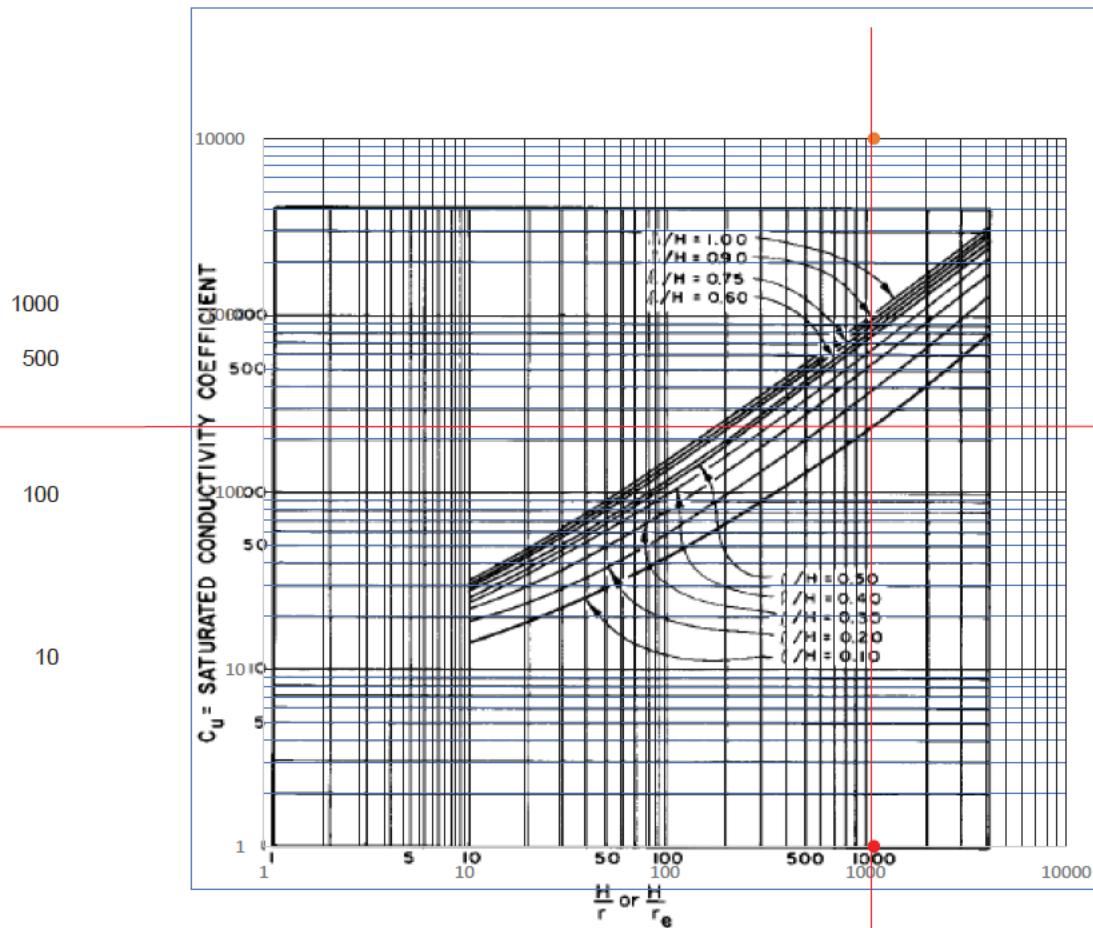
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B109</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1c
Project No.: 1703345		Ground Surface El.: 3539.6
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/14/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	93	Exposed surface area of the test zone, a, ft. <sup>2</sup>	8.91
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.0	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	209.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.2

**PACKER TEST METHOD:** Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	59	H / r	1339
$X = \frac{H}{T_u} (100)$		ℓ / H	0.04
T <sub>u</sub> / ℓ	40	Saturated Conductivity Coefficient, C <sub>u</sub>	275
	<u>Zone 1</u>		

**PACKER TEST DATA**  
*Note: Observed slight leak at ground surface during testing.*

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.47	1.26	20	0.0011	1.2E-07	3.69	3.6E-06

  
**Check Applicability**


Q / a =	0.000118	≤	0.1	Yes
ℓ (ft.) =	9	≥	10 r (ft.) =	1.6
				Yes

**Notes:**

1. Water pressure was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

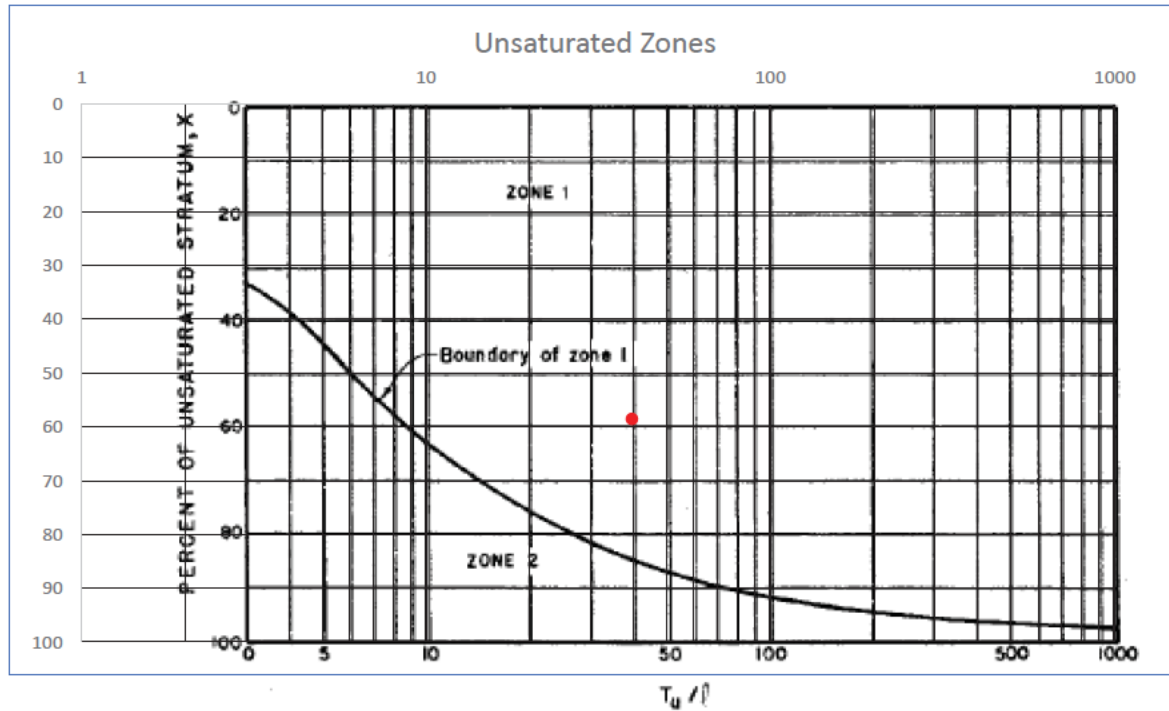
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

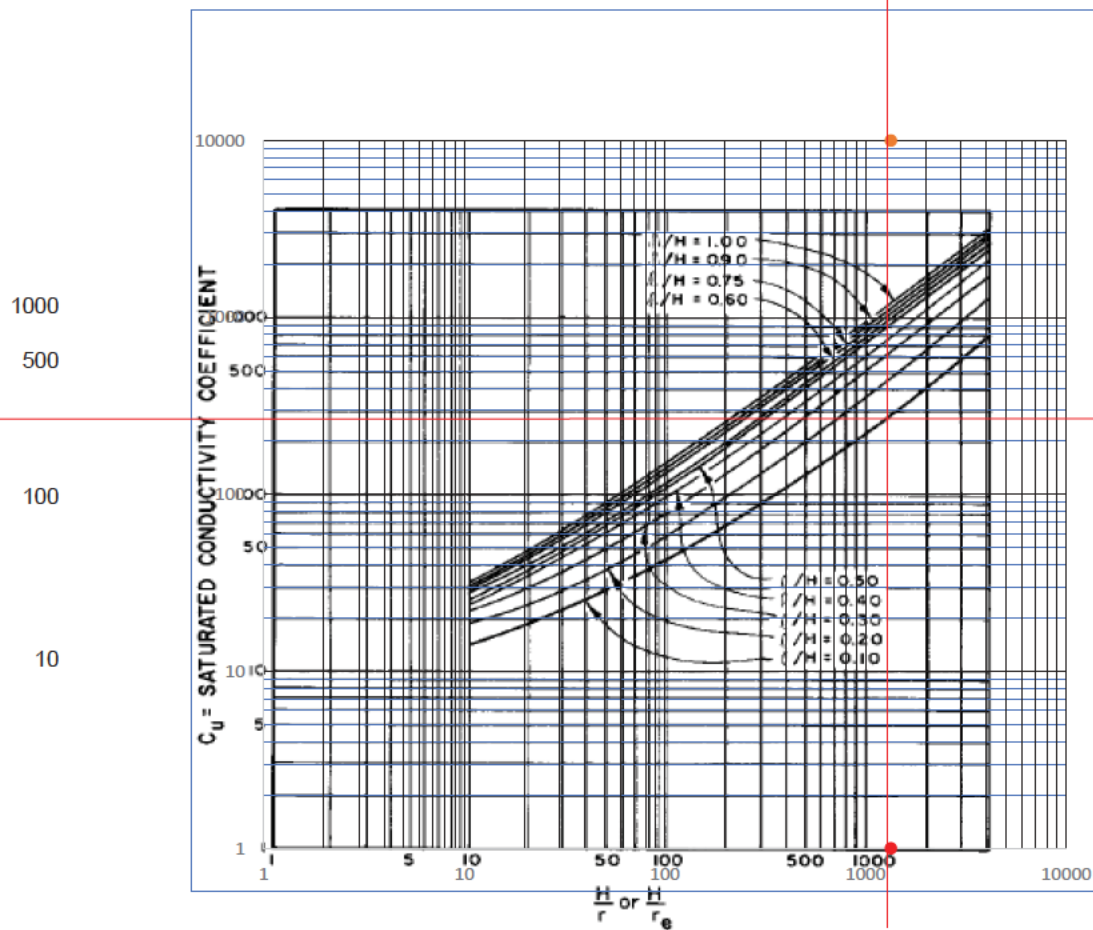
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>	
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2a	
Project No.: 1703345				Ground Surface El.: 3535.48	
Location: Lea County, New Mexico				Datum: NAVD 1988	
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017	
Calculated By: J. Scully				Date: 11/10/2017	
Checked By: M. Hernandez-Cabal				Date: 11/20/2017	

<b>Packer Test Setup</b>					
Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.			
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	251		
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	254.5		
Depth to Top of Test Zone, ft.	237.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.04		
Depth to Bottom of Borehole, D, ft.	250.6	Head Loss, L, ft.			
Length of Test Zone, ℓ, ft.	13.2	<i>Ignored for flow less than 2 gpm</i>	0		
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	16		
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	36.9		
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	291.4		
		Effective distance to water surface, T <sub>u</sub> , ft.			
		T <sub>u</sub> = U - D + H	291.8		

PACKER TEST METHOD: Method 1 (Single Packer)	
Fig. 17-6	Fig. 17-8
Percent of unsaturated stratum, X	84
$X = \frac{H}{T_u} (100)$	Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>
T <sub>u</sub> / ℓ	110
22	
Zone 2	

PACKER TEST DATA						
Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.8E-08	0.56	5.4E-07

Check Applicability			
Q / a =	0.000007	≤	0.1
ℓ (ft.) =	13.2	≥ 10 r (ft.) =	1.6
			Yes
			Yes


  

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 2:

$$K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}$$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

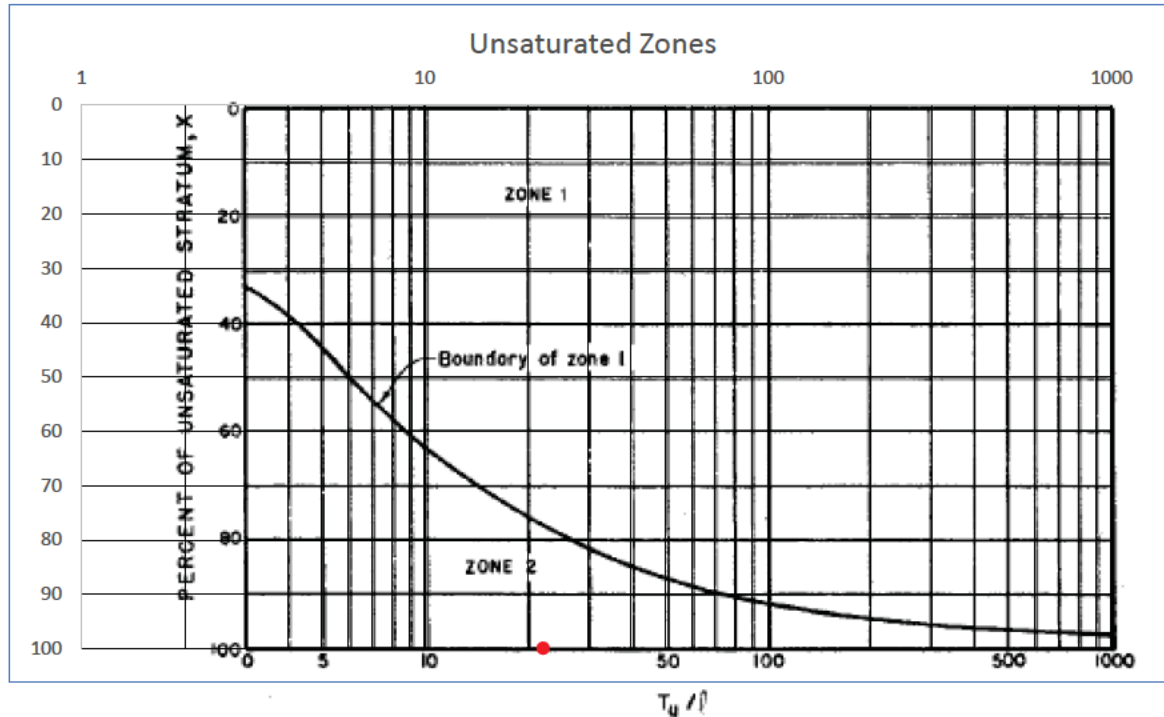
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

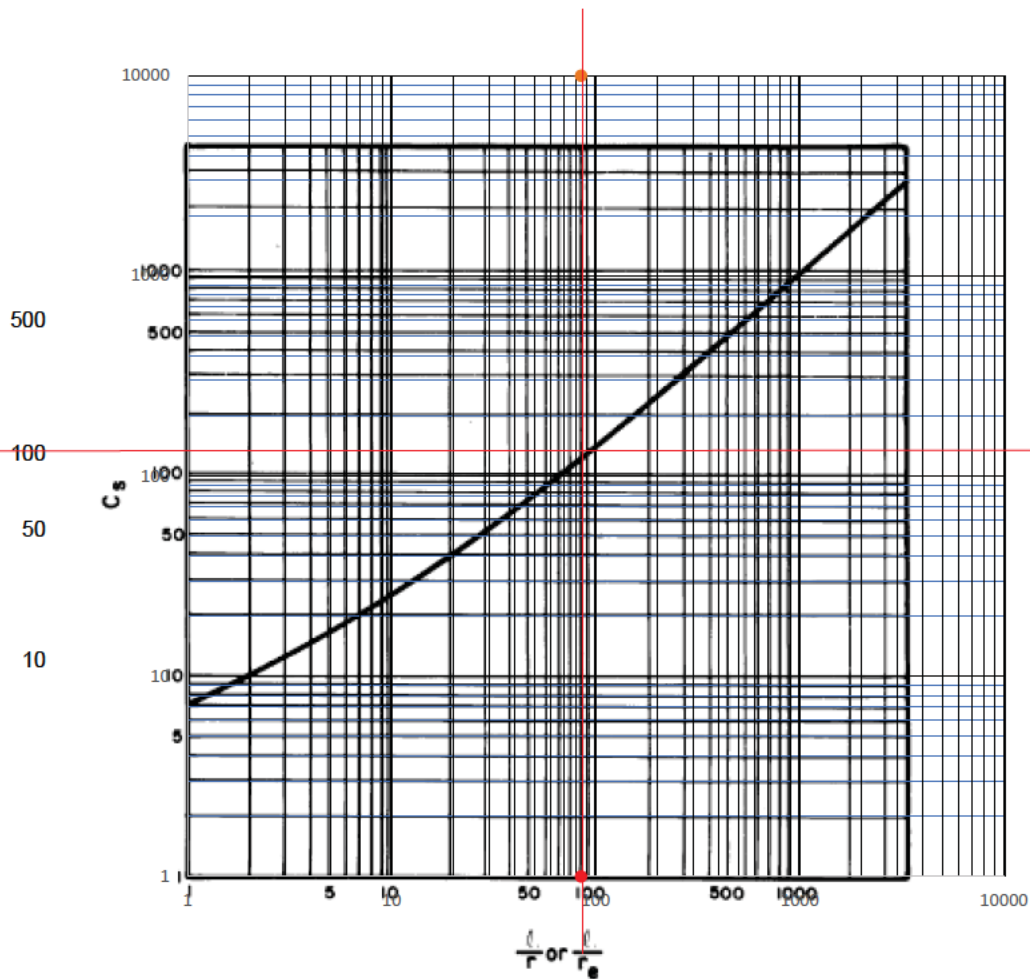
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>	
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2b	
Project No.: 1703345				Ground Surface El.: 3535.48	
Location: Lea County, New Mexico				Datum: NAVD 1988	
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017	
Calculated By: J. Scully				Date: 11/10/2017	
Checked By: M. Hernandez-Cabal				Date: 11/20/2017	

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	251
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	254.5
Depth to Top of Test Zone, ft.	237.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.04
Depth to Bottom of Borehole, D, ft.	250.6	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	32
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	73.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	328.3
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	328.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-8	
Percent of unsaturated stratum, X	100	ℓ / r	84
$X = \frac{H}{T_u} (100)$		Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>	110
T <sub>u</sub> / ℓ	25		
	<u>Zone 2</u>		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.6E-08	0.49	4.8E-07

Check Applicability

Q / a =	0.000007	≤	0.1	
ℓ (ft.) =	13.2	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 2:

$$K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}$$

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

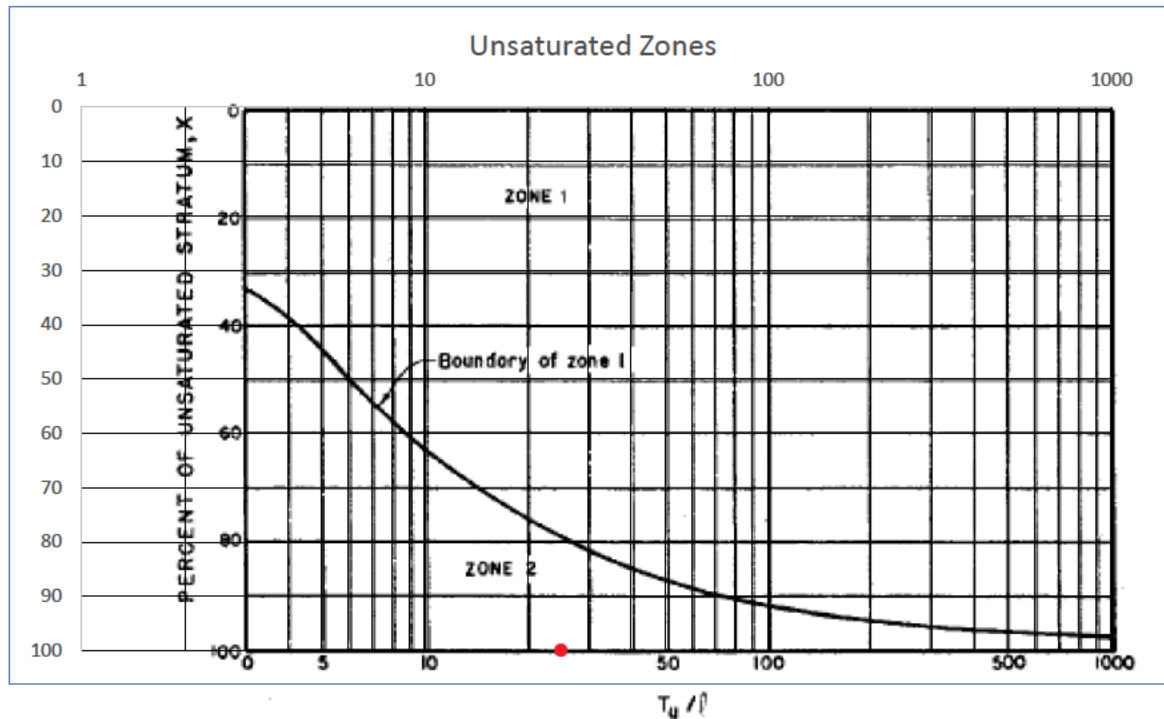
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower  
boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

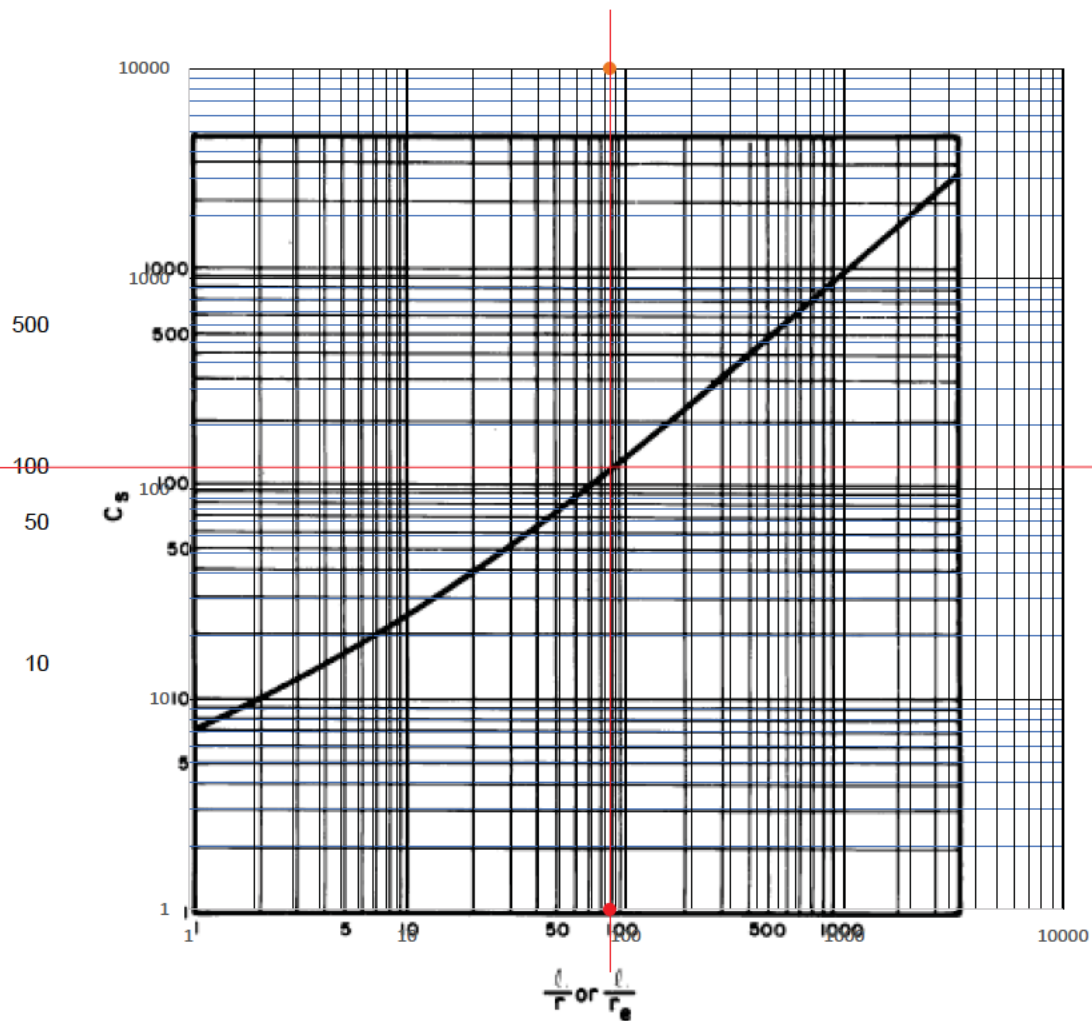
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b


Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B101</b>		
Project: HI-STORE CISF Site Characterization				Packer Test No.: 2c		
Project No.: 1703345				Ground Surface El.: 3535.48		
Location: Lea County, New Mexico				Datum: NAVD 1988		
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/21/2017		
Calculated By: J. Scully				Date: 11/10/2017		
Checked By: M. Hernandez-Cabal				Date: 11/20/2017		
<b>Packer Test Setup</b>						
Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.	<u>251</u>			
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>				
Gauge Height, ft.	<u>3.9</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>254.5</u>			
Depth to Top of Test Zone, ft.	<u>237.4</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>13.04</u>			
Depth to Bottom of Borehole, D, ft.	<u>250.6</u>	Head Loss, L, ft.	<u>0</u>			
Length of Test Zone, ℓ, ft.	<u>13.2</u>	<i>Ignored for flow less than 2 gpm</i>	<u>44</u>			
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	<u>101.5</u>			
Drum Diameter, ft.	<u>1.85</u>	h <sub>2</sub> , ft	<u>356.0</u>			
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	Effective Head, H, ft.	<u>356.4</u>			
		Effective distance to water surface, T <sub>u</sub> , ft.	<u>356.4</u>			
		T <sub>u</sub> = U - D + H	<u>356.4</u>			
PACKER TEST METHOD: <u>Method 1 (Single Packer)</u>						
Fig. 17-6		Fig. 17-8				
Percent of unsaturated stratum, X	<u>100</u>	ℓ / r	<u>84</u>			
$X = \frac{H}{T_u} (100)$		Conductivity Coefficient for semi-spherical flow in saturated materials, C <sub>s</sub>				
T <sub>u</sub> / ℓ	<u>27</u>	<u>110</u>				
		<u>Zone 2</u>				
PACKER TEST DATA						
Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.04	0.11	5	0.0004	5.8E-08	1.81	1.8E-06
Check Applicability						
Q / a =	0.000027	≤	0.1	<u>Yes</u>		
ℓ (ft.) =	13.2	≥	10 r (ft.) =	1.6	<u>Yes</u>	
Notes:						
1. Water pressure was measured with a pressure gauge attached to the water line above ground.						
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.						
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.						
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.						
<div style="display: flex; justify-content: space-between; align-items: center;"> <div>Method 1      Zone 2:</div> <div> <math display="block">K = \frac{2Q}{(C_s + 4)r(T_u + H - l)}</math> </div> <div style="text-align: right;">  </div> </div>						

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

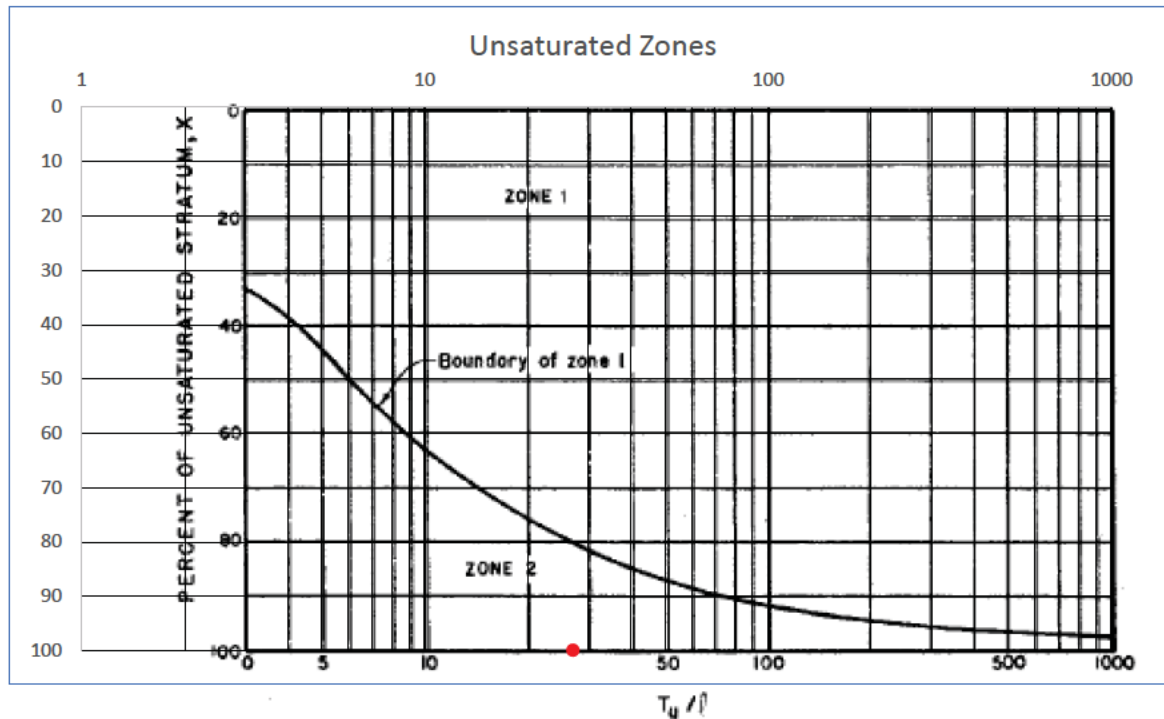
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

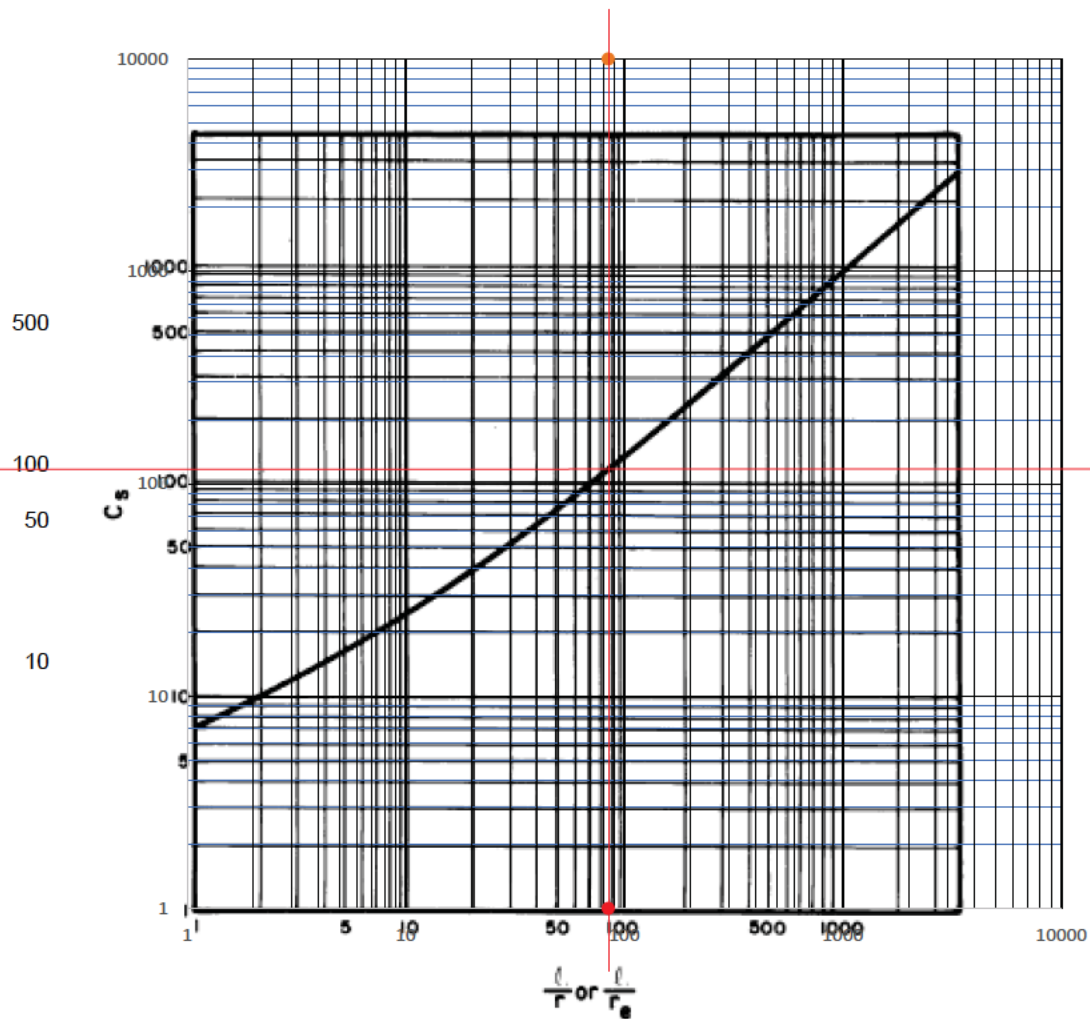
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients  
for semispherical flow in saturated  
materials through partially penetrating  
cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	16
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	36.9
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	291.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	140.4

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-8 Zone 3

ℓ / r 404.5

Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.04	0.11	5	0.0004	2.0E-08	0.62	5.9E-07

Check Applicability


Q / a =	0.0000058	≤	0.1	Yes
ℓ (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:       $K = \frac{Q}{(C_s + 4)rH}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

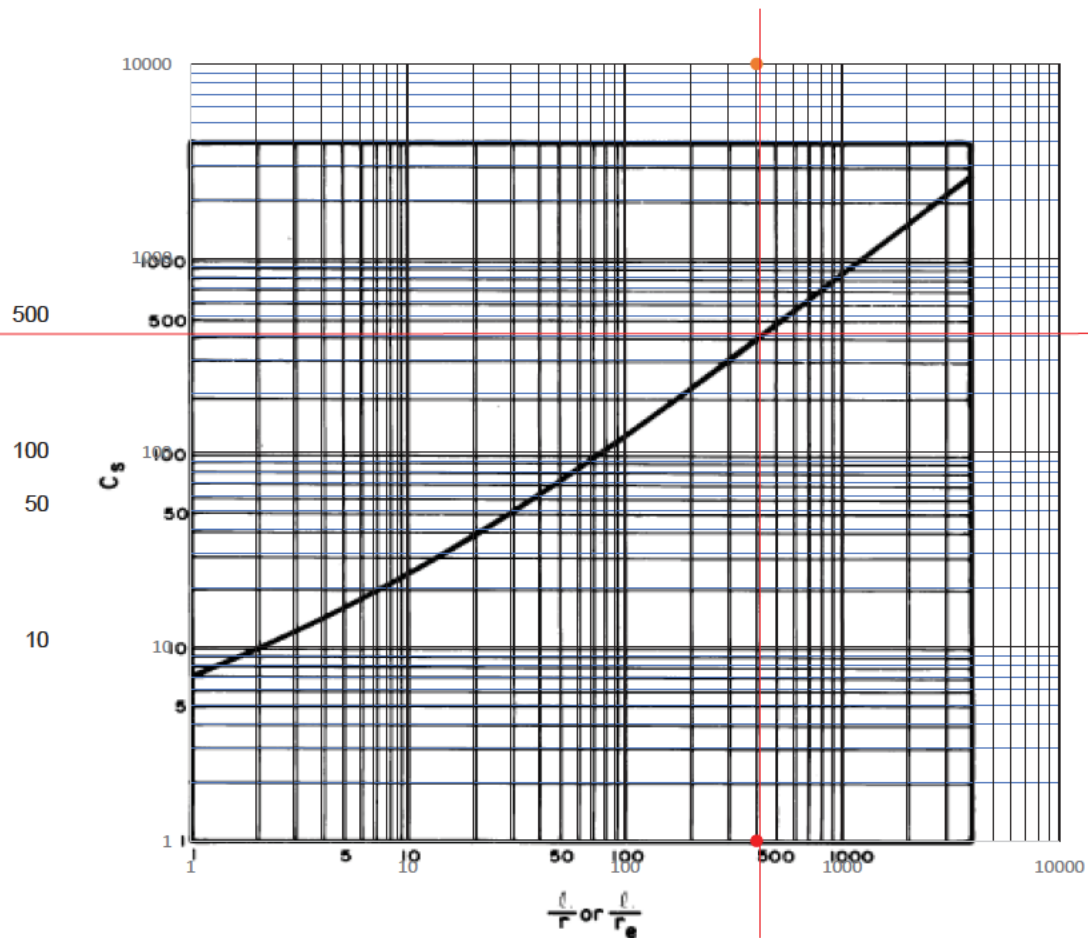
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	32
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	73.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	327.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	177.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-8 Zone 3

ℓ / r 404.5

Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	8.7E-09	0.27	2.6E-07

Check Applicability

Q / a =	0.0000029	≤	0.1	Yes
ℓ (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes


  

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:

$$K = \frac{Q}{(C_s + 4)rH}$$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

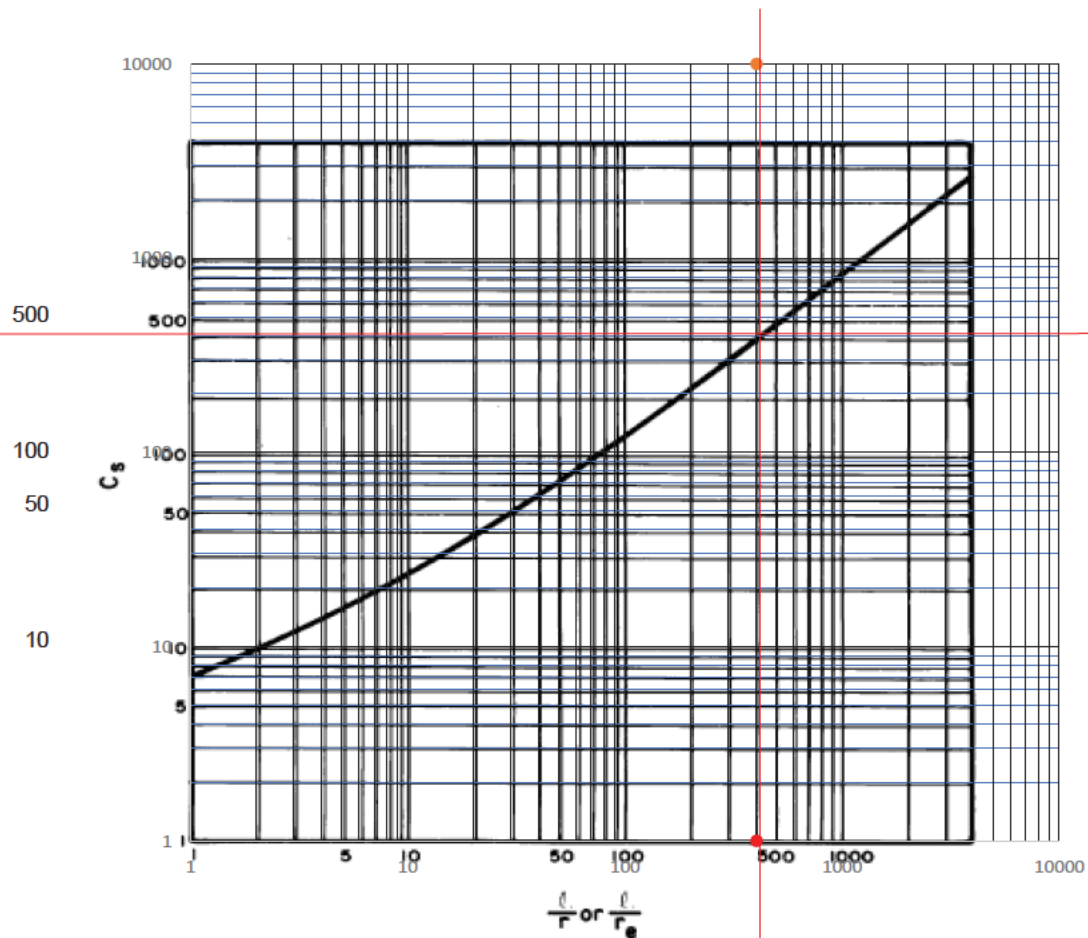
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Below Water Table)</b>		Boring: <b>B101</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3c
Project No.: 1703345		Ground Surface El.: 3535.48
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/23/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and depth to water, h <sub>1</sub> , ft.	254.1
Depth to Top of Test Zone, ft.	337.4	Exposed surface area of the test zone, a, ft. <sup>2</sup>	62.12
Depth to Bottom of Borehole, D, ft.	400.6	Head Loss, L, ft.	
Length of Test Zone, l, ft.	63.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	357.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	207.3

**PACKER TEST METHOD:** Method 1 (Single Packer)  
 Fig. 17-8 Zone 3  
 l / r 404.5  
 Conductivity Coefficient for semi-spherical flow in saturated materials, C<sub>s</sub> 400

**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	20	0.0001	5.9E-09	0.19	1.8E-07

  
 Check Applicability  


Q / a =	0.0000022	≤	0.1	Yes
l (ft.) =	63.2	≥ 10 r (ft.) =	1.6	Yes

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 3:       $K = \frac{Q}{(C_s + 4)rH}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B101**

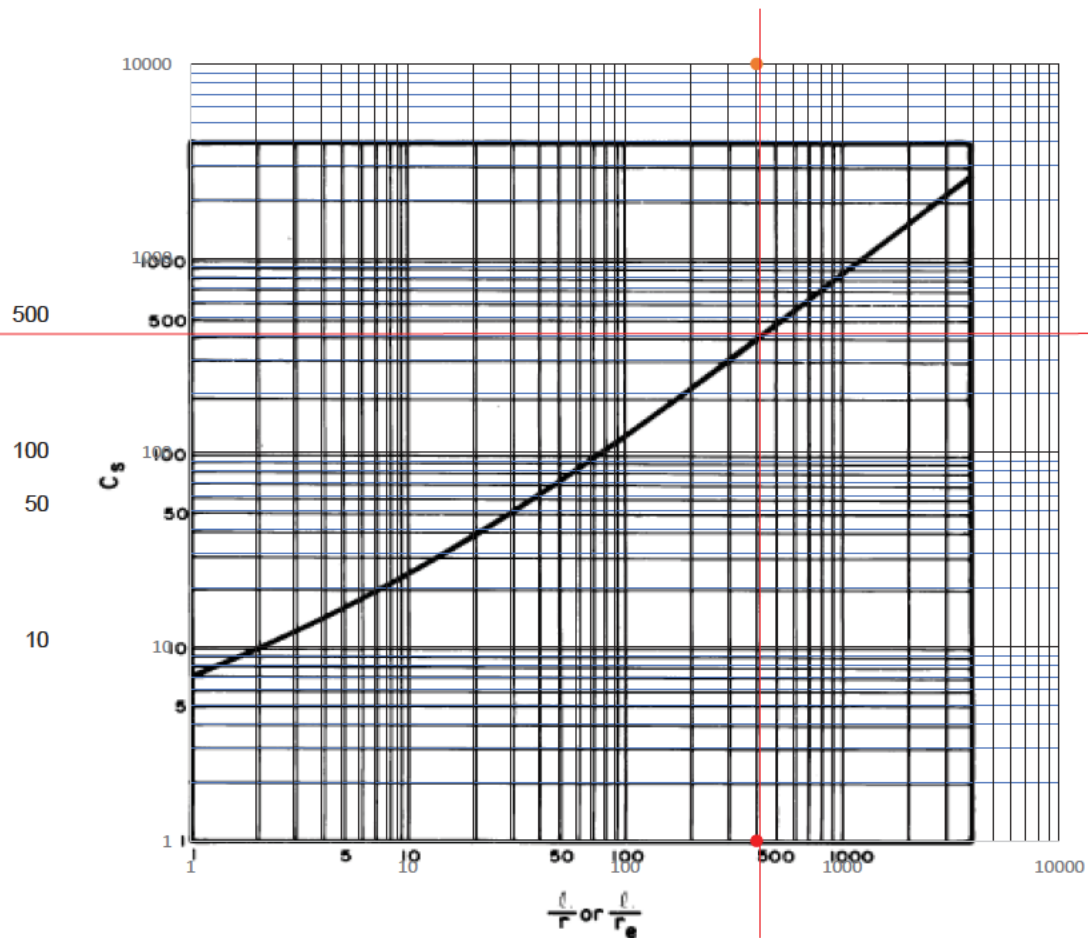
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-8.—Conductivity coefficients for semispherical flow in saturated materials through partially penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/27/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	85.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	16.28
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	16.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	28
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	64.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	170.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	318.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6

Percent of unsaturated stratum, X

$$X = \frac{H}{T_u} (100)$$

T<sub>u</sub> / ℓ

19  
Zone 1

Fig. 17-7

H / r

ℓ / H

Saturated Conductivity Coefficient, C<sub>u</sub>

54	1094
0.10	230

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	2.9E-08	0.92	8.9E-07

Check Applicability


Q / a =	0.000011	≤	0.1	Yes
ℓ (ft.) =	16.5	≥	10 r (ft.) =	1.6
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

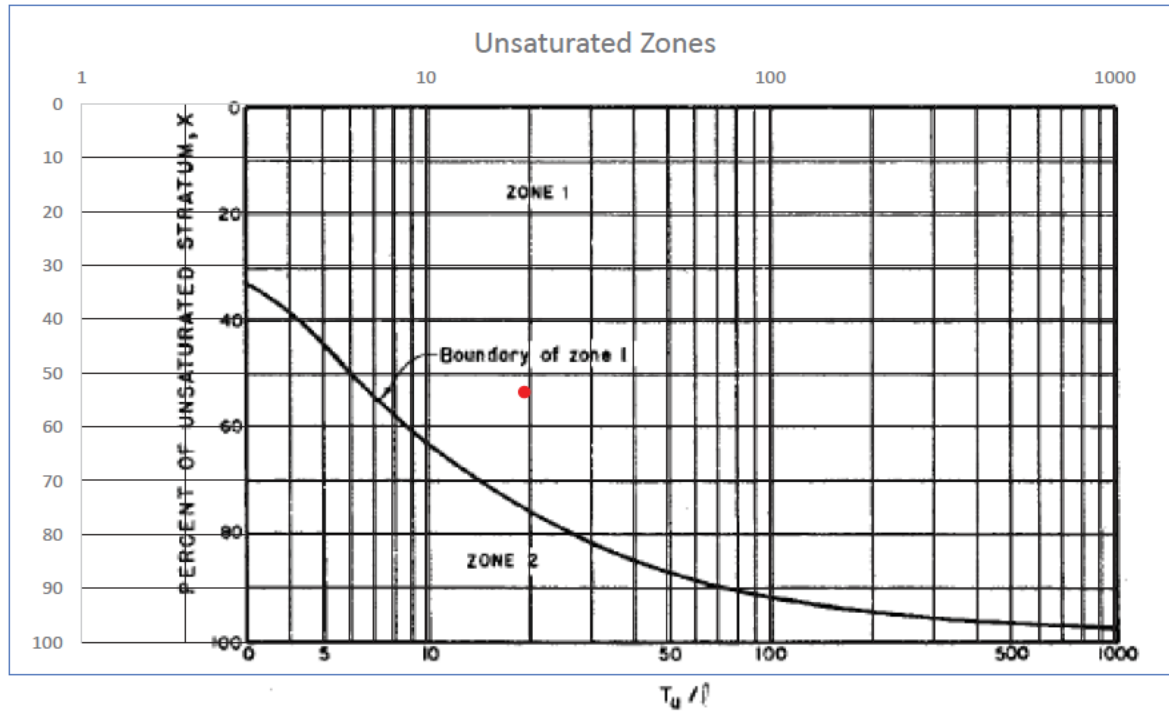
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

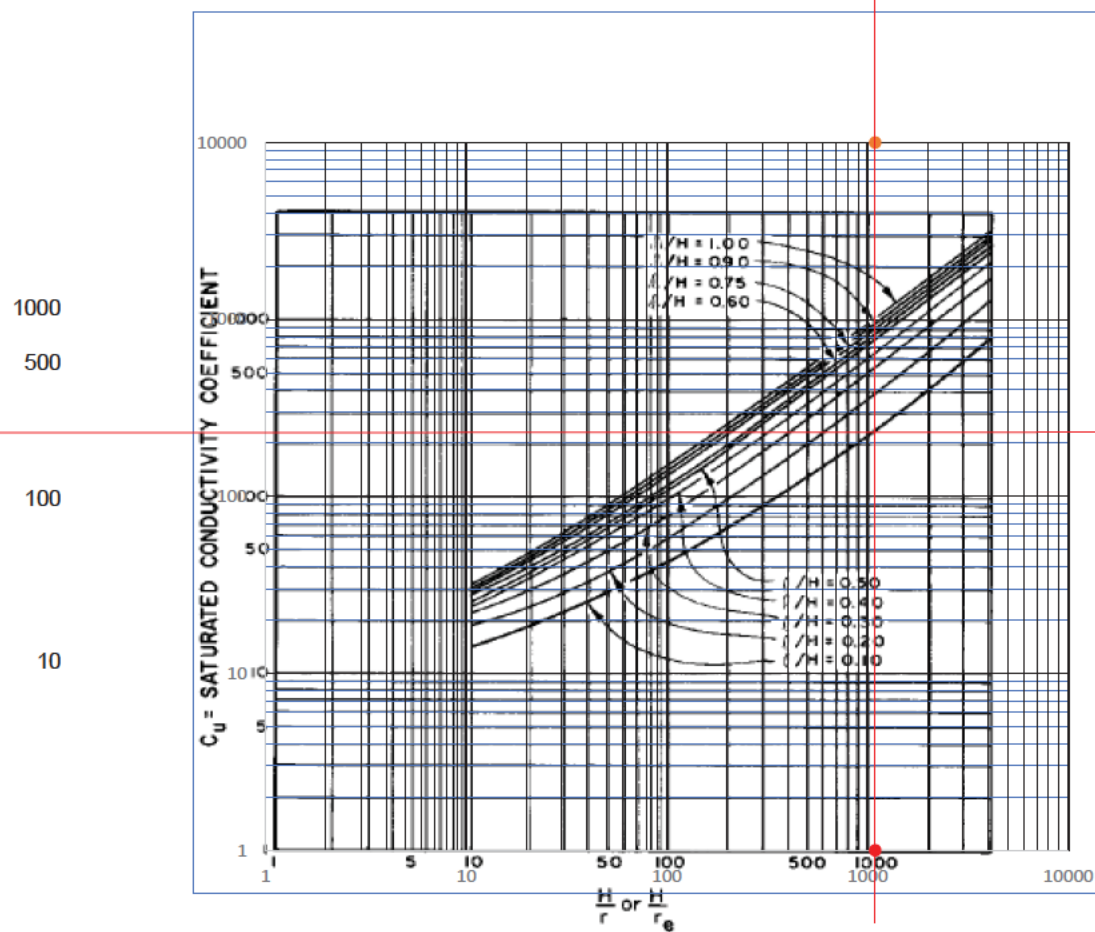
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/27/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	85.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	16.28
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	16.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	37
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	85.4
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	191.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	339.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	56
$X = \frac{H}{T_u} (100)$	1227
	0.09
	275
T <sub>u</sub> / ℓ	21
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	3.3E-08	1.03	9.9E-07


Check Applicability

Q / a =	0.000017	≤	0.1	
ℓ (ft.) =	16.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

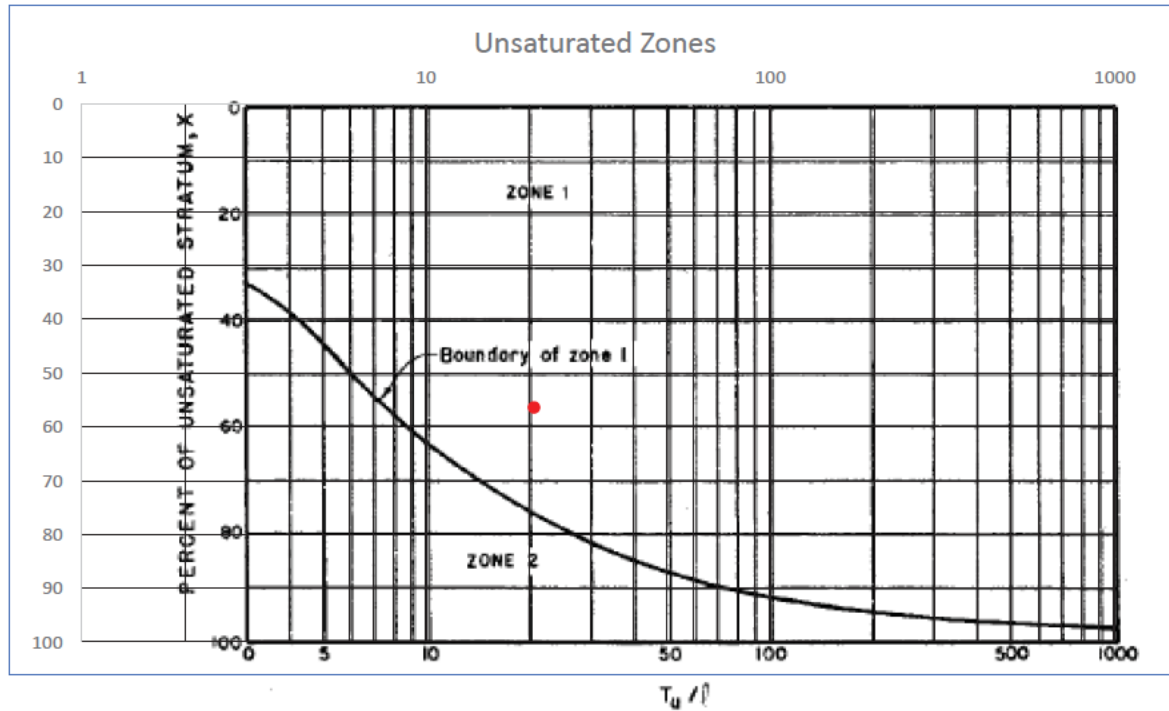
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

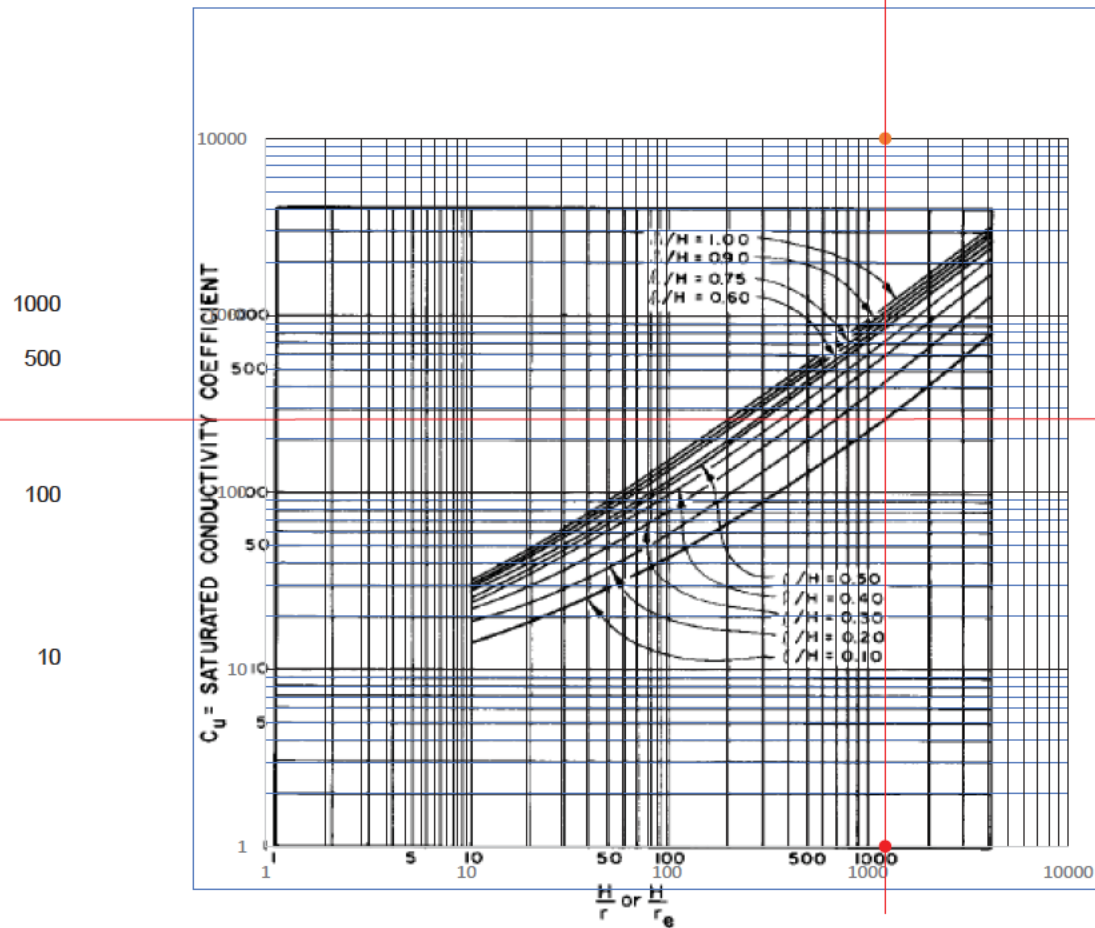
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	80.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	21.18
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	21.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	34
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	78.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	184.8
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	332.8

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	56	H / r	1182
$X = \frac{H}{T_u} (100)$		ℓ / H	0.12
T <sub>u</sub> / ℓ	15	Saturated Conductivity Coefficient, C <sub>u</sub>	300
	<u>Zone 1</u>		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	2.1E-08	0.65	6.3E-07

Check Applicability


Q / a =	0.000008	≤	0.1	Yes
ℓ (ft.) =	21.5	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

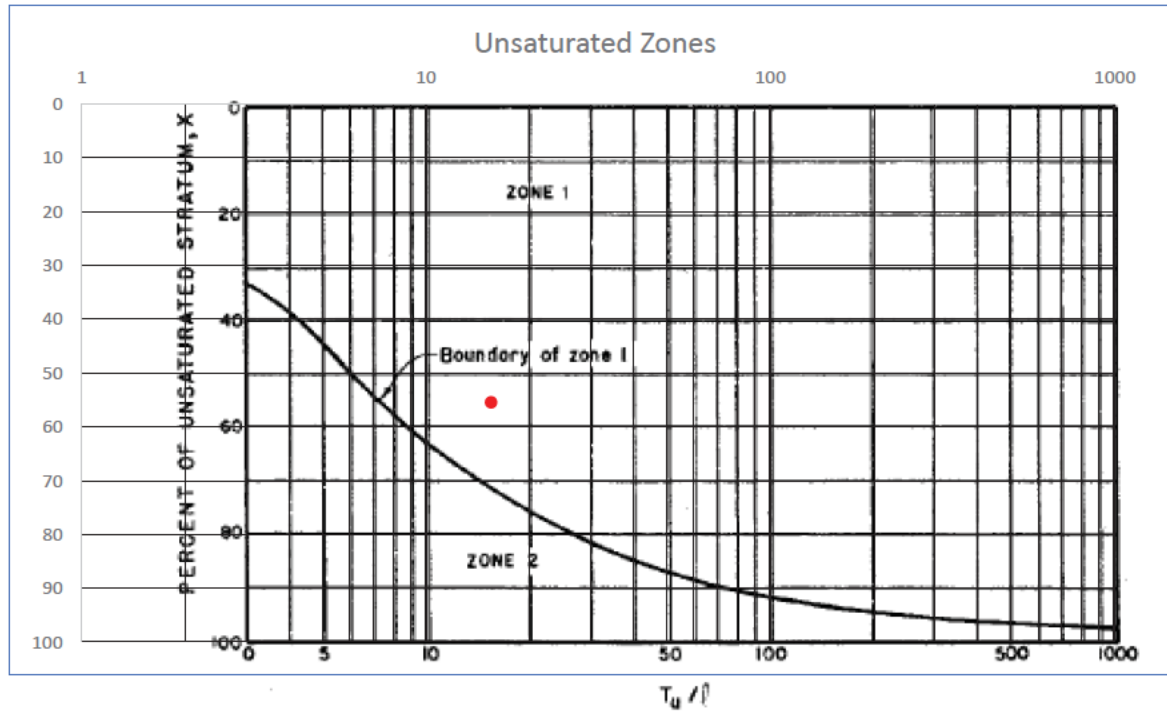
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

