Applied GeoTech

GEOTECHNICAL INVESTIGATION

COMMERCE CROSSROADS PHASE 1

COMMERCE
CROSSROADS
LOGISTICS | INDUSTRIAL | COMMERCIAL

HIGHWAY 380 (IRON SPRINGS ROAD, 6700 WEST), 2000 NORTH

CEDAR CITY, UTAH

PREPARED FOR:
BZI STEEL

HC BOX 340
KANARAVILLE, UTAH, 84742

ATTENTION: RYAN OBRAY

PROJECT NO. 2221598

SEPTEMBER 22, 2023

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SUMMARY

1. AGEC has conducted a subsurface investigation for approximately 310 acres of property by drilling 28 new borings at the locations shown on Figure 2. In addition, 4 borings were previously drilled during the initial study of the area.

2. The subsurface conditions within the borings indicate the subsurface soils consist of interlayered silt, lean clay, and sand the maximum depth investigated, approximately 51½ feet below the existing grade. In addition the sand contained varied amounts of gravel in the area of B-1, B-2, B-15 and B-16 (current study) and B-2, B-4 and B-5 (previous study). Practical auger refusal was encountered on dense silty gravel at a depth of approximately 10 feet within Boring B-2 (current study).

   Portions of the near surface soils were observed to be porous. Laboratory tests indicate that the near surface soils are moisture sensitive or collapsible. The depth of these soils varied from up to approximately 3 to 10 feet across the property. A higher plastic clay (Fat Clay) layer was encountered within Boring B-26 at a depth of 32 to 47 feet.

3. Groundwater was not encountered within the borings to the maximum depth investigated, approximately 51 ½ feet (Boring B-15). Fluctuations in the groundwater level may occur over time. Our experience in the area has shown that the groundwater level has fluctuated with the levels in the Quichapa Lake to the southwest and irrigation patterns. An evaluation of such fluctuations is beyond the scope of this report. On a site to the southeast of the property (American Packaging Corp), the groundwater was encountered at approximately 30 to 35 feet below the surface, which correlates to an elevation of approximately 5470 feet. Thus, there is a potential for fluctuations during wet periods.

4. The upper approximately 3 to 10 feet of soil within the explorations was found to be slightly cemented and porous. Laboratory testing on relatively undisturbed samples obtained from the borings from this zone were found to have relatively low in-place density values and also showed moderate to high collapse characteristics or moisture sensitivity. Samples tested from the borings for moisture sensitivity and compressibility indicate the deeper soils were non to slightly moisture sensitive.

5. The details for proposed buildings are not known at this time. We anticipate that buildings will be steel frame structures. The proposed buildings may be supported on conventional foundation systems. Due to the variability in depth of moisture sensitive soil conditions and the unknown pad grading for each site, we recommend that each lot or building/project within the overall project be further evaluated for the proposed construction and site specific recommendations may be provided. AGEC will provide general recommendations for evaluation and consideration.

6. The majority of the upper soils are fine sand with varied amounts of silt and clay, these soils be re-used as site grading fill through out the project. The upper portion of support soils will need to be granular, structural fill to provide the support and bearing for foundations, roadways and slabs. The thickness of the materials will vary on loads and type of use. Typcically, foundation may require 1 to 7 feet of structural fill (depending on loads) and slabs 12 to 24 inches. Roadways will require 6 to 12 inches below the roadway section of base course and asphaltic pavement.

7. Our experience when using the on-site soils as site grading fill, they are sensitive to the amount of moisture within the soil when compacting and using as site grading fill. The moisture should be within 2 percent of the optimum to assist in achieving compaction. Depending on the time of year and moisture conditions, (wet or dry), these soils will likely require additional moisture conditioning (wetting or drying) to achieve the compaction. The proper compaction of these materials is critical to the performance of the foundations, slabs and pavement.

   In addition, the low in-place density of the soils will result in a shrinkage or loss as the materials are removed, processed and recompacted. We estimate a shrinkage of 15-20 percent.

   There are portions of the site that contain granular materials. Lot No. 1 and the two eastern knolls of material were a mix of sand and gravel. These materials were investigated during previous and current borings. The previous investigation data is provided in the appendix of the report. The granular materials may be used as structural fill.

8. Additional recommendations for subgrade preparation, pavements, materials, foundations, and drainage are included in the report.

9. The information provided in this summary should not be used independent of that provided within the body of this report.

SCOPE OF WORK

Our scope of work included the drilling of 28 borings on the subject site to observe the subsurface profile and obtain samples for laboratory testing. The borings were drilled to depths of approximately 20 to 50 feet at the locations shown on Figure 2. The locations were initially located by a hand held Global Positioning Survey (GPS) and later surveyed by Platt and Platt, Inc. AGEC conducted laboratory testing on the samples obtained from the field study.

In addition, AGEC has previously drilled 5 borings on the site, of which 4 were located within the area of this phase of work. The information from the previous work is included in the Appendix of this report. (Report by AGEC, Project No. 2220054, dated June 4, 2022). Two of the borings during this study were drilled as a part of the Rail Spur study.

AGEC also has reviewed a previous study conducted for the American Packaging Corporation (APC) across the rail road and to the southeast. The information from this study was also reviewed to assist in our evaluation. (Report by AGEC, Project No. 2211462, dated October 5, 2021.)

AGEC has analyzed the results of the field and laboratory work to prepare geotechnical reocmmendations. The specific information for buildings is not known at this time and additional work should be conducted at each location to provide site specific recommendations. This report will provide recommendations for the site improvements and for typical conditions for buildings.

SITE CONDITIONS

The subject site consists of approximately 310 acres of a larger 780 Acre property. The property at the time of our investigation is primarily undeveloped property. It is located on the west side of the existing rail road and east of Iron Springs Road or County Road 380, in Cedar City, Utah as shown on Figures 1 and 2. The property slopes down slightly to the southwest and there is approximately 20 feet of elevation change across the main parcel. The north parcel or office building area slopes down to the south with approximately 30 feet of elevation change down to the southeast. There are two small knolls on the east center of the site. Each knoll is on the order of 10 to 15 feet high. They are located on lots 9, 10 and into the northern portion of lot 11 and the second knoll to the west is located on the boundary of lots 12 and 14. A topography map with the exploration locations is shown on Figure 2a.

There is a railway along the east side of the site and Iron Springs Road to the west. The rail and the roadway are oriented in a northwest to southeast direction. The north parcel is moderately vegetated with Juniper trees and small brush, while the remainder of the site contains sage brush and occasional areas with exposed soil. Occasional dirt roads traverse the site.

There is a cultivated area on the southeast portion of the site that has an irrigation pivot on the site. There are vacant undeveloped properties to the north and south with an occasional house or structure to the south.

A recent railroad spur has been completed along the east side of the project.

SUBSURFACE CONDITIONS

On September 15, 16, 19, 20, 21 and 28, 2022, an engineer from AGEC visited the site and observed the drilling of 28 borings at the approximate locations shown on the site plan, Figure 2. The borings were drilled with a truck mounted drill rig equipped with 8-inch diameter hollow-stem augers. Samples were taken periodically through the drilling process. The borings were located with a handheld GPS unit and were later surveyed by Platt and Platt, Inc.

The subsurface conditions within the borings indicate the subsurface soils consist of interlayered silt, lean clay, and sand the maximum depth investigated, approximately 51½ feet below the existing grade. In addition the sand contained varied amounts of gravel in the area of B-1, B-2, B-15 and B-16 (current study) and B-2, B-4 and B-5 (previous study). Practical auger refusal was encountered on silty gravel at a depth of approximately 10 feet within Boring B-2 (current study).

Portions of the near surface soils were observed to be porous. Laboratory tests indicate that the near surface soils are moisture sensitive or collapsible. The depth of these soils varied from up to approximately 5 to 10 feet across the property. A higher plastic clay (Fat Clay) layer was encountered within Boring B-26 at a depth of 32 to 47 feet.

Additional description of each of the soil and types are provided below:

> Topsoil - The site is sparcely to moderately vegetated with small brush and grasses and trees on the northwest. The near surface soils were found to contain organics and roots. These soils were generally silt, sand and some clay. The will vary from 6 to 12 inches thick with occasional root zones going deeper for Sage Brush and trees.
>
> Fat Clay - The fat clay was found in a layer within Boring B-26 at a depth of approximately 32 to 47 feet below the original surface. The clay contains layers of sand. It varied from very soft to stiff, moist to wet, and is grey to black in color. The Fat Clay was not encountered within other borings, likely due to the lack of depth.

Laboratory tests conducted on samples of the fat clay indicate in-place moisture contents ranging from 12 to 63 percent, in-place dry densities ranging from 58 to 104 pounds per cubic foot (pcf), and a fines content (percent passing the No. 200 sieve) of 83 percent. An Atterberg Limits test indicates a liquid limit of 81 percent and a plasticity index of 47 percent.

Lean Clay - The lean clay was encountered throughout the site. The lean clay contains layers of silt and sand. Occasional thin layers of moderately plastic clay were also encountered through the profile. The lean clay is stiff to very stiff, dry to moist (increasing in moisture with depth), contains porous zones generally in the upper portion of the profile, occasional sage roots or root holes in the upper 3 to 4 feet and is generally brown in color.

Laboratory tests conducted on samples of the lean clay indicate in-place moisture contents ranging from 2 to 19 percent, in-place dry densities ranging from 91 to 120 pcf, gravel contents (percent retained on the No. 4 sieve) ranging from 0 to 8 percent, and fines contents ranging from 56 to 100 percent. Atterberg Limits tests indicate liquid limits ranging from 23 to 47 percent and plasticity indexes ranging from 8 to 30 percent. Water soluble sulfate tests indicate water soluble sulfates concentration ranging from 420 to 4,500 parts per million (ppm).

One dimensional consolidation tests conducted on relatively undisturbed samples of the lean clay indicate the material is slightly-moisture sensitive to moderately collapsible when wetted under a constant pressure of 1,000 pounds per cubic foot (psf) and slightly to highly compressible under additional loading. Collapse potentials ranging from approximately ¼ to 3½ percent were measured. A swell potential of approximately ¼ percent was measured with one sample.

Silt - The silt was found throughout the site and generally was found in the upper portion of the profile. The silt contained varied amounts of sand also contains layers/lenses of lean clay and silty sand. It is stiff to hard, dry to slightly moist, contains porous zones, generally in the upper 10 feet, occasional sage roots or root holes were observed in upper 3 to 4 feet, and is light brown to grey in color.

Laboratory tests conducted on samples of the silt indicate in-place moisture contents ranging from 1 to 13 percent, in-place dry densities ranging from 93 to 115 pcf, and fines contents ranging from 70 to 100 percent. Atterberg Limits test indicate liquid limits ranging from 21 to 26 percent and plasticity indexes ranging from non plastic to 7 percent. Water soluble sulfate tests indicate water soluble sulfates concentration ranging from 540 to 2,500 ppm.

A one dimensional consolidation/collapse test conducted on one relatively undisturbed sample of the silt indicates the material is moderately collapsible when wetted under a constant pressure of 1,000 pounds per cubic foot (psf) and moderately compressible under additional loading. A collapse potential of approximately 3¼ percent was measured.

Silty Sand - The silty sand was also observed in layers sporadically throughout the site. The silty sand is interlayered with layers/lenses of lean clay and clayey sand and varied amounts of gravel. There was moderate amounts of gravel encountered in Borings B-1, B-2, B-15 and B-16. The silty sand varies from loose to very dense, dry to slightly moist, porous in the upper 3 to 10 feet, sage root holes in the upper 3 to 4 feet and is brown to red-brown in color.

Laboratory tests conducted on samples of the silty sand indicate in-place moisture contents ranging from 1 to 7 percent, in-place dry densities ranging from 96 to 123 pcf, gravel contents ranging from 6 to 28 percent and fines contents ranging from 13 to 49 percent. An Atterberg Limits test indicates the material is non plastic. A water soluble sulfate test indicates a water soluble sulfate concentration of 550 ppm.

A one dimensional consolidation/collapse test conducted on one relatively undisturbed sample of the silty sand indicates the material is highly collapsible when wetted under a constant pressure of 1,000 pounds per cubic foot (psf) and moderately compressible under additional loading. A collapse potential of approximately 5½ percent was measured.

Poorly Graded Sand to Poorly Graded Sand with Silt - The poorly graded sand to poorly graded sand with silt was found within Borings B-5, B-9, B-13, B-17 and B-23. The sand is dense to very dense, dry, and is yellowish-brown in color.

Laboratory tests conducted on samples of the poorly graded sand indicate in-place moisture contents ranging from 3 to 11 percent, in-place dry densities ranging from 91 to 103 pcf, a gravel content of 14 percent and a fines content of 6 percent.

Silty Gravel with Sand - The gravel was primarily found within Borings B-4 and B-5 (initial study, see appendix) that are located within the two small knolls. Borings around the knolls also showed moderate amounts of gravel within the silty sand. Borings B-1 and B-2 within Lot No. 1 also contained moderate amounts of gravel within the silty sand portion of hte profile. The silty gravel with sand is very dense, dry, and is brown to grey in color.

The Logs of Exploratory Borings are shown on Figures 3-8. The Legend and Notes of Exploratory

Borings are shown on Figure 9. The laboratory test results are also shown on Figures 3-8 and are summarized in the Summary of Laboratory Test Results, Table 1. The One-dimensional Consolidation/Collapse/Swell test results are shown graphically on Figures 10-20. The initial explorations and laboratory testing from the 4 other borings is included in the Appendix of the report.

SUBSURFACE WATER

Groundwater was not encountered within the borings to the maximum depth investigated, approximately 51 ½ feet (Boring B-15). Fluctuations in the groundwater level may occur over time. Our experience in the area has shown that the groundwater level has fluctuated with the levels in the Quichapa Lake to the southwest and irrigation patterns. An evaluation of such fluctuations is beyond the scope of this report. On a site to the southeast of the property (American Packaging Corp), the groundwater was encountered at approximately 30 to 35 feet below the surface, which correlates to an elevation of approximately 5470 feet. Thus, there is a potential for fluctuations during wet periods.

PROPOSED CONSTRUCTION

We understand that the site will be developed into an industrial development with 16 lots varying in size from approximately 8 to 53 acres. There will be several roadways constructed as shown on Figure 2 and 2a. We anticipate that the majority of the structures will be steel framed type structures. The buildings are anticipated to be supported using conventional spread footings or deep foundation elements with slab on grade floors. We anticipate relatively high column loads and possible floor loads for various types of use or equipment.

The proposed grading for the project will require cuts and fills on the order of 10 to 15 feet with the majority being less than 5 feet.

The development will include asphaltic concrete and rigid pavement, associated site improvements and underground utilities.

As the proposed construction for individual sites become available, AGEC should review and provide site/design specific recommendations.

RECOMMENDATIONS

Based on the subsurface conditions encountered, the laboratory test results, the proposed construction, and our experience with similar conditions, the following recommendations are provided:

A. SITE GRADING

1. Subgrade Preparation

a. **Clearing and Grubbing**: The site should be cleared of vegetation and soils containing organics. We anticipate that approximately 6 to 12 inches of soil will need to be removed. These materials are not suitable for use as structural fill below structures or pavement areas.

b. **Roadways/Parking/Docks Areas:** The parking and roadway areas should be prepared by removing at least 2 feet of the on site soils below the proposed subgrade or existing grade, which ever is greater in depth. Following removal, the subgrade should be scarified to a depth of 12 inches, moisture conditioned to within 2 percent of the optimum moisture content and properly compacted to at least 90 percent of the maximum dry density as determined by ASTM D-1557. If during the subgrade preparation process, soft or “pumpy” areas occur, the following should be used to stabilize the subgrade:
If an unstable subgrade is observed during grubbing, the subgrade should be stabilized prior to placing fill using geogrid and crushed aggregate fill as provided below.

c. **Subgrade Stabilization:** The subgrade should be stabilized by placementbiaxial geogrid (TENSAR BX1200 or TX160) on the exposed, undisturbed subgrade below fill areas following removal of soft, disturbed or rutted soil to assist in obtaining compaction during fill placement above the soft subgrade. The geogrid should be placed on a smooth, level surface. This should be accomplished by cutting the subgrade with a trackhoe bucket with a smooth blade, preferably from outside the disturbed/unstable area. The geogrid should be rolled and stretched taught/free of wrinkles. The layers of geogrid should be overlapped and placed per manufactures specifications and guidelines.

We recommend placing on the order of 12 inches of angular, granular fill (base course type material) over the geogrid in soft areas to assist in stabilizing the subgrade. The base course layer should be placed in one pre-moisture conditioned lift and spread over the geogrid with track mounted equipment. We recommend spreading the gravel by pushing the material in front of the equipment (wide tracked dozer or trackhoe) so the equipment is being supported on top of the full thickness of aggregate.

After the full thickness of the base course layer is placed, base course material should be compacted. A rolling pattern should be established to determine the minimum number of passes which are required to achieve compaction. If excessively soft areas are exposed, a separation layer of geosynthetic, such as Mirafi 600X, may be necessary below the geogrid. If excessively soft soil conditions are encountered, a representative of AGEC should be notified to provide guidance in the field for the appropriate stabilization process.

Use of crushed/angular 6-10 inch minus, angular rock below the geogrid may reduce the amount of aggregate required above the geogrid and provide a more stable subgrade. An engineer from AGEC should be notified to provide on-site recommendations and observations during the stabilization process.

d. Building Pad ***:*** Due to the moisture sensitive or collapsible soils encountered within the upper approximate 3 to 10 feet at the site, we estimate that up to 4 to 6 inches of potential settlement could occur if these soils were wetted while under a loaded condition. Thus, we recommend removing the entire thickness of these soils below foundations and portion of the moisture sensitive soils as a minimum below slabs and pavement areas. As individual projects and site grading are determined, the amount of overexcavation and recompaction along the the thickness of structural fill may be determined for each project.

We recommend removing the entire thickness of moisture sensitive soils below foundations including a zone extending beyond the perimeter of the foundation equal to ½ of the width of the foundation (each side of the footing). The removed soils may be re-used as replacement fill with the upper portion being granular/structural fill. The thickness of imported material will depend on the foundation loading conditions as outlined in the Foundations Section of this report.

In building slab areas, we recommend (as a minimum) removing and recompacting the moisture sensitive soils to a depth of 4 feet below the original grade. The removed soils free of organics may be re-used as fill up to within 12 inches of the subgrade. It should be noted that there remains a zone of material below the removal zone that still may experience wetting and subsequent movement/settlement. If this risk of further movement is not acceptable, then the amount of over-excavation should be increased.

2. Excavation/Earthwork

The on-site soils may be excavated with typical excavation equipment. Some difficulty may be encountered within deeper excavations the area of Lot 1 or within the areas of the two knolls on the eastern portion of the site.

3. Material Suitability

The on-site soils varied across the property. The majority of the near surface soils consist of silt, silty sand and lean clay. These soils free of organics may be used as site grading fill a portion of the on site soils may be used below slabs and building pads/roadways. For the upper subbase or structural fill below roadways, foundations and slabs, granular materials should be used. AGEC has investigated previously the two knolls on the east portion of the property. The data from the investigation which includes a boring at the top of each knoll and laboratory testing is included in the Appendix. These areas include silty sand with gravel and silty gravel. These materials may be used as structural fill in the roadays, below foundations and slabs. In addition, the hillside area (Lot 1), was granular and these materials from this area may also be used as structural fill.

The on-site soils will vary with moisture conditions, depending on the time of year and weather conditions. They will require significant processing and moisture added or removed to achieve the proper moisture content for compaction. The fine grained silts, sands and clay are sensitive to the amount of moisture and become difficult to achieve compaction when too wet or dry. Imported materials should meet the criteria outlined below:

Area	Fill Type	Recommendations
Footings/pad	Structural fill	**-200** <35%, **LL** <30% Maximum size: 4 inches
Under slab/ stabilization	Base course (crushed)	**-200** <12% Maximum size: 1 inch
Parking/Roadway	Granular fill	**-200** < 50%, **LL** < 25% Maximum Size: 6 inches
Stabilization Rock	Crushed/angular rock	**-200** < 5%, Well Graded Maximum Size: 10 inches

-200 = Percent Passing the No. 200 Sieve
LL = Liquid Limit

Base course materials should be Cedar City Specifcations.

4. Compaction

Compaction of fill placed at the site should equal or exceed the following percentages of the maximum dry density as determined by ASTM D-1557:

Area of Compaction	%
Site Grading/Building Pad	95
Subgrade (following scarification)	90
Utility Trench Backfill	95
Utility Trench Backfill (pipe zone)	90
Wall Backfill	95
Foundation Subgrade	95
Pavement (base course)	95
Slab (base course)	95

5. Grading Slopes and Trenches

Permanent cut slopes excavated into the overburden soils above the groundwater table should be cut no steeper than 2:1 (horizontal to vertical). Unretained fill slopes constructed with properly compacted on-site soil should be graded no steeper than 2:1 (horizontal to vertical). Slopes should include benches in accordance with the 2021 IBC.

Fill slopes should be graded by overbuilding and then cutting them back to the desired grade to provide a compacted slope face. Fill placed on existing slopes steeper than 3:1 (horizontal to vertical) should be placed using a benching procedure to “key” the fill into the existing slope. Benches should be of sufficient width to allow adequate area for the compaction equipment.

Utility trenches excavated in the on-site soils above the groundwater level should be excavated in accordance with OSHA requirements using an OSHA Soil Class C (1½:1 horizontal:vertical). Steeper trenches or trenches below the groundwater level will likely require the use of shoring or a trench box to provide a safe work environment.

Based on the water levels measured in the test pits, the water level will likely need to be lowered to place utilities. The actual quantity of water required to dewater the excavations may vary significantly due to various soil conditions and the length of time which dewatering is conducted. A pump test should be conducted to better estimate dewatering quantities. Dewatering methods will depend on contractor preference, but may consist of well points, secondary trenches, or sump holes.

6. Drainage

Positive site drainage should be maintained during the course of construction. After construction has been completed, positive drainage of the surface water away from the buildings in each direction must be maintained. To reduce infiltration adjacent to foundations we recommend the following:

A minimum slope of 6 inches in the first 10 feet from the perimeter of structures should be provided.

Roof drain systems should be installed to control roof water. In no case should roof water be allowed to pond adjacent foundations. Roof downspouts should discharge away from the buildings. We recommend piping roof drains away from structures to avoid ponding and infiltration next to structures.

Infiltration of surface water may be disposed of in retention and detention ponds that are designed away from structures. Due to the interlayered, fine grained soils the near the surface, the infiltration rate may result is slow rates and cause water to flow laterally through the more porous layers on clay layers. It may be necessary to place vertical sand/gravel drain within the ponds to increase the infiltration rate. AGEC can provide further evaluation after the pond locations and subsurface conditions are determined for each project.

B. FOUNDATIONS

The proposed building may be supported on conventional spread and spot footings bearing on properly compacted structural fill underlain by a properly prepared subgrade as recommended in the Subgrade Preparation section of this report. Recommendations for spread footing design and support follow.

1. <u>Bearing Capacity and Bearing Material</u>

   For design purposes, the following table may be used to design foundations for conventional spread and spot footings bearing on properly compacted structural fill. A net allowable bearing pressure of 2,500 to 3,500 pounds per square foot (psf) may be used as noted in the table below. The structural fill thickness is the amount of granular fill that is necessary for the allowable bearing pressures to be used and to limit settlement from the fine grained soils. Additional overexcavation and recompaction of the on-site soils may be necessary below the structural fill materials. Each project or site should be evaluated on an individual basis for the overexcavation thicknesses.

Load Type	Max Load	Footing Width "B"	Net Allowable Bearing Pressure (psf)	Minimum Structural Fill Thickness (feet)
Wall/Continuous	5klf	B≤2 ft	2,500	2
Wall/Continuous	7.5 klf	2<B≤3 ft	2,500	2.5
Wall/Continuous	12 klf	3<B≤4 ft	3,000	4
Column/Spot	10 kips	B≤2 ft	2,500	1
Column/ Spot	27 kips	2<B≤3 ft	3,000	1.5
Column/Spot	56 kips	3<B≤4 ft	3,500	2
Column/Spot	87.5 kips	4<B≤5 ft	3,500	3
Columns/Spot	126 kips	5<B≤6 ft	3,500	3.5
Columns/Spot	171.5 kips	6<B≤7 ft	3,500	4
Columns/Spot	224 kips	7<B≤8 ft	3,500	5
Columns/Spot	300 kips	8<B≤10 ft	3,500	6
Columns/Spot	>300	10<B≤12 ft	3,500	7

The area of removal should extend laterally beyond the foundation at least ½ the fill thickness. When a grading plan and specific building loads are known, AGEC should re-evaluate the overexcavation and structural fill thicknesses.

2. Footing Width and Embedment

   Footings should have a minimum width of 18 inches and footings should be embedded at least 30 inches below the lowest adjacent grade for frost depth and at least 12 inches in heated or non-frost areas.

3. Temporary Loading Conditions

   The allowable bearing pressure may be increased by one-third for temporary loading conditions such as wind or seismic loads.

4. Settlement

   We estimate that settlement will be less than 1 inch for footings designed as indicated above due to the load of the structure. Differential settlement is estimated to be approximately ½ inch. These estimates do not account for the moisture sensitive soils below the removed zone.

5. Foundation Base
   The base of excavations should be cleared of loose or deleterious material prior to placement of fill or concrete.

