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GEOLOGIC HAZARD ASSESMENT
ADVANCED STORAGE BARNES
5560 BARNES ROAD
PARCEL NO. 63251-06-040
COLORADO SPRINGS, COLORADO

Prepared for:
Advanced Storage Barnes, LLC
5001 South Windermere Street, #100
Littleton, Colorado 80120

Attn: Lisa Glynn

September 22, 2023

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist

Reviewed by:

COLORADO REGISTERED
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9-22-2023
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LLL

GEOLOGIC HAZARD STUDY APPLICATION

Applicant: Advanced Storage Barnes, LLC Telephone: 303-995-8065

Address: 5001 S Windermere St. #100 Email: lglynn@trccompanies.us

City/State/Zip: Littleton, Colorado, 80120

Site Location: 5560 Barnes Road

The following documents have been included and considered as part of this study (checked off by individual(s) preparing the geologic study):

____ Rezoning

____ Development Plan

____ Land Use Plan

____ Public Improvement construction drawings

____ Final Plat

ENGINEER'S STATEMENT

I hereby attest that I am qualified to prepare a Geologic Hazard Study in accordance with the provisions of the City of Colorado Springs Unified Development Code Section, 7.4.5 Geological Hazards. I am qualified as:

___X___ Professional Geologist as defined by C.R.S. § 23-41-208; or,

_____ A Professional Geotechnical Engineer licensed by the Colorado State Board of Licensure for Architects, Professional Engineers and Professional Land Surveyors.

Submitted by: _____ Logan L. Langford, P.G. Date: 9/22/2023

This Geologic Hazard Study is filed in accordance with the City of Colorado Springs Unified Development Code Section 7.4.5 Geological Hazards.

City Engineering: _____ **Date:** _____

Table of Contents

1 SUMMARY

Project Location

The project site is located in a portion of the NE¼ of Section 25, Township 13 South, Range 66 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located northeast of the intersection of Barnes Road and Jeffery Road in the northeastern portion of Colorado Springs, Colorado.

Project Description

The project site is approximately 3.6 acres. A multi-story storage facility and future commercial pad site with a storm water quality pond, and other associated site improvements are proposed. The development will be serviced by Colorado Springs Utilities.

Scope of Report

This report presents the results of our geologic evaluation and recommended treatment of engineering geologic hazards. This report presents the results of our geologic reconnaissance, a review of available maps, aerial photographs and our conclusions with respect to the impacts of the geologic conditions on the proposed development.

Land Use and Engineering Geology

This site was found to be suitable for the proposed development if constraints are mitigated. Areas were encountered where the geologic conditions will impose some constraints on development and land use. These include areas of artificial fill, potentially expansive soils, erosion, and potentially unstable slopes. Based on the proposed development plan, it appears that these areas will have some impact on the development. These conditions will be discussed in greater detail in the report.

In general, it is our opinion that the development can be achieved if the observed geologic conditions on site are either avoided or properly mitigated. All recommendations are subject to the limitations discussed in the report.

2 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in a portion of the NE¼ of Section 25, Township 13 South, Range 66 West of the 6th Principal Meridian in El Paso County, Colorado. The site is located northeast of the intersection of Barnes Road and Jeffery Road in the northeastern portion of Colorado Springs, Colorado. The location of the site is as shown on the Vicinity Map, Figure 1.

The topography of the site is generally gradually sloping to the east with moderate to stee slopes along the drainage on the southern side and the eastern side of the site along Chapparal Road. The drainage on the site flows in an easterly direction, and a small, ponded area lies in the southwest corner of the site. This pond is dammed with a culvert which drains into the erosion gully that flows along the southern side of the site. Other areas of erosion were observed in the southeastern portion of the site. The site boundaries are indicated on the USGS Map, Figure 2. The site is undeveloped and contains primarily field grasses, weeds, with some shrubs and trees in the southeastern and southwestern portions of the site. Site photographs, taken September 14, 2023, are included in Appendix A.

The project site is approximately 3.6 acres. A multi-story storage facility and future commercial pad site with a storm water quality pond, and other associated site improvements are proposed. Preliminary grading plans are presented on the Development and Exploration Plan presented in Figure 3.

The site is currently zoned as C6/CR AO (General Business, Airport Overlay), and does not lie in the Hillside Overlay (Reference 1). The proposed site is currently undeveloped, with the existing residential to the west and north, and commercial development to the east and south. The proposed development consists of a storage facility and future commercial development pad site, retaining walls, a storm water quality pond in the southeastern portion of the site, and other associated site improvements.

3 SCOPE OF THE REPORT

The scope of the report will include a general geologic analysis utilizing published geologic data. Detailed site-specific mapping will be conducted to obtain general information in respect to major geographic and geologic features, geologic descriptions and their effects on the development of the property.

4 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of any bedrock features and significant surficial deposits. The Natural Resource Conservation Service (NRCS), previously the Soil Conservation Service (SCS) survey was also reviewed to evaluate the site. The position of mappable units within the subject property are shown on the Geologic Map. Our mapping procedures involved both field reconnaissance and measurements and air photo reconnaissance and interpretation. The same mapping procedures have also been utilized to produce the Engineering Geology Map which identified pertinent geologic conditions affecting development. The field mapping was performed by personnel of Entech Engineering, Inc. on September 14, 2023.

A Subsurface Soil Investigation was completed for the site by Entech Engineering, Inc. (Entech) dated May 2, 2023 (Reference 2, Appendix B), and a Geologic Hazard Study completed by Entech dated May 28, 1998 (Reference 3, Appendix C). A total of nine test borings were drilled as part of the previous investigations to determine general soil and bedrock characteristics. The locations of the test borings are indicated on the Development and Exploration Plan, Figure 3. The Test Boring Logs and Laboratory Testing Results are presented in Appendices B and C. Results of this testing will be discussed later in this report.

Laboratory testing was also performed on some of the soils to classify and determine the soils engineering characteristics. Laboratory tests included grain-size analysis ASTM D-422, Atterberg Limits ASTM D-4318, volume change testing using Swell/Consolidation test. Sulfate testing was performed on select samples to evaluate potential for below grade concrete degradation due to sulfate attack. Results of the laboratory testing are included in Appendices B and C.

5 SOIL, GEOLOGY, AND ENGINEERING GEOLOGY

5.1 General Geology

Physiographically, the site lies in the western portion of the Great Plains Physiographic Province. Approximately 8¼ miles to the west is a major structural feature known as the Rampart Range Fault. This fault marks the boundary between the Great Plains Physiographic Province and the Southern Rocky Mountain Province. The site exists within the southeastern edge of a large structural feature known as the Denver Basin. Bedrock in the area tends to be very gently dipping in a northerly direction (Reference 4). The rocks in the area of the site are sedimentary in nature and typically Upper Cretaceous in age. The bedrock underlying the site consists of the Dawson Formation. Overlying this formation are unconsolidated deposits of man-placed fill. The site's stratigraphy will be discussed in more detail in Section 5.3.

5.2 Soil Conservation Survey

The Natural Resource Conservation Service (Reference 5), previously the Soil Conservation Service (Reference 6) has mapped one soil type on the site (Figure 4). In general, the soils classify as sandy loam. The soils are described as follows:

Type	Description
85	Stapleton-Bernal sandy loams, 3 to 20% slopes

Complete descriptions of each soil type are presented in Appendix D. The soils have generally been described to have moderate to moderately rapid permeabilities. Possible hazards with soil erosion are present on the site. The erosion potential can be controlled with vegetation. The majority of the soils have been described to have moderate erosion hazards

5.3 Site Stratigraphy

The Falcon NW Quadrangle Geology Map showing the site is presented in Figure 5 (Reference 7). The Geology Map prepared for the site is presented in Figure 6. One mappable unit was identified on this site which are described as follows:

Qaf **Artificial Fill of Holocene Age:** These are recent man-placed fill deposits. Depths encountered in the test borings ranged from 3 to 19 feet of fill. The fill is considered uncontrolled, unless fill records can be obtained. The uncontrolled fill will require mitigation.

The bedrock underlying the site consists of the Dawson Formation of Tertiary to Cretaceous Age. The Dawson Formation typically consists of arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone. Overlying this formation are variable layers of eolian sands and residual soil. The residual soils were derived from the in-situ weathering of the bedrock materials on-site. These soils consisted of silty to clayey sands and with underlying claystone and sandstone.

The soils listed above were mapped from site-specific mapping, the *Geologic Map of the Falcon NW Quadrangle* distributed by the Colorado Geological Survey in 2003 (Reference 5), the *Geologic Map of the Colorado Springs-Castle Rock Area*, distributed by the US Geological Survey in 1978 (Reference 8), and the *Geologic Map of the Pueblo 1^0 x 2^0 Quadrangle*, distributed by the US Geological Survey in 1981 (Reference 4). The Test Borings were also used in evaluating the site and are included in Appendix B. The Geology/Engineering Geology Map prepared for the site is presented in Figure 6.

5.4 Soil Conditions

The soils encountered in the Test Borings can be grouped into three general soil types. The soils were classified using the Unified Soil Classification System (USCS).

Soil Type 1 classified as slightly silty to silty sand fill (SM-SW, SM). The sand fill was encountered in four of the test borings from the existing ground surface extending to depths ranging from 3 to 19 feet. Standard Penetration Testing resulted in SPT N-values between 14 to greater than 50 blows-per-foot (bpf), indicating medium dense to very dense states. Water content and grain size testing resulted in approximately 3 to 21 percent water content and approximately 11 to 18 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing resulted in non-plastic results. Sulfate testing performed on a sample of Soil Type 1 resulted in less than 0.01 percent sulfate by weight. The result indicates that Soil Type 1 exhibits a negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 classified as slightly silty and silty sand (SM-SW, SM). The native sand was encountered in Test Boring No. 1 underlying Soil Type 1 at 19 to 21 feet. Standard Penetration Testing resulted in N-values of greater than 34 bpf, indicating medium dense states. Water content and grain size testing resulted in approximately 24 percent water content.

Soil Type 3 classified as sandy clay and clay (CL). The clay was encountered Test Boring No. 4 underlying Soil Type 1 at depths at 4 to 6 feet bgs. Standard Penetration Testing resulted in N-values of greater 38 bpf, indicating hard consistencies. Water content and grain size testing resulted in approximately 28 percent water content and approximately 63 to 99 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing resulted in a liquid limit of 37 and a plastic index of 16. Swell/Consolidation Testing resulted in a volume change of 1.1 percent, indicating a low expansion potential. Sulfate testing performed on a sample of Soil Type 2 resulted in 0.00 percent sulfate by weight. The result indicates that the clay exhibits a negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 4 classified as silty to very silty sandstone and clayey sandstone (SM). The sandstone was encountered in four the test borings interbedded with Soil Type 5 at depths ranging from 1 to 13 feet bgs and extending to depths of 16 feet to the termination of the borings (10 to 30 feet). Standard Penetration Testing resulted in N-values of greater than 50 bpf, indicating very dense states. Water content and grain size testing resulted in approximately 9 to 23 percent water content and approximately 42 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing resulted in the very silty sandstone being non-plastic. Sulfate testing performed on a sample of the very silty sandstone resulted in less than 0.01 percent sulfate by weight. The result indicates that the sandstone exhibits a negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 5 classified as sandy siltstone and claystone (ML, CL). The siltstone and claystone were encountered in Test Boring Nos. 1, 3, and 5 interbedded with Soil Type 4 at depths ranging from 7 to 14 feet bgs and extending to the depths explored (10 to 30 feet). Standard Penetration Testing resulted in SPT N-values of greater than 50 bpf, indicating hard consistencies. Water content and grain size testing resulted in water contents of approximately 23 to 24 percent with approximately 87 percent of the soil size particles being smaller than the No. 200 sieve. Atterberg limits testing resulted in liquid limit of 47 and a plastic index of 15. Swell/Consolidation Testing resulted in 0.4 percent, indicating a low expansion potential. The claystone and siltstone is typically moderately to highly expansive in this area.

The Test Boring Logs are presented in Appendix B. The Test Boring Logs and Laboratory Testing Results are presented in Appendices B and C.

5.5 Groundwater

Groundwater was not encountered in the test borings which were drilled to depths of 10 to 25 feet on April 11, 2023 (Reference 2). However, a small ponded area is located in the southwestern portion of the site. This area is further discussed in the following section. Fluctuation in groundwater conditions may occur due to variations in rainfall and other factors not readily apparent at this time. It should be noted that in the sandy materials on-site, some groundwater conditions might be encountered due to the variability in the soil profile. Isolated sand and gravel layers within the soils, sometimes only a few feet in thickness and width, can carry water in the subsurface. Groundwater may also flow on top of the underlying bedrock. Builders and planners should be cognizant of the potential for the occurrence of such subsurface water features during construction on-site and deal with each individual conditions as necessary at the time of construction.

6 ENGINEERING GEOLOGY – IDENTIFICATION AND MITIGATION OF GEOLOGIC HAZARDS

Detailed mapping has been performed on this site to produce an Engineering Geology Map Figure 6. This map shows the location of various geologic conditions of which the developers should be cognizant during the planning, design and construction stages of the project. These hazards and the recommended mitigation techniques are as follows:

Artificial Fill

Fill was observed on the site and was encountered in eight of the nine test borings drilled on the site. The fill was encountered to depths ranging from 3 to 19 feet across the stie. An embankment was also observed along the eastern side of the small, ponded area in the southwestern portion of the site. The fill is considered uncontrolled for construction purposes and will require mitigation. Mitigation: Any uncontrolled fill encountered beneath foundations will require removal and recompaction at a minimum of 95% of its maximum Modified Procter Dry Density, ASTM D-1557. Most of the fill will be mitigated with the proposed site development and construction of the storage facility.

Collapsible Soils

The soils encountered in the test borings did not exhibit collapsible characteristics, however, the fill on the site could experience settling unless properly compacted.

Mitigation: The fill should be removed to native soils and recompacted at 95% of its Modified Proctor Dry Density, ASTM D-1557. The ground surface around all permanent structures should be positively sloped away from the structure to all points, and water must not be allowed to stand or pond anywhere on the site. We recommend that the ground surface within 10 feet of the structures be sloped away with a minimum gradient of ten percent. If this is not possible on the upslope side of the structures, then a well-defined swale should be created to intercept the surface water and carry it quickly and safely around and away from the structures. Roof drains should be made to discharge well away from the structures and into areas of positive drainage.

Expansive Soils

Expansive soils were encountered in the test borings drilled on site. These occurrences are typically sporadic; therefore, none have been indicated on the maps. The clays and claystone, if encountered at foundation grade, can cause differential movement in structures. These occurrences should be identified and dealt with on an individual basis. Specific recommendations have been provided in the subsurface soil investigation (Reference 2).