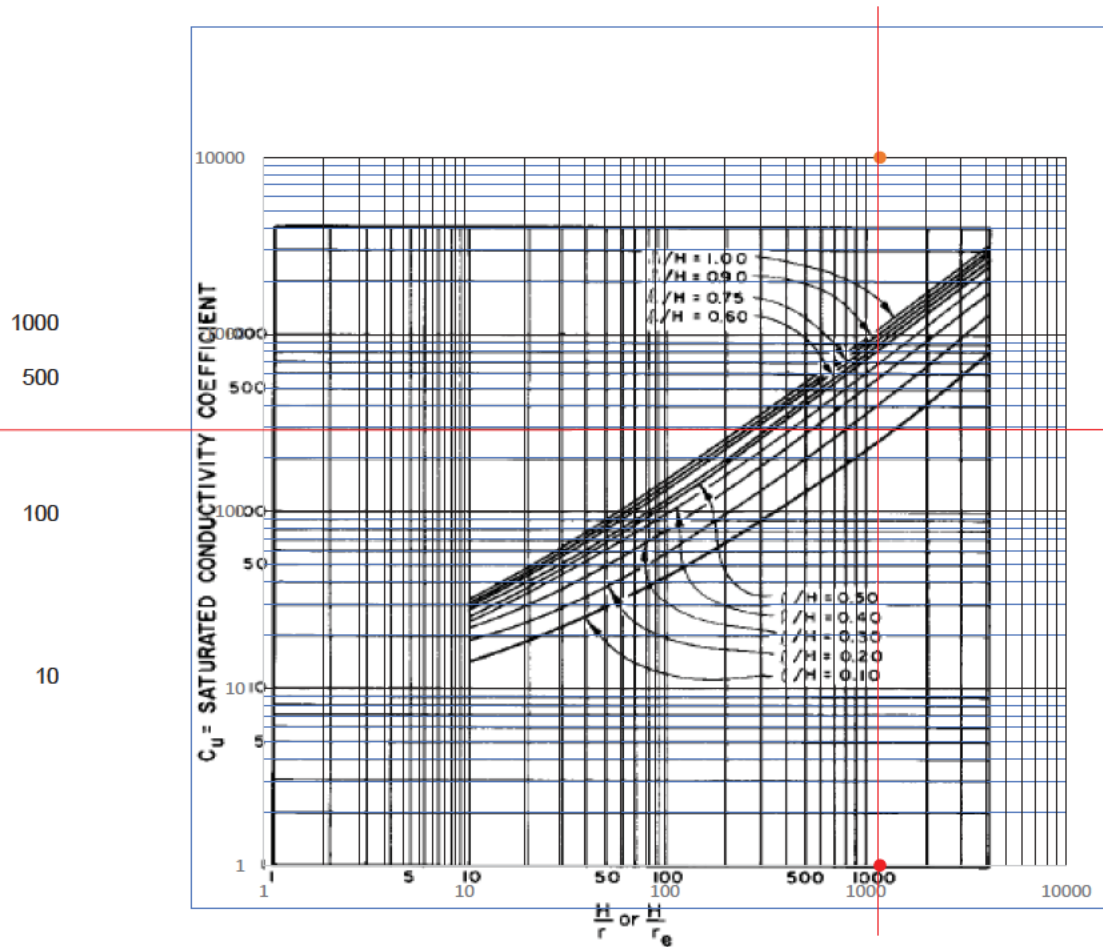
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.3	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106.3
Depth to Top of Test Zone, ft.	80.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	21.18
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	21.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	46
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	106.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	212.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	360.5

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	59	H / r	1360
$X = \frac{H}{T_u} (100)$		ℓ / H	0.10
T <sub>u</sub> / ℓ	17	Saturated Conductivity Coefficient, C <sub>u</sub>	300
	<u>Zone 1</u>		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	9.0E-09	0.28	2.7E-07

Check Applicability


Q / a =	0.00000	≤	0.1		Yes
ℓ (ft.) =	21.5	≥	10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

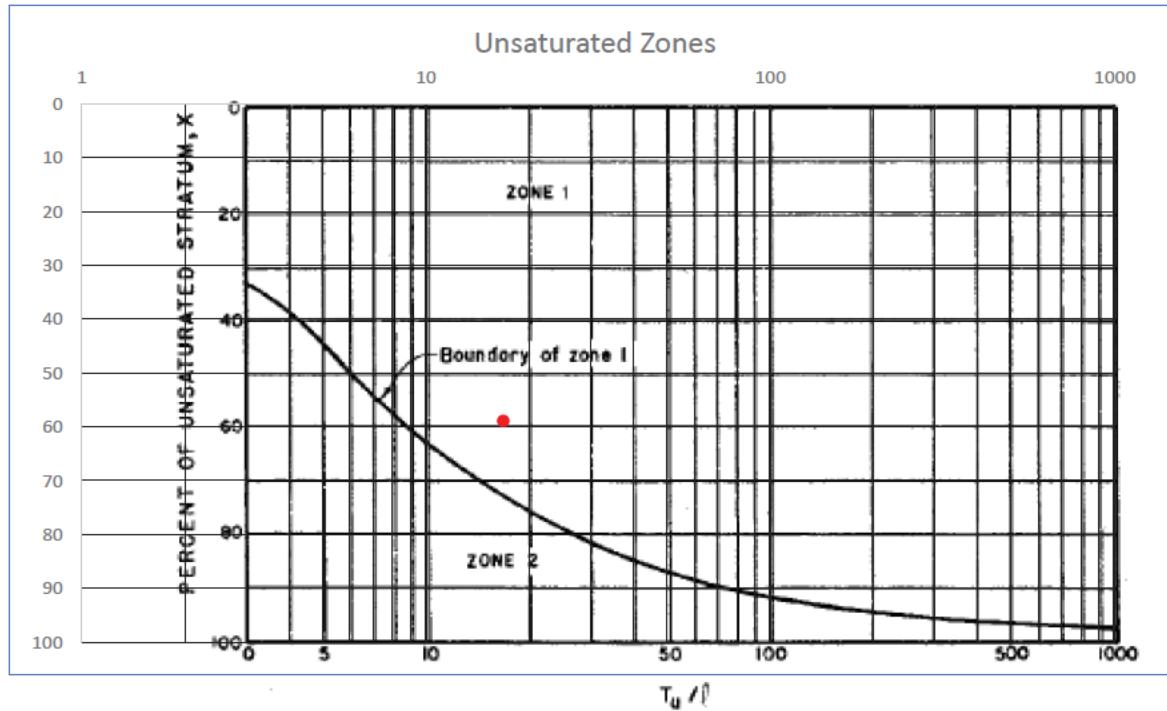
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

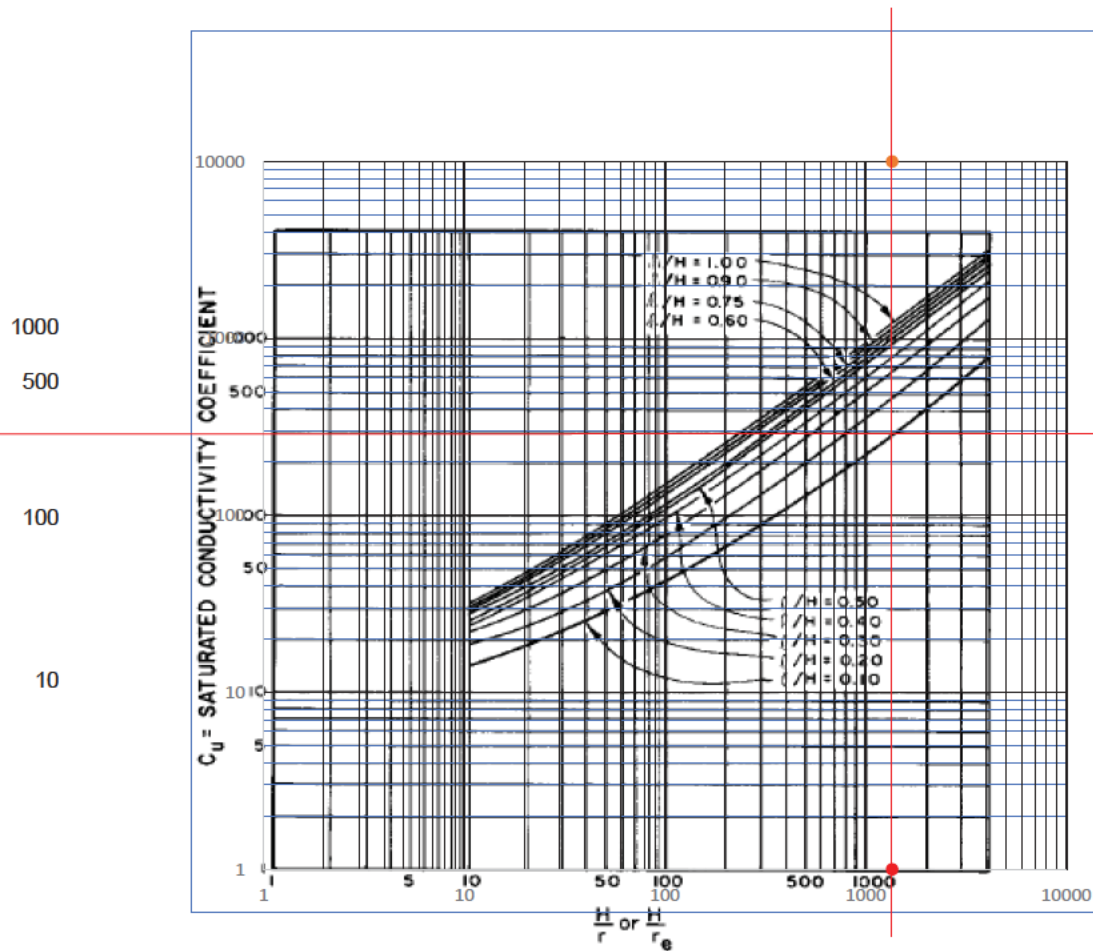
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106
Depth to Top of Test Zone, ft.	75.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	25.90
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	26.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	145.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	293.2

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	50	H / r	929
$X = \frac{H}{T_u} (100)$		ℓ / H	0.18
T <sub>u</sub> / ℓ	11	Saturated Conductivity Coefficient, C <sub>u</sub>	300
	<u>Zone 1</u>		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.3E-08	0.42	4.0E-07

Check Applicability


Q / a =	0.000003	≤	0.1		Yes
ℓ (ft.) =	26.3	≥	10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

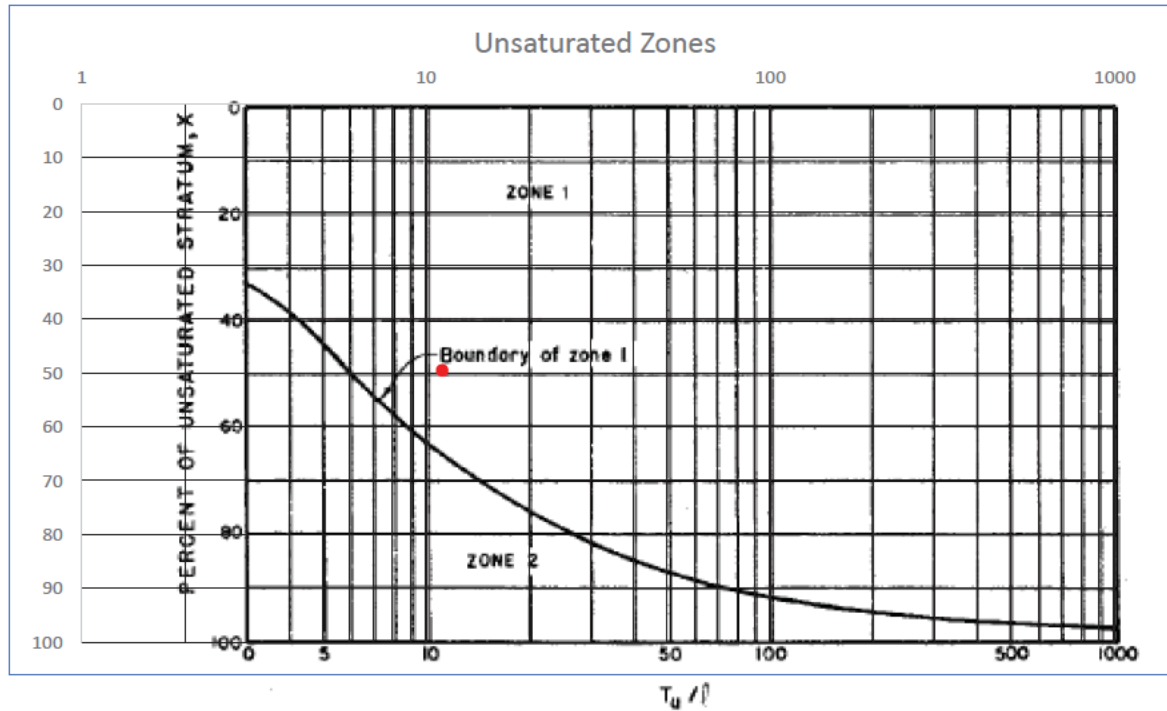
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

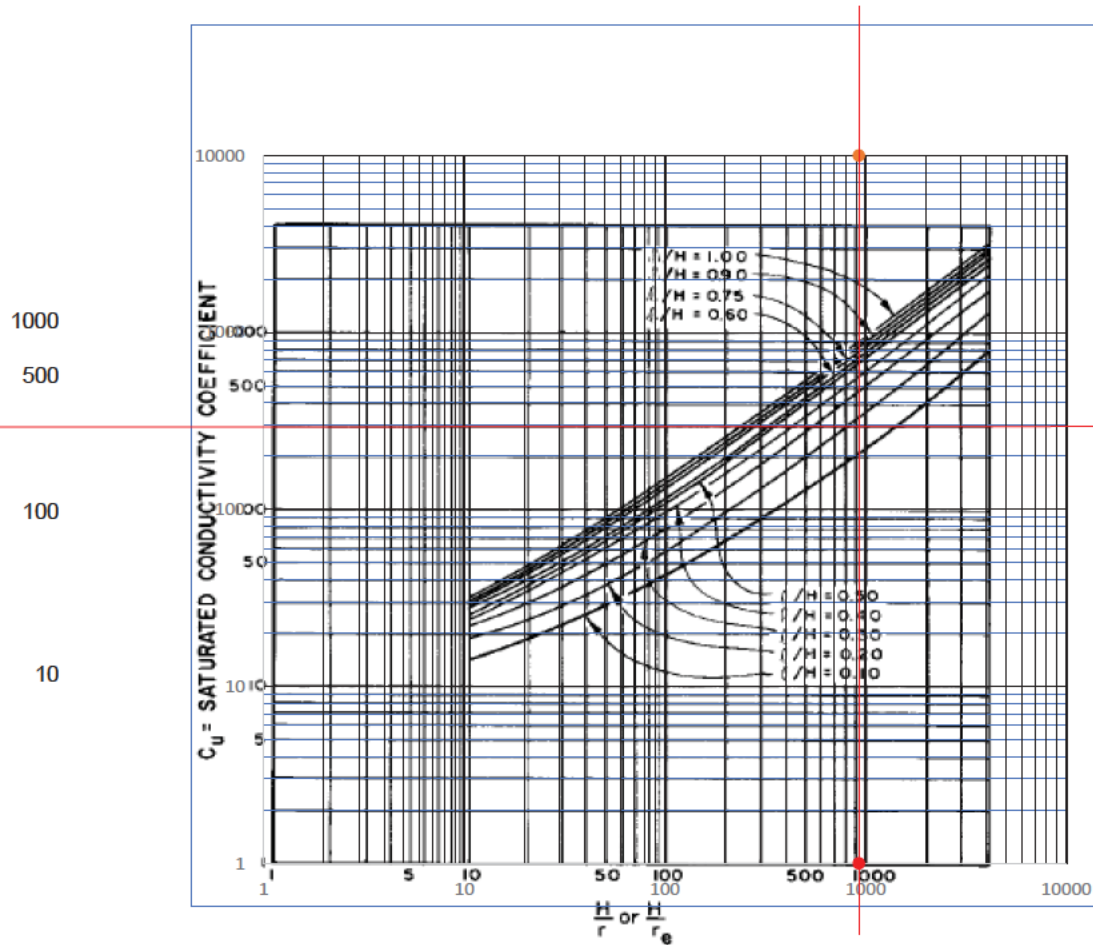
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/28/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106
Depth to Top of Test Zone, ft.	75.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	25.90
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	26.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	31
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	71.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	177.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	325.5

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	55
$X = \frac{H}{T_u} (100)$	1136
	ℓ / H
	0.15
	Saturated Conductivity Coefficient, C <sub>u</sub>
	310
T <sub>u</sub> / ℓ	12
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
< 0.01	0.03	5	0.0001	1.0E-08	0.33	3.2E-07

Check Applicability


Q / a =	0.000003	≤	0.1	
ℓ (ft.) =	26.3	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

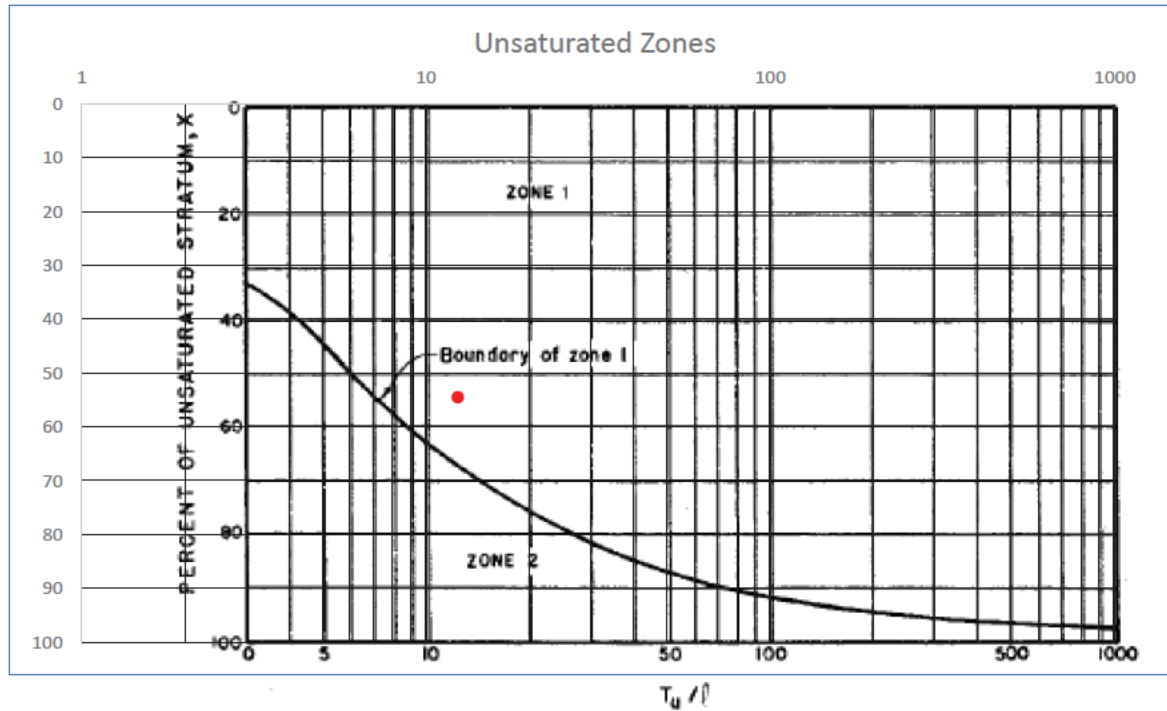
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

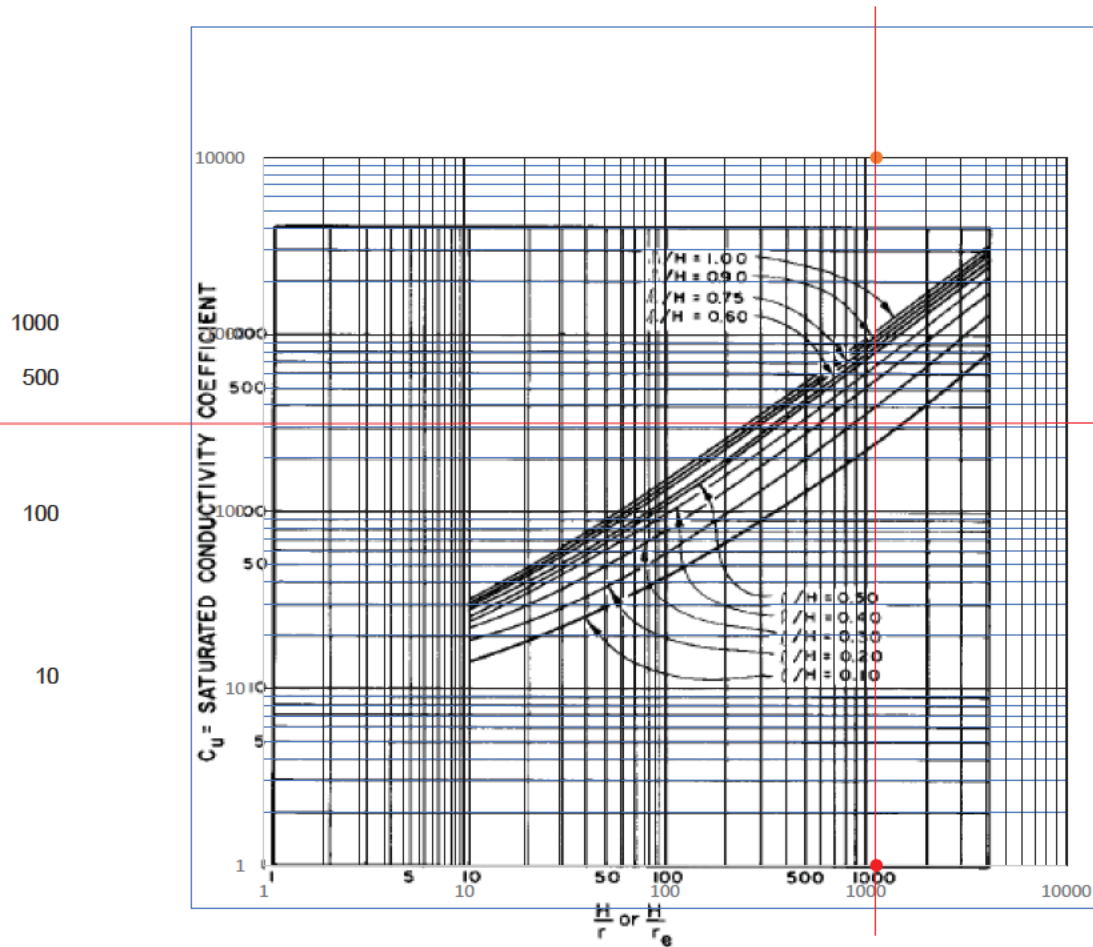
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization Project No.: 1703345 Location: Lea County, New Mexico		Packer Test No.: 3c Ground Surface El.: 3530.62 Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal Calculated By: J. Scully Checked By: M. Hernandez-Cabal		Date: 9/28/2017 Date: 11/10/2017 Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	106
Depth to Top of Test Zone, ft.	75.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	25.90
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	26.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	46
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	106.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	212.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	360.2

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	59	H / r	1358
$X = \frac{H}{T_u} (100)$		ℓ / H	0.12
T <sub>u</sub> / ℓ	14	Saturated Conductivity Coefficient, C <sub>u</sub>	325
	Zone 1		

**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
< 0.01	0.03	5	0.0001	8.3E-09	0.26	2.5E-07

**Check Applicability**  
 $Q / a = 0.000003 \leq 0.1$   
 $\ell \text{ (ft.)} = 26.3 \geq 10 r \text{ (ft.)} = 1.6$


Yes
Yes

**Notes:**

1. Water pressure was measured with a pressure gauge attached to the water line above ground.
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

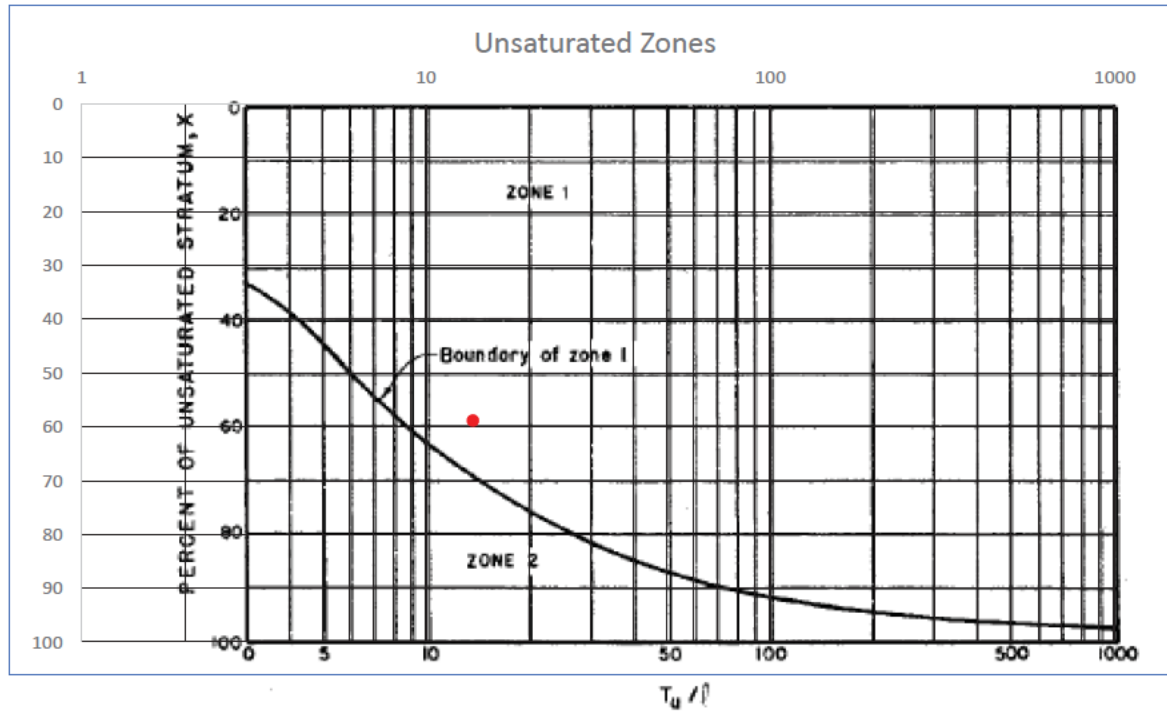
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

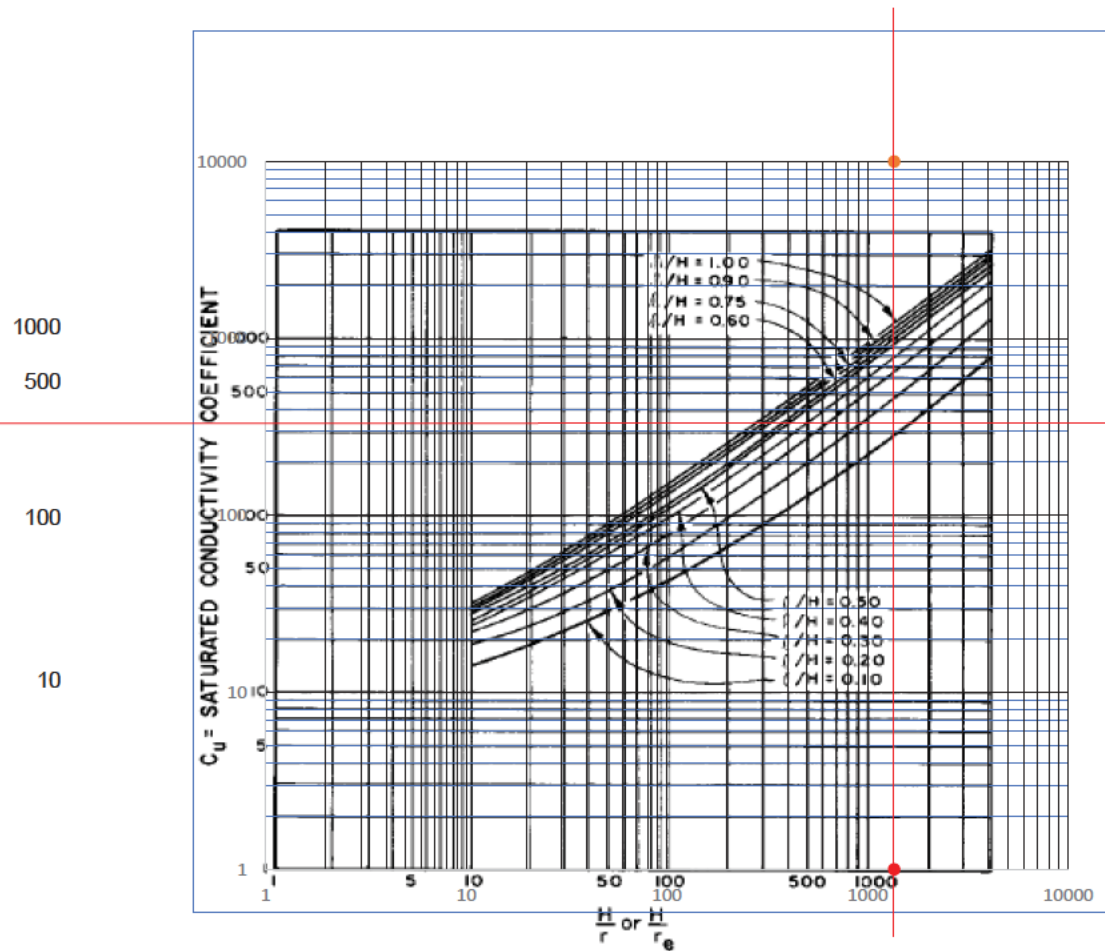
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4a
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	131.1
Depth to Top of Test Zone, ft.	117.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.40
Depth to Bottom of Borehole, D, ft.	127	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	16
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	36.9
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	168.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	291.0

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	58
$X = \frac{H}{T_u} (100)$	1075
	0.06
T <sub>u</sub> / ℓ	31
	Zone 1
	225

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	5	0.001	9.1E-08	2.87	2.8E-06


Check Applicability

Q / a =	0.00006	≤	0.1	
ℓ (ft.) =	9.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

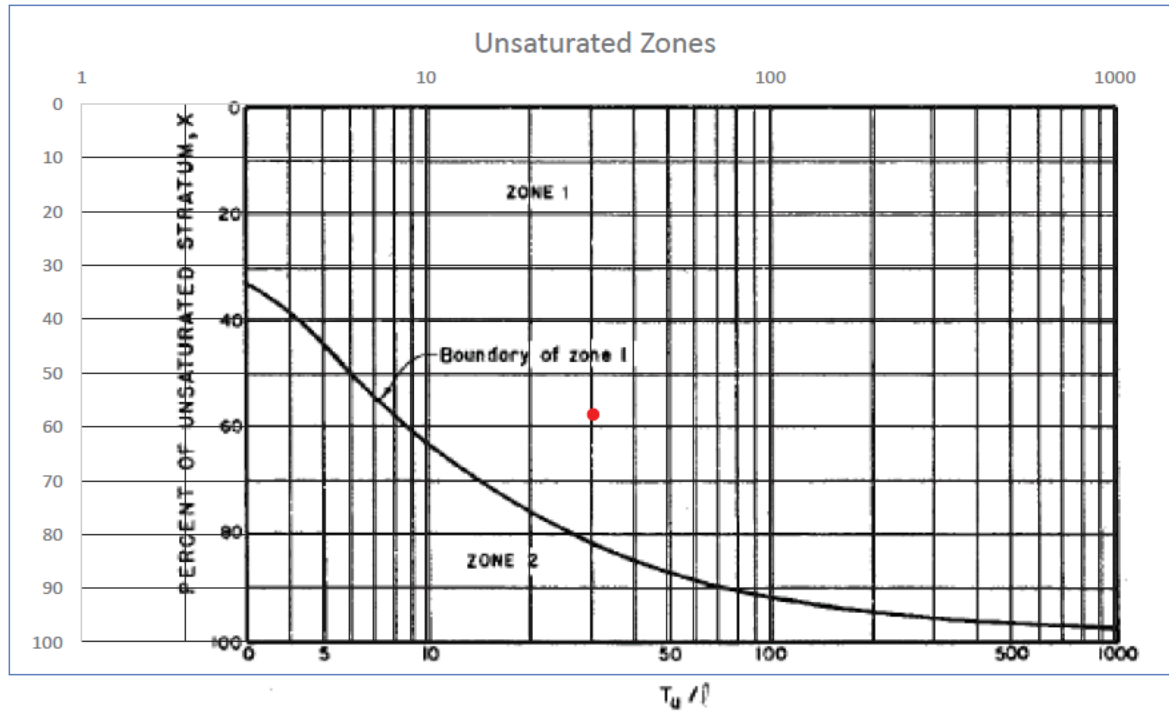
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

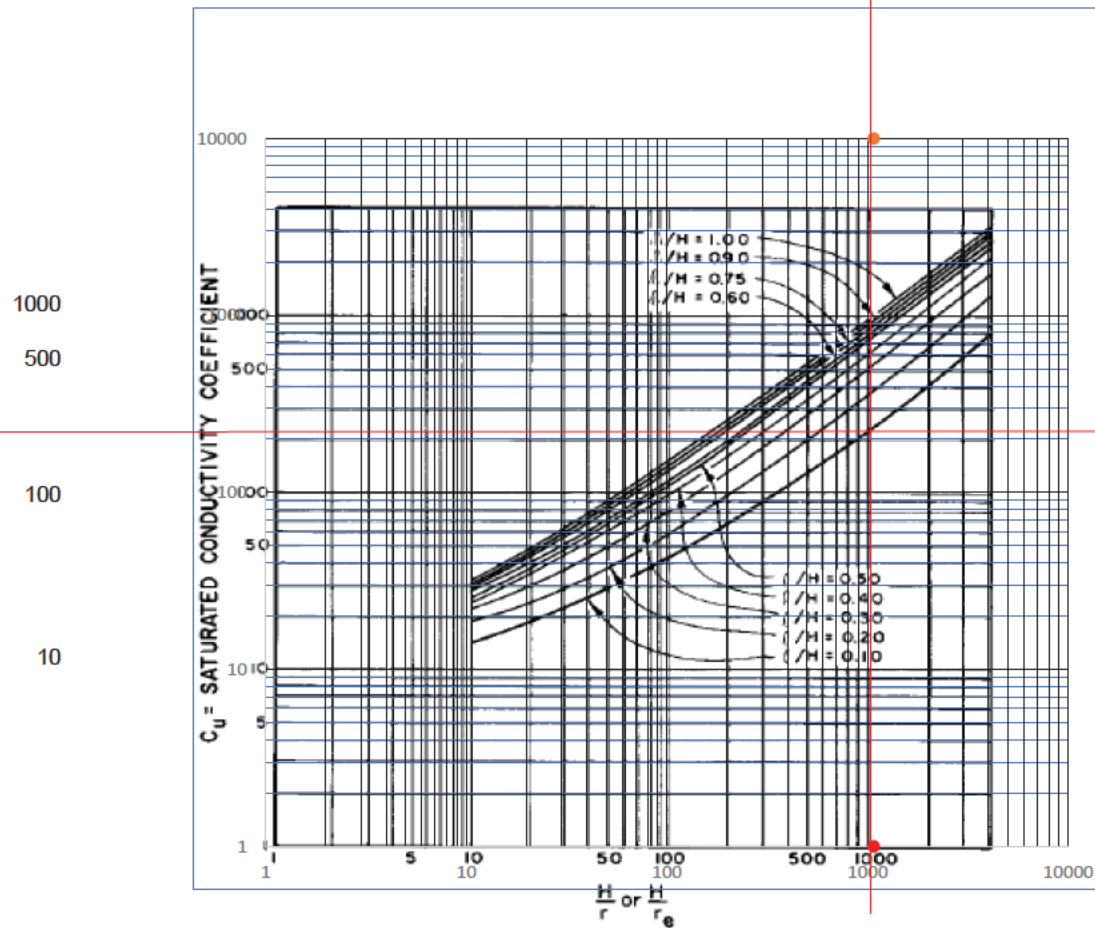
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4b
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.	<u>250</u>
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	<u>4.1</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>131.1</u>
Depth to Top of Test Zone, ft.	<u>117.5</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>9.40</u>
Depth to Bottom of Borehole, D, ft.	<u>127</u>	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	<u>9.5</u>	<i>Ignored for flow less than 2 gpm</i>	<u>0</u>
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	<u>30</u>
Drum Diameter, ft.	<u>1.85</u>	h <sub>2</sub> , ft	<u>69.2</u>
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	Effective Head, H, ft.	<u>200.3</u>
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	<u>323.3</u>

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	<u>62</u>
$X = \frac{H}{T_u} (100)$	<u>1282</u>
	<u>0.05</u>
T <sub>u</sub> / ℓ	<u>34</u>
	<u>Zone 1</u>
	<u>275</u>

Saturated Conductivity Coefficient, C<sub>u</sub>

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.08	<u>0.22</u>	5	<u>0.001</u>	<u>8.3E-08</u>	<u>2.63</u>	<u>2.5E-06</u>

  
**Check Applicability**


Q / a =	<u>0.00008</u>	≤	0.1	
ℓ (ft.) =	<u>9.5</u>	≥	10 r (ft.) =	<u>1.6</u>
				<u>Yes</u>

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

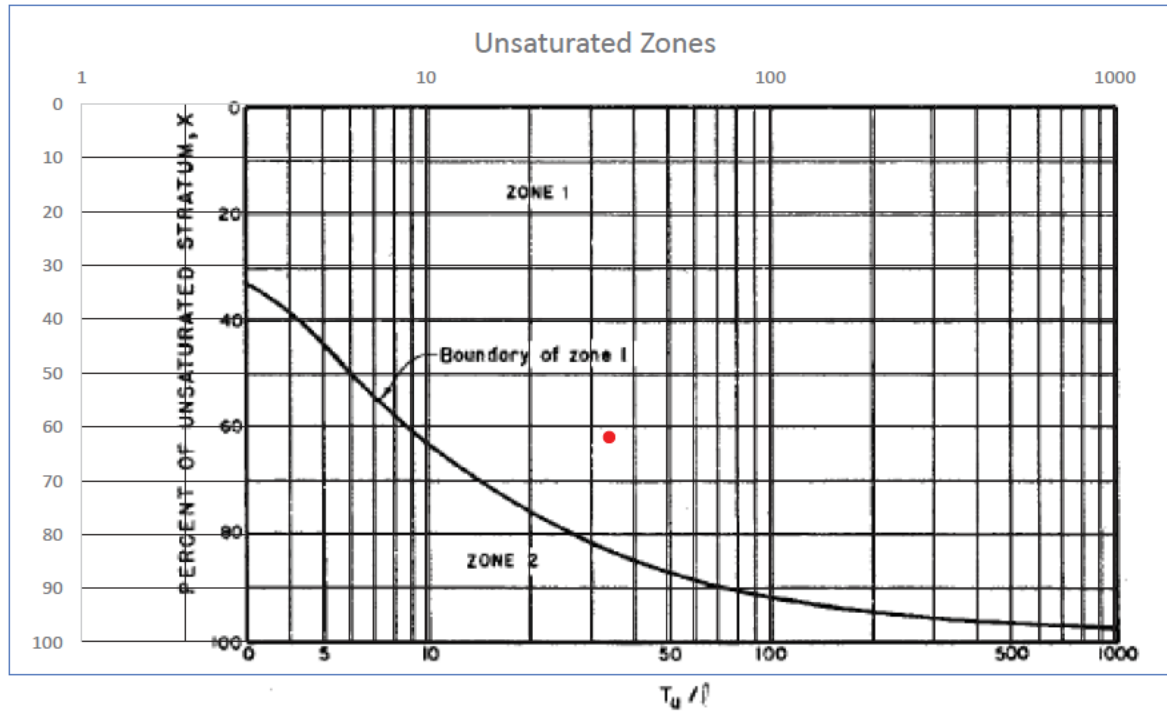
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

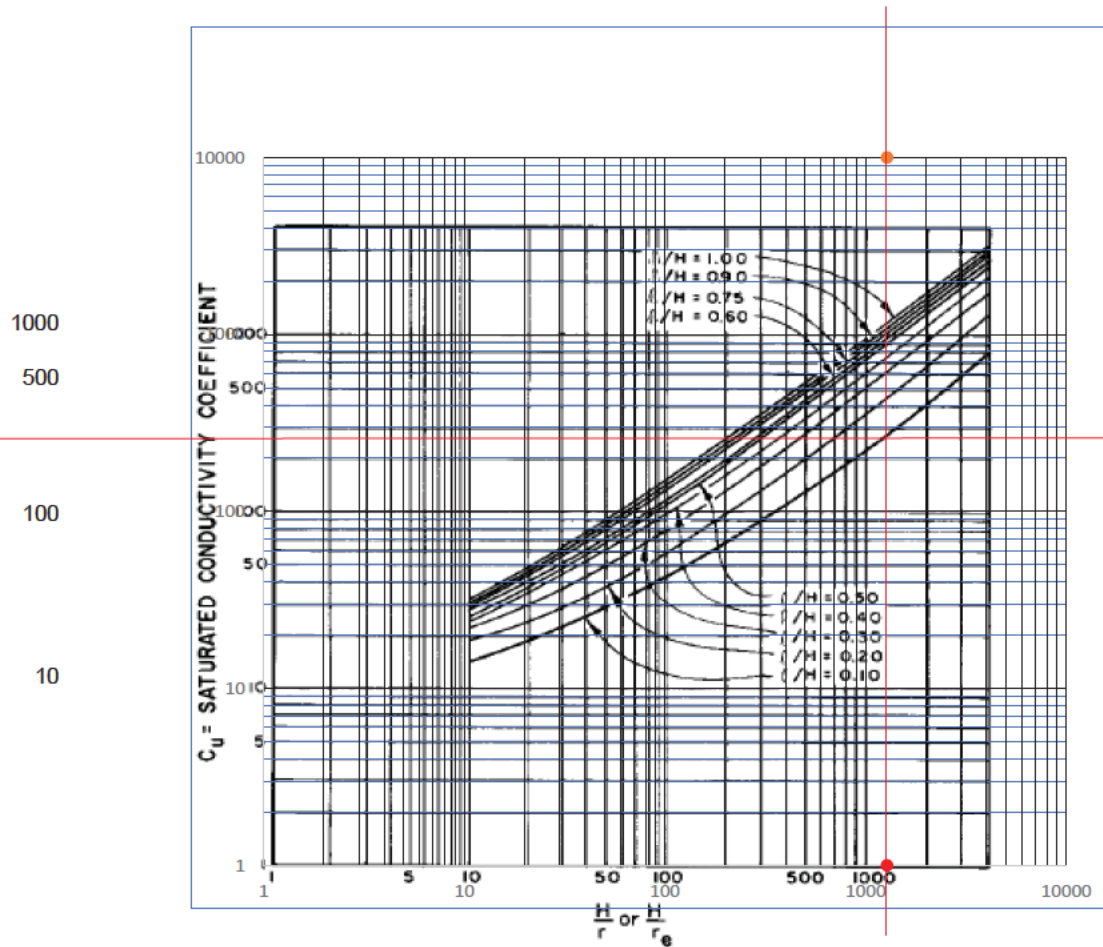
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B106</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 4c
Project No.: 1703345		Ground Surface El.: 3530.62
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/3/2017
Calculated By: J. Scully		Date: 11/9/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	4.1	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	131.1
Depth to Top of Test Zone, ft.	117.5	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.40
Depth to Bottom of Borehole, D, ft.	127	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.5	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	234.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	66
$X = \frac{H}{T_u} (100)$	1504
	0.04
	300
T <sub>u</sub> / ℓ	38
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.38	1.02	20	0.001	7.7E-08	2.44	2.4E-06


Check Applicability

Q / a =	0.00009	≤	0.1	
ℓ (ft.) =	9.5	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

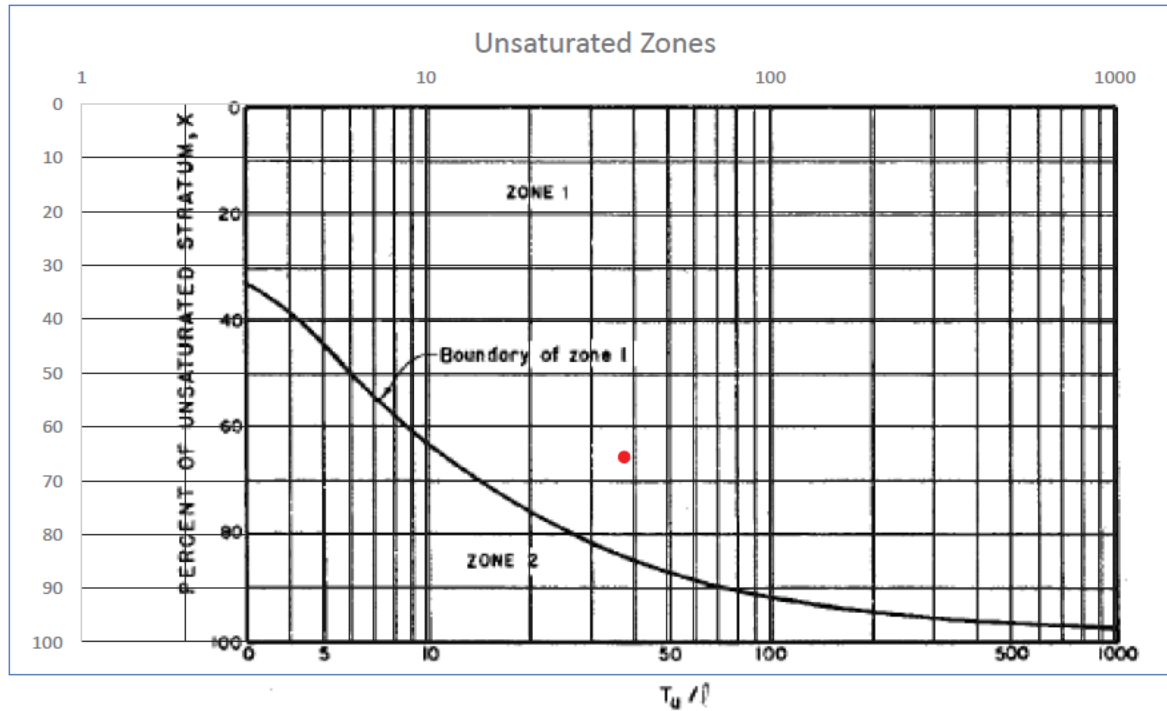
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B106**

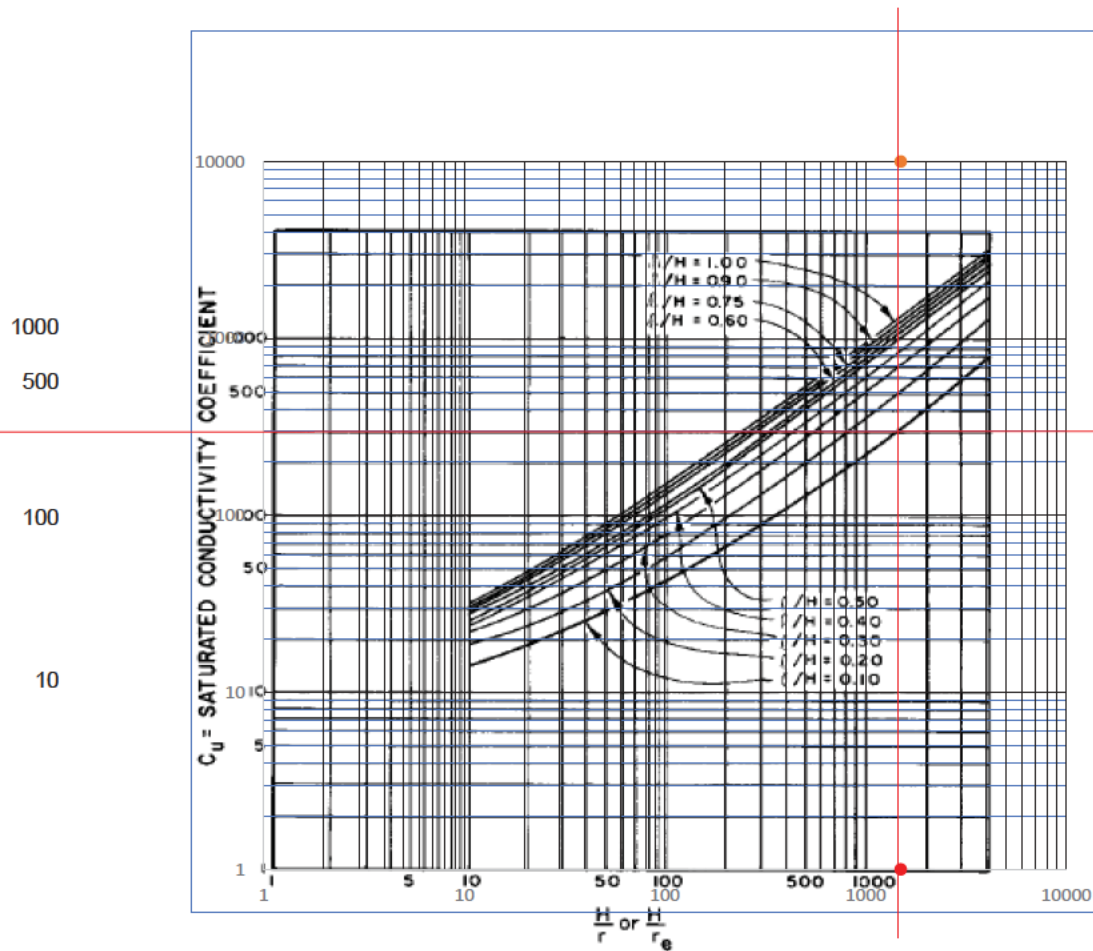
Project: HI-STORE CISF Site Characterization

Packer Test No.:

4c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	120.1
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	293.1

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	41
$X = \frac{H}{T_u} (100)$	769
	0.08
	190
T <sub>u</sub> / ℓ	32
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	5.0E-08	1.58	1.5E-06

Check Applicability


Q / a =	0.000019	≤	0.1	Yes
ℓ (ft.) =	9.3	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig.17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

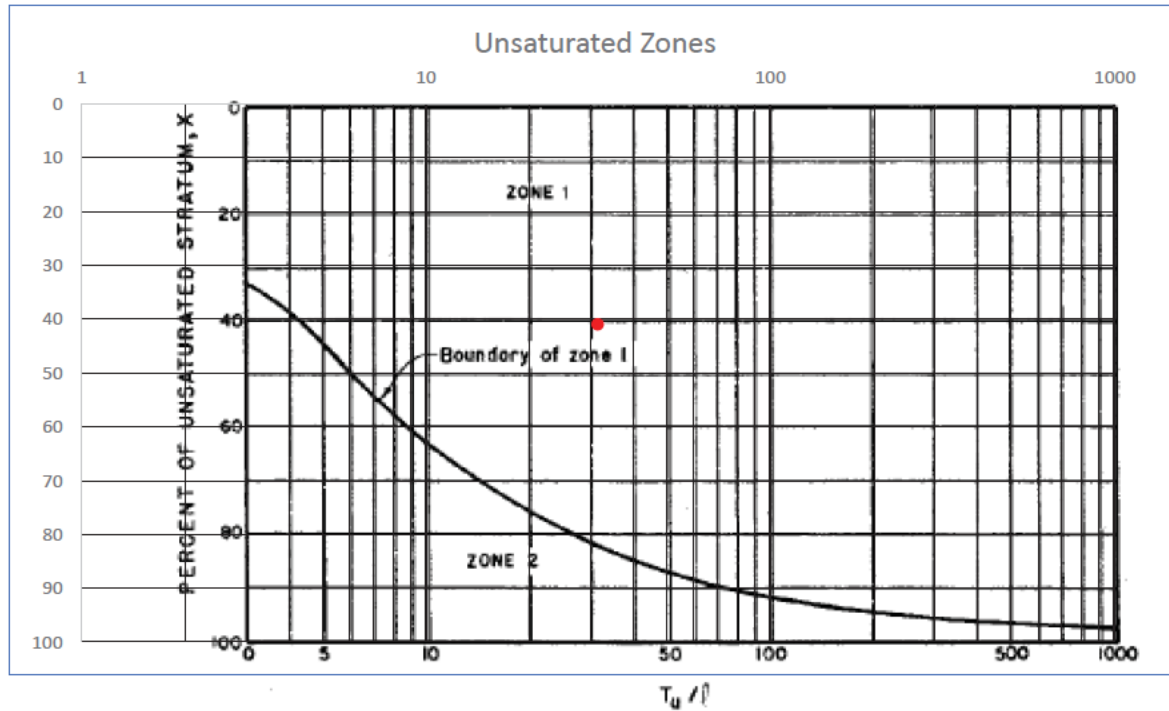
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

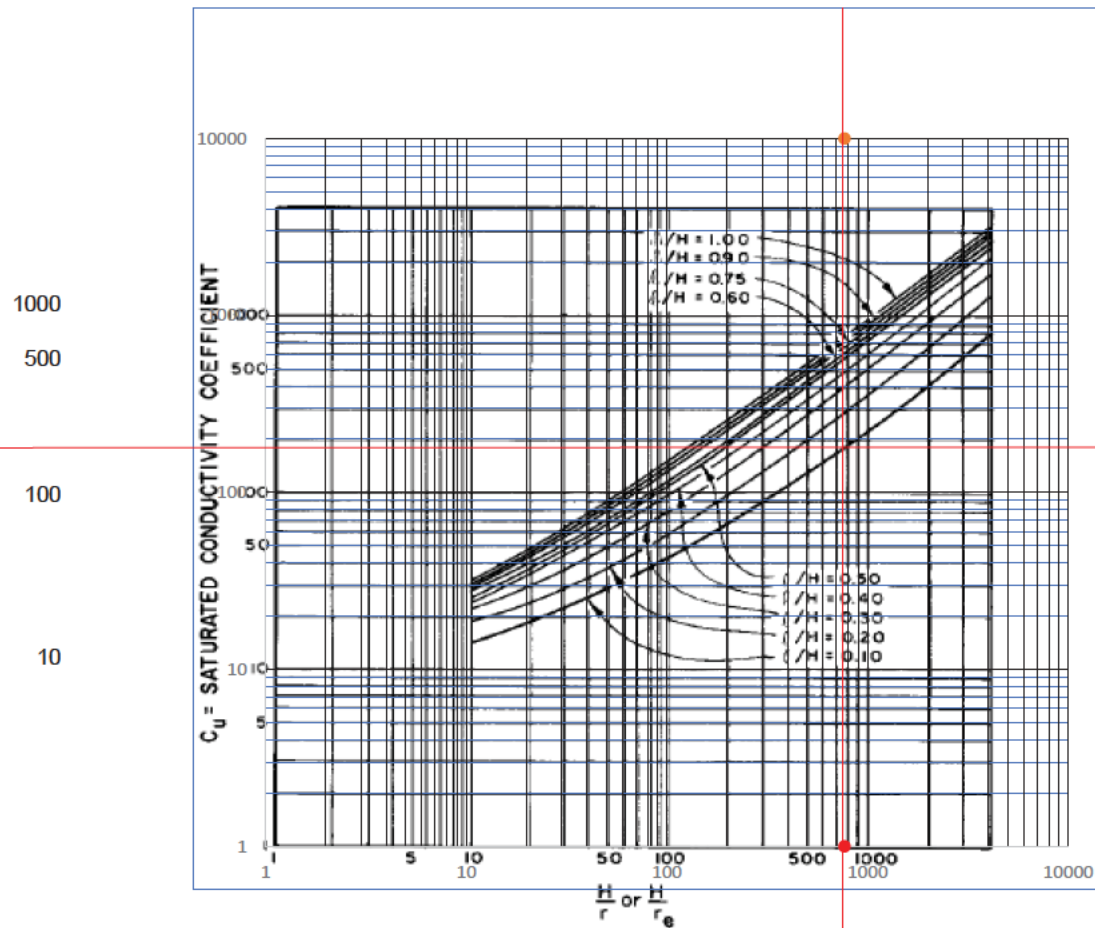
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	32
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	73.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	154.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	327.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	47	H / r	990
$X = \frac{H}{T_u} (100)$		ℓ / H	0.06
T <sub>u</sub> / ℓ	35	Saturated Conductivity Coefficient, C <sub>u</sub>	210
	Zone 1		

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.8E-08	0.56	5.4E-07

Check Applicability


Q / a =	0.000010	≤	0.1	Yes
ℓ (ft.) =	9.3	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

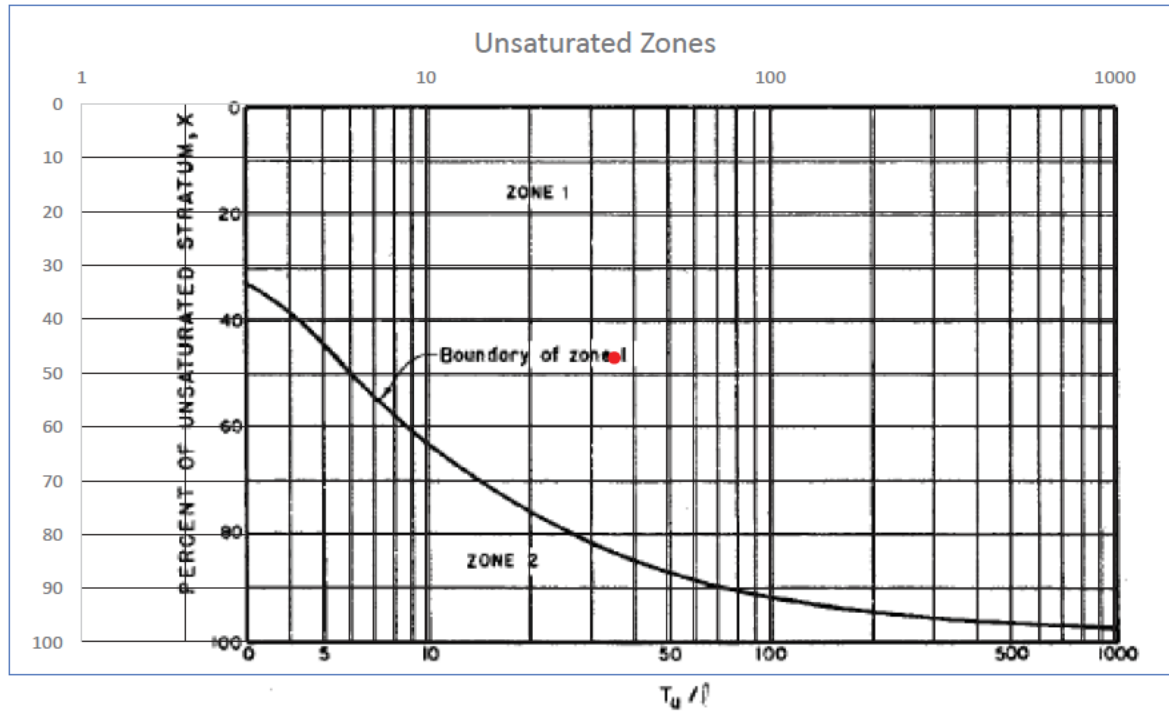
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