C. CONCRETE SLAB ON GRADE

1. Slab Support
   Concrete slabs may be supported on a properly overexcavated and compacted subgrade as recommended in the Subgrade Preparation section of this report. Fill placed in slab areas should be tested to verify compaction meets the recommendations provided within this report.

2. Underslab Base Course
   A 4-6 inch layer of properly compacted base course should be placed below slabs to provide a firm and consistent subgrade and promote even curing of the concrete.

D. LATERAL EARTH PRESSURES

1. Lateral Resistance for Footings
   Lateral resistance for spread footings is controlled by sliding resistance developed between the footing and the subgrade soil. The following ultimate friction value may be used in design for lateral sliding resistance of footings:

Subgrade Support Soil	Ultimate friction value - μ
On-site Fine Grained Soils	0.4
Imported Structural fill	0.5

The value provided above is considered ultimate. The structural design should incorporate an appropriate factor of safety.

2. Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. We recommend the basement walls be designed in an at-rest condition.

The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Soil Type	Equivalent Fluid Weight		
	Active	At-Rest	Passive
On-site Soil	40 pcf	55 pcf	325 pcf
Imported Granular/Structural Fill	35 pcf	50 pcf	375 pcf

The above values account for the lateral earth pressures due to the soil and level backfill conditions and do not account for hydrostatic pressures or surcharge loads.

Lateral loading should be increased to account for surcharge loading using the appropriate earth pressure coefficient and a rectangular distribution if structures are placed above the wall and are within a horizontal distance equal to the height of the wall. If the ground surface slopes up away from the wall, the equivalent fluid weights should also be increased.

Care should be taken to prevent percolation of surface water into the backfill material adjacent to the retaining walls. The risk of hydrostatic buildup can be reduced by placing a subdrain behind the walls consisting of free-draining gravel wrapped in a filter fabric.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weights should be modified as follows according to the Mononobe-Okabe method assuming a level backfill condition:

Lateral Earth Pressure Condition	Seismic Modification (2% PE in 50 yrs)
	On-Site Soil
Active	8 pcf increase
At-rest	No increase
Passive	19 pcf decrease

The resultant of the seismic increase should be placed up ⅓ from the base of the wall.

4. Safety Factors

The values recommended assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. SEISMICITY

1. Seismic Design Parameters

Description	Value - Seismic Event - % PE in 50 yrs
2021 IBC Site Class	D
PGA	0.31g
Ss	0.72g
S1	0.23g
F_{PGA}	1.29
F_a	1.23
Fv	See ASCE 7-16, section 11.4.8

The values provided above were generated using the ASCE 7-16 Seismic Hazard Tool.

Based on the observed subsurface conditions, a ground motion hazard analysis (GMHA) as per ASCE 7-16 is not required by the 2021 International Building Code. A 10-percent decrease in design seismic load might be achieved if shear wave velocities are measured on site. If this is requested, we propose to perform a Refraction Microtremor (ReMi) survey to measure subsurface shear wave velocity.

AGEC has conducted a previous GMHA for the project to the southeast of the property. Based on our results, the decrease in the design seismic load was not realized.

2. Liquefaction:

   Research indicates that the soil type most susceptible to liquefaction during a large earthquake is loose, clean sand. The liquefaction potential for soil tends to decrease with an increase in fines content and density. Based on the lack of groundwater within the 50 foot borings, the potential for liquefaction is very low.

3. Faults:

   The nearest mapped fault, considered to be active is the Cedar City section of the Hurricane Fault Zone. The nearest surface trace of this fault zone is approximately 6½ miles to the southeast of the site. The fualt is anormal fault, dipping down to the northwest. The site is located on the a hanging wall of the fault.

F. SOIL CORROSION

Our experience in the area has shown the on-site soils contain sulfate concentrations corresponding to severe potential sulfate attack on concrete exposed to these materials. Therefore, we recommend concrete elements that will be exposed to the on-site soils be designed in accordance with provisions provided in the American Concrete Institute Manual of Concrete Practice (ACI) 318-14. Tables 19.3.1.1 and 19.3.2.1 of ACI 318-14 should be referenced for design of concrete elements utilizing a Sulfate Exposure Class of S2.

Consideration should also be given to cathodic protection of buried metal pipes. We recommend utilizing PVC pipes where local building codes allow.

G. PAVEMENTS

Based on the subsoil conditions encountered and the laboratory test results, the following recommendations are given. Specific traffic conditons were not provided. Additional design information may lead to greater pavement section thicknesses.

1. Analysis
   a. Asphaltic Concrete: The flexible pavement analysis is based on UDOT and AASHTO design methods and a 20 year design life. The following parameters were considered for our analysis:

      - Base course that meets specifications which corresponds to a Structural Coefficient (a_2) of at least 0.12. Asphalt that provides a Structural Coefficient (a_1) of at least 0.40.
      - Drainage Coefficient = 1.0.
      - The subgrade support soils consist of properly compacted silty sand. A M_R value of 10,500 psi was used for the subgrade based upon an estimated CBR value of 7 percent and the relationship between CBR and Resilient Modulus (M_R).
      - Serviceability Index: P_o=4.2, P_t=2.5.
      - Reliability of 90 percent.
      - Standard Deviation (S_o) = 0.45.

   b. Portland Cement Concrete: The rigid pavement analysis is based on UDOT and AASHTO design methods and a 20 year design life. The following parameters were considered for our analysis:

- Concrete with a minimum compressive strength of 4,500 psi supported on high quality base course that meets specifications provided in the Materials section of this report.
- Drainage Coefficient = 1.0.
- The subgrade support soils consist of silt and sand with a subgrade modulus of 250 pci.
- A joint transfer coefficient of 4.0 for joints without load transfer devises.
- Serviceability Index: P_o=4.5, P_t=2.5.
- Reliability of 90 percent.
- Standard Deviation (S_o) = 0.35

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2. Subgrade Support

   We anticipate the subgrade materials will consist of properly compacted on-site fill (silty sand/silt). Our design assumes a California Bearing Ratio of 7 for the on site materials. Prior to placing base course or site grading fill, the subgrade should be prepared as recommended in the Subgrade Preparation section of this report.

3. Pavement Thickness

   Based on the anticipated traffic, a 20 year design life, PCC and AASHTO design methods, the following pavement sections are recommended.

Area	Unreinforced Rigid Pavement		Flexible Pavement		
	Portland Cement Concrete (inches)	Base Course (inches)	Asphaltic concrete (inches)	Base Course (inches)	Granular Borrow (inches)
Employee Parking	NA	NA	3	8	-
Truck Parking Areas/Delivery Routes	-	-	3.5	6	8
Roadways	NA	NA	4	10	12
Roadways (alternate section with geo-grid)*			4	12	0

* geo grid should be Tensar TX-160/BX 1200 or equal. See subgrade preparation/stabilization section above for geogrid placement.

4. Pavement Materials

   a. *Flexible Pavement (Asphaltic Concrete)*

      The pavement materials should meet AASHTO and Cedar City specifications for gradation and quality. The pavement thicknesses indicated above assume that the base course is high quality material with a CBR of at least 60 percent. Asphalt material should have a Marshall stability of at least 1,800 pounds.

   b. *Rigid Pavement (Portland Cement Concrete)*

      The pavement thicknesses indicated assumes that the concrete will have a 28-day compressive strength of 4,500 psi.

5. Jointing

   Joints for concrete (rigid) pavement should be laid out in a square or rectangular pattern. Joint spacings should not exceed 30 times the thickness of the slab. The depth of joints should be at least one-quarter of the slab thickness. Load transfer dowels may be incorporated in longitudinal joints to transfer load between slabs.

6. Drainage

   The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided. We further recommend a yearly maintenance program including crack sealing and a surface treatment such as a "slurry seal" to extend the pavement life and reduce water infiltration into the subsurface soil.

H. CONSTRUCTION TESTING AND OBSERVATIONS

We recommend testing fill, concrete, and asphalt materials at a frequency which meets or exceeds Cedar City minimum testing frequency requirements for city improvements. We also recommend the following testing and observations be done as a minimum.

1. Verify the building overexcavation including deeper areas for foundations is properly removed and replaced with the appropriate materials.

2. Conduct compaction testing on fill placed below foundations, in building pads, and paved areas. We recommend testing each foot of fill placed.

3. Conduct construction materials testing of soils, concrete and asphalt materials and special inspections as required for the proposed construction by Cedar City and the structural engineer.

4. Conduct special inspections on the proposed building as required by the 2021 International Building Code and the structural engineer.

I. GEOTECHNICAL RECOMMENDATION REVIEW

The client should familiarize themselves with the information contained in this report. If specific questions arise or if the client does not fully understand the conclusions/recommendations provided, AGEC should be contacted to provide clarification.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the borings drilled, laboratory testing, engineering analysis and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface soil or groundwater conditions are found to be different from what is described in this report, we should be notified to reevaluate the recommendations provided.

Sincerely,
APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

LICENSED PROFESSIONAL ENGINEER
9.22.23
No. 177876
G. WAYNE ROGERS
STATE OF UTAH

G. Wayne Rogers, P.E.

Rev by: AD, P.E.

P:\2022 Project Files\2221500\2221598 - GT Commerce Crossroads\Report.wpd

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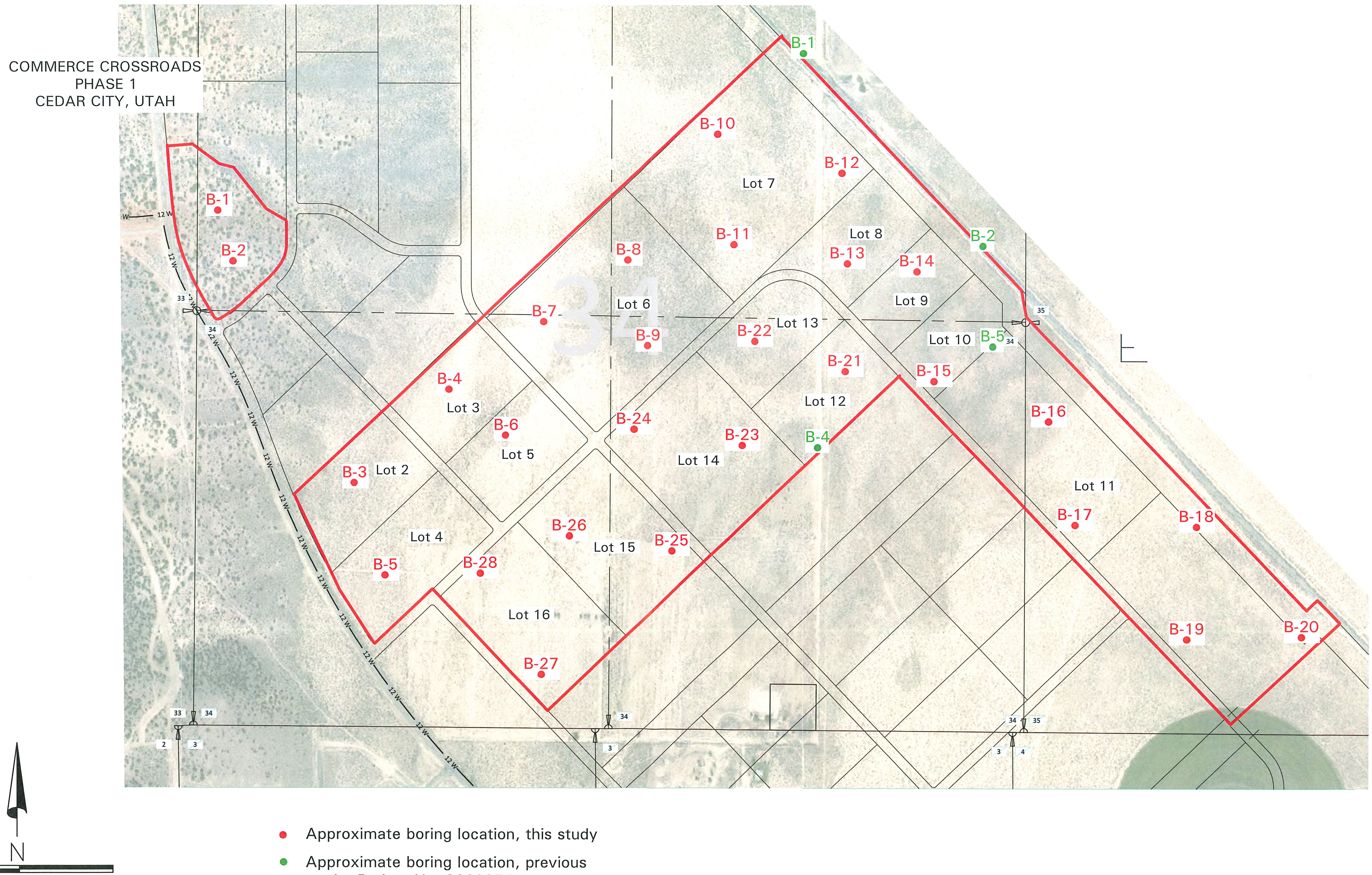
Not to Scale

COMMERCE CROSSROADS, PHASE 1
CEDAR CITY, UTAH

2221598	AGEC	Vicinity Map	Figure 1



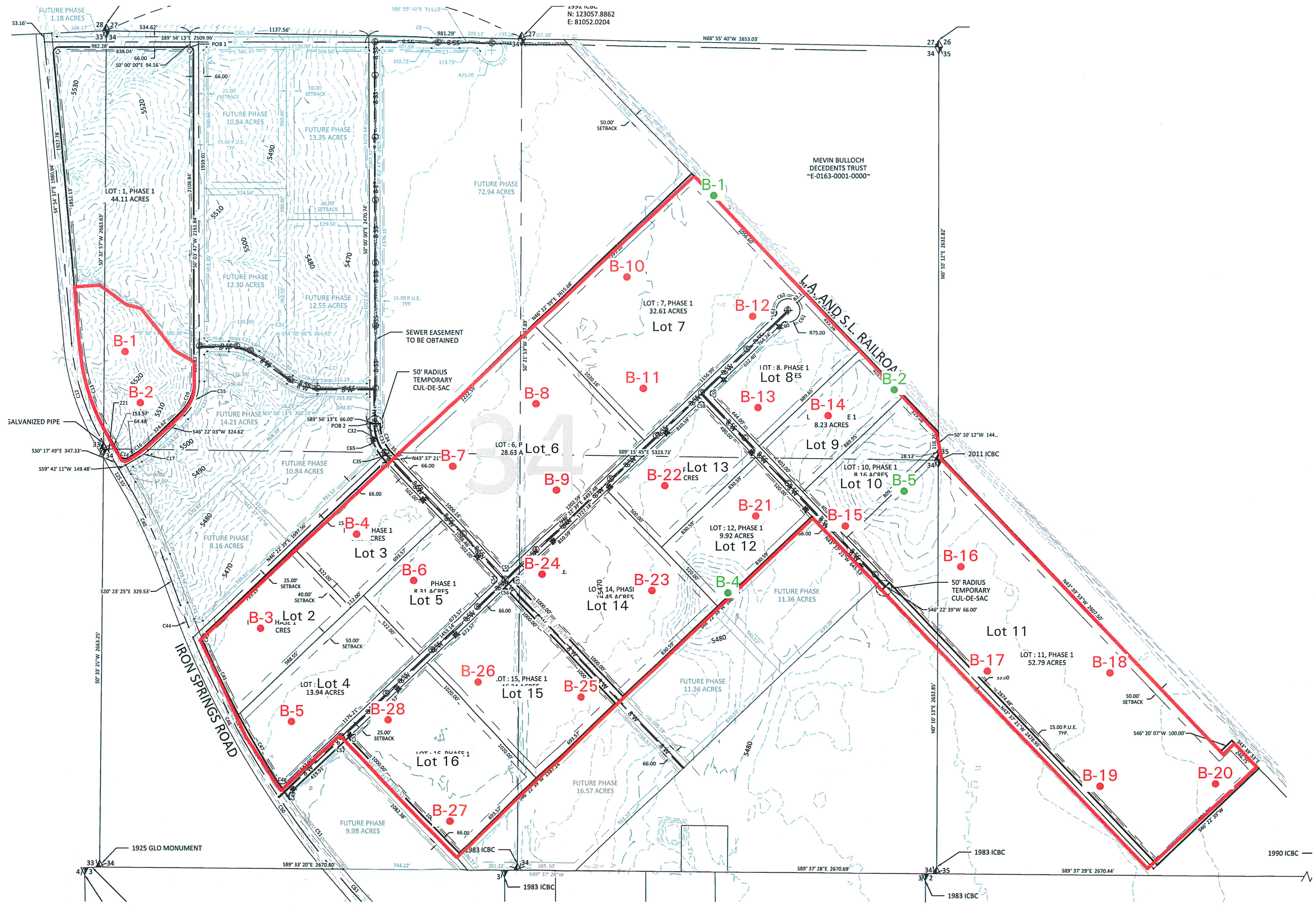
● Approximate boring location, this study

● Approximate boring location, previous study, Project No. 2220054

2221598	AGEC	Site Plan	Figure 2

COMMERCE CROSSROADS
PHASE 1
CEDAR CITY, UTAH

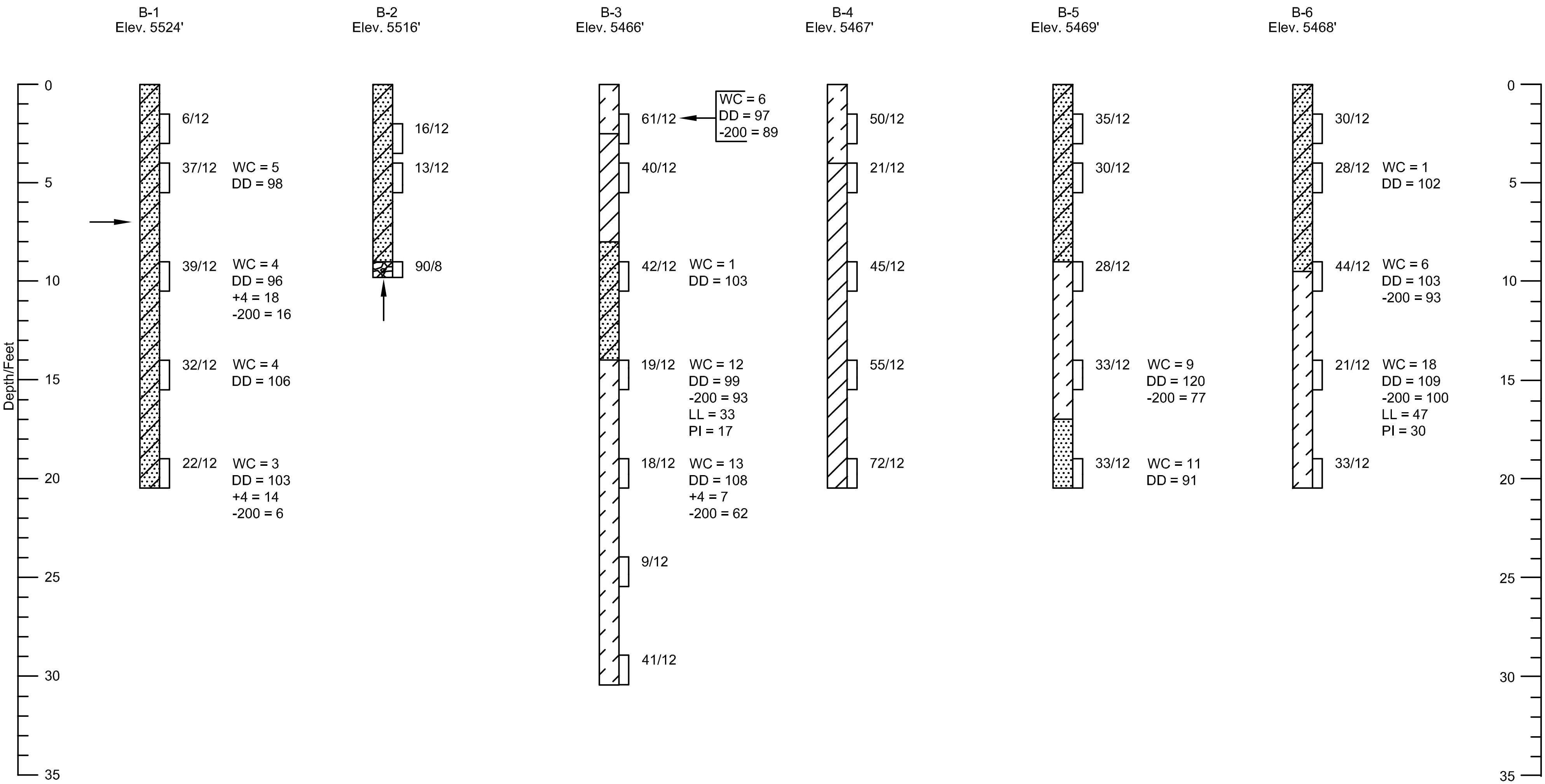
- Approximate boring location, this study
- Approximate boring location, previous study, Project No. 2220054