Mitigation Should expansive soils be encountered beneath foundations; mitigation will be necessary. Mitigation of expansive soils will require special foundation design. Overexcavation 4 feet and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements.

Landslide Hazard and Slope Stability

The site is not mapped as susceptible to landslides according to the *Map of Potential Areas of Landslide Susceptibility in Colorado Springs* by White and Wait, 2003, distributed by The Colorado Geological Survey (Reference 11). Site topography is gradually sloping to the east with moderate to steep slopes along the drainage on the southern side and slopes along the eastern side of the stie. The steeper slopes and slopes along the drainage have been identified as potentially unstable. The slopes along the eastern side of the site appear to have recently been partially regraded. The slopes along the drainage exhibit signs of instability in some portions with excess rill erosion, sluffing, and gullies.

Potentially Unstable Slopes

The potentially unstable slopes are located along the drainage in the southern portion of the stie and along the steeper slopes in the eastern portion of the site. A storm water quality pond is proposed in the southeastern portion on the site along the slope. Considerable care should be taken in construction of the pond and related retaining walls. The retaining wall should be designed by a qualified engineer and should account for the additional lateral pressures from the slope above. A lateral pressure diagram is presented in Figure 7. Lining the pond is recommended to prevent saturation of the subgrade materials at the toe of the slope. Development plans for the future commercial pad site were not available at this time. Construction along the crest of the slope should be avoided unless properly mitigated, and a building setback of a minimum of 15 feet from the crest of the slope is recommended. Site specific slope stability analysis was conducted for the proposed storage building and storm water quality pond and is presented below. The pond and drainage along the southern side of the site will be regraded and piped during the proposed grading operations.

Slope Stability Analysis

Slope Stability Analyses were conducted utilizing the GSTABL7 computer program. The sections analyzed are shown on the Slope Section Map, Figure 8. The sections were analyzed with the proposed grading. Results of the Slope Stability Analysis are included in Appendix E, and a Summary of Slope Stability Analysis is included in Table E-1.

Soil strength values were estimated using conservative values based on testing of similar soils in the area and engineering judgment. The values are similar to nearby studies as shown in Appendix F. Soil strength values used for the analysis were as follows.

Soil Type	Angle of Internal Friction (degrees)	Cohesion (psf)
Sand	32	50
Claystone	32	50
Structural Fill	22	220

Factors of safety were calculated by the Modified Bishop Method for Circular Failure Surface for failures within the proposed storage building, and the retaining wall and stromwater quality pond. Retaining walls on this site were evaluated as mechanically stabilized earth walls. Mitigation of

the existing fill was also assumed to be completed in the slope analysis. **This analysis does not constitute a retaining wall design.** Geogrid is necessary behind all MSE retaining walls.

Factors of safety of 1.3 to 1.5 were obtained based on the proposed development plan, provided excavation/overexcavation drains and retaining walls **(designed for local and global stability with geogrid used in the analysis)** are installed as recommended. **All slopes should be evaluated for local and global stability for final designs.** Results of the slope stability analysis are presented in Appendix E. A factor of safety of 1.5 is recommended for areas of critical structures such as buildings, and a factor of safety of 1.3 for non-critical structures such as roadways, ponds, and parking areas. Preliminary analysis of the proposed development show that adequate factors of safety can be achieved.

Mitigation: The potentially unstable slopes will be mitigated with site grading and proposed retaining walls (designed by qualified personnel). The majority of the potentially unstable slopes can be avoided by development. Areas where the structures should be located a minimum distance to allow for a 3:1 projection from the toe of the slope and the excavation for the foundation. Steep cuts should be avoided in areas of potentially unstable slopes unless analyzed for the global slope stability. This includes cuts of landscaping and terracing. The potentially unstable slopes in the eastern portion of the site will be regraded and retaining walls constructed as a part of the development. Walls up to 17 feet in exposed height are proposed for the storage building and walls up to 7 feet for the stormwater quality pond. The building foundation will be stiffened with buttresses and tie-beams, and a minimum 10-inch thick floor slab is proposed. The slope analysis was based on these conditions. Site retaining walls should be designed for the existing site conditions by a qualified professional engineer. **Due to the sloping conditions retaining walls on this site must be designed for internal and external global slope stability.** Unretained slopes inside the recommended 3:1 for sand soils to slopes that are analyzed for global slope stability.

Proper control of drainage at both the surface and in the subsurface is extremely important to slope performance. Areas of ponded water at the surface should be avoided. We recommend surface drainage be directed away from the slopes to prevent saturation of the slopes that could create unstable conditions. Utility trenches, basement excavations and other subsurface features should not be permitted to become water traps which may promote saturation of the subsurface materials. Additional moisture may create unstable conditions on the slopes. Drainage should be directed away from these slopes to avoid saturation of the materials. Downspouts and other

concentrated flows should be piped down the slopes. Discharges and flows onto the slopes should not be permitted.

Subsidence Area

Based on a review of the Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 12) the site is not mapped within any potential subsidence zones. The closest underground mines in the area are approximately 5 miles to the west.

Debris Fans

Based on observations, debris fans are not located on the site.

Areas of Erosion

These are areas that are undergoing erosion by water and sheetwash producing gullies and rill erosion and primarily located along portions of the drainage in the southern and southeastern portions of the site. These areas are to be regraded as part of the site development, and the drainage piped to the proposed stormwater quality pond.

Mitigation: Due to the nature of the soils on this site, virtually all the soils are subject to erosion by wind and water. Areas of erosion can occur across the entire site, particularly if the soils are disturbed during construction. Vegetation reduces the potential for erosion. The areas identified where erosion is actually taking place may require check dams, regrading and revegetation using channel lining mats to anchor vegetation. Further recommendations for erosion control are discussed under Section "Erosion Control" of this report. Recommendations pertaining to revegetation may require input from a qualified landscape architect and/or the Natural Resource Conservation Service (previously Soil Conservation Service).

Groundwater and Floodplain Areas

The site is not mapped within floodplain zones according to the FEMA Map No. 08041CO538G, (Figure 9, Reference 13). The drainage on the site flows in an easterly direction, and a small, ponded area lies in the southwest corner of the site. This pond is dammed with an outlet culvert which drains into the erosion gully that flows along the southern side of the site. Other areas of erosion were observed in the southeastern portion of the site. Water was observed in the pond at the time of our site investigation. Groundwater was not encountered in the test borings at depths ranging from 10 to 25 feet below the existing surface grade.

Foundations must have a minimum 30-inch depth for frost protection. Fluctuation in groundwater conditions may occur due to variations in precipitation where water can flow through permeable sands on top of less permeable bedrock materials. Subsurface perimeter drains are recommended in areas below grade. Typical drain details are presented in Figure 10. Where shallow groundwater is encountered, underslab drains or interceptor drains may be necessary. Typical drain details are presented in Figures 11 – 13.

Faults

The closest fault is the Rampart Range Fault, located 8 miles to the west. No faults are mapped on the site itself. Previously Colorado was mapped entirely within Seismic Zone 1, a very low seismic risk. According to a report by the Colorado Geological Survey by Robert M. Kirkman and William P. Rogers, Bulletin 43 (1981) (Reference 14), this area should be designated for Zone 2 due to more recent data on the potential for movement in this area, and any resultant earthquakes.

Dipping Bedrock

The bedrock underlying the site is the Dawson Formation of Tertiary to Cretaceous Age. According to the map of *Areas Susceptible to Differential Heave in Expansive, Steeply Dipping Bedrock* by Himmelreich and Noe in 1999 (Reference 15), the site does not lie within the area mapped with steeply dipping bedrock (>30°). Bedrock in the area of the site is typically gently sloping in a northerly direction. Bedrock encountered in the test borings was not steeply dipping, therefore, no mitigation is necessary.

Radon – Hazard

Radon levels for the area have been reported by the Colorado Geologic Survey in the open file, Report No. 91-4 (Reference 16). Average Radon levels for the area of 2.56 pCi/l have been measured in the area. The following is a table of radon levels in this area.

0 < 4 pCi/l	76.47%
4 < 10 pCi/l	23.53%
10 < 20 pCi/l	0.00%
> 20 pCi/l	0.00%

Mitigation: The potential for high radon levels is present for the site. Build-ups of radon gas can be mitigated by providing increased ventilation of basements and crawlspaces and sealing of joints. Specific requirements for mitigation should be based on site specific testing.

6.1 Relevance of Geologic Conditions to Land Use Planning

We understand that the development will consist of a multi-story storage facility and future commercial pad site with a storm water quality pond, and other associated site improvements. It is our opinion that the existing geologic and engineering geologic conditions will impose some constraints on the proposed development and construction. The most significant problems affecting development will be those associated with the artificial fill, potentially unstable slopes, erosion, and ponded water that can be satisfactorily mitigated through proper engineering design and construction practices.

Subsurface soil conditions encountered in the test borings drilled for the planned structure and pad sites generally consisted of slightly silty to silty sand fill, silty sand, sandy clay and clay with underlying sandstone, claystone, and siltstone bedrock. Fill was encountered eight of the borings on the site at depths ranging from 3 to 19 feet below the existing surface grade. The fill was encountered at medium dense to very dense states. The fill is considered uncontrolled for construction purposes, unless fill records can be obtained. Removal and recompaction will be required if records cannot be obtained. Bedrock was encountered in the test borings at one (1) to 21 feet. The sandstone was encountered at very dense states, and the claystone and siltstone were encountered at hard consistencies. Expansive clays, claystone, or siltstone encountered beneath foundations will require overexcavation. Overexcavation on the order of 4 feet below foundation footings is anticipated where expansive soils are encountered. The very dense sandstone, medium dense sands, suitable moisture conditioned and recompacted site soils, or imported structural fill approved by Entech are considered to exhibit an adequate in-place density for support of the planned building using shallow foundations (i.e. spread footings).

Lower bearing, recompacted granular structural fill and higher bearing sandstone may be encountered in the excavation at foundation grades. The foundation should rest on native sand or adequate structural fill. Groundwater is not expected to affect the construction of the shallow foundations across most of the site. Areas where deeper fill was encountered in the southwestern portion of the site may encroach on groundwater levels. A minimum of 3 feet separation between groundwater levels and foundation grade is recommended. These soils will not prohibit development. Specific recommendations have been provided in the Subsurface Soil Investigation (Reference 2).

The potentially unstable slopes are located along the drainage in the southern portion of the site and along the steeper slopes in the eastern portion of the site. A storm water quality pond is

proposed in the southeastern portion on the site along the slope. Considerable care should be taken in construction of the pond and related retaining walls. The retaining wall should be designed by a qualified engineer and should account for the additional lateral pressures from the slope above. A lateral pressure diagram is presented in Figure 7. It is recommended that the pond is lined to prevent the oversaturation of the subgrade materials at the toe of the slope. Development plans for the future commercial pad site were not available at this time. Construction along the crest of the slope should be avoided unless properly mitigated, and a building setback of a minimum of 15 feet from the crest of the slope is recommended. Site specific slope stability analysis was conducted for the proposed storage building and storm water quality pond and is presented below. The pond and drainage along the southern side of the site will be regraded and piped during the proposed grading operations.

Slope stability analysis resulted in factors of safety of 1.3 to 1.5 were obtained based on the proposed development plan, provided excavation/overexcavation drains and retaining walls **(designed for local and global stability with geogrid used in the analysis)** are installed as recommended. **All slopes should be evaluated for local and global stability for final designs.** Results of the slope stability analysis are presented in Appendix E. A factor of safety of 1.5 is recommended for areas of critical structures such as buildings, and a factor of safety of 1.3 for non-critical structures such as roadways, ponds, and parking areas. Preliminary analysis of the proposed development show that adequate factors of safety can be achieved.

The drainage on the site flows in an easterly direction, and a small, ponded area lies in the southwest corner of the site. This pond is dammed with an outlet culvert which drains into the erosion gully that flows along the southern side of the site. Other areas of erosion were observed in the southeastern portion of the site. Water was observed in the pond at the time of our site investigation. Groundwater was not encountered in the test borings at depths ranging from 10 to 25 feet below the existing surface grade. These are areas that are undergoing erosion by water and sheetwash producing gullies and rill erosion and primarily located along portions of the drainage in the southern and southeastern portions of the site. These areas are to be regraded as part of the site development, and the drainage piped to the proposed stormwater quality pond

In summary, development of the site can be achieved if the items mentioned above are mitigated. These items can be mitigated through proper design and construction or through avoidance. Investigation on each lot is recommended prior to construction.

7 EROSION CONTROL

The soil types observed on the site are mildly to highly susceptible to wind erosion, and moderately to highly susceptible to water erosion. A minor wind erosion and dust problem may be created for a short time during and immediately after construction. Should the problem be considered severe enough during this time, watering of the cut areas or the use of chemical palliative may be required to control dust. However, once construction has been completed and vegetation re-established, the potential for wind erosion should be considerably reduced.

With regard to water erosion, loosely compacted soils will be the most susceptible to water erosion, residually weathered soils become increasingly less susceptible to water erosion. For the typical soils observed on-site, allowable velocities or unvegetated and unlined earth channels would be on the order of 3 to 4 feet/second, depending upon the sediment load carried by the water. Permissible velocities may be increased through the use of vegetation to something on the order of 4 to 7 feet/second, depending upon the type of vegetation established. Should the anticipated velocities exceed these values, some form of channel lining material may be required to reduce erosion potential. These might consist of some of the synthetic channel lining materials on the market or conventional riprap. In cases where ditch-lining materials are still insufficient to control erosion, small check dams or sediment traps may be required. The check dams will serve to reduce flow velocities, as well as provide small traps for containing sediment. The determination of the amount, location and placement of ditch linings, check dams and of the special erosion control features should be performed by or in conjunction with the drainage engineer who is more familiar with the flow quantities and velocities.

Cut and fill slope areas will be subjected primarily to sheetwash and rill erosion. Unchecked rill erosion can eventually lead to concentrated flows of water and gully erosion. The best means to combat this type of erosion is, where possible, the adequate re-vegetation of cut and fill slopes. Cut and fill slopes having gradients more than three (3) horizontal to one (1) vertical become increasingly more difficult to revegetate successfully. Therefore, recommendations pertaining to the vegetation of the cut and fill slopes may require input from a qualified landscape architect and/or the Soil Conservation Service.

8 ROADWAY AND EMBANKMENT CONSTRUCTION RECOMMENDATIONS

In general, the site soils are suitable for the proposed roadways and embankments. Groundwater should be expected to be encountered in deeper cuts and along drainages and low-lying areas. If excavations encroach on the groundwater level unstable soil conditions may be encountered. Excavation of saturated soils will be difficult with rubber-tired equipment. Stabilization using shot rock or geogrids may be necessary.