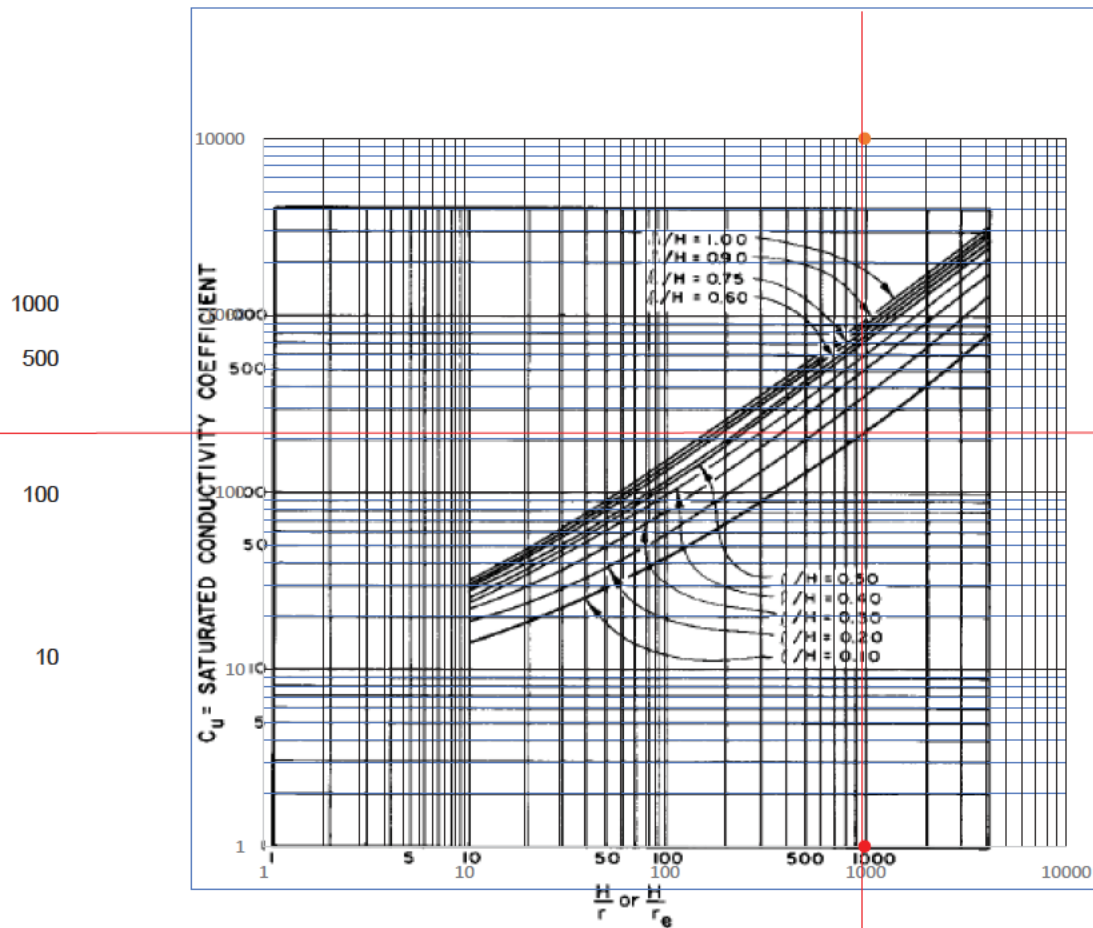
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/29/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.9	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	80.9
Depth to Top of Test Zone, ft.	67.7	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.21
Depth to Bottom of Borehole, D, ft.	77	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.3	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	184.7
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.7

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6

Percent of unsaturated stratum, X 52

$$X = \frac{H}{T_u} (100)$$

T<sub>u</sub> / ℓ 38

Zone 1

Fig. 17-7

H / r 1182

ℓ / H 0.05

Saturated Conductivity Coefficient, C<sub>u</sub> 250

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	3.7E-08	1.17	1.1E-06

Check Applicability


Q / a =	0.000029	≤	0.1	Yes
ℓ (ft.) =	9.3	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

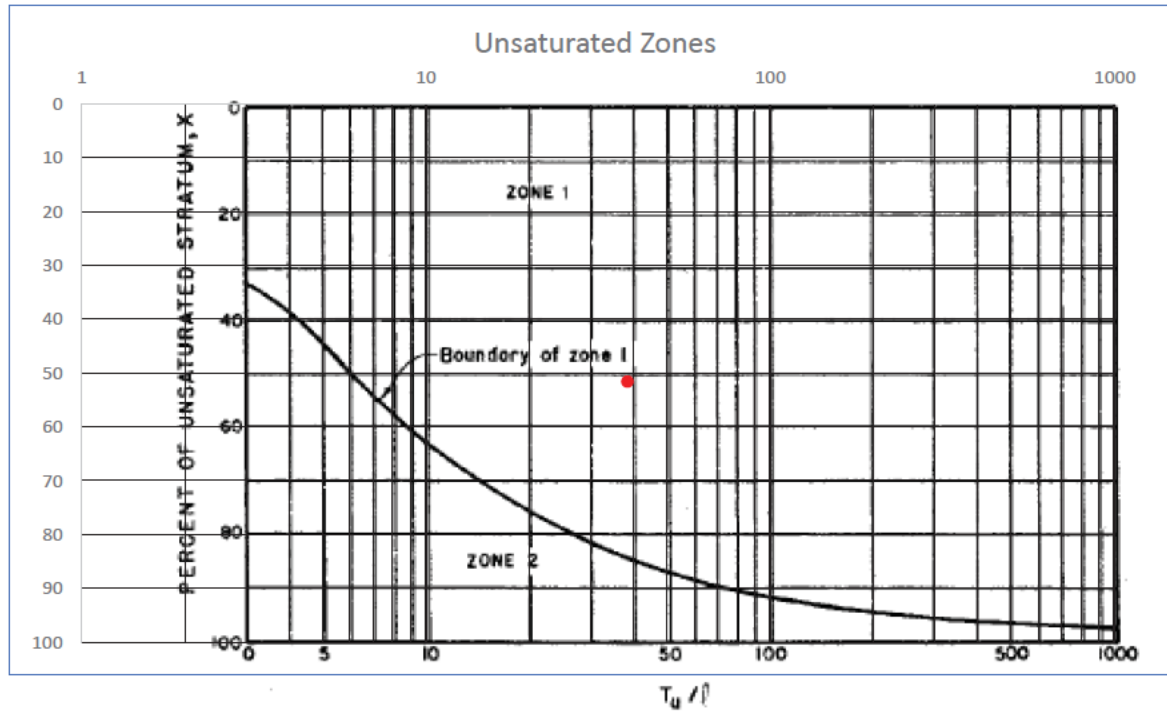
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

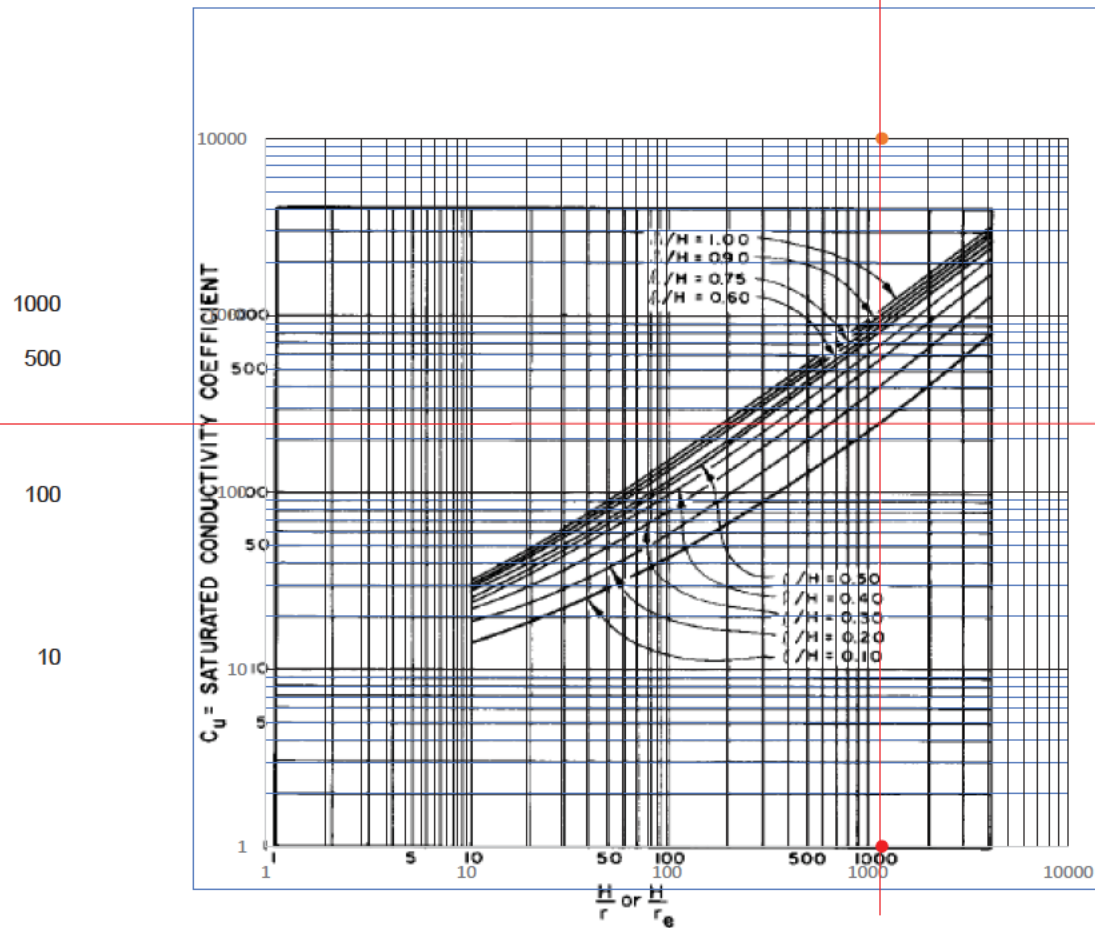
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	15
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	34.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	125.3
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	288.3

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	43
$X = \frac{H}{T_u} (100)$	802
	0.07
	190
T <sub>u</sub> / ℓ	31
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.11	0.30	5	0.0010	2.6E-07	8.35	8.1E-06

Check Applicability


Q / a =	0.000108	≤	0.1	Yes
ℓ (ft.) =	9.2	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

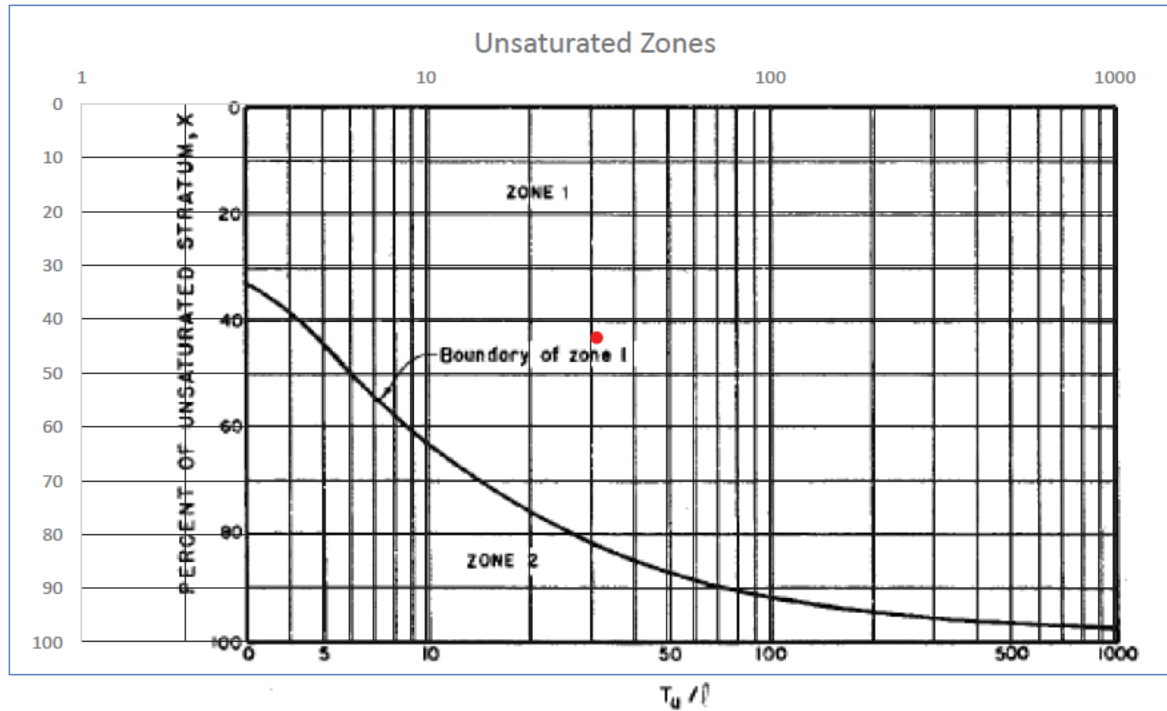
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

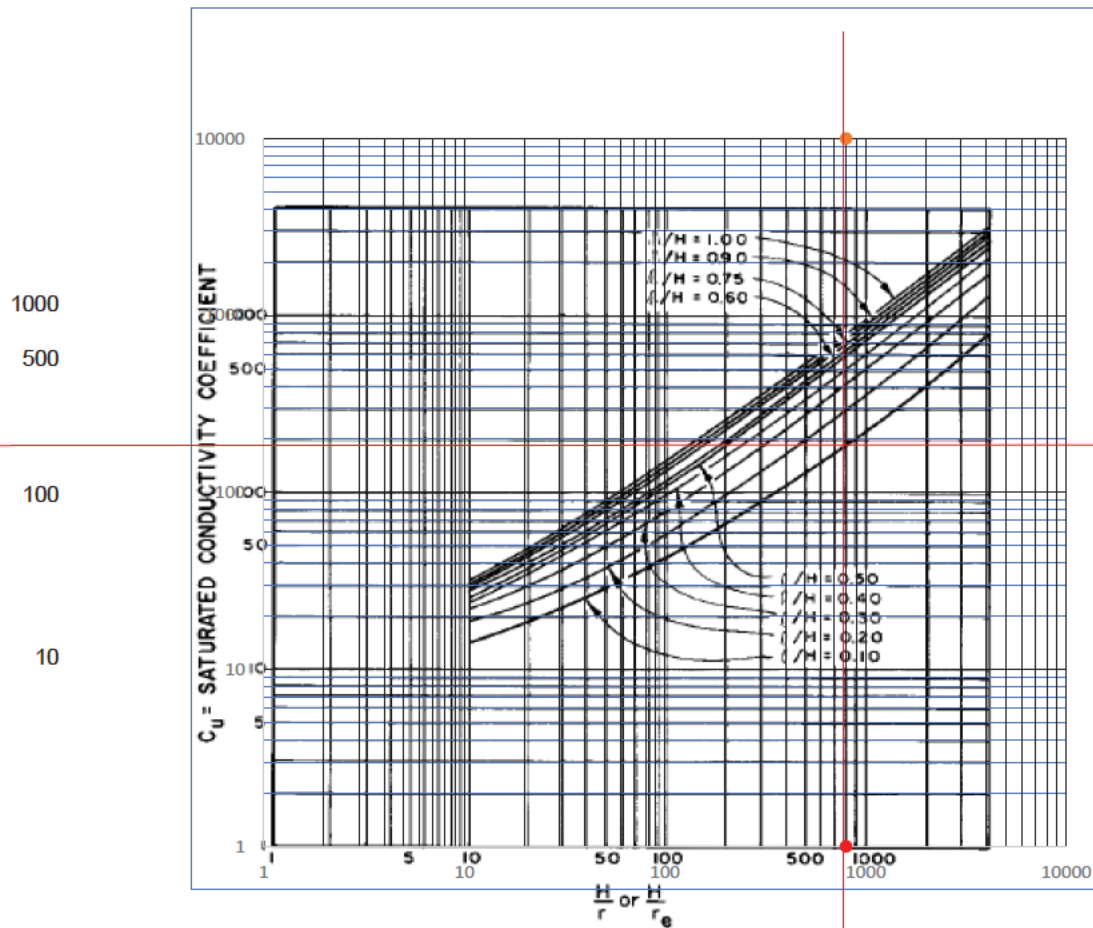
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	30
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	69.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	159.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	322.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	50
$X = \frac{H}{T_u} (100)$	1024
	0.06
	210
T <sub>u</sub> / ℓ	35
	Zone 1

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.16	0.43	5	0.0014	2.7E-07	8.62	8.3E-06


Check Applicability

Q / a =	0.000157	≤	0.1	
ℓ (ft.) =	9.2	≥	10 r (ft.) =	1.6
				Yes
				Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

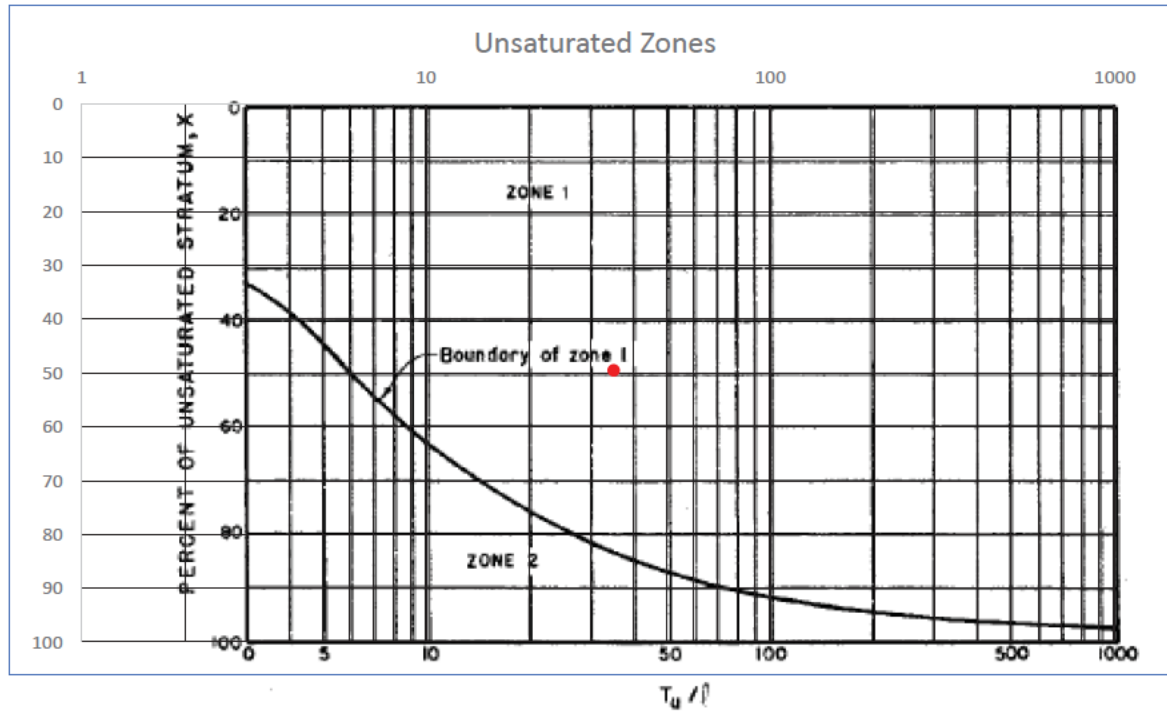
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

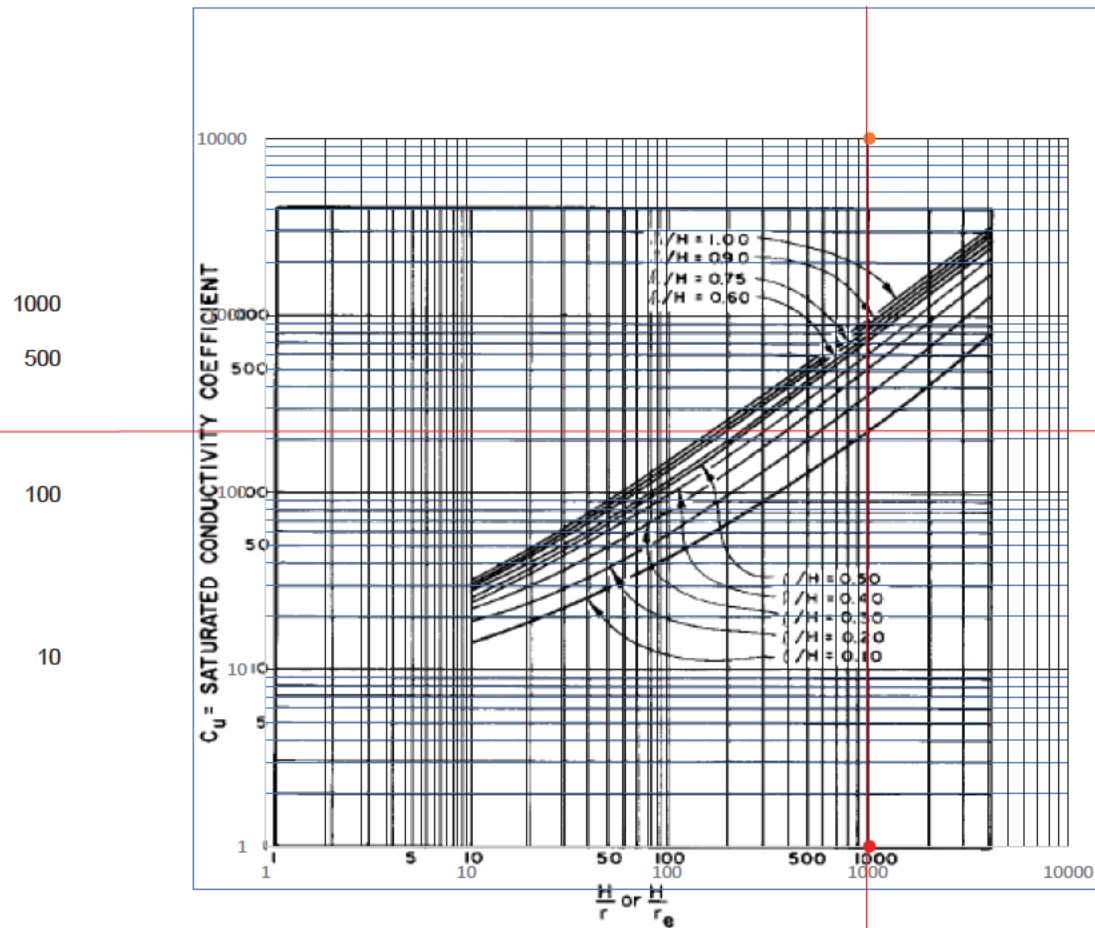
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 2c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By:		Date:

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.7	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	90.7
Depth to Top of Test Zone, ft.	77.8	Exposed surface area of the test zone, a, ft. <sup>2</sup>	9.11
Depth to Bottom of Borehole, D, ft.	87	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.2	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	194.5
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.5

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6

Percent of unsaturated stratum, X 54

$$X = \frac{H}{T_u} (100)$$

T<sub>u</sub> / ℓ 39

Zone 1

Fig. 17-7

H / r 1245

ℓ / H 0.05

Saturated Conductivity Coefficient, C<sub>u</sub> 250

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.19	0.51	5	0.0017	2.2E-07	7.06	6.8E-06

Check Applicability


Q / a = 0.000187	≤	0.1	Yes
ℓ (ft.) = 9.2	≥	10 r (ft.) = 1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

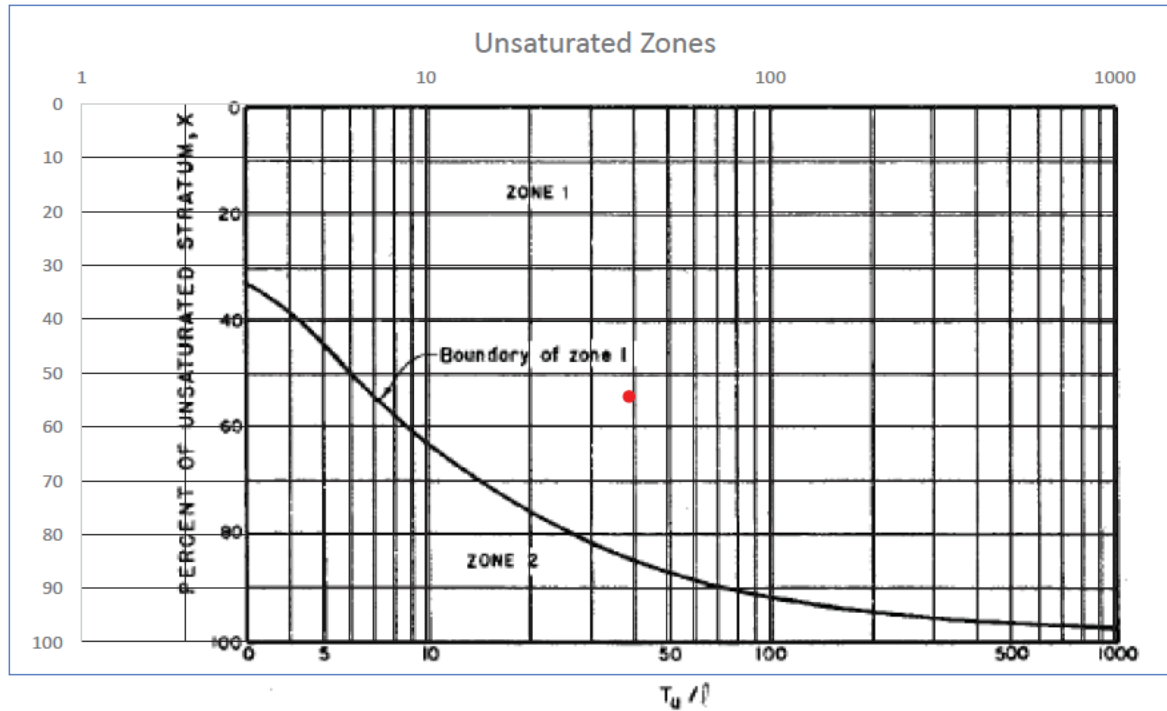
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

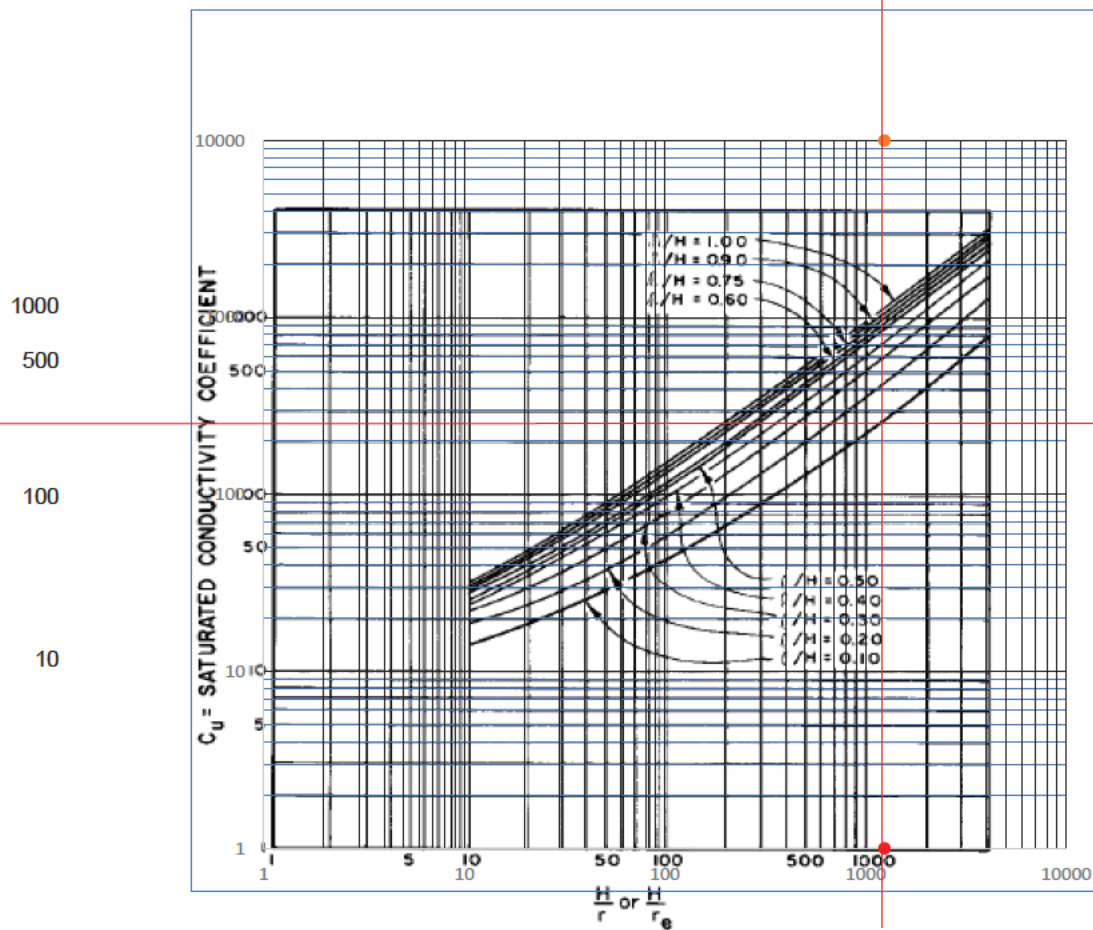
Project: HI-STORE CISF Site Characterization

Packer Test No.:

2c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3a
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	17
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	39.2
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	144.6
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	292.6

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	49	H / r	926
$X = \frac{H}{T_u} (100)$		ℓ / H	0.10
T <sub>u</sub> / ℓ	21	Saturated Conductivity Coefficient, C <sub>u</sub>	205
	Zone 1		

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.02	0.05	5	0.0002	3.9E-08	1.22	1.2E-06

  
**Check Applicability**


Q / a =	0.000013	≤	0.1		Yes
ℓ (ft.) =	13.9	≥	10 r (ft.) =	1.6	Yes

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$





**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

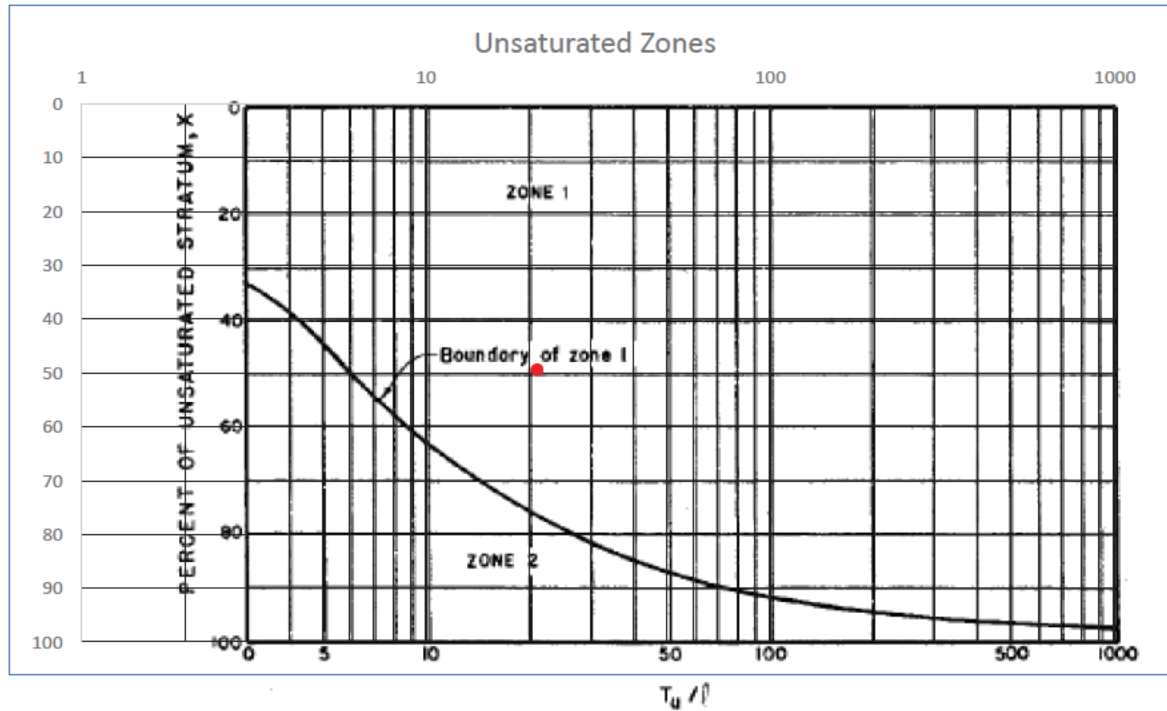
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

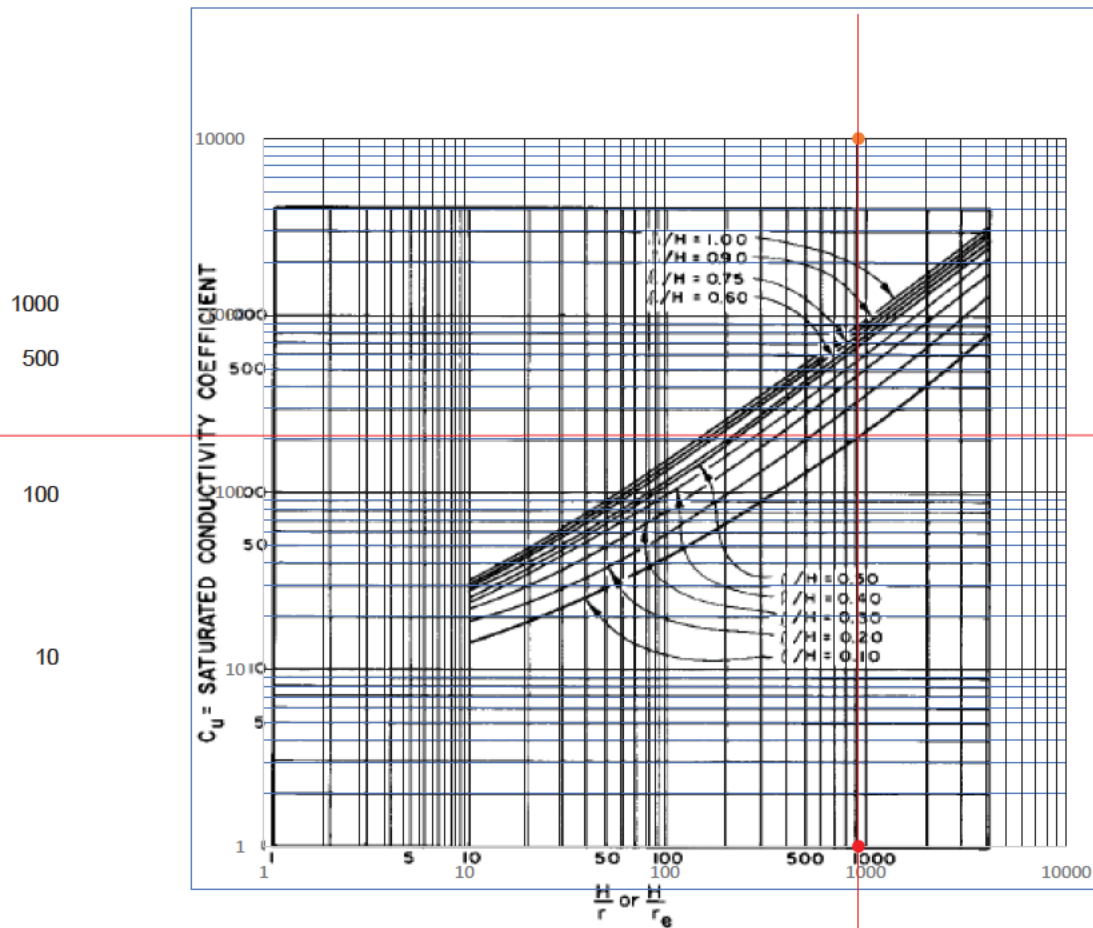
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3b
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	31
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	71.5
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	176.9
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	324.9

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7	
Percent of unsaturated stratum, X	54	H / r
$X = \frac{H}{T_u} (100)$		ℓ / H
		Saturated Conductivity Coefficient, C <sub>u</sub>
T <sub>u</sub> / ℓ	23	1132
	Zone 1	0.08
		250

PACKER TEST DATA

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.01	0.03	5	0.0001	1.3E-08	0.41	4.0E-07

Check Applicability


Q / a =	0.000007	≤	0.1	Yes
ℓ (ft.) =	13.9	≥ 10 r (ft.) =	1.6	Yes

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

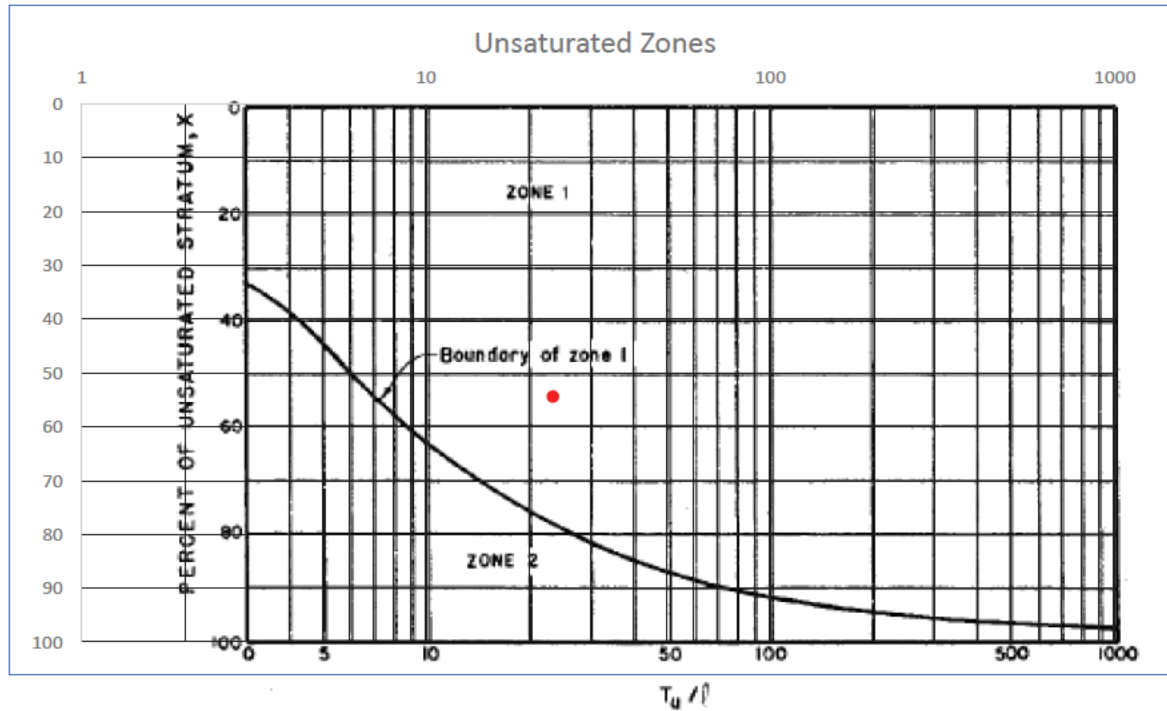
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

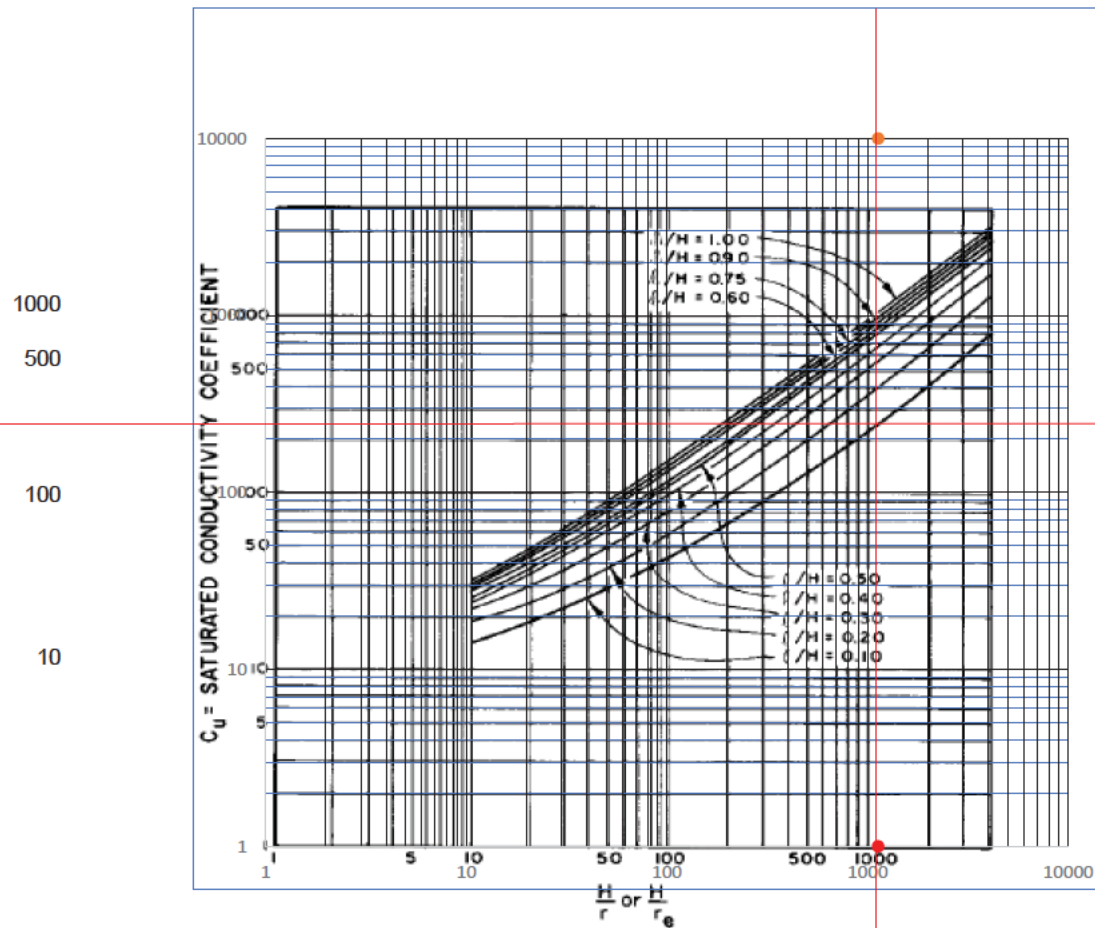
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B107</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 3c
Project No.: 1703345		Ground Surface El.: 3529.55
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 9/30/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	88.1	Exposed surface area of the test zone, a, ft. <sup>2</sup>	13.72
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	13.9	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	209.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.2

**PACKER TEST METHOD: Method 1 (Single Packer)**

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	59
$X = \frac{H}{T_u} (100)$	1339
	ℓ / H
	0.07
	Saturated Conductivity Coefficient, C <sub>u</sub>
	275
T <sub>u</sub> / ℓ	26
	Zone 1

  
**PACKER TEST DATA**

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.06	0.16	7	0.0004	4.3E-08	1.35	1.3E-06

  
**Check Applicability**


Q / a =	0.000028	≤	0.1	
ℓ (ft.) =	13.9	≥	10 r (ft.) =	1.6
				Yes
				Yes

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1      Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

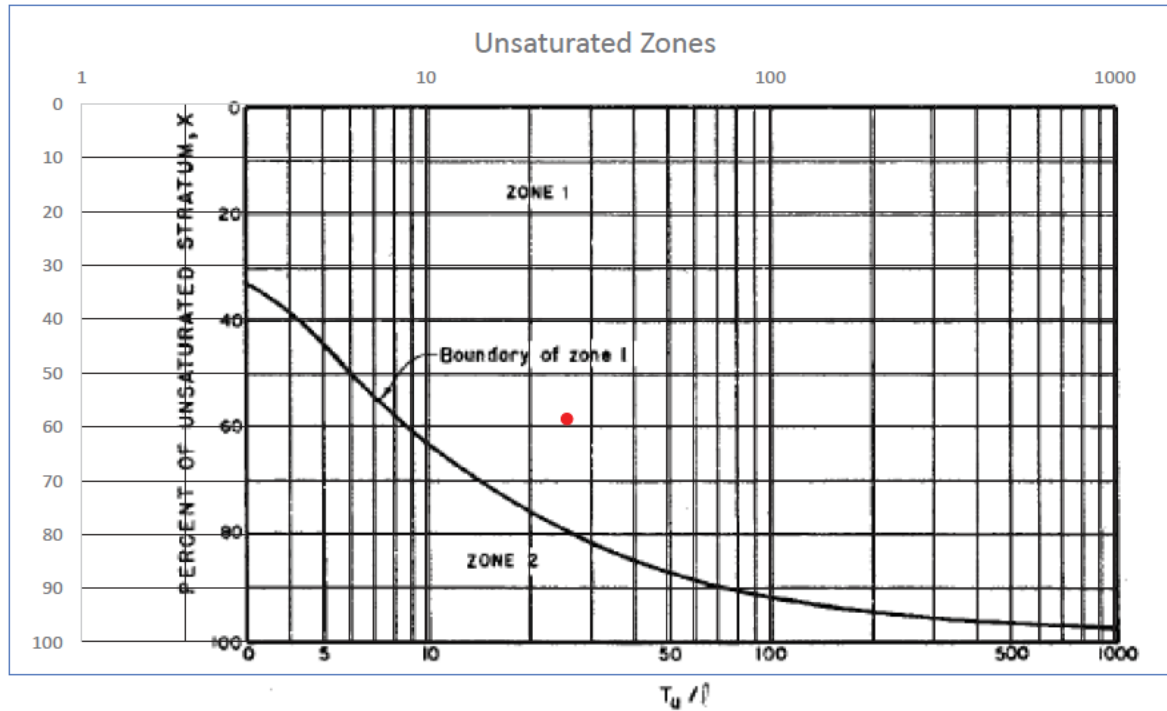
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B107**

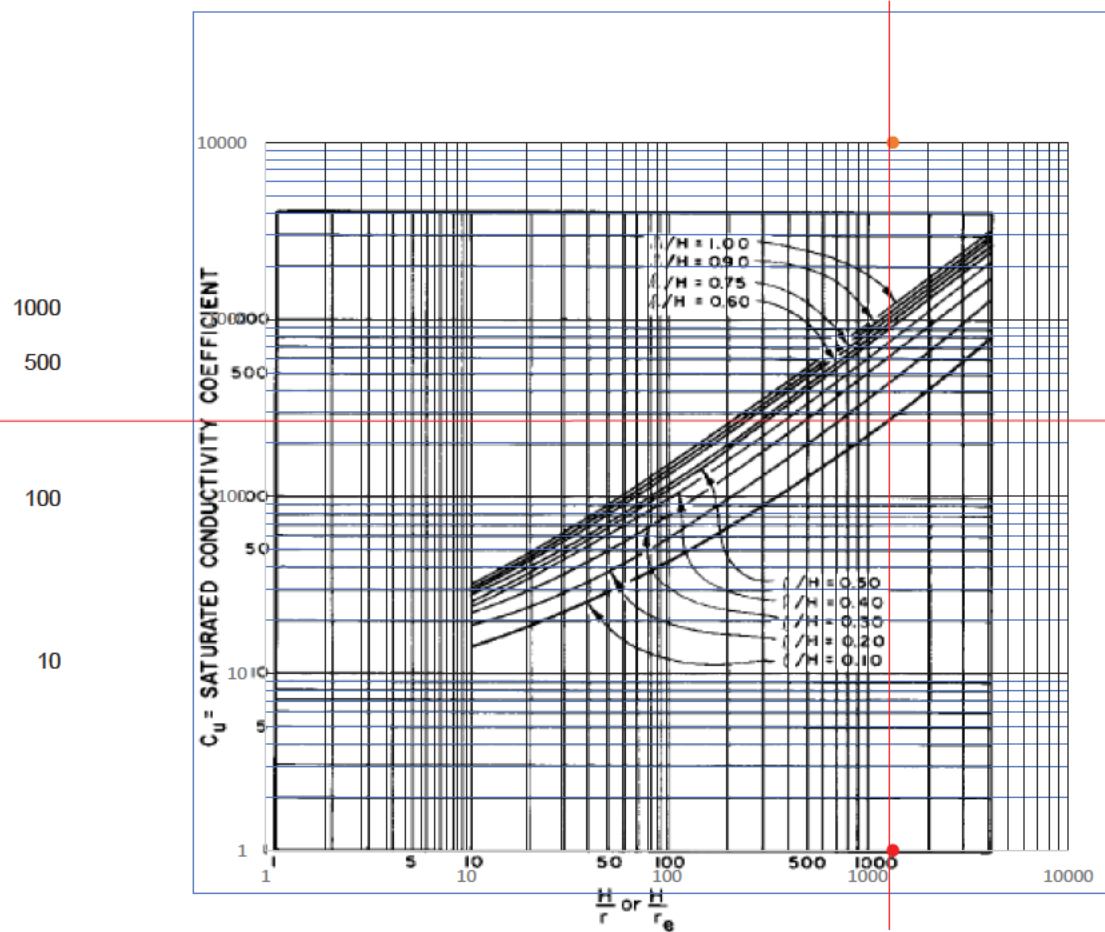
Project: HI-STORE CISF Site Characterization

Packer Test No.:

3c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B109</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1a
Project No.: 1703345		Ground Surface El.: 3539.6
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/14/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	250
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	93	Exposed surface area of the test zone, a, ft. <sup>2</sup>	8.91
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.0	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	15
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	34.6
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	140.0
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	288.0

**PACKER TEST METHOD:** Method 1 (Single Packer)

Fig. 17-6	Fig. 17-7
Percent of unsaturated stratum, X	49
$X = \frac{H}{T_u} (100)$	896
	0.06
T <sub>u</sub> / ℓ	32
	Zone 1
	205

**PACKER TEST DATA**

*Note: Observed slight leak at ground surface during testing.*

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.03	0.08	5	0.0003	6.0E-08	1.89	1.8E-06

**Check Applicability**

Q / a =	0.000030	≤	0.1	
ℓ (ft.) =	9	≥	10 r (ft.) =	1.6
				Yes
				Yes


  

**Notes:**

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1

Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

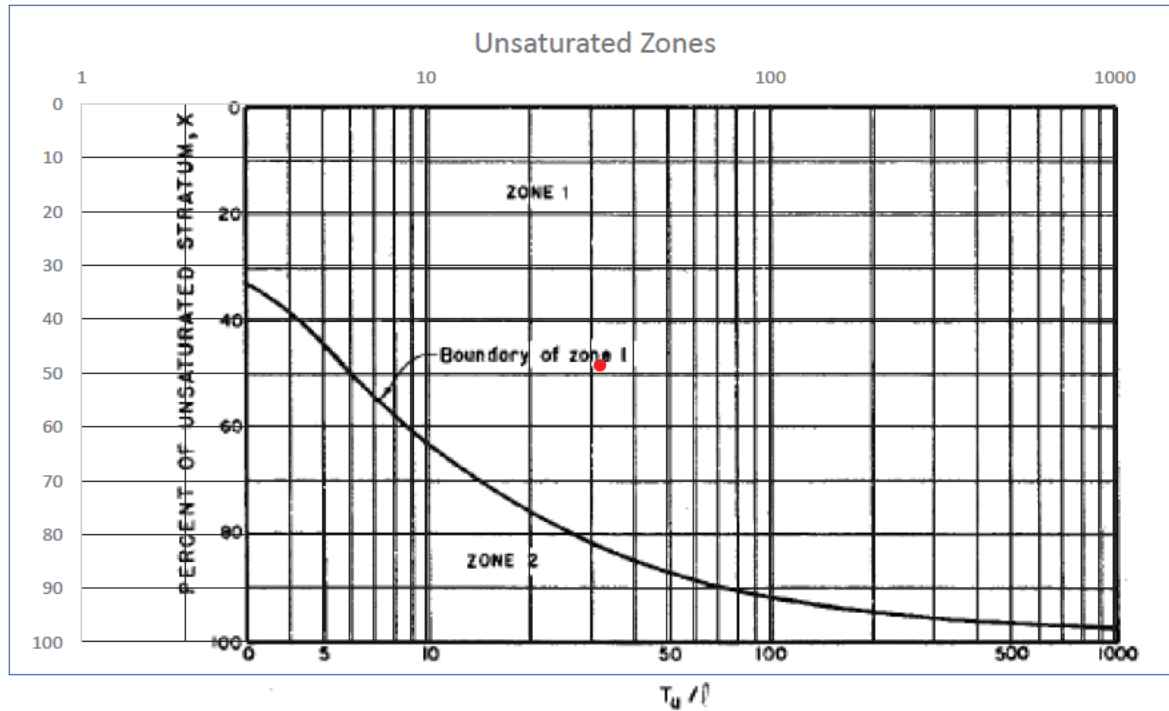
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

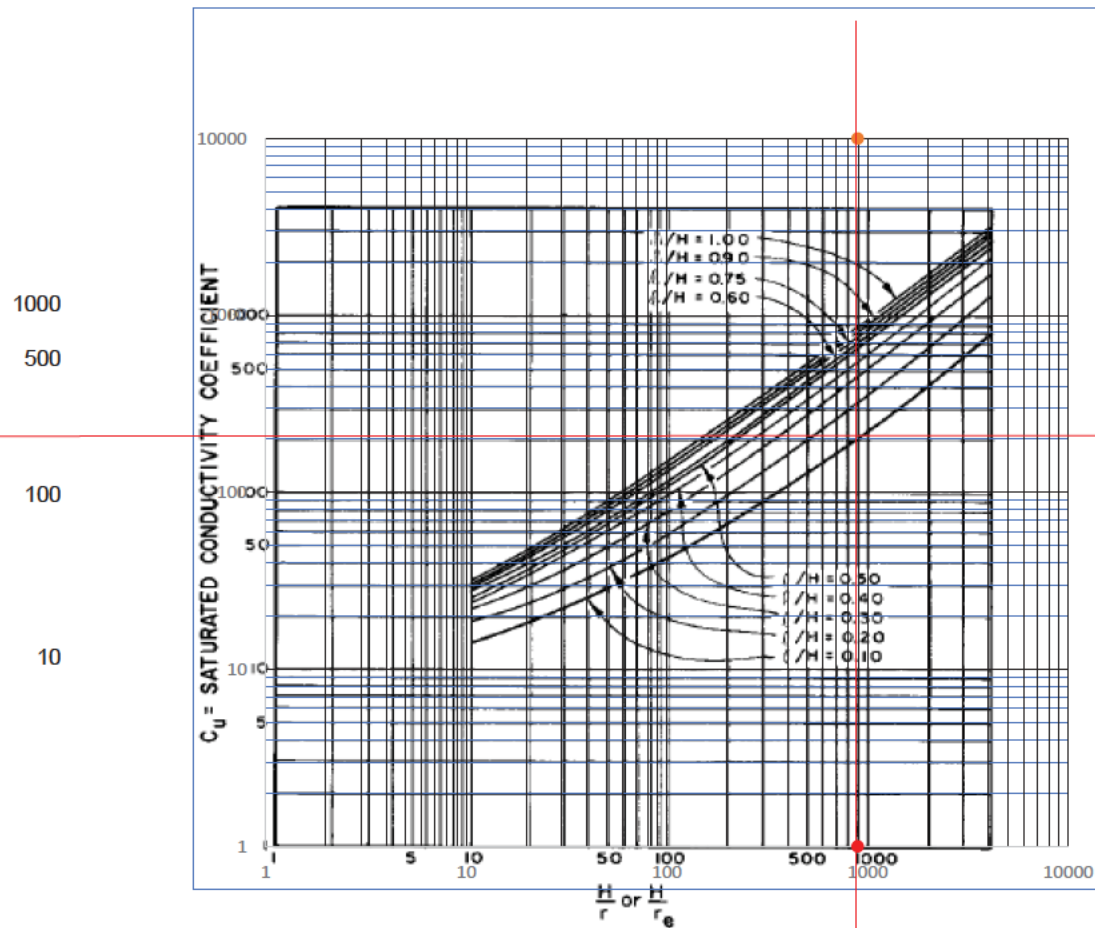
Project: HI-STORE CISF Site Characterization

Packer Test No.:


1a

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**

<b>Water Pressure Test in Bedrock (Above Water Table)</b>				Boring: <b>B109</b>	
Project: HI-STORE CISF Site Characterization				Packer Test No.: 1b	
Project No.: 1703345				Ground Surface El.: 3539.6	
Location: Lea County, New Mexico				Datum: NAVD 1988	
Performed By: A. McDonald / M. Hernandez-Cabal				Date: 10/14/2017	
Calculated By: J. Scully				Date: 11/10/2017	
Checked By: M. Hernandez-Cabal				Date: 11/20/2017	
<b>Packer Test Setup</b>					
Borehole Diameter, d, in.	<u>3.75</u>	Thickness of Unsaturated Material, U, ft.	<u>250</u>		
Radius of Hole, r, ft.	<u>0.156</u>	<i>Estimated from B101(MW)</i>			
Gauge Height, ft.	<u>3.4</u>	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	<u>105.4</u>		
Depth to Top of Test Zone, ft.	<u>93</u>	Exposed surface area of the test zone, a, ft. <sup>2</sup>	<u>8.91</u>		
Depth to Bottom of Borehole, D, ft.	<u>102</u>	Head Loss, L, ft.	<u>0</u>		
Length of Test Zone, ℓ, ft.	<u>9.0</u>	<i>Ignored for flow less than 2 gpm</i>			
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	<u>29</u>		
Drum Diameter, ft.	<u>1.85</u>	h <sub>2</sub> , ft	<u>66.9</u>		
Drum Area, ft. <sup>2</sup>	<u>2.69</u>	Effective Head, H, ft.	<u>172.3</u>		
		Effective distance to water surface, T <sub>u</sub> , ft.	<u>320.3</u>		
		T <sub>u</sub> = U - D + H	<u>320.3</u>		
PACKER TEST METHOD: <u>Method 1 (Single Packer)</u>					
Fig. 17-6		Fig. 17-7			
Percent of unsaturated stratum, X	<u>54</u>	H / r	<u>1103</u>		
$X = \frac{H}{T_u} (100)$		ℓ / H	<u>0.05</u>		
T <sub>u</sub> / ℓ	<u>36</u>	Saturated Conductivity Coefficient, C <sub>u</sub>	<u>230</u>		
		Zone 1			
PACKER TEST DATA					
<i>Note: Observed slight leak at ground surface during testing.</i>					
Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K	
0.05	0.13	5	0.0004	(ft./sec)	(cm./sec)
				(ft./yr)	(cm./sec)
				7.2E-08	2.28
				2.2E-06	
Check Applicability					
Q / a =	0.000050	≤	0.1	<u>Yes</u>	
ℓ (ft.) =	9	≥	10 r (ft.) = 1.6	<u>Yes</u>	
Notes:					
1. Water pressure was measured with a pressure gauge attached to the water line above ground.					
2. Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.					
3. Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.					
4. Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.					
<div style="display: flex; justify-content: space-between; align-items: center;"> <div> <p>Method 1</p> <p>Zone 1: <math>K = \frac{Q}{C_u r H}</math></p> </div> <div style="text-align: right;">  </div> </div>					