N

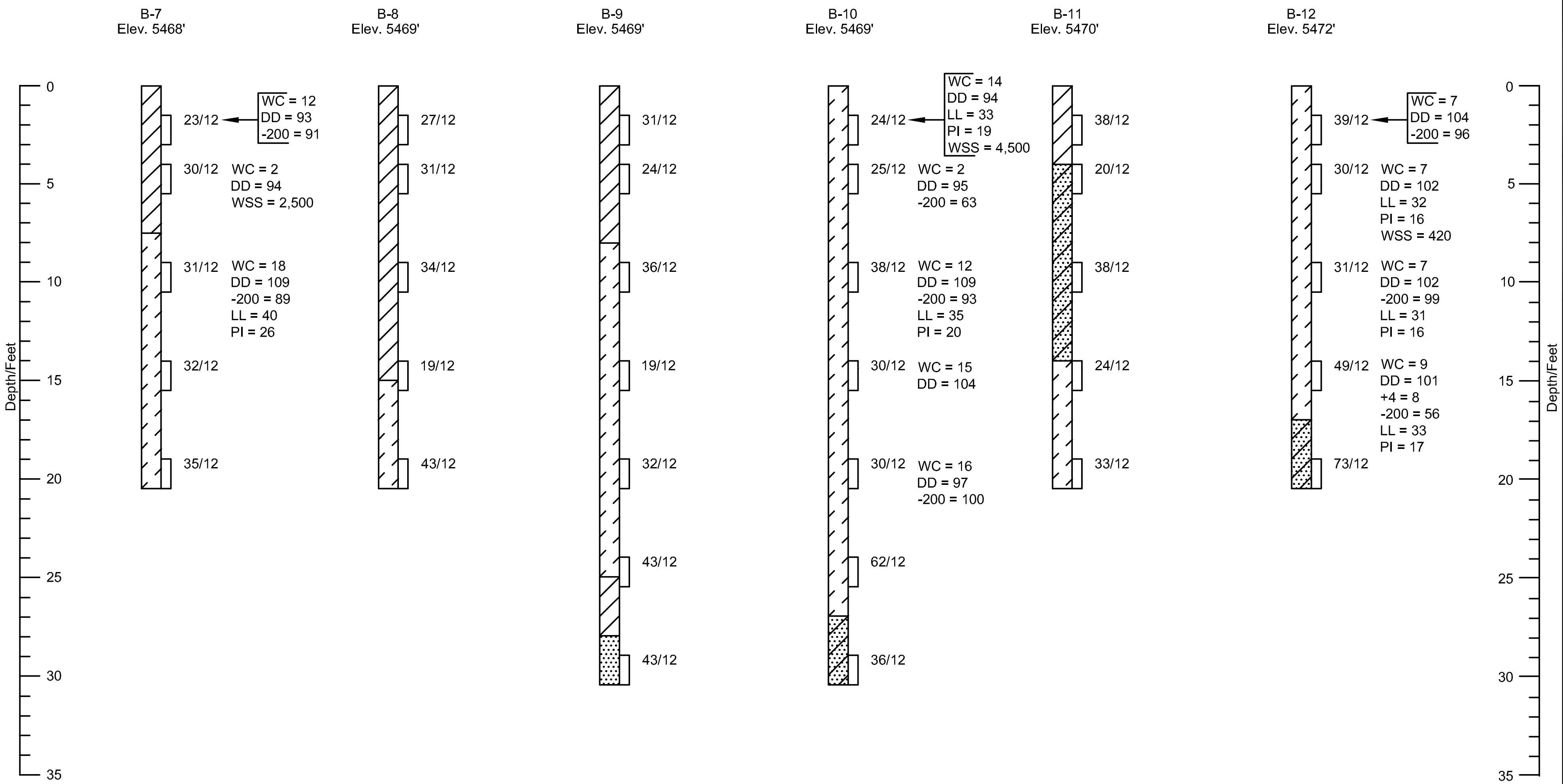
0 700 1,400 feet

2221598	AGEC	Site Plan	Figure 2a

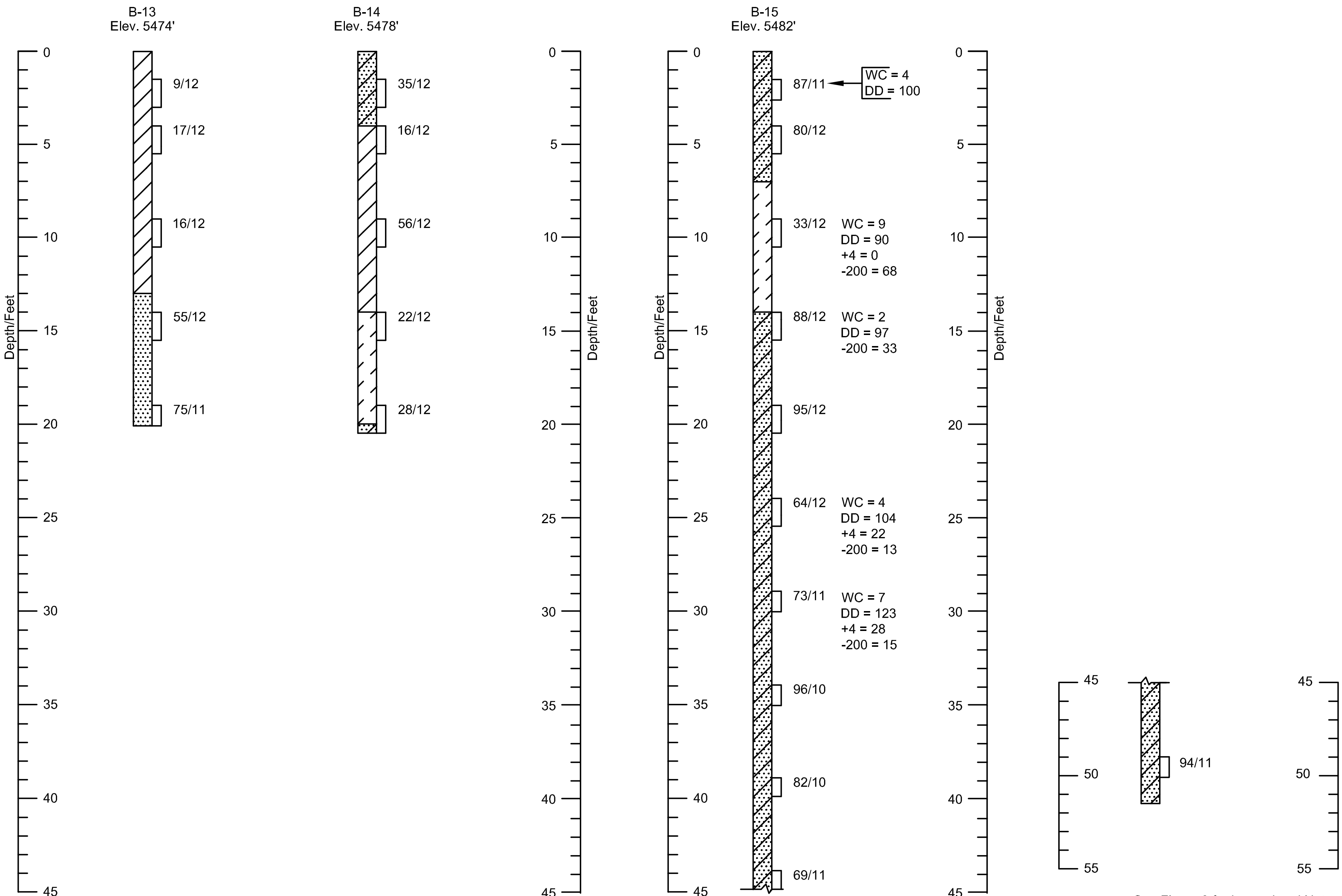


See Figure 9 for Legend and Notes

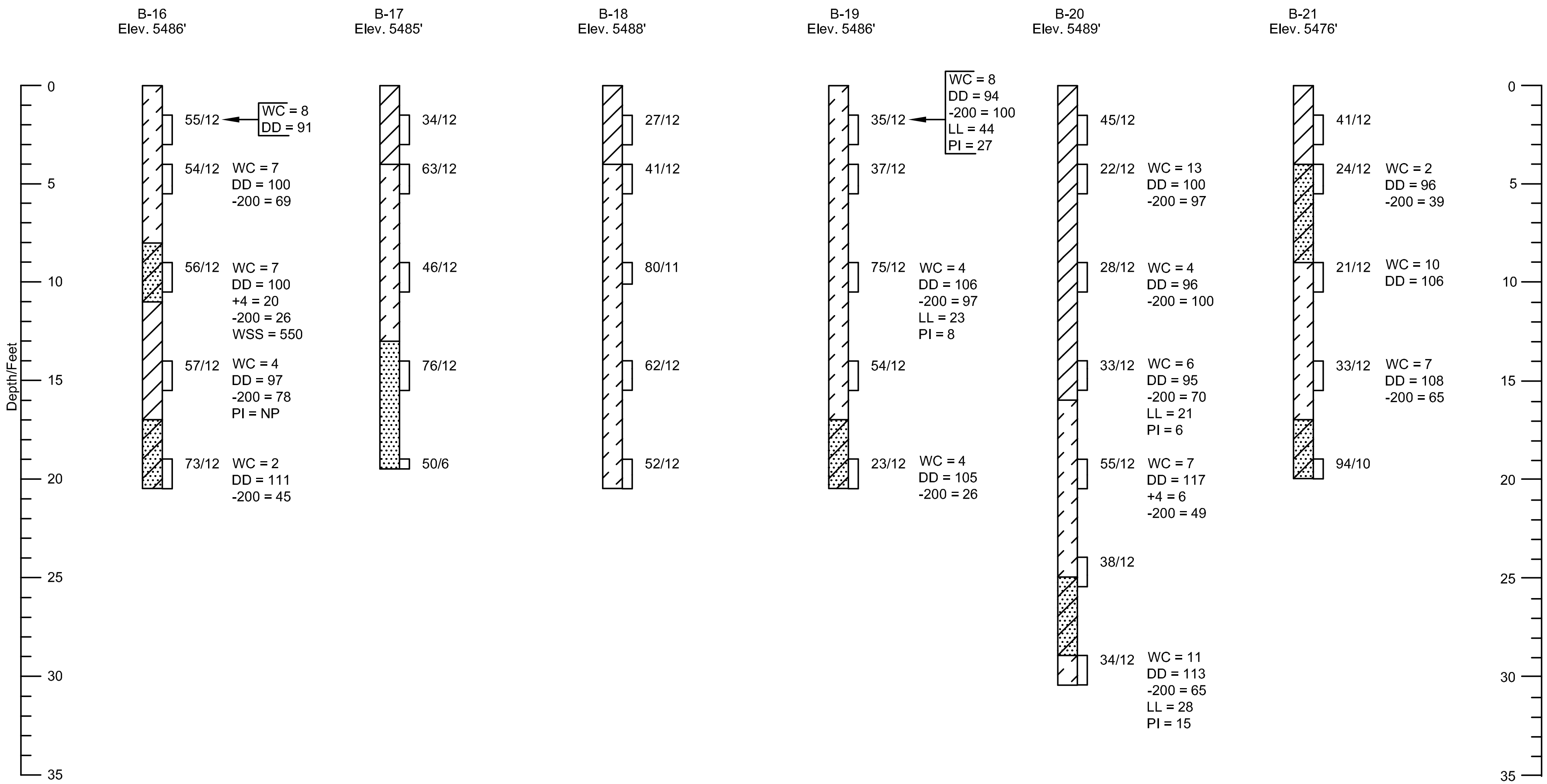
2221598 | AGEC | Logs of Exploratory Borings | Figure 3



See Figure 9 for Legend and Notes

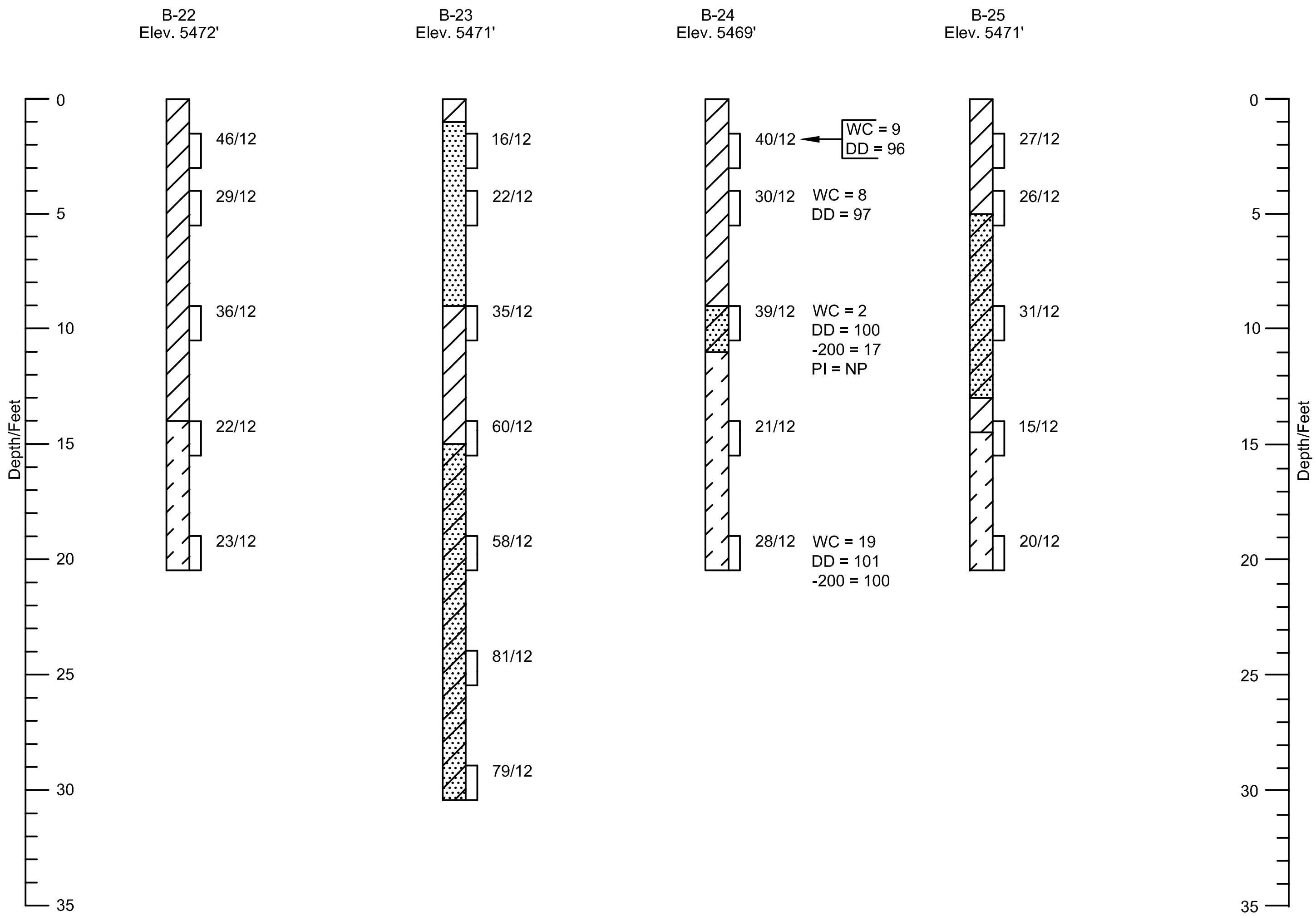


See Figure 9 for Legend and Notes



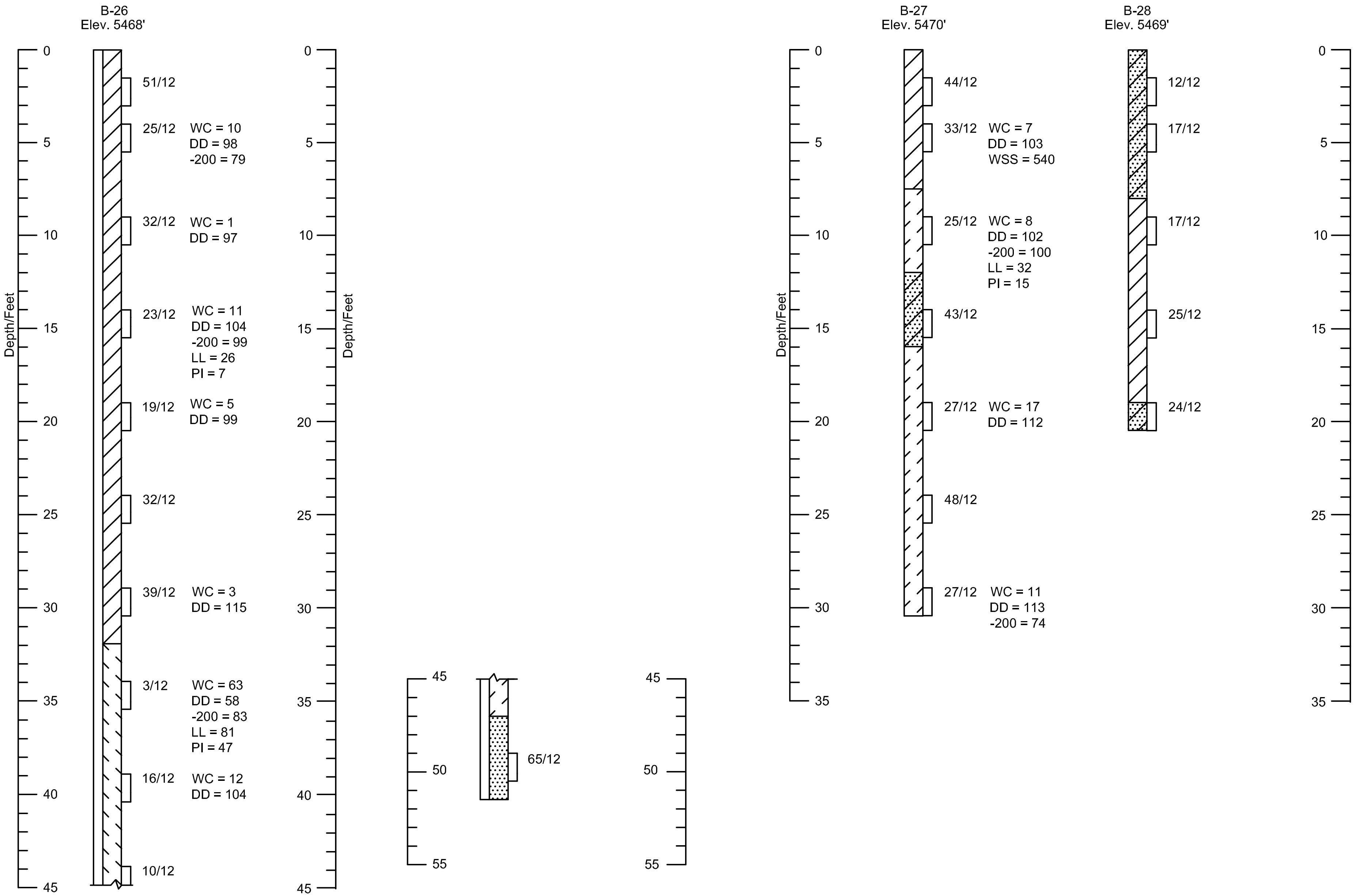
See Figure 9 for Legend and Notes

2221598	AGEC	Logs of Exploratory Borings	Figure 6



See Figure 9 for Legend and Notes

2221598	AGEC	Logs of Exploratory Borings	Figure 7



See Figure 9 for Legend and Notes

2221598	AGEC	Logs of Exploratory Borings	Figure 8

LEGEND:

Fat Clay (CH); contains layers of sand, soft to stiff, moist to very moist, grey with black streaks

Lean Clay (CL); contains layers of silt and sand, stiff to very stiff, dry to moist (with depth), porous zones/rooted in upper 3 to 4', brown.

Silt (ML); contains layers of lean clay and silty sand, stiff to hard, dry to slightly moist, porous zones, rooted upper 3 to 4', light brown to grey.

Silty Sand (SM); contains layers of lean clay and clayey sand, varied amounts of gravel, loose to dense, dry to slightly moist, porous near surface, rooted upper 3 to 4 ', brown to red-brown.

Poorly Graded Sand (SP) to Poorly Graded Sand with Silt (SP-SM) ; dense, dry, yellowish-brown.

Silty Gravel with Sand (GM); very dense, dry, brown to grey.

10/12 California drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates slotted 1 inch PVC pipe installed in the boring to the depth shown.

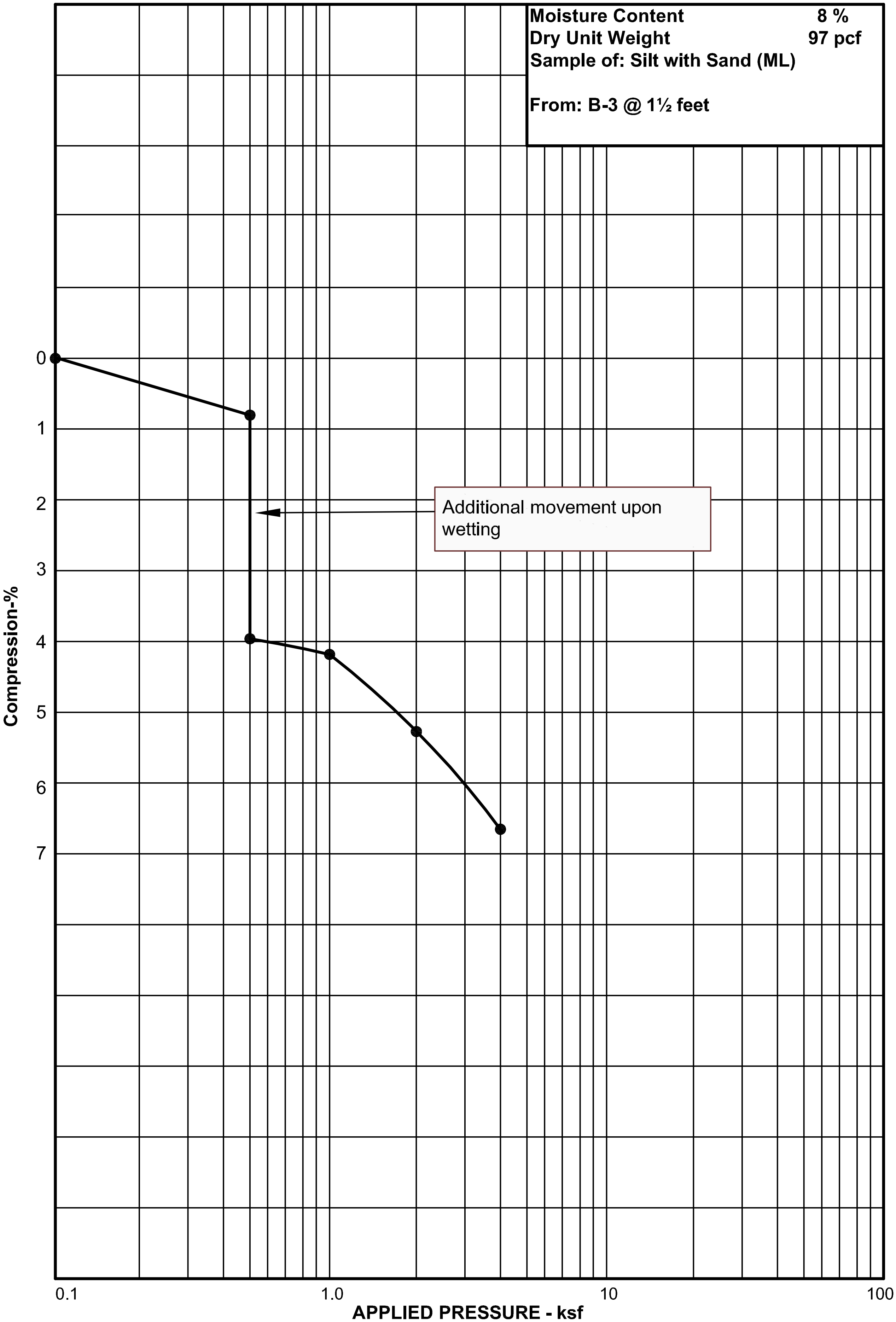
Depth to caving.

Indicates practical auger refusal on boulders.

NOTES:

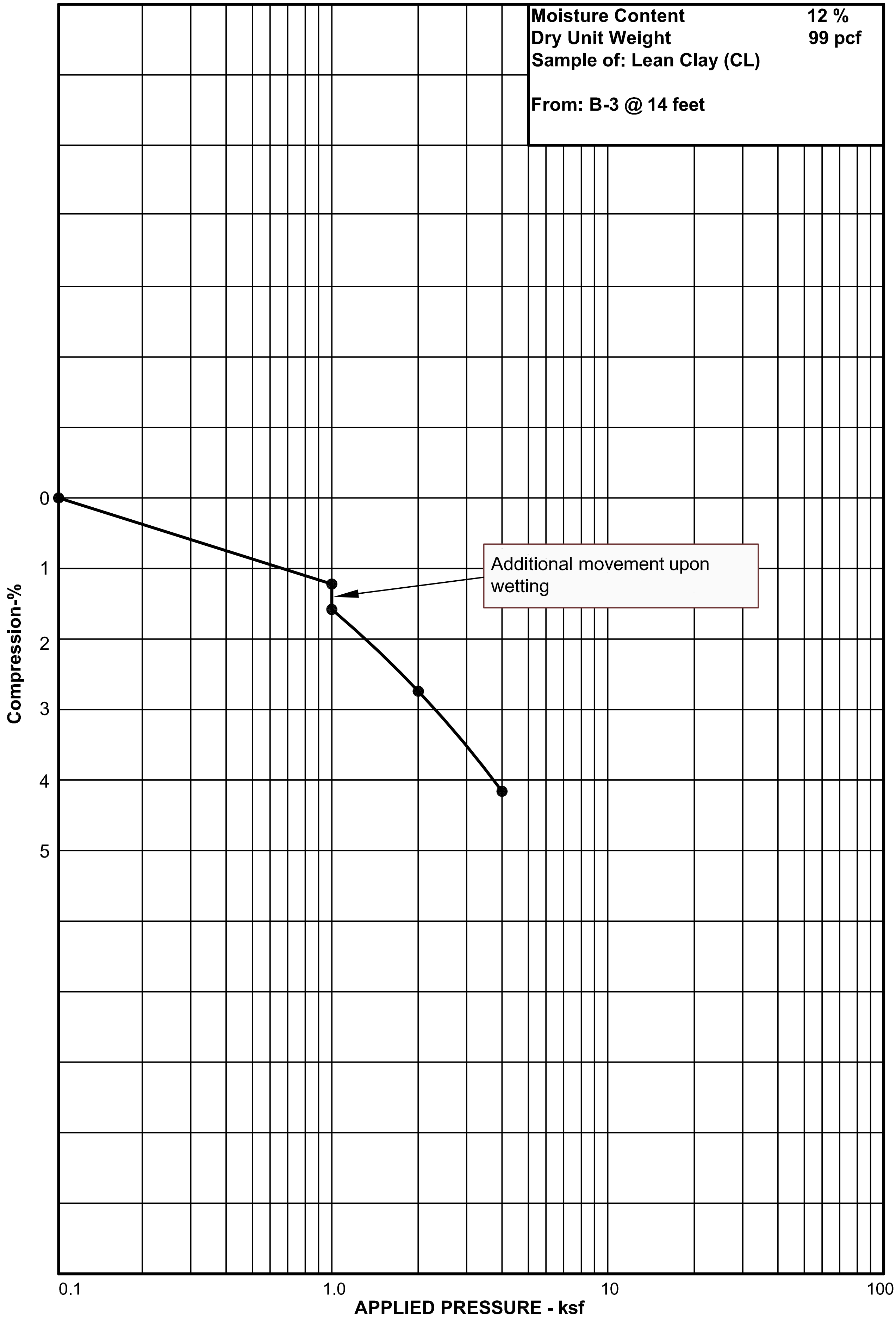
1. The borings were drilled on September 15, 16, 19, 20, 21, and 28, 2022 with a truck mounted drill rig equipped with 8-inch hollow-stem augers. Air rotary techniques were implemented to drill through very dense gravels and boulders, A 2½" HQ core barrel was utilized to core basalt Air was used to remove cuttings.
2. The locations of the borings were measured by a hand held GPS.
3. The elevation of the borings were interpolated between contours from the site plan provided.
4. The boring locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Free water was not encountered in the borings at the time of drilling.
7. WC = water content (%);
   DD = dry density (pcf);
   +4 = percent retained on the No. 4 sieve;
   -200 = percent passing No. 200 sieve;
   LL = liquid limit (%);
   PI = plasticity index (%);
   NP = non plastic;
   WSS = water soluble sulfates (ppm).

Applied Geotechnical Engineering Consultants, Inc.