Any areas to receive fill should have all topsoil, organic material or debris removed. Prior to fill placement Entech should observe the subgrade. Fill must be properly benched and compacted to minimize potentially unstable conditions in slope areas. Fill slopes should be 3:1. The subgrade should be scarified and moisture conditioned to within 2% of optimum moisture content and compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557, prior to placing new fill. Areas receiving fill may require stabilization with rock or fabric if shallow groundwater conditions are encountered.

New fill should be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95% of its maximum Modified Proctor Dry Density, ASTM D-1557. These materials should be placed at a moisture content conducive to compaction, usually 0 to ±2% of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech during construction. Entech should approve any import materials prior to placing or hauling them to the site. Additional investigation will be required for pavement designs once roadway grading is completed and utilities are installed.

9 CLOSURE

It is our opinion that the existing geologic engineering and geologic conditions will impose some constraints on development and construction of the site. The majority of these conditions can be mitigated through proper engineering design and construction practices. The proposed development and use are consistent with anticipated geologic and engineering geologic conditions.

It should be pointed out that because of the nature of data obtained by random sampling of such variable and non-homogeneous materials as soil and rock, it is important that we be informed of any differences observed between surface and subsurface conditions encountered in construction and those assumed in the body of this report. Additional investigations are required for the commercial pad building sites prior to construction. Construction and design personnel should be made familiar with the contents of this report. Reporting such discrepancies to Entech Engineering, Inc. soon after they are discovered would be greatly appreciated and could possibly help avoid construction and development problems.

This report has been prepared for Advanced Storage Barnes, LLC for application to the proposed project in accordance with generally accepted geologic soil and engineering practices. No other warranty expressed or implied is made.

We trust that this report has provided you with all the information that you required. Should you require additional information, please do not hesitate to contact Entech Engineering, Inc.

10 BIBLIOGRAPHY

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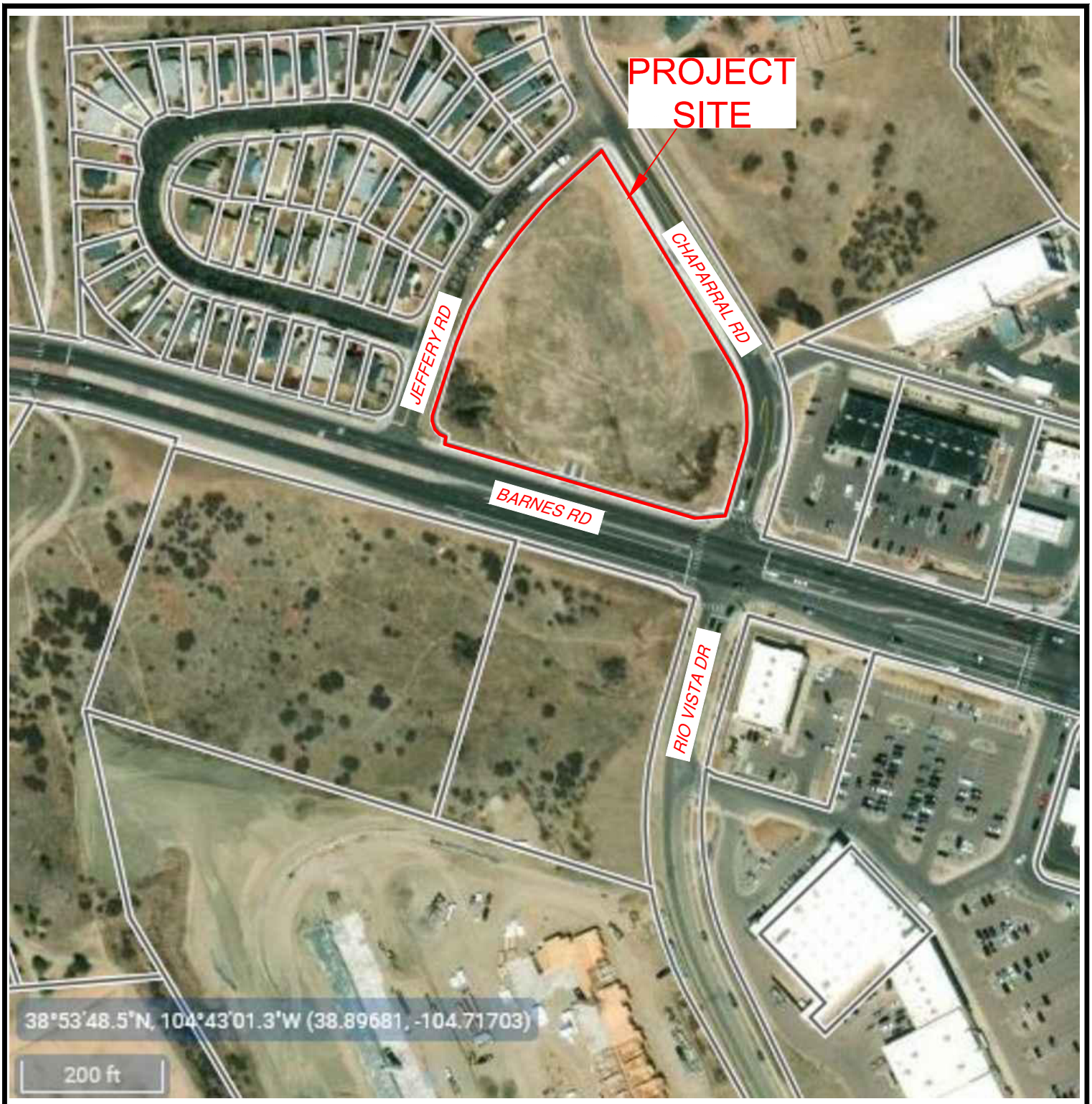
FIGURES



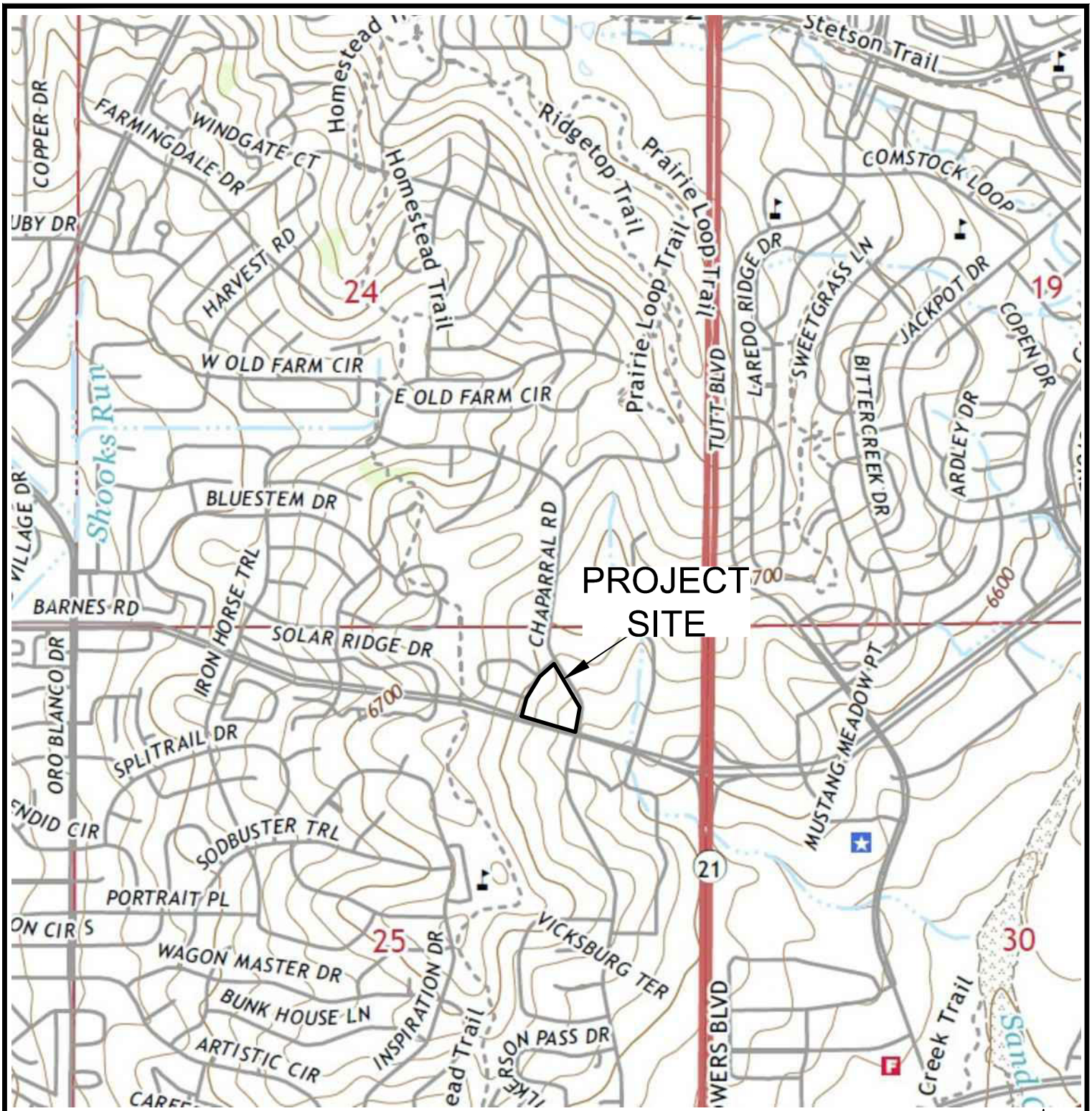
N

ENTECH ENGINEERING, INC.

VICINITY MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 1

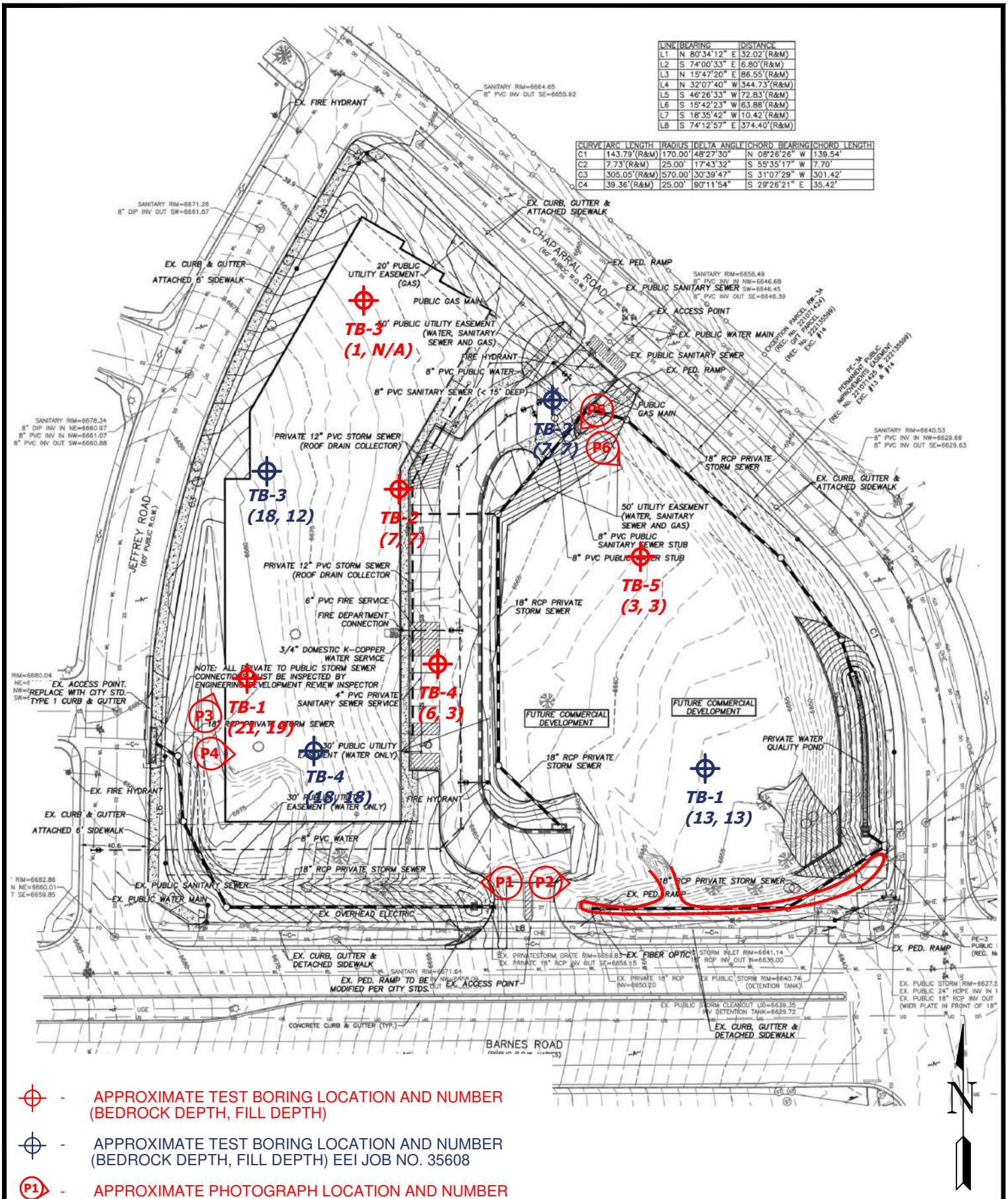


ENTECH ENGINEERING, INC.