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

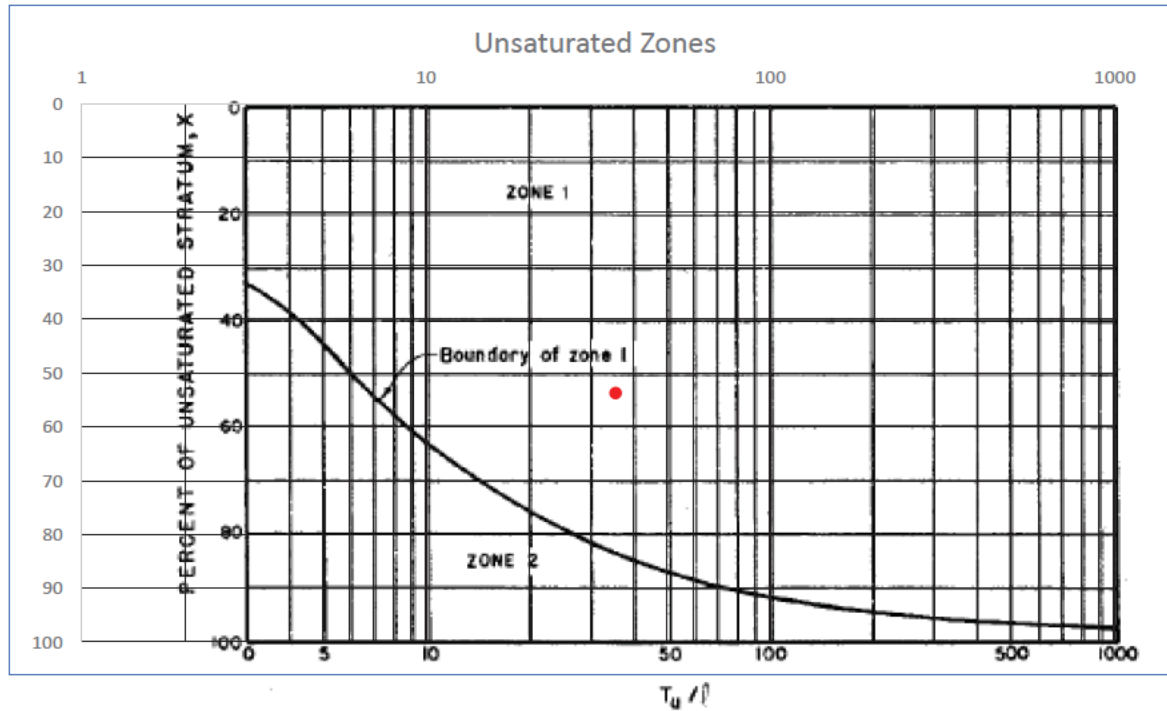
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

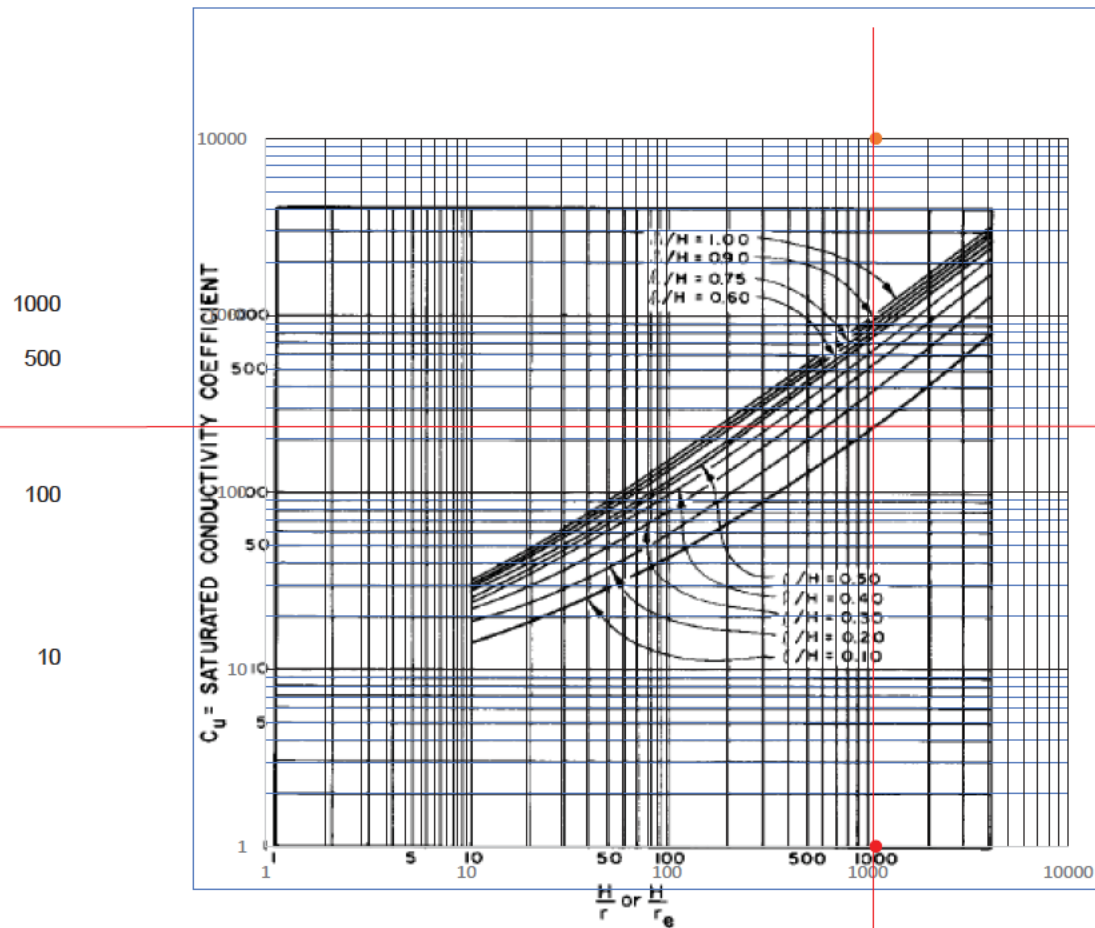
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1b

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients  
for permeability determination in  
unsaturated materials with partially  
penetrating cylindrical test wells.**



<b>Water Pressure Test in Bedrock (Above Water Table)</b>		Boring: <b>B109</b>
Project: HI-STORE CISF Site Characterization		Packer Test No.: 1c
Project No.: 1703345		Ground Surface El.: 3539.6
Location: Lea County, New Mexico		Datum: NAVD 1988
Performed By: A. McDonald / M. Hernandez-Cabal		Date: 10/14/2017
Calculated By: J. Scully		Date: 11/10/2017
Checked By: M. Hernandez-Cabal		Date: 11/20/2017

**Packer Test Setup**

Borehole Diameter, d, in.	3.75	Thickness of Unsaturated Material, U, ft.	
Radius of Hole, r, ft.	0.156	<i>Estimated from B101(MW)</i>	250
Gauge Height, ft.	3.4	Distance between gauge and bottom of borehole, h <sub>1</sub> , ft.	105.4
Depth to Top of Test Zone, ft.	93	Exposed surface area of the test zone, a, ft. <sup>2</sup>	8.91
Depth to Bottom of Borehole, D, ft.	102	Head Loss, L, ft.	
Length of Test Zone, ℓ, ft.	9.0	<i>Ignored for flow less than 2 gpm</i>	0
Reservoir, 55 gallon drum		Applied Water Pressure, h <sub>2</sub> , psi	45
Drum Diameter, ft.	1.85	h <sub>2</sub> , ft	103.8
Drum Area, ft. <sup>2</sup>	2.69	Effective Head, H, ft.	209.2
		Effective distance to water surface, T <sub>u</sub> , ft.	
		T <sub>u</sub> = U - D + H	357.2

PACKER TEST METHOD: Method 1 (Single Packer)

Fig. 17-6		Fig. 17-7	
Percent of unsaturated stratum, X	59	H / r	1339
$X = \frac{H}{T_u} (100)$		ℓ / H	0.04
T <sub>u</sub> / ℓ	40	Saturated Conductivity Coefficient, C <sub>u</sub>	275
	<u>Zone 1</u>		

PACKER TEST DATA

*Note: Observed slight leak at ground surface during testing.*

Drop in Reservoir (ft.)	Test Volume (ft. <sup>3</sup> )	Test Duration (mins)	Flow, Q (ft. <sup>3</sup> /sec)	Coefficient of Permeability, K		
				(ft./sec)	(ft./yr)	(cm./sec)
0.47	1.26	20	0.0011	1.2E-07	3.69	3.6E-06

Check Applicability

Q / a =	0.000118	≤	0.1		Yes
ℓ (ft.) =	9	≥	10 r (ft.) =	1.6	Yes


  

Notes:

- Water pressure was measured with a pressure gauge attached to the water line above ground.
- Volume of water was calculated from the measured drop in a 55 gallon drum of known dimensions.
- Friction losses in the water pipes were considered negligible based on USBR Field Manual Fig. 17-4.
- Coefficient of Permeability, K, per USBR Engineering Geology Field Manual, Second Edition, 2001, Chapter 17.

Method 1

Zone 1:  $K = \frac{Q}{C_u r H}$



**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

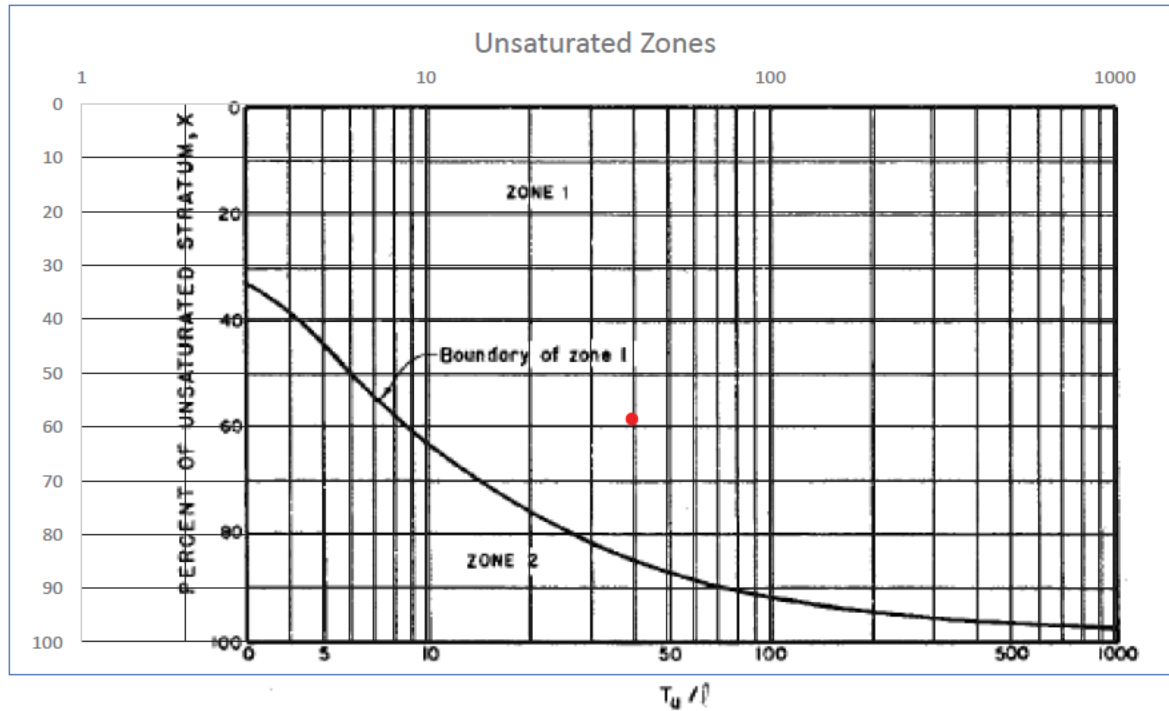
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-6.—Location of zone 1 lower boundary for use in unsaturated materials.**

**Water Pressure Test in Bedrock (Above Water Table)**

Boring:

**B109**

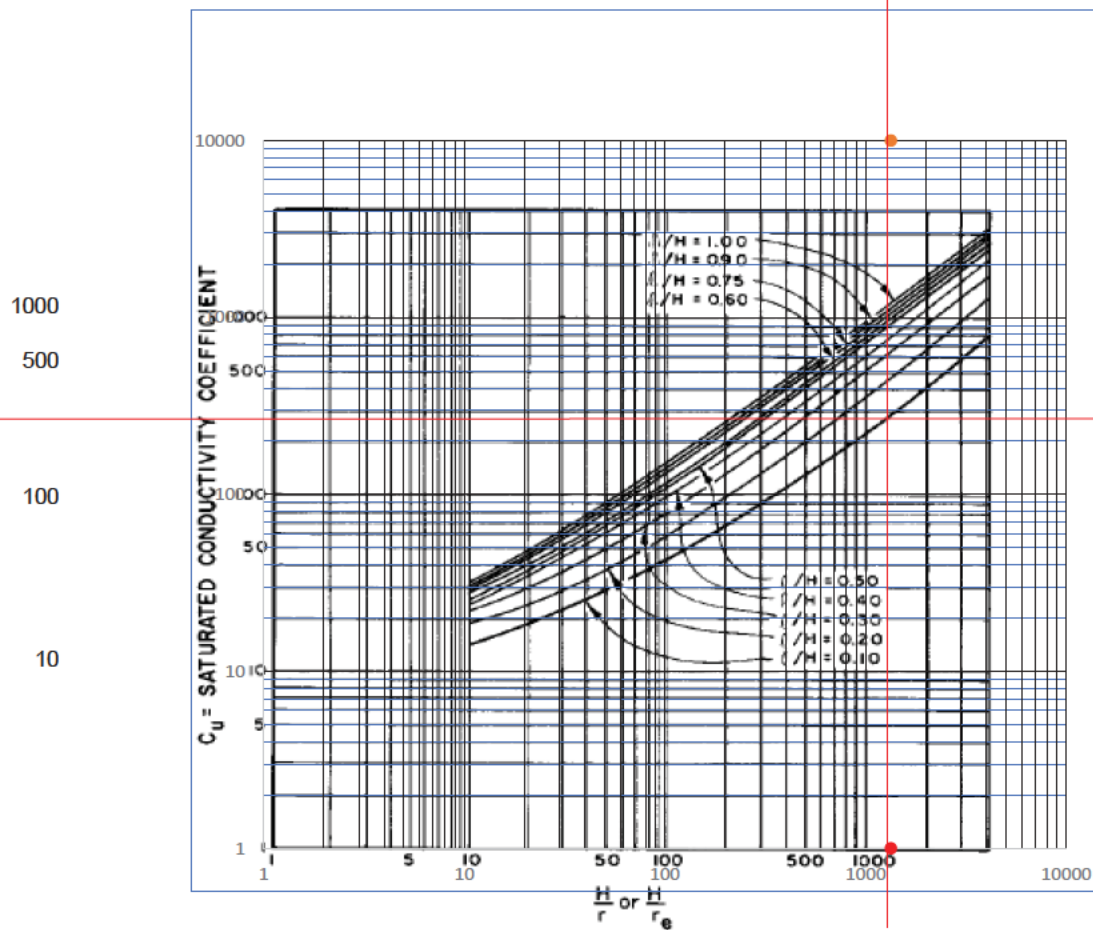
Project: HI-STORE CISF Site Characterization

Packer Test No.:

1c

Project No.: 1703345

Location: Lea County, New Mexico



**Figure 17-7.—Conductivity coefficients for permeability determination in unsaturated materials with partially penetrating cylindrical test wells.**

Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## Attachment H

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### Geotechnical Laboratory Soil Test Data by GEI

<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B101			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S19			
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal				Date: 10/27/2017			
Checked by: D. Aghjayan				Date: 10/31/2017			

<b>SAMPLE PREPARATION</b>							
Bowl No.:	AC-10	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/26/2017	Mixed By:	MHC

<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	1074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				

<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/27/2017 02:05 PM	10/27/2017 02:25 PM	10/27/2017 02:35 PM	10/27/2017 03:20 PM	10/27/2017 03:20 PM	NA	NA
Date/Time out Oven	10/30/2017 10:30 AM	10/30/2017 10:30 AM	10/30/2017 10:30 AM	10/30/2017 10:30 AM	10/30/2017 10:30 AM	NA	NA
No. Blows	16	24	32	NA	NA	NA	NA
Tare No.	10	2	72	S-6	S-9	NA	NA
Wet Soil + Tare	22.81	22.7	23.95	17.65	18.05	NA	NA
Dry Soil + Tare	19.91	19.91	21	16.78	17.14	NA	NA
Tare	11.43	11.39	11.82	11.4	11.42	NA	NA
Water	2.9	2.79	2.95	0.87	0.91	NA	NA
Dry Soil	8.48	8.52	9.18	5.38	5.72	NA	NA
Moisture Content	34.2%	32.7%	32.1%	16.2%	15.9%	NA	Note 4

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content	10.4%
Liquid Limit	33
Plastic Limit	16
Plasticity Index	17

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- From water content sheet.

<b>Atterberg (Liquid and Plastic) Limits</b>	Boring/TP: B101
Project Name: Hi Store CISF GEI Project No.: 1703345	Sample(s): S23
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal	Date: 10/27/2017
Checked by: D. Aghjayan	Date: 11/9/2017

**SAMPLE PREPARATION**

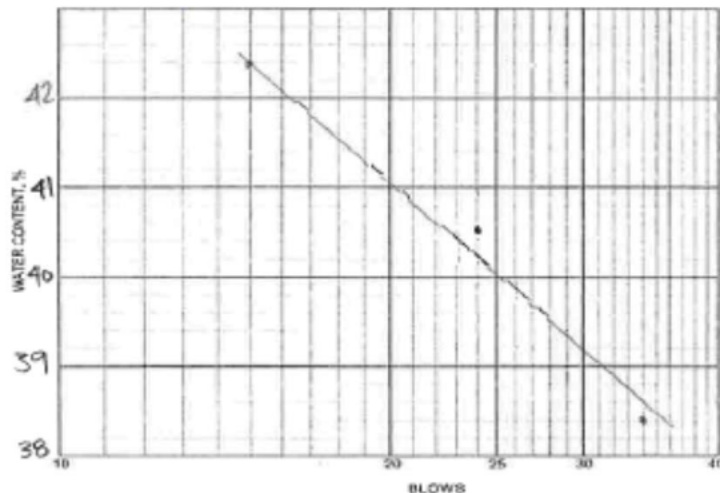
Bowl No.: EF-22	Passed thru #40 sieve? (Y/N) Y	Date Mixed: 10/26/2017	Mixed By: MHC
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**TEST EQUIPMENT**

Oven No. 3	Balance ID 1128030399	Liquid Limit Device ID 1074228	Gage Block ID WB2
Grooving Tool ID GT12	#40 Wash Sieve ID 40BS8F709693		

**TEST DATA**

Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	11/01/2017 11:05 AM	10/30/2017 01:05 PM	10/27/2017 11:05 AM	10/27/2017 12:15 PM	10/27/2017 12:25 PM	NA	NA
Date/Time out Oven	11/02/2017 8:55 AM	10/31/2017 08:20 AM	10/30/2017 10:30 AM	10/30/2017 10:30 AM	10/30/2017 10:30 AM	NA	NA
No. Blows	15	24	34	NA	NA	NA	NA
Tare No.	S-15	6	S-94	S-3AA	1	NA	NA
Wet Soil + Tare	26.33	22.77	20.1	18.76	18.49	NA	NA
Dry Soil + Tare	22.04	19.52	16.42	17.55	17.3	NA	NA
Tare	11.93	11.49	6.84	11.41	11.42	NA	NA
Water	4.29	3.25	3.68	1.21	1.19	NA	NA
Dry Soil	10.11	8.03	9.58	6.14	5.88	NA	NA
Moisture Content	42.4%	40.5%	38.4%	19.7%	20.2%	NA	Note 4



LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35  
PL determination sample > 6 g (moist)

**TEST RESULTS**

Natural Water Content	15.9%
Liquid Limit	40
Plastic Limit	20
Plasticity Index	20

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- Refer to Water Content sheet.



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<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B106			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S5			
Perf. by, per GEI Proc. 108: D. Aghjayan / M. Hernandez-Cabal				Date: 10/25/2017			
Checked by: D. Aghjayan				Date: 10/26/2017			

<b>SAMPLE PREPARATION</b>							
Bowl No.:	EF-25	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/24/2017	Mixed By:	D. Aghjayan

<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	01074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				

<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/25/2017 10:00 AM	10/25/2017 10:10 AM	10/25/2017 10:15 AM	10/25/2017 03:05 PM	10/25/2017 03:10 PM	NA	NA
Date/Time out Oven	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	NA	NA
No. Blows	17	22	38	NA	NA	NA	NA
Tare No.	11	S-10	S-7	S-4	S-39	NA	NA
Wet Soil + Tare	22.59	26.85	26.71	17.73	18.69	NA	NA
Dry Soil + Tare	19.16	22.24	22.16	16.12	16.83	NA	NA
Tare	11.45	11.67	11.32	11.39	11.39	NA	NA
Water	3.43	4.61	4.55	1.61	1.86	NA	NA
Dry Soil	7.71	10.57	10.84	4.73	5.44	NA	NA
Moisture Content	44.5%	43.6%	42.0%	34.0%	34.2%	NA	Note 4

BLOWNS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content (4)	12.7%
Liquid Limit	43
Plastic Limit	34
Plasticity Index	9

Notes:

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- From water content sheet.



<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B106			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S7 (6-24")			
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal				Date: 10/25/2017			
Checked by: D. Aghjayan				Date: 10/26/2017			

<b>SAMPLE PREPARATION</b>							
Bowl No.:	JD-77	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/24/2017	Mixed By:	M. Hernandez-Cabal

<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	01074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				

<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	LL	PL	PL	Natural Water Content
Date/Time in Oven	10/25/2017 10:20 AM	10/25/2017 10:30 AM	10/25/2017 10:45 AM	10/25/2017 10:55 AM	10/25/2017 04:00 PM	10/25/2017 04:00 PM	NA
Date/Time out Oven	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	NA
No. Blows	16	20	25	28	NA	NA	NA
Tare No.	S-36	S-3	S-8	S-15	B-8	B-33	NA
Wet Soil + Tare	20.29	24.87	21.72	25.92	28.19	28.13	NA
Dry Soil + Tare	17.55	21.07	18.80	22.02	27.33	27.28	NA
Tare	11.18	12.02	11.44	11.96	21.54	21.55	NA
Water	2.74	3.8	2.92	3.9	0.86	0.85	NA
Dry Soil	6.37	9.05	7.36	10.06	5.79	5.73	NA
Moisture Content	43.0%	42.0%	39.7%	38.8%	14.9%	14.8%	Note 4

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content (4)	11.5%
Liquid Limit	40
Plastic Limit	15
Plasticity Index	25

Notes:

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- From water content sheet.

<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B106			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S9			
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal				Date: 10/25/2017			
Checked by: D. Aghjayan				Date: 10/31/2017			
<b>SAMPLE PREPARATION</b>							
Bowl No.: DA-31		Passed thru #40 sieve? (Y/N) Y		Date Mixed: 10/24/2017		Mixed By: MHC	
<b>TEST EQUIPMENT</b>							
Oven No. 3		Balance ID 1128030399		Liquid Limit Device ID 1074228		Gage Block ID WB2	
Grooving Tool ID GT12		#40 Wash Sieve ID 40BS8F709693					
<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/25/2017 11:15 AM	10/25/2017 11:15 AM	10/25/2017 11:15 AM	10/25/2017 11:15 AM	10/25/2017 11:15 AM	NA	NA
Date/Time out Oven	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	NA	NA
No. Blows	15	22	32	NA	NA	NA	NA
Tare No.	S-2F	13	S-41	B-20	S-34	NA	NA
Wet Soil + Tare	23.41	22.43	19	27.5	19.37	NA	NA
Dry Soil + Tare	19.7	19.27	15.71	26.82	18.54	NA	NA
Tare	11.39	11.43	7.03	21.27	11.73	NA	NA
Water	3.71	3.16	3.29	0.68	0.83	NA	NA
Dry Soil	8.31	7.84	8.68	5.55	6.81	NA	NA
Moisture Content	44.6%	40.3%	37.9%	12.3%	12.2%	NA	Note 4.

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

**TEST RESULTS**

Natural Water Content (4)	9.6%
Liquid Limit	40
Plastic Limit	12
Plasticity Index	28

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- See water content sheet.

<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B106			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S10			
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal				Date: 10/25/2017			
Checked by: D. Aghjayan				Date: 10/30/2017			

<b>SAMPLE PREPARATION</b>							
Bowl No.:	CW-1A	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/24/2017	Mixed By:	M. Hernandez-Cabal

<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	01074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				

<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/25/2017 12:55 PM	10/25/2017 01:25 PM	10/25/2017 01:40 PM	10/25/2017 05:45 PM	10/25/2017 05:45 PM	NA	NA
Date/Time out Oven	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	NA	NA
No. Blows	17	25	33	NA	NA	NA	NA
Tare No.	S-9	S-26	S-94	B-17	2	NA	NA
Wet Soil + Tare	27.25	23.48	17.85	27.88	20.92	NA	NA
Dry Soil + Tare	22.41	19.98	14.77	27.10	19.72	NA	NA
Tare	11.44	11.31	6.84	21.39	11.4	NA	NA
Water	4.84	3.5	3.08	0.78	1.20	NA	NA
Dry Soil	10.97	8.67	7.93	5.71	8.32	NA	NA
Moisture Content	44.1%	40.4%	38.8%	13.7%	14.4%	NA	Note 4

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content (4)	10.8%
Liquid Limit	41
Plastic Limit	14
Plasticity Index	27

Notes:

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- See water content sheet.

<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B106			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S13			
Perf. by, per GEI Proc. 108: M. Hernandez-Cabal				Date: 10/25/2017			
Checked by: D. Aghjayan				Date: 10/30/2017			

<b>SAMPLE PREPARATION</b>							
Bowl No.:	EF-23	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/24/2017	Mixed By:	M. Hernandez-Cabal

<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	01074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				

<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/25/2017 02:10 PM	10/25/2017 02:20 PM	10/25/2017 02:30 PM	10/25/2017 06:25 PM	10/25/2017 06:25 PM	NA	NA
Date/Time out Oven	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	10/26/2017 08:40 AM	NA	NA
No. Blows	18	23	33	NA	NA	NA	NA
Tare No.	10	1	6	S-3AA	B-18	NA	NA
Wet Soil + Tare	21.97	23.08	21.89	17.85	29.79	NA	NA
Dry Soil + Tare	18.85	19.70	18.95	16.88	28.47	NA	NA
Tare	11.39	11.42	11.49	11.41	21.41	NA	NA
Water	3.12	3.38	2.94	0.97	1.32	NA	NA
Dry Soil	7.46	8.28	7.46	5.47	7.06	NA	NA
Moisture Content	41.8%	40.8%	39.4%	17.7%	18.7%	NA	Note 4

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content (4)	11.0%
Liquid Limit	40
Plastic Limit	18
Plasticity Index	22

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit
- See water content sheet.

<b>Atterberg (Liquid and Plastic) Limits</b>				Boring/TP: B107			
Project Name: Hi Store CISF GEI Project No.: 1703345				Sample(s): S7			
Perf. by, per GEI Proc. 108: E. Fazlic				Date: 10/24/2017			
Checked by: D. Aghjayan				Date: 10/31/2017			
<b>SAMPLE PREPARATION</b>							
Bowl No.: P-34		Passed thru #40 sieve? (Y/N) Y		Date Mixed: 10/19/2017		Mixed By: EF	
<b>TEST EQUIPMENT</b>							
Oven No. 1		Balance ID 1128030399		Liquid Limit Device ID VH-10853		Gage Block ID WB1	
Grooving Tool ID GT12		#40 Wash Sieve ID 40BS8F709693					
<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/26/2017 02:15 PM	10/26/2017 02:36 PM	10/26/2017 02:58 PM	10/24/2017 04:25 PM	10/24/2017 04:50 PM	NA	10/24/2017 02:16 PM
Date/Time out Oven	10/30/2017 08:33 AM	10/30/2017 08:33 AM	10/30/2017 08:33 AM	10/25/2017 08:45 AM	10/25/2017 08:45 AM	NA	10/25/2017 08:45 AM
No. Blows	16	24	34	NA	NA	NA	NA
Tare No.	S-4	S-39	S-10	S-41A	B-7	NA	B-22A
Wet Soil + Tare	28.08	24.65	21.86	17.78	17.94	NA	58.65
Dry Soil + Tare	22.81	20.7	18.94	16.74	16.87	NA	54.99
Tare	11.39	11.39	11.66	11.37	11.42	NA	21.499
Water	5.27	3.95	2.92	1.04	1.07	NA	3.66
Dry Soil	11.42	9.31	7.28	5.37	5.45	NA	33.491
Moisture Content	46.1%	42.4%	40.1%	19.4%	19.6%	NA	10.9%

48

46

44

42

40

38

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

**TEST RESULTS**

Natural Water Content	10.9%
Liquid Limit	42
Plastic Limit	20
Plasticity Index	22

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit



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<b>Atterberg (Liquid and Plastic) Limits</b>	Boring/TP: B107
Project Name: Hi Store CISF GEI Project No.: 1703345	Sample(s): S13
Perf. by, per GEI Proc. 108: <u>M. Hernandez-Cabal</u>	Date: <u>10/27/2017</u>
Checked by: <u>D. Aghjayan</u>	Date: <u>10/31/2017</u>

**SAMPLE PREPARATION**

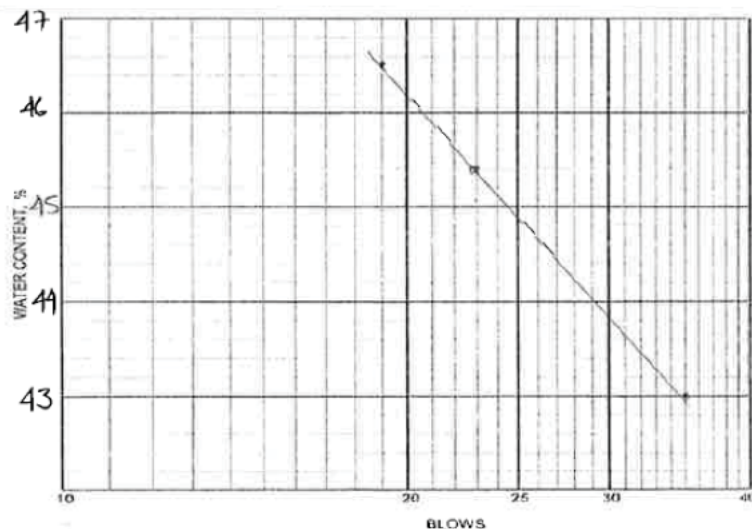
Bowl No.: P-10	Passed thru #40 sieve? (Y/N) Y	Date Mixed: 10/23/2017	Mixed By: EF
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**TEST EQUIPMENT**

Oven No. 3	Balance ID 1128030399	Liquid Limit Device ID 1074228	Gage Block ID WB2
Grooving Tool ID GT12	#40 Wash Sieve ID 40BS8F709693		

**TEST DATA**

Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/26/2017 11:00 AM	10/26/2017 11:10 AM	10/26/2017 11:30 AM	10/26/2017 04:10 PM	10/26/2017 04:10 PM	NA	10/23/2017 02:45 PM
Date/Time out Oven	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	NA	10/27/2017 08:30 AM
No. Blows	19	23	35	NA	NA	NA	NA
Tare No.	B-36	B-30	B-7	15	AB-9	NA	B-31
Wet Soil + Tare	33.25	33.49	32.92	18.89	17.69	NA	55.09
Dry Soil + Tare	29.52	29.74	29.58	17.74	16.69	NA	51.45
Tare	21.49	21.48	21.82	11.48	11.16	NA	21.41
Water	3.73	3.75	3.34	1.15	1.00	NA	3.64
Dry Soil	8.03	8.26	7.76	6.26	5.53	NA	30.04
Moisture Content	46.5%	45.4%	43.0%	18.4%	18.1%	NA	12.1%



LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35  
PL determination sample > 6 g (moist)

**TEST RESULTS**

Natural Water Content	12.1%
Liquid Limit	45
Plastic Limit	18
Plasticity Index	27

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit



<b>Atterberg (Liquid and Plastic) Limits</b>					Boring/TP: B107		
Project Name: Hi Store CISF GEI Project No.: 1703345					Sample(s): S15		
Perf. by, per GEI Proc. 108: <u>M. Hernandez-Cabal</u>					Date: <u>10/26/2017</u>		
Checked by: <u>D. Aghjayan</u>					Date: <u>10/31/2017</u>		
<b>SAMPLE PREPARATION</b>							
Bowl No.:	EF-21	Passed thru #40 sieve? (Y/N)	Y	Date Mixed:	10/20/2017	Mixed By:	EF
<b>TEST EQUIPMENT</b>							
Oven No.	3	Balance ID	1128030399	Liquid Limit Device ID	1074228	Gage Block ID	WB2
Grooving Tool ID	GT12	#40 Wash Sieve ID	40BS8F709693				
<b>TEST DATA</b>							
Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/26/2017 12:50 PM	10/26/2017 01:20 PM	10/27/2017 11:30 AM	10/26/2017 03:20 PM	10/26/2017 03:20 PM	NA	10/20/17 2:00 PM
Date/Time out Oven	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/30/2017 10:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	NA	10/23/17 10:00 AM
No. Blows	16	26	34	NA	NA	NA	NA
Tare No.	B-14	B-16	5	S-58	3	NA	B-10
Wet Soil + Tare	31.92	32.16	22.85	13.81	18.06	NA	62.38
Dry Soil + Tare	28.87	29.04	19.58	12.66	16.93	NA	56.60
Tare	21.85	21.43	11.43	7.02	11.36	NA	21.65
Water	3.05	3.12	3.27	1.15	1.13	NA	5.78
Dry Soil	7.02	7.61	8.15	5.64	5.57	NA	34.95
Moisture Content	43.4%	41.0%	40.1%	20.4%	20.3%	NA	16.5%

WATER CONTENT, %

BLOWS

LL No. of Blows (Suggested Ranges): 15 - 20  
20 - 27  
27 - 35

PL determination sample > 6 g (moist)

<b>TEST RESULTS</b>	
Natural Water Content	16.5%
Liquid Limit	41
Plastic Limit	20
Plasticity Index	21

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit





<b>Atterberg (Liquid and Plastic) Limits</b>	Boring/TP: B107
Project Name: Hi Store CISF GEI Project No.: 1703345	Sample(s): S17
Perf. by, per GEI Proc. 108: <u>M. Hernandez-Cabal</u>	Date: <u>10/26/2017</u>
Checked by: <u>D. Aghjayan</u>	Date: <u>10/31/2017</u>

**SAMPLE PREPARATION**

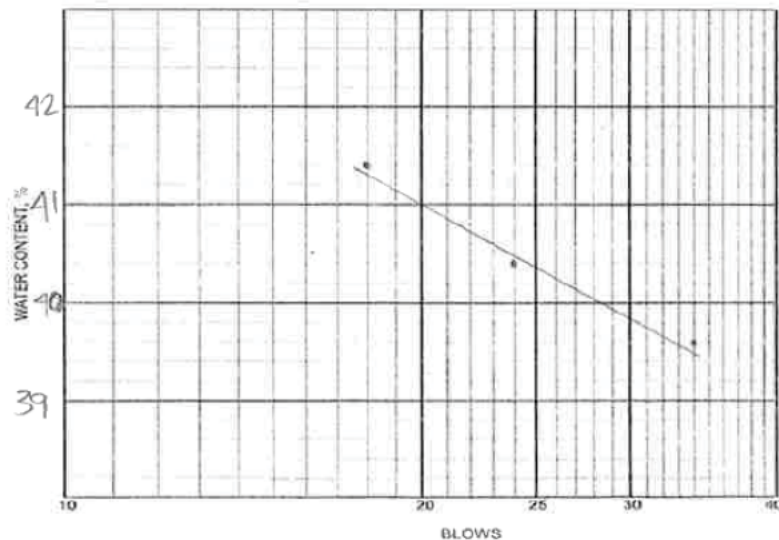
Bowl No.: EF-26	Passed thru #40 sieve? (Y/N) Y	Date Mixed: 10/23/2017	Mixed By: EF
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**TEST EQUIPMENT**

Oven No. 3	Balance ID 1128030399	Liquid Limit Device ID 1074228	Gage Block ID WB2
Grooving Tool ID GT12	#40 Wash Sieve ID 40BS8F709693		

**TEST DATA**

Test Type <sup>3</sup> (LL or PL)	LL	LL	LL	PL	PL	NA	Natural Water Content
Date/Time in Oven	10/26/2017 02:20 PM	10/26/2017 02:30 PM	10/26/2017 02:35 PM	10/26/2017 04:51 PM	10/26/2017 04:51 PM	NA	10/23/2017 02:45 PM
Date/Time out Oven	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	10/27/2017 08:30 AM	NA	10/27/2017 08:30 AM
No. Blows	18	24	34	NA	NA	NA	NA
Tare No.	B-4	B-19	B-29	7	B-1	NA	B-37
Wet Soil + Tare	33.33	34.22	34.02	17.75	29.91	NA	54.19
Dry Soil + Tare	29.88	30.6	30.39	16.66	28.45	NA	49.91
Tare	21.55	21.63	21.22	11.42	21.35	NA	21.28
Water	3.45	3.62	3.63	1.09	1.46	NA	4.28
Dry Soil	8.33	8.97	9.17	5.24	7.1	NA	28.63
Moisture Content	41.4%	40.4%	39.6%	20.8%	20.6%	NA	14.9%



LL No. of Blows (Suggested Ranges): 15 - 20

20 - 27

27 - 35

PL determination sample &gt; 6 g (moist)

**TEST RESULTS**

Natural Water Content	14.9%
Liquid Limit	40
Plastic Limit	21
Plasticity Index	19

**Notes:**

- Oven dry soil at 110°C (±5°C) for 12 hours minimum.
- Cool soil in dessicator for at least 30 minutes upon removal from oven before weighing.
- LL = Liquid limit, PL = Plastic limit



Form 108.1, Rev. 0

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S11 (35-36.8 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)				Dispersing Agent (g)	
W1	W2	W3	W4	(B)	(C)
0.00	0.00	7.77	57.01	5.00	0.00
Total Sample Dry Wt. (g)				59.78	
Initial Sample Wet Wt. (g)				65.00	
Water Content (%)				8.7%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	193.71	193.71	100.0	0.0
#16	1.180	193.75		99.9	0.1
#30	0.600	193.85		99.8	0.2
#50	0.300	193.96		99.6	0.4
#100	0.150	194.14		99.3	0.7
#200	0.075	195.87		96.4	3.6

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	59.78

## Hydrometer Corrections

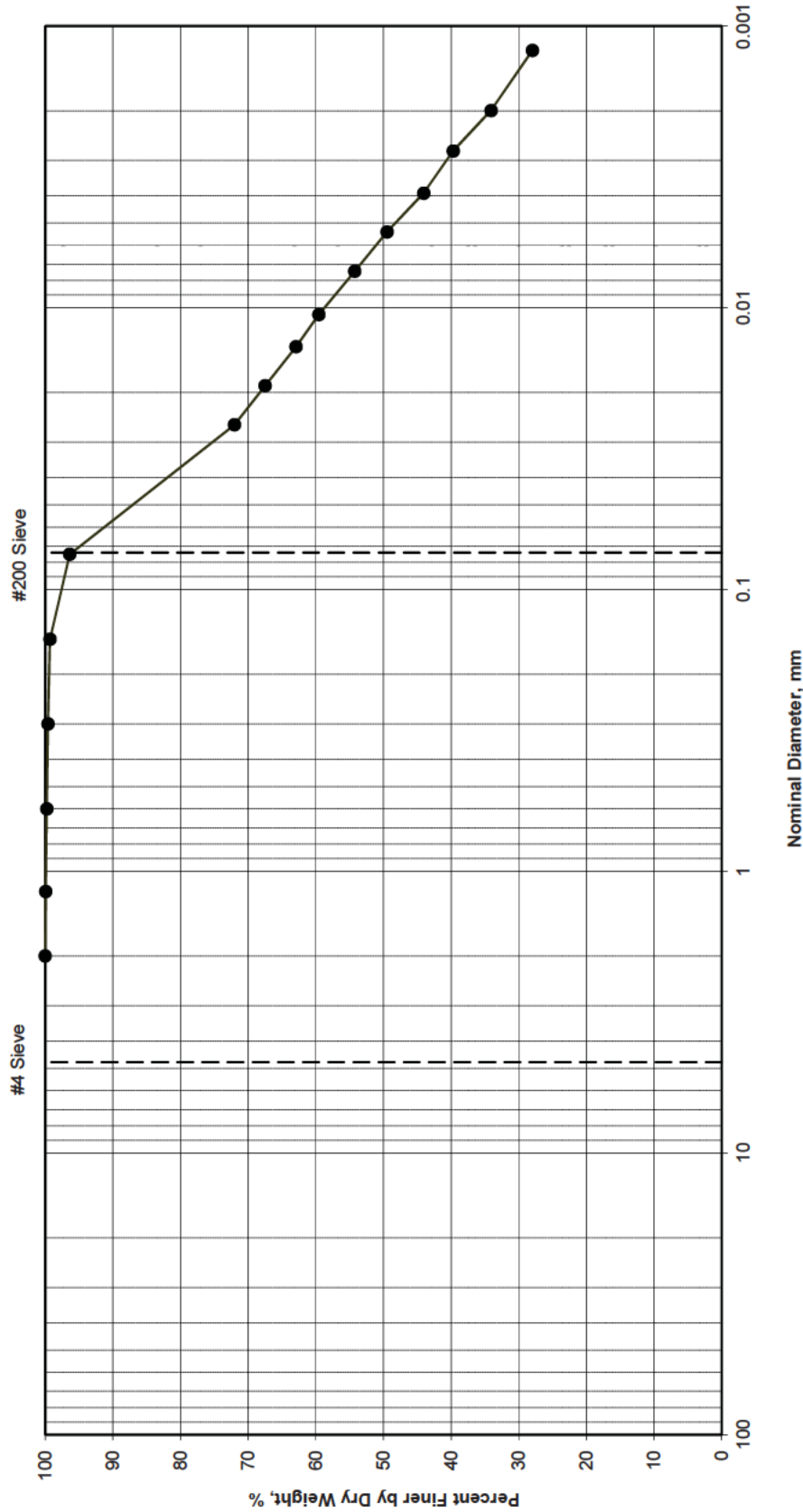
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Temperature °C	Hydrometer Reading
1	3.3	26.1	0.0
2	5.7	15.7	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.4	31.0	-3.89	27.11	1.02711	7.91	1.00	0.01308	0.0260	72.0
4	22.4	29.3	-3.89	25.41	1.02541	8.36	1.00	0.01308	0.0189	67.5
8	22.2	27.6	-3.91	23.69	1.02369	8.81	1.00	0.01311	0.0138	62.9
14	22.5	26.3	-3.88	22.42	1.02242	9.16	1.00	0.01306	0.0106	59.6
30	22.5	24.3	-3.88	20.42	1.02042	9.69	1.00	0.01306	0.0074	54.3
60	22.5	22.5	-3.88	18.62	1.01862	10.16	1.00	0.01306	0.0054	49.5
120	20.5	20.5	-3.92	16.58	1.01658	10.69	1.00	0.01312	0.0039	44.1
246	22.7	18.8	-3.86	14.94	1.01494	11.14	1.00	0.01303	0.0028	39.7
480	24.6	16.5	-3.67	12.83	1.01283	11.75	1.00	0.01275	0.0020	34.1
1440	21.6	14.5	-3.97	10.53	1.01053	12.28	1.00	0.01320	0.0012	28.0




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	3.6	96.4

USCS	Description
CL	LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic based on visual examination.

HI-STORE CISF Lea County, New Mexico	<div> GEI Consultants</div> <div>Project 1703345</div>	Grain Size Curve	
		Boring/Test Pit No. :	B101
		Sample No. :	S11 (35-36.8 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S13 (45-46.8 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)				Dispersing Agent (g)	
W1	W2	W3	W4	-#10	+ #10
0.00	0.00	32.26	34.16	5.00	0.00
Total Sample Dry Wt. (g)				61.42	
Initial Sample Wet Wt. (g)				70.63	
Water Content (%)				15.0%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	200.95	200.95	100.0	0.0
#16	1.180	201.69		98.8	1.2
#30	0.600	205.64		92.4	7.6
#50	0.300	213.21		80.0	20.0
#100	0.150	222.09		65.6	34.4
#200	0.075	229.72		53.2	46.8

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	61.42

## Hydrometer Corrections

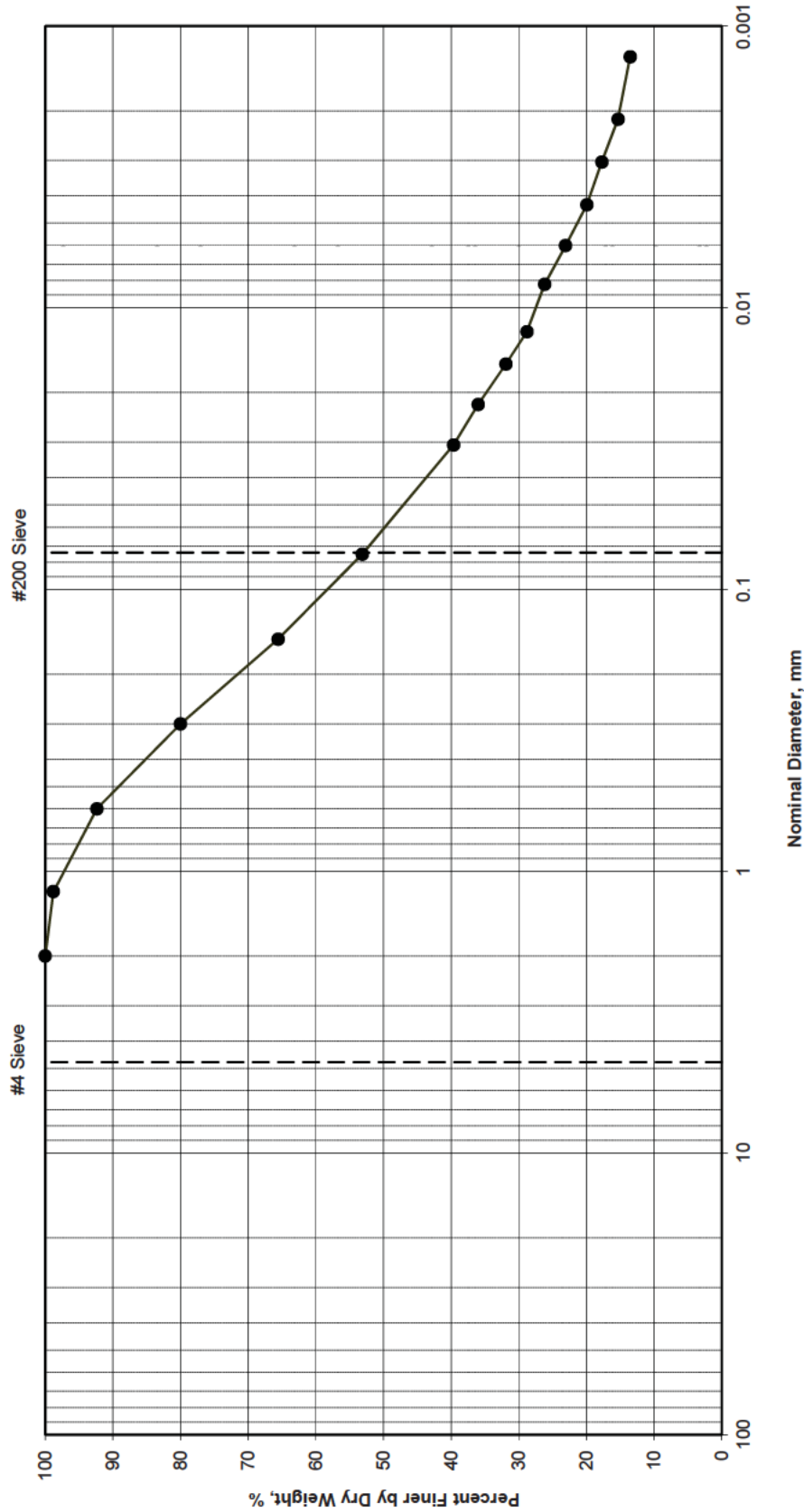
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Temperature °C	Hydrometer Reading
1	3.3	26.1	0.0
2	5.7	15.7	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.6	19.2	-3.87	15.33	1.01533	11.04	1.00	0.01305	0.0306	39.6
4	22.6	17.8	-3.87	13.93	1.01393	11.41	1.00	0.01305	0.0220	36.0
8	22.7	16.2	-3.86	12.34	1.01234	11.83	1.00	0.01303	0.0158	31.9
14	22.7	15.0	-3.86	11.14	1.01114	12.15	1.00	0.01303	0.0121	28.8
31	22.6	14.0	-3.87	10.13	1.01013	12.41	1.00	0.01305	0.0083	26.2
60	22.6	12.8	-3.87	8.93	1.00893	12.73	1.00	0.01305	0.0060	23.1
120	22.5	11.6	-3.88	7.72	1.00772	13.05	1.00	0.01306	0.0043	20.0
244	22.9	10.7	-3.84	6.86	1.00686	13.28	1.00	0.01300	0.0030	17.7
480	24.7	9.6	-3.66	5.94	1.00594	13.58	1.00	0.01273	0.0021	15.4
1440	21.7	9.2	-3.96	5.24	1.00524	13.68	1.00	0.01318	0.0013	13.6




Form 104.3, Rev. 1



%+3"	% Gravel	% Sand	% Fines
0.0	0.0	46.8	53.2

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic based on visual examination.

HI-STORE CISF Lea County, New Mexico	 <b>GEI</b> Consultants	Grain Size Curve	
		Boring/Test Pit No. : B101	Sample No. : S13 (45-46.8 ft)
	Project 1703345		Form 104.4, Rev. 1

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S15 (55-56.4 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	25.50	43.83		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					64.33	
Initial Sample Wet Wt. (g)					72.72	
Water Content (%)					13.0%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	205.83	205.83	100.0	0.0
#16	1.180	206.38		99.1	0.9
#30	0.600	209.81		93.8	6.2
#50	0.300	215.69		84.7	15.3
#100	0.150	222.46		74.1	25.9
#200	0.075	228.47		64.8	35.2

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	64.33

## Hydrometer Corrections

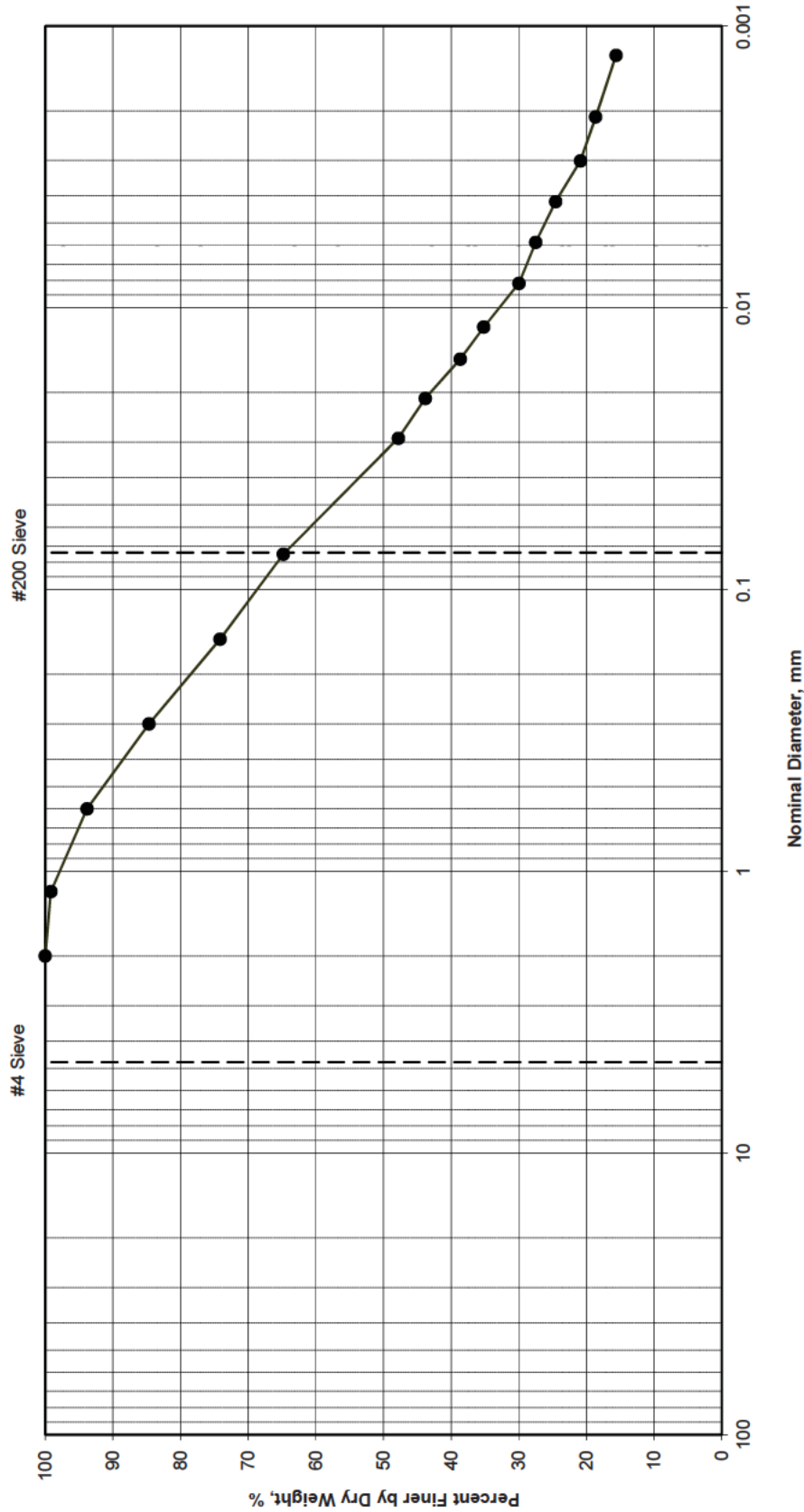
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.9	23.2	-3.84	19.36	1.01936	9.98	1.00	0.01300	0.0290	47.8
4	22.9	21.6	-3.84	17.76	1.01776	10.40	1.00	0.01300	0.0210	43.8
8	22.9	19.5	-3.84	15.66	1.01566	10.96	1.00	0.01300	0.0152	38.7
14	22.8	18.1	-3.85	14.25	1.01425	11.33	1.00	0.01302	0.0117	35.2
30	22.8	16.0	-3.85	12.15	1.01215	11.88	1.00	0.01302	0.0082	30.0
60	22.8	15.0	-3.85	11.15	1.01115	12.15	1.00	0.01302	0.0059	27.5
120	22.8	13.8	-3.85	9.95	1.00995	12.46	1.00	0.01302	0.0042	24.6
240	23.0	12.3	-3.83	8.47	1.00847	12.86	1.00	0.01299	0.0030	20.9
480	24.9	11.2	-3.64	7.56	1.00756	13.15	1.00	0.01270	0.0021	18.7
1440	21.7	10.3	-3.96	6.34	1.00634	13.39	1.00	0.01318	0.0013	15.7



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## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S19 (75-76.2 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)				Dispersing Agent (g)	
W1	W2	W3	W4	(B)	(C)
0.00	0.00	22.08	47.70	5.00	0.00
Total Sample Dry Wt. (g)				64.78	
Initial Sample Wet Wt. (g)				71.41	
Water Content (%)				10.2%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	190.50	190.5	100.0	0.0
#16	1.180	190.93		99.3	0.7
#30	0.600	192.95		96.2	3.8
#50	0.300	197.67		88.9	11.1
#100	0.150	204.31		78.7	21.3
#200	0.075	210.33		69.4	30.6

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	64.78

## Hydrometer Corrections

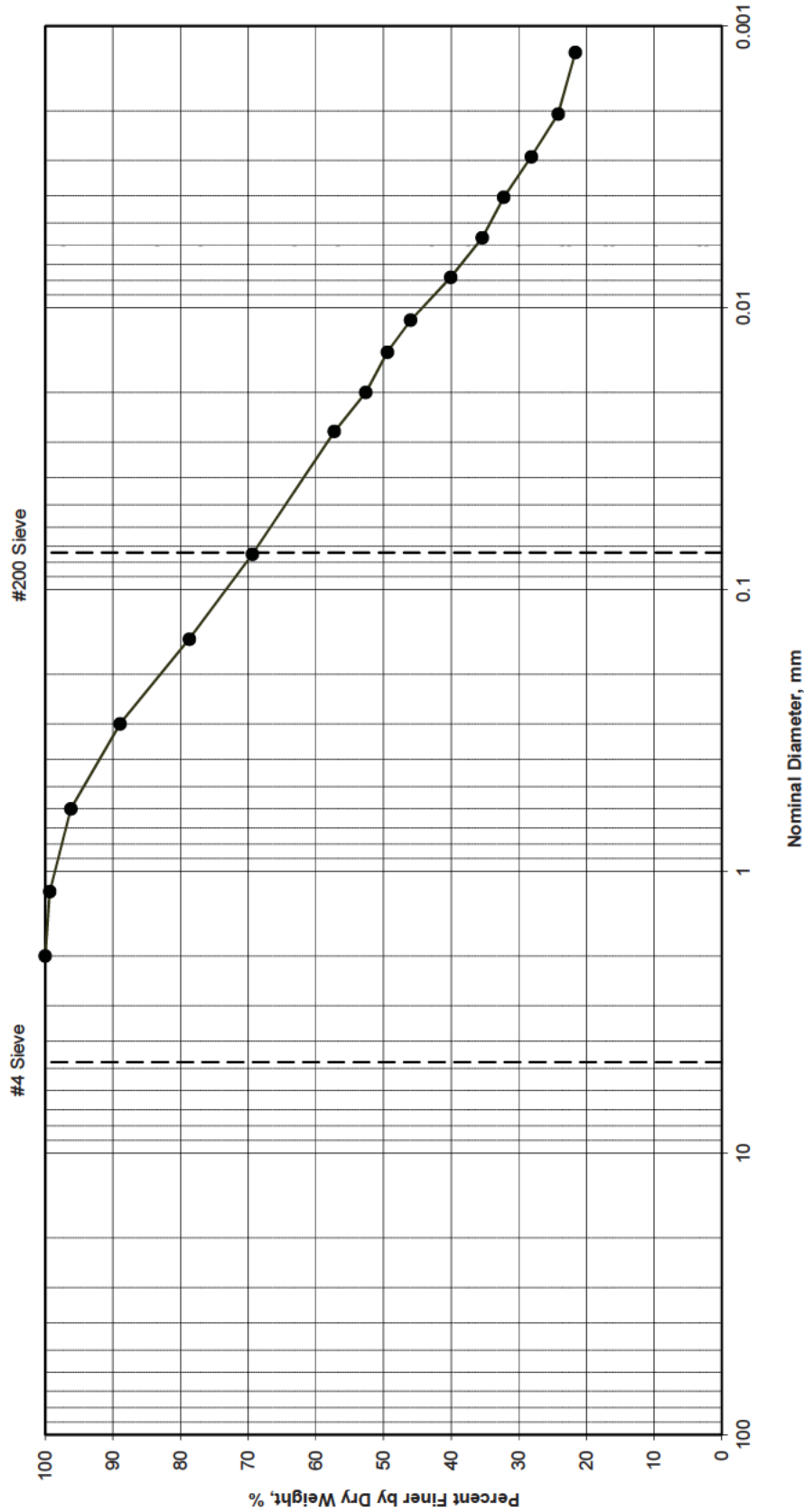
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.9	27.2	-3.84	23.36	1.02336	8.92	1.00	0.01300	0.0275	57.3
4	22.9	25.3	-3.84	21.46	1.02146	9.42	1.00	0.01300	0.0200	52.6
8	22.9	24.0	-3.84	20.16	1.02016	9.77	1.00	0.01300	0.0144	49.4
14	22.9	22.6	-3.84	18.76	1.01876	10.14	1.00	0.01300	0.0111	46.0
30	22.8	20.2	-3.85	16.35	1.01635	10.77	1.00	0.01302	0.0078	40.1
60	22.8	18.3	-3.85	14.45	1.01445	11.27	1.00	0.01302	0.0056	35.4
120	22.8	17.0	-3.85	13.15	1.01315	11.62	1.00	0.01302	0.0040	32.2
240	23.1	15.3	-3.82	11.48	1.01148	12.07	1.00	0.01297	0.0029	28.1
480	25.0	13.5	-3.63	9.87	1.00987	12.54	1.00	0.01269	0.0021	24.2
1440	21.6	12.8	-3.97	8.83	1.00883	12.73	1.00	0.01320	0.0012	21.7




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	30.6	69.4

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B101	Sample No. : S19 (75-76.2 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S20 (80-81.3 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/7/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		#10	#10
0.00	0.00	14.67	56.37		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					66.04	
Initial Sample Wet Wt. (g)					73.15	
Water Content (%)					10.8%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	189.09	189.09	100.0	0.0
#16	1.180	189.97		98.7	1.3
#30	0.600	192.78		94.4	5.6
#50	0.300	196.57		88.7	11.3
#100	0.150	199.68		84.0	16.0
#200	0.075	201.91		80.6	19.4

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	66.04

## Hydrometer Corrections

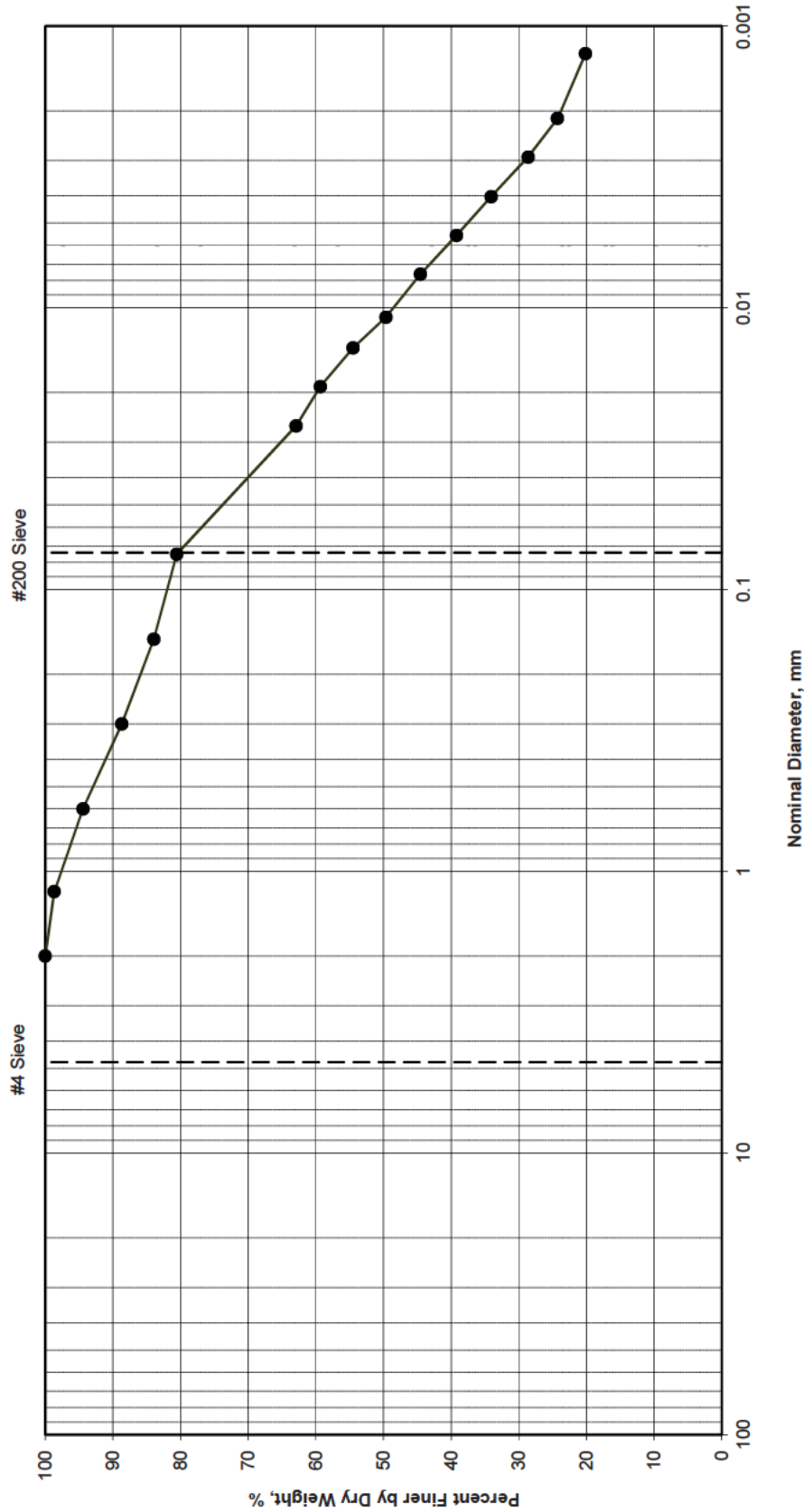
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Temperature °C	Hydrometer Reading
1	3.3	26.1	0.0
2	5.7	15.7	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.0	30.0	-3.83	26.17	1.02617	8.18	1.00	0.01299	0.0263	62.9
4	23.0	28.5	-3.83	24.67	1.02467	8.58	1.00	0.01299	0.0190	59.3
8	22.9	26.5	-3.84	22.66	1.02266	9.10	1.00	0.01300	0.0139	54.5
14	22.8	24.5	-3.85	20.65	1.02065	9.63	1.00	0.01302	0.0108	49.7
30	22.6	22.4	-3.87	18.53	1.01853	10.19	1.00	0.01305	0.0076	44.6
60	22.4	20.2	-3.89	16.31	1.01631	10.77	1.00	0.01308	0.0055	39.2
120	22.1	18.1	-3.92	14.18	1.01418	11.33	1.00	0.01312	0.0040	34.1
240	22.4	15.8	-3.89	11.91	1.01191	11.93	1.00	0.01308	0.0029	28.6
480	21.3	14.1	-4.00	10.10	1.01010	12.38	1.00	0.01325	0.0021	24.3
1440	21.1	12.4	-4.02	8.38	1.00838	12.83	1.00	0.01328	0.0013	20.2




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	19.4	80.6

USCS	Description
CL	LEAN CLAY with Sand

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic based on visual examination.