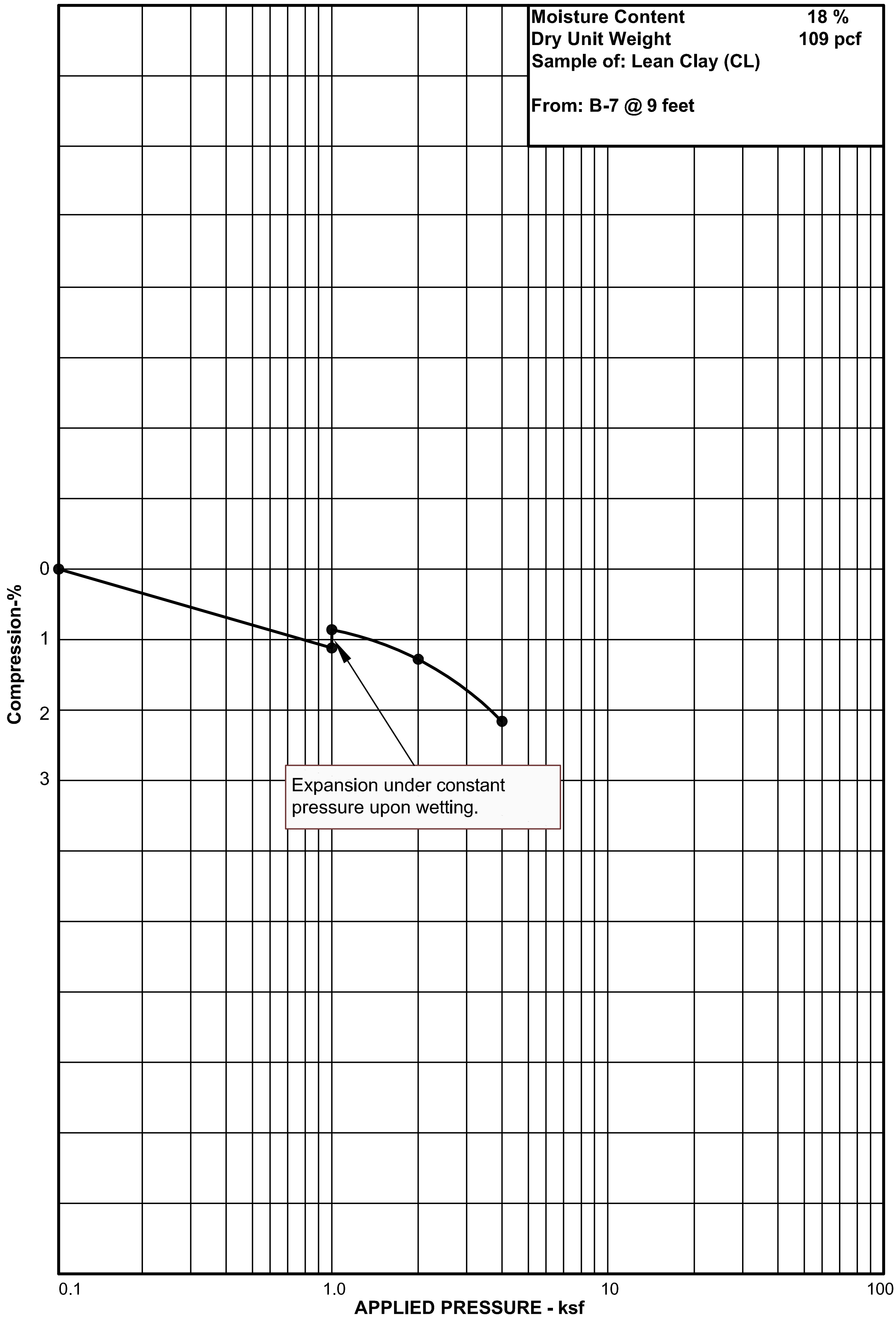


Project No. 2221598 CONSOLIDATION TEST RESULTS Figure 10

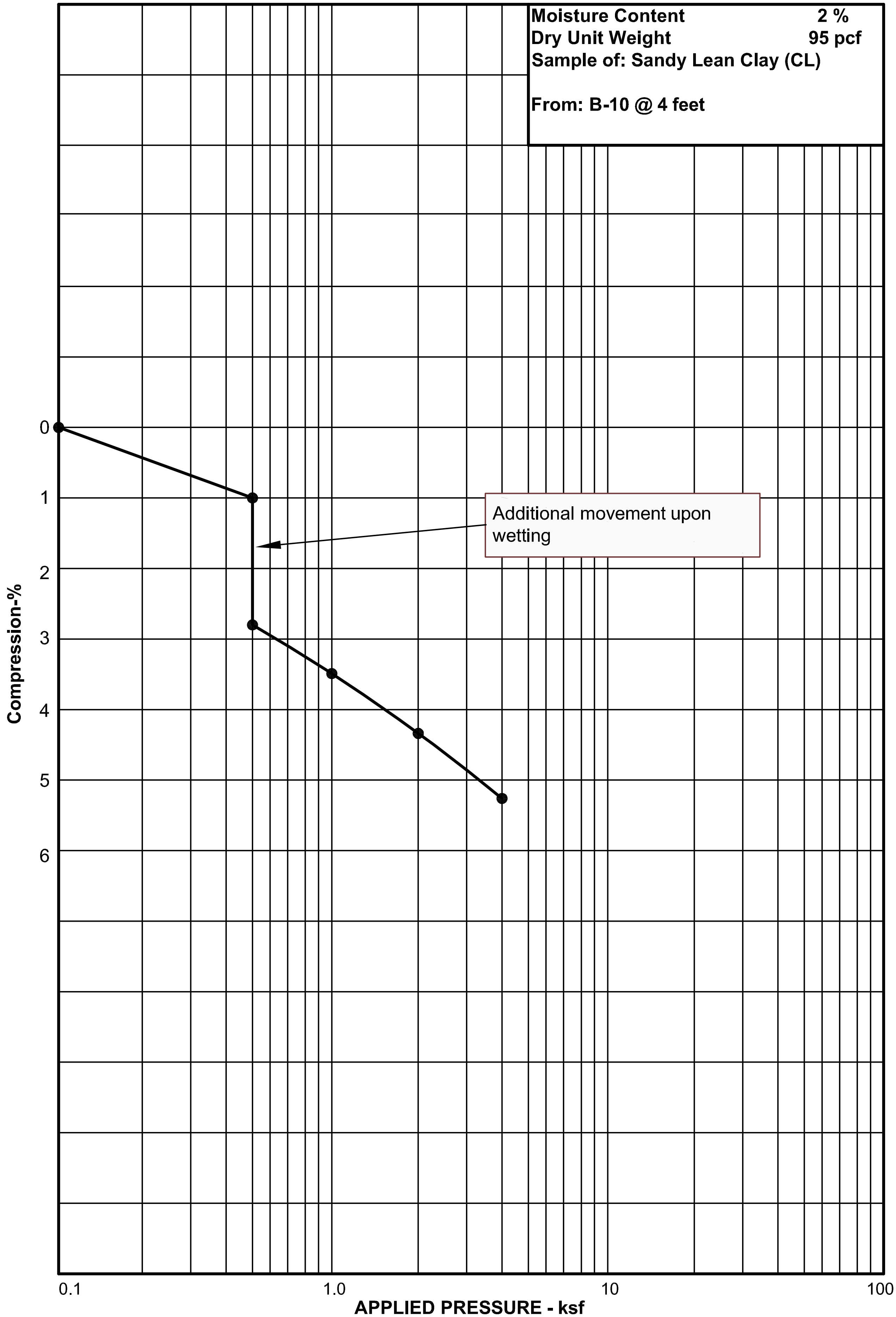
Applied Geotechnical Engineering Consultants, Inc.



Applied Geotechnical Engineering Consultants, Inc.

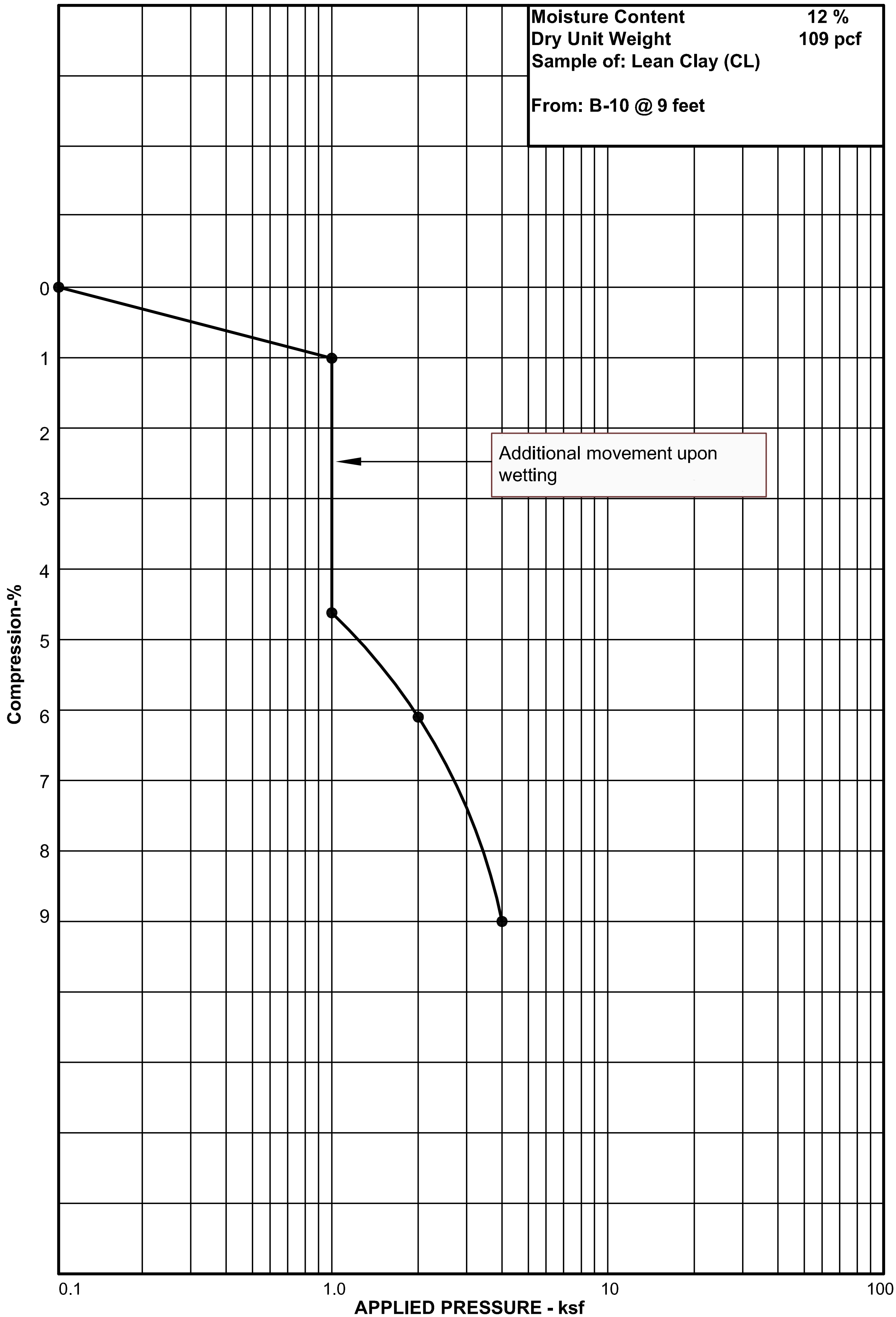


Applied Geotechnical Engineering Consultants, Inc.



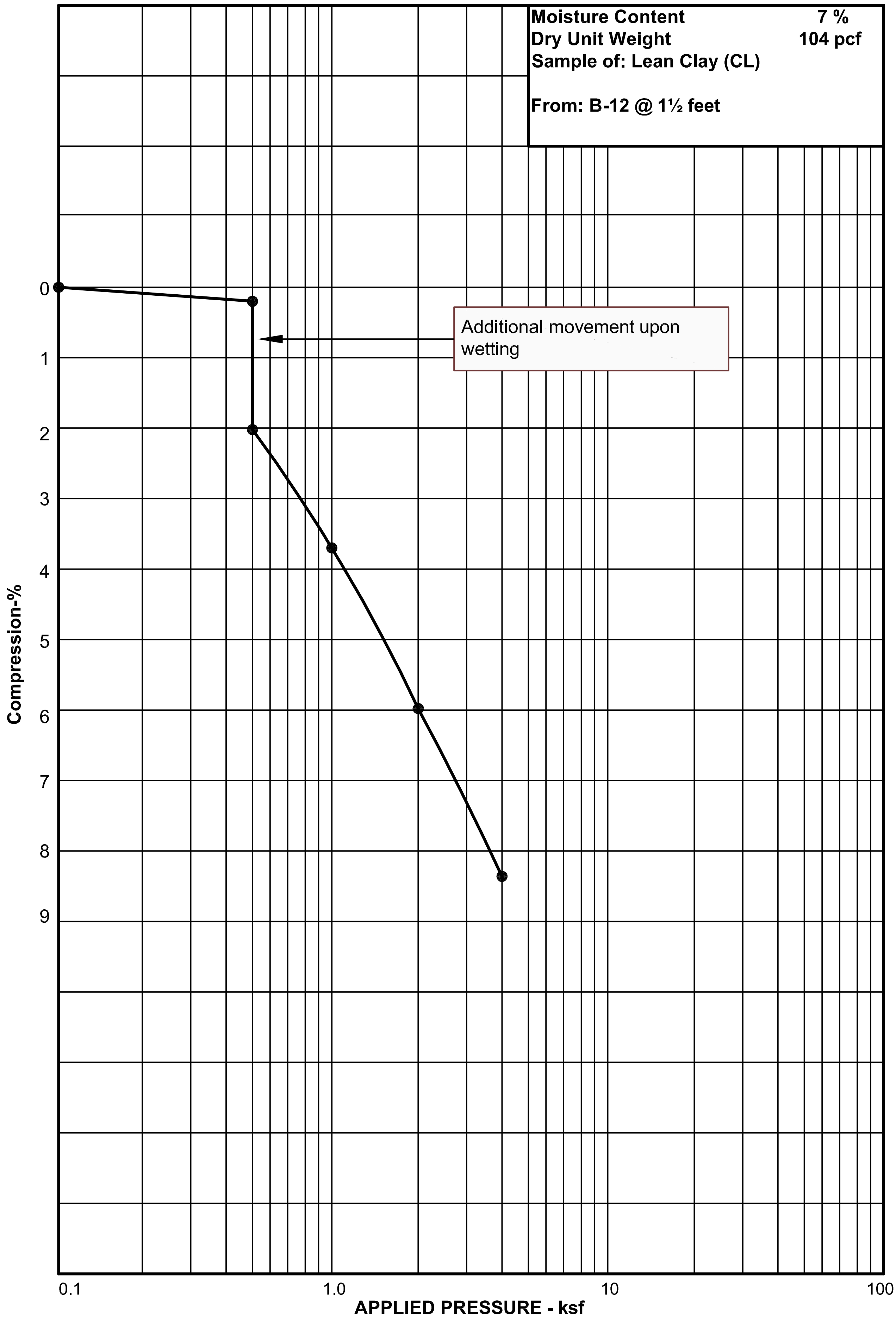
Project No. 2221598 CONSOLIDATION TEST RESULTS Figure 13

Applied Geotechnical Engineering Consultants, Inc.



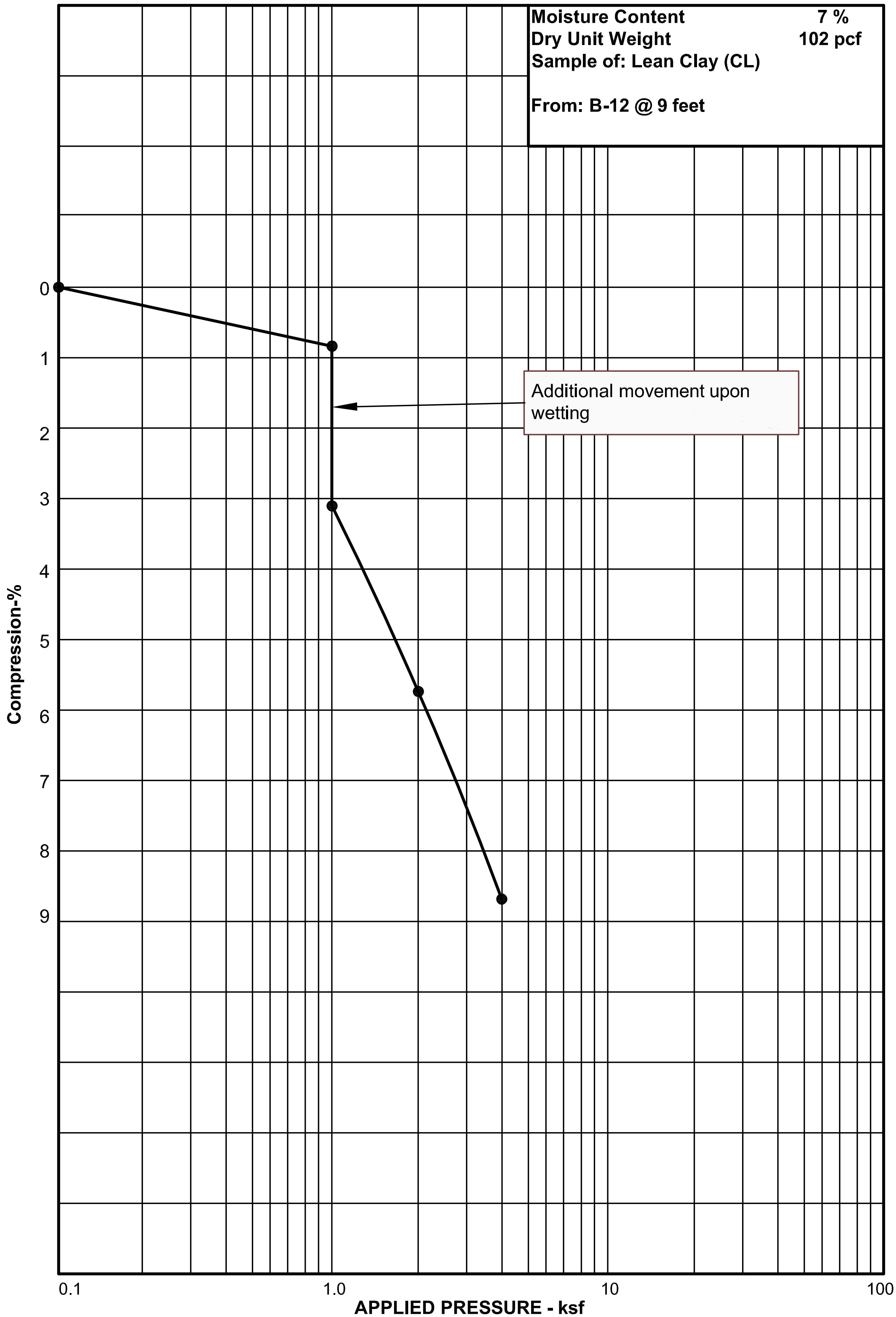
Project No. 2221598 CONSOLIDATION TEST RESULTS Figure 14

Applied Geotechnical Engineering Consultants, Inc.

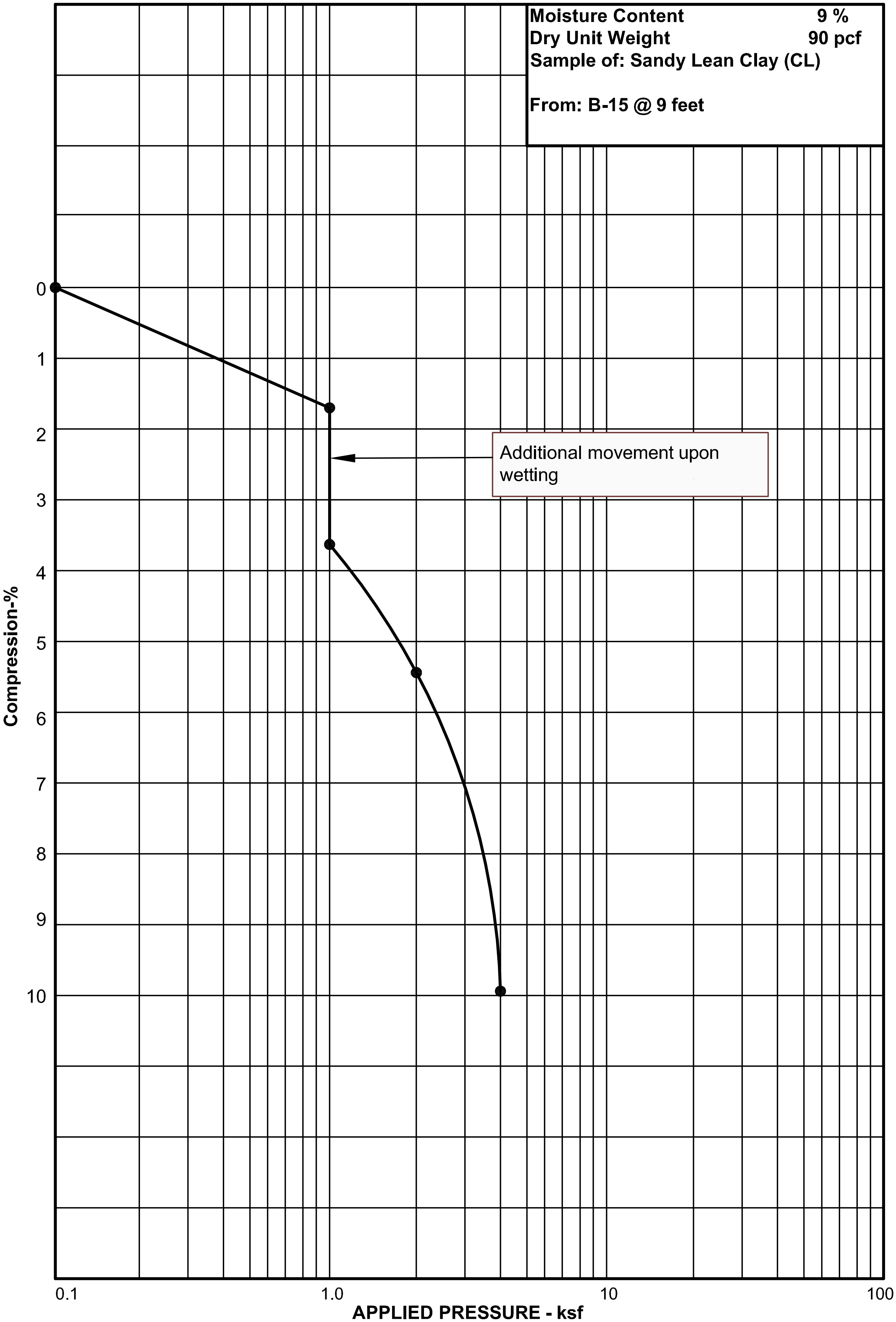


Project No. 2221598 CONSOLIDATION TEST RESULTS Figure 15

Applied Geotechnical Engineering Consultants, Inc.

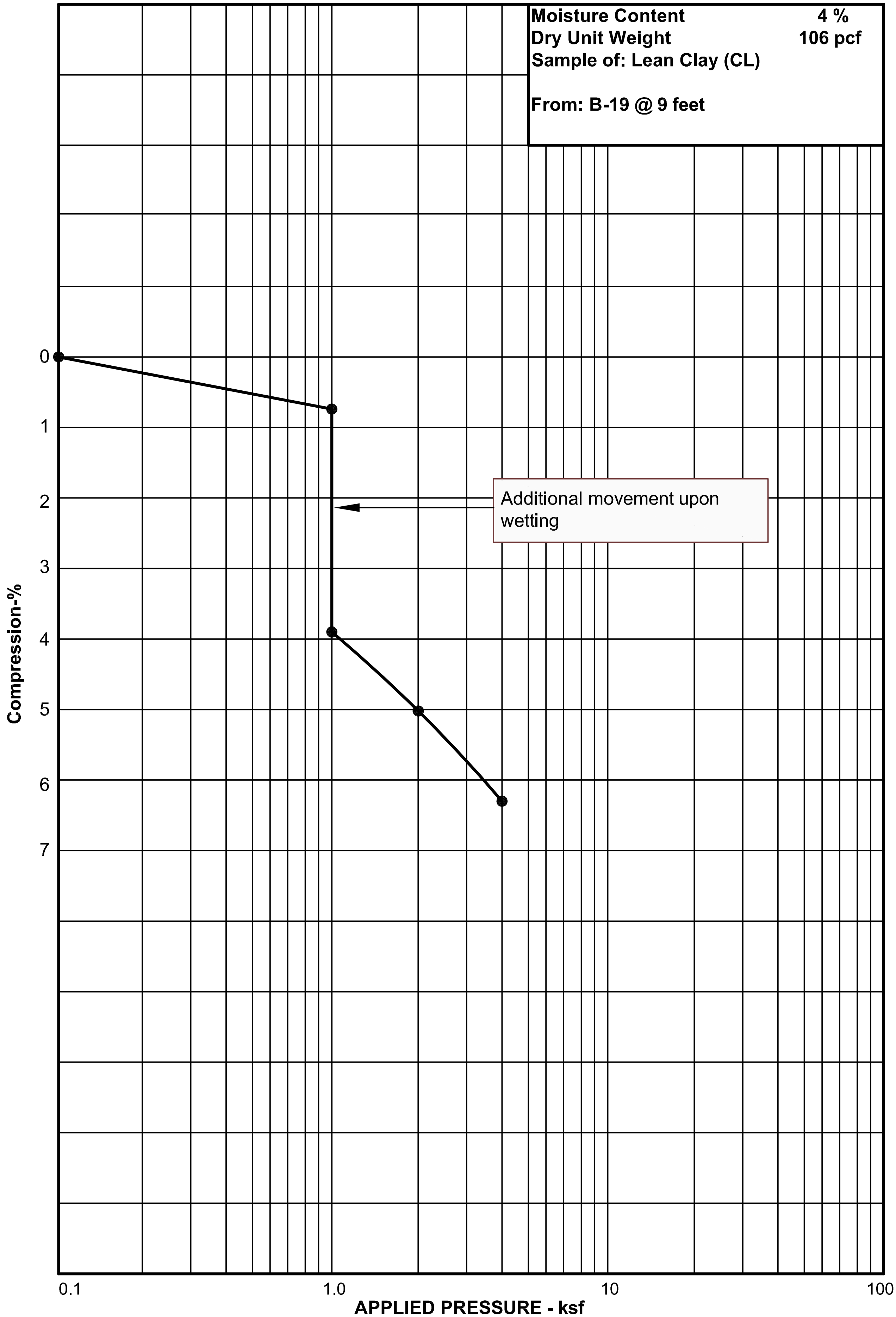


Applied Geotechnical Engineering Consultants, Inc.