USGS TOPOGRAPHY MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 2



- APPROXIMATE TEST BORING LOCATION AND NUMBER (BEDROCK DEPTH, FILL DEPTH)
- APPROXIMATE TEST BORING LOCATION AND NUMBER (BEDROCK DEPTH, FILL DEPTH) EEI JOB NO. 35608
- P1 - APPROXIMATE PHOTOGRAPH LOCATION AND NUMBER

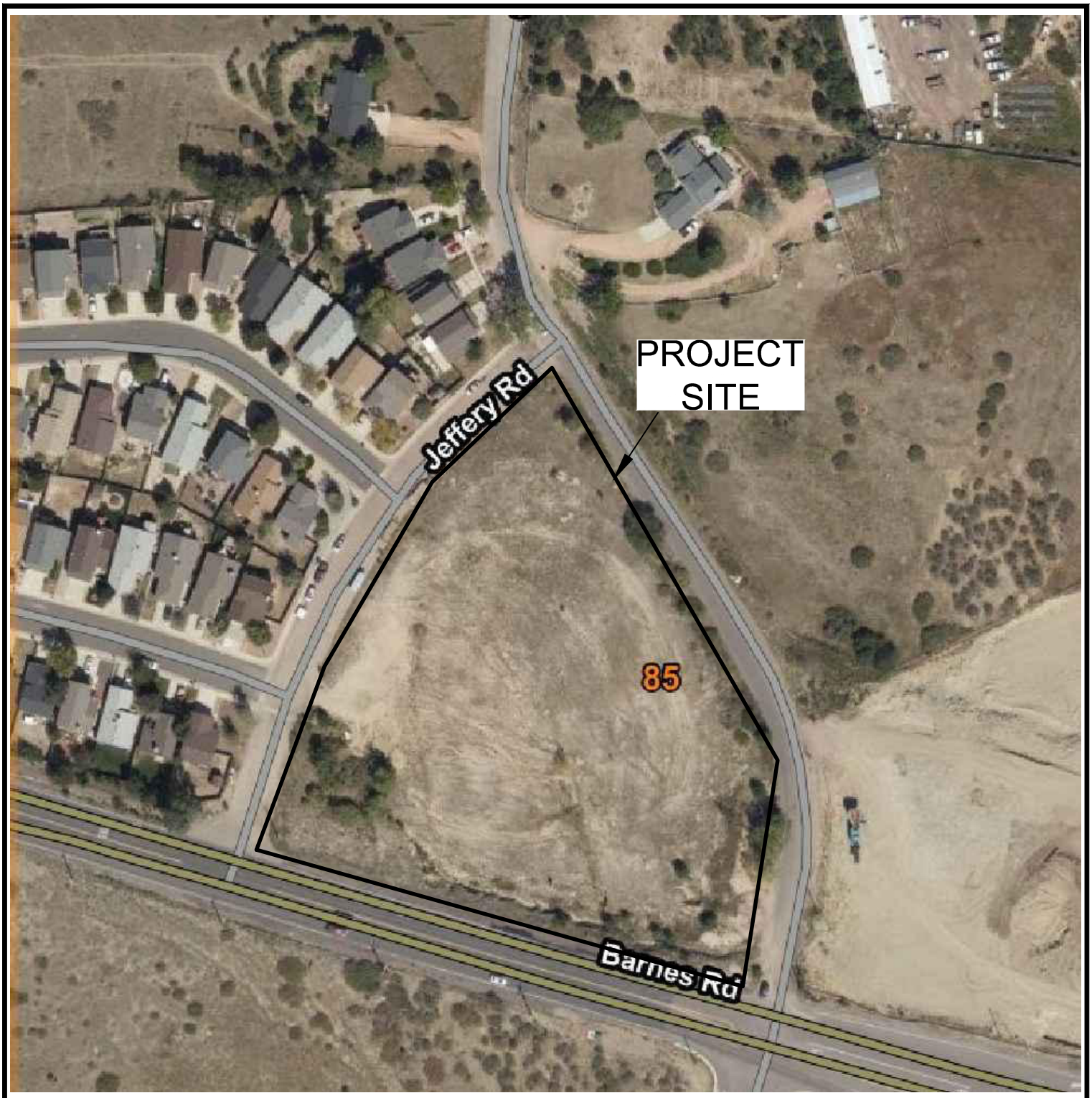
ENTECH ENGINEERING, INC.

SITE AND EXPOLORATION PLAN

5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO. 231507

FIG. 3



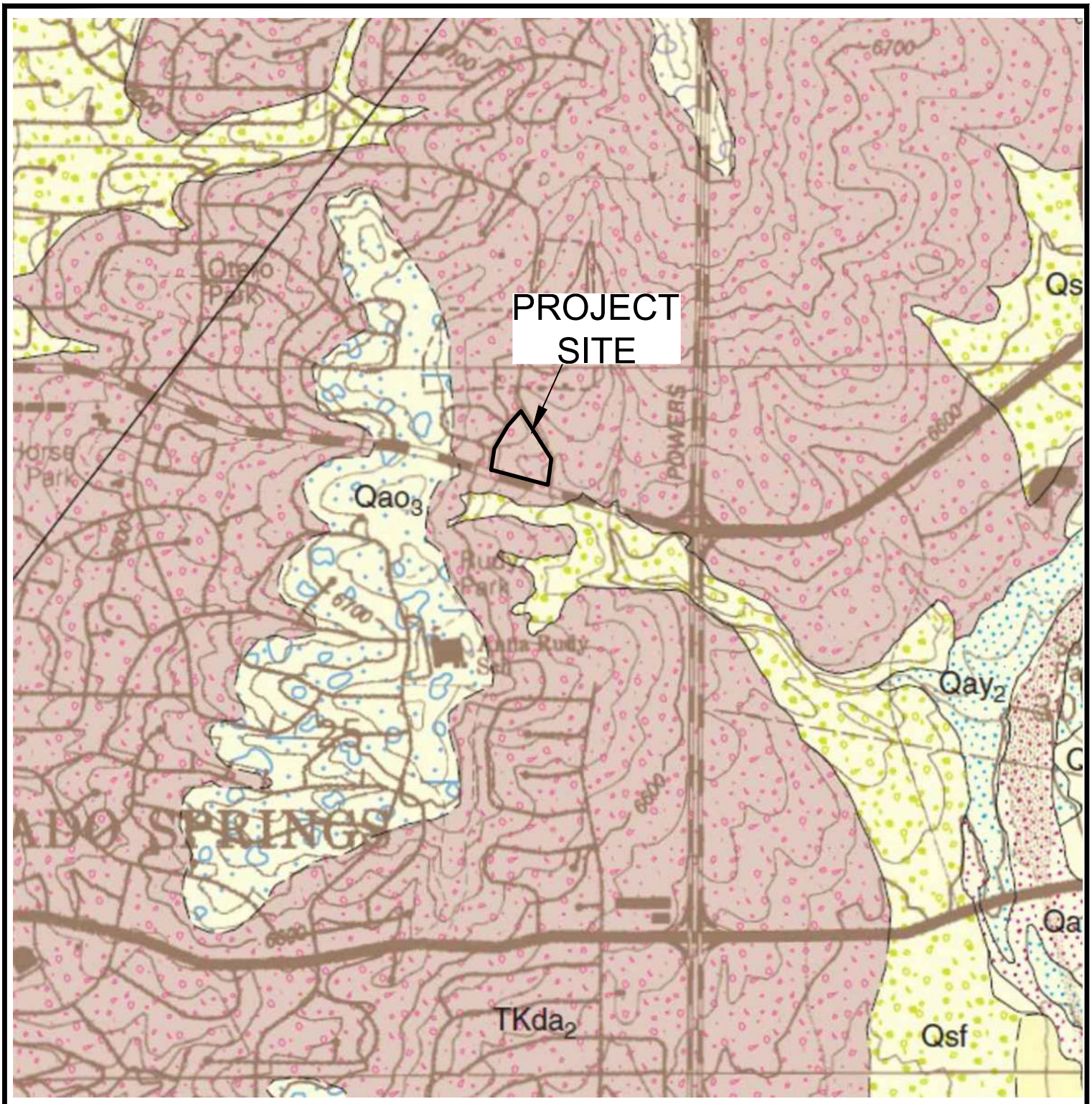
N

ENTECH ENGINEERING, INC.

SOIL SURVEY MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 4

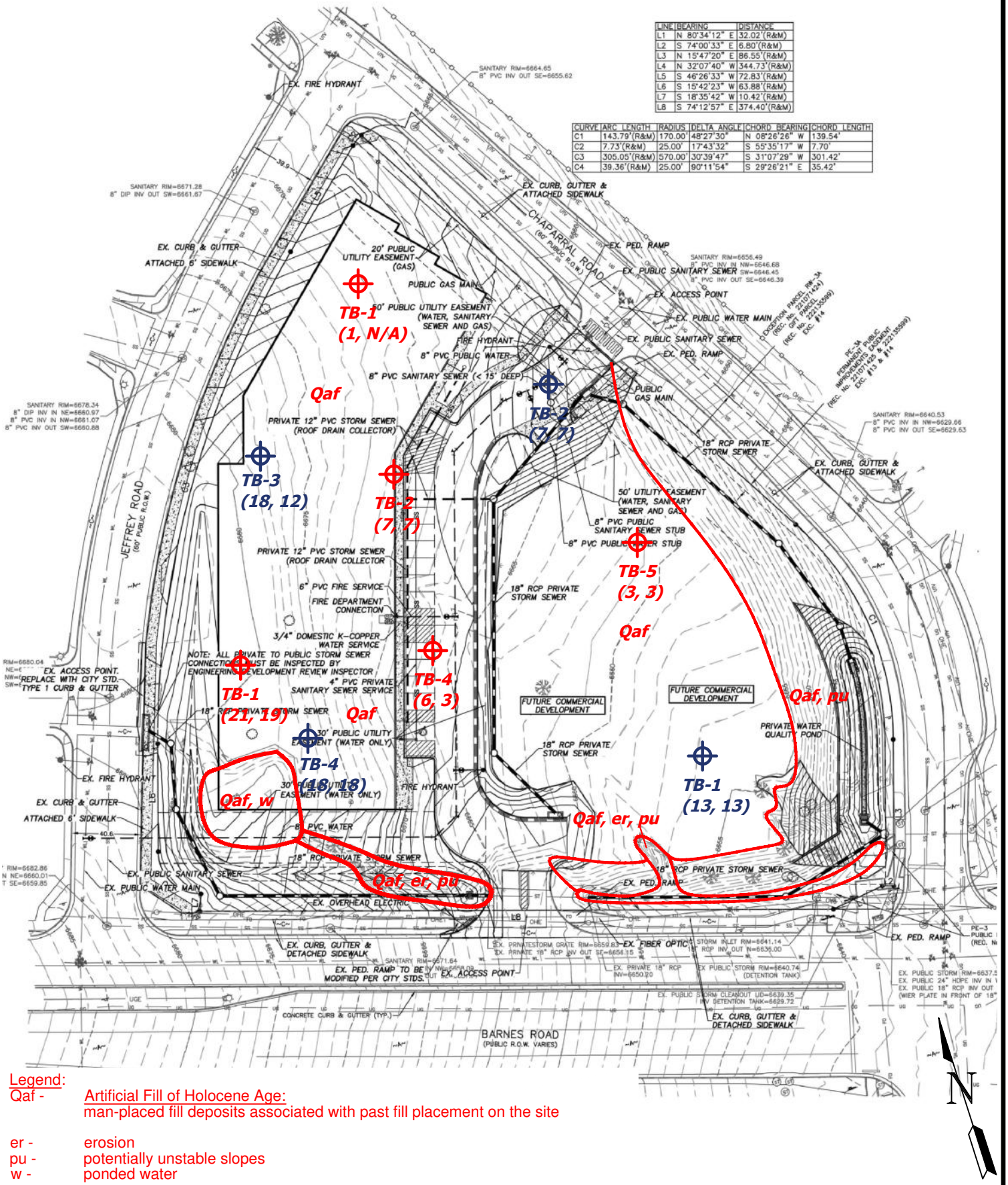


ENTECH ENGINEERING, INC.

FALCON NW QUADRANGLE GEOLOGIC MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 5



Legend:

Qaf - Artificial Fill of Holocene Age:
man-placed fill deposits associated with past fill placement on the site

er - erosion
pu - potentially unstable slopes
w - ponded water

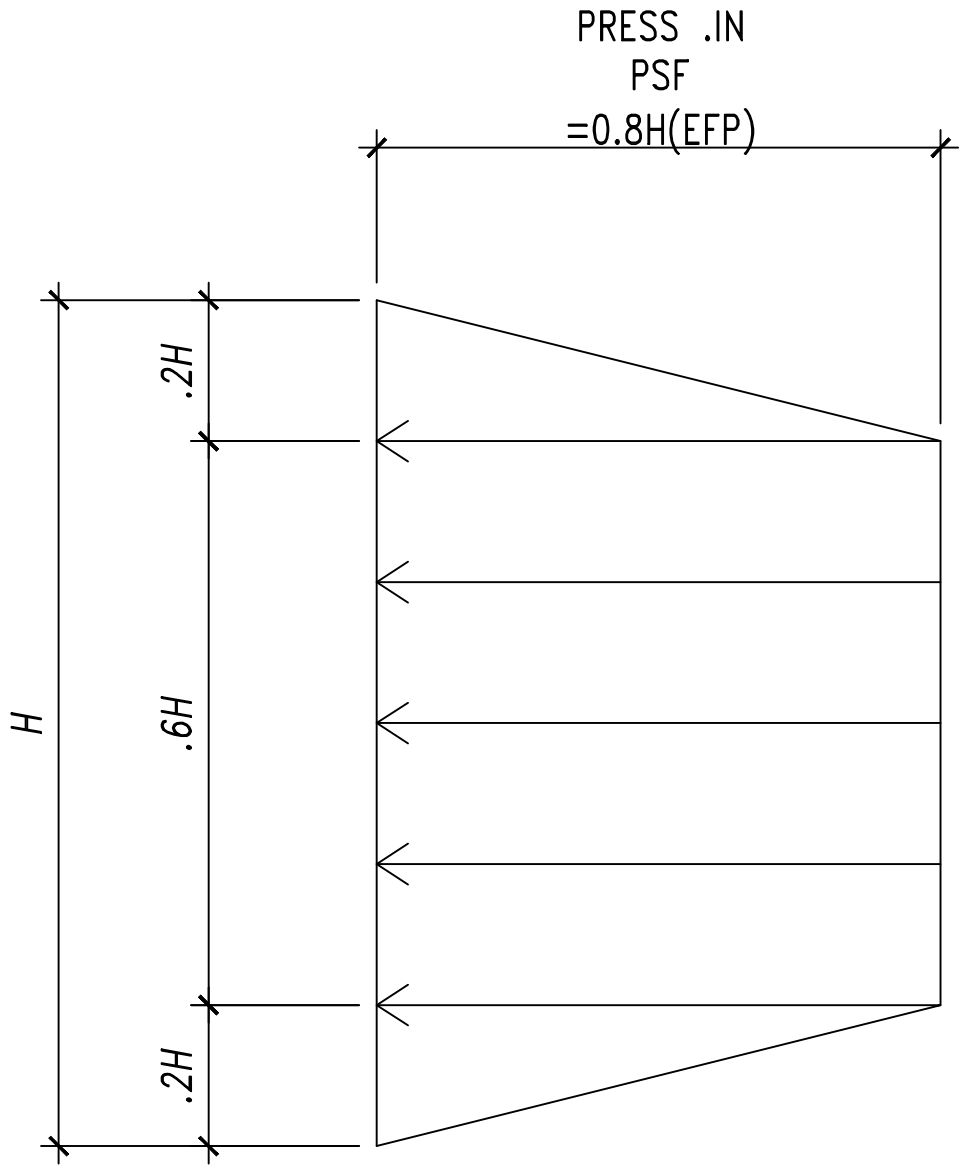
ENTECH ENGINEERING, INC.