HI-STORE CISF Lea County, New Mexico	 <b>GEI</b> Consultants	Grain Size Curve	
		Boring/Test Pit No. : B101	Sample No. : S20 (80-81.3 ft)
	Project 1703345		Form 104.4, Rev. 1

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S22 (90-91.4 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	20.05	46.23		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					61.28	
Initial Sample Wet Wt. (g)					70.00	
Water Content (%)					14.2%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	217.42	217.42	100.0	0.0
#16	1.180	217.59		99.7	0.3
#30	0.600	219.35		96.9	3.1
#50	0.300	224.29		88.8	11.2
#100	0.150	230.85		78.1	21.9
#200	0.075	235.36		70.7	29.3

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	61.28

## Hydrometer Corrections

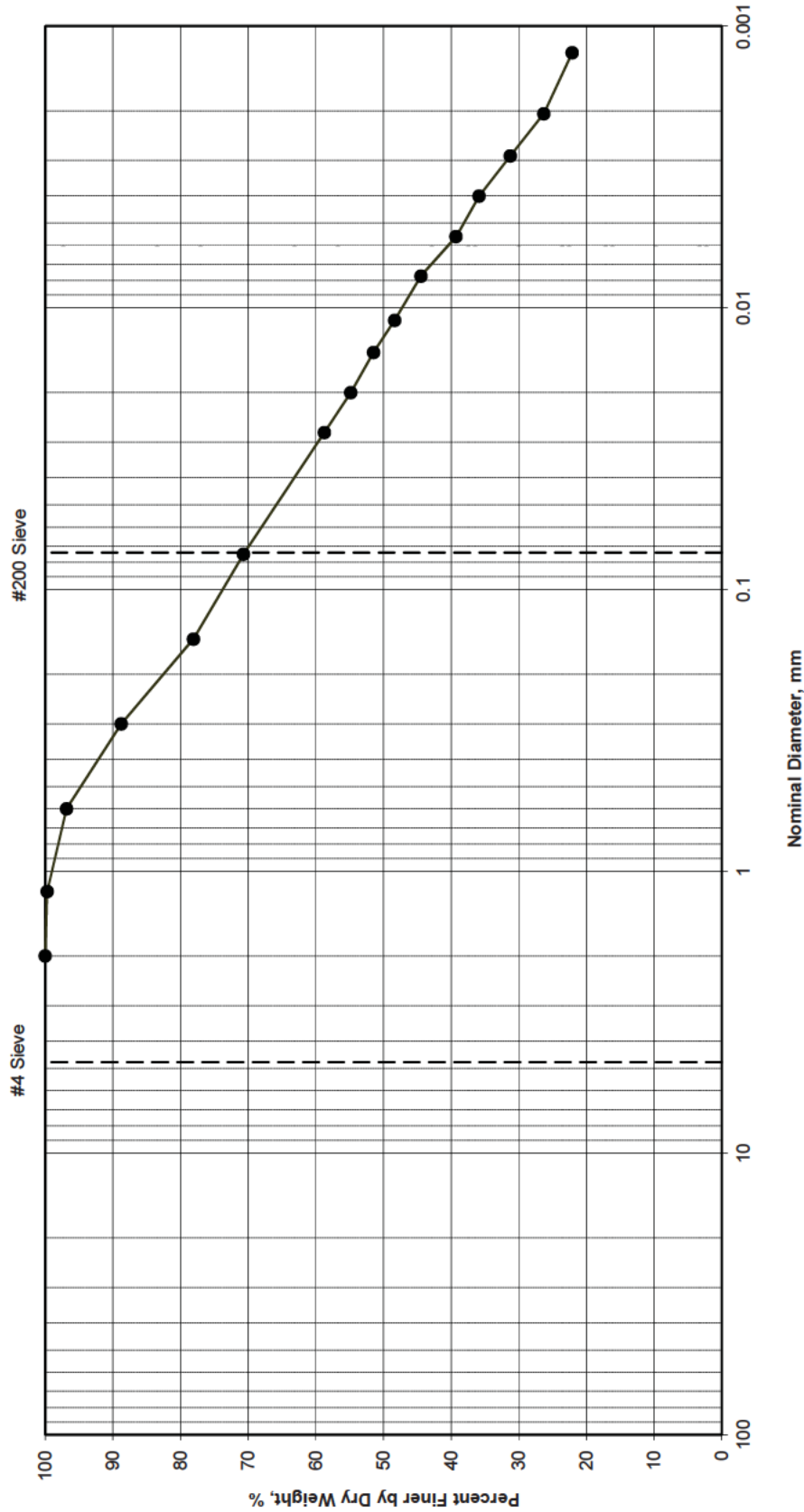
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.0	26.5	-3.83	22.67	1.02267	9.10	1.00	0.01299	0.0277	56.8
4	23.0	25.0	-3.83	21.17	1.02117	9.50	1.00	0.01299	0.0200	54.9
8	23.0	23.7	-3.83	19.87	1.01987	9.84	1.00	0.01299	0.0144	51.5
14	22.9	22.5	-3.84	18.66	1.01866	10.16	1.00	0.01300	0.0111	48.4
30	22.9	21.0	-3.84	17.16	1.01716	10.56	1.00	0.01300	0.0077	44.5
60	22.9	19.0	-3.84	15.16	1.01516	11.09	1.00	0.01300	0.0056	39.3
120	22.8	17.7	-3.85	13.85	1.01385	11.43	1.00	0.01302	0.0040	35.9
240	23.0	15.9	-3.83	12.07	1.01207	11.91	1.00	0.01299	0.0029	31.3
480	24.9	13.8	-3.64	10.16	1.01016	12.46	1.00	0.01270	0.0020	26.3
1440	21.6	12.5	-3.97	8.53	1.00853	12.81	1.00	0.01320	0.0012	22.1




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	29.3	70.7

USCS	Description
CL	LEAN CLAY with Sand

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic based on visual examination.

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B101	Sample No. : S22 (90-91.4 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B101  
 Sample Number S23 (95-96.8 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/3/2017  
 Date 11/7/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	29.06	37.93		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					61.99	
Initial Sample Wet Wt. (g)					70.63	
Water Content (%)					13.9%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	202.00	202	100.0	0.0
#16	1.180	204.29		96.3	3.7
#30	0.600	211.43		84.8	15.2
#50	0.300	219.35		72.0	28.0
#100	0.150	224.9		63.1	36.9
#200	0.075	228.12		57.9	42.1

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	61.99

## Hydrometer Corrections

Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

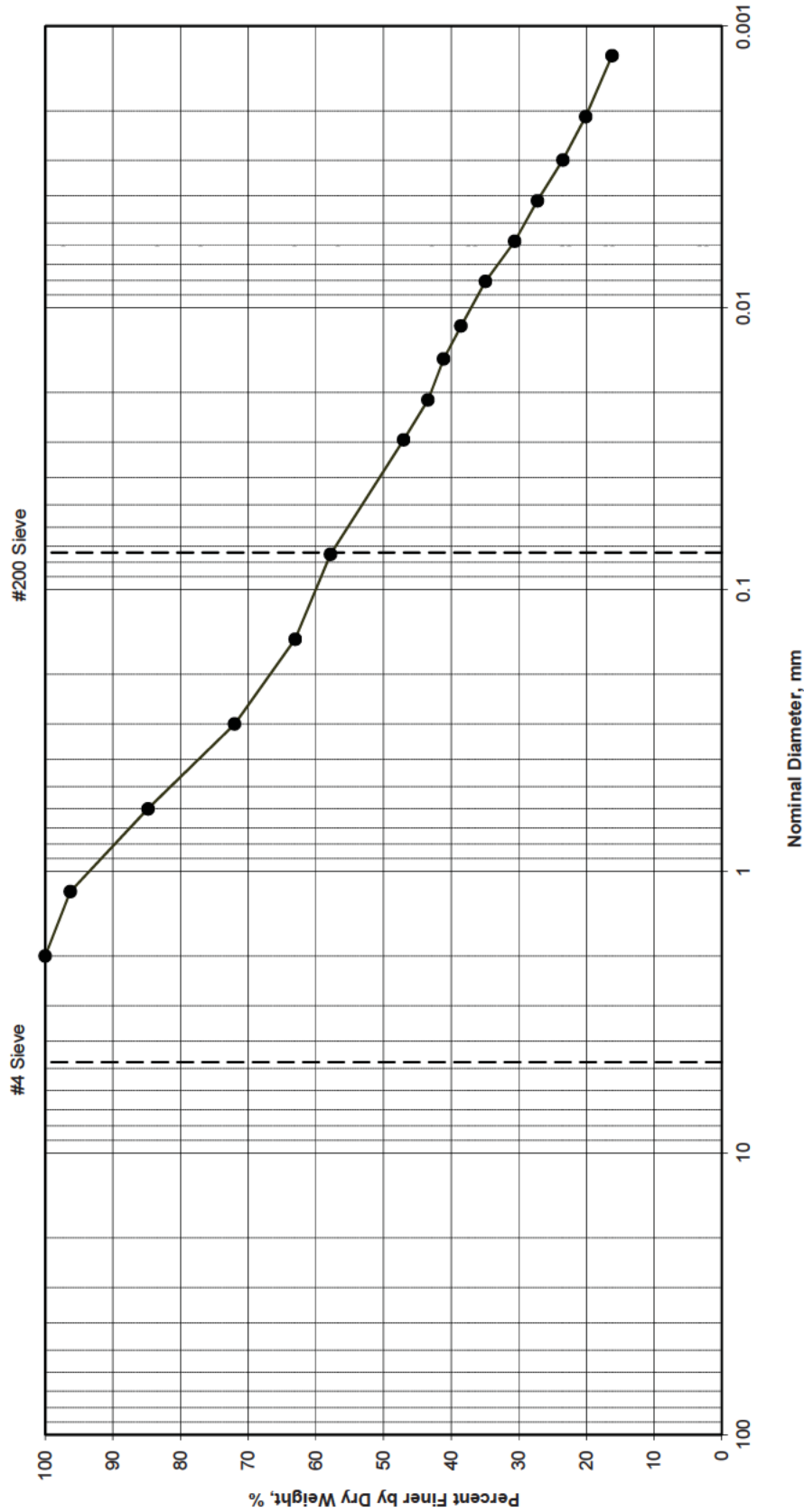
## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.9	22.2	-3.84	18.36	1.01836	10.24	1.00	0.01300	0.0294	47.0
4	22.8	20.8	-3.85	16.95	1.01895	10.61	1.00	0.01302	0.0212	43.4
8	22.8	19.9	-3.85	16.05	1.01605	10.85	1.00	0.01302	0.0152	41.1
14	22.8	18.9	-3.85	15.05	1.01505	11.11	1.00	0.01302	0.0116	38.6
30	22.7	17.5	-3.86	13.64	1.01364	11.49	1.00	0.01303	0.0081	34.9
60	22.8	15.8	-3.85	11.95	1.01195	11.93	1.00	0.01302	0.0058	30.6
120	22.7	14.5	-3.86	10.64	1.01064	12.28	1.00	0.01303	0.0042	27.3
240	23.0	13.0	-3.83	9.17	1.00917	12.68	1.00	0.01299	0.0030	23.5
480	24.9	11.5	-3.64	7.86	1.00786	13.07	1.00	0.01270	0.0021	20.1
1440	21.6	10.3	-3.97	6.33	1.00633	13.39	1.00	0.01320	0.0013	16.2



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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	42.1	57.9

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B101	Sample No. : S23 (95-96.8 ft)
			Form 104.4, Rev. 1

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B102  
 Sample Number S13 (5-17 in) (30-32 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/7/2017  
 Date 11/8/2017

## Sample Weight Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	192.71	192.71	100.0	0.0
#16	1.180	194.88		96.7	3.3
#30	0.600	199.85		89.3	10.7
#50	0.300	205.20		81.2	18.8
#100	0.150	209.24		75.1	24.9
#200	0.075	211.04		72.4	27.6

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	66.43

## Hydrometer Corrections

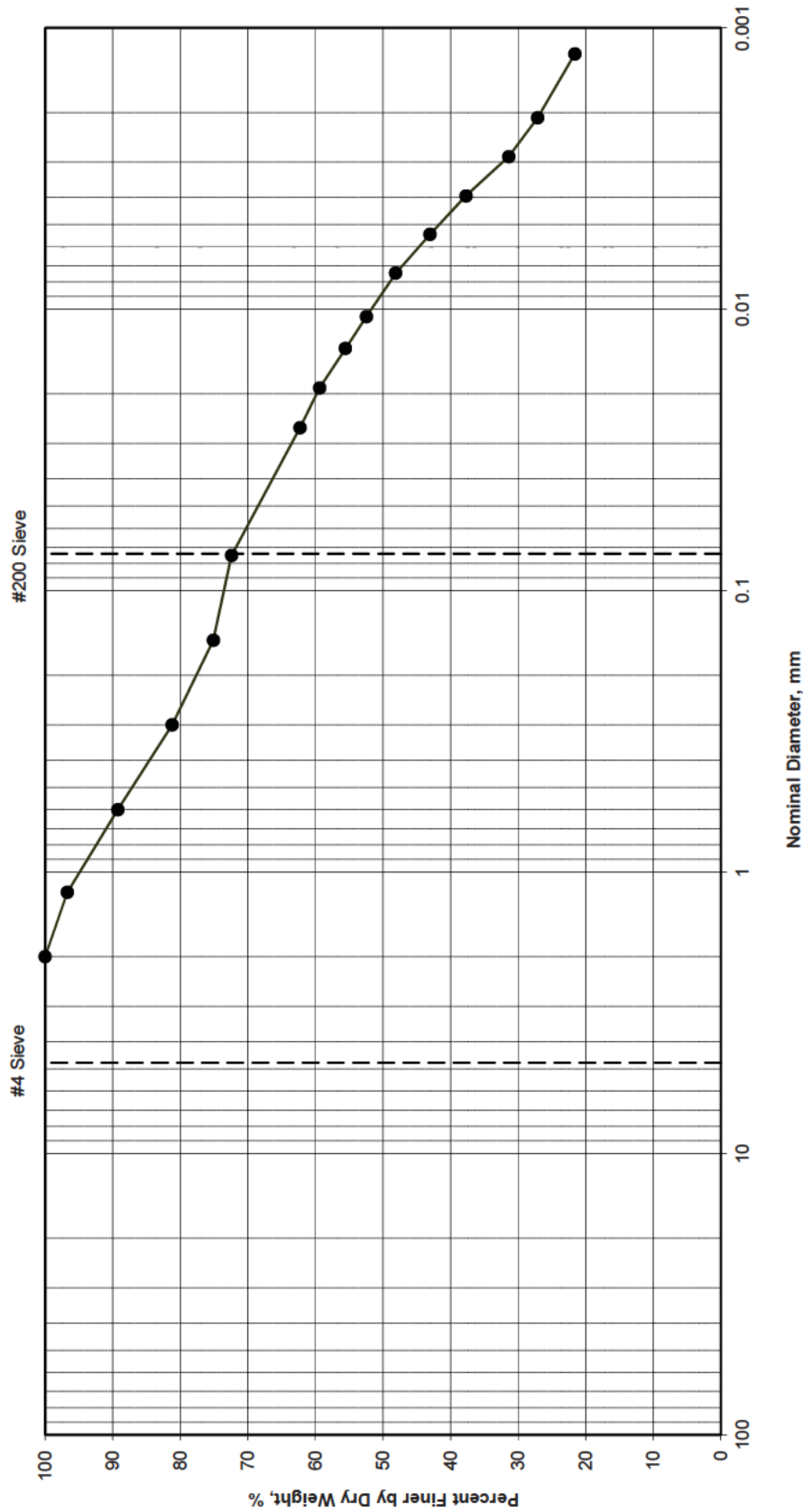
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.8	29.9	-3.85	26.05	1.02605	8.20	1.00	0.01302	0.0264	62.3
4	22.7	28.7	-3.86	24.84	1.02484	8.52	1.00	0.01303	0.0190	59.4
8	22.7	27.1	-3.86	23.24	1.02324	8.95	1.00	0.01303	0.0138	55.6
14	22.7	25.8	-3.86	21.94	1.02194	9.29	1.00	0.01303	0.0106	52.5
30	22.6	24.0	-3.87	20.13	1.02013	9.77	1.00	0.01305	0.0074	48.1
60	22.4	21.9	-3.89	18.01	1.01801	10.32	1.00	0.01308	0.0054	43.1
120	22.1	19.7	-3.92	15.78	1.01578	10.90	1.00	0.01312	0.0040	37.7
240	22.7	17.0	-3.86	13.14	1.01314	11.62	1.00	0.01303	0.0029	31.4
480	21.8	15.3	-3.95	11.35	1.01135	12.07	1.00	0.01317	0.0021	27.1
1440	21.7	13.0	-3.96	9.04	1.00904	12.68	1.00	0.01318	0.0012	21.6




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	27.6	72.4

USCS	Description
CL	LEAN CLAY with Sand

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic by visual examination.

HI-STORE CISF Lea County, New Mexico	 <b>GEI</b> Consultants	Grain Size Curve	
		Boring/Test Pit No. : B102	Form 104.4, Rev. 1
		Sample No. : S13 (5-17 in) (30-32 ft)	
Project 1703345			

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B102  
 Sample Number S15 (40-41.4 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/7/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	13.53	66.53		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					75.06	
Initial Sample Wet Wt. (g)					79.99	
Water Content (%)					6.6%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	205.33	205.33	100.0	0.0
#16	1.180	205.65		99.6	0.4
#30	0.600	206.16		98.9	1.1
#50	0.300	206.61		98.3	1.7
#100	0.150	207.54		97.1	2.9
#200	0.075	216.38		85.3	14.7

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	75.06

## Hydrometer Corrections

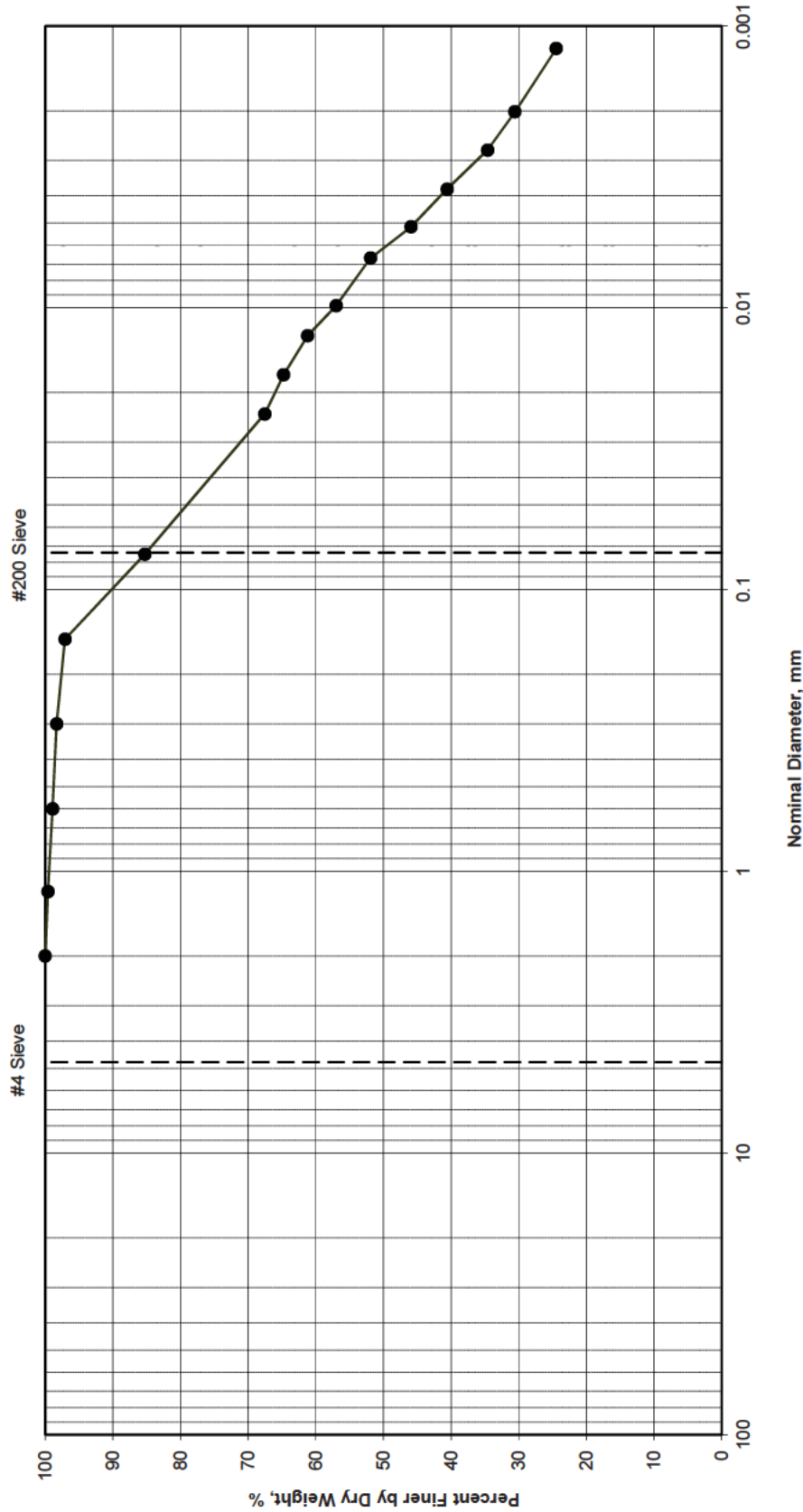
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.5	35.8	-3.88	31.92	1.03192	6.64	1.00	0.01306	0.0238	67.5
4	22.4	34.5	-3.89	30.61	1.03061	6.99	1.00	0.01308	0.0173	64.8
8	22.7	32.8	-3.86	28.94	1.02894	7.44	1.00	0.01303	0.0126	61.2
14	22.7	30.8	-3.86	26.94	1.02694	7.97	1.00	0.01303	0.0098	57.0
33	22.6	28.4	-3.87	24.53	1.02453	8.60	1.00	0.01305	0.0067	51.9
60	22.4	25.6	-3.89	21.71	1.02171	9.34	1.00	0.01308	0.0052	45.9
120	22.1	23.1	-3.92	19.18	1.01918	10.00	1.00	0.01312	0.0038	40.6
240	22.8	20.2	-3.85	16.35	1.01635	10.77	1.00	0.01302	0.0028	34.6
480	21.8	18.4	-3.95	14.45	1.01445	11.25	1.00	0.01317	0.0020	30.6
1440	21.9	15.5	-3.94	11.56	1.01156	12.01	1.00	0.01315	0.0012	24.5




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	14.7	85.3

USCS	Description
CL	LEAN CLAY with Sand

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic by visual examination.

<b>HI-STORE CISF</b> Lea County, New Mexico	 <b>GEI</b> Consultants	<b>Grain Size Curve</b>	
		Boring/Test Pit No. : B102 Sample No. : S15 (40-41.4 ft)	Form 104.4, Rev. 1

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B105  
 Sample Number S15 (55-56.4 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/7/2017  
 Date 11/8/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		#10	#10
0.00	0.00	33.44	34.63		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					63.07	
Initial Sample Wet Wt. (g)					71.21	
Water Content (%)					12.9%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	183.36	183.36	100.0	0.0
#16	1.180	184.92		97.5	2.5
#30	0.600	190.74		88.3	11.7
#50	0.300	199.20		74.9	25.1
#100	0.150	207.62		61.5	38.5
#200	0.075	214.15		51.2	48.8

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	63.07

## Hydrometer Corrections

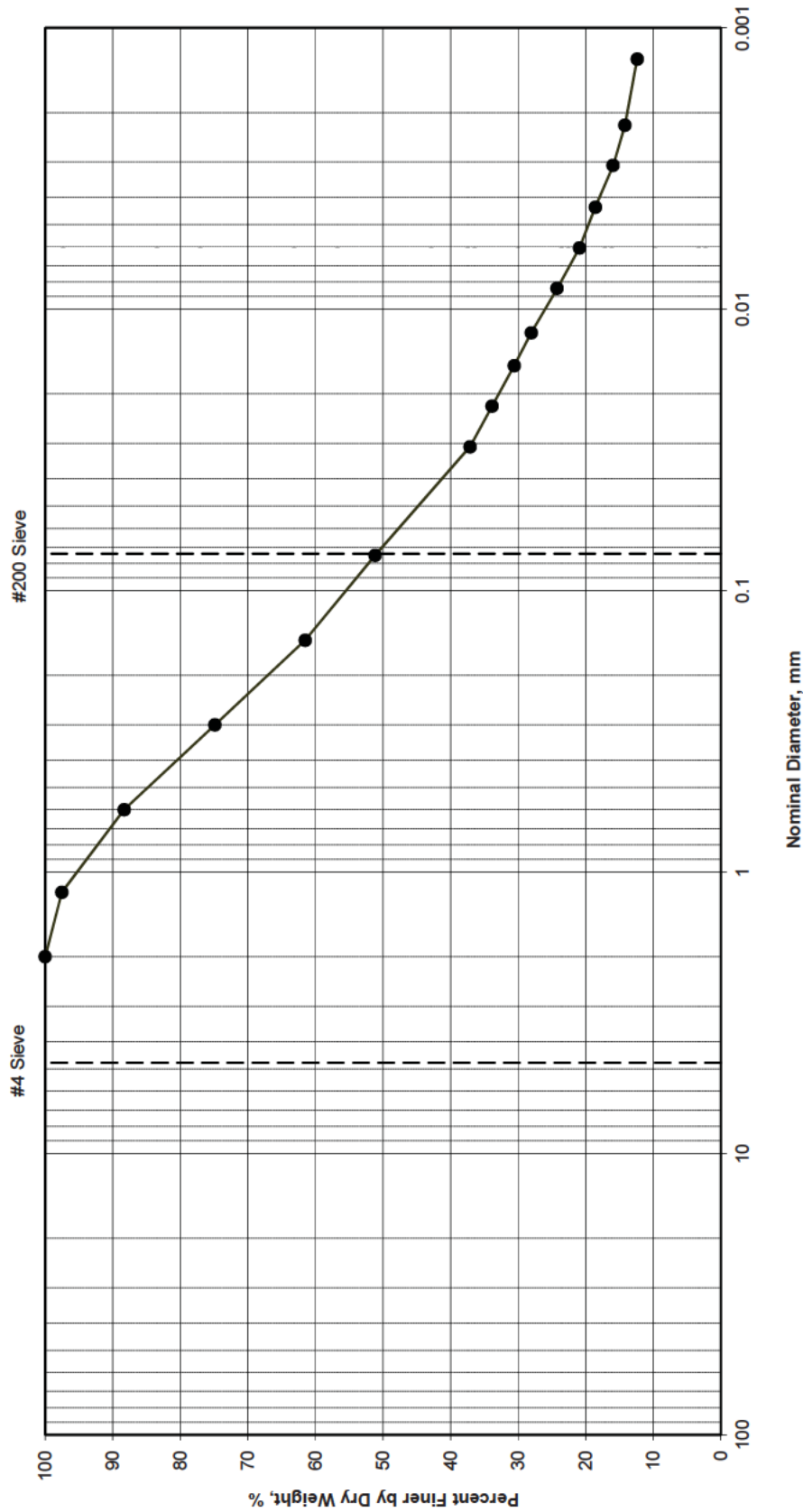
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	3.3	1	0.0
2	5.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.8	18.6	-3.85	14.75	1.01475	11.19	1.00	0.01302	0.0308	37.1
4	22.8	17.3	-3.85	13.45	1.01345	11.54	1.00	0.01302	0.0221	33.9
8	22.8	16.0	-3.85	12.15	1.01215	11.88	1.00	0.01302	0.0159	30.6
14	22.8	15.0	-3.85	11.15	1.01115	12.15	1.00	0.01302	0.0121	28.1
30	22.6	13.5	-3.87	9.63	1.00963	12.54	1.00	0.01305	0.0084	24.2
60	22.5	12.2	-3.88	8.32	1.00832	12.89	1.00	0.01306	0.0061	21.0
120	22.1	11.3	-3.92	7.38	1.00738	13.13	1.00	0.01312	0.0043	18.6
240	22.7	10.2	-3.86	6.34	1.00634	13.42	1.00	0.01303	0.0031	16.0
480	21.7	9.6	-3.96	5.64	1.00564	13.58	1.00	0.01318	0.0022	14.2
1440	21.5	8.9	-3.98	4.92	1.00492	13.76	1.00	0.01322	0.0013	12.4




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	48.8	51.2

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic by visual examination.

HI-STORE CISF Lea County, New Mexico	<div> Project 1703345</div>	Grain Size Curve	
		Boring/Test Pit No. : B105	Sample No. : S15 (55-56.4 ft)
		Form 104.4, Rev. 1	



## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B106  
 Sample Number S5 (10-12 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/30/2017  
 Date 10/31/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
187.89	8.73	47.15	16.98		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					255.75	
Initial Sample Wet Wt. (g)					288.93	
Water Content (%)					13.0%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	205		100.0	0.0
0.75	19.00	258.47		79.1	20.9
0.375	9.50	295.03		64.8	35.2
#4	4.75	330.88		50.8	49.2
#10	2.00	366.19	205	37.0	63.0
#16	1.180	380.9		31.2	68.8
#30	0.600	396.14		25.3	74.7
#50	0.300	411.08		19.4	80.6
#100	0.150	428.29		12.7	87.3
#200	0.075	438.18		8.8	91.2

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	59.13

## Hydrometer Corrections

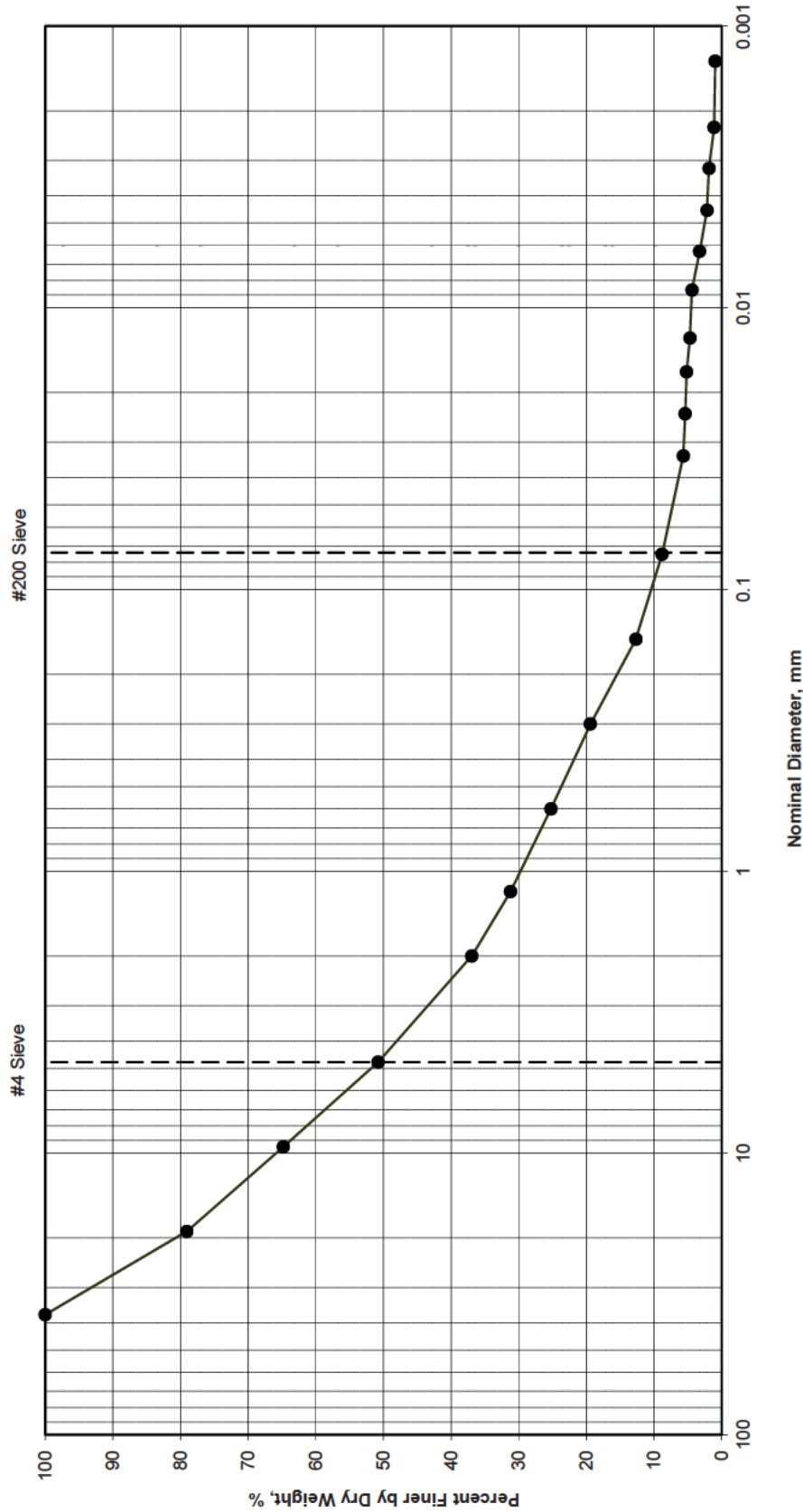
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.7	9.5	-3.76	5.74	1.00574	13.60	1.00	0.01288	0.0336	5.7
4	23.8	9.2	-3.75	5.45	1.00545	13.68	1.00	0.01287	0.0238	5.4
8	23.7	9.0	-3.76	5.24	1.00524	13.73	1.00	0.01288	0.0169	5.2
14	23.8	8.5	-3.75	4.75	1.00475	13.87	1.00	0.01287	0.0128	4.7
31	23.6	8.2	-3.77	4.43	1.00443	13.95	1.00	0.01290	0.0086	4.4
60	23.3	7.1	-3.80	3.30	1.00330	14.24	1.00	0.01294	0.0063	3.3
120	23.2	6.0	-3.81	2.19	1.00219	14.53	1.00	0.01296	0.0045	2.2
240	23.2	5.7	-3.81	1.89	1.00189	14.61	1.00	0.01296	0.0032	1.9
480	22.7	5.0	-3.86	1.14	1.00114	14.79	1.00	0.01303	0.0023	1.1
1440	22.1	4.9	-3.92	0.98	1.00098	14.82	1.00	0.01312	0.0013	1.0




Form 104.3, Rev. 1



%+3"	% Gravel	% Sand	% Fines
0.0	49.2	42.0	8.8

USCS	Description
GW-GM	Widely-graded GRAVEL with silt and sand

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<div>HI-STORE CISF Lea County, New Mexico</div>	<div><div>GEI Consultants</div></div>	Grain Size Curve	
		Boring/Test Pit No. : B106	
		Sample No. : S5 (10-12 ft)	
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B106  
 Sample Number S7 (6-24 in) (15-17 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/30/2017  
 Date 11/3/2017

## Sample Weight Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	205.39		100.0	0.0
#4	4.75	205.95		99.7	0.3
#10	2.00	208.95	205.39	97.8	2.2
#16	1.180	228.02		86.1	13.9
#30	0.600	242.7		77.1	22.9
#50	0.300	257.69		67.8	32.2
#100	0.150	311.07		35.0	65.0
#200	0.075	336.37		19.5	80.5

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	61.58

## Hydrometer Corrections

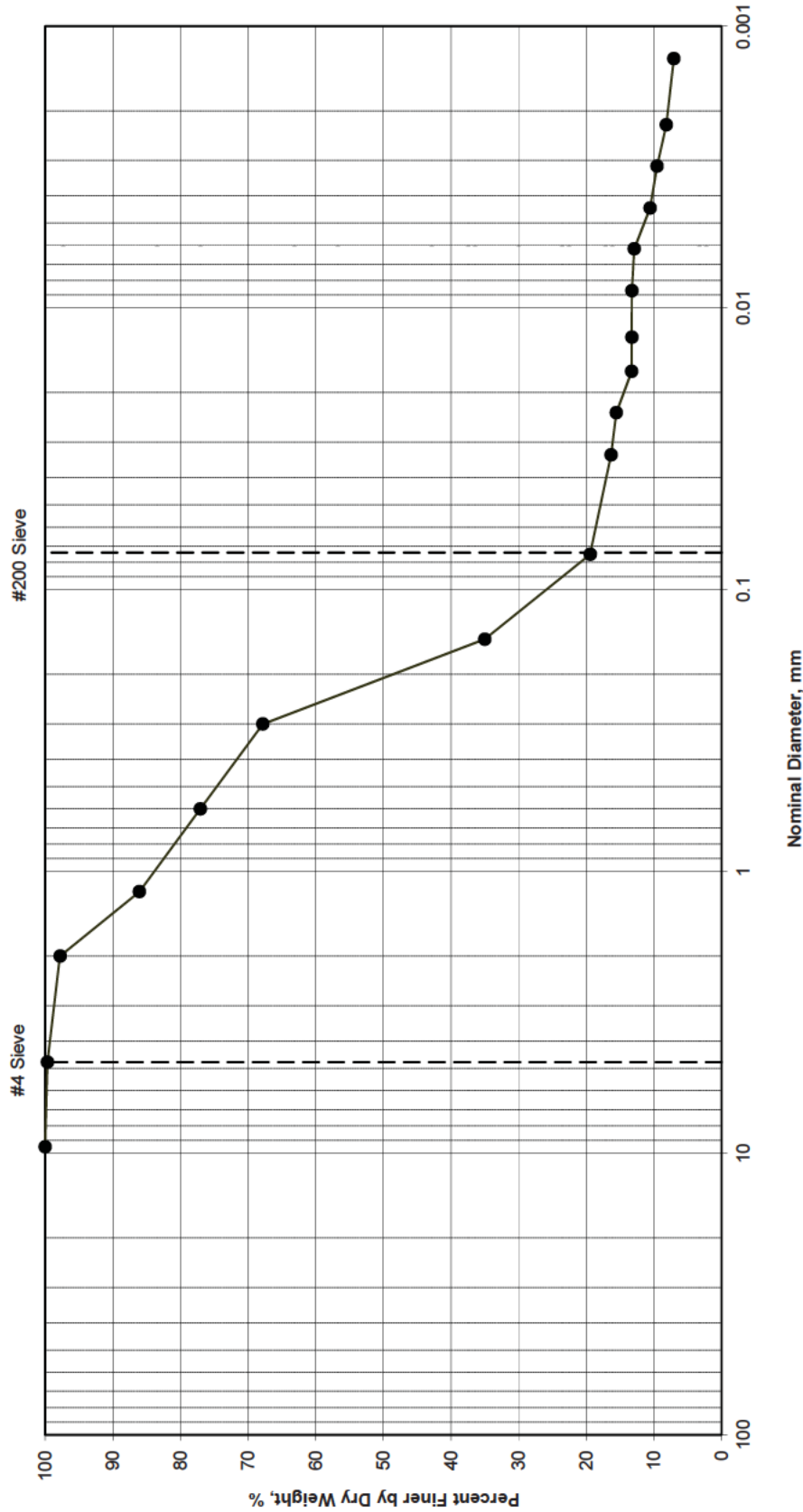
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	24.1	10.2	-3.72	6.48	1.00648	13.42	1.00	0.01282	0.0332	16.3
4	24.1	9.9	-3.72	6.18	1.00618	13.50	1.00	0.01282	0.0235	15.6
8	24.1	9.0	-3.72	5.28	1.00528	13.73	1.00	0.01282	0.0168	13.3
14	24.0	9.0	-3.73	5.27	1.00527	13.73	1.00	0.01284	0.0127	13.3
30	23.9	9.0	-3.74	5.26	1.00526	13.73	1.00	0.01285	0.0087	13.3
60	23.6	8.9	-3.77	5.13	1.00513	13.76	1.00	0.01290	0.0062	12.9
120	23.3	8.0	-3.80	4.20	1.00420	14.00	1.00	0.01294	0.0044	10.6
240	23.2	7.6	-3.81	3.79	1.00379	14.10	1.00	0.01296	0.0031	9.6
480	22.8	7.1	-3.85	3.25	1.00325	14.24	1.00	0.01302	0.0022	8.2
1440	22.4	6.7	-3.89	2.81	1.00281	14.34	1.00	0.01308	0.0013	7.1




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USCS	Description
SC	Clayey SAND

%+3"	% Gravel	% Sand	% Fines
0.0	0.3	80.2	19.5

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<div>  <div> <div>HI-STORE CISF</div> <div>Lea County, New Mexico</div> </div> </div>	<div> <div>Grain Size Curve</div> <div> <div>Boring/Test Pit No. : B106</div> <div>Sample No. : S7 (6-24 in) (15-17 ft)</div> </div> </div>	
	<div> <div>Project 1703345</div> <div>Form 104.4, Rev. 1</div> </div>	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B106  
 Sample Number S9 (20-21.9 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/30/2017  
 Date 11/3/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	30.91	45.79		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					71.70	
Initial Sample Wet Wt. (g)					78.31	
Water Content (%)					9.2%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	220.79	220.79	100.0	0.0
#16	1.180	221.18		99.5	0.5
#30	0.600	221.88		98.5	1.5
#50	0.300	223.48		96.2	3.8
#100	0.150	236.23		78.5	21.5
#200	0.075	248.28		61.7	38.3

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	71.70

## Hydrometer Corrections

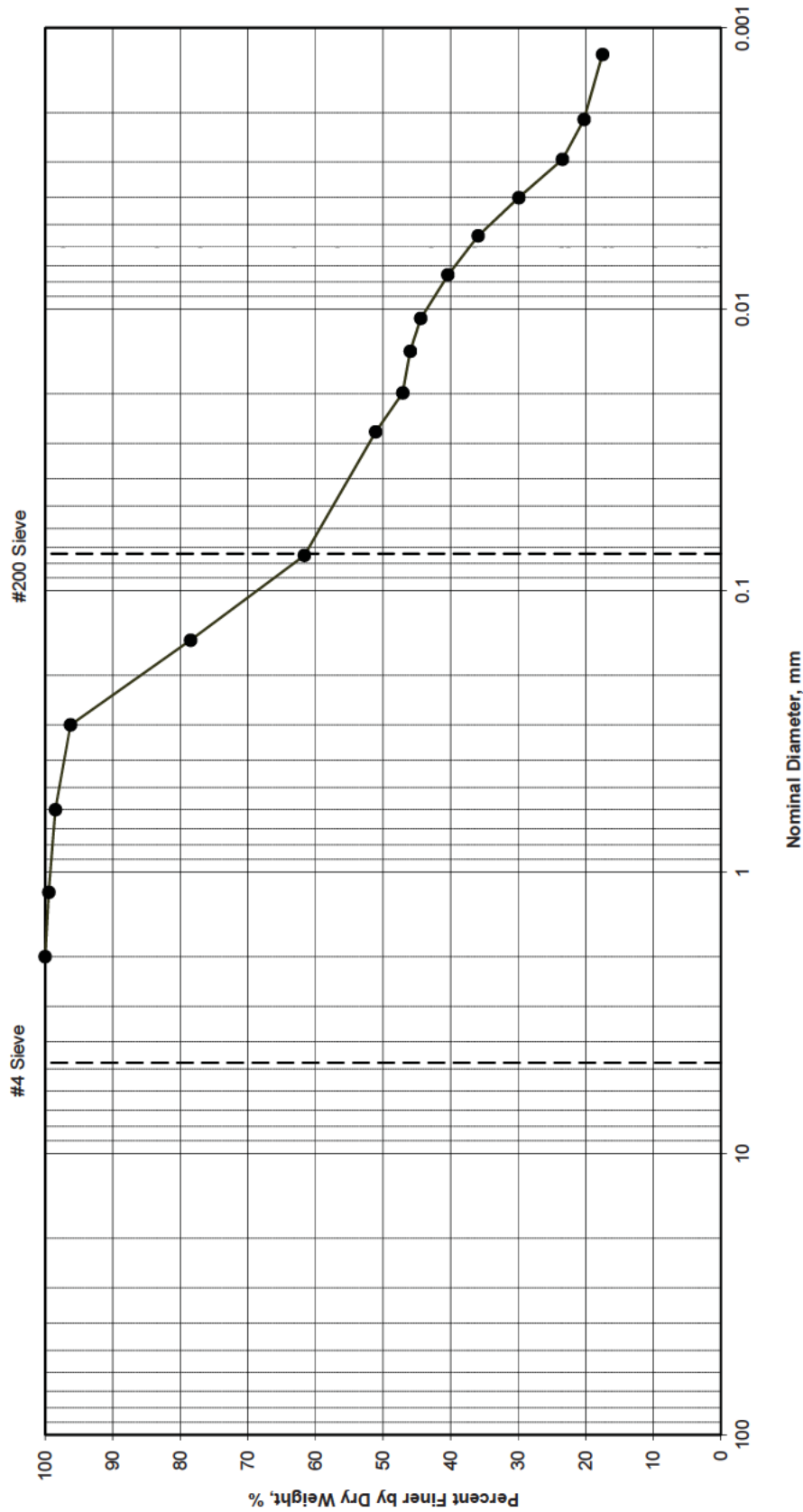
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	24.0	26.8	-3.73	23.07	1.02307	9.02	1.00	0.01284	0.0273	51.1
4	23.9	25.0	-3.74	21.26	1.02126	9.50	1.00	0.01285	0.0198	47.1
8	23.9	24.5	-3.74	20.76	1.02076	9.63	1.00	0.01285	0.0141	46.0
14	23.8	23.8	-3.75	20.05	1.02005	9.82	1.00	0.01287	0.0108	44.4
30	23.7	22.0	-3.76	18.24	1.01824	10.29	1.00	0.01288	0.0075	40.4
60	23.5	20.0	-3.78	16.22	1.01622	10.82	1.00	0.01291	0.0055	35.9
120	23.3	17.3	-3.80	13.50	1.01350	11.54	1.00	0.01294	0.0040	29.9
240	23.2	14.4	-3.81	10.59	1.01059	12.31	1.00	0.01296	0.0029	23.5
480	22.8	13.0	-3.85	9.15	1.00915	12.68	1.00	0.01302	0.0021	20.3
1440	22.4	11.8	-3.89	7.91	1.00791	12.99	1.00	0.01308	0.0012	17.5




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	38.3	61.7

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<b>HI-STORE CISF</b> Lea County, New Mexico	 Project 1703345	<b>Grain Size Curve</b>	
		Boring/Test Pit No. : B106 Sample No. : S9 (20-21.9 ft)	Form 104.4, Rev. 1

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B106  
 Sample Number S10  
 Calculated By EF  
 Checked By DJA  
 Date 11/13/2010  
 Date 11/21/2017

## Sample Weight Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	213.06	213.06	100.0	0.0
#16	1.180	213.68		99.0	1.0
#30	0.600	215.06		96.9	3.1
#50	0.300	216.78		94.2	5.8
#100	0.150	231.54		71.2	28.8
#200	0.075	249.00		44.1	55.9

Sample Weights (g)					Dispersing Agent (g)
W1	W2	W3	W4		+ #10
0.00	0.00	41.02	28.24		(B)
					(C)
					0.00

Total Sample Dry Wt. (g) 64.26

Initial Sample Wet Wt. (g) 70.18

Water Content (%) 9.2%

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	64.26

## Hydrometer Corrections

Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

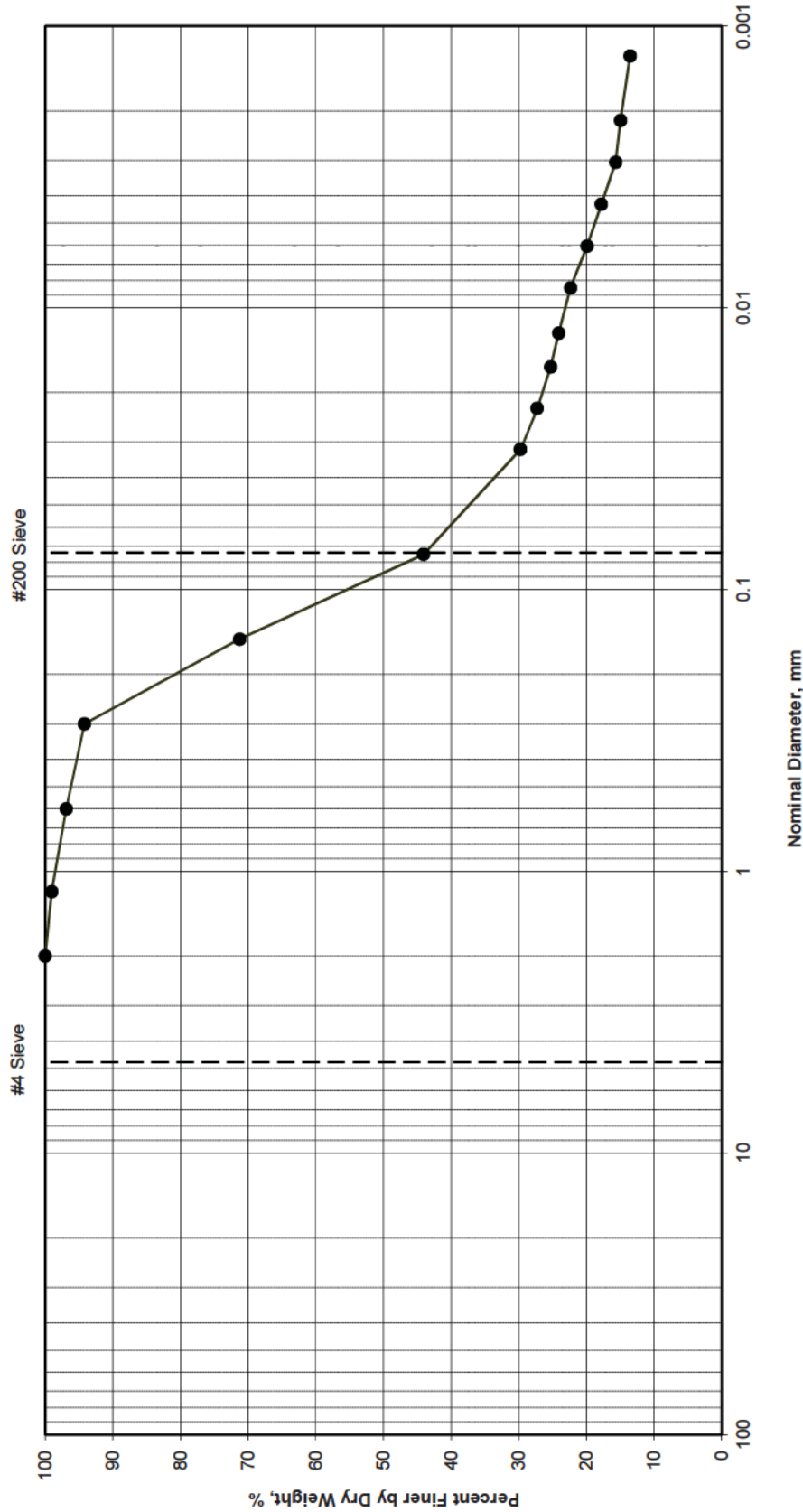
## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.7	15.9	-3.86	12.04	1.01204	11.91	1.00	0.01303	0.0318	29.8
4	22.7	14.9	-3.86	11.04	1.01104	12.17	1.00	0.01303	0.0227	27.3
8	22.7	14.1	-3.86	10.24	1.01024	12.38	1.00	0.01303	0.0162	25.3
14	22.8	13.6	-3.85	9.75	1.00975	12.52	1.00	0.01302	0.0123	24.1
30	22.7	12.9	-3.86	9.04	1.00904	12.70	1.00	0.01303	0.0085	22.3
60	22.9	11.9	-3.84	8.06	1.00806	12.97	1.00	0.01300	0.0060	19.9
120	23.3	11.0	-3.80	7.20	1.00720	13.20	1.00	0.01294	0.0043	17.8
240	23.8	10.1	-3.75	6.35	1.00635	13.44	1.00	0.01287	0.0030	15.7
480	23.8	9.8	-3.75	6.05	1.00605	13.52	1.00	0.01287	0.0022	14.9
1440	22.1	9.4	-3.92	5.48	1.00548	13.63	1.00	0.01312	0.0013	13.5