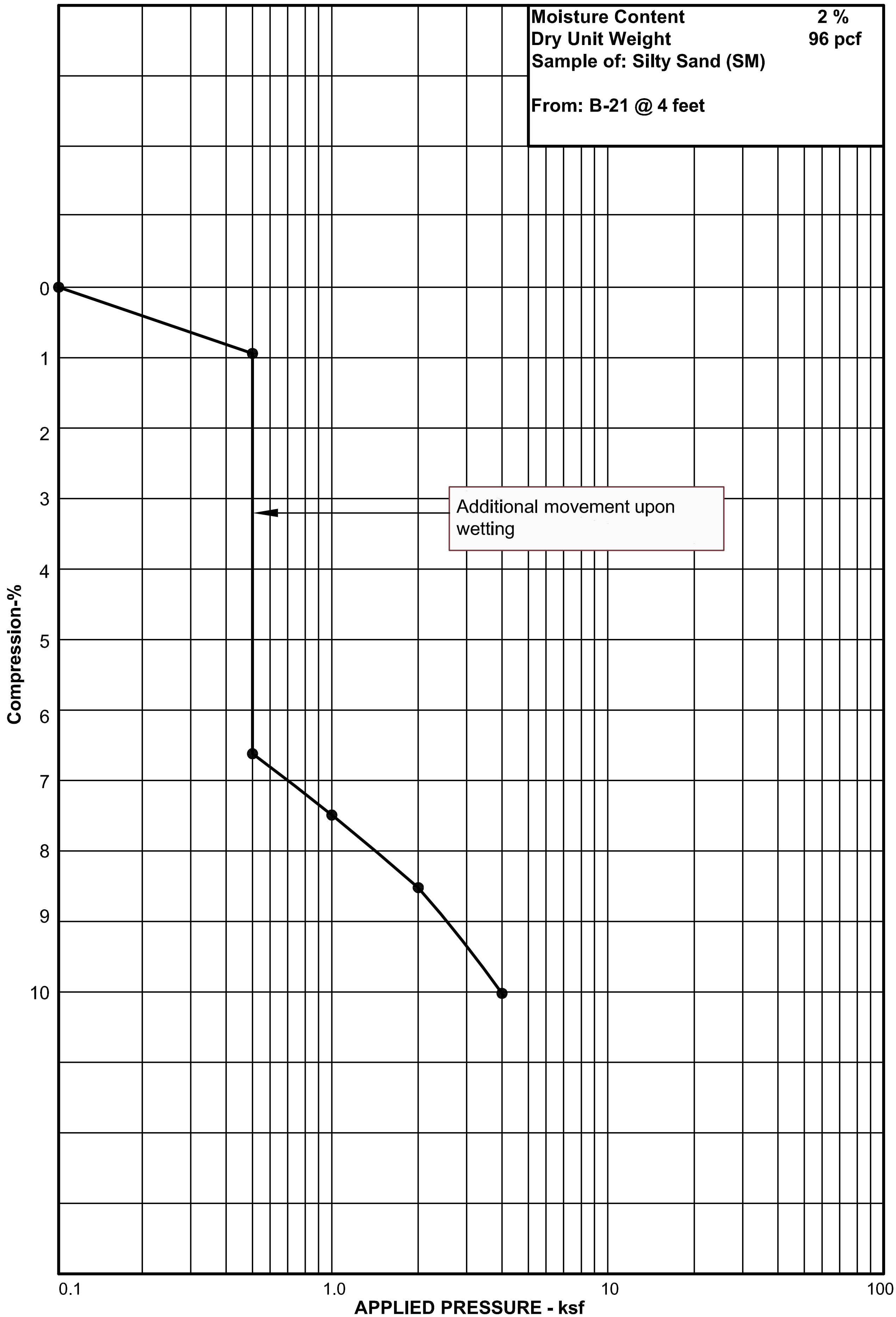


Project No. 2221598 **CONSOLIDATION TEST RESULTS** **Figure 17**

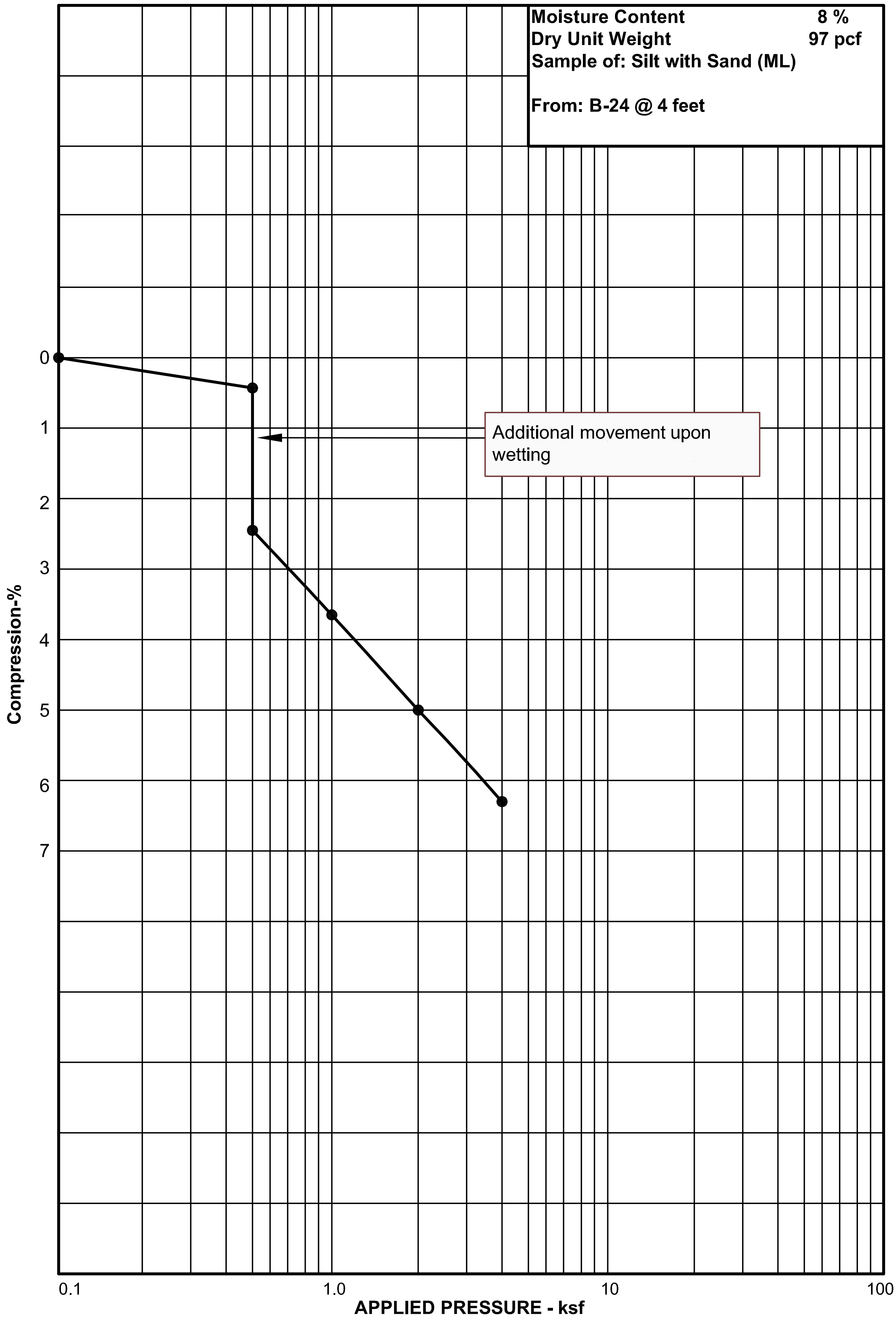
Applied Geotechnical Engineering Consultants, Inc.



Project No. 2221598 CONSOLIDATION TEST RESULTS Figure 18


Moisture Content 2 %
Dry Unit Weight 96 pcf
Sample of: Silty Sand (SM)
From: B-21 @ 4 feet
Additional movement upon wetting
Compression-%
0
1
2
3
4
5
6
7
8
9
10
0.1
1.0
10
100
APPLIED PRESSURE - ksf

Applied Geotechnical Engineering Consultants, Inc.



APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Commerce Crossroads Phase 1 — Project Number 2221598

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Water Soluble Sulfates (ppm)	Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)		
B-1	4	5	98							Silty Sand (SM)
B-1	9	4	96	18	66	16				Silty Sand (SM)
B-1	14	4	106							Silty Sand (SM)
B-1	19	3	103	14	80	6				Poorly Graded Sand with Silt (SP-SM)
B-3	1½	6	97			89				Silt with Sand (ML)
B-3	9	1	103							Silty Sand (SM)
B-3	14	12	99			93	33	17		Lean Clay (CL)
B-3	19	13	108	7	31	62				Sandy Lean Clay (CL)
B-5	9	9	120			77				Lean Clay with Sand (CL)
B-5	14	11	91							Poorly Graded Sand (SP)
B-6	4	1	102							Silty Sand (SM)
B-6	9	6	103			93				Lean Clay (CL)
B-6	14	18	109			100	47	30		Lean Clay (CL)
B-7	1½	12	93			91				Silt (ML)
B-7	4	2	94						2,500	Silt (ML)

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Commerce Crossroads Phase 1 | Project Number 2221598

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Water Soluble Sulfates (ppm)	Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)		
B-7	9	18	109			89	40	26		Lean Clay (CL)
B-10	1½	14	94				33	19	4,500	Lean Clay (CL)
B-10	4	2	95			63				Sandy Lean Clay (CL)
B-10	9	12	109			93	35	20		Lean Clay (CL)
B-10	14	15	104							Lean Clay (CL)
B-10	19	16	97			100				Lean Clay (CL)
B-12	1½	7	104			96				Lean Clay (CL)
B-12	4	7	102				32	16	420	Lean Clay (CL)
B-12	9	7	102			99	31	16		Lean Clay (CL)
B-12	14	9	101	8	36	56	33	17		Sandy Lean Clay (CL)
B-15	1½	4	100							Silty Sand (SM)
B-15	9	9	90	0	32	68				Sandy Lean Clay (CL)
B-15	14	2	97			33				Silty Sand (SM)
B-15	24	4	104	22	65	13				Silty Sand with Gravel (SM)
B-15	29	7	123	28	57	15				Silty Sand with Gravel (SM)
B-16	1½	8	91							Sandy Lean Clay (CL)

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Commerce Crossroads Phase 1 | Project Number 2221598

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Water Soluble Sulfates (ppm)	Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)		
B-16	4	7	100			69				Sandy Lean Clay (CL)
B-16	9	7	100	20	54	26			550	Silty Sand (SM)
B-16	14	4	97			78		NP		Silt with Sand (ML)
B-16	19	2	111			45				Silty Sand (SM)
B-19	1½	8	94			100	44	27		Lean Clay (CL)
B-19	9	4	106			97	23	8		Lean Clay (CL)
B-19	19	4	105			26				Silty Sand (SM)
B-20	4	13	100			97				Silt (ML)
B-20	9	4	96			100				Silt (ML)
B-20	14	6	95			70	21	6		Sandy Silt (ML)
B-20	19	7	117	6	45	49				Silty Sand (SM)
B-20	29	11	113			65	28	15		Sandy Lean Clay (CL)
B-21	4	2	96			39				Silty Sand (SM)
B-21	9	10	106							Sandy Lean Clay (CL)
B-21	14	7	108			65				Sandy Lean Clay (CL)
B-24	1½	9	96							Silt with Sand (ML)

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Commerce Crossroads Phase 1 — Project Number 2221598

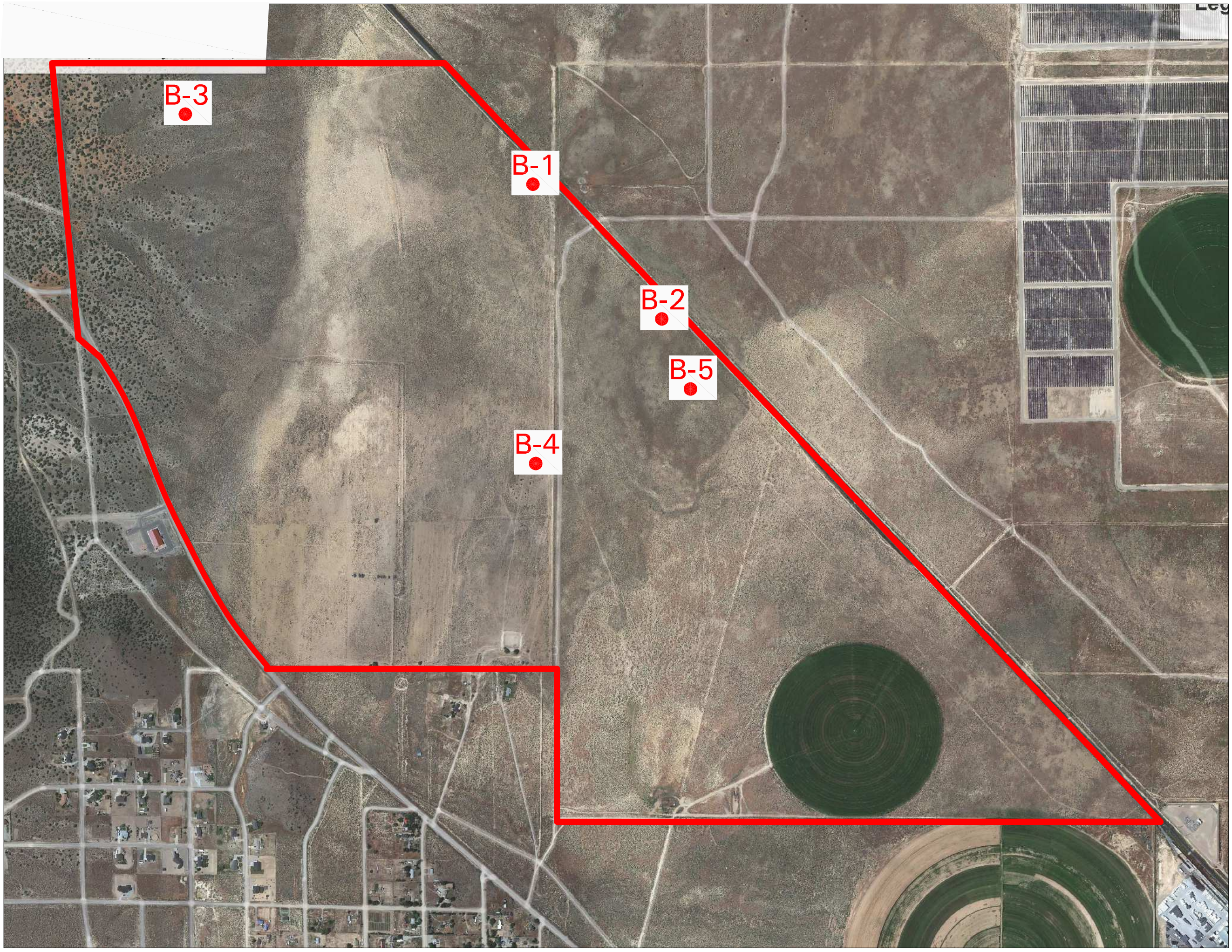
Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Water Soluble Sulfates (ppm)	Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)		
B-24	4	8	97			100				Silt with Sand (ML)
B-24	9	2	100			17		NP		Silty Sand (SM)
B-24	19	19	101			100				Lean Clay (CL)
B-26	4	10	98			79				Silt with Sand (ML)
B-26	9	1	97							Silt (ML)
B-26	14	11	104			99	26	7		Silt (ML)
B-26	19	5	99							Silt (ML)
B-26	29	3	115							Silt (ML)
B-26	34	63	58			83	81	47		Fat Clay with Sand (CH)
B-26	39	12	104							Fat Clay (CH)
B-27	4	7	103						540	Silt with Sand (ML)
B-27	9	8	102			100	32	15		Lean Clay (CL)
B-27	19	17	112							Lean Clay (CL)
B-27	29	11	113			74				Lean Clay with Sand (CL)

APPENDIX
Previous Study Data

Not to Scale

CEDAR IRON APEX
CEDAR CITY, UTAH

2220054	AGEC	Vicinity Map	Figure 1



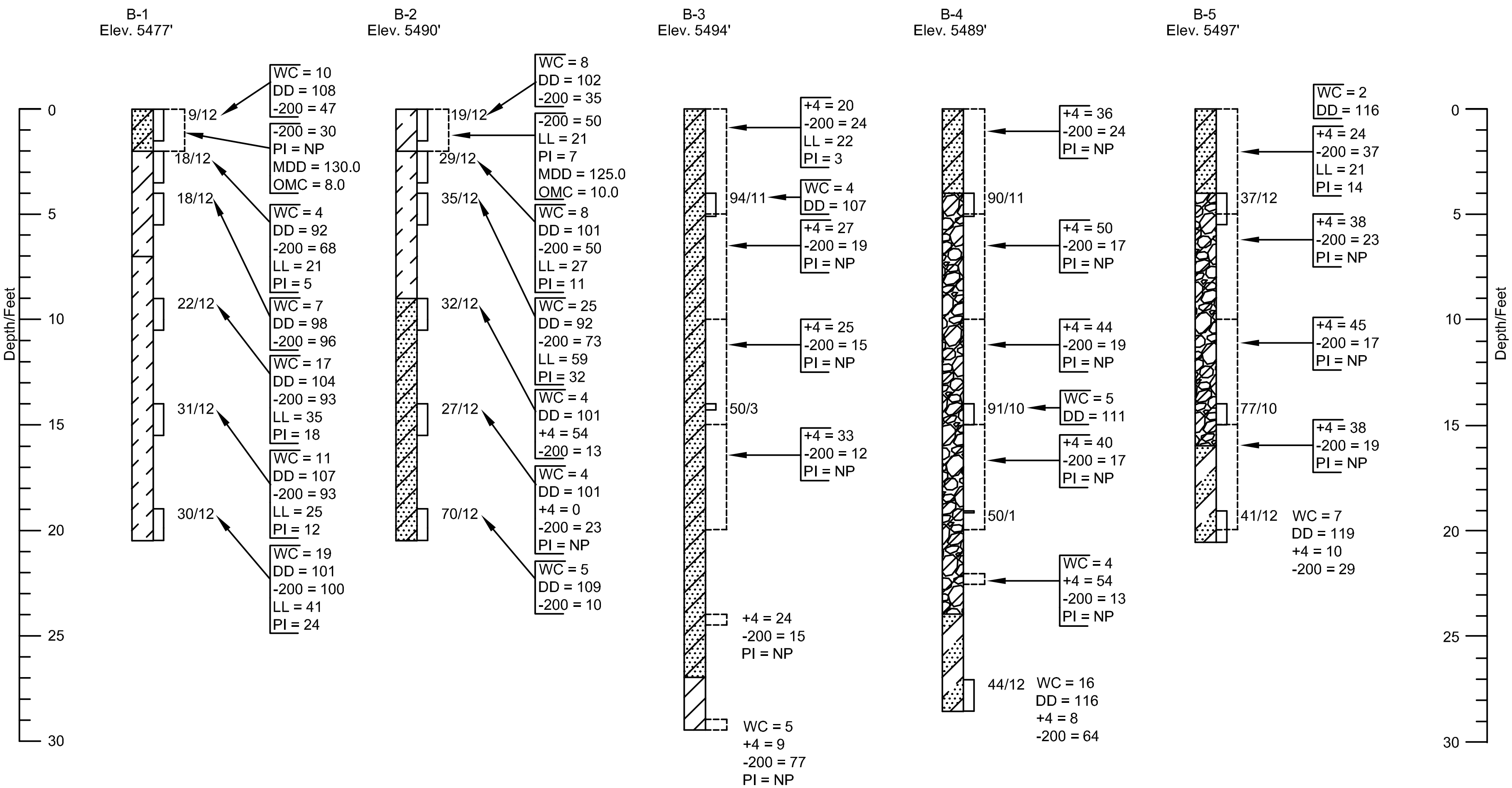
CEDAR APEX RAIL SPUR
CEDAR CITY, UTAH

● Approximate boring location

N

0 1,500 3,000 feet

2220054	AGEC	Site Plan	Figure 2



2220054	AGEC	Logs of Exploratory Borings	Figure 3

LEGEND:

Lean Clay (CL); varied amounts of sand, stiff to very stiff, slightly moist, varies from low to medium plastic, light brown.

Silty -Clay (CL-ML); varied amounts of sand, medium stiff to stiff, slightly moist, light brown.

Silt (ML); contains layers of lean clay and silty sand, stiff to hard, dry to slightly moist, porous zones, rooted upper 3 to 4', light brown to grey.

Interlayered Silty Sand and Lean Clay, stiff to very stiff, moist, light brown.

Silty Sand (SM); medium dense to very dense, interlayered with thin layers of silt and clay and occasional small gravel, slightly moist, generally fine grained, brown.

Silty Gravel with Sand (GM); very dense, dry, brown to grey.

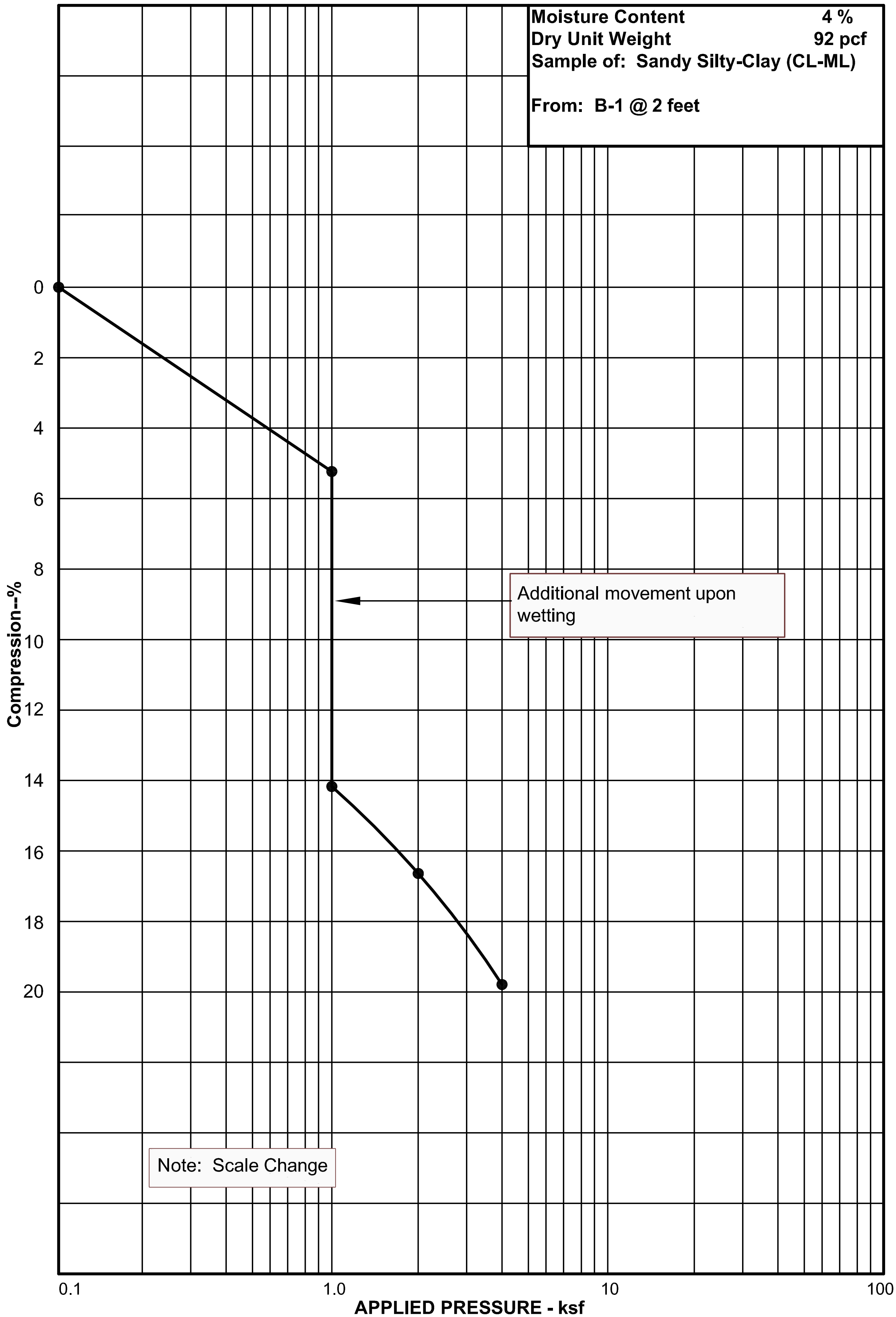
10/12 California drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates disturbed sample taken.