GEOLOGY/ENGINEERING GEOLOGY MAP

5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO. 231507

FIG. 6



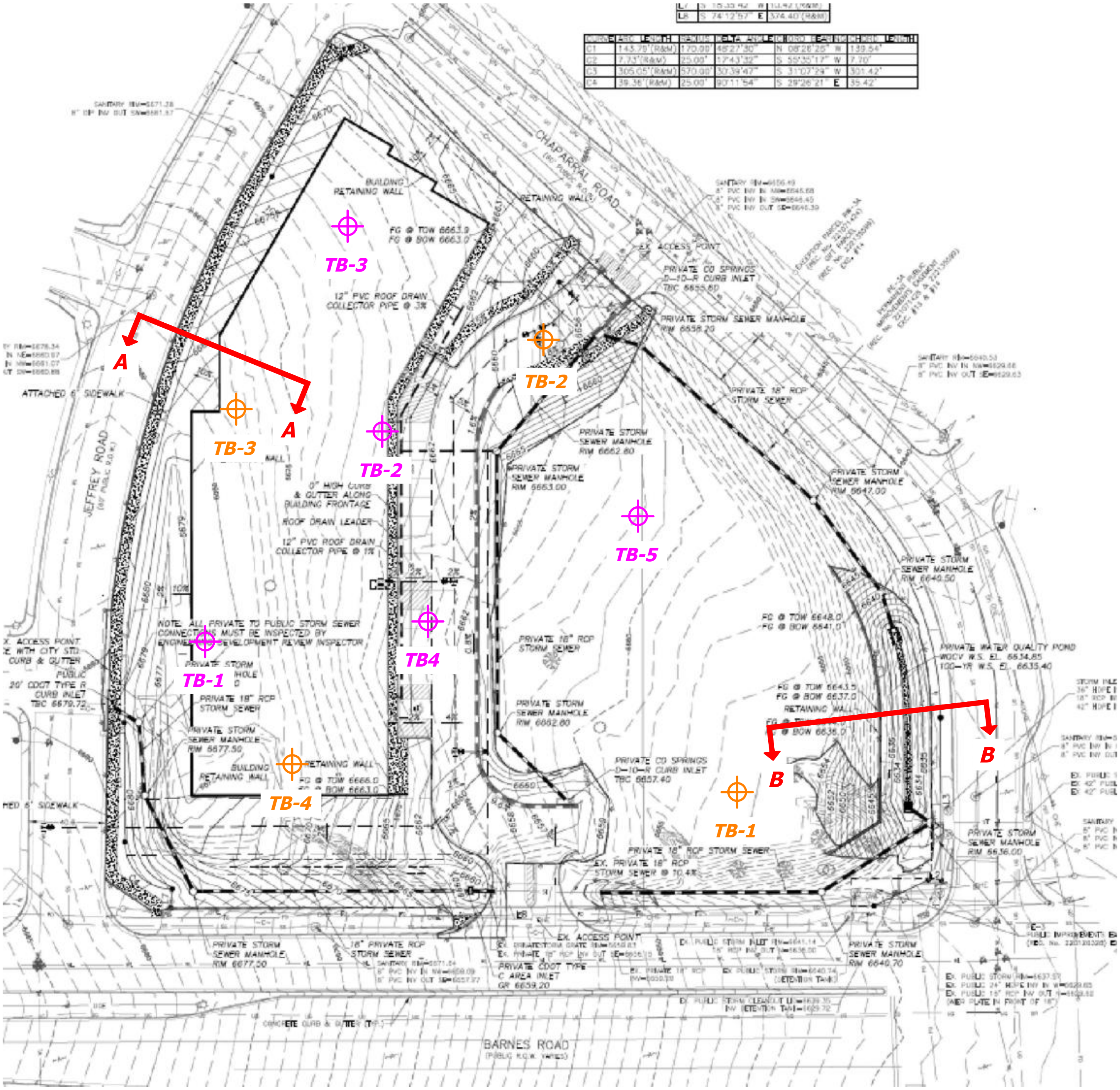
PRESSURE DISTRIBUTION

ENTECH ENGINEERING, INC.

LATERAL PRESSURE DIAGRAM
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 7



TB- approximate test boring location and number (Entech Job No. 231507)

TB- approximate test boring location and number (Entech Job No.35608.1)

SLOPE STABILITY SECTION

ENTECH ENGINEERING, INC.

SLOPE SECTION MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES

JOB NO.
231507

FIG. 8

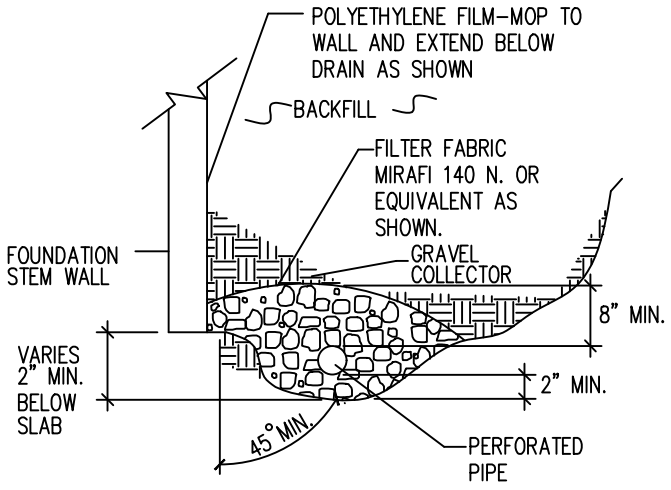
N

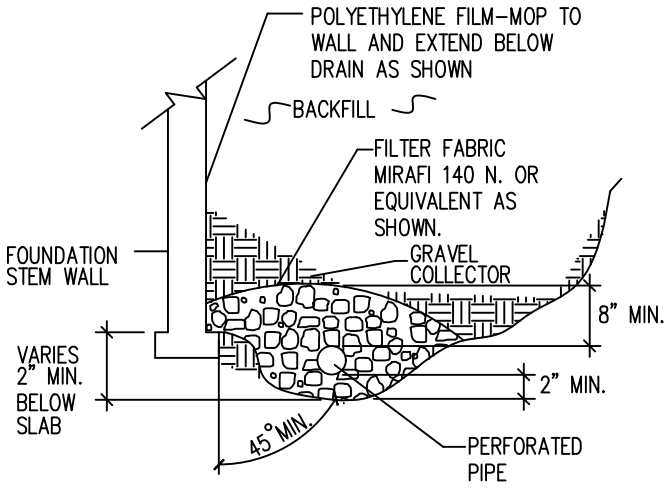
ENTECH
ENGINEERING, INC.

FEMA FLOODPLAIN MAP
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 9





NOTES:

–GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS–85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

–PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4–INCH DIAMETER IS MOST OFTEN USED.

–ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON–PERFORATED PIPE.

–FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

–MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

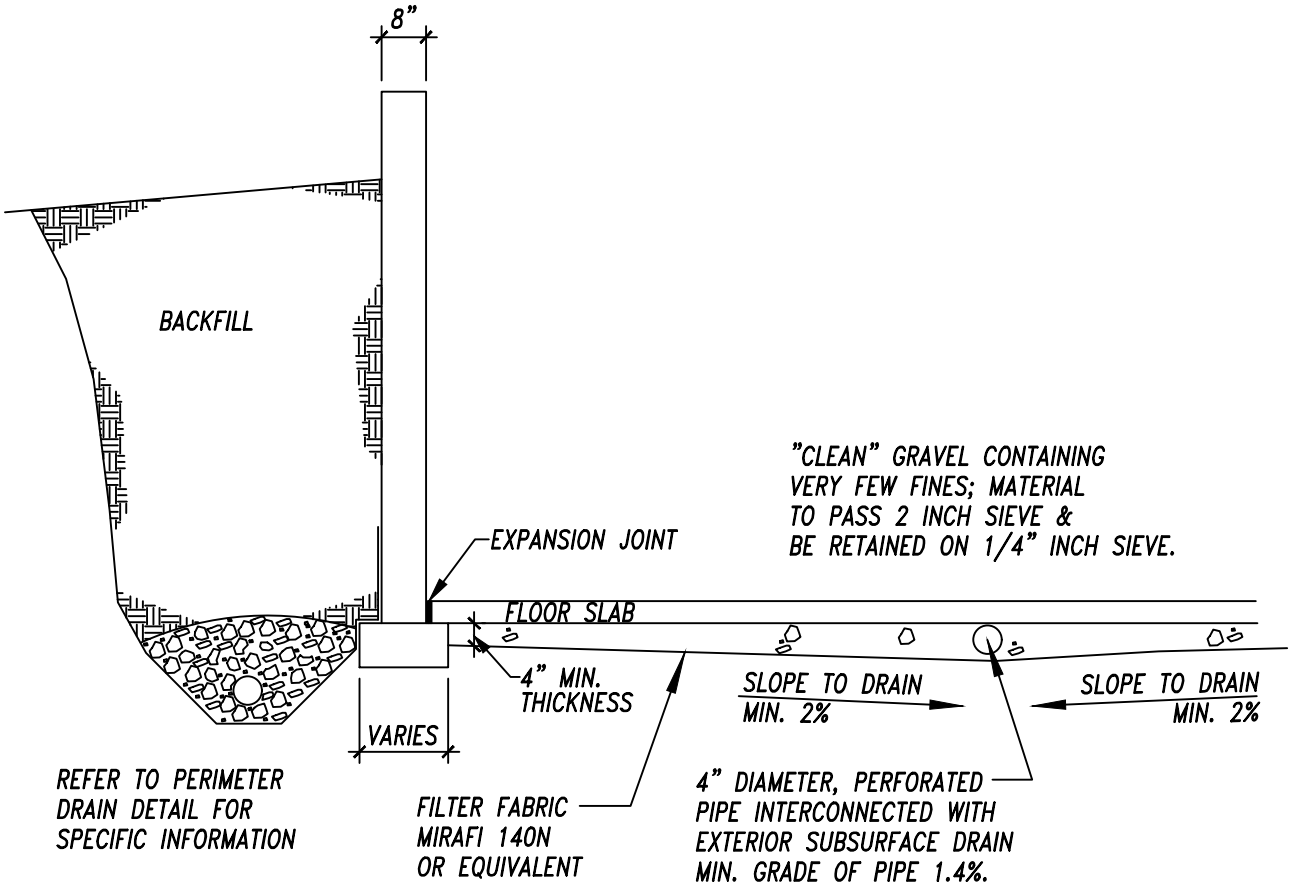
–DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

ENTECH ENGINEERING, INC.

PERIMETER DRAIN DETAIL
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO. 231507

FIG. 10



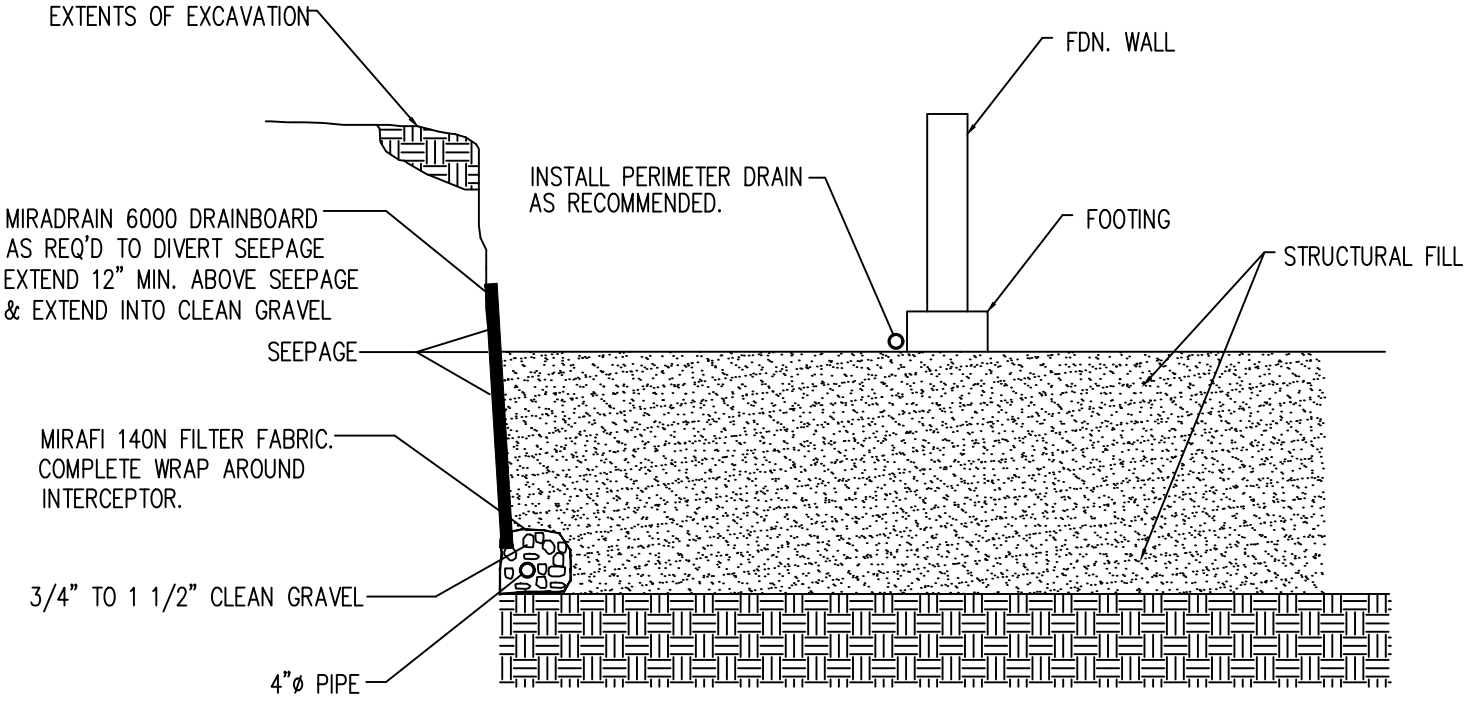
ENTECH ENGINEERING, INC.

TYP. UNDERSLAB DRAINAGE LAYER (CAPILLARY BREAK)

5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 11



NOTE:
EXTEND INTERCEPTOR DRAIN TO UNDERDRAIN OR TO SUMP.
BENCH DRAIN INTO NATIVE SOILS 12 INCHES MINIMUM.