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USCS	Description
SC	Clayey SAND

%+3"	% Gravel	% Sand	% Fines
0.0	0.0	55.9	44.1

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<div> <div> </div> <div> <div>HI-STORE CISF</div> <div>Lea County, New Mexico</div> </div> </div>	<div> <div>Project 1703345</div> </div>	Grain Size Curve	
		Boring/Test Pit No. :	B106
		Sample No. :	S10
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B106  
 Sample Number S13 (30-31.1 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/30/2017  
 Date 10/31/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		#10	#10
0.00	0.00	25.89	48.55		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					69.44	
Initial Sample Wet Wt. (g)					76.30	
Water Content (%)					9.9%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	220.41	220.41	100.0	0.0
#16	1.180	224.71		93.8	6.2
#30	0.600	234.64		79.5	20.5
#50	0.300	241.11		70.2	29.8
#100	0.150	243.04		67.4	32.6
#200	0.075	244.20		65.7	34.3

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	69.44

## Hydrometer Corrections

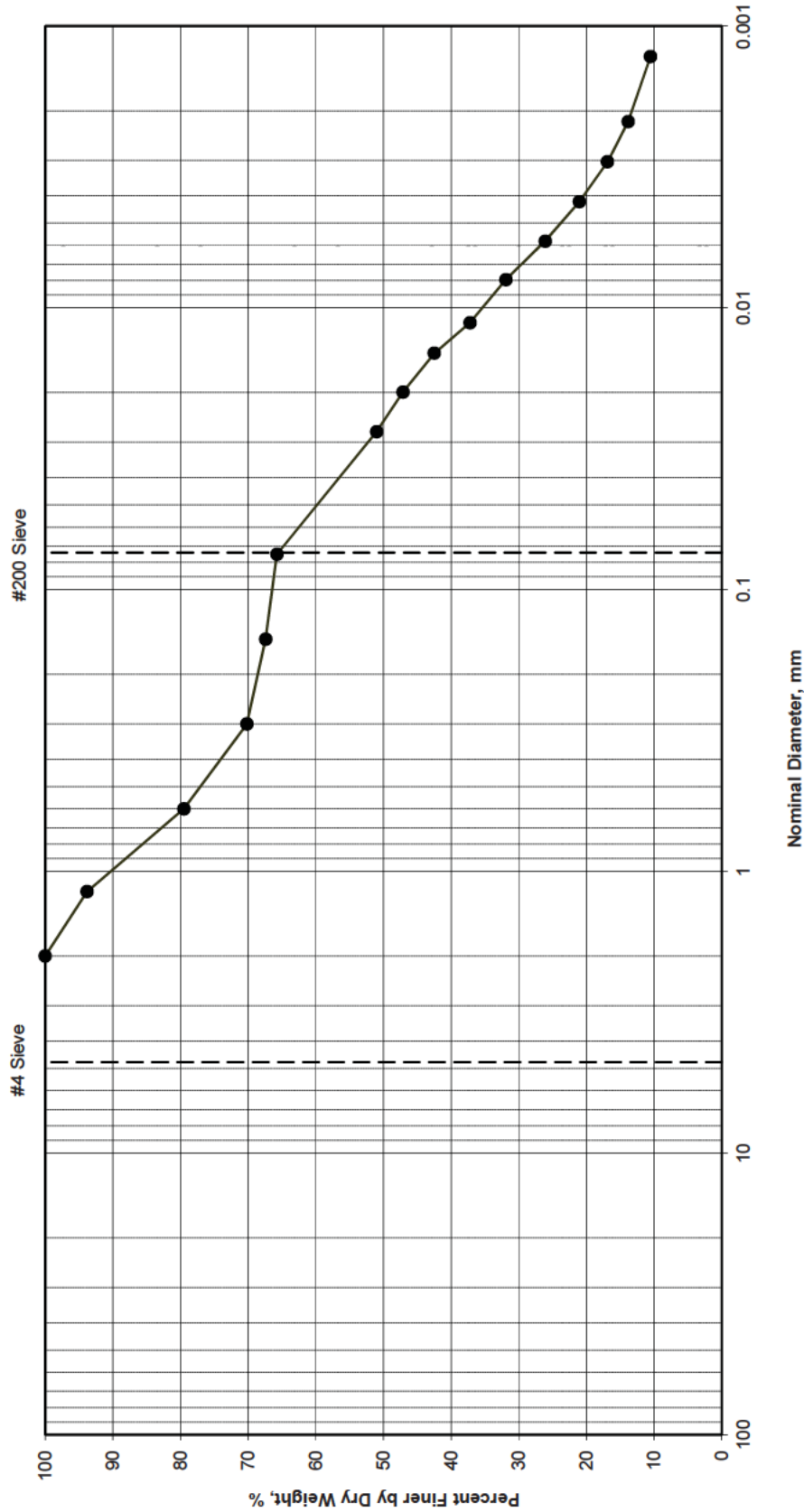
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	24.3	26.0	-3.70	22.30	1.02230	9.24	1.00	0.01279	0.0275	51.0
4	24.3	24.3	-3.70	20.60	1.02060	9.69	1.00	0.01279	0.0199	47.1
8	24.1	22.3	-3.72	18.58	1.01858	10.22	1.00	0.01282	0.0145	42.5
14	24.0	20.0	-3.73	16.27	1.01627	10.82	1.00	0.01284	0.0113	37.2
30	23.8	17.7	-3.75	13.95	1.01395	11.43	1.00	0.01287	0.0079	31.9
60	23.5	15.2	-3.78	11.42	1.01142	12.09	1.00	0.01291	0.0058	26.1
120	23.0	13.0	-3.79	9.21	1.00921	12.68	1.00	0.01293	0.0042	21.1
240	23.2	11.2	-3.81	7.39	1.00739	13.15	1.00	0.01296	0.0030	16.9
480	22.8	9.9	-3.85	6.05	1.00605	13.50	1.00	0.01302	0.0022	13.8
1440	22.4	8.5	-3.89	4.61	1.00461	13.87	1.00	0.01308	0.0013	10.5




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	34.3	65.7

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B106	Sample No. : S13 (30-31.1 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B107  
 Sample Number S7 (15-16.9 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/30/2017  
 Date 11/2/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	38.00	25.51		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					58.51	
Initial Sample Wet Wt. (g)					63.34	
Water Content (%)					8.3%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	214.19	214.19	100.0	0.0
#16	1.180	215.12		98.4	1.6
#30	0.600	215.98		96.9	3.1
#50	0.300	218.52		92.6	7.4
#100	0.150	235.72		63.2	36.8
#200	0.075	249.35		39.9	60.1

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	58.51

## Hydrometer Corrections

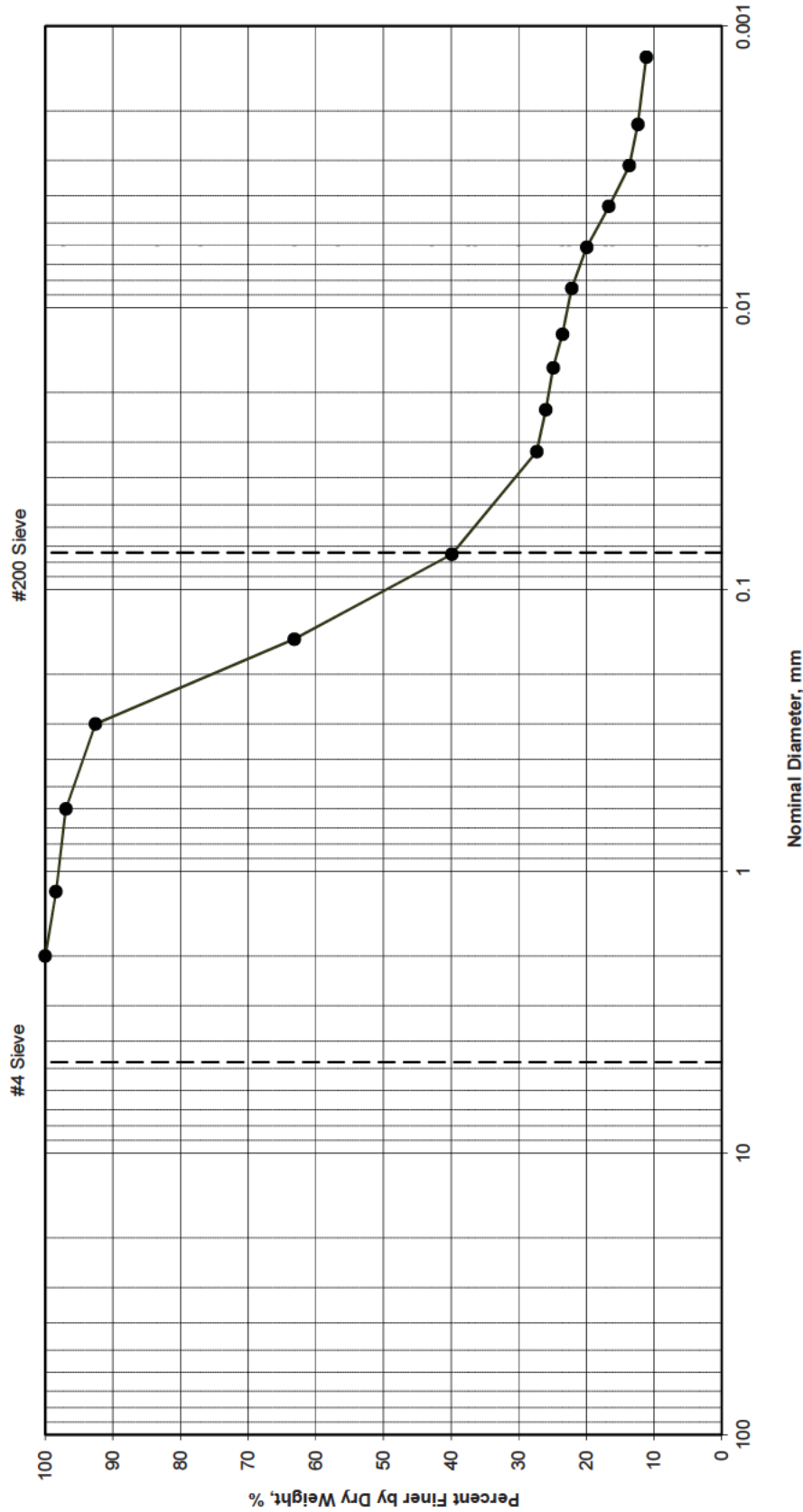
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.0	13.9	-3.83	10.07	1.01007	12.44	1.00	0.01299	0.0324	27.3
4	23.1	13.4	-3.82	9.58	1.00958	12.57	1.00	0.01297	0.0230	26.0
8	23.1	13.0	-3.82	9.18	1.00918	12.68	1.00	0.01297	0.0163	24.9
14	23.1	12.5	-3.82	8.68	1.00868	12.81	1.00	0.01297	0.0124	23.6
30	23.0	12.0	-3.83	8.17	1.00817	12.94	1.00	0.01299	0.0085	22.2
60	22.8	11.2	-3.85	7.35	1.00735	13.15	1.00	0.01302	0.0061	19.9
120	22.0	8.5	-3.85	4.65	1.00615	13.47	1.00	0.01302	0.0044	16.7
240	22.6	8.9	-3.87	5.03	1.00503	13.76	1.00	0.01305	0.0031	13.7
480	22.0	8.5	-3.93	4.57	1.00457	13.87	1.00	0.01314	0.0022	12.4
1440	22.4	8.0	-3.89	4.11	1.00411	14.00	1.00	0.01308	0.0013	11.2




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USCS	Description
SC	Clayey SAND

%+3"	% Gravel	% Sand	% Fines
0.0	0.0	60.1	39.9

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<div>  <div> <div>HI-STORE CISF</div> <div>Lea County, New Mexico</div> </div> </div>	Project 1703345	
	<div>Grain Size Curve</div> <div> <div>Boring/Test Pit No. : B107</div> <div>Sample No. : S7 (15-16.9 ft)</div> </div>	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B107  
 Sample Number S13 (30-32 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/31/2017  
 Date 10/31/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+#10
0.00	0.00	8.14	50.02		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					53.16	
Initial Sample Wet Wt. (g)					59.34	
Water Content (%)					11.6%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	191.76	191.76	100.0	0.0
#16	1.180	192.5		98.6	1.4
#30	0.600	193.46		96.8	3.2
#50	0.300	194.32		95.2	4.8
#100	0.150	195.34		93.3	6.7
#200	0.075	197.32		89.5	10.5

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	53.16

## Hydrometer Corrections

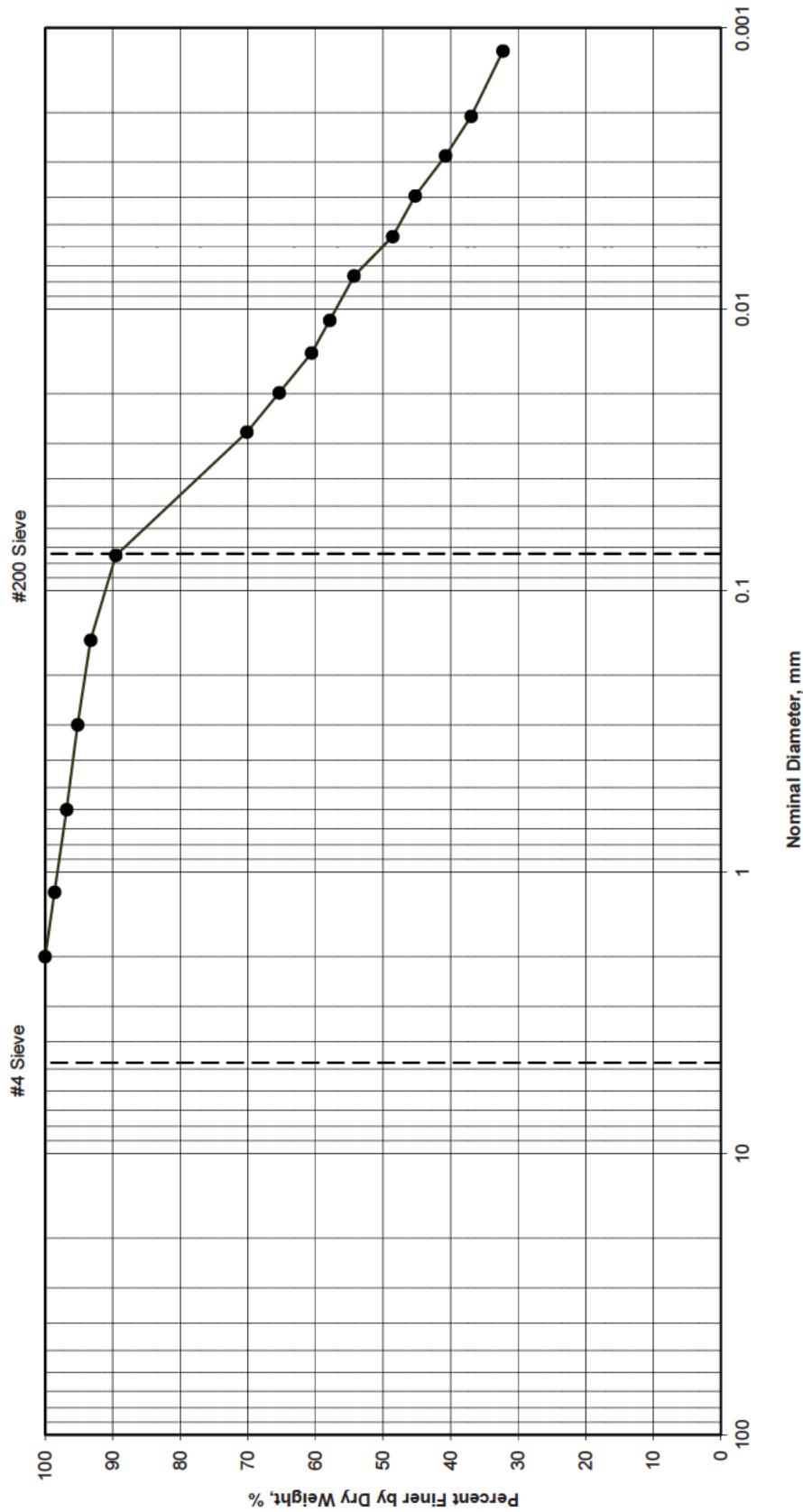
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.1	27.3	-3.82	23.48	1.02348	8.89	1.00	0.01297	0.0273	70.1
4	23.1	25.7	-3.82	21.88	1.02188	9.32	1.00	0.01297	0.0198	65.4
8	23.1	24.1	-3.82	20.28	1.02028	9.74	1.00	0.01297	0.0143	60.6
14	23.1	23.2	-3.82	19.38	1.01938	9.98	1.00	0.01297	0.0109	57.9
30	23.0	22.0	-3.83	18.17	1.01817	10.29	1.00	0.01299	0.0076	54.3
60	22.9	20.1	-3.84	16.26	1.01626	10.80	1.00	0.01300	0.0055	48.6
120	22.8	19.0	-3.85	15.15	1.01515	11.09	1.00	0.01302	0.0040	45.3
240	22.7	17.5	-3.86	13.64	1.01364	11.49	1.00	0.01303	0.0029	40.8
480	22.0	16.3	-3.93	12.37	1.01237	11.80	1.00	0.01314	0.0021	37.0
1440	22.2	14.7	-3.91	10.79	1.01079	12.23	1.00	0.01311	0.0012	32.2




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	10.5	89.5

USCS	Description
CL	LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

<b>HI-STORE CISF</b> Lea County, New Mexico	 Project 1703345	<b>Grain Size Curve</b>	
		Boring/Test Pit No. : B107 Sample No. : S13 (30-32 ft)	Form 104.4, Rev. 1



## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B107  
 Sample Number S15 (40-42 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/31/2017  
 Date 11/3/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	24.77	45.26		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					65.03	
Initial Sample Wet Wt. (g)					72.10	
Water Content (%)					10.9%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	199.24	199.24	100.0	0.0
#16	1.180	199.77		99.2	0.8
#30	0.600	202.21		95.4	4.6
#50	0.300	206.32		89.1	10.9
#100	0.150	212.21		80.1	19.9
#200	0.075	219.94		68.2	31.8

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	65.03

## Hydrometer Corrections

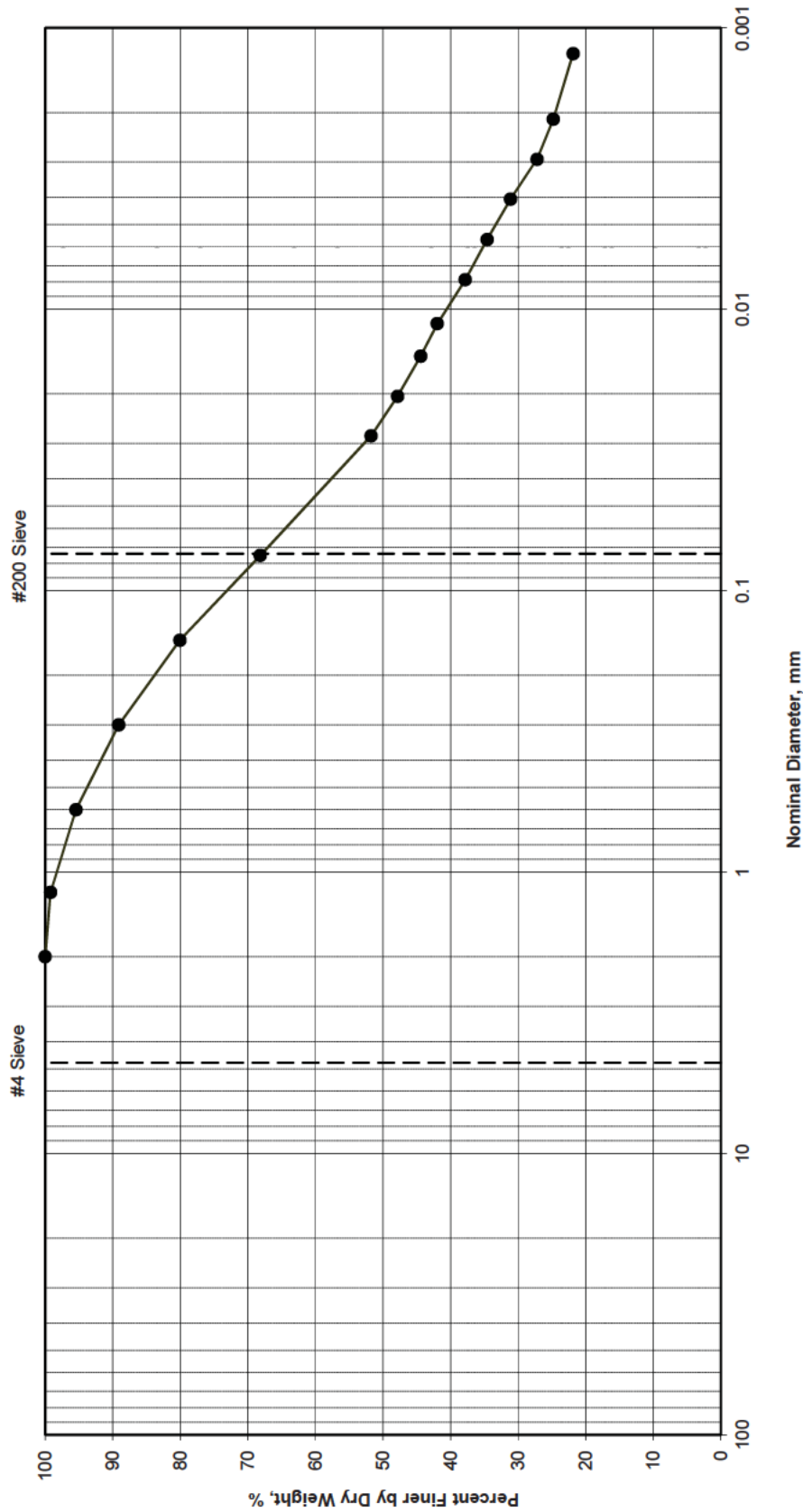
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2
			15.3

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.3	25.0	-3.80	21.20	1.02120	9.50	1.00	0.01294	0.0282	51.8
4	23.3	23.4	-3.80	19.60	1.01960	9.92	1.00	0.01294	0.0204	47.9
8	23.3	22.0	-3.80	18.20	1.01820	10.29	1.00	0.01294	0.0147	44.4
14	23.2	21.0	-3.81	17.19	1.01719	10.56	1.00	0.01296	0.0113	42.0
30	23.2	19.3	-3.81	15.49	1.01549	11.01	1.00	0.01296	0.0078	37.8
60	23.0	18.0	-3.83	14.17	1.01417	11.35	1.00	0.01299	0.0056	34.6
120	22.9	16.6	-3.84	12.76	1.01276	11.72	1.00	0.01300	0.0041	31.2
240	22.8	15.0	-3.85	11.15	1.01115	12.15	1.00	0.01302	0.0029	27.2
480	21.9	14.1	-3.94	10.16	1.01016	12.38	1.00	0.01315	0.0021	24.8
1440	21.9	12.9	-3.94	8.96	1.00896	12.70	1.00	0.01315	0.0012	21.9




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	31.8	68.2

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B107	Sample No. : S15 (40-42 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B107  
 Sample Number S17 (50-51.3 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 10/23/2017  
 Date 10/31/2017

## Sample Weight Data

Sample Weights (g)					Dispersing Agent (g)	
W1	W2	W3	W4		-#10	+ #10
0.00	0.00	29.71	37.52		(B)	(C)
					5.00	0.00
Total Sample Dry Wt. (g)					62.23	
Initial Sample Wet Wt. (g)					70.50	
Water Content (%)					13.3%	

## Mechanical Sieve Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	206.22	206.22	100.0	0.0
#16	1.180	207.16		98.5	1.5
#30	0.600	211.42		91.6	8.4
#50	0.300	218.70		79.9	20.1
#100	0.150	226.57		67.3	32.7
#200	0.075	232.78		57.3	42.7

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	62.23

## Hydrometer Corrections

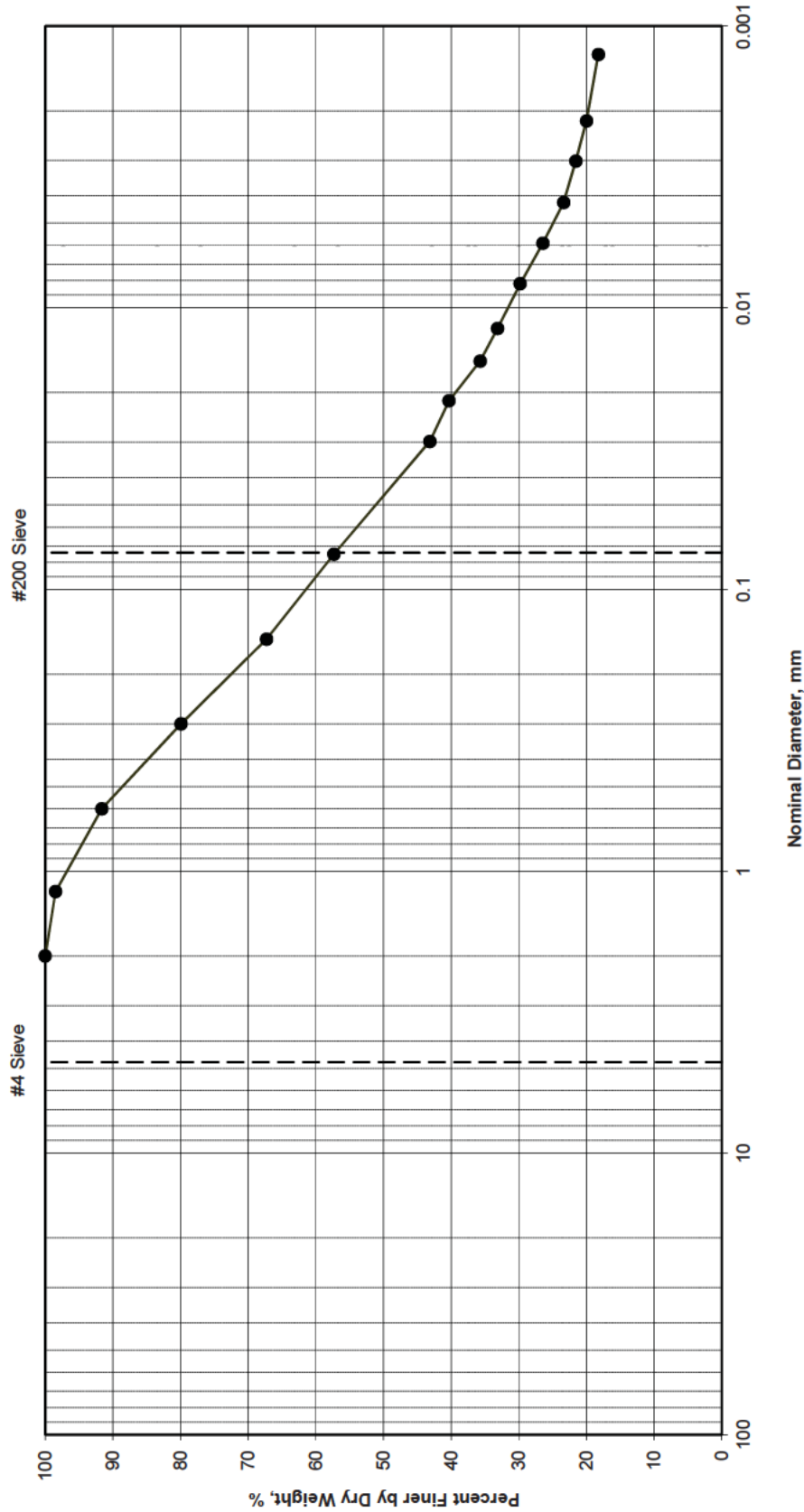
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	23.4	20.7	-3.79	16.91	1.01691	10.64	1.00	0.01293	0.0298	43.2
4	23.3	19.6	-3.80	15.80	1.01580	10.93	1.00	0.01294	0.0214	40.3
8	23.3	17.8	-3.80	14.00	1.01400	11.41	1.00	0.01294	0.0155	35.7
14	23.2	16.8	-3.81	12.99	1.01299	11.67	1.00	0.01296	0.0118	33.2
30	23.1	15.5	-3.82	11.68	1.01168	12.01	1.00	0.01297	0.0082	29.8
60	23.0	14.2	-3.83	10.37	1.01037	12.36	1.00	0.01299	0.0059	26.5
120	22.9	13.0	-3.84	9.16	1.00916	12.68	1.00	0.01300	0.0042	23.4
240	22.8	12.3	-3.85	8.45	1.00845	12.86	1.00	0.01302	0.0030	21.6
480	21.7	11.8	-3.96	7.84	1.00784	12.99	1.00	0.01318	0.0022	20.0
1440	21.8	11.1	-3.95	7.15	1.00715	13.18	1.00	0.01317	0.0013	18.2




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	42.7	57.3

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104 (referenced to ASTM D422).

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B107	Sample No. : S17 (50-51.3 ft)
		Form 104.4, Rev. 1	

## Grain Size Analysis - Combined Sieve Data Calculation

GEI Project Number 1703345  
 Boring/Test Pit No. B108  
 Sample Number S14 (45-47 ft)  
 Calculated By EF  
 Checked By DJA  
 Date 11/7/2017  
 Date 11/8/2017

## Sample Weight Data

Sieve No.	Diameter (mm)	Cumulative Wt. Retained	Tare Wt.	% Finer	% Retained
3	75.00	NA		NA	NA
1.5	37.50	NA		NA	NA
0.75	19.00	NA		NA	NA
0.375	9.50	NA		NA	NA
#4	4.75	NA		NA	NA
#10	2.00	213.07	213.07	100.0	0.0
#16	1.180	214.88		97.3	2.7
#30	0.600	221.16		87.9	12.1
#50	0.300	229.49		75.5	24.5
#100	0.150	237.93		63.0	37.0
#200	0.075	244.59		53.0	47.0

## Hydrometer Data and Corrections

Specific Gravity	2.7
Meniscus Correction	0.7
Sample Weight (g)	67.10

## Hydrometer Corrections

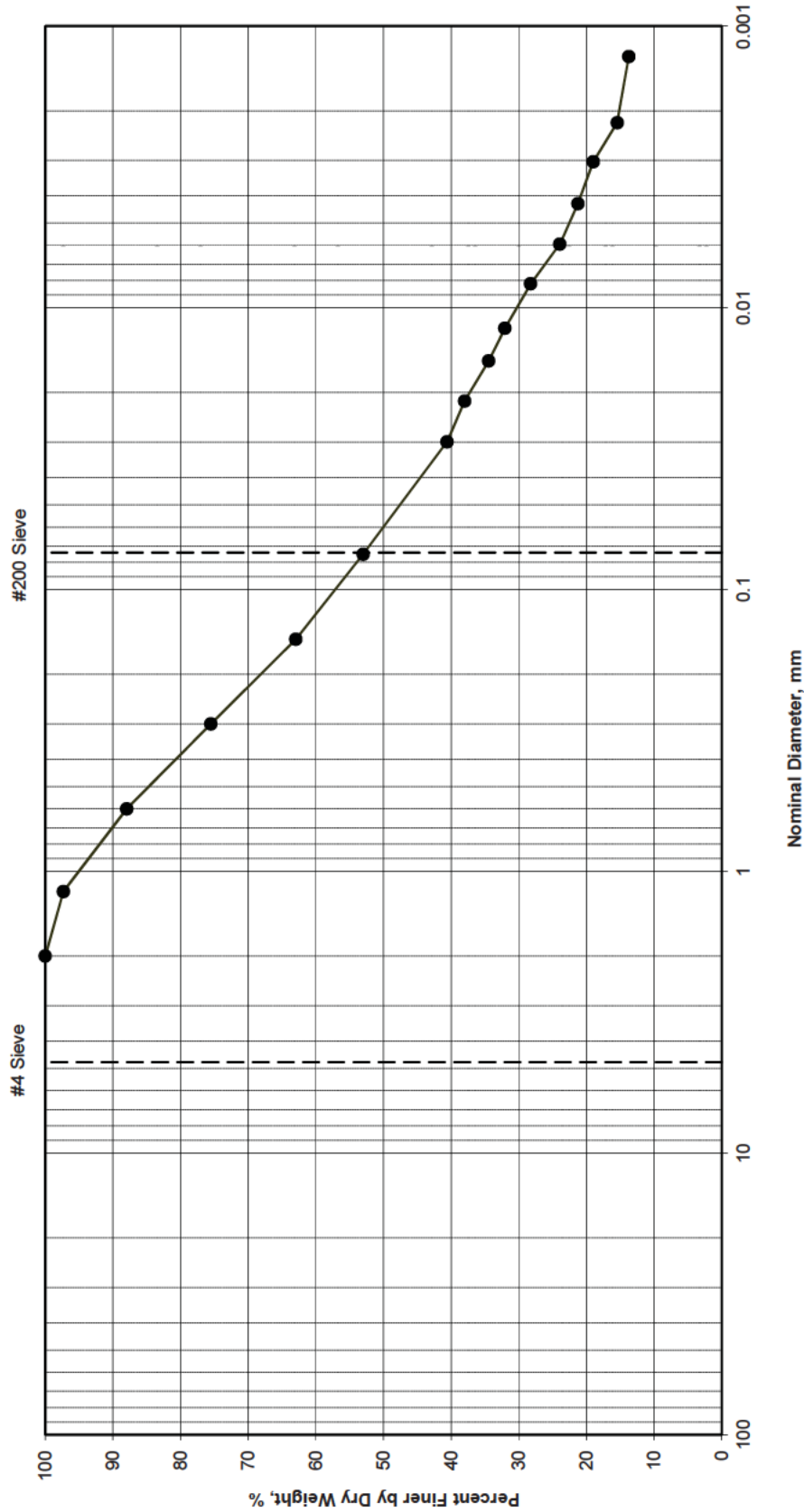
Distilled Water + Dispersing Agent		Distilled Water Only	
Reading No.	Hydrometer Reading	Reading No.	Hydrometer Reading
1	26.1	1	0.0
2	15.7	2	1.2

## Hydrometer Data

Elapsed Time	Temp (C°)	Hydrometer Reading	Composite Correction	Reading with Composite Correction	Adjusted Hydrometer Reading	Effective Depth (cm)	Specific Gravity of water	K	Particle Diameter (mm)	% Finer
2	22.9	21.0	-3.84	17.16	1.01716	10.56	1.00	0.01300	0.0299	40.6
4	22.9	19.9	-3.84	16.06	1.01606	10.85	1.00	0.01300	0.0214	38.0
8	22.9	18.4	-3.84	14.56	1.01456	11.25	1.00	0.01300	0.0154	34.5
14	22.8	17.4	-3.85	13.55	1.01355	11.51	1.00	0.01302	0.0118	32.1
30	22.7	15.8	-3.86	11.94	1.01194	11.93	1.00	0.01303	0.0082	28.3
60	22.5	14.0	-3.88	10.12	1.01012	12.41	1.00	0.01306	0.0059	24.0
120	22.9	12.9	-3.91	8.99	1.00899	12.70	1.00	0.01311	0.0043	21.3
240	22.6	11.9	-3.87	8.03	1.00803	12.97	1.00	0.01305	0.0030	19.0
480	21.6	10.5	-3.97	6.53	1.00653	13.34	1.00	0.01320	0.0022	15.5
1440	21.4	9.8	-3.99	5.81	1.00581	13.52	1.00	0.01323	0.0013	13.8




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%+3"	% Gravel	% Sand	% Fines
0.0	0.0	47.0	53.0

USCS	Description
CL	Sandy LEAN CLAY

Notes: Test performed in accordance with GEI Procedure No. 104. Fines determined to be plastic by visual examination.

HI-STORE CISF Lea County, New Mexico	 Project 1703345	Grain Size Curve	
		Boring/Test Pit No. : B108	Sample No. : S14 (45-47 ft)
		Form 104.4, Rev. 1	

## Specific Gravity Measurement

Project Name: HI-STORE CISFGEI Project No.: 1703345Perf. by, Per GEI Proc. 103: E. FazlicDate: 10/23/2017Checked by: D. AghjayanDate: 10/30/2017

Boring	B107	B102	NA
Sample	G1	G1	NA
Test No.	SG1	SG2	NA
USCS Group Name and Symbol	Silty Gravel with Sand (GM)	Silty Gravel with Sand (GM)	NA
Percent of total sample passing #4 sieve. Indicate if estimated ("est.") or if based on gradation test ("from test")	50 est.	50 est.	NA
Describe material excluded from test, if any	Gravel up to 1.5 in	Gravel up to 1.5 in	NA
Oven ID	1	1	NA
Thermometer ID	2113290	2113290	NA
Balance ID	1128030399	1128030399	NA
Method of Air Removal (e.g. "vacuum," "vacuum and ultrasonic")	Vacuum and Ultrasonic	Vacuum and Ultrasonic	NA
Pycnometer ID	SG6	SG21	NA
Mass of Dry Empty Pycnometer, $M_p$	178.822 g	170.606 g	NA
Volume of Pycnometer, $V_p$	499.34 mL	499.31 mL	NA
Test Temperature, $t$	23.1 deg.C	23.1 deg.C	NA
$M_{pws, t}$	760.332 g	784.504 g	NA
Tare #	Q-14	S-4A	NA
Dry Wt. + Tare	541.490 g	588.423 g	NA
Tare	407.614 g	403.265 g	NA
Mass of oven dry solids, $M_s$	133.876 g	185.158 g	NA
Density of water at test temperature, $\rho_{w, t}$	0.99752 g/mL	0.99752 g/mL	NA
Temperature coefficient, $K$	0.99931	0.99931	NA
$M_{pw, t} = M_p + (V_p * \rho_{w, t})$	676.924 g	668.678 g	NA
$G_t = \frac{M_s}{(M_{pw, t} - (M_{pws, t} - M_s))}$	2.653	2.671	NA
$G_{20^\circ C} = K * G_t$	2.65	2.67	NA

 $G_t$  = specific gravity at test temperature $G_{20^\circ C}$  = specific gravity at 20°C $M_{pw, t}$  = mass of pycnometer and water at the test temperature $M_{pws, t}$  = mass of pycnometer, water, and soil solids at the test temperature $M_s$  = mass of the oven dry soil solids $\rho_{w, t}$  = density of water at the test temperature (Table 2, ASTM D854) $K$  = temperature coefficient (Table 2, ASTM D854)

Notes:



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## Specific Gravity Measurement

Project Name: HI-STORE CISFGEI Project No.: 1703345Perf. by, Per GEI Proc. 103: E. FazlicDate: 11/1/2017Checked by: D. AghjayanDate: 11/10/2017

Boring	B102	B102	B105
Sample	S14	S16	S9
Test No.	SG3	SG4	SG5
USCS Group Name and Symbol	LEAN CLAY with Sand (CL)	LEAN CLAY with Sand (CL)	LEAN CLAY with Sand (CL)
Percent of total sample passing #4 sieve. Indicate if estimated ("est.") or if based on gradation test ("from test")	100 est.	100 est.	100 est.
Describe material excluded from test, if any	NA	NA	NA
Oven ID	2	2	1
Thermometer ID	2113290	2113290	2113290
Balance ID	1128030399	1128030399	1128030399
Method of Air Removal (e.g. "vacuum," "vacuum and ultrasonic")	Vacuum and Ultrasonic	Vacuum and Ultrasonic	Vacuum and Ultrasonic
Pycnometer ID	SG6	SG21	SG6
Mass of Dry Empty Pycnometer, $M_p$	178.822 g	170.606 g	178.822 g
Volume of Pycnometer, $V_p$	499.34 mL	499.31 mL	499.34 mL
Test Temperature, $t$	22.1 deg.C	22.1 deg.C	22.0 deg.C
$M_{pws, t}$	757.793 g	768.561 g	729.430 g
Tare #	MB-999	KF-10	R-1
Dry Wt. + Tare	357.861 g	385.421 g	478.672 g
Tare	231.837 g	230.546 g	396.171 g
Mass of oven dry solids, $M_s$	126.024 g	154.857 g	82.501 g
Density of water at test temperature, $\rho_{w, t}$	0.99775 g/mL	0.99775 g/mL	0.99777 g/ml
Temperature coefficient, $K$	0.99954	0.99954	0.99957
$M_{pw, t} = M_p + (V_p * \rho_{w, t})$	677.038 g	668.793 g	677.048 g
$G_t = \frac{M_s}{(M_{pw, t} - (M_{pws, t} - M_s))}$	2.784	2.810	2.739
$G_{20^\circ C} = K * G_t$	2.78	2.81	2.74

 $G_t$  = specific gravity at test temperature $G_{20^\circ C}$  = specific gravity at 20°C $M_{pw, t}$  = mass of pycnometer and water at the test temperature $M_{pws, t}$  = mass of pycnometer, water, and soil solids at the test temperature $M_s$  = mass of the oven dry soil solids $\rho_{w, t}$  = density of water at the test temperature (Table 2, ASTM D854) $K$  = temperature coefficient (Table 2, ASTM D854)

Notes:



Form 103.1, Rev. 0

**Specific Gravity Measurement**Project Name: HI-STORE CISFGEI Project No.: 1703345Perf. by, Per GEI Proc. 103: E. FazlicDate: 11/2/2017Checked by: D. AghjayanDate: 11/10/2017

Boring	B105	NA	NA
Sample	S14	NA	NA
Test No.	SG6	NA	NA
USCS Group Name and Symbol	LEAN CLAY with Sand (CL)	NA	NA
Percent of total sample passing #4 sieve. Indicate if estimated ("est.") or if based on gradation test ("from test")	100 est.	NA	NA
Describe material excluded from test, if any	NA	NA	NA
Oven ID	2	NA	NA
Thermometer ID	2113290	NA	NA
Balance ID	1128030399	NA	NA
Method of Air Removal (e.g. "vacuum," "vacuum and ultrasonic")	Vacuum and Ultrasonic	NA	NA
Pycnometer ID	SG21	NA	NA
Mass of Dry Empty Pycnometer, $M_p$	170.606 g	NA	NA
Volume of Pycnometer, $V_p$	499.31 mL	NA	NA
Test Temperature, $t$	22.1 deg.C	NA	NA
$M_{pws, t}$	735.382 g	NA	NA
Tare #	Q1	NA	NA
Dry Wt. + Tare	512.832 g	NA	NA
Tare	409.502 g	NA	NA
Mass of oven dry solids, $M_s$	103.330 g	NA	NA
Density of water at test temperature, $\rho_{w, t}$	0.99775 g/mL	NA	NA
Temperature coefficient, $K$	0.99954	NA	NA
$M_{pw, t} = M_p + (V_p * \rho_{w, t})$	668.793 g	NA	NA
$G_t = \frac{M_s}{(M_{pw, t} - (M_{pws, t} - M_s))}$	2.812	NA	NA
$G_{20^\circ C} = K * G_t$	2.81	NA	NA

 $G_t$  = specific gravity at test temperature $G_{20^\circ C}$  = specific gravity at 20°C $M_{pw, t}$  = mass of pycnometer and water at the test temperature $M_{pws, t}$  = mass of pycnometer, water, and soil solids at the test temperature $M_s$  = mass of the oven dry soil solids $\rho_{w, t}$  = density of water at the test temperature (Table 2, ASTM D854) $K$  = temperature coefficient (Table 2, ASTM D854)

Notes:



Form 103.1, Rev. 0

**Unit Weight of Soil**Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345Project Location: Lea County, New MexicoPerf. by, per GEI Proc. 242 Rev. 0: D. Aghjayan Date: 10/30/2017Checked by: Maria Hernandez-Cabal Date: 11/10/2017Balance ID 1128030399 Ruler ID NAOven ID Oven # 3 Caliper ID NA**Sample Information**Boring/Test Pit B101 Sample No. MC1 Depth 10-11 Test No. UW1Sample Type CA. Modified split spoon sampler linerDescription Orange silty sand**Specimen Dimensions**

Tube/Liner Length	NA	NA	NA	NA	Avg.	NA	cm	
Top Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Bot. Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Tube/Liner ID	NA	NA	NA	NA	Avg.	NA	cm	
Length of Soil	NA	cm	Area	NA	cm <sup>2</sup>	Volume, V <sub>t</sub>	NA	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	NA	gm
Wt. Tube/Liner + Other	NA	gm
Wt. Moist Soil, $W_t$	NA	gm
Wt. Dry Soil, $W_d = W_t / (1 + wc)$	NA	gm

**Water Content**

Tare ID	U19	
Wt. Moist Soil + Tare	153.37	gm
Wt. Dry Soil + Tare	136.79	gm
Wt. Tare	31.53	gm
Wt. Water	16.58	gm
Wt. Dry Soil	105.26	gm
Water Content, wc	15.8%	
Specimen Fraction Used	NA	

**Unit Weight Determination**

Total Unit Weight = $W_t/V_t$	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf
Dry Unit Weight = $W_d/V_t$	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf

**Notes:**

Unable to obtain suitable specimen for unit weight determination.



**Unit Weight of Soil**Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345Project Location: Lea County, New MexicoPerf. by, per GEI Proc. 242 Rev. 0: D. Aghjayan Date: 10/30/2017Checked by: Maria Henandez-Cabal Date: 11/10/2017Balance ID 1128030399 Ruler ID NAOven ID Oven # 3 Caliper ID NA**Sample Information**Boring/Test Pit B101 Sample No. MC2 Depth 20-21 Test No. UW2Sample Type CA. Modified split spoon sampler linerDescription Severely weathered claystone, extremely fractured**Specimen Dimensions**

Tube/Liner Length	NA	NA	NA	NA	Avg.	NA	cm	
Top Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Bot. Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Tube/Liner ID	NA	NA	NA	NA	Avg.	NA	cm	
Length of Soil	NA	cm	Area	NA	cm <sup>2</sup>	Volume, V <sub>t</sub>	NA	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	NA	gm
Wt. Tube/Liner + Other	NA	gm
Wt. Moist Soil, W <sub>t</sub>	NA	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	NA	gm

**Water Content**

Tare ID	T-11	
Wt. Moist Soil + Tare	223.02	gm
Wt. Dry Soil + Tare	206.49	gm
Wt. Tare	31.26	gm
Wt. Water	16.53	gm
Wt. Dry Soil	175.23	gm
Water Content, wc	9.4%	
Specimen Fraction Used	NA	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf

**Notes:**

Unable to obtain suitable specimen for unit weight determination.



**Unit Weight of Soil**Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345Project Location: Lea County, New MexicoPerf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/30/2017Checked by: D. Aghjayan Date: 10/31/2017Balance ID 1128030399 Ruler ID NAOven ID Oven # 3 Caliper ID 7180821**Sample Information**Boring/Test Pit B101 Sample No. MC3 Depth 30-30.4 Test No. UW6Sample Type CA. Modified split spoon sampler linerDescription Red pink and white very stiff clay with sand and gravel.**Specimen Dimensions**

Tube/Liner Length	2.57	2.55	2.56	2.56	Avg.	2.56	cm	
Top Empty Length	0	0	0	0	Avg.	0.00	cm	
Bot. Empty Length	0	0	0	0	Avg.	0.00	cm	
Tube/Liner ID	6.13	6.14	6.14	6.14	Avg.	6.14	cm	
Length of Soil	2.56	cm	Area	29.59	cm <sup>2</sup>	Volume, V <sub>t</sub>	75.74	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	198.83	gm
Wt. Tube/Liner + Other	45.46	gm
Wt. Moist Soil, W <sub>t</sub>	153.37	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	132.86	gm

**Water Content**

Tare ID	U16	
Wt. Moist Soil + Tare	183.35	gm
Wt. Dry Soil + Tare	162.88	gm
Wt. Tare	30.25	gm
Wt. Water	20.47	gm
Wt. Dry Soil	132.63	gm
Water Content, wc	15.4%	
Specimen Fraction Used	100%	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	2.025	gm/cm <sup>3</sup>
x 62.43	126.4	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.754	gm/cm <sup>3</sup>
x 62.43	109.5	pcf

Notes:



Form 242.1, Rev. 0

## Unit Weight of Soil

Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345  
 Project Location: Lea County, New Mexico  
 Perf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/30/2017  
 Checked by: D. Aghjayan Date: 11/10/2017

Balance ID 1128030399 Ruler ID NA  
 Oven ID Oven # 3 Caliper ID NA

### Sample Information

Boring/Test Pit B105 Sample No. MC1 Depth 10-11 Test No. UW7  
 Sample Type CA. Modified split spoon sampler liner  
 Description Pink and light gray silty sand with gravel

### Specimen Dimensions

Tube/Liner Length	NA	NA	NA	NA	Avg.	NA	cm	
Top Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Bot. Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Tube/Liner ID	NA	NA	NA	NA	Avg.	NA	cm	
Length of Soil	NA	cm	Area	NA	cm <sup>2</sup>	Volume, V <sub>t</sub>	NA	cm <sup>3</sup>

### Specimen Weight

Wt. Moist Soil + Tube/Liner	NA	gm
Wt. Tube/Liner + Other	NA	gm
Wt. Moist Soil, W <sub>t</sub>	NA	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	NA	gm

### Water Content

Tare ID	6B	
Wt. Moist Soil + Tare	276.55	gm
Wt. Dry Soil + Tare	242.66	gm
Wt. Tare	30.75	gm
Wt. Water	33.89	gm
Wt. Dry Soil	211.91	gm
Water Content, wc	16.0%	
Specimen Fraction Used	NA	

### Unit Weight Determination

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf

### Notes:

Unable to obtain suitable specimen for unit weight determination.



**Unit Weight of Soil**Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345Project Location: Lea County, New MexicoPerf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/30/2017Checked by: D. Aghjayan Date: 11/9/2017Balance ID 1128030399 Ruler ID NAOven ID Oven # 3 Caliper ID NA**Sample Information**Boring/Test Pit B105 Sample No. MC2 Depth 20-20.9 Test No. UW4Sample Type CA. Modified split spoon sampler linerDescription Red and pink brown stiff lean clay with sand and gravel.**Specimen Dimensions**

Tube/Liner Length	NA	NA	NA	NA	Avg.	NA	cm	
Top Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Bot. Empty Length	NA	NA	NA	NA	Avg.	NA	cm	
Tube/Liner ID	NA	NA	NA	NA	Avg.	NA	cm	
Length of Soil	NA	cm	Area	NA	cm <sup>2</sup>	Volume, V <sub>t</sub>	NA	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	NA	gm
Wt. Tube/Liner + Other	NA	gm
Wt. Moist Soil, W <sub>t</sub>	NA	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	NA	gm

**Water Content**

Tare ID	T-10	
Wt. Moist Soil + Tare	190.99	gm
Wt. Dry Soil + Tare	176.97	gm
Wt. Tare	40.47	gm
Wt. Water	14.02	gm
Wt. Dry Soil	136.50	gm
Water Content, wc	10.3%	
Specimen Fraction Used	NA	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	NA	gm/cm <sup>3</sup>
x 62.43	NA	pcf

**Notes:**

Unable to obtain suitable specimen for unit weight determination.





**Unit Weight of Soil**Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345Project Location: Lea County, New MexicoPerf. by, per GEI Proc. 242 Rev. 0: D. Aghjayan Date: 10/30/2017Checked by: Maria Hernandez-Cabal Date: 11/10/2017Balance ID 1128030399 Ruler ID NAOven ID Oven # 3 Caliper ID 7180821**Sample Information**Boring/Test Pit B105 Sample No. MC3 Depth 40-41 Test No. UW3Sample Type CA. Modified split spoon sampler linerDescription Reddish brown stiff lean clay/severely weathered claystone.**Specimen Dimensions**

Tube/Liner Length	2.55	2.55	2.55	2.55	Avg.	2.55	cm	
Top Empty Length	0	0	0	0	Avg.	0.00	cm	
Bot. Empty Length	0.32	0.33	0.2	0.33	Avg.	0.30	cm	
Tube/Liner ID	6.14	6.13	6.14	6.14	Avg.	6.14	cm	
Length of Soil	2.26	cm	Area	29.59	cm <sup>2</sup>	Volume, V <sub>t</sub>	66.71	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	178.29	gm
Wt. Tube/Liner + Other	45.59	gm
Wt. Moist Soil, W <sub>t</sub>	132.70	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	114.62	gm

**Water Content**

Tare ID	D-27	
Wt. Moist Soil + Tare	174.82	gm
Wt. Dry Soil + Tare	156.77	gm
Wt. Tare	42.37	gm
Wt. Water	18.05	gm
Wt. Dry Soil	114.40	gm
Water Content, wc	15.8%	
Specimen Fraction Used	100%	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	1.989	gm/cm <sup>3</sup>
x 62.43	124.2	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.718	gm/cm <sup>3</sup>
x 62.43	107.3	pcf

Notes:



Form 242.1, Rev. 0

**Unit Weight of Soil**

Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345  
 Project Location: Lea County, New Mexico  
 Perf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/31/2017  
 Checked by: D. Aghjayan Date: 11/9/2017

Balance ID 1128030399 Ruler ID NA  
 Oven ID Oven # 3 Caliper ID 7180821

**Sample Information**

Boring/Test Pit B108 Sample No. MC1 Depth 10-11 Test No. UW10  
 Sample Type CA. Modified split spoon sampler liner  
 Description Red silty sand with gravel

**Specimen Dimensions**

Tube/Liner Length	2.61	2.72	2.83	2.77	Avg.	2.73	cm	
Top Empty Length	0	0	0	0		Avg.	0.00	cm
Bot. Empty Length	0.32	0.32	0.31	0.32		Avg.	0.32	cm
Tube/Liner ID	6.13	6.14	6.14	6.13		Avg.	6.14	cm
Length of Soil	2.42	cm	Area	29.56	cm <sup>2</sup>	Volume, V <sub>t</sub>	71.39	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	153.88	gm
Wt. Tube/Liner + Other	46.18	gm
Wt. Moist Soil, W <sub>t</sub>	107.70	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	95.09	gm

**Water Content**

Tare ID	T-19	
Wt. Moist Soil + Tare	139.29	gm
Wt. Dry Soil + Tare	126.7	gm
Wt. Tare	31.78	gm
Wt. Water	12.59	gm
Wt. Dry Soil	94.92	gm
Water Content, wc	13.3%	
Specimen Fraction Used	100%	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	1.509	gm/cm <sup>3</sup>
x 62.43	94.2	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.332	gm/cm <sup>3</sup>
x 62.43	83.2	pcf

Notes:

**Unit Weight of Soil**

Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345  
 Project Location: Lea County, New Mexico  
 Perf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/30/2017  
 Checked by: D. Aghjayan Date: 11/9/2017

Balance ID 1128030399 Ruler ID NA  
 Oven ID Oven # 3 Caliper ID 7180821

**Sample Information**

Boring/Test Pit B108 Sample No. MC2 Depth 40-40.9 Test No. UW5  
 Sample Type CA. Modified split spoon sampler liner  
 Description Reddish brown, yellow and purple stiff lean clay with greenish gray clay concentrations.

**Specimen Dimensions**

Tube/Liner Length	2.66	2.66	2.65	2.66	Avg.	2.66	cm	
Top Empty Length	0	0	0	0		0.00	cm	
Bot. Empty Length	0	0	0	0		0.00	cm	
Tube/Liner ID	6.14	6.14	6.14	6.14		6.14	cm	
Length of Soil	2.66	cm	Area	29.61	cm <sup>2</sup>	Volume, V <sub>t</sub>	78.69	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	201.82	gm
Wt. Tube/Liner + Other	45.61	gm
Wt. Moist Soil, W <sub>t</sub>	156.21	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	136.20	gm

**Water Content**

Tare ID	U6	
Wt. Moist Soil + Tare	185.90	gm
Wt. Dry Soil + Tare	165.95	gm
Wt. Tare	30.15	gm
Wt. Water	19.95	gm
Wt. Dry Soil	135.80	gm
Water Content, wc	14.7%	
Specimen Fraction Used	100%	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	1.985	gm/cm <sup>3</sup>
x 62.43	123.9	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.731	gm/cm <sup>3</sup>
x 62.43	108.1	pcf

Notes:

**Unit Weight of Soil**

Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345  
 Project Location: Lea County, New Mexico  
 Perf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/31/2017  
 Checked by: D. Aghjayan Date: 11/9/2017

Balance ID 1128030399 Ruler ID NA  
 Oven ID Oven # 3 Caliper ID 7180821

**Sample Information**

Boring/Test Pit B109 Sample No. MC1 Depth 10-11 Test No. UW8  
 Sample Type CA. Modified split spoon sampler liner  
 Description Pink and light gray silty sand with gravel

**Specimen Dimensions**

Tube/Liner Length	2.97	2.73	2.73	2.86	Avg.	2.82	cm	
Top Empty Length	0	0	0	0	Avg.	0.00	cm	
Bot. Empty Length	0	0	0	0	Avg.	0.00	cm	
Tube/Liner ID	6.13	6.15	6.13	6.14	Avg.	6.14	cm	
Length of Soil	2.82	cm	Area	29.59	cm <sup>2</sup>	Volume, V <sub>t</sub>	83.50	cm <sup>3</sup>

**Specimen Weight**

Wt. Moist Soil + Tube/Liner	159.05	gm
Wt. Tube/Liner + Other	46.02	gm
Wt. Moist Soil, W <sub>t</sub>	113.03	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	97.55	gm

**Water Content**

Tare ID	C31	
Wt. Moist Soil + Tare	144.51	gm
Wt. Dry Soil + Tare	129.09	gm
Wt. Tare	31.9	gm
Wt. Water	15.42	gm
Wt. Dry Soil	97.19	gm
Water Content, wc	15.9%	
Specimen Fraction Used	100%	

**Unit Weight Determination**

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	1.354	gm/cm <sup>3</sup>
x 62.43	84.5	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.168	gm/cm <sup>3</sup>
x 62.43	72.9	pcf

**Notes:**

Loose sand.  
 Surface was uneven.



## Unit Weight of Soil

Project Name: HI-STORE CISF Site Characterization GEI Project No.: 1703345  
 Project Location: Lea County, New Mexico  
 Perf. by, per GEI Proc. 242 Rev. 0: M. Hernandez-Cabal Date: 10/31/2017  
 Checked by: D. Aghjayan Date: 11/9/2017

Balance ID 1128030399 Ruler ID NA  
 Oven ID Oven # 3 Caliper ID 7180821

### Sample Information

Boring/Test Pit B109 Sample No. MC2 Depth 20-20.3 Test No. UW9  
 Sample Type CA. Modified split spoon sampler liner  
 Description Red silty sand with gravel

### Specimen Dimensions

Tube/Liner Length	2.85	2.92	2.81	2.74	Avg.	2.83	cm	
Top Empty Length	0	0	0	0	Avg.	0.00	cm	
Bot. Empty Length	0	0	0	0	Avg.	0.00	cm	
Tube/Liner ID	6.14	6.13	6.13	6.14	Avg.	6.14	cm	
Length of Soil	2.83	cm	Area	29.56	cm <sup>2</sup>	Volume, V <sub>t</sub>	83.66	cm <sup>3</sup>

### Specimen Weight

Wt. Moist Soil + Tube/Liner	177.85	gm
Wt. Tube/Liner + Other	45.75	gm
Wt. Moist Soil, W <sub>t</sub>	132.10	gm
Wt. Dry Soil, W <sub>d</sub> = W <sub>t</sub> /(1 + wc)	122.92	gm

### Water Content

Tare ID	F12	
Wt. Moist Soil + Tare	166.70	gm
Wt. Dry Soil + Tare	157.52	gm
Wt. Tare	34.65	gm
Wt. Water	9.18	gm
Wt. Dry Soil	122.87	gm
Water Content, wc	7.5%	
Specimen Fraction Used	100%	

### Unit Weight Determination

Total Unit Weight = W <sub>t</sub> /V <sub>t</sub>	1.579	gm/cm <sup>3</sup>
x 62.43	98.6	pcf
Dry Unit Weight = W <sub>d</sub> /V <sub>t</sub>	1.469	gm/cm <sup>3</sup>
x 62.43	91.7	pcf

### Notes:

Loose sand.  
 Surface was uneven.