NOTES:

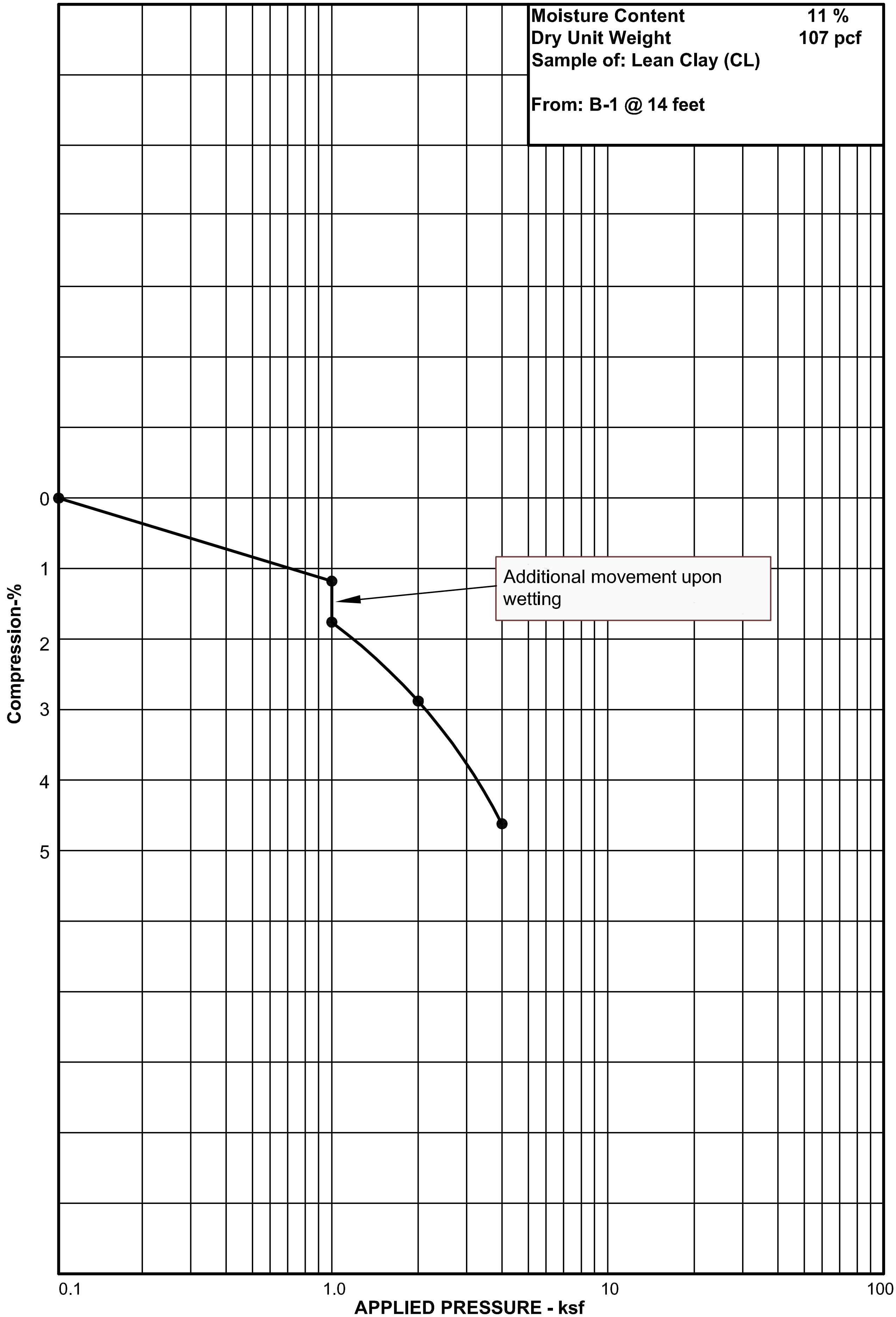
1. The borings were drilled on March 9, 2022 with a truck mounted drill rig equipped with 4-inch solid-stem augers.
2. The locations and elevations of the borings were located by a hand held GPS.
3. The boring locations and elevations should be considered accurate only to the degree implied by the method used.
4. The lines between the materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
5. Free water was not encountered in the borings at the time of drilling.
6. WC = water content (%);
   DD = dry density (pcf);
   +4 = percent retained on the No. 4 sieve;
   -200 = percent passing No. 200 sieve;
   LL = liquid limit (%);
   PI = plasticity index (%);
   NP = non-plastic;
   MDD = maximum dry density (pcf);
   OMC = optimum moisture content (%);

Applied Geotechnical Engineering Consultants, Inc.



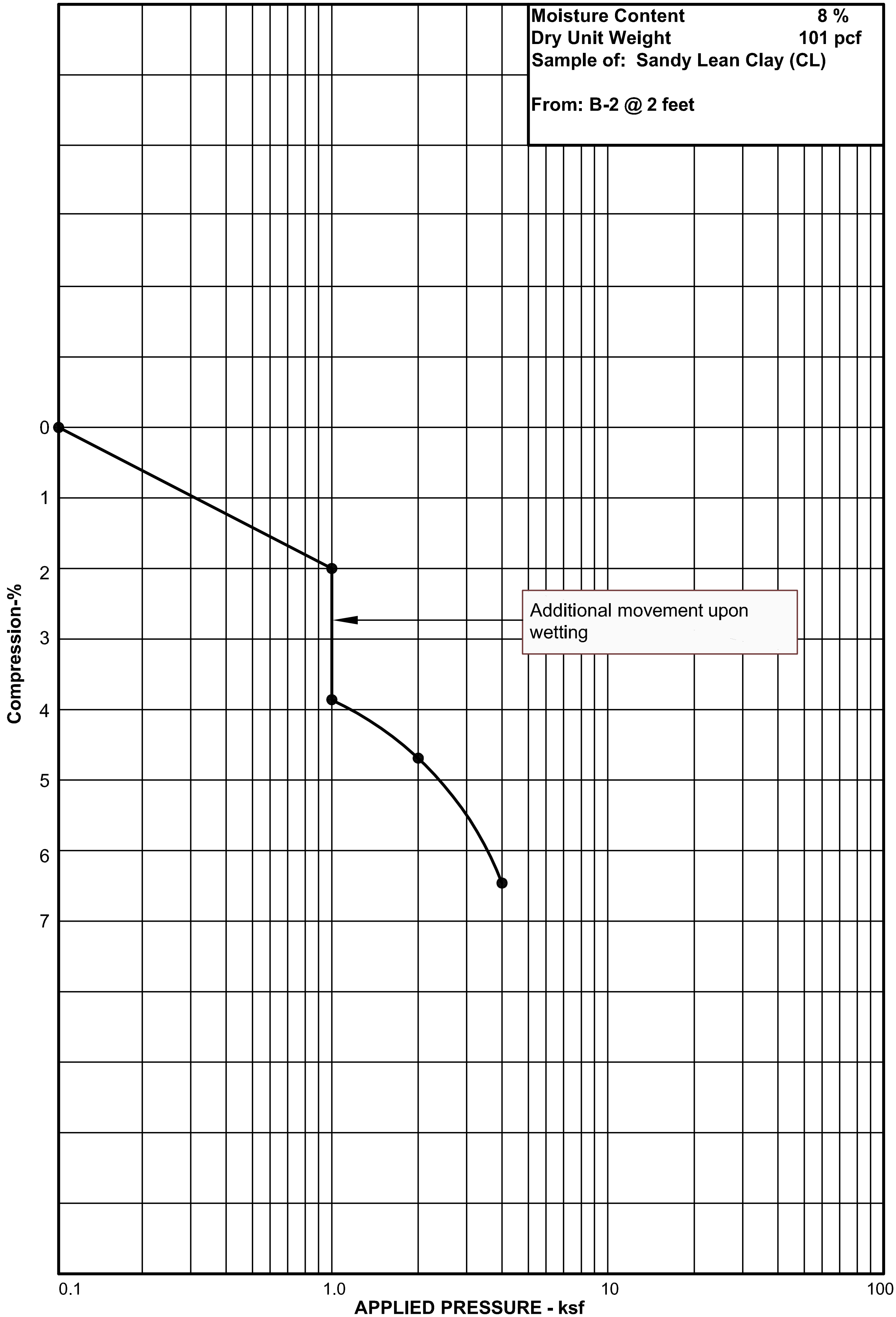
Project No. 2220054 CONSOLIDATION TEST RESULTS Figure 5

Applied Geotechnical Engineering Consultants, Inc.

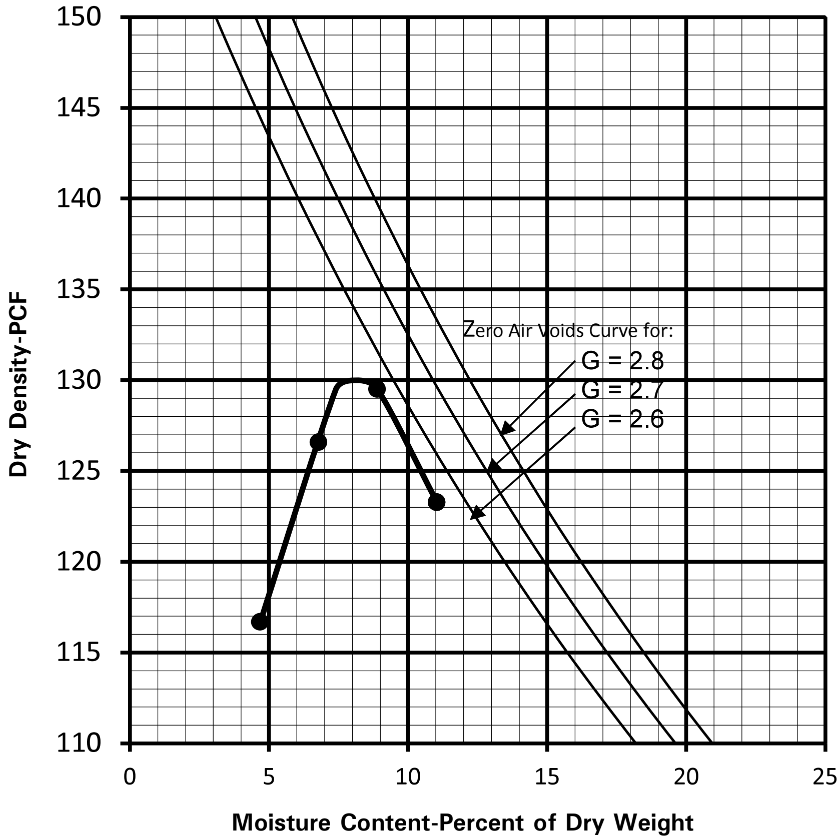


Project No. 2220054 **CONSOLIDATION TEST RESULTS** **Figure 6**

Applied Geotechnical Engineering Consultants, Inc.



Applied GeoTech Project: Cedar Apex Rail Spur

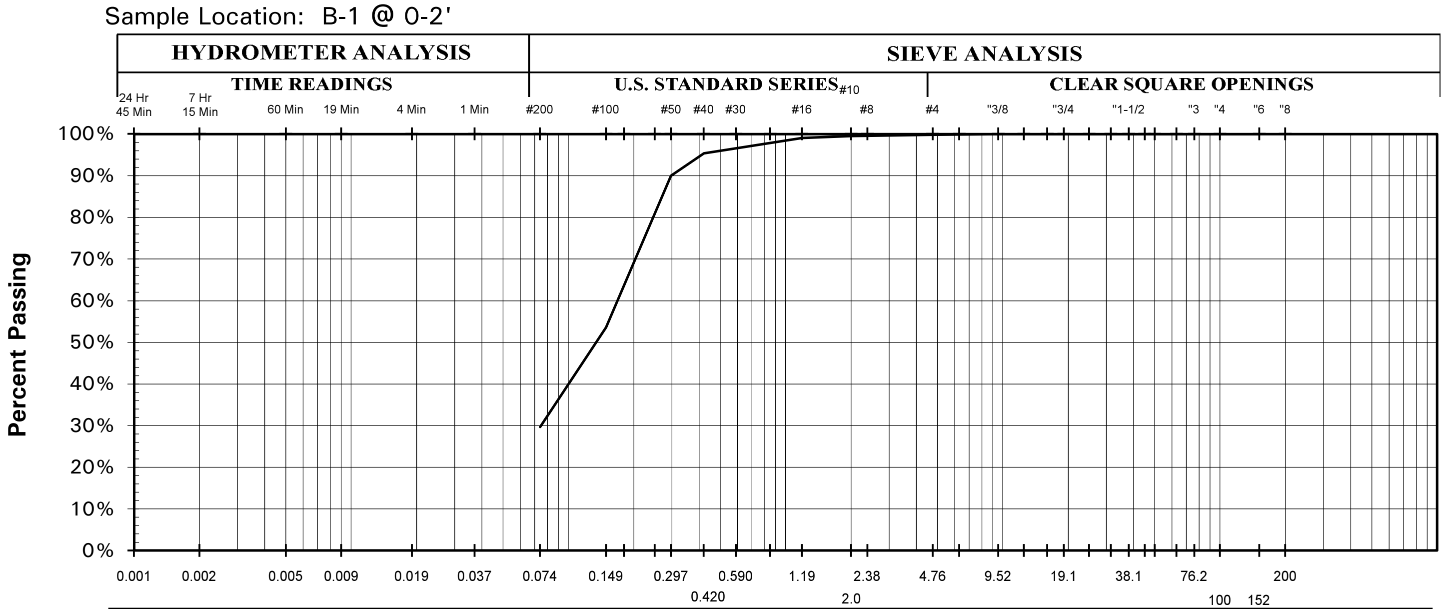


Sample Date: 2/26/22
Sample No. 220328A
Maximum Dry Density: 130.0
Optimum Moisture: 8.0

Atterberg Limits
Liquid Limit:
Plasticity Index: Non-Plastic

Gradation
Gravel: 0%
Sand: 70%
Silt & Clay: 30%

Moisture - Density Relationship Test Procedure: ASTM D-1557 B Reviewed By: TT
USCS Classification: silty sand (SM)
AASHTO Classification: A-2-4
Sample Location: B-1 @ 0-2'



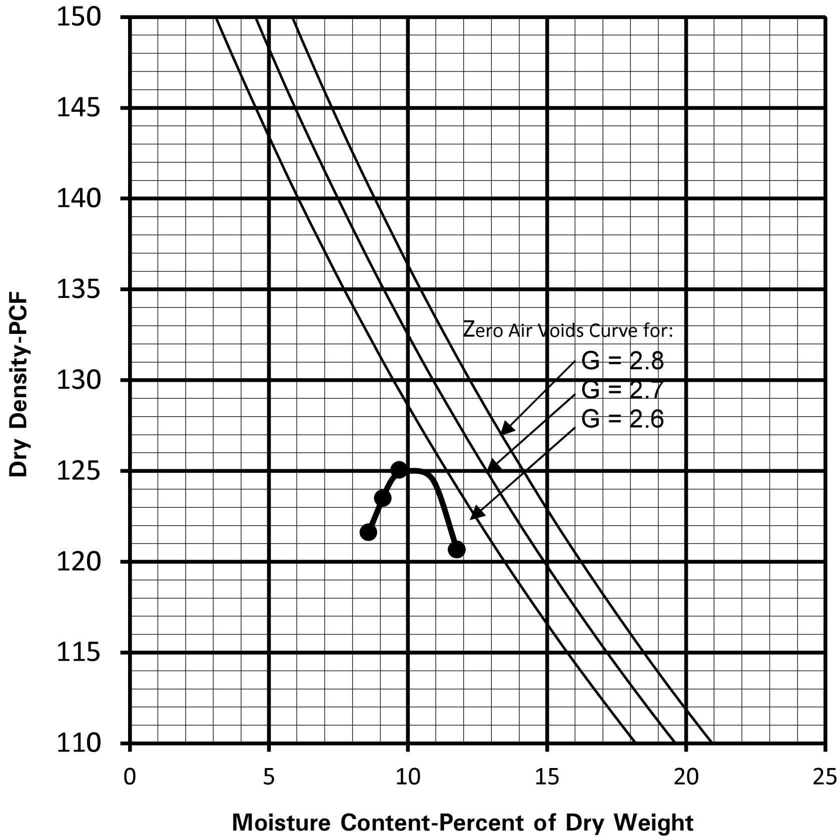
CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

GRADATION AND MOISTURE-DENSITY RELATIONSHIP RESULTS

Project No.: 2220054 Figure: 8

Applied GeoTech

Project: Cedar Apex Rail Spur



Sample Date:	2/26/22
Sample No.	220328B
Maximum Dry Density:	125.0
Optimum Moisture:	10.0
Atterberg Limits	
Liquid Limit:	21%
Plasticity Index:	7%
Gradation	
Gravel:	0%
Sand:	50%
Silt & Clay:	50%

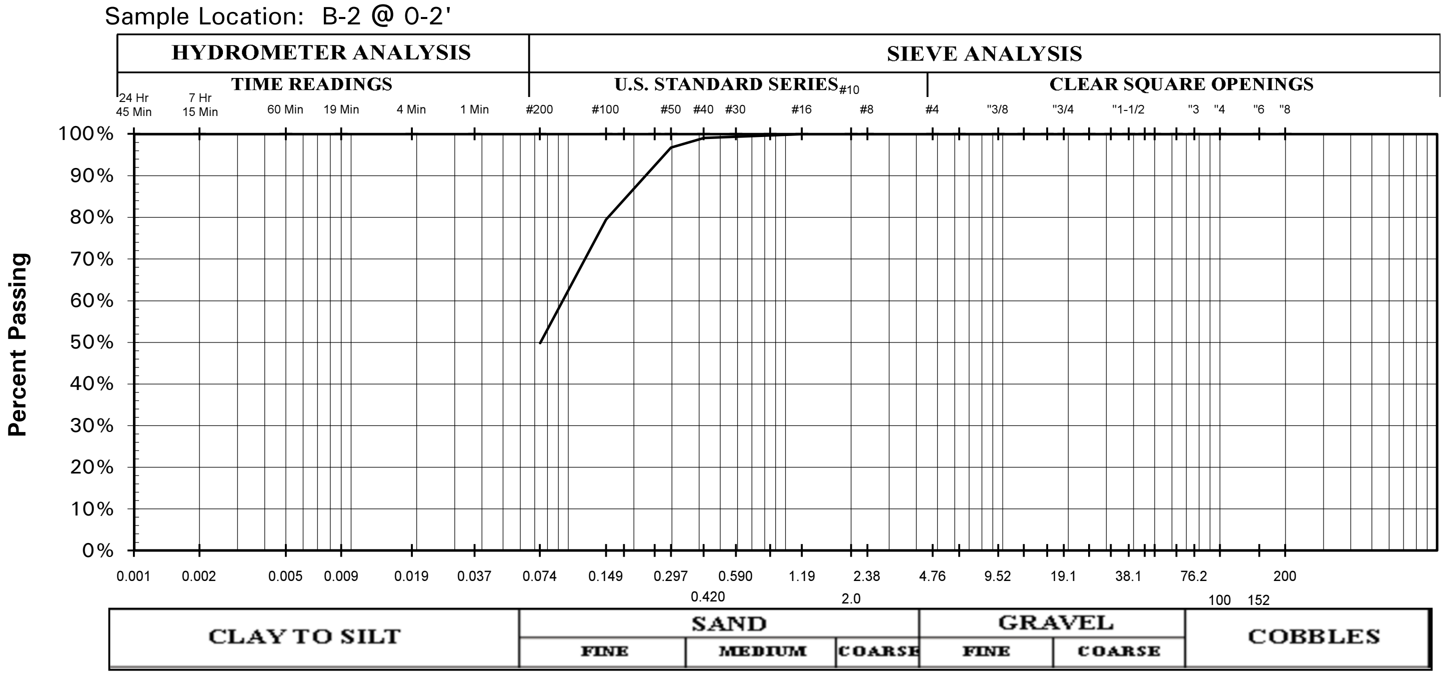
Moisture - Density Relationship Test Procedure: ASTM D-1557 B

Reviewed By: TT

USCS Classification: Sandy Silty-Clay (CL-ML)

AASHTO Classification: A-4

Sample Location: B-2 @ 0-2'



GRADATION AND MOISTURE-DENSITY RELATIONSHIP RESULTS

Project No.: 2220054

Figure: 9

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-3 @ 0-5'

Supplier:

Aggregate Size:

Gradation

Gravel:	20%
Sand:	56%
Silt & Clay:	24%

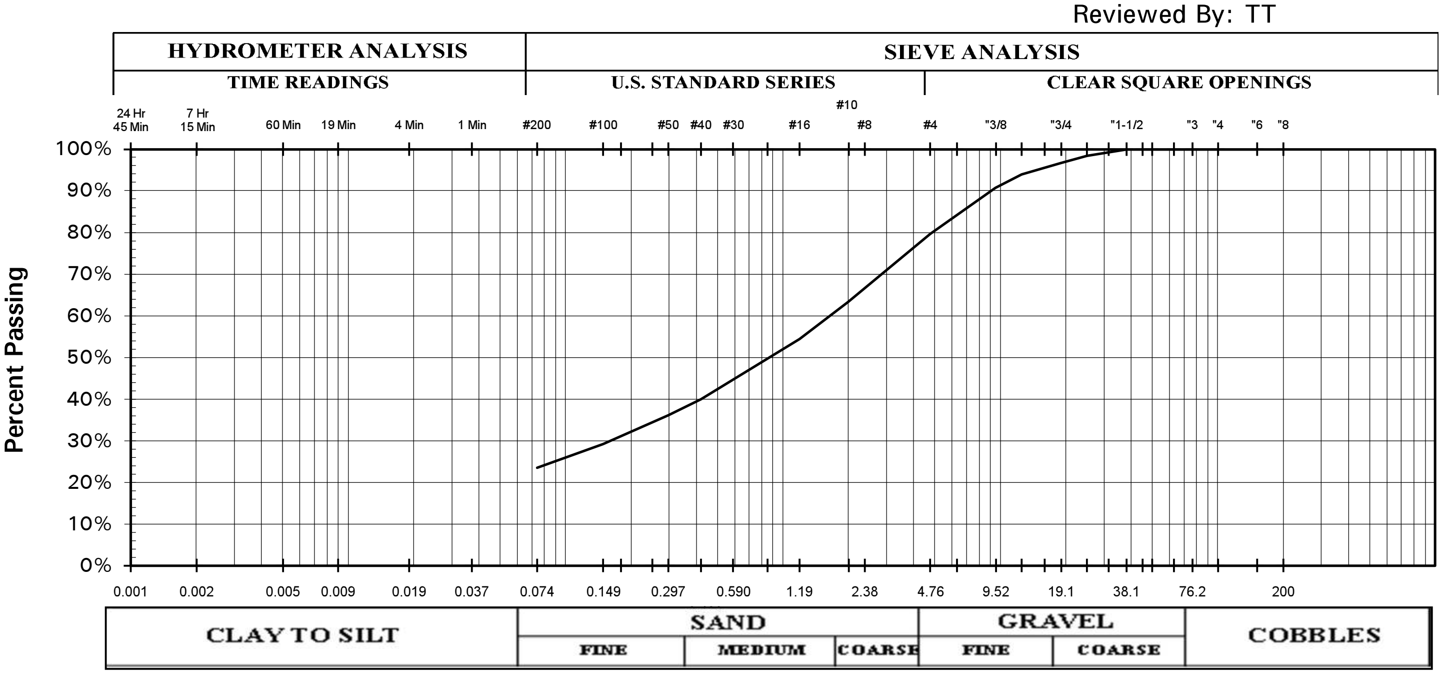
Atterberg Limits

Liquid Limit:	22%
Plasticity Index:	3%

USCS Classification: silty sand with gravel (SM)

AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 10

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-3 @ 5-10'

Supplier:

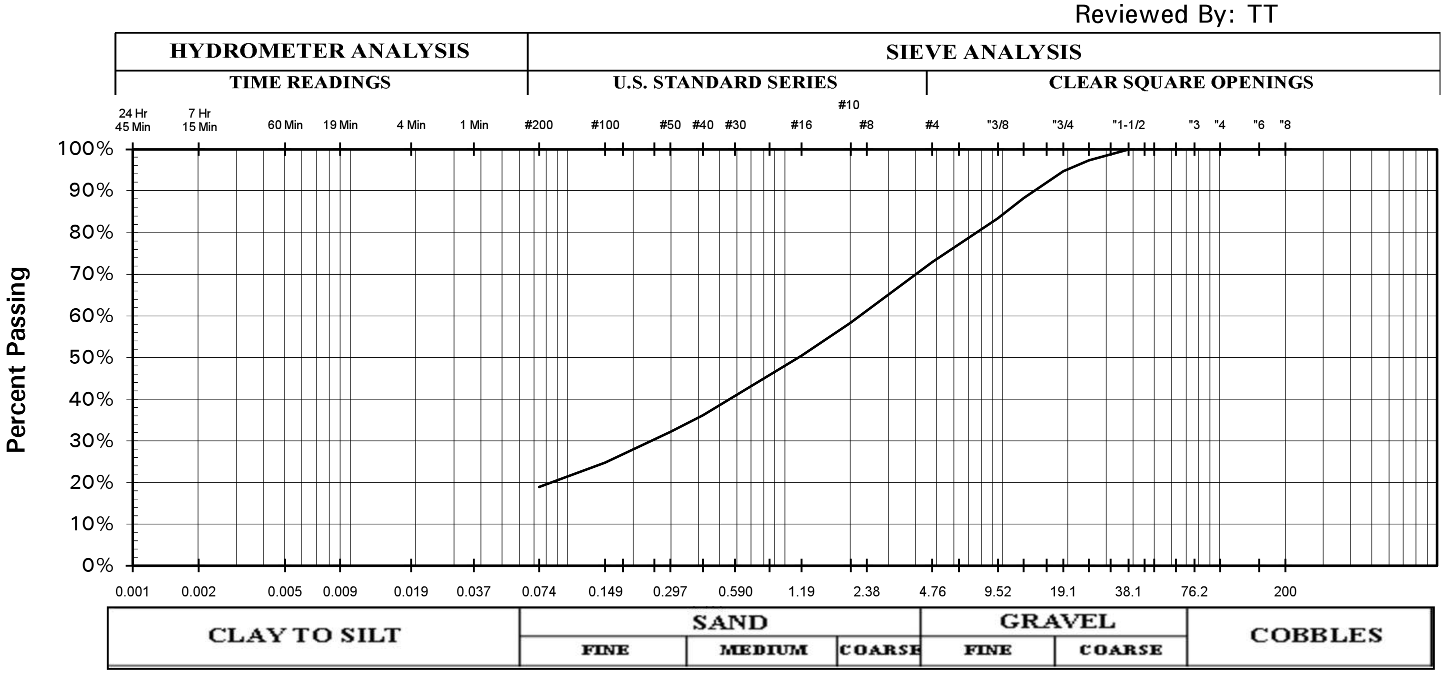
Aggregate Size:

Gradation		Atterberg Limits	
Gravel:	27%	Liquid Limit:	
Sand:	54%	Plasticity Index:	Non-Plastic
Silt & Clay:	19%		

USCS Classification: silty sand with gravel (SM)

AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 11

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-3 @ 10-15'

Supplier:

Aggregate Size:

Gradation

Gravel: 25%

Sand: 60%

Silt & Clay: 15%

Atterberg Limits

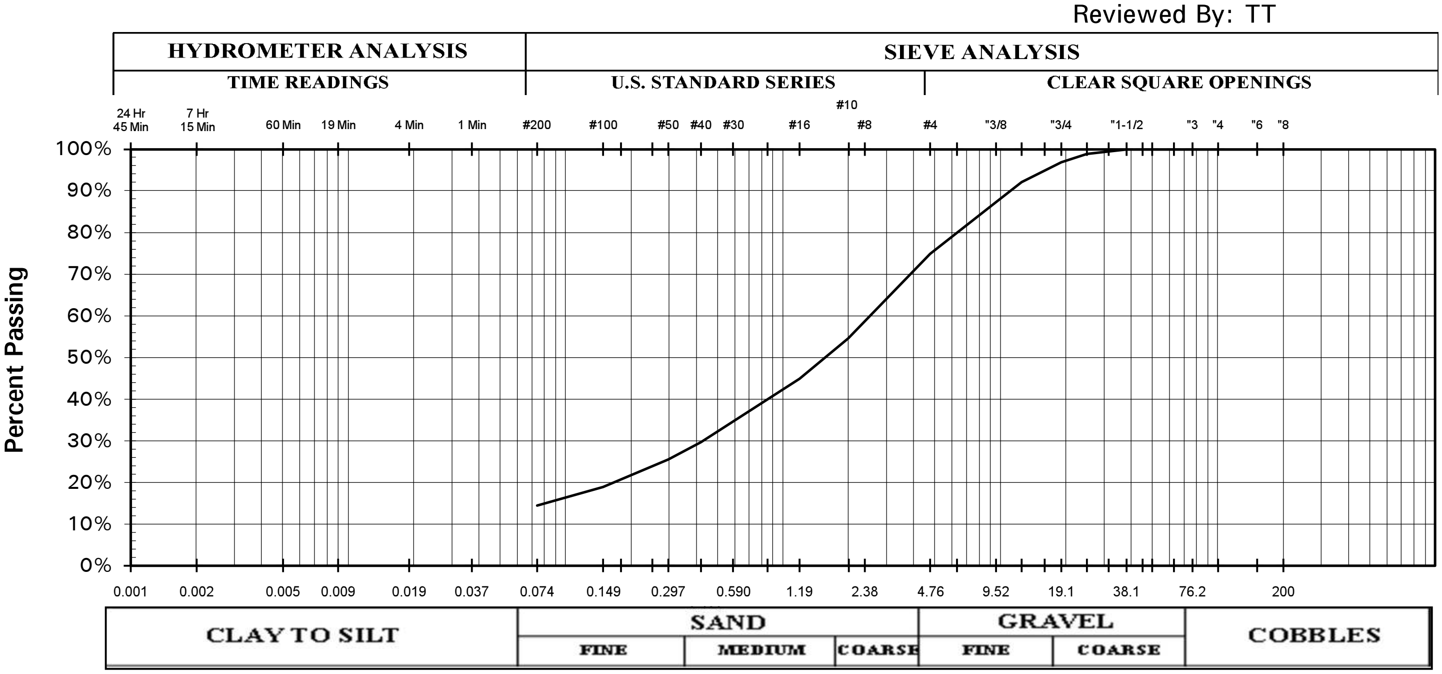
Liquid Limit:

Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)

AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 12

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-3 @ 15-20'

Supplier:

Aggregate Size:

Gradation

Gravel:	33%
Sand:	55%
Silt & Clay:	12%

Atterberg Limits

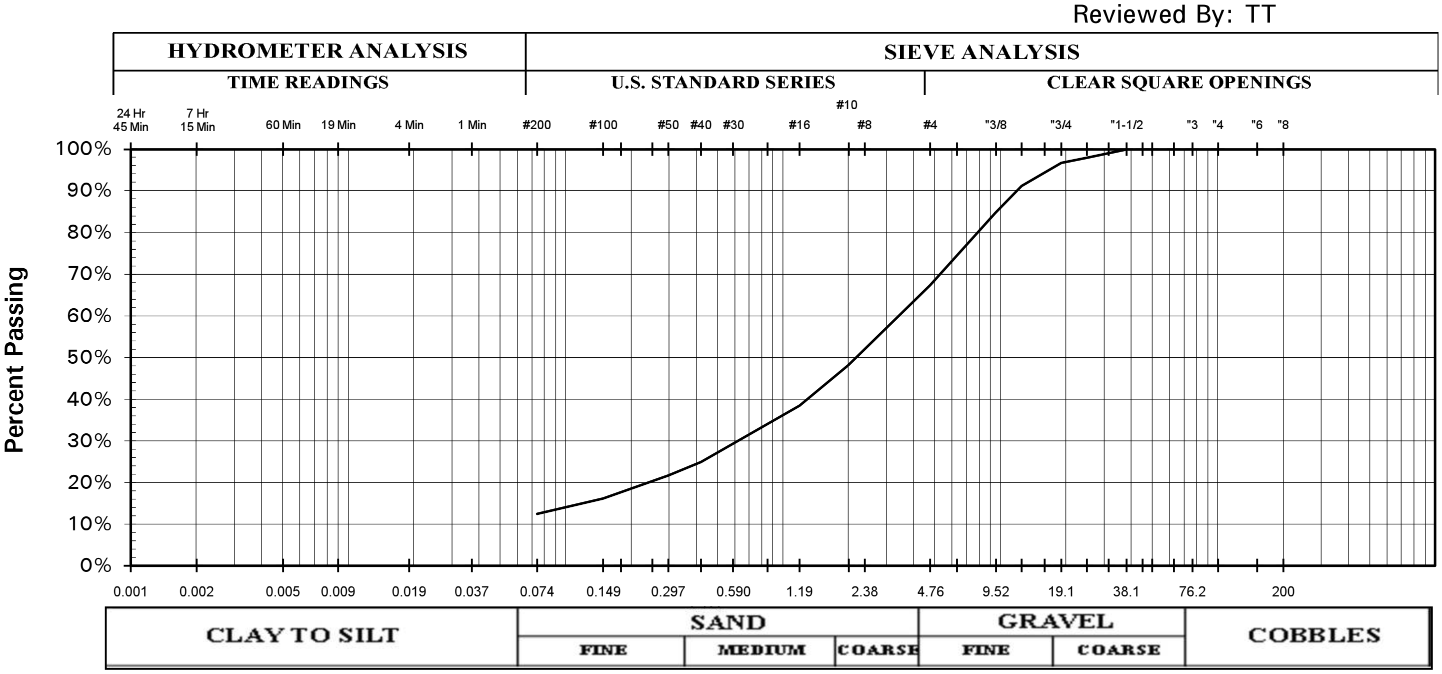
Liquid Limit:

Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)

AASHTO Classification: A-1-a

Reviewed By: TT



GRADATION CURVE

Figure: 13

Applied Geotechnical Engineering Consultants, Inc.

SIEVE ANALYSIS TEST REPORT

Quality Control

Sample Date	1/0/00	**Lab Number:**	0
Project Number:	2220054	**Sampled by:**	0
Project Name :	Cedar Apex Rail Spur	**Tested by:**	BI
Client:	BZI Steel		

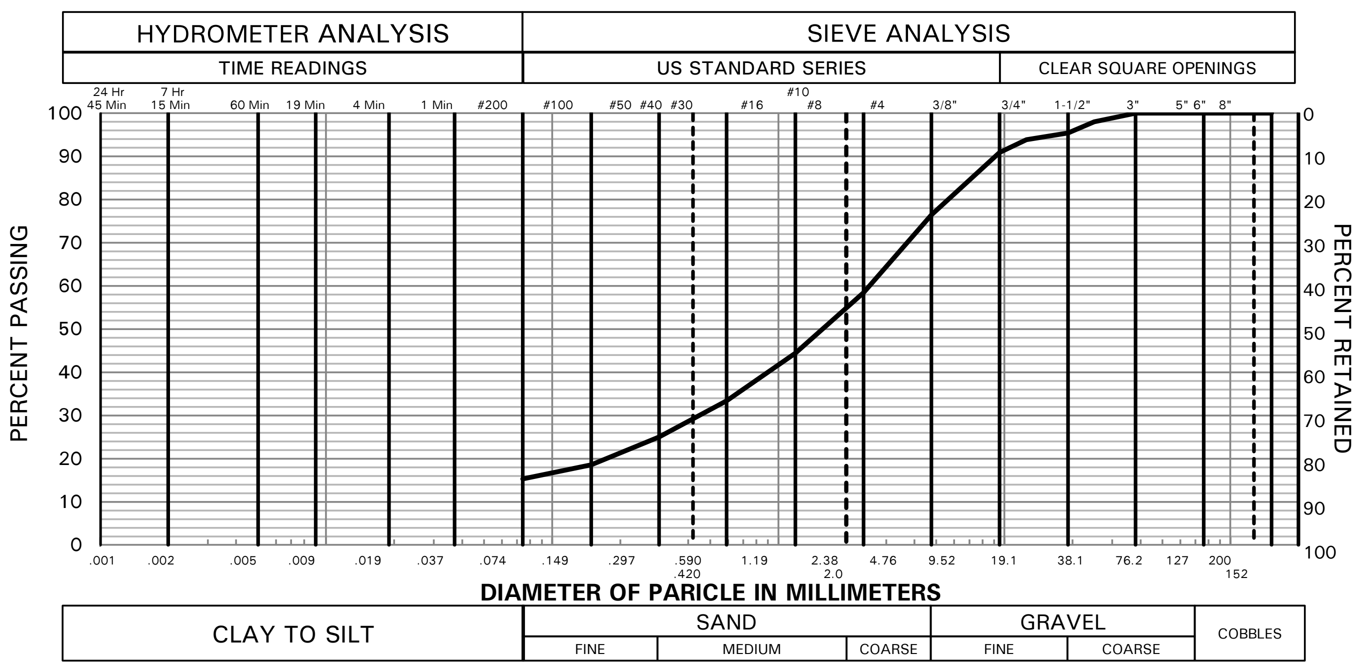
Sample Location: B-3 @ 24

Supplier: Native

Aggregate Size:

Gradation		Atterberg Limits	
Gravel:	24%	Liquid Limit:	
Sand:	61%	Plasticity Index:	Non-Plastic
Silt & Clay:	15%		

Sample Discription: silty sand with gravel (SM)



Sample Remarks:

Figure: 14

Reviewed by: TT

Applied Geotechnical Engineering Consultants, Inc.

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date	1/0/00	**Lab Number:**	0
Project Number:	2220054	**Sampled by:**	0
Project Name :	Cedar Apex Rail Spur	**Tested by:**	BI
Client:	BZI Steel		

Sample Location: B-3 @ 29
Supplier: Native
Aggregate Size:

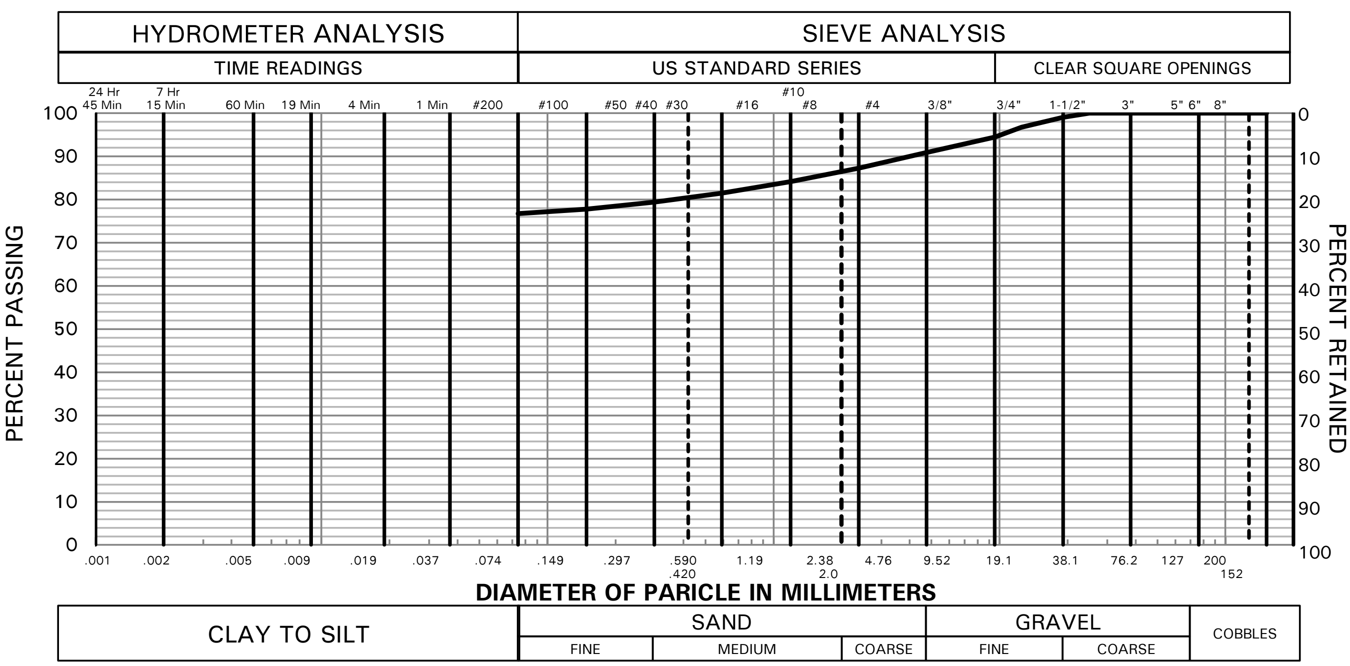
Gradation

Gravel:	9%
Sand:	14%
Silt & Clay:	77%

Atterberg Limits

Liquid Limit:	
Plasticity Index:	Non-Plastic

Sample Discription: silt with sand (ML)



Sample Remarks:

Figure: 15

Reviewed by: TT

1420 South 270 East • St. George, Utah 84790 • (435) 673-6850 • FAX (435) 673-1044

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date: 4/1/22
Project Number: 2220054
Project Name: Cedar Apex Rail Spur
Client: BZI Steel

Lab Number:
Sampled By: WR
Tested By: KB/SD

Sample Location: B-4 @ 0-5'
Supplier:
Aggregate Size:

Gradation

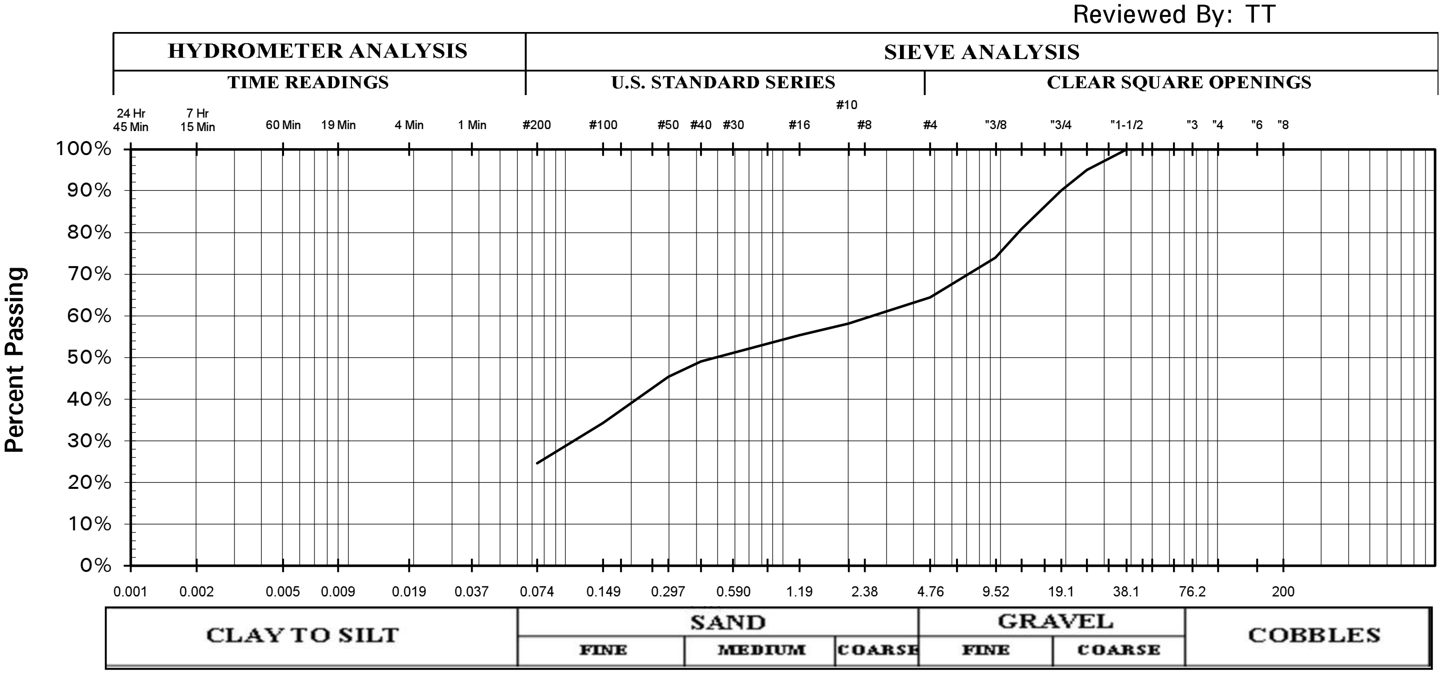
Gravel: 36%
Sand: 40%
Silt & Clay: 24%

Atterberg Limits

Liquid Limit:
Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)
AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 16

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date: 4/1/22
Project Number: 2220054
Project Name: Cedar Apex Rail Spur
Client: BZI Steel

Lab Number:
Sampled By: WR
Tested By: KB/SD

Sample Location: B-4 @ 5-10'
Supplier:
Aggregate Size:

Gradation

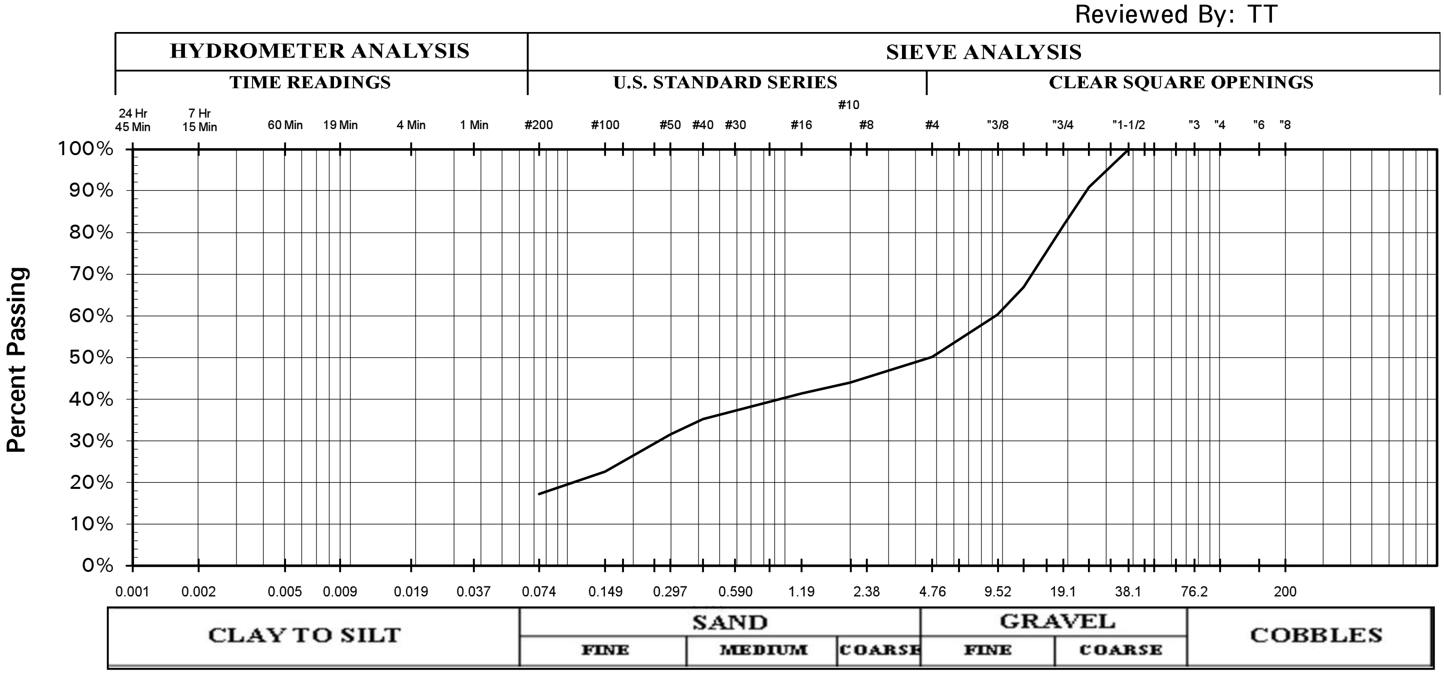
Gravel: 50%
Sand: 33%
Silt & Clay: 17%

Atterberg Limits

Liquid Limit:
Plasticity Index: Non-Plastic

USCS Classification: silty gravel with sand (GM)
AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 17

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-4 @ 10-15'

Supplier:

Aggregate Size:

Gradation

Gravel: 44%

Sand: 37%

Silt & Clay: 19%

Atterberg Limits

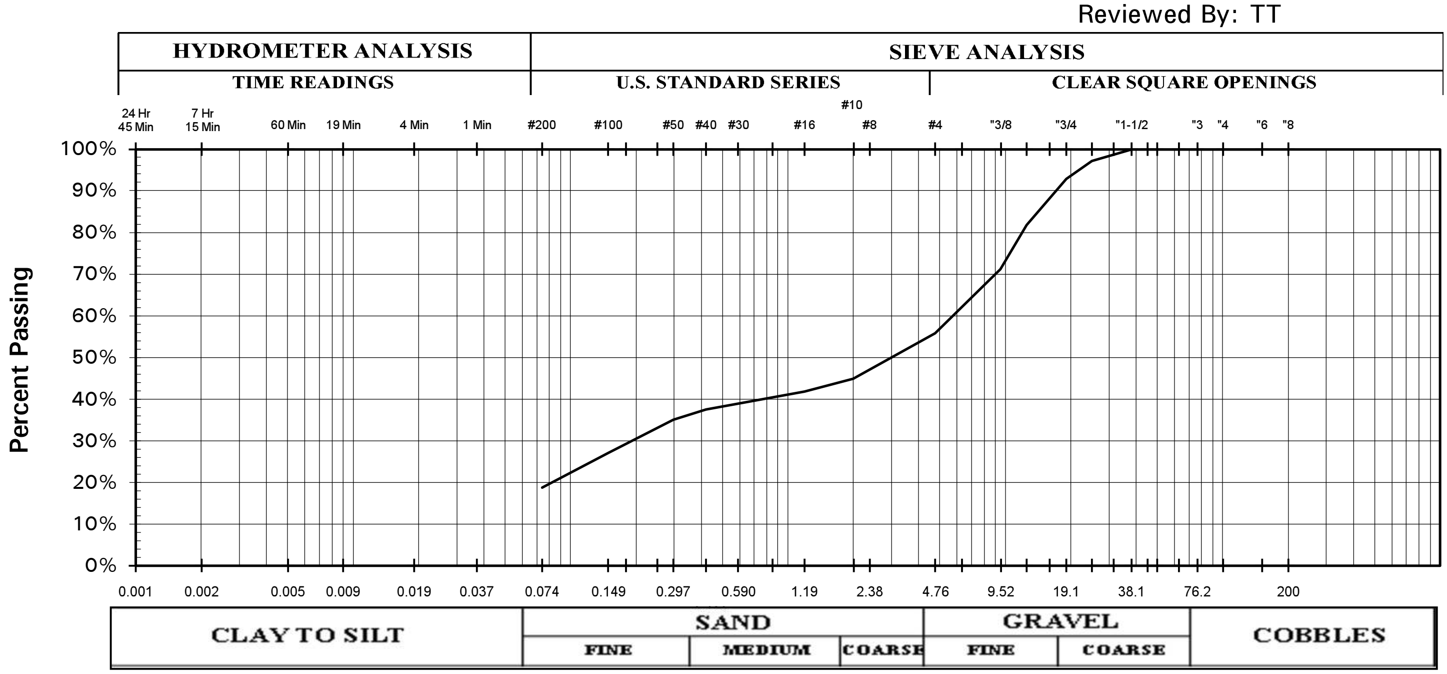
Liquid Limit:

Plasticity Index: Non-Plastic

USCS Classification: silty gravel with sand (GM)

AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 18

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-4 @ 15-20'

Supplier:

Aggregate Size:

Gradation

Gravel: 40%

Sand: 43%

Silt & Clay: 17%

Atterberg Limits

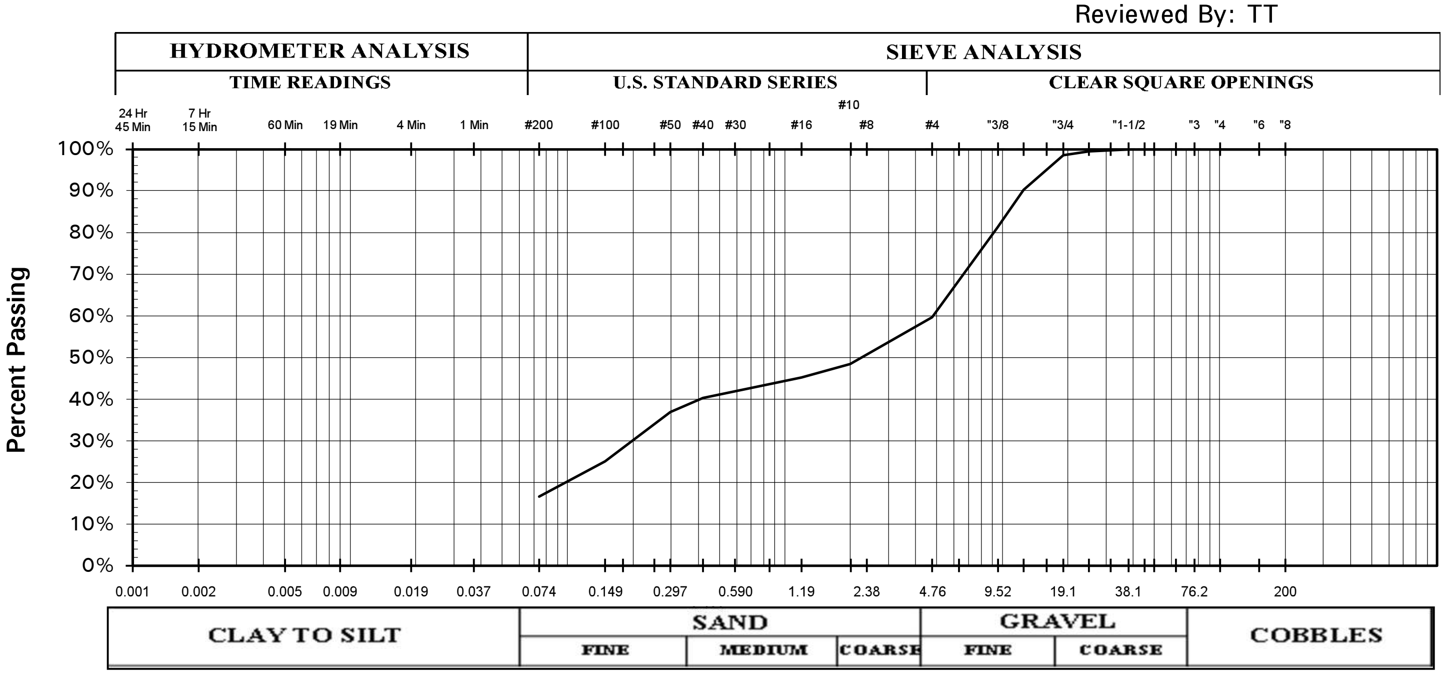
Liquid Limit:

Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)

AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 19

Applied Geotechnical Engineering Consultants, Inc.

SIEVE ANALYSIS TEST REPORT

Quality Control

Sample Date	1/0/00	**Lab Number:**	0
Project Number:	2220054	**Sampled by:**	0
Project Name :	Cedar Apex Rail Spur	**Tested by:**	BI
Client:	BZI Steel		

Sample Location: B-4 @ 22

Supplier: Native

Aggregate Size:

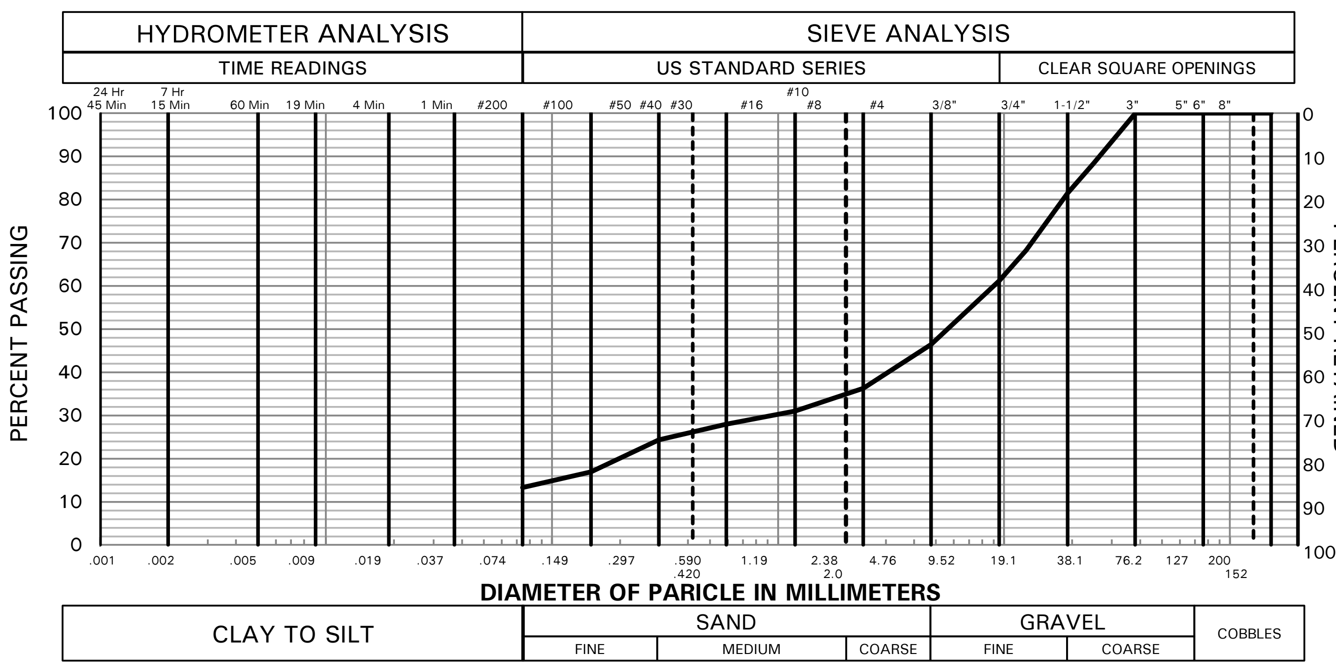
Gradation

Gravel:	54%
Sand:	33%
Silt & Clay:	13%

Atterberg Limits

Liquid Limit:	
Plasticity Index:	Non-Plastic

Sample Discription: silty gravel with sand (GM)



Sample Remarks:

Figure: 20

Reviewed by: TT

AGEC
Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

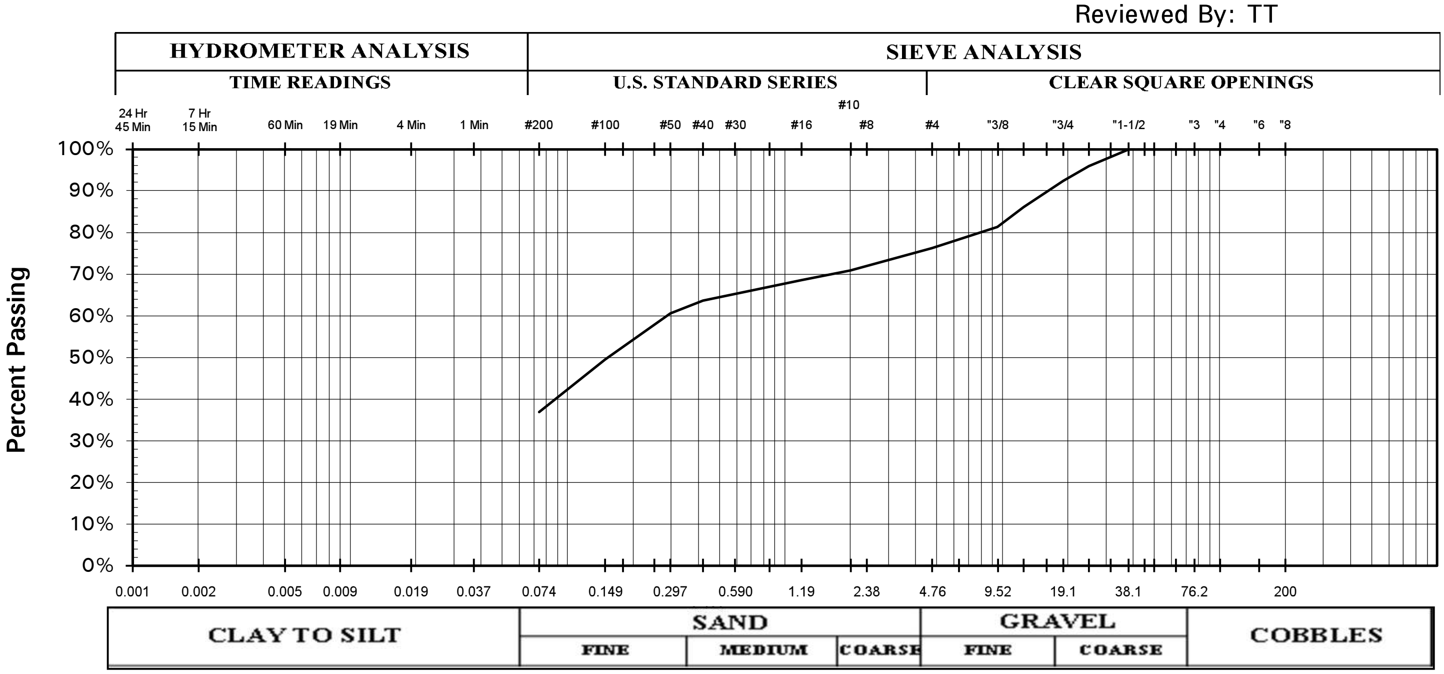
Sample Location: B-5 @ 0-5'
Supplier:
Aggregate Size:

Gradation	
Gravel:	24%
Sand:	39%
Silt & Clay:	37%

Atterberg Limits	
Liquid Limit:	32%
Plasticity Index:	14%

USCS Classification: clayey sand with gravel (SC)
AASHTO Classification: A-6

Reviewed By: TT



GRADATION CURVE

Figure: 21

Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date: 4/1/22 — Lab Number:
Project Number: 2220054 — Sampled By: WR
Project Name: Cedar Apex Rail Spur — Tested By: KB/SD
Client: BZI Steel

Sample Location: B-5 @ 5-10'
Supplier:
Aggregate Size:

Gradation

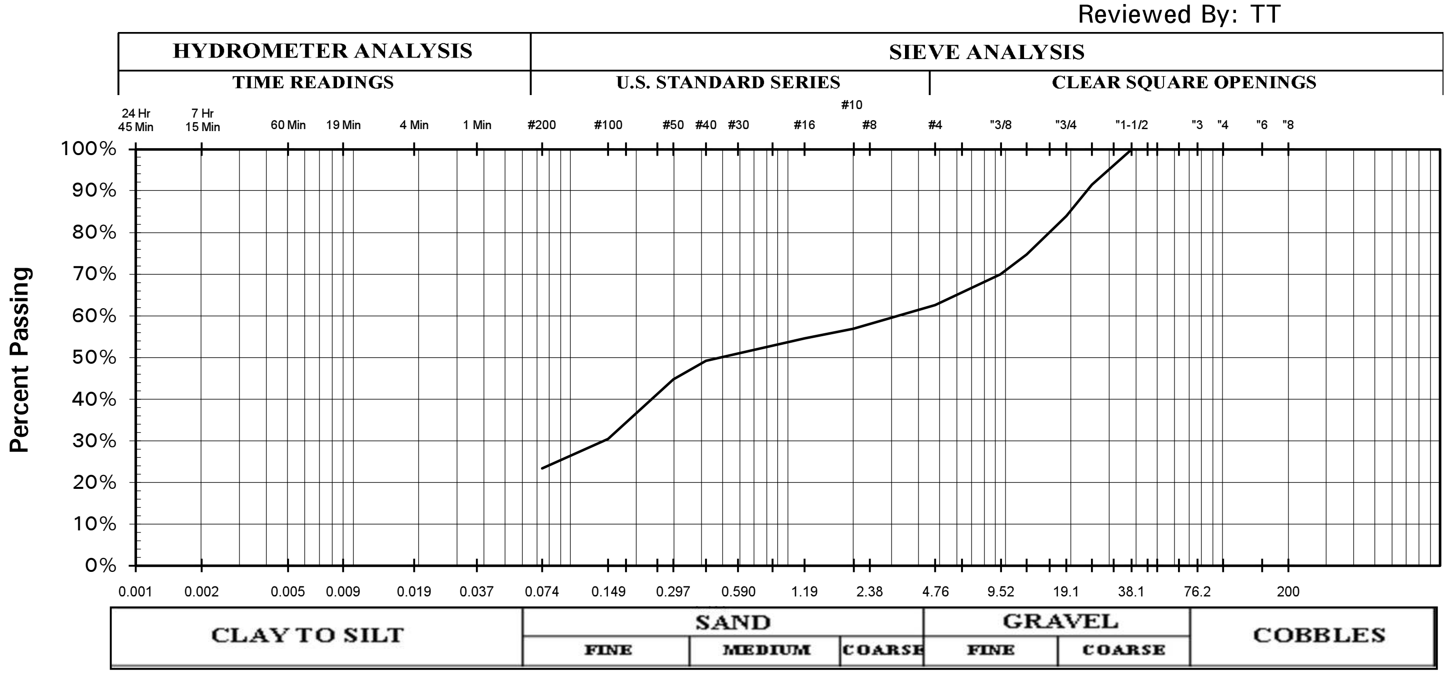
Gravel: 38%
Sand: 39%
Silt & Clay: 23%

Atterberg Limits

Liquid Limit:
Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)
AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 22

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date:	4/1/22	Lab Number:	
Project Number:	2220054	Sampled By:	WR
Project Name:	Cedar Apex Rail Spur	Tested By:	KB/SD
Client:	BZI Steel		

Sample Location: B-5 @ 10-15'
Supplier:
Aggregate Size:

Gradation

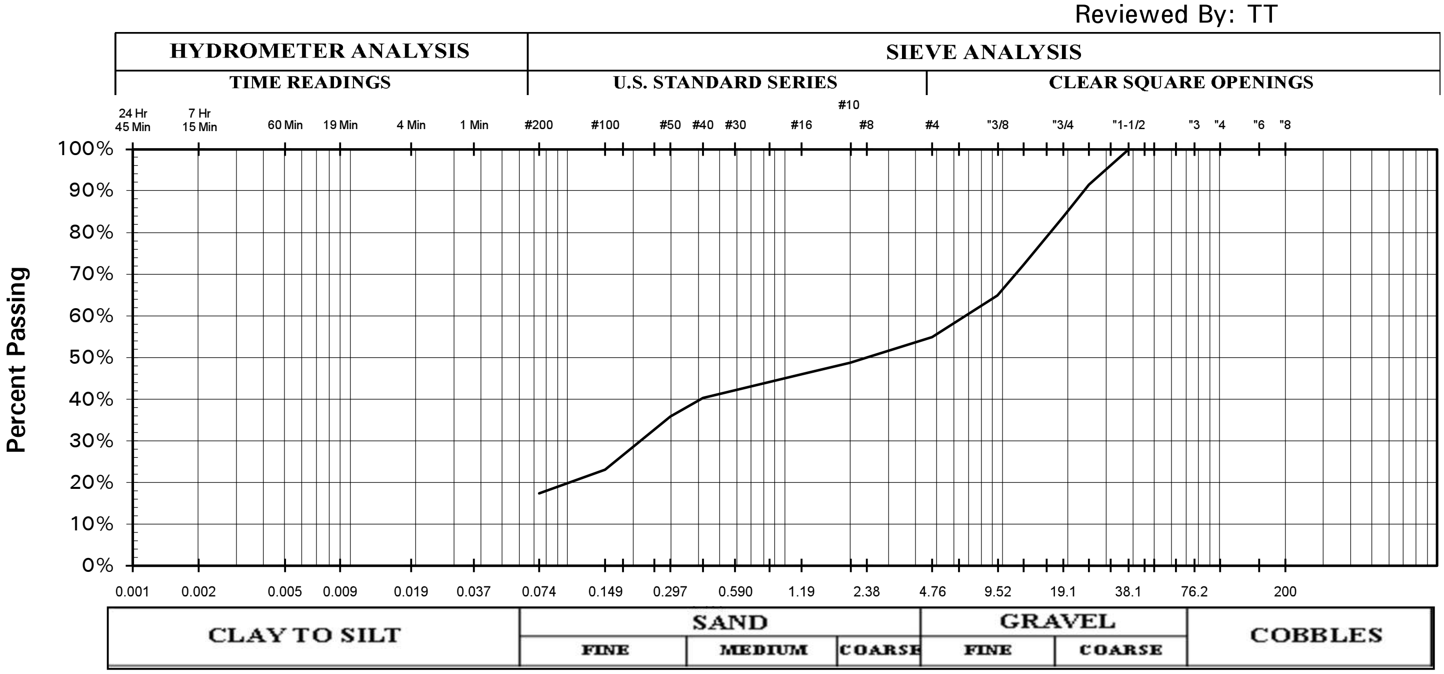
Gravel: 45%
Sand: 38%
Silt & Clay: 17%

Atterberg Limits

Liquid Limit:
Plasticity Index: Non-Plastic

USCS Classification: silty gravel with sand (GM)
AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 23

AGEC
Applied GeoTech

SIEVE ANALYSIS TEST REPORT
Quality Control

Sample Date: 4/1/22 | Lab Number:
Project Number: 2220054 | Sampled By: WR
Project Name: Cedar Apex Rail Spur | Tested By: KB/SD
Client: BZI Steel

Sample Location: B-5 @ 15-20'
Supplier:
Aggregate Size:

Gradation

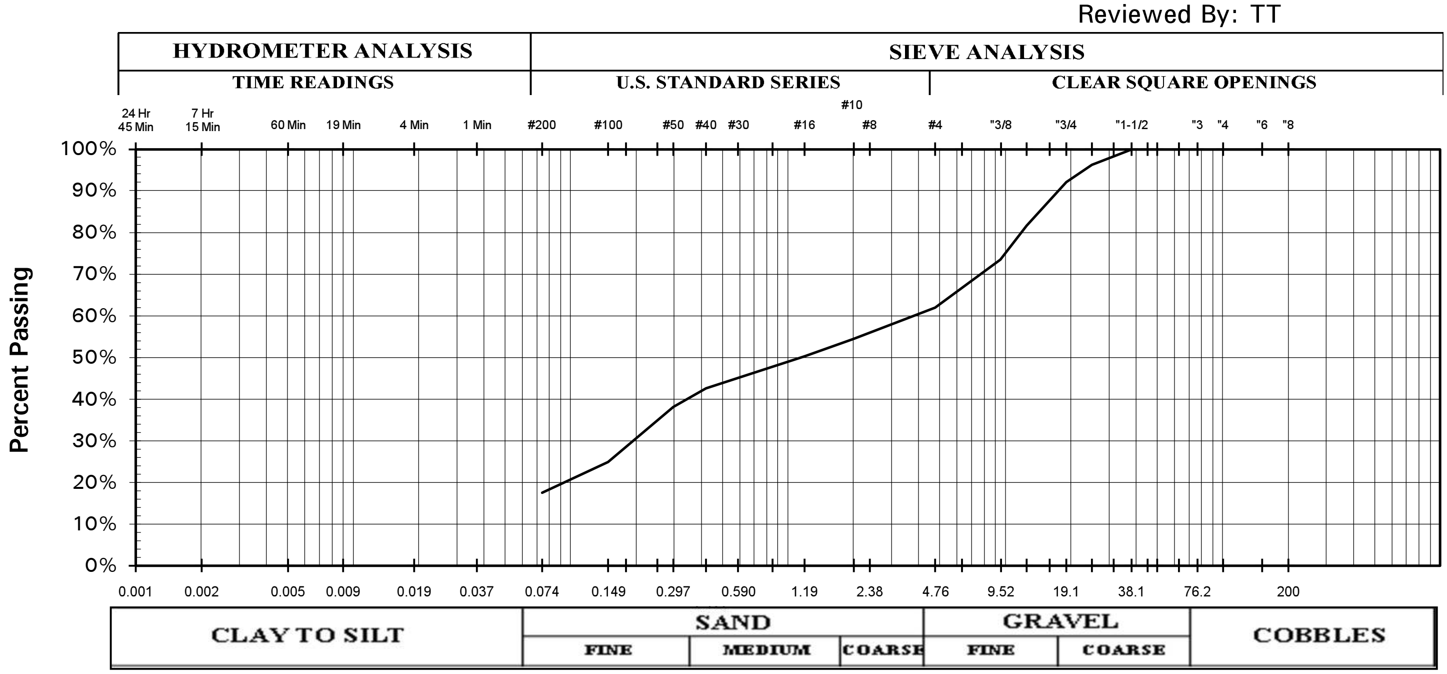
Gravel: 38%
Sand: 44%
Silt & Clay: 18%

Atterberg Limits

Liquid Limit:
Plasticity Index: Non-Plastic

USCS Classification: silty sand with gravel (SM)
AASHTO Classification: A-1-b

Reviewed By: TT



GRADATION CURVE

Figure: 24

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Cedar Apex Railroad Spur

Project Number 2220054

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Moisture Density Relationship		Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	
B-1	0	10	108			47					Silty Sand (SM)
B-1	0-2			0	70	30		NP	130.0	8.0	Silty Sand (SM)
B-1	2	4	92			68	21	5			Sandy Silty Clay (CL-ML)
B-1	4	7	98			96					Silty Clay (CL-ML)
B-1	9	17	104			93	35	18			Lean Clay (CL)
B-1	14	11	107			93	25	12			Lean Clay (CL)
B-1	19	19	101			100	41	24			Lean Clay (CL)
B-2	0	8	102			35					Silty Sand (SM)
B-2	0-2			0	50	50	21	7	125.0	10.0	Sandy Silty Clay (CL-ML)
B-2	2	8	101			50	27	11			Sandy Lean Clay (CL)
B-2	4	25	92			72	59	32			Sandy Fat Clay (CH)
B-2	9	4	101	54	33	13					Silty Sand (SM)
B-2	14	5	99	0	77	23		NP			Poorly Graded Sand with Silt (SP-SM)
B-2	19	5	109			10					Silty Sand (SM)
B-3	0-5			20	56	24	22	3			Silty Sand with Gravel (SM)

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Cedar Apex Railroad Spur

Project Number 2220054

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Moisture Density Relationship		Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	
B-3	4	4	107								Silty Sand with Gravel (SM)
B-3	5-10			27	54	19		NP			Silty Sand with Gravel (SM)
B-3	10-15			25	60	15		NP			Silty Sand with Gravel (SM)
B-3	15-20			33	55	12		NP			Silty Sand with Gravel (SM)
B-3	24			24	61	15		NP			Silty Sand with Gravel (SM)
B-3	29	5		9	14	77		NP			Silty Sand (SM)
B-4	0-5			36	40	24		NP			Silty Sand with Gravel (SM)
B-4	5-10			50	33	17		NP			Silty Sand with Gravel (SM)
B-4	10-15			44	37	19		NP			Silty Gravel with Sand (GM)
B-4	14	5	111								Silty Gravel with Sand (GM)
B-4	15-20			40	43	17		NP			Silty Sand with Gravel (SM)
B-4	22	4		54	33	13		NP			Silty Gravel with Sand (GM)
B-4	27	16	116	8	28	64					Sandy Silt (ML)
B-5	4"	2	116								Silty Sand (SM)

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Cedar Apex Railroad Spur

Project Number 2220054

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Moisture Density Relationship		Sample Classification
Boring No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	
B-5	0-5			24	39	37	21	14			Clayey Sand with Gravel (SC)
B-5	5-10			38	39	23		NP			Silty Sand with Gravel (SM)
B-5	10-15			45	38	17		NP			Silty Gravel with Sand (GM)
B-5	15-20			38	44	18		NP			Silty Sand with Gravel (SM)
B-5	19	7	119	10	61	29					Silty Sand (SM)

NP = Non Plastic