INTERCEPTOR DRAIN DETAIL

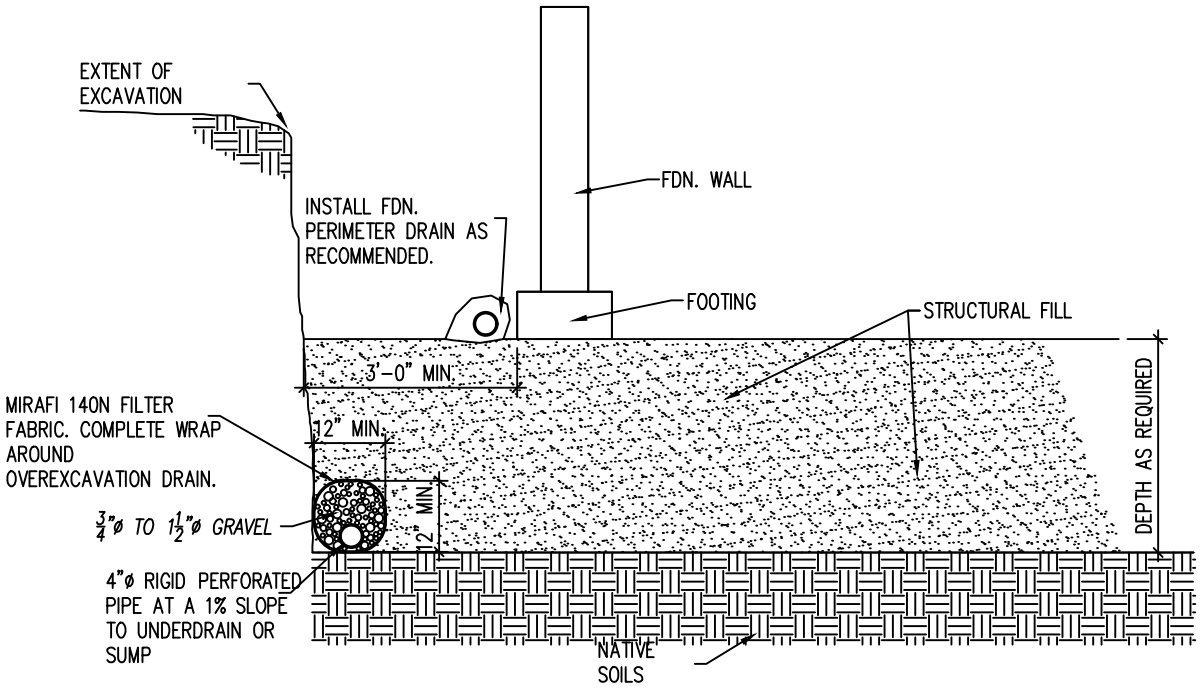
N.T.S.

ENTECH ENGINEERING, INC.

INTERCEPTOR DRAIN DETAIL
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO.
231507

FIG. 12



OVEREXCAVATION DRAIN DETAIL

N.T.S.

NOTE:

EXTEND DRAIN TO SUMP AS REQ'D.

ENTECH ENGINEERING, INC.

OVEREXCAVATION DRAIN
5560 BARNES ROAD
COLORADO SPRINGS, CO
ADVANCED STORAGE BARNES, LLC

JOB NO. 231507

FIG. 13

APPENDIX A: Site Photographs

1

Looking east from the southern side of the site.

September 14, 2023

2

Looking west from the southern side of the site.

September 14, 2023

Job No. 231507

3

Looking north from the western side of the site.

September 14, 2023

4

Looking east from the western side of the site.

June 14, 2023

Job No. 231507

5

Looking southwest from the northeastern side of the site.

September 14, 2023

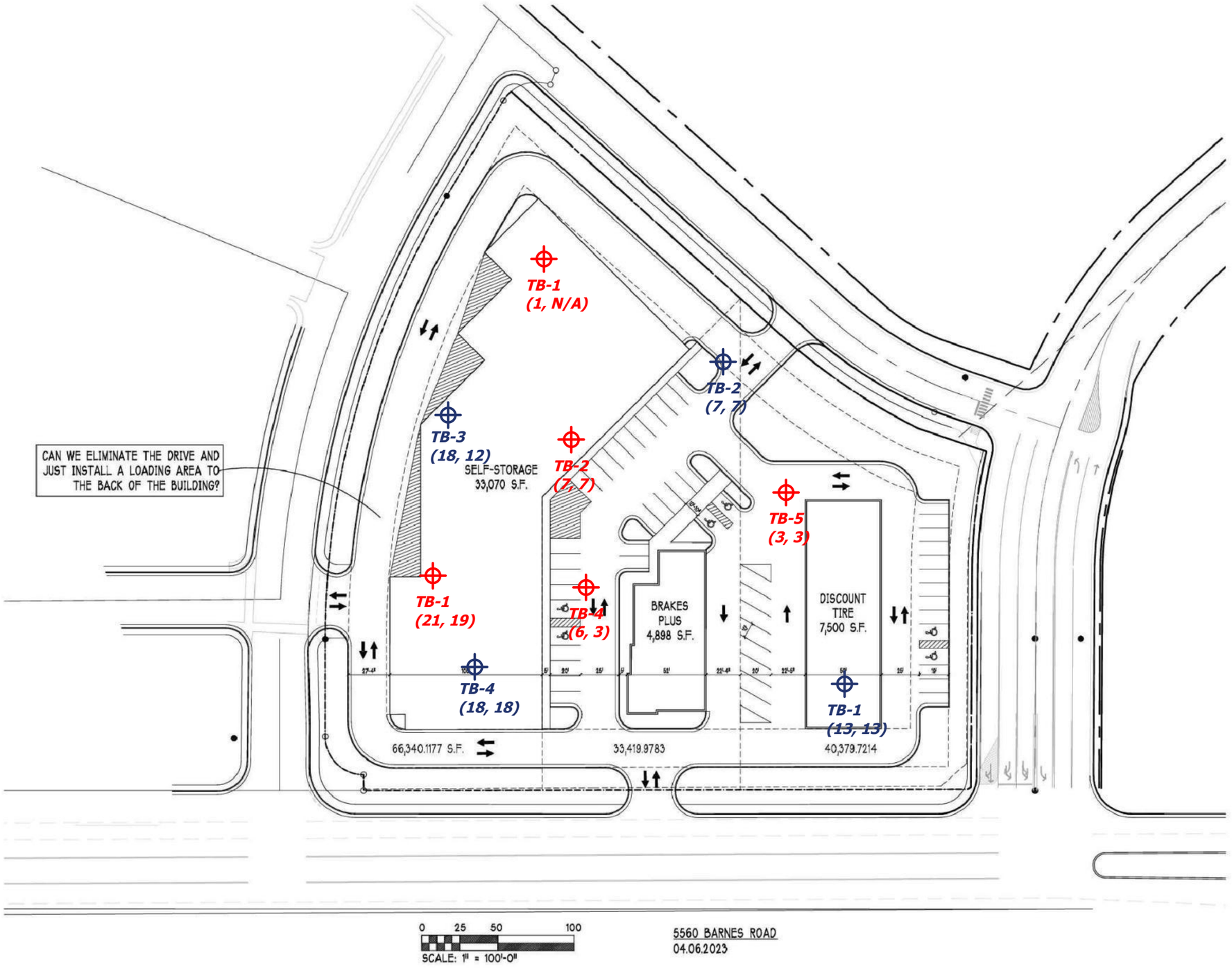
6

Looking south from the eastern side of the site.

September 14, 2023

Job No. 231507

APPENDIX B: EEI, Subsurface Soil Investigation, Test Boring Logs Laboratory Testing Summary, Job No. 230521



TB- TEST BORING NUMBER AND APPROXIMATE LOCATION (BEDROCK DEPTH, FILL DEPTH)

TB- TEST BORING NUMBER AND APPROXIMATE LOCATION (BEDROCK DEPTH, FILL DEPTH) EEI JOB NO. 35608

REVISION	BY

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907
(719) 531-5599

SITE PLAN/TEST BORING LOCATION MAP
SELF-STORAGE
5560 BARNES ROAD
COLORADO SPRINGS, CO
FOR: TRC COMPANIES INC.

DRAWN	LLL
CHECKED	
DATE	4/25/23
SCALE	AS SHOWN
JOB NO.	230521
FIGURE No.	2

TABLE 1A

DEPTH TO BEDROCK, FILL, & GROUNDWATER

CLIENT TRC COMPANIES
PROJECT 5560 BARNES ROAD
JOB NO. 230521

TEST BORING NO.	DEPTH TO BEDROCK (ft.)	DEPTH OF FILL (ft.)	DEPTH OF GROUNDWATER (ft.)
1	21	19	/
2	7	7	/
3	1	/	/
4	6	3	/
5	3	3	/
ENTECH JOB NO. 35608			
TEST BORING NO.	DEPTH TO BEDROCK (ft.)	DEPTH OF FILL (ft.)	DEPTH OF GROUNDWATER (ft.)
1	13	13	/
2	7	7	/
3	18	12	/
4	18	18	14

TEST BORING NO. 1
DATE DRILLED 4/11/2023
Job # 230521

REMARKS

DRY TO 29', 4/13/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50/10"	5.5	1
5			37	6.2	1
10			34	5.6	1
15			50/10"	5.2	1
20			34	23.5	2
25			50/6"	23.6	5

FILL -19', SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE TO DENSE, MOIST

SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE, MOIST

CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST

TEST BORING NO. 2
DATE DRILLED 4/11/2023
CLIENT TRC COMPANIES
LOCATION 5560 BARNES ROAD

REMARKS

DRY TO 18.5', 4/13/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			31	19.2	1
5			50/10"	21.2	1
10			50/7"	23.8	5
15			50/3"	16.1	4
20			50/7"	25.6	5

FILL 0-7', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE TO VERY DENSE, MOIST

SILTSTONE, SANDY, GRAY BROWN, HARD, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST

CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	4/25/23

JOB NO.: 230521
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 4/11/2023
Job # 230521

REMARKS

DRY TO 18.5', 4/13/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
					2	SAND, SILTY, TAN
			50/3"	8.9	4	SANDSTONE, VERY SILTY, FINE GRAINED, TAN TO GRAY BROWN, VERY DENSE, MOIST
5			50/7"	15.8	4	
10			50/8"	23.0	4	
15			50/9"	17.8	4	
20			50/9"	22.7	4	

TEST BORING NO. 4
DATE DRILLED 4/11/2023
CLIENT TRC COMPANIES
LOCATION 5560 BARNES ROAD

REMARKS

DRY TO 8.5', 4/13/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			14	3.0	1	FILL 0-3', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5			38	27.6	3	CLAY, BROWN, HARD, MOIST
						SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST
10			50/6"	21.1	4	
15						
20						

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED: LLL	DATE: 4/25/23

JOB NO.: 230521
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 4/11/2023
Job # 230521

TEST BORING NO.
DATE DRILLED
CLIENT TRC COMPANIES
LOCATION 5560 BARNES ROAD

REMARKS

DRY TO 9', 4/13/23

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50	4.6	1
5			50 9"	23.2	5
10			50 6"	17.6	4
15					
20					

FILL 0-3', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST

CLAYSTONE, GRAY BROWN, HARD, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5					
10					
15					
20					

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	4/25/23

JOB NO.: 230521

FIG NO.: A- 3

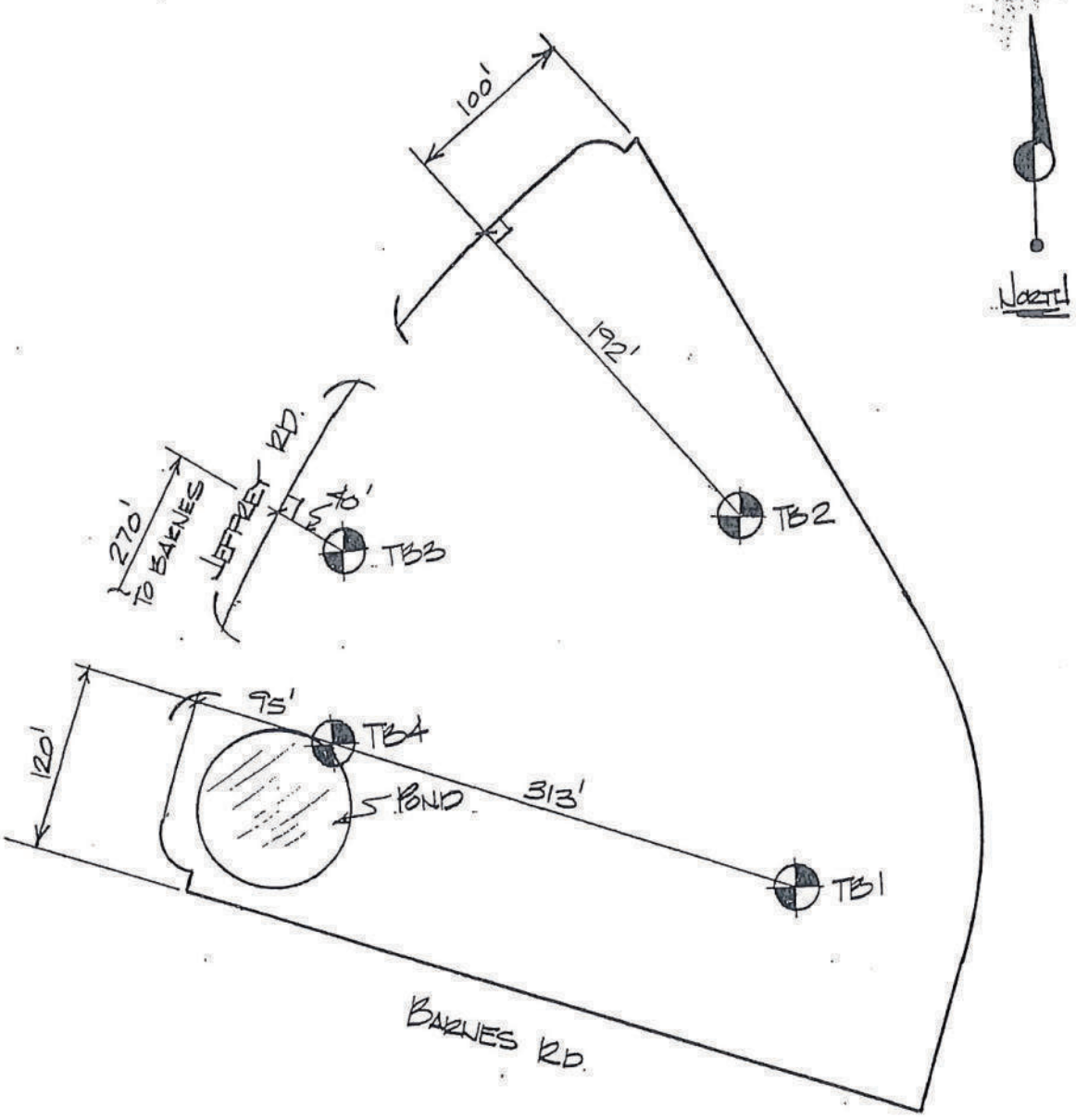
TABLE 1B

SUMMARY OF LABORATORY TEST RESULTS

CLIENT TRC COMPANIES
PROJECT 5560 BARNES ROAD
JOB NO. 230521

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	5			11.4	NV	NP	<0.01			SM-SW	FILL, SAND, SLIGHTLY SILTY
1	5	1-2			17.9	NV	NP				SM	FILL, SAND, SILTY
3	4	0-3			62.8	36	16				CL	CLAY, SANDY
3	4	5	32.0	89.3	98.9					1.1	CL	CLAY
4	3	2-3			42.0	NV	NP	<0.01			SM	SANDSTONE, VERY SILTY
5	2	10	25.4	87.4	65.6	47	15	<0.01		0.4	ML	SILTSTONE, SANDY

APPENDIX C: EEI, Geologic Hazard Study, Test Boring Logs and Laboratory Testing, Job No. 35608.1



ENTECH ENGINEERING, INC.

TEST BORING LOCATION PLAN

Drawn	Date	Checked	Date

Job No. 35608

Fig. No. 3

TEST BORING NO. 1
DATE DRILLED 3/27/98
Job # 35608

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL, 0-13'						
SAND, SILTY WITH CLAY POCKETS, MOTTLED BROWNS, MEDIUM DENSE, MOIST				19	7.1	1
	5			15	19.4	1
	10			25	9.5	1
SILTSTONE, GRAY, HARD, MOIST	15			50/1"	15.3	3
SANDSTONE, SILTY, FINE GRAINED, BROWN, VERY DENSE, MOIST	20			50/2"	9.4	4

TEST BORING NO. 2
DATE DRILLED 3/27/98

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL, 0-7'						
SAND, SILTY TO CLAYEY, MOTTLED BROWNS, MEDIUM DENSE, MOIST				16	14.6	1
	5			15	12.4	1
SILTSTONE, SLIGHTLY CLAYEY LENSES, BROWN, HARD, MOIST	10			50/5"	17.6	3
	15			50/6"	20.5	3
	20			50/4"	20.5	3

ENTECH ENGINEERING, INC.

TEST BORING LOG

Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-1

TEST BORING NO. 3
DATE DRILLED 3/27/98
Job # 35608

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL, 0-12'						
SAND, SILTY TO CLAYEY, MOTTLED BROWNS, DENSE, MOIST				35	6.2	1
	5			44	6.2	1
	10			33	8.2	1
SAND, SLIGHTLY SILTY, MEDIUM GRAINED, BROWN, MEDIUM DENSE MOIST	15			13	8.2	2
CLAYSTONE-SILTSTONE, BROWN, HARD, MOIST	20			50/6"	26.7	5

TEST BORING NO. 4
DATE DRILLED 3/27/98

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL, 0-18'						
SAND, SILTY, MOTTLED BROWNS, MEDIUM DENSE TO DENSE, MOIST				23	4.9	1
CLAYEY LENSE	5			44	7.4	1
	10			26	6.6	1
WATER AT 14'	15			37	7.9	1
SANDSTONE, BROWN, FINE GRAINED, VERY DENSE, MOIST	20			50/6"	15.6	4

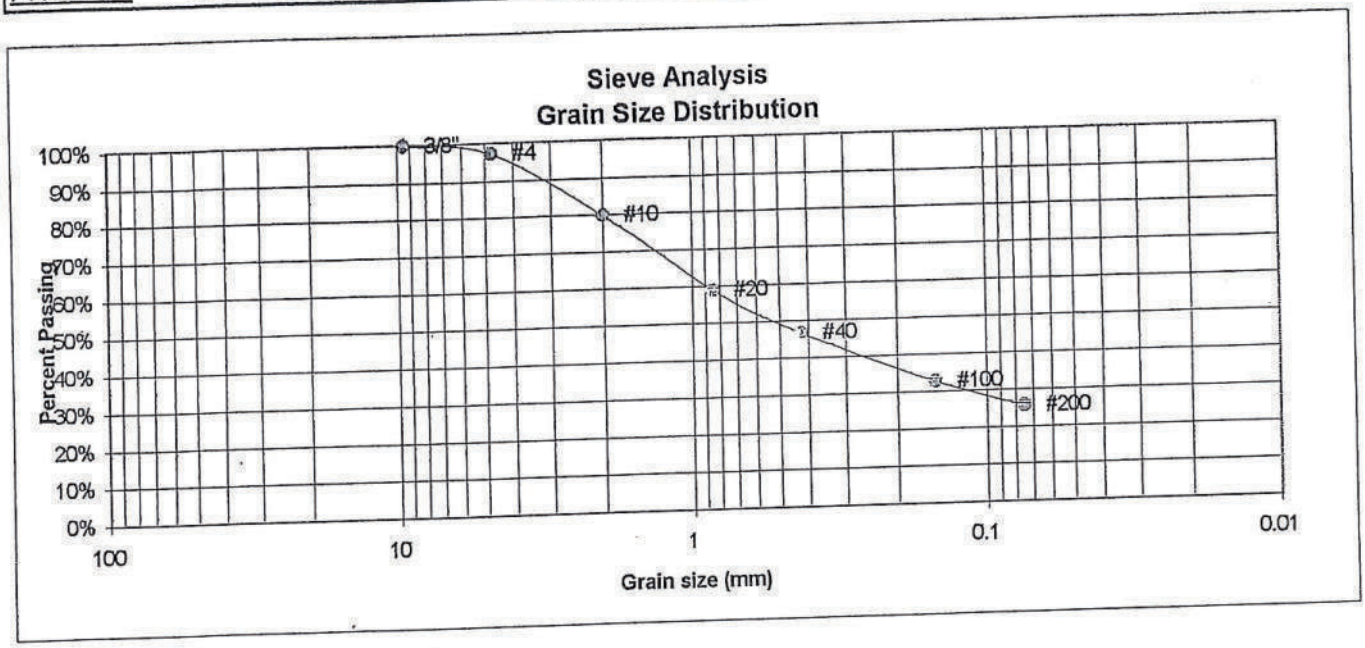
ENTECH ENGINEERING, INC.

TEST BORING LOG

Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-2

SOIL TYPE #	1, TB-1 @ 5'	UNIFIED CLASSIFICATION	SM	TEST BY	DG
CLIENT	BAGHERIAN DEVELOPMENT	AASHTO CLASSIFICATION		JOB NO.	35608
PROJECT	NORTHWEST CORNER POWERS AT BARNES				



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.4%
10	79.9%
20	58.9%
40	46.7%
100	32.8%
200	25.7%

Atterberg Limits

Plastic Limit	24
Liquid Limit	28
Plastic Index	4

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH ENGINEERING, INC.

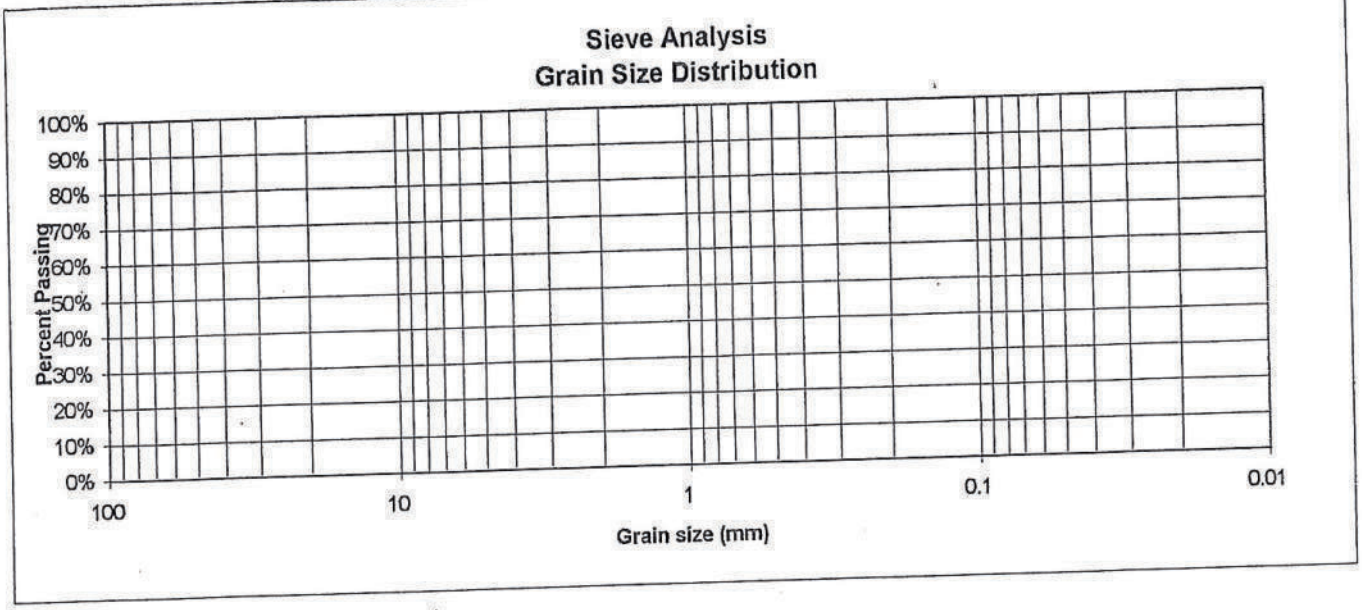
LABORATORY TEST RESULTS

Drawn	Date	Checked	Date

Job No. 35608

Fig. No. A-3

SOIL TYPE #	1, TB-4 @ 5'	UNIFIED CLASSIFICATION	SC	TEST BY	DG
CLIENT	BAGHERIAN DEVELOPMENT	AASHTO CLASSIFICATION		JOB NO.	35608
PROJECT	NORTHWEST CORNER POWERS AT BARNES				



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	
200	

Atterberg Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	9.6%
Moisture at finish	21.9%
Moisture increase	12.2%
Initial dry density (pcf)	98
Swell (psf)	62

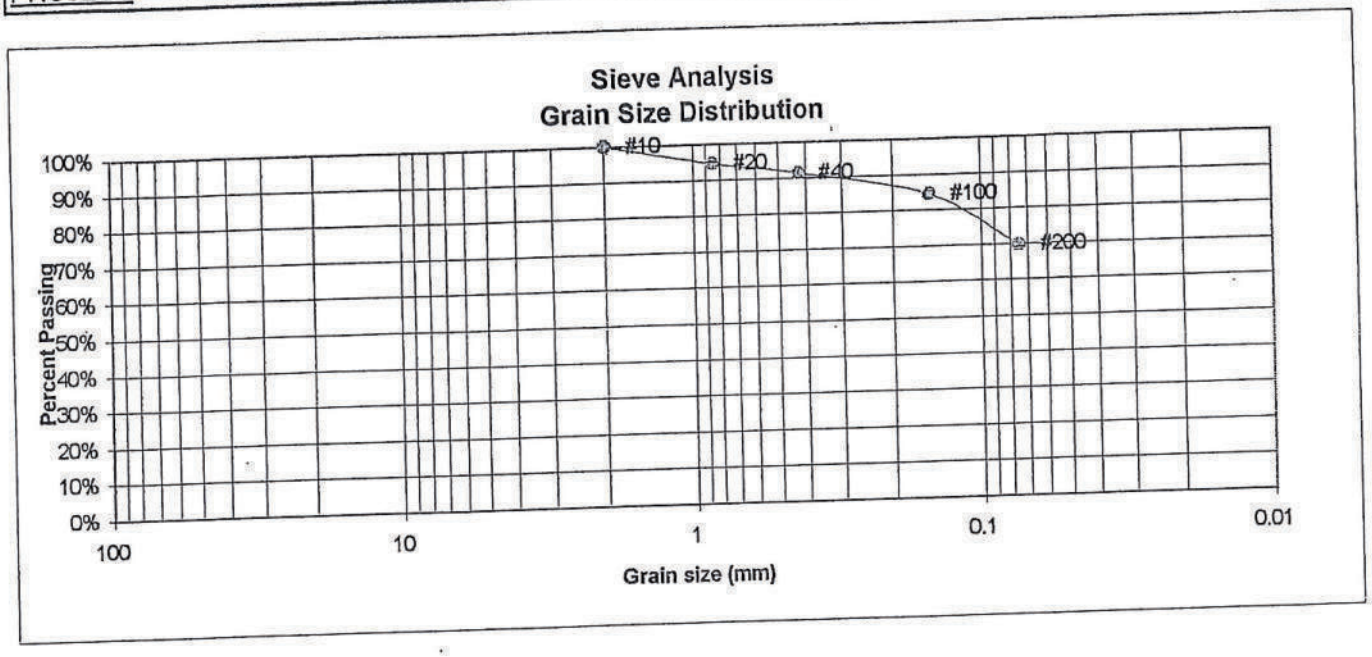
ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-4

SOIL TYPE #	3, TB-2 @ 10'	UNIFIED CLASSIFICATION	ML	TEST BY	DG
CLIENT	BAGHERIAN DEVELOPMENT	AASHTO CLASSIFICATION		JOB NO.	35608
PROJECT	NORTHWEST CORNER POWERS AT BARNES				



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	94.6%
40	91.4%
100	84.6%
200	69.7%

Atterberg Limits

Plastic Limit	43
Liquid Limit	48
Plastic Index	5

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH ENGINEERING, INC.

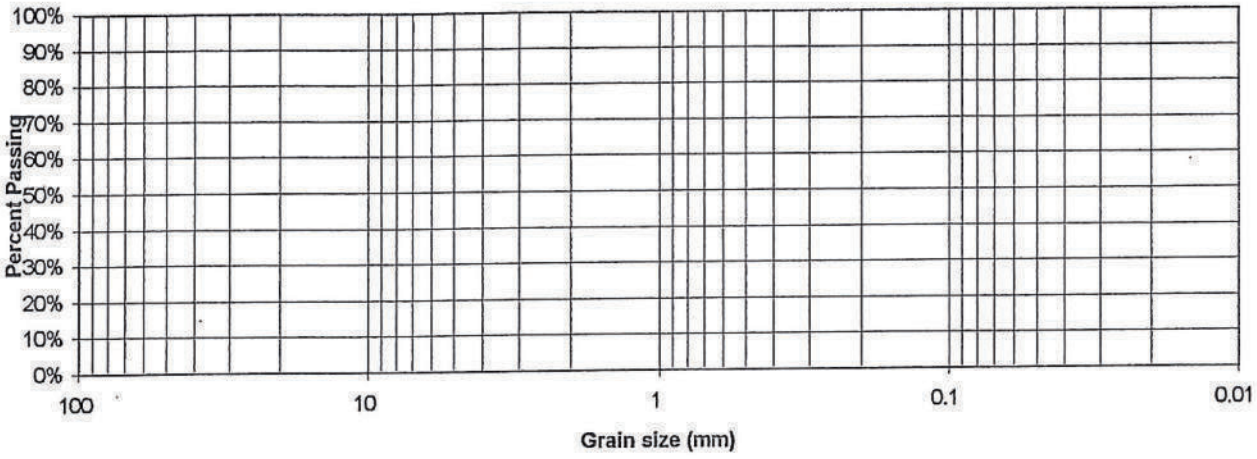
LABORATORY TEST RESULTS

Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-5

SOIL TYPE #	5, TB-3 @ 20'	UNIFIED CLASSIFICATION	CL	TEST BY	DG
CLIENT	BAGHERIAN DEVELOPMENT	AASHTO CLASSIFICATION		JOB NO.	35608
PROJECT	NORTHWEST CORNER POWERS AT BARNES				

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	
200	

Atterberg Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	22.1%
Moisture at finish	41.9%
Moisture increase	19.8%
Initial dry density (pcf)	77
Swell (psf)	1810

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

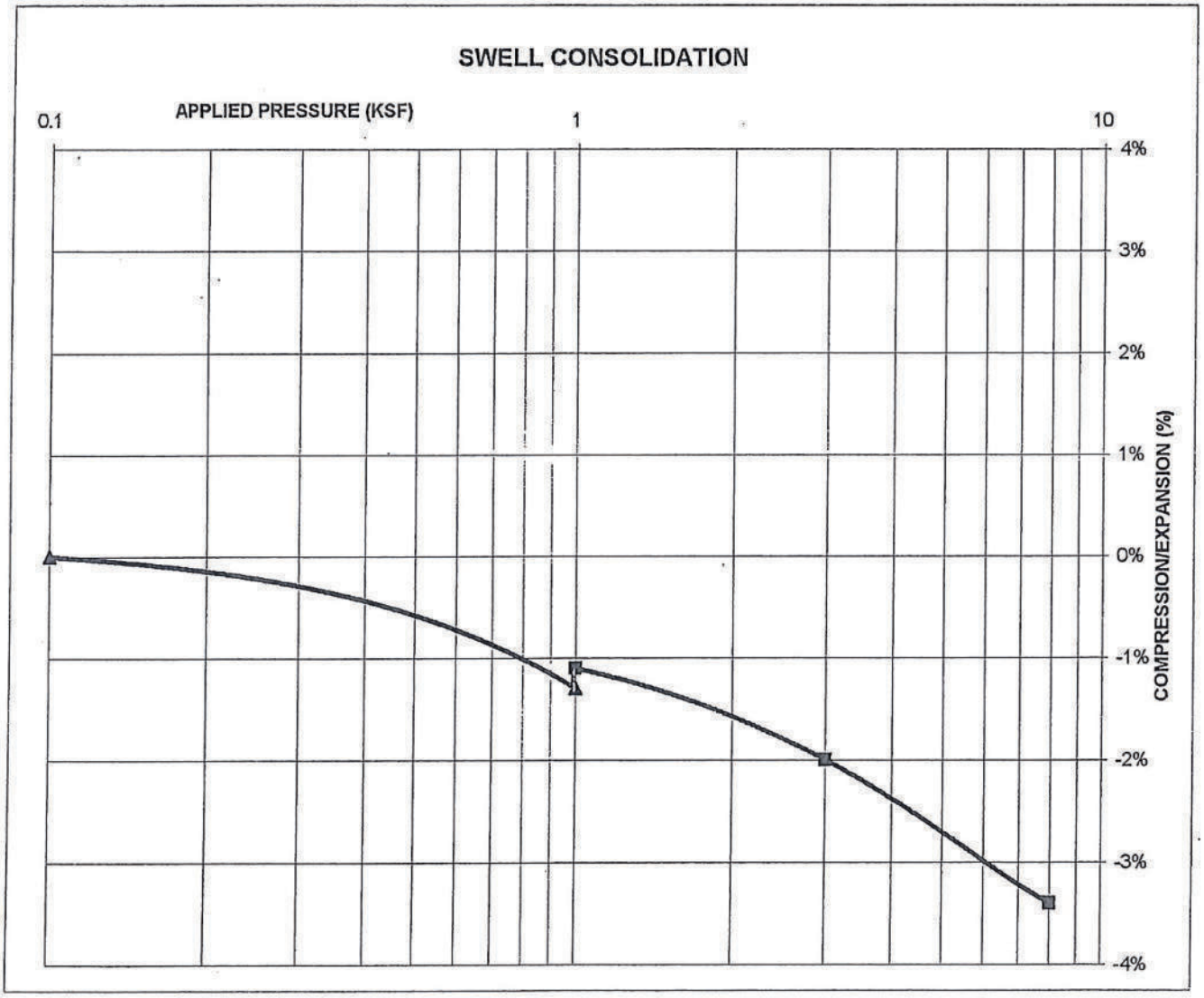
Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-6

CONSOLIDATION TEST RESULTS

SAMPLE FROM:	TB-2	AT DEPTH	10'
DESCRIPTION	ML	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			103
NATURAL MOISTURE CONTENT			20.5%

JOB NO. 35608
CLIENT BAGHERIAN DEVELOPMENT
PROJECT NORTHWEST CORNER POWERS



ENTECH ENGINEERING, INC.

SWELL CONSOLIDATION TEST RESULTS

Drawn	Date	Checked	Date

Job No. 35608
Fig. No. A-7

APPENDIX D: Soil Survey Descriptions

El Paso County Area, Colorado

85—Stapleton-Bernal sandy loams, 3 to 20 percent slopes

Map Unit Setting

National map unit symbol: 36b1
Elevation: 6,500 to 6,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Stapleton and similar soils: 55 percent
Bernal and similar soils: 44 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stapleton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

A - 0 to 11 inches: sandy loam
Bw - 11 to 17 inches: gravelly sandy loam
C - 17 to 60 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Description of Bernal

Setting

Landform: Hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: sandy loam
Bt - 4 to 11 inches: sandy clay loam
C - 11 to 13 inches: sandy loam
R - 13 to 17 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 20 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R049XB204CO - Shallow Foothill
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 20, Sep 2, 2022

APPENDIX E: Slope Stability Analysis

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599

TABLE E-1

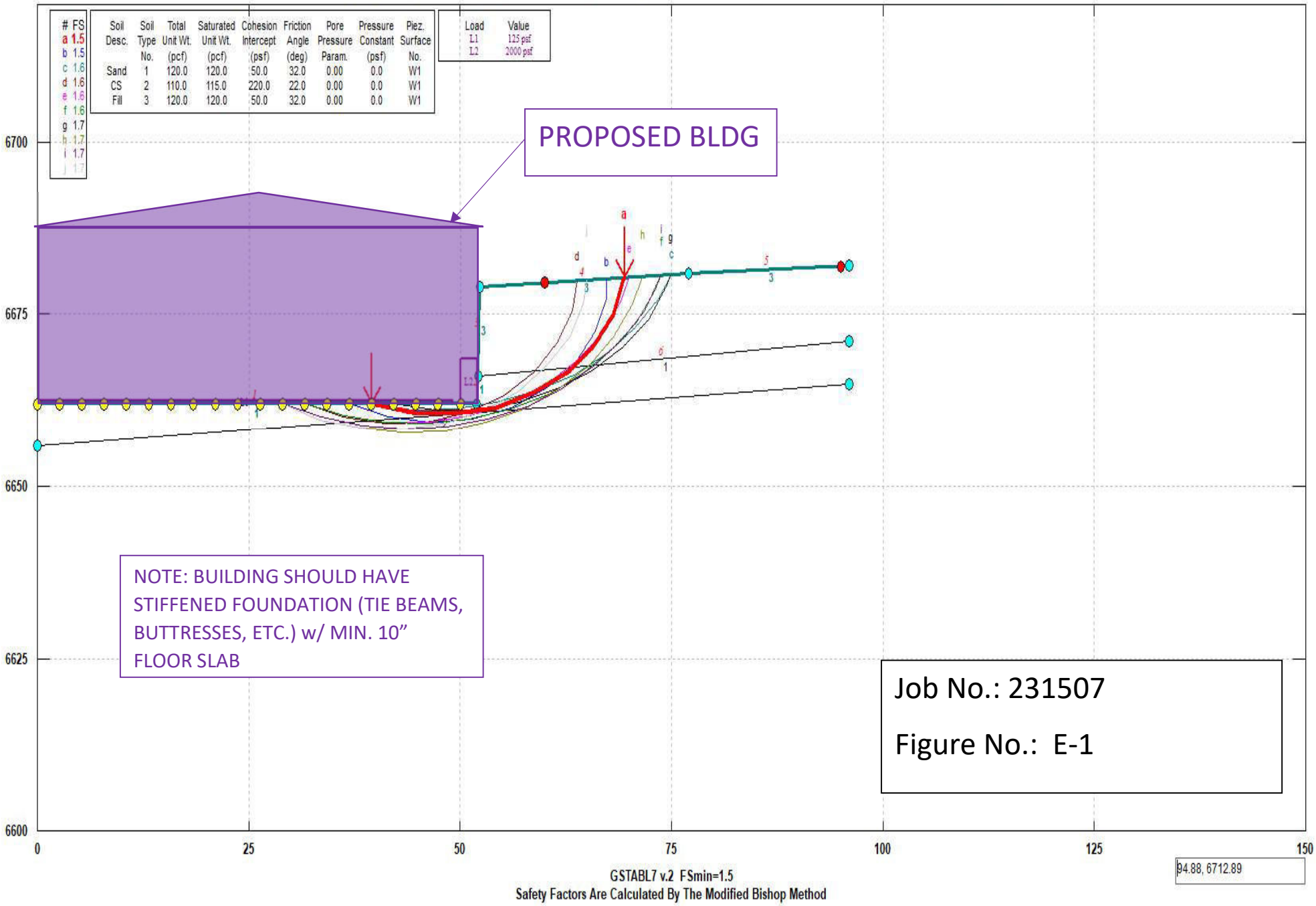
SUMMARY OF SLOPE STABILITY ANALYSIS

CLIENT Advanced Storage Barnes
PROJECT 5560 Barnes
JOB NO. 231269

Figure #	Section	Water Table	F.O.S.	Description
E-1	A-A	Low	1.5	Proposed site analyzed with circular failure surface with stiffened foundation. Nominal loads of 2000 psf (exterior foundation) and 150 psf (minimum 10" thick floor slab) are provided for analysis.
E-2	A-A	High	1.5	Proposed site analyzed with circular failure surface with stiffened foundation. Nominal loads of 2000 psf (exterior foundation) and 150 psf (minimum 10" thick floor slab) are provided for analysis. Elevated water table.
E-3	A-A	Low	1.3	Proposed site analyzed with circular failure surface with lined detention pond.
E-4	A-A	High	1.3	Proposed site analyzed with circular failure surface with lined detention pond. Elevated water table

Note: Slope stability analysis was conducted utilizing the GSTABL7 (2-dimensional, limit equilibrium program) w/ Stedwin user interface. Soil descriptions shown on the cross-sections correlate to soil labels (in black/green for surface boundary lines) below soil boundary lines. Soil boundary lines are labeled above the line (in red). Piezometric surfaces associated with soil types are labeled upgradient of the associated surface. Additional information on the analysis may be found in the GStabl7 with Stedwin program manual.

ADVANCED STORAGE BARNES – 5560 BARNES – A-A

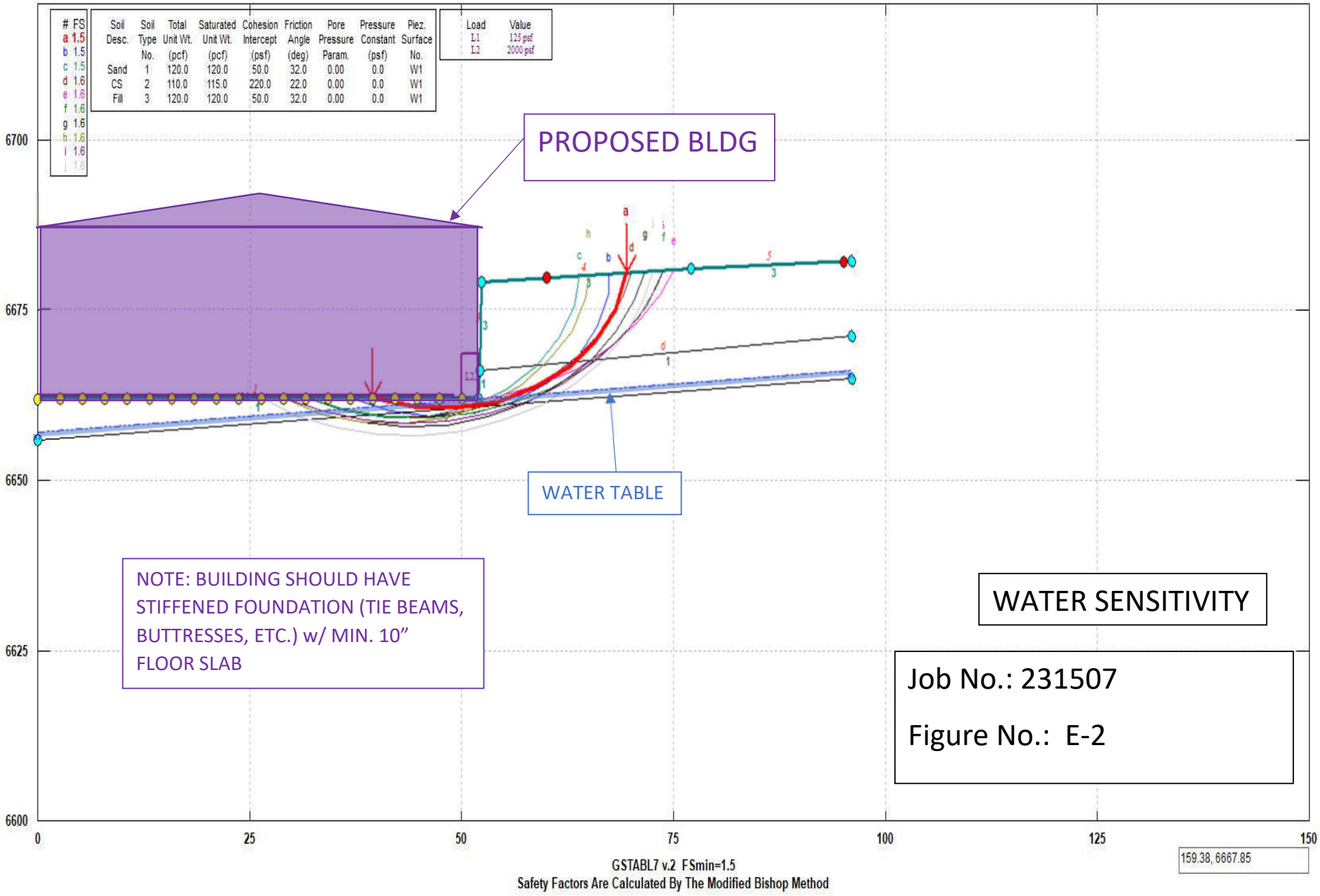


NOTE: BUILDING SHOULD HAVE STIFFENED FOUNDATION (TIE BEAMS, BUTTRESSES, ETC.) w/ MIN. 10" FLOOR SLAB