<b>Water Content Measurement</b>					
Project Name:	Holtec HI-STORE CISF				
GEI Project No.:	1703345				
Perf. by, Per GEI Proc. 101:	D. Aghjayan / M. Hernandez-Cabal			Date: 10/24/17	
Checked by:	D. Aghjayan			Date: 10/26/17	
Determination No.	1	2	3	4	5
Boring	B106	B106	B106	B106	B106
Sample	S5	S7 (6-24")	S9	S10	S13
Oven ID	Oven #3	Oven #3	Oven #3	Oven #3	Oven #3
Balance ID	1128030399	1128030399	1128030399	1128030399	1128030399
Date/Time in Oven	10/24/17 01:40 PM	10/24/17 01:45 PM	10/24/17 01:50 PM	10/24/17 01:55 PM	10/24/17 02:00 PM
Date/Time Out of Oven	10/25/17 09:10 AM	10/25/17 09:10 AM	10/25/17 09:10 AM	10/25/17 09:15 AM	10/25/17 09:15 AM
Tare No.	U16	T-10	U-19	D-27	U6
[a] Wet Wt. + Tare (gms)	203.01	208.11	233.49	244.01	182.45
[b] Dry Wt. + Tare (gms)	183.59	190.81	215.75	224.3	167.36
[c] Wt. Tare (gms)	30.26	40.48	31.52	42.37	30.14
[d] Wt. Water (gms)	19.42	17.3	17.74	19.71	15.09
Wt. Wet Solids [a - c] (gms)	172.75	167.63	201.97	201.64	152.31
[e] Wt. Dry Solids [b - c] (gms)	153.33	150.33	184.23	181.93	137.22
Water Content [d/e] x 100, %	12.7	11.5	9.6	10.8	11.0
Is Wet Wt. enough for Method B? (yes/no)	Yes	Yes	Yes	Yes	Yes
Remarks:					
Test Notes: 1. Oven dry at 110°C (±5°C) for 12 hours minimum. 2. Cool in desiccator for a minimum of 30 minutes before weighing.					

<b>Water Content Measurement</b>					
Project Name:	Holtec HI-STORE CISF				
GEI Project No.:	1703345				
Perf. by, Per GEI Proc. 101:	M. Hernandez-Cabal			Date: 10/26/17	
Checked by:	D. Aghjayan			Date: 10/31/17	
Determination No.	1	2	NA	NA	NA
Boring	B101	B101	NA	NA	NA
Sample	S19	S23	NA	NA	NA
Oven ID	Oven #3	Oven #3	NA	NA	NA
Balance ID	1128030399	1128030399	NA	NA	NA
Date/Time in Oven	10/26/17 05:25 PM	10/26/17 05:35 PM	NA	NA	NA
Date/Time Out of Oven	10/27/17 08:30 AM	10/27/17 08:30 AM	NA	NA	NA
Tare No.	D35	U18	NA	NA	NA
[a] Wet Wt. + Tare (gms)	150.13	227.80	NA	NA	NA
[b] Dry Wt. + Tare (gms)	139.81	200.73	NA	NA	NA
[c] Wt. Tare (gms)	40.39	30.47	NA	NA	NA
[d] Wt. Water (gms)	10.32	27.07	NA	NA	NA
Wt. Wet Solids [a - c] (gms)	109.74	197.33	NA	NA	NA
[e] Wt. Dry Solids [b - c] (gms)	99.42	170.26	NA	NA	NA
Water Content [d/e] x 100, %	10.4	15.9	NA	NA	NA
Is Wet Wt. enough for Method B? (yes/no)	Yes	Yes	NA	NA	NA
Remarks:					
Test Notes: 1. Oven dry at 110°C (±5°C) for 12 hours minimum. 2. Cool in desiccator for a minimum of 30 minutes before weighing.					



<b>Water Content Measurement</b>					
Project Name:	Holtec HI-STORE CISF				
GEI Project No.:	1703345				
Perf. by, Per GEI Proc. 101:	M. Hernandez-Cabal			Date: 10/31/17	
Checked by:	D. Aghjayan			Date: 11/8/2017	
Determination No.	1	2	3	4	5
Boring	B108	B101	B102	B102	B102
Sample	S14	S20	S13(5-17")	S14	S15
Oven ID	Oven #3	Oven #3	Oven #3	Oven #3	Oven #3
Balance ID	1128030399	1128030399	1128030399	1128030399	1128030399
Date/Time in Oven	10/31/17 04:55 PM	10/31/17 04:55 PM	10/31/17 04:55 PM	10/31/17 04:55 PM	10/31/17 04:55 PM
Date/Time Out of Oven	11/01/17 08:30 AM	11/01/17 08:30 AM	11/01/17 08:30 AM	11/01/17 08:30 AM	11/01/17 08:30 AM
Tare No.	A7	A9	A5	A31	A12
[a] Wet Wt. + Tare (gms)	116.64	97.93	119.4	105.69	112.5
[b] Dry Wt. + Tare (gms)	112.18	91.68	108.85	99.02	106.52
[c] Wt. Tare (gms)	31.59	31.54	31.31	31.4	31.33
[d] Wt. Water (gms)	4.46	6.25	10.55	6.67	5.98
Wt. Wet Solids [a - c] (gms)	85.05	66.39	88.09	74.29	81.17
[e] Wt. Dry Solids [b - c] (gms)	80.59	60.14	77.54	67.62	75.19
Water Content [d/e] x 100, %	5.5	10.4	13.6	9.9	8.0
Is Wet Wt. enough for Method B? (yes/no)	Yes	Yes	Yes	Yes	Yes
Remarks:					
Test Notes: 1. Oven dry at 110°C (±5°C) for 12 hours minimum. 2. Cool in desiccator for a minimum of 30 minutes before weighing.					

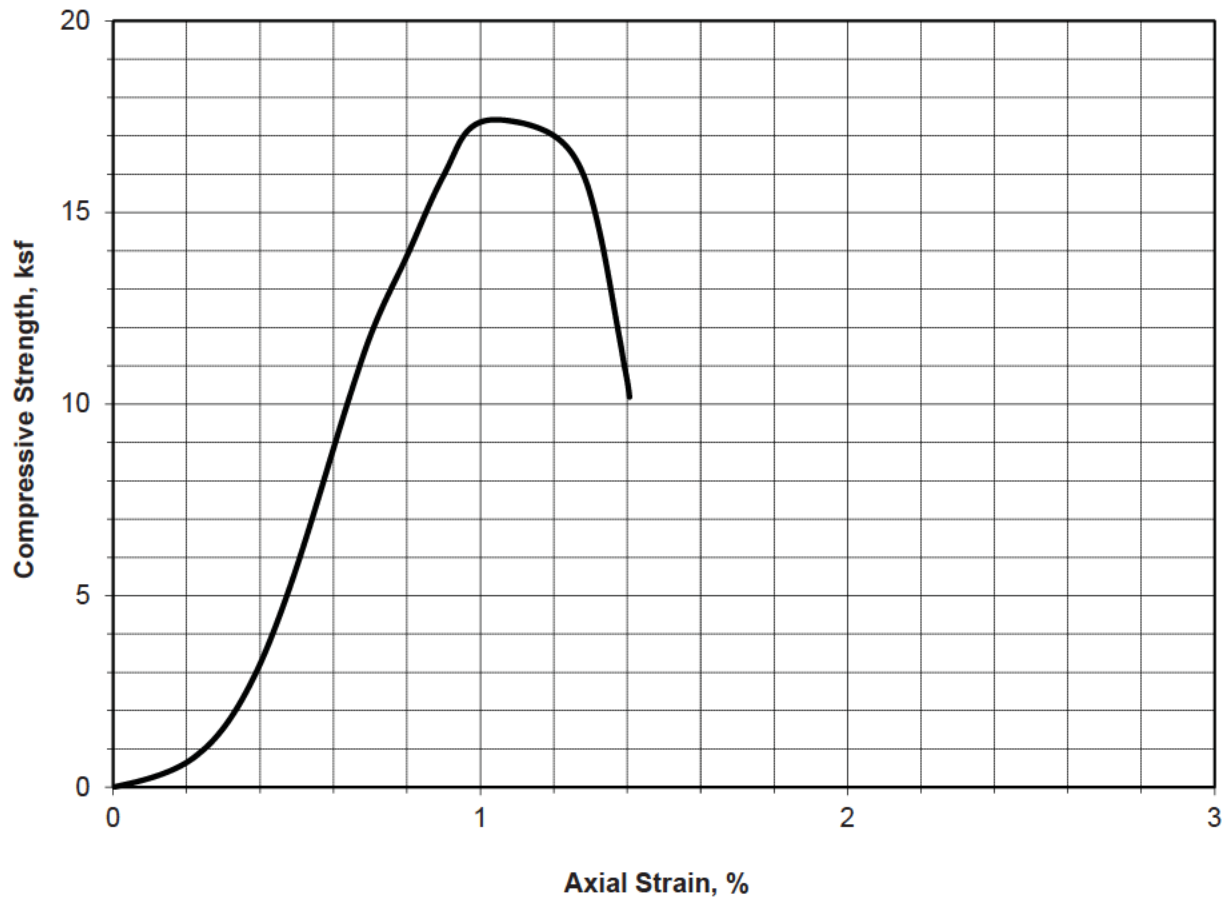
<b>Water Content Measurement</b>					
Project Name:	Holtec HI-STORE CISF				
GEI Project No.:	1703345				
Perf. by, Per GEI Proc. 101:	M. Hernandez-Cabal			Date: 10/31/17	
Checked by:	D. Aghjayan			Date: 11/8/2017	
Determination No.	6	7	8	9	NA
Boring	B102	B105	B105	B105	NA
Sample	S16	S9	S14	S15	NA
Oven ID	Oven #3	Oven #3	Oven #3	Oven #3	NA
Balance ID	1128030399	1128030399	1128030399	1128030399	NA
Date/Time in Oven	10/31/17 05:20 PM	10/31/17 05:20 PM	10/31/17 05:20 PM	10/31/17 05:20 PM	NA
Date/Time Out of Oven	11/01/17 08:30 AM	11/01/17 08:30 AM	11/01/17 08:30 AM	11/01/17 08:30 AM	NA
Tare No.	A-32	A-11	A-30	B-21	NA
[a] Wet Wt. + Tare (gms)	89.95	113.44	100.17	109.94	NA
[b] Dry Wt. + Tare (gms)	82.48	105.02	90.76	99.77	NA
[c] Wt. Tare (gms)	31.34	31.65	30.91	31.94	NA
[d] Wt. Water (gms)	7.47	8.42	9.41	10.17	NA
Wt. Wet Solids [a - c] (gms)	58.61	81.79	69.26	78	NA
[e] Wt. Dry Solids [b - c] (gms)	51.14	73.37	59.85	67.83	NA
Water Content [d/e] x 100, %	14.6	11.5	15.7	15.0	NA
Is Wet Wt. enough for Method B? (yes/no)	Yes	Yes	Yes	Yes	NA
Remarks:					
Test Notes: 1. Oven dry at 110°C (±5°C) for 12 hours minimum. 2. Cool in desiccator for a minimum of 30 minutes before weighing.					

Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

# Attachment I

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## Geotechnical Laboratory Rock Test Data by GEI

**SAMPLE INFORMATION**

Boring: B107  
 Sample: C6  
 Depth (ft): 84-85  
 Elevation: na  
 Type: Rock Core

Description: Severely weathered mudstone

USCS: NA  
 LL = nm, PL = nm, PI = nm

Remarks: Specimen ends capped with plaster of paris.  
 Specimen height and density includes end caps.

**SPECIMEN INFORMATION**

Height: 4.10 inch  
 Diameter: 2.29 inch  
 Area: 4.11 sq in  
 L/D Ratio: 1.79

Water Content: 15.2 %  
 Total Unit Weight: 126.6 pcf  
 Dry Unit Weight: 109.9 pcf

**TEST SUMMARY**

Peak Compressive Strength: 17.35 ksf  
 Peak Shear Strength: 8.68 ksf  
 Axial Strain at Peak Strength: 1.00 %  
 Strain Rate: 0.63 %/min.

Test Date: 10/30/2017  
 Tested By: DJA  
 Checked By: FDL  
 Check Date: 12/1/2017



Failure Sketch

Holtec Hi-Store CISF  
 Site Characterization  
 Lea County, New Mexico

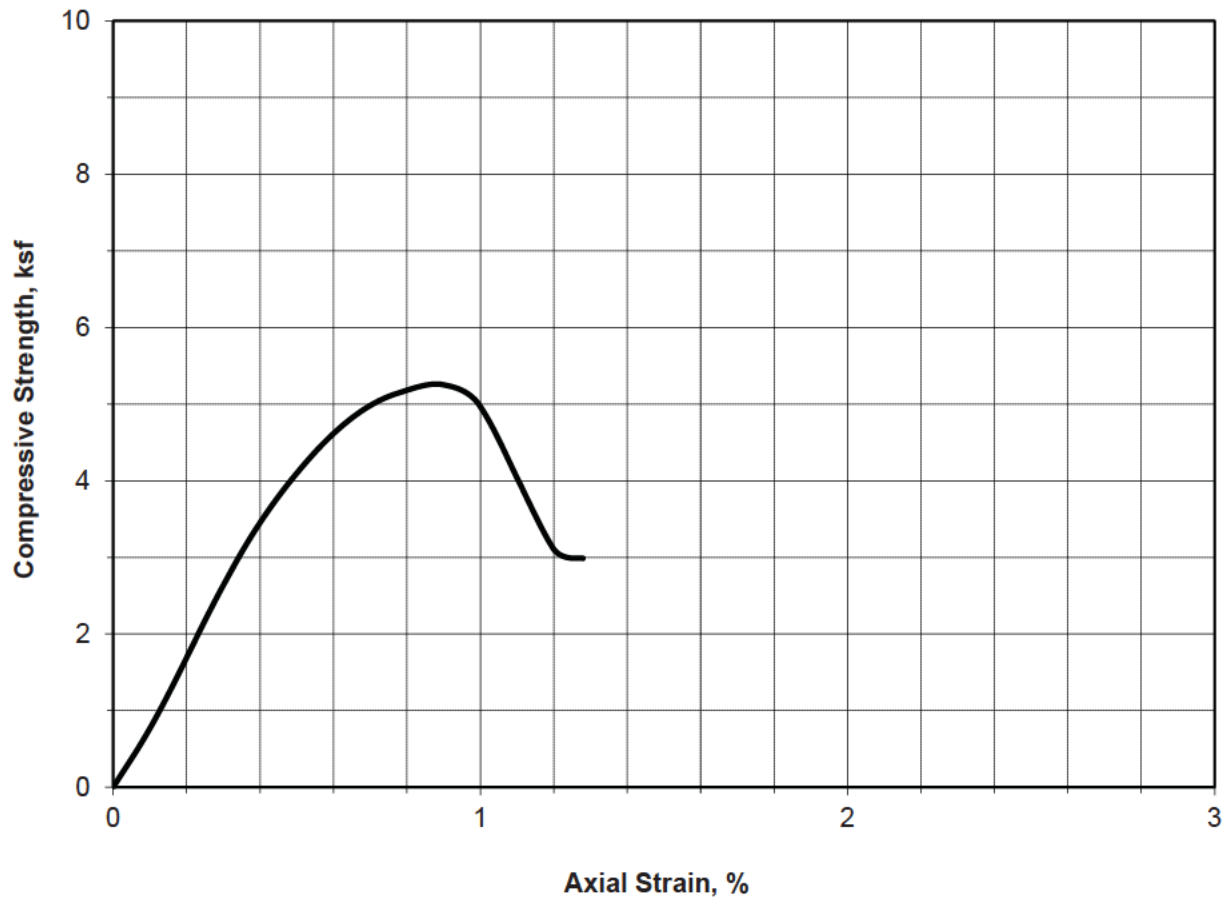
Holtec International  
 Camden, New Jersey



Project 1703345

UNCONFINED COMPRESSION  
 TEST UC-1

Form 238.5 rev. 0

**SAMPLE INFORMATION**

Boring: B107  
 Sample: C6  
 Depth (ft): 84-85  
 Elevation: na  
 Type: Rock Core

Description: Weathered mudstone

USCS: NA  
 LL = nm, PL = nm, PI = nm

Remarks: Specimen ends capped with plaster of paris.  
 Specimen height and density includes end caps.

**SPECIMEN INFORMATION**

Height: 4.89 inch  
 Diameter: 2.46 inch  
 Area: 4.76 sq in  
 L/D Ratio: 1.98

Water Content: 16.8 %  
 Total Unit Weight: 136.9 pcf  
 Dry Unit Weight: 117.2 pcf

**TEST SUMMARY**

Peak Compressive Strength: 5.25 ksf  
 Peak Shear Strength: 2.63 ksf  
 Axial Strain at Peak Strength: 0.90 %  
 Strain Rate: 0.62 %/min.

Test Date: 11/18/2017  
 Tested By: DJA  
 Checked By: FDL  
 Check Date: 12/1/2017



Failure Sketch

Holtec Hi-Store CISF  
 Site Characterization  
 Lea County, New Mexico

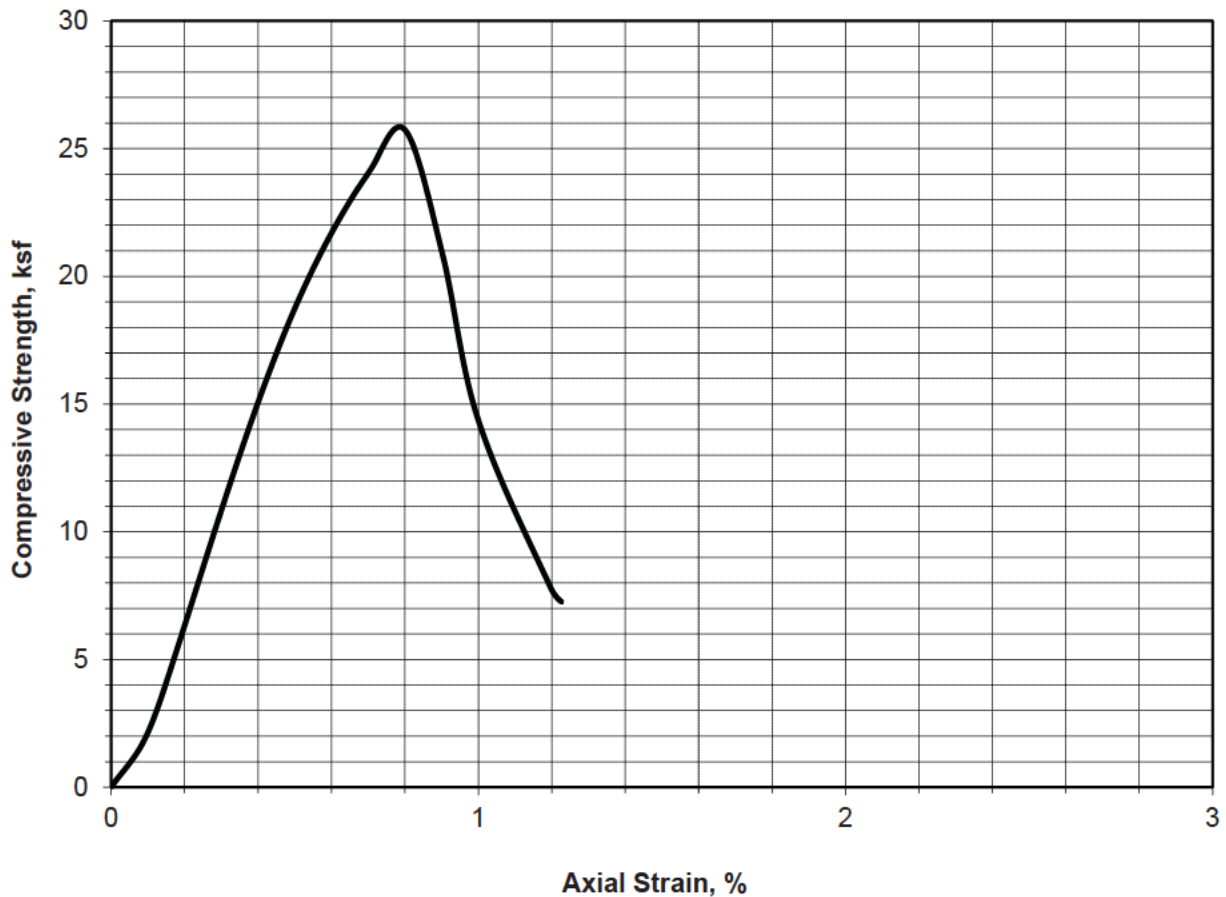
Holtec International  
 Camden, New Jersey



Project 1703345

UNCONFINED COMPRESSION  
 TEST UC-2

Form 238.5 rev. 0

**SAMPLE INFORMATION**

Boring: B107  
 Sample: C4  
 Depth (ft): 73.9-74.6  
 Elevation: na  
 Type: Rock Core

Description: Weathered mudstone

USCS: NA  
 LL = nm, PL = nm, PI = nm

Remarks: Specimen ends capped with plaster of paris.  
 Specimen height and density includes end caps.

**SPECIMEN INFORMATION**

Height: 4.19 inch  
 Diameter: 2.32 inch  
 Area: 4.21 sq in  
 L/D Ratio: 1.81

Water Content: 15.4 %  
 Total Unit Weight: 137.8 pcf  
 Dry Unit Weight: 119.5 pcf

**TEST SUMMARY**

Peak Compressive Strength: 25.74 ksf  
 Peak Shear Strength: 12.87 ksf  
 Axial Strain at Peak Strength: 0.80 %  
 Strain Rate: 0.65 %/min.

Test Date: 11/18/2017  
 Tested By: DJA  
 Checked By: FDL  
 Check Date: 12/1/2017



Failure Sketch

Holtec Hi-Store CISF  
 Site Characterization  
 Lea County, New Mexico

Holtec International  
 Camden, New Jersey



Project 1703345

UNCONFINED COMPRESSION  
 TEST UC-3

Form 238.5 rev. 0


Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment J**

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### **Geotechnical Laboratory Soil Test Data by GeoTesting Express**

**Subcontractor Document Approval**

	Issued for use. Verify Current Revision.
	CIS - GEO 06 - 00

Project Name: HI-STORE CISFProject Location: Lea County, New MexicoGEI Project No.: 1703345Subcontractor: Geotesting Express

Document Title: California Bearing Ratio (ASTM D1883),  
Compaction Reports (ASTM D1557),  
and Particle Size Analysis (ASTM D422)  
for samples:  
B101 and B107 (Composite)  
B105 and B108 (Composite)

**Technical Reviewer**Signature:  Date: 12/1/2017Printed Name: Jay scully

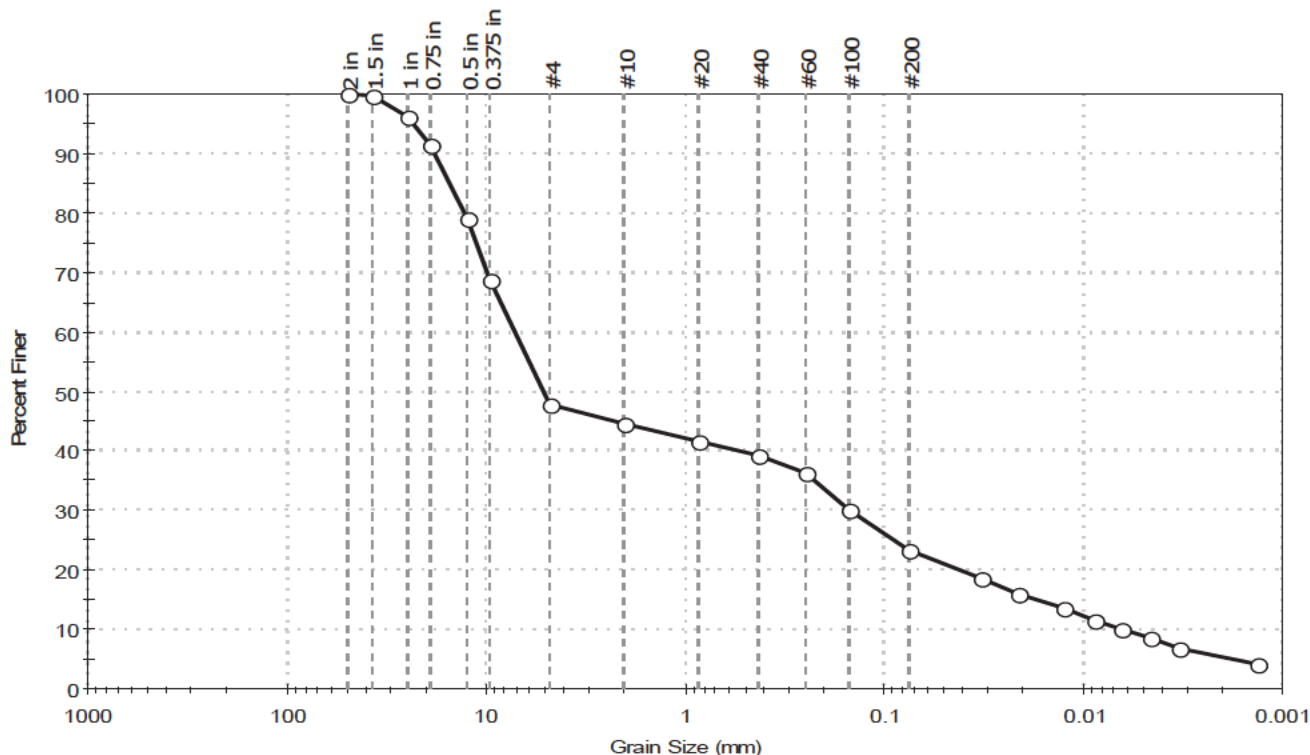
Electronic signature inserted by J. Scully 12/1/2017.

**QA Manager**Signature:  Date: 12/1/2017Printed Name: Leslie Lombardo



Client:	GEI Consultants, Inc.	CIS-GEO 06-00	Page 2
Project:	ATTACHMENT 5 TO HOLTEC LETTER 5025021		
Location:	Lea County, NM	Project No:	GTX-307245
Boring ID:	B101 and B107	Sample Type:	bucket
Sample ID:	G1 Composite	Test Date:	11/10/17
Depth:	---	Test Id:	431699
Test Comment:	Sieves: Coarse Stack 1 & Fine Stack 1, Hydrometer: 264047		
Visual Description:	Moist, very pale brown silty gravel with sand		
Sample Comment:	Scales: 15613366 & 3805414, Oven: B22ER-00159 & B22ER-00105		

## Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	52.3	24.3	23.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	100		
1 in	25.00	96		
0.75 in	19.00	91		
0.5 in	12.50	79		
0.375 in	9.50	69		
#4	4.75	48		
#10	2.00	45		
#20	0.85	42		
#40	0.42	39		
#60	0.25	36		
#100	0.15	30		
#200	0.075	23		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0327	19		
---	0.0214	16		
---	0.0126	14		
---	0.0089	11		
---	0.0064	10		
---	0.0046	8		
---	0.0033	7		
---	0.0013	4		

### Coefficients

D <sub>85</sub> = 15.2716 mm	D <sub>30</sub> = 0.1471 mm
D <sub>60</sub> = 7.1084 mm	D <sub>15</sub> = 0.0172 mm
D <sub>50</sub> = 5.1231 mm	D <sub>10</sub> = 0.0062 mm
C <sub>u</sub> = 1146.516	C <sub>c</sub> = 0.491

### Classification

ASTM N/A

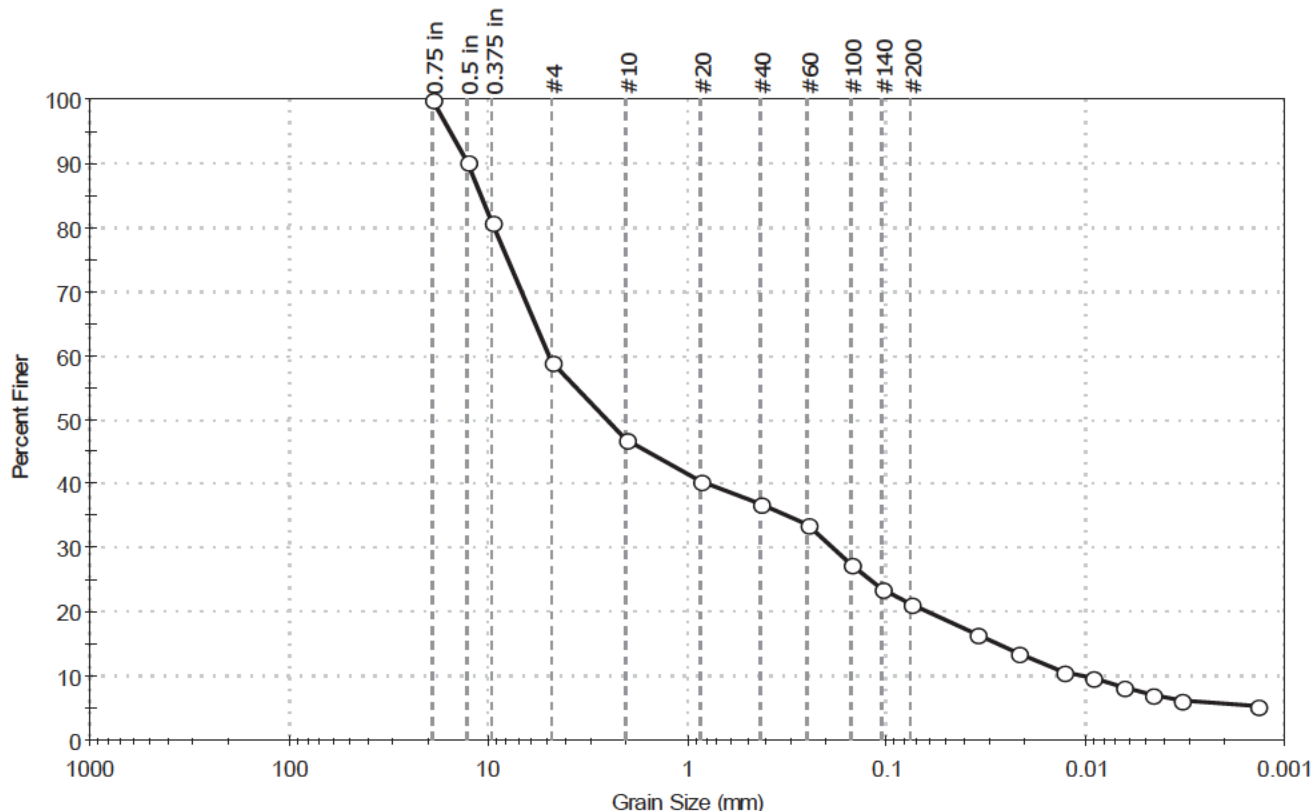
AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

### Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR  
 Sand/Gravel Hardness : HARD  
 Dispersion Device : Apparatus A - Mech Mixer  
 Dispersion Period : 1 minute  
 Specific Gravity : 2.65  
 Separation of Sample: #200 Sieve

Client:	GEI Consultants, Inc.	CIS-GEO 06-00	Page 3
Project:	ATTACHMENT 5 TO HOLTEC LETTER 5025021		
Location:	Lea County, NM	Project No:	GTX-307245
Boring ID:	B101 and B107	Sample Type:	bucket
Sample ID:	G1 Composite (2)	Test Date:	12/01/17
Depth :	---	Test Id:	431700
Test Comment:	Sieves: Coarse Stack 1 & Fine Stack 1 , Hydrometer: 264047		
Visual Description:	Moist, very pale brown silty gravel with sand		
Sample Comment:	Scales: 15613366 & 3805414, Oven: B22ER-00159 & B22ER-00105		

## Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	41.0	37.8	21.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.70	90		
0.375 in	9.50	81		
#4	4.75	59		
#10	2.00	47		
#20	0.85	40		
#40	0.42	37		
#60	0.25	34		
#100	0.15	27		
#140	0.11	24		
#200	0.075	21		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0347	17		
---	0.0215	14		
---	0.0129	11		
---	0.0092	10		
---	0.0065	8		
---	0.0046	7		
---	0.0033	6		
---	0.0014	5		

### Coefficients

D <sub>85</sub> = 10.7850 mm	D <sub>30</sub> = 0.1862 mm
D <sub>60</sub> = 4.9045 mm	D <sub>15</sub> = 0.0269 mm
D <sub>50</sub> = 2.4788 mm	D <sub>10</sub> = 0.0100 mm
C <sub>u</sub> = 490.450	C <sub>c</sub> = 0.707

### Classification

ASTM N/A

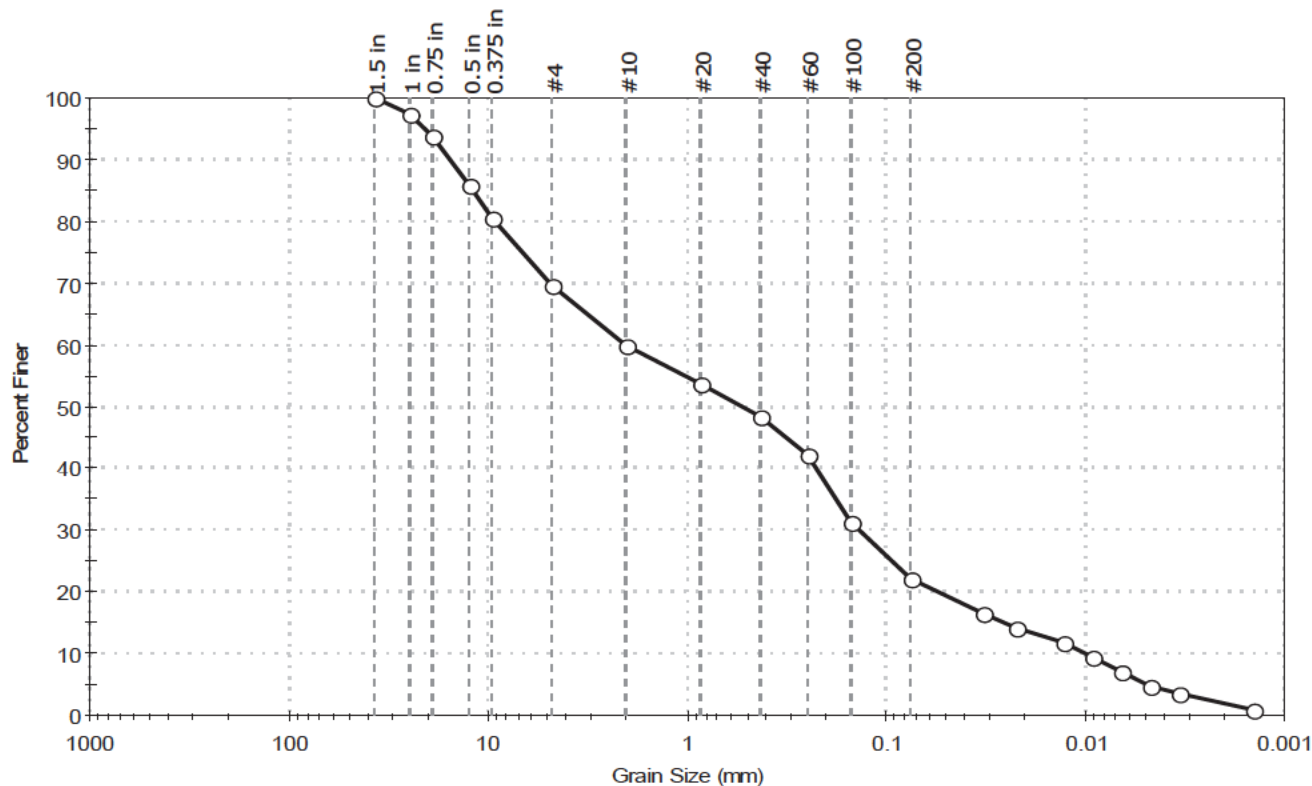
AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

### Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR  
 Sand/Gravel Hardness : HARD  
 Dispersion Device : Apparatus A - Mech Mixer  
 Dispersion Period : 1 minute  
 Specific Gravity : 2.65  
 Separation of Sample: #200 Sieve

Client:	GEI Consultants, Inc.	CIS-GEO 06-00	Page 4
Project:	ATTACHMENT 5 TO HOLTEC LETTER 5025021		
Location:	Lea County, NM	Project No:	GTX-307245
Boring ID:	B105 and B108	Sample Type:	bucket
Sample ID:	G1 Composite	Test Date:	11/13/17
Depth:	---	Test Id:	431698
Test Comment:	Sieves: Coarse Stack 1 & Fine Stack 1 , Hydrometer: 264047		
Visual Description:	Moist, very pale brown silty sand with gravel		
Sample Comment:	Scales: 15613366 & 3805414, Oven: B22ER-00159 & B22ER-00105		

## Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	30.4	47.4	22.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	97		
0.75 in	19.00	94		
0.5 in	12.50	86		
0.375 in	9.50	81		
#4	4.75	70		
#10	2.00	60		
#20	0.85	54		
#40	0.42	48		
#60	0.25	42		
#100	0.15	31		
#200	0.075	22		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0325	16		
---	0.0225	14		
---	0.0130	12		
---	0.0093	9		
---	0.0066	7		
---	0.0047	5		
---	0.0034	4		
---	0.0014	1		

### Coefficients

D <sub>85</sub> = 11.9772 mm	D <sub>30</sub> = 0.1349 mm
D <sub>60</sub> = 2.0062 mm	D <sub>15</sub> = 0.0258 mm
D <sub>50</sub> = 0.5284 mm	D <sub>10</sub> = 0.0101 mm
C <sub>u</sub> = 198.634	C <sub>c</sub> = 0.898

### Classification

ASTM N/A

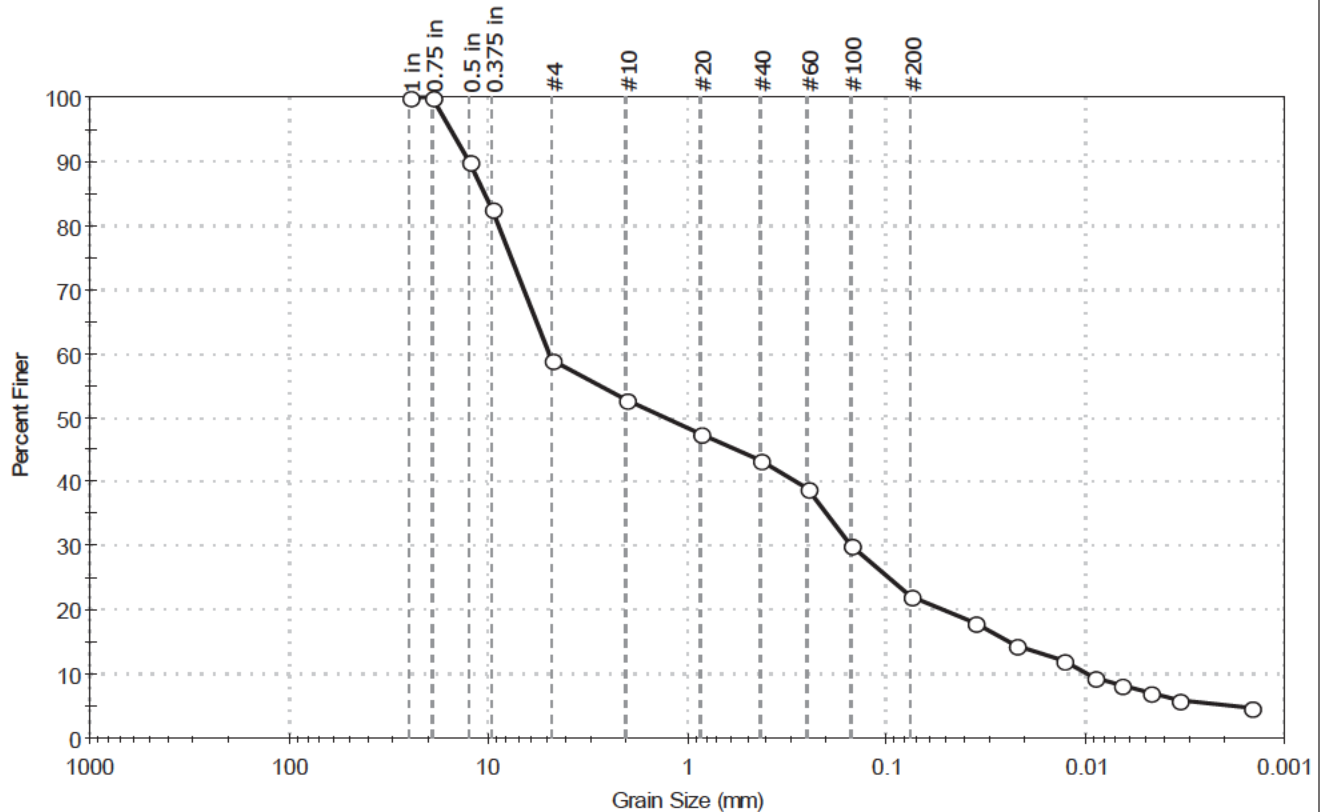
AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

### Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR  
 Sand/Gravel Hardness : HARD  
 Dispersion Device : Apparatus A - Mech Mixer  
 Dispersion Period : 1 minute  
 Specific Gravity : 2.65  
 Separation of Sample: #200 Sieve

Client: GEI Consultants, Inc.	CIS-GEO 06-00 Page 5
Project: ATTACHMENT 5 TO HOLTEC LETTER 5025021	
Location: Lea County, NM	Project No: GTX-307245
Boring ID: B105 and B108	Sample Type: bucket
Sample ID: G1 Composite (2)	Test Date: 12/01/17
Depth: ---	Test Id: 431701
Test Comment: Sieves: Coarse Stack 1 & Fine Stack 1, Hydrometer: 264031	
Visual Description: Moist, very pale brown silty gravel with sand	
Sample Comment: Scales: 15607183 & 3805414, Oven: B22ER-00159 & B22ER-00105	

## Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	41.0	36.9	22.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	100		
0.5 in	12.50	90		
0.375 in	9.50	83		
#4	4.75	59		
#10	2.00	53		
#20	0.85	48		
#40	0.42	43		
#60	0.25	39		
#100	0.15	30		
#200	0.075	22		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0355	18		
---	0.0223	14		
---	0.0129	12		
---	0.0089	10		
---	0.0066	8		
---	0.0047	7		
---	0.0033	6		
---	0.0015	5		

### Coefficients

D <sub>85</sub> = 10.3818 mm	D <sub>30</sub> = 0.1478 mm
D <sub>60</sub> = 4.8828 mm	D <sub>15</sub> = 0.0241 mm
D <sub>50</sub> = 1.2792 mm	D <sub>10</sub> = 0.0096 mm
C <sub>u</sub> = 508.625	C <sub>c</sub> = 0.466

### Classification

ASTM N/A

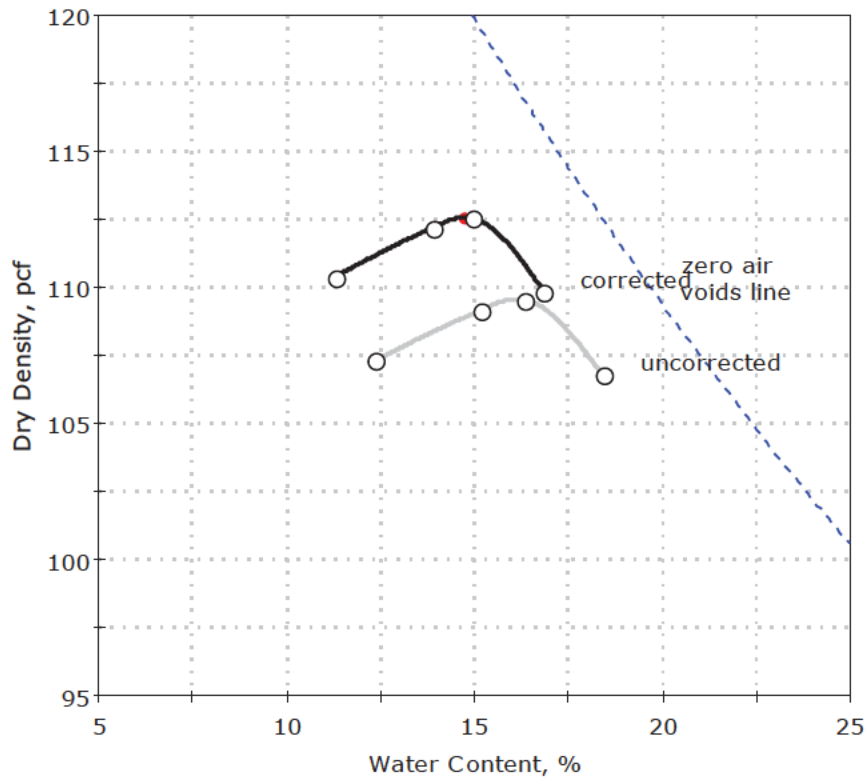
AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

### Sample/Test Description

Sand/Gravel Particle Shape : ---  
 Sand/Gravel Hardness : ---  
 Dispersion Device : Apparatus A - Mech Mixer  
 Dispersion Period : 1 minute  
 Specific Gravity : 2.65  
 Separation of Sample: #200 Sieve

Client:	GEI Consultants, Inc.	CIS-GEO 06-00	Page 6
Project:	ATTACHMENT 5 TO HOLTEC LETTER 5025021		
Location:	Lea County, NM	Project No:	GTX-307245
Boring ID:	B101 and B107	Sample Type:	bucket
Sample ID:	G1 Composite	Test Date:	11/09/17
Depth :	---	Test Id:	431697
Test Comment:	Mold:Equip600, Rammer:MR-01, Comp Mach:M100-212082166		
Visual Description:	Moist, very pale brown silty gravel with sand		
Sample Comment:	Scales:N0105255 & B625645825 , Oven:B22ER-00159		

## Compaction Report - ASTM D1557



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	107.3	109.2	109.5	106.8
Moisture Content, %	12.4	15.2	16.4	18.4

Method : C

Preparation :

As received Moisture : 7 %

Rammer : Mechanical

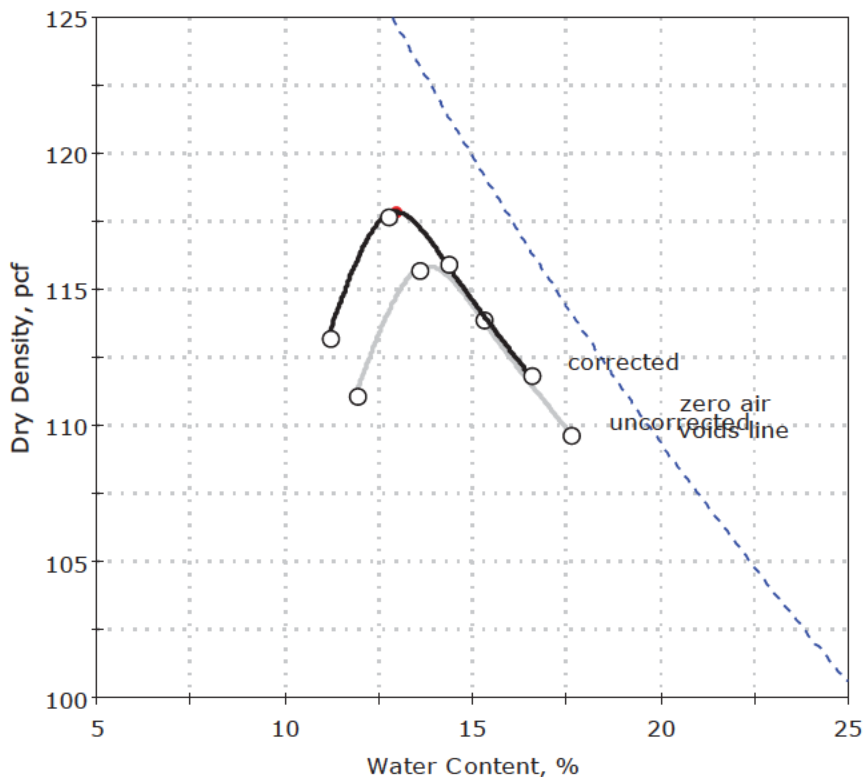
Zero voids line based on assumed specific gravity of 2.70

Maximum Dry Density= 109.6 pcf  
Optimum Moisture= 16.1 %

### Oversize Correction (8.6% > 3/4 inch Sieve)

Corrected Maximum Dry Density= 112.6 pcf  
Corrected Optimum Moisture= 14.7 %  
Assumed Average Bulk Specific Gravity = 2.55

## Compaction Report - ASTM D1557



Data Points	Point 1	Point 2	Point 3	Point 4
Dry density, pcf	111.2	115.8	113.9	109.7
Moisture Content, %	11.9	13.6	15.3	17.6

Method : C

Preparation : DRY

As received Moisture : 5 %

Rammer : Mechanical

Zero voids line based on assumed specific gravity of 2.70

Maximum Dry Density= 115.9 pcf  
Optimum Moisture= 13.8 %

Oversize Correction (6.2% > 3/4 inch Sieve)

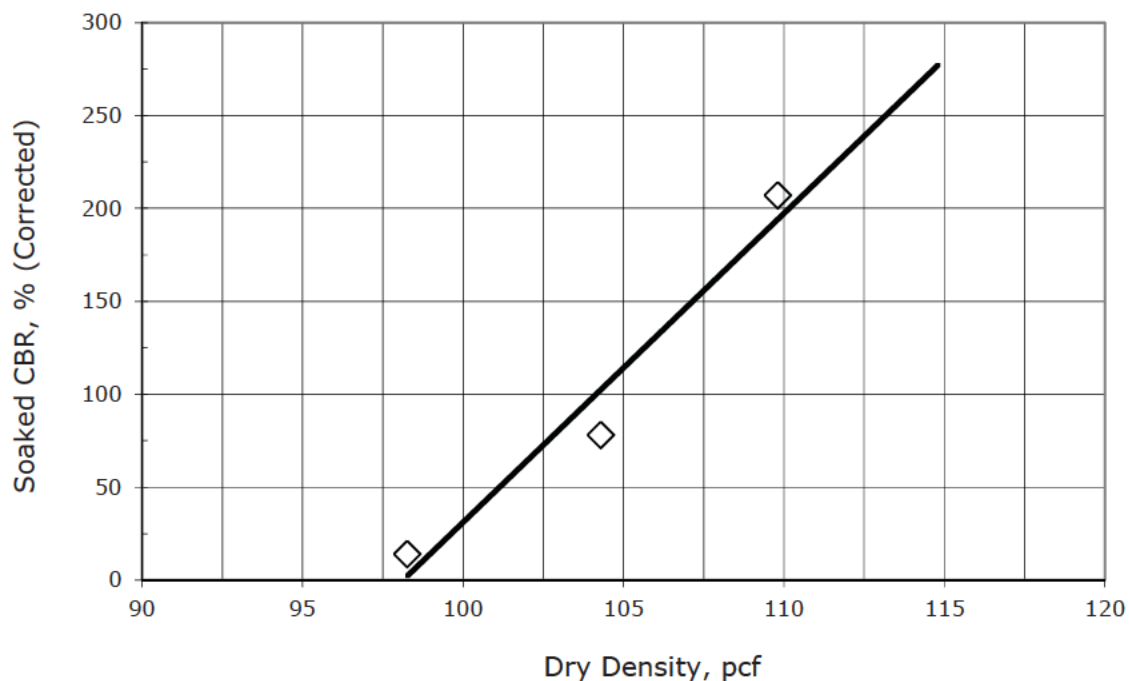
Corrected Maximum Dry Density= 117.9 pcf  
Corrected Optimum Moisture= 12.9 %  
Assumed Average Bulk Specific Gravity = 2.55



Client:	GEI Consultants, Inc.		
Project Name:	HI-STORE CISF		
Project Location:	Lea County, NM		
GTX #:	307245	Tested By:	cwd
Test Date:	07/25/07	Checked By:	emm
Boring ID:	B101 and B107		
Sample ID:	G1 Composite		
Depth, ft.	---		
Description:	Moist, very pale brown silty gravel with sand		
Preparation:	Three test specimens compacted using 10, 25, and 56 blows per layer at the optimum moisture content (14.7%).		
Equipment:	Scales: N0105255 & B625645825 , Oven: B22ER-00159 Molds: CBR-2A, CBR-3, CBR-4		

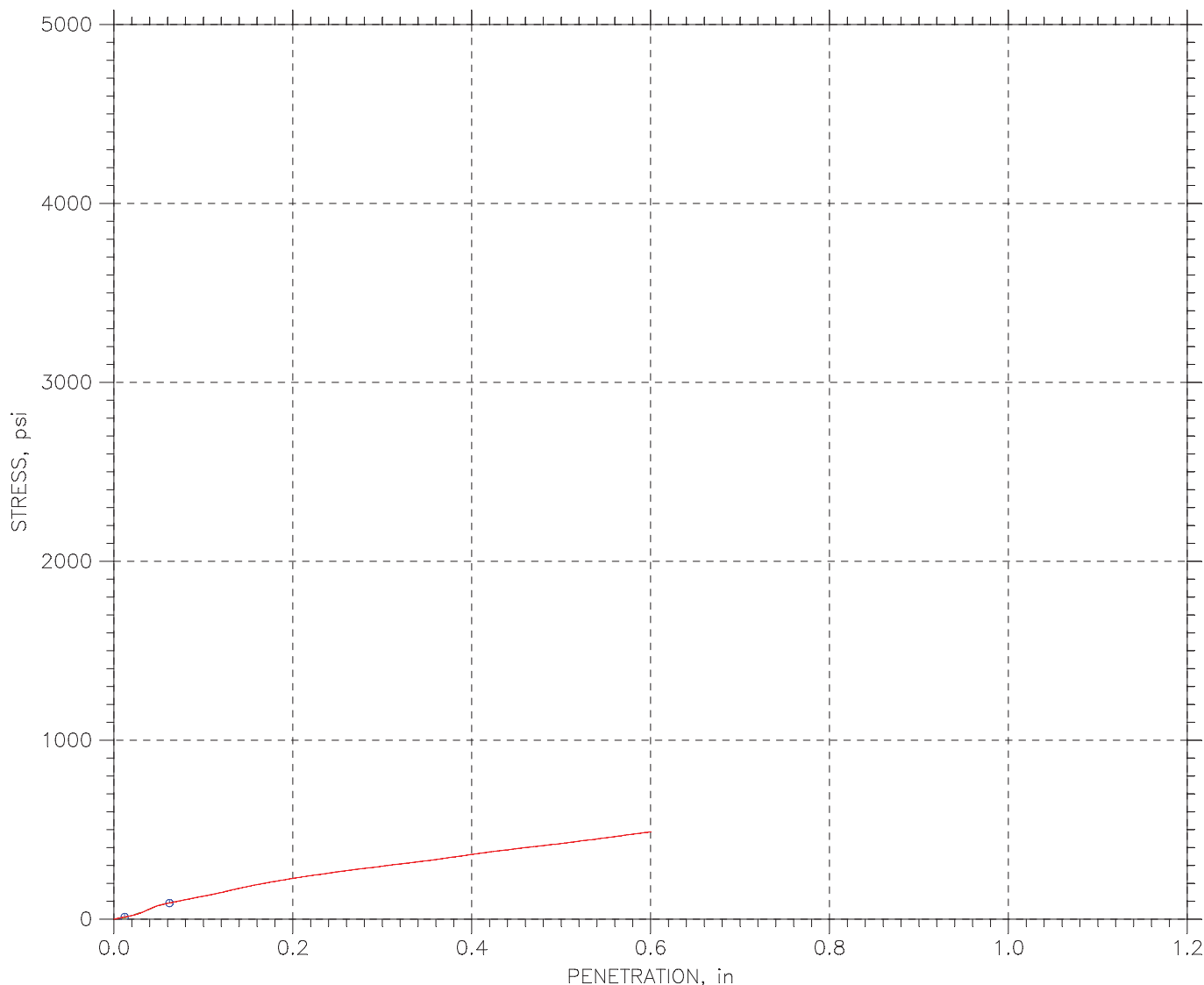
## California Bearing Ratio by ASTM D1883

Dry Density vs. Soaked CBR at 0.1 inches



Comments: See attached CBR test reports for additional sample information  
Plotted CBR values are at 0.1 inch

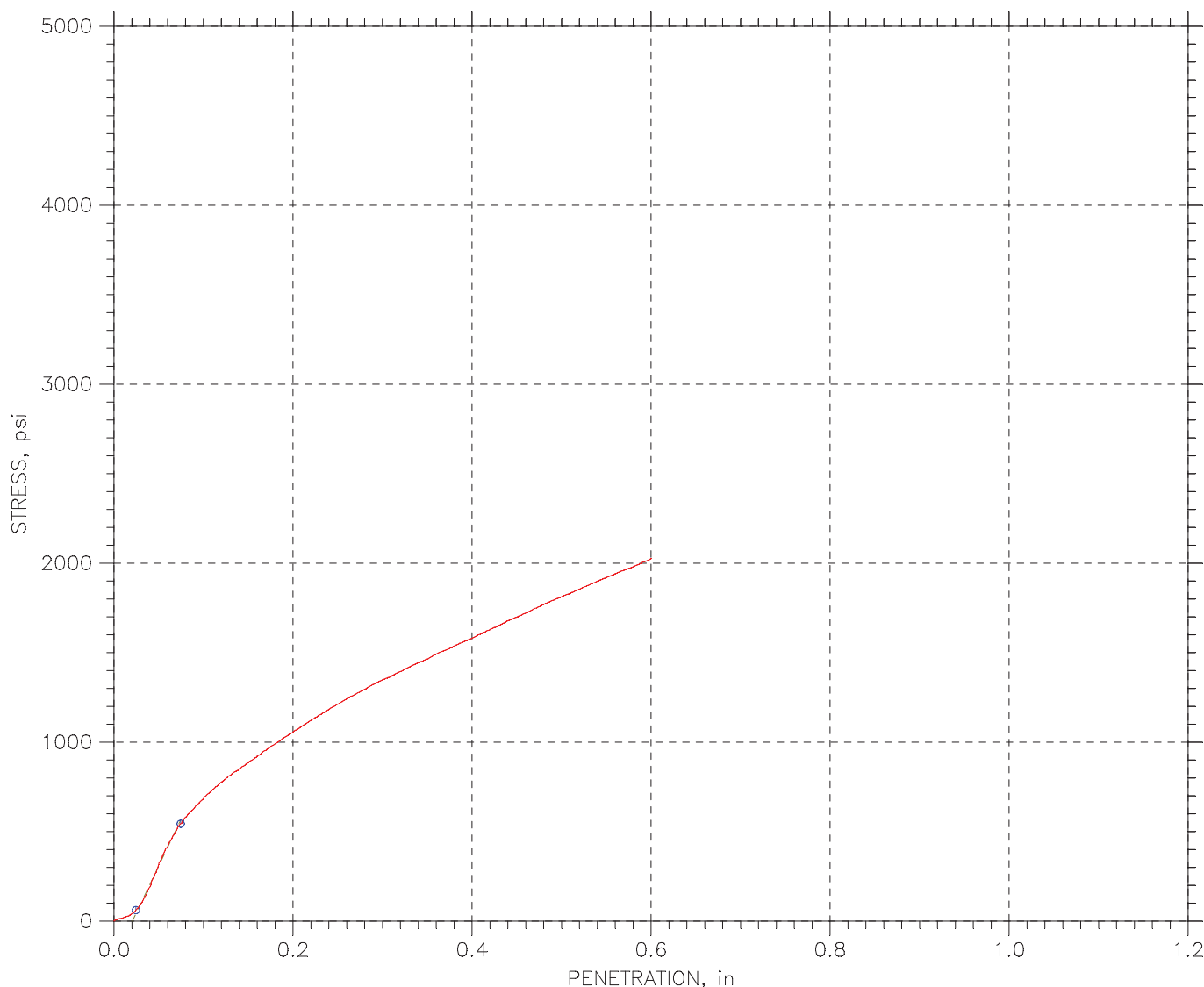
Blows per Layer	Dry Density, pcf	CBR at 0.1 in
10	98.3	14
25	104.3	78
56	109.8	207



Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 14	at 0.3 in: 16	at 0.5 in: 16	
Sample Volume: 0.07494 ft^3	at 0.2 in: 16	at 0.4 in: 16		
Sample Mass: 3839.2 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.22 %	Tare ID	16005	C1502	C1762
Surcharge: 4540 gm	Tare Mass, gm	8.36	7.93	8.25
Void Ratio: 0.68	Mass Tare + Wet Soil, gm	409.75	283.84	369.44
Wet Unit Weight: 112.94 pcf	Mass Tare + Dry Soil, gm	357.59	234.68	304.91
Dry Unit Weight: 98.267 pcf	Water Content, %	14.94	21.68	21.75

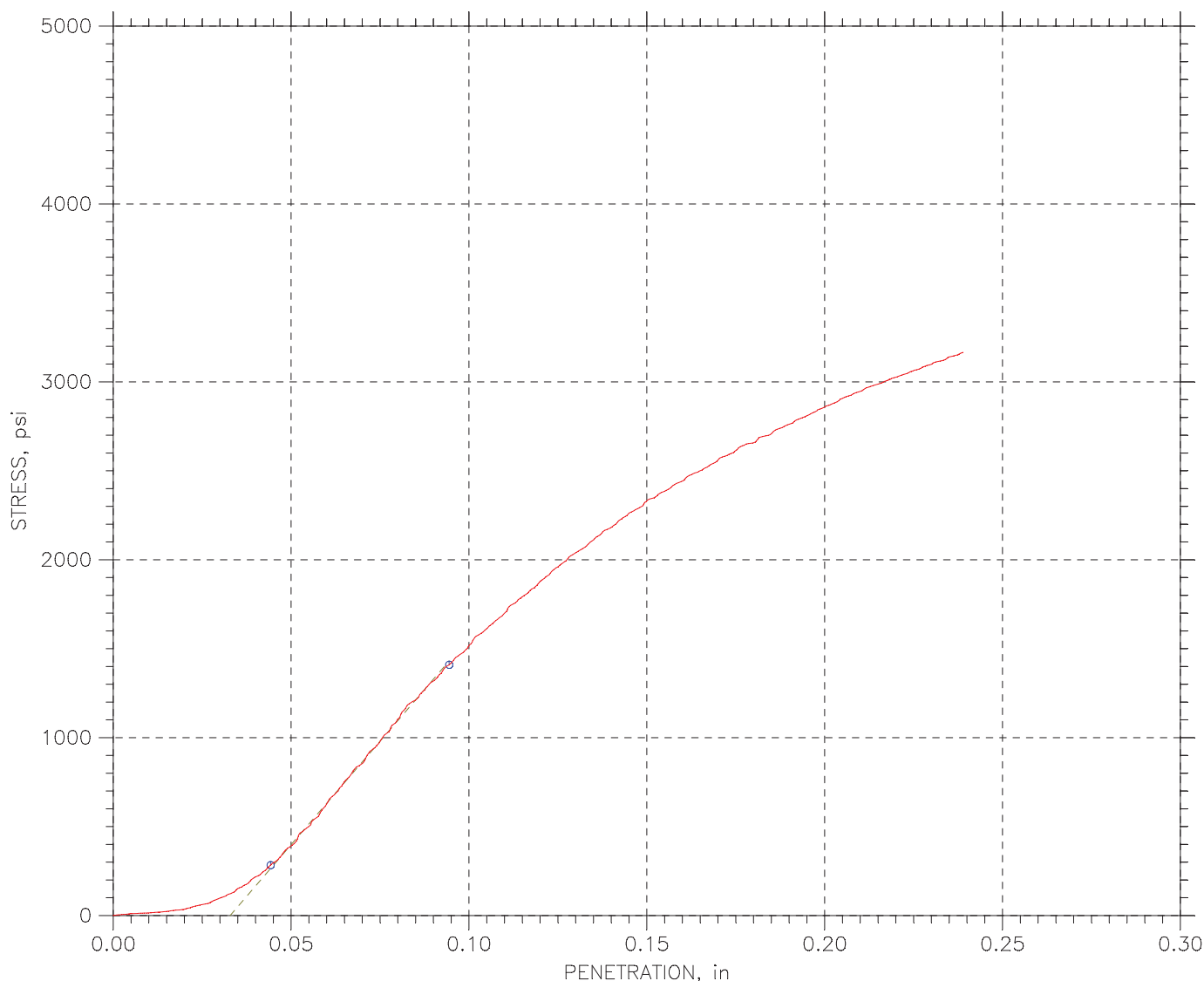
Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B101 & B107	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/17/17	Depth: ---
Test No.: CBR-1	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty gravel with sand		
Remarks: Test specimen compacted with 10 blows per layer at optimum moisture content (14.7%)		
Page 488 of 520		





Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 78	at 0.3 in: 73	at 0.5 in: 71	
Sample Volume: 0.07494 ft^3	at 0.2 in: 75	at 0.4 in: 71		
Sample Mass: 4075 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.24 %	Tare ID	16005	C2003	C2011
Surcharge: 4540 gm	Tare Mass, gm	8.36	8.53	8.45
Void Ratio: 0.59	Mass Tare + Wet Soil, gm	409.75	249.73	371.66
Wet Unit Weight: 119.88 pcf	Mass Tare + Dry Soil, gm	357.59	210.15	312.2
Dry Unit Weight: 104.3 pcf	Water Content, %	14.94	19.63	19.58

Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B101 & B107	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/17/17	Depth: ---
Test No.: CBR-2	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty gravel with sand		
Remarks: Test specimen compacted with 25 blows per layer at optimum moisture content (14.7%)		
Page 489 of 520		



Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 207	at 0.3 in: N/A	at 0.5 in: N/A	
Sample Volume: 0.07494 ft^3	at 0.2 in: 208	at 0.4 in: N/A		
Sample Mass: 4290.1 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.09 %	Tare ID	16005	C1066	C1247
Surcharge: 4540 gm	Tare Mass, gm	8.36	8.28	8.44
Void Ratio: 0.51	Mass Tare + Wet Soil, gm	409.75	245.7	364.84
Wet Unit Weight: 126.21 pcf	Mass Tare + Dry Soil, gm	357.59	209.6	310.75
Dry Unit Weight: 109.81 pcf	Water Content, %	14.94	17.93	17.89

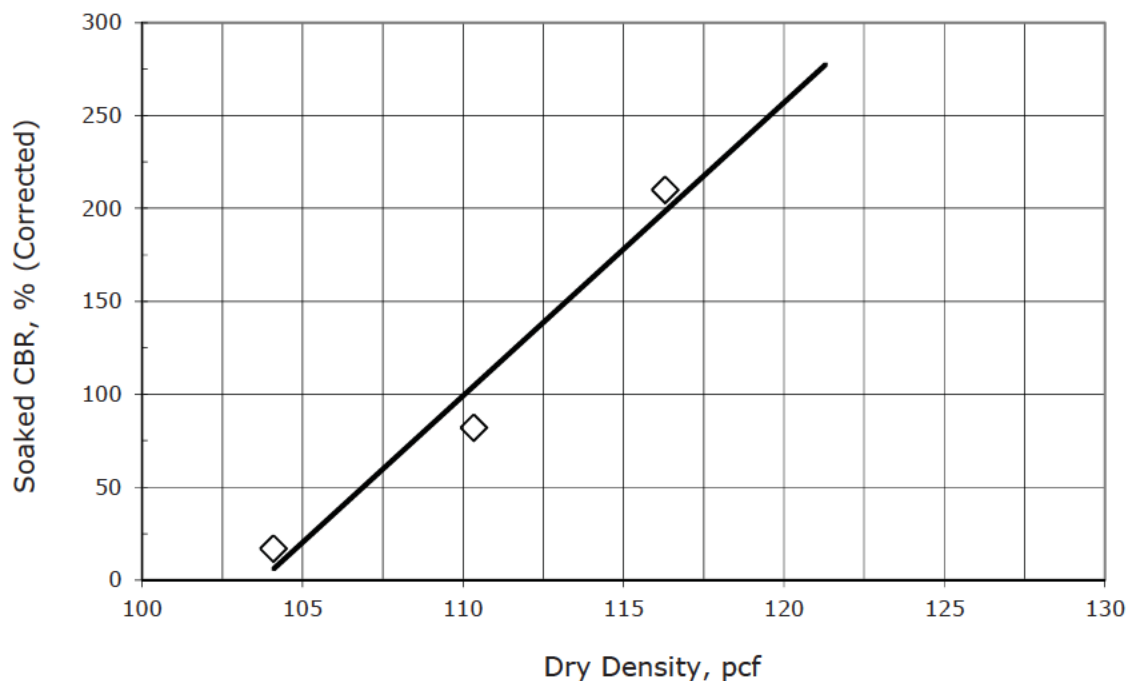
Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B101 & B107	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/17/17	Depth: ---
Test No.: CBR-3	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty gravel with sand		
Remarks: Test specimen compacted with 56 blows per layer at optimum moisture content (14.7%)		
Machine reach maximum load capacity prior to 0.5 inches penetration		



Client:	GEI Consultants, Inc.		
Project Name:	HI-STORE CISF		
Project Location:	Lea County, NM		
GTX #:	307245	Tested By:	cwd
Test Date:	11/21/17	Checked By:	emm
Boring ID:	B105 and B108		
Sample ID:	G1 Composite		
Depth, ft.	---		
Description:	Moist, very pale brown silty sand with gravel		
Preparation:	Three test specimens compacted using 10, 25, and 56 blows per layer at the optimum moisture content (12.9%).		
Equipment:	Scales: N0105255 & B625645825 , Oven: B22ER-00159 Molds: CBR-2A, CBR-3, CBR-4		

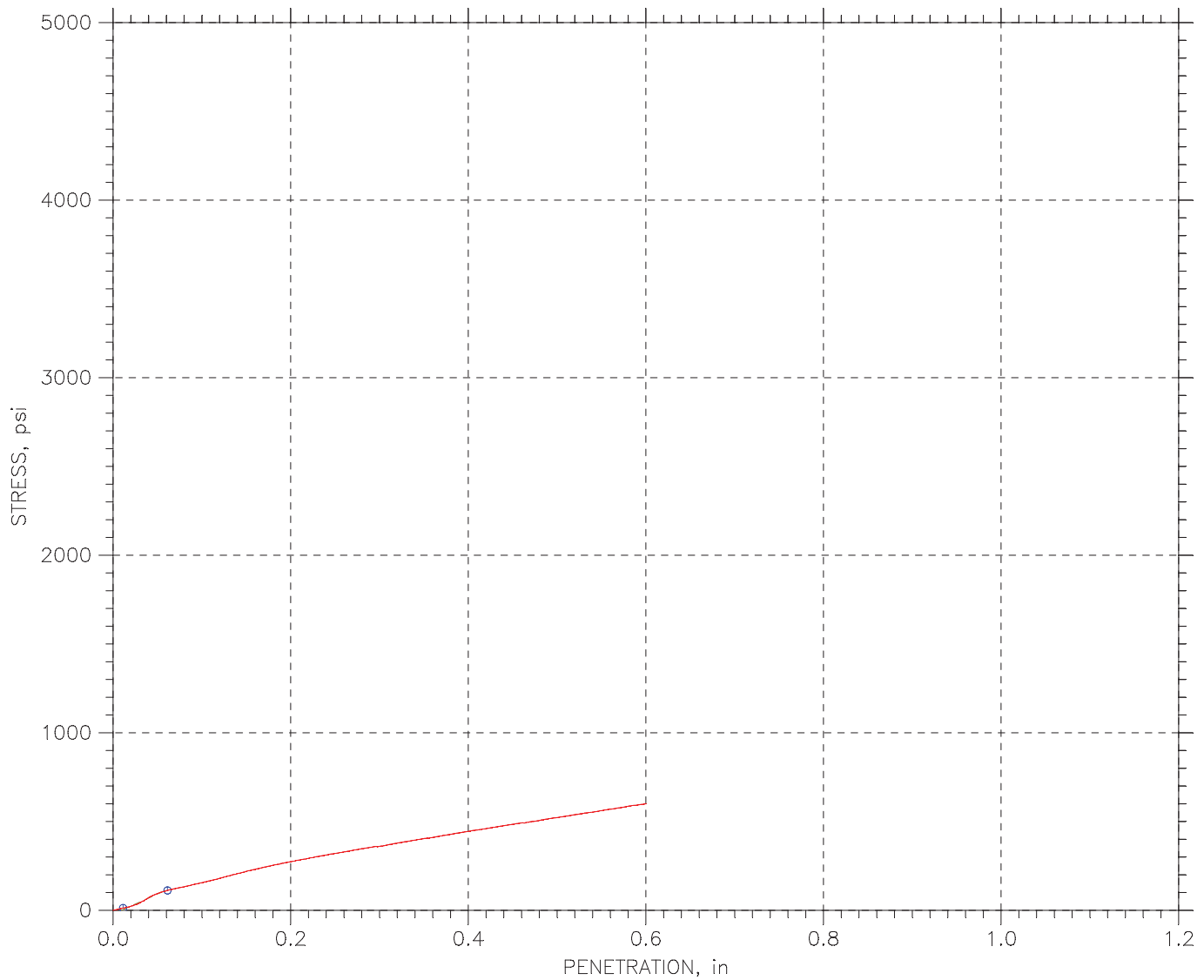
## California Bearing Ratio by ASTM D1883

Dry Density vs. Soaked CBR at 0.1 inches



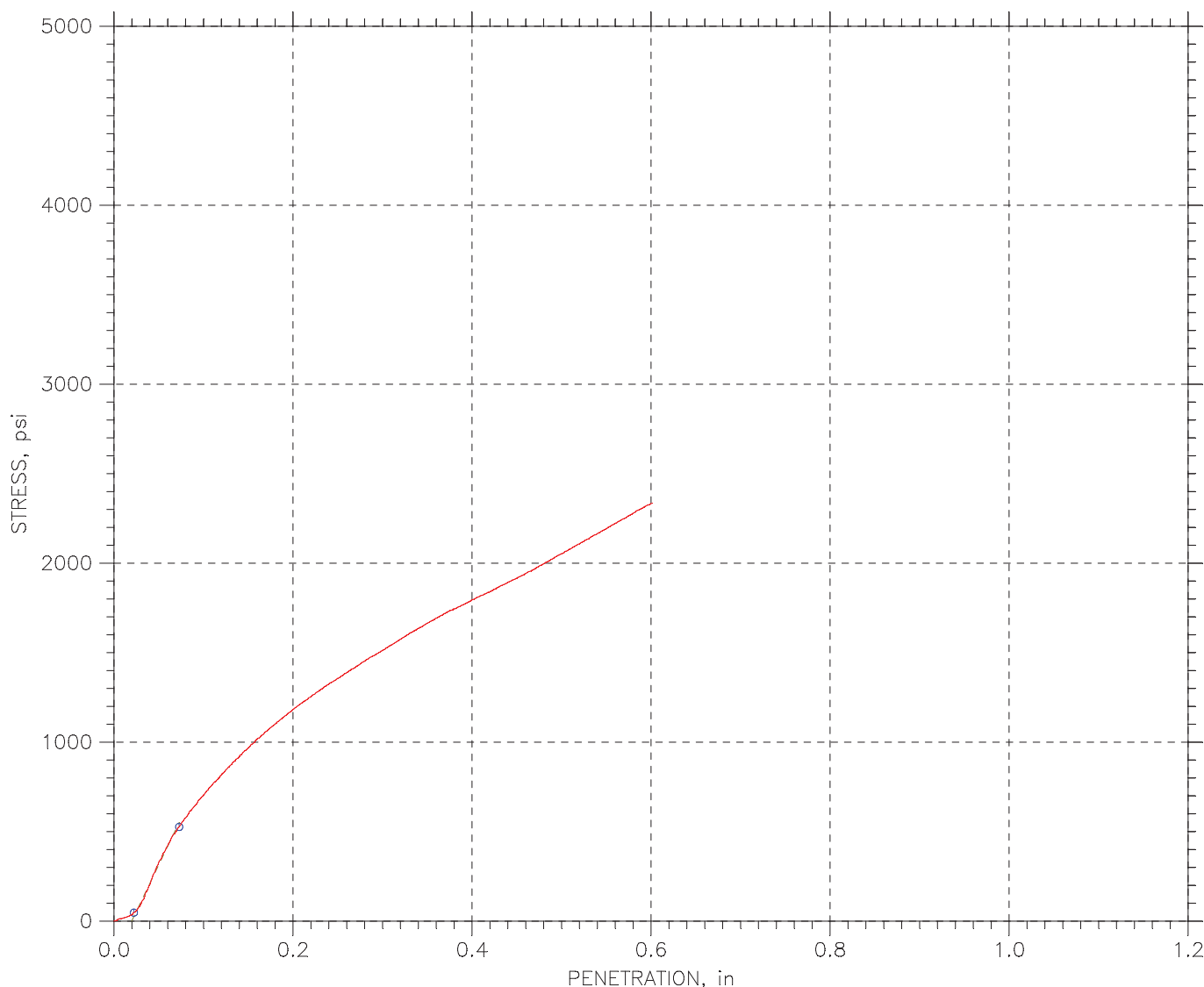
Comments: See attached CBR test reports for additional sample information  
Plotted CBR values are at 0.1 inch

Blows per Layer	Dry Density, pcf	CBR at 0.1 in
10	104.1	17
25	110.3	82
56	116.3	210



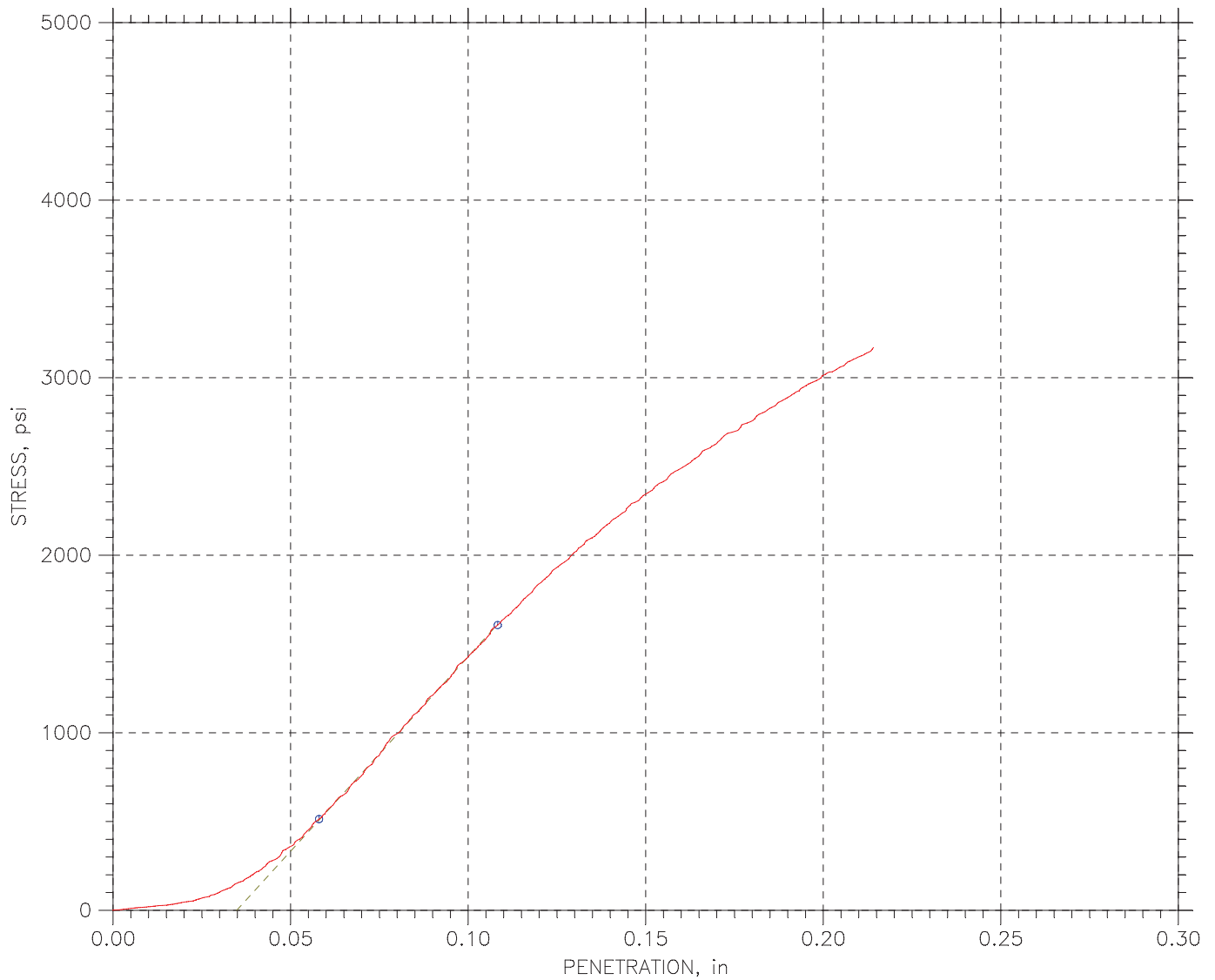
Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 17	at 0.3 in: 19	at 0.5 in: 20	
Sample Volume: 0.07494 ft^3	at 0.2 in: 19	at 0.4 in: 20		
Sample Mass: 3996.7 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.09 %	Tare ID	D1281	9353	C987
Surcharge: 4540 gm	Tare Mass, gm	8.41	8.43	8.51
Void Ratio: 0.59	Mass Tare + Wet Soil, gm	323.78	286.97	339.69
Wet Unit Weight: 117.58 pcf	Mass Tare + Dry Soil, gm	287.64	243.33	288.06
Dry Unit Weight: 104.1 pcf	Water Content, %	12.94	18.58	18.47

Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B105 & B108	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/20/17	Depth: ---
Test No.: CBR-4	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty sand with gravel		
Remarks: Test specimen compacted with 10 blows per layer at optimum moisture content (12.9%)		
Page 492 of 520		



Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 82	at 0.3 in: 83	at 0.5 in: 81	
Sample Volume: 0.07494 ft^3	at 0.2 in: 84	at 0.4 in: 80		
Sample Mass: 4236 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.11 %	Tare ID	D1281	C160	C889
Surcharge: 4540 gm	Tare Mass, gm	8.41	8.25	8.31
Void Ratio: 0.50	Mass Tare + Wet Soil, gm	323.78	293.54	416.8
Wet Unit Weight: 124.62 pcf	Mass Tare + Dry Soil, gm	287.64	253.1	360.54
Dry Unit Weight: 110.34 pcf	Water Content, %	12.94	16.52	15.97

Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B105 & B108	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/20/17	Depth: ---
Test No.: CBR-5	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty sand with gravel		
Remarks: Test specimen compacted with 25 blows per layer at optimum moisture content (12.9%)		
Page 493 of 520		



Sample Height: 4.58 in	California Bearing Ratio			
Sample Area: 28.274 in^2	at 0.1 in: 210	at 0.3 in: N/A	at 0.5 in: N/A	
Sample Volume: 0.07494 ft^3	at 0.2 in: N/A	at 0.4 in: N/A		
Sample Mass: 4465 gm				
Sample Condition: Soaked	Water Content	Before	Top	Average
Swell: 0.04 %	Tare ID	D1281	A442	D1210
Surcharge: 4540 gm	Tare Mass, gm	8.41	8.75	8.56
Void Ratio: 0.42	Mass Tare + Wet Soil, gm	323.78	283.38	404.7
Wet Unit Weight: 131.35 pcf	Mass Tare + Dry Soil, gm	287.64	247.76	355.02
Dry Unit Weight: 116.3 pcf	Water Content, %	12.94	14.90	14.34

Project: HI-STORE CISF	Location: Lea County, NM	Project No.: GTX-307245
Boring No.: B105 & B108	Tested By: cwd	Checked By: emm
Sample No.: G1 Comp.	Test Date: 11/20/17	Depth: ---
Test No.: CBR-6	Sample Type: remolded	Elevation: ---
Description: Moist, very pale brown silty sand with gravel		
Remarks: Test specimen compacted with 56 blows per layer at optimum moisture content (12.9%)		
Machine reach maximum load capacity prior to 0.5 inches penetration		


Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment K**

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### **Geotechnical Laboratory Rock Test Data by GeoTesting Express**

**Subcontractor Document Approval**

	Issued for use. Verify Current Revision.
	CIS - GEO 05 - 00

Project Name: HI-STORE CISF Phase 1 Site CharacterizationProject Location: Lea County, New MexicoGEI Project No.: 1703345Subcontractor: GeoTesting Express

Document Title: Results 11292017 Revised.pdf  
Compressive Strength and Elastic Moduli of Rock (ASTM D7012)  
Submitted on November 30, 2017 (via email)  
Samples:  
B101 C28, B101 C31, B101 C39, B101 C45, B101 C48, B101 C55, and  
B101 C63

**Technical Reviewer**Signature:  Date: 11/30/2017Printed Name: Jay Scully

Electronic signature inserted by J. Scully. 11/30/2017.

**QA Manager**Signature:  Date: 11/30/2017Printed Name: Leslie Lombardo

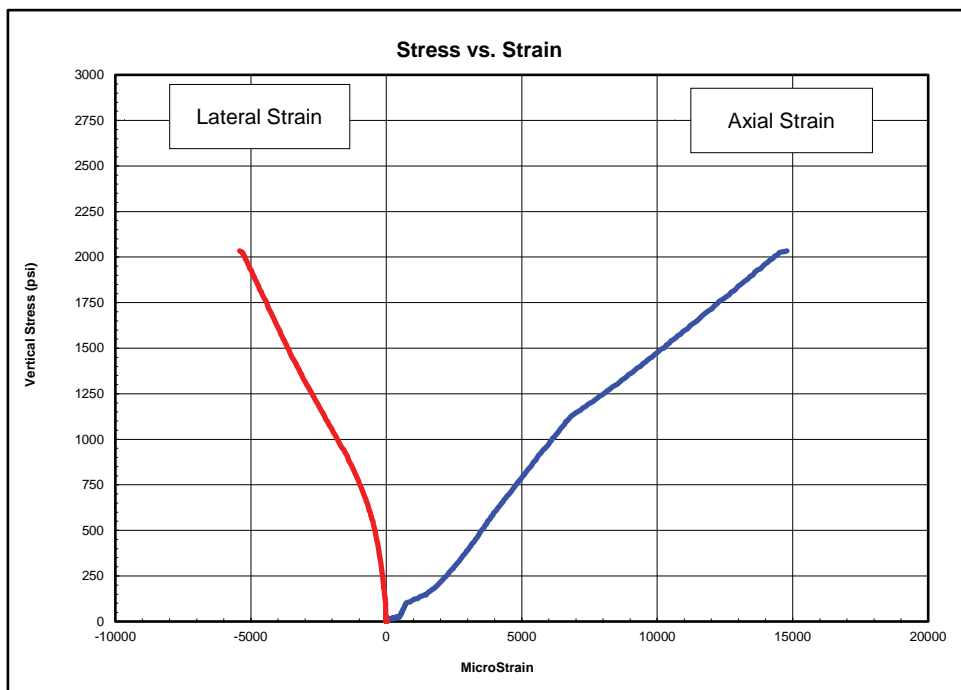
Electronic signature inserted by L. Lombardo 11/30/2017.





Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C28
Depth, ft:	226.25-226.67
Sample Type:	rock core
Sample Description:	See photographs Intact material failure
Equipment:	Compression Machine: 197 Deformation Device: RX2 LVDT's: 171770, 171771, 178883

## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D




Peak Compressive Stress: 2,034 psi

The strain values recorded for this 700-1,300 stress range produced values of Poisson's Ratio that exceed maximum values found in rocks.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
200-700	200,000	0.28
700-1300	160,000	---
1300-1800	120,000	0.39

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.

	Client: GEI Consultants, Inc. Project Name: HI-STORE CISF Project Location: Lea County, NM GTX #: 307245	Test Date: 11/15/2017 Tested By: rlc Checked By: mpd
	Boring ID: B101 Sample ID: C28 Depth: 226.25-226.67 ft Visual Description: See photographs	Caliper: 9047598 Scale: 15606518 Digital Dial Indicator: 61636022 Feeler Gauge: FG-02

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		DEVIATION FROM STRAIGHTNESS (Procedure S1)	
Specimen Length, in:	1	Average	
Specimen Diameter, in:	2	4.96	
Specimen Mass, g:	4.96	2.37	
Bulk Density, lb/ft <sup>3</sup> :	912.81		
Length to Diameter Ratio:	2.1		
Minimum Diameter Tolerance Met? <b>YES</b>		Straightness Tolerance Met? <b>YES</b>	
Length to Diameter Ratio Tolerance Met? <b>YES</b>		Maximum gap between side of core and reference surface plate: Is the maximum gap $\leq 0.02$ in.? <b>YES</b>	
Maximum difference must be $< 0.020$ in.			
END FLATNESS AND PARALLELISM (Procedure FP1)		Flatness Tolerance Met? <b>YES</b>	
END 1			
Diameter 1, in	-0.875	-0.750	0.750
Diameter 2, in (rotated 90°)	0.00050	0.00030	-0.00040
	0.00040	0.00030	0.00020
			0.00000
END 2			
Diameter 1, in	-0.875	-0.750	0.750
Diameter 2, in (rotated 90°)	0.00060	0.00050	-0.00020
	0.00000	-0.00010	0.00000
			0.00030
Difference between max and min readings, in:		90° = 0.00050	
0° = 0.001		90° = 0.0005	
Maximum difference must be $< 0.0020$ in.		Flatness Tolerance Met? <b>YES</b>	
Difference = $\pm 0.00050$			
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00047		0.00041	
0.02693		0.02349	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00009		0.00115	
0.00009		0.00115	
Maximum Angular Difference:		Maximum Angular Difference:	
0.00344		0.00344	
Parallelism Tolerance Met? <b>YES</b>		Parallelism Tolerance Met? <b>YES</b>	
Spherically Seated		Spherically Seated	
DIAMETER 1		DIAMETER 1	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 2		DIAMETER 2	
End 1:		End 1:	
Slope of Best Fit Line		Slope of Best Fit Line	
Angle of Best Fit Line:		Angle of Best Fit Line:	
0.00011		0.00009	
0.00630		0.00516	
DIAMETER 1		DIAMETER 1	
End 2:		End 2:	



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C28
Depth, ft:	226.25-226.67



After cutting and grinding

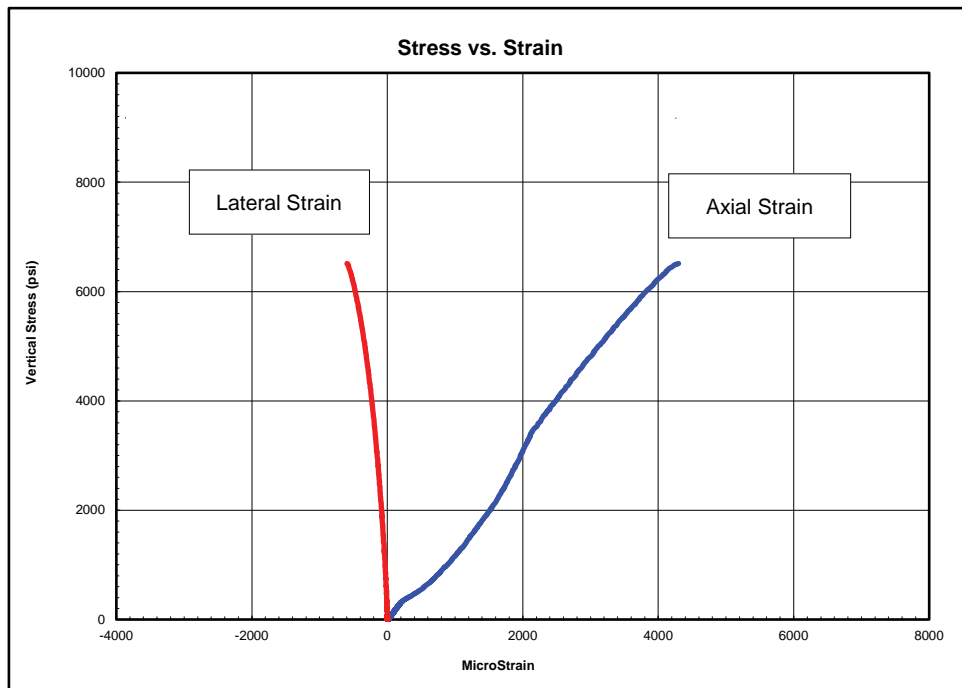


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C31
Depth, ft:	244.50-244.92
Sample Type:	rock core
Sample Description:	See photographs Intact material failure
Equipment:	Compression Machine: 197 Deformation Device: RX2 LVDT's: 171770, 171771, 178883

## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 6,512 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
700-2400	1,580,000	0.08
2400-4200	2,080,000	0.16
4200-5900	1,500,000	0.18

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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END 1					-0.875					-0.750					-0.625					-0.500					-0.375					-0.250					-0.125					0.000					0.125					0.250					0.375					0.500					0.625					0.750					0.875																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Diameter 1, in					0.00030					0.00030					0.00020					0.00010					0.00000					0.00000					0.00000					0.00000					0.00010					0.00010					0.00010					0.00020					0.00020					0.00030					0.00030																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Diameter 2, in (rotated 90°)					-0.00030					-0.00030					-0.00020					-0.00010					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000					0.00000				





Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C31
Depth, ft:	244.50-244.92



After cutting and grinding

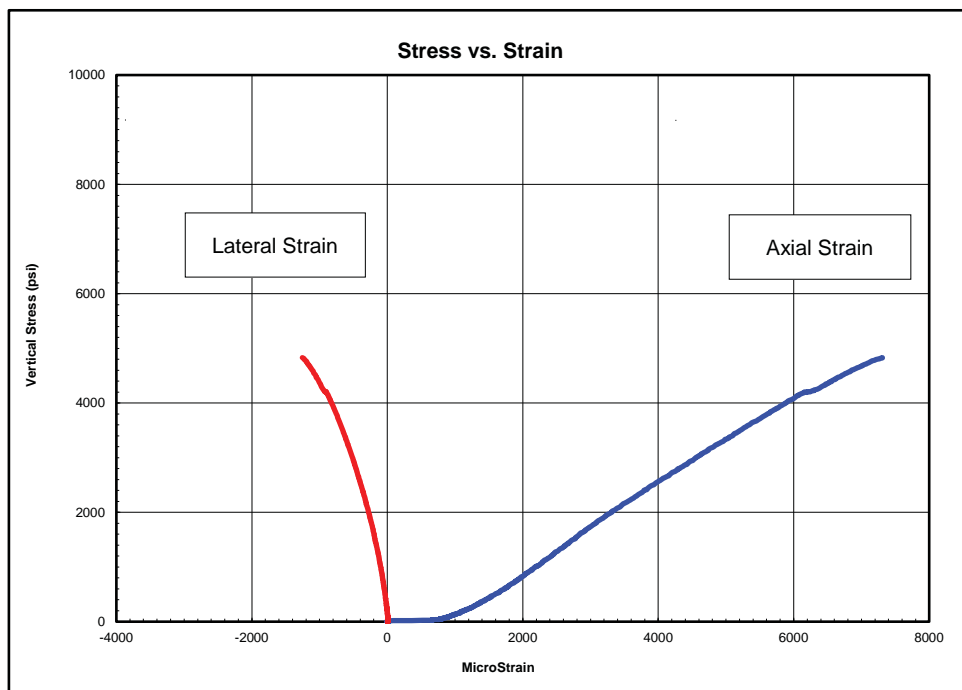


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C39
Depth, ft:	283.36-283.79
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,830 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1800	891,000	0.14
1800-3100	799,000	0.19
3100-4300	719,000	0.25

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.

Client: Project Name: Project Location: GTX #:	GEL Consultants, Inc. HI-STORE CISF Lea County, NM 307245	Test Date: Tested By: Checked By:	11/7/2017 trm/rjc jsc
Boring ID: Sample ID: Depth: Visual Description:	B101 C39 283.36-283.79 ft See photographs	Caliper: Scale: Digital Dial Indicator: Feeler Gauge:	9047598 15606518 61636022 FC-02
		Square: Surface Plate:	#120 Y-42-08



## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY				DEVIATION FROM STRAIGHTNESS (Procedure S1)			
Specimen Length, in:		1	2	Average		Maximum gap between side of core and reference surface plate: Is the maximum gap ≤ 0.02 in.?	
Specimen Diameter, in:		4.94	4.94	4.94		YES	
Specimen Mass, g:		2.38	2.38	2.38			
Bulk Density, lb/ft³		925.8		YES			
Length to Diameter Ratio:		160		YES			
		2.1					
END FLATNESS AND PARALLELISM (Procedure FP1)							
END 1		-0.875	-0.750	-0.500	-0.375	-0.250	-0.125
Diameter 1, in		-0.00050	-0.00050	-0.00030	-0.00020	-0.00010	0.00000
Diameter 2, in (rotated 90°)		-0.00030	-0.00020	0.00000	0.00010	0.00000	0.00000
END 2		-0.875	-0.750	-0.500	-0.375	-0.250	-0.125
Diameter 1, in		-0.00050	-0.00040	-0.00020	-0.00020	0.00000	0.00000
Diameter 2, in (rotated 90°)		0.00020	0.00010	-0.00010	-0.00020	0.00000	0.00010
Flatness Tolerance Met?				Straightness Tolerance Met?			
Maximum difference must be < 0.0020 in.				Maximum difference must be < 0.0020 in.			
0° = 0.0008				90° = 0.0006			
Difference between max and min readings, in:				Difference between max and min readings, in:			
0° = 0.0008				90° = 0.0006			
Maximum difference must be < 0.0020 in.				Maximum difference must be < 0.0020 in.			
Flatness Tolerance Met?				Straightness Tolerance Met?			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00044				0.00044			
0.02521				0.02521			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00042				0.00042			
0.02406				0.02406			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00115				0.00115			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
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0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00028				0.00028			
0.01604				0.01604			
End 2:				End 2:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			
0.00023				0.00023			
0.01318				0.01318			
Maximum Angular Difference:				Maximum Angular Difference:			
0.00286				0.00286			
Parallelism Tolerance Met?				Parallelism Tolerance Met?			
Spherically Seated				Spherically Seated			
YES				YES			
Diameter 1				Diameter 2			
End 1:				End 1:			
Slope of Best Fit Line				Slope of Best Fit Line			
Angle of Best Fit Line:				Angle of Best Fit Line:			





Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C39
Depth, ft:	283.36-283.79



After cutting and grinding

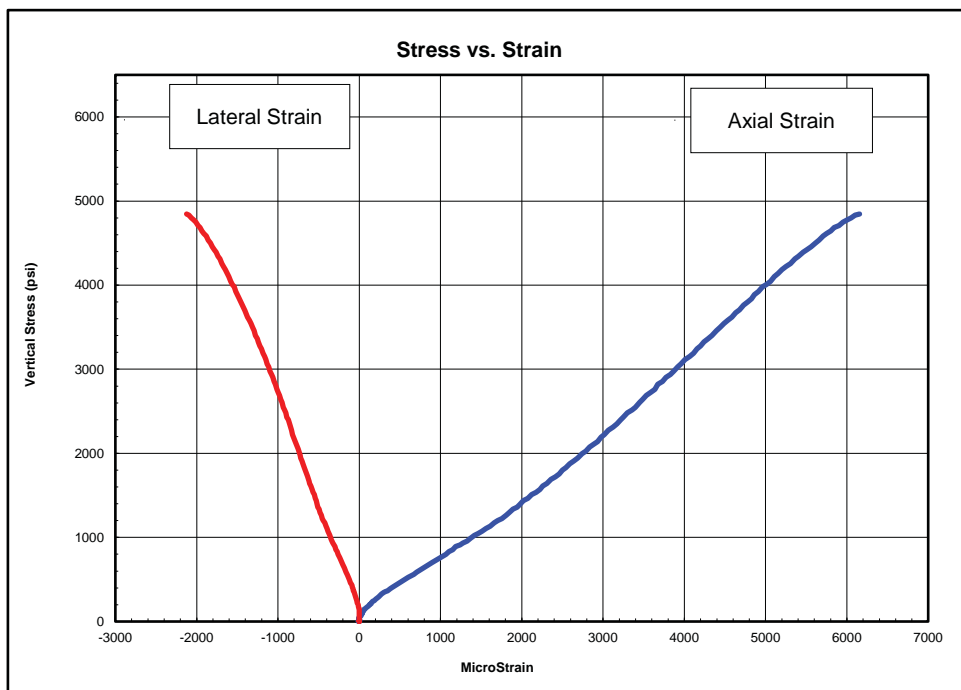


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C45
Depth, ft:	309.80-310.21
Sample Type:	rock core
Sample Description:	See photographs Intact material failure
Equipment:	Compression Machine: 197 Deformation Device: RX2 LVDT's: 171770, 171771, 178883


## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,855 psi

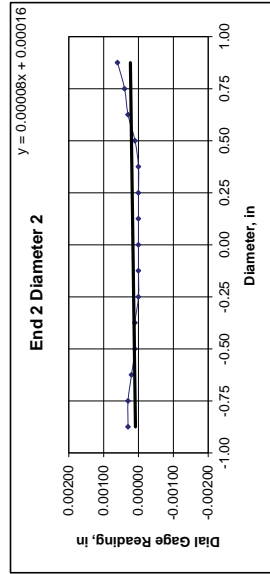
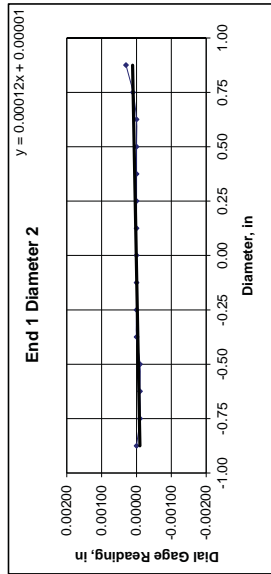
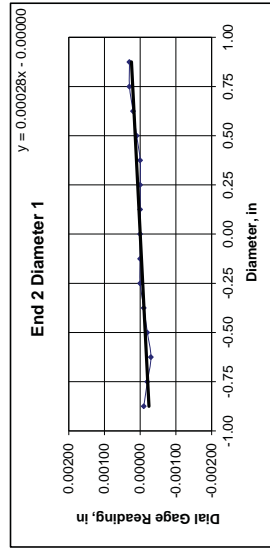
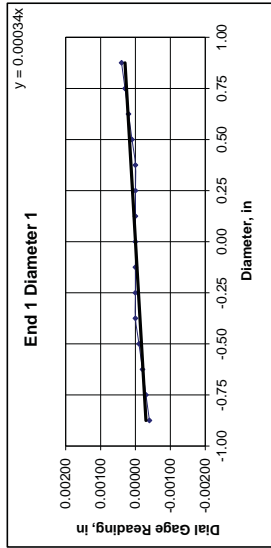
Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1800	660,000	0.28
1800-3100	870,000	0.32
3100-4400	890,000	0.43

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.

	Client: GEI Consultants, Inc.	Test Date: 11/15/2017
	Project Name: HI-STORE CISF	Tested By: rlc
Project Location: Lea County, NM GTX #: 307245	Checked By: mpd	Surface Plate: #120 Y-42-08
	Boring ID: B101	
Sample ID: C45	Scale: 15606518	Surface Plate: #120 Y-42-08
Depth: 309.80-310.21 ft	Digital Dial Indicator: 61636022	
Visual Description: See photographs	Feeler Gauge: FG-02	

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		DEVIATION FROM STRAIGHTNESS (Procedure S1)		Straightness Tolerance Met?	
Specimen Length, in:	4.85	Average			
Specimen Diameter, in:	2.38	4.85			
Specimen Mass, g:	884.12	2.38			
Bulk Density, lb/ft <sup>3</sup> :	156				
Length to Diameter Ratio:	2.0				
END FLATNESS AND PARALLELISM (Procedure FP1)		Minimum Diameter Tolerance Met?		Straightness Tolerance Met?	
END 1					
Diameter 1, in:	-0.875	-0.750	-0.375	-0.250	-0.125
Diameter 2, in (rotated 90°)	-0.00040	-0.00030	-0.00010	0.00000	0.00000
	0.00000	-0.00010	0.00000	0.00000	0.00000
END 2					
Diameter 1, in:	-0.875	-0.750	-0.375	-0.250	-0.125
Diameter 2, in (rotated 90°)	-0.00010	-0.00020	-0.00010	0.00000	0.00000
	0.00030	0.00020	0.00010	0.00000	0.00000
Flatness Tolerance Met?		Flatness Tolerance Met?		Flatness Tolerance Met?	
YES		YES		YES	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		Parallelism Tolerance Met?	
Spherically Seated		Spherically Seated		Spherically Seated	
YES		YES		YES	
Perpendicularity Tolerance Met?		Perpendicularity Tolerance Met?		Perpendicularity Tolerance Met?	
Maximum angle of departure must be ≤ 0.25°		Maximum angle of departure must be ≤ 0.25°		Maximum angle of departure must be ≤ 0.25°	
YES		YES		YES	





Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C45
Depth, ft:	309.80-310.21



After cutting and grinding

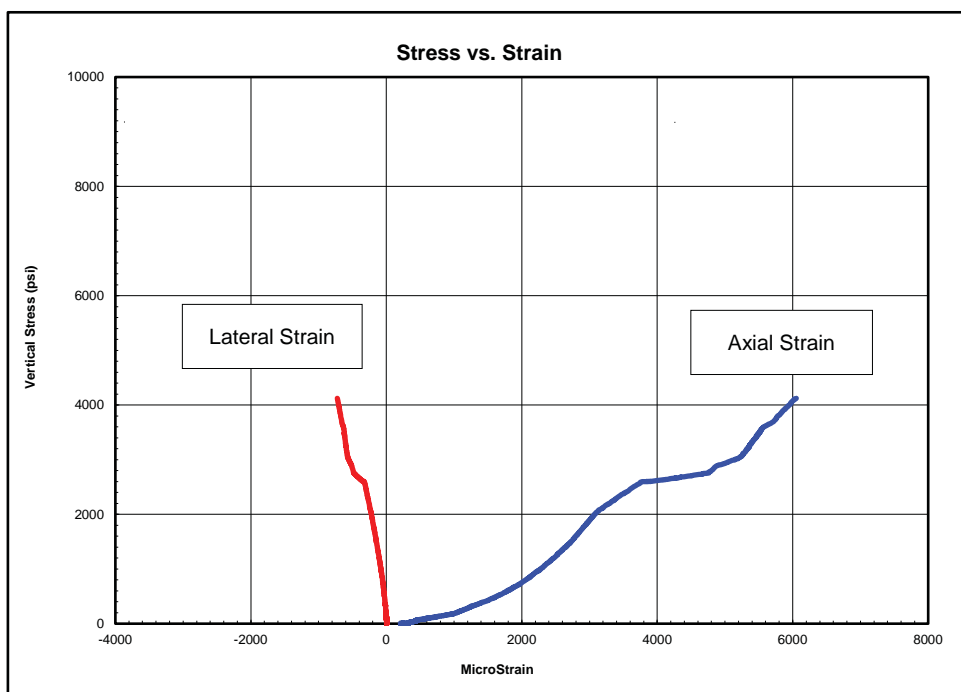


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C48
Depth, ft:	324.49-325.90
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,123 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
400-1500	865,000	0.10
1500-2600	1,040,000	0.17
2600-3700	564,000	0.17

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.



<div><div>GeoTesting</div><div>EXPRESS</div></div>		Client: GEI Consultants, Inc. Project Name: HI-STORE C1SF Project Location: Lea County, NM GTX #: 307245		Test Date: 11/7/2017 Tested By: trm/rjc Checked By: Jsc		Square: #120 Surface Plate: Y-42-08	
Boring ID: B101 Sample ID: C48 Depth: 324.49-325.90 ft Visual Description: See photographs		Calliper: 9047598 Scale: 15606518 Digital Dial Indicator: 61636022 Feeler Gauge: FG-02					
UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543							
BULK DENSITY							
1		2		Average			
Specimen Length, in: 4.84		2.37		4.84			
Specimen Diameter, in: 2.37		2.37		2.37			
Specimen Mass, g: 916.91							
Bulk Density, lb/ft³: 163							
Length to Diameter Ratio: 2.0							
Minimum Diameter Tolerance Met?		YES					
Length to Diameter Ratio Tolerance Met?		YES					
DEVIATION FROM STRAIGHTNESS (Procedure S1)							
Maximum gap between side of core and reference surface plate: Is the maximum gap ≤ 0.02 in.?				YES			
Maximum difference must be < 0.020 in.				Straightness Tolerance Met?			
				YES			
END FLATNESS AND PARALLELISM (Procedure FP1)							
END 1		END 2		0° = 0.00040		90° = 0.00040	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)		Diameter 2, in (rotated 90°)	
Diameter 1, in		Diameter 1, in		Diameter 1, in		Diameter 1, in	
Diameter 2, in (rotated 90°)							



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/14/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	B101
Sample ID:	C48
Depth, ft:	324.49-325.90



After cutting and grinding

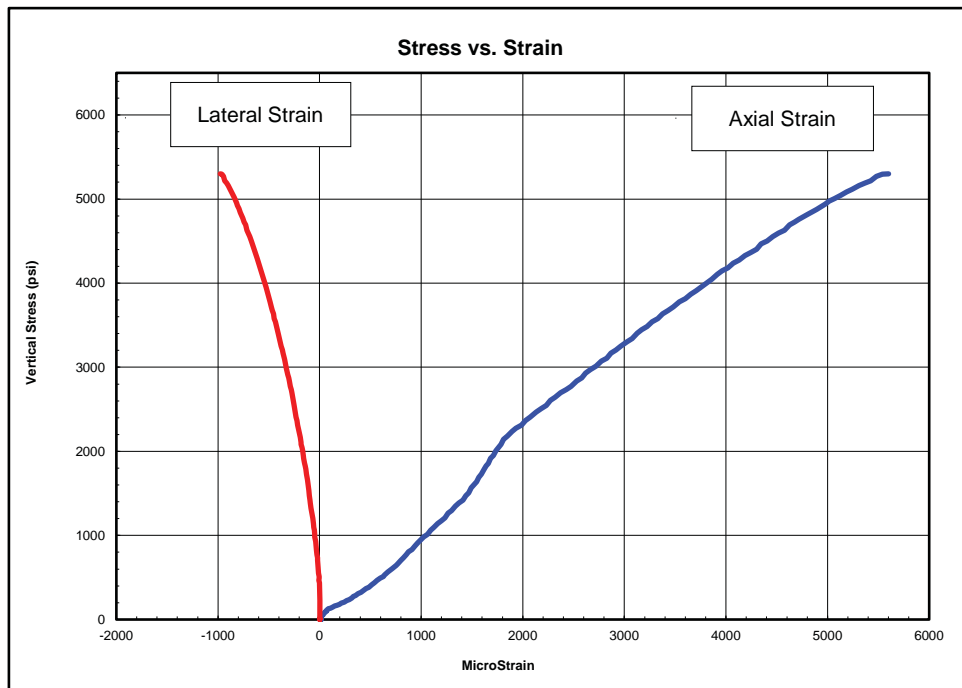


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C55
Depth, ft:	360.72-361.14
Sample Type:	rock core
Sample Description:	See photographs Intact material failure
Equipment:	Compression Machine: 197 Deformation Device: RX2 LVDT's: 171770, 171771, 178883

## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D




Peak Compressive Stress: 5,319 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1900	1,260,000	0.13
1900-3400	990,000	0.17
3400-4800	850,000	0.22

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.



	Client: GEL Consultants, Inc.	Test Date: 11/15/2017
	Project Name: HI-STORE CISF	Tested By: rlc
GTX #:	Project Location: Lea County, NM	Checked By: mpd
	307245	
Boring ID: B101	Scale: 9047598	Surface: #120
Sample ID: C55	Scale: 15606518	Surface Plate: Y-42-08
Depth: 360.72-361.14 ft	Digital Dial Indicator: 61636022	
Visual Description: See photographs	Feeler Gauge: FG-02	

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY				DEVIATION FROM STRAIGHTNESS (Procedure S1)												
Specimen Length, in:		1	Average	Maximum gap between side of core and reference surface plate: Is the maximum gap $\leq 0.02$ in? YES												
Specimen Diameter, in:		2	4.84													
Specimen Mass, g:		2.39	2.39													
Bulk Density, lb/ft <sup>3</sup> :		892.25														
Length to Diameter Ratio:		157														
		2.0														
END FLATNESS AND PARALLELISM (Procedure FP1)																
END 1		-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in		0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	0.00000	-0.00010	-0.00010
Diameter 2, in (rotated 90°)		-0.00020	-0.00020	-0.00010	0.00000	-0.00010	-0.00020	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	0.00000	-0.00010
END 2		-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in		-0.00010	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00000	0.00000	-0.00020
Diameter 2, in (rotated 90°)		0.00020	0.00010	0.00000	0.00000	0.00010	0.00000	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010
</																



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C55
Depth, ft:	360.72-361.14



After cutting and grinding

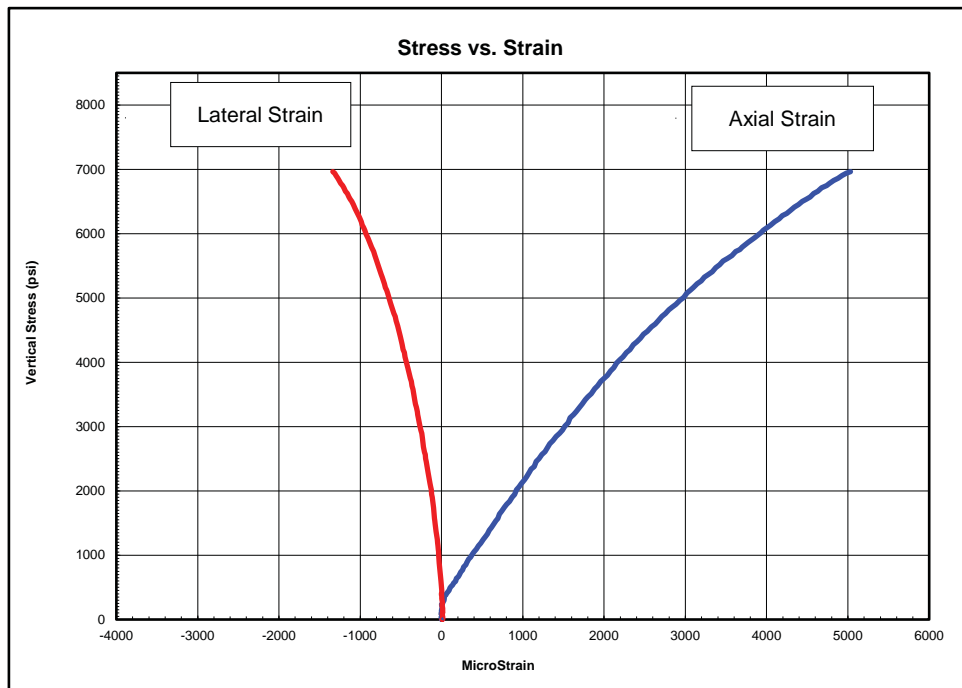


After break



Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C63
Depth, ft:	399.83-400.25
Sample Type:	rock core
Sample Description:	See photographs Intact material failure
Equipment:	Compression Machine: 197 Deformation Device: RX2 LVDT's: 171770, 171771, 178883


## Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 6,967 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
700-2600	1,830,000	0.18
2600-4400	1,510,000	0.25
4400-6300	1,080,000	0.30

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.  
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.  
Calculations assume samples are isotropic, which is not necessarily the case.

	Client: GEL Consultants, Inc.	Test Date: 11/15/2017
	Project Name: HI-STORE CISF	Tested By: rlc
Project Location: Lea County, NM GTX #: 307245	Checked By: mpd	
Boring ID: B101	Caliper: 9047598	Square: #120
Sample ID: C63	Scale: 15606518	Surface Plate: Y-42-08
Depth: 399.83-400.25 ft	Digital Dial Indicator: 61636022	
Visual Description: See photographs	Feeler Gauge: FG-02	

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY			DEVIATION FROM STRAIGHTNESS (Procedure S1)			Straightness Tolerance Met?		
Specimen Length, in:			Average			Maximum gap between side of core and reference surface plate: Is the maximum gap ≤ 0.02 in.? YES		
Specimen Diameter, in:			2					
Specimen Mass, g:			4.87					
Bulk Density, lb/in <sup>3</sup> :			2.38					
Length to Diameter Ratio:			936.82					
			164					
			2.0					
END FLATNESS AND PARALLELISM (Procedure FP1)								
END 1			-0.875			-0.750		
Diameter 1, in			0.00020			0.00010		
Diameter 2, in (rotated 90°)			0.00010			-0.00010		
			0.00010			0.00000		
END 2			-0.875			-0.750		
Diameter 1, in			0.00030			0.00020		
Diameter 2, in (rotated 90°)			0.00050			0.00040		
			0.00010			0.00030		
			0.00010			0.00010		
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Client:	GEI Consultants, Inc.
Project Name:	HI-STORE CISF
Project Location:	Lea County, NM
GTX #:	307245
Test Date:	11/15/2017
Tested By:	rlc
Checked By:	mpd
Boring ID:	B101
Sample ID:	C63
Depth, ft:	399.83-400.25



After cutting and grinding



After break


Geotechnical Data Report  
HI-STORE CISF Phase 1 Site Characterization  
Lea County, New Mexico  
December 2017

## **Attachment L**

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### **Corrosivity Soil Test Data by Cooper Testing**

**Subcontractor Document Approval**

	Issued for use. Verify Current Revision.
	CIS - COT 02 - 00

Project Name: Holtec HI-STORE CISFProject Location: Lea County, New MexicoGEI Project No.: 1703345Subcontractor: Cooper Testing Labs

Document Title: Corrosivity Tests Summary  
Dated November 9, 2017  
Samples:  
B101, B105, B108

**Technical Reviewer**Signature:  Date: 11/15/2017Printed Name: Chad Conti

Electronic signature used per email direction, M.Bose. 11-15-2017.

**QA Manager**Signature:  Date: 11/15/2017Printed Name: Leslie Lombardo

Electronic signature used per email direction, M.Bose. 11-15-2017.



## Corrosivity Tests Summary



CTL #	250-078	Date:	11/9/2017	Tested By:	PJ	Checked:	PJ
Client:	GEI Consultants	Project:	HI-STORE C/SF			Proj. No:	1703345
Remarks:							

[illegible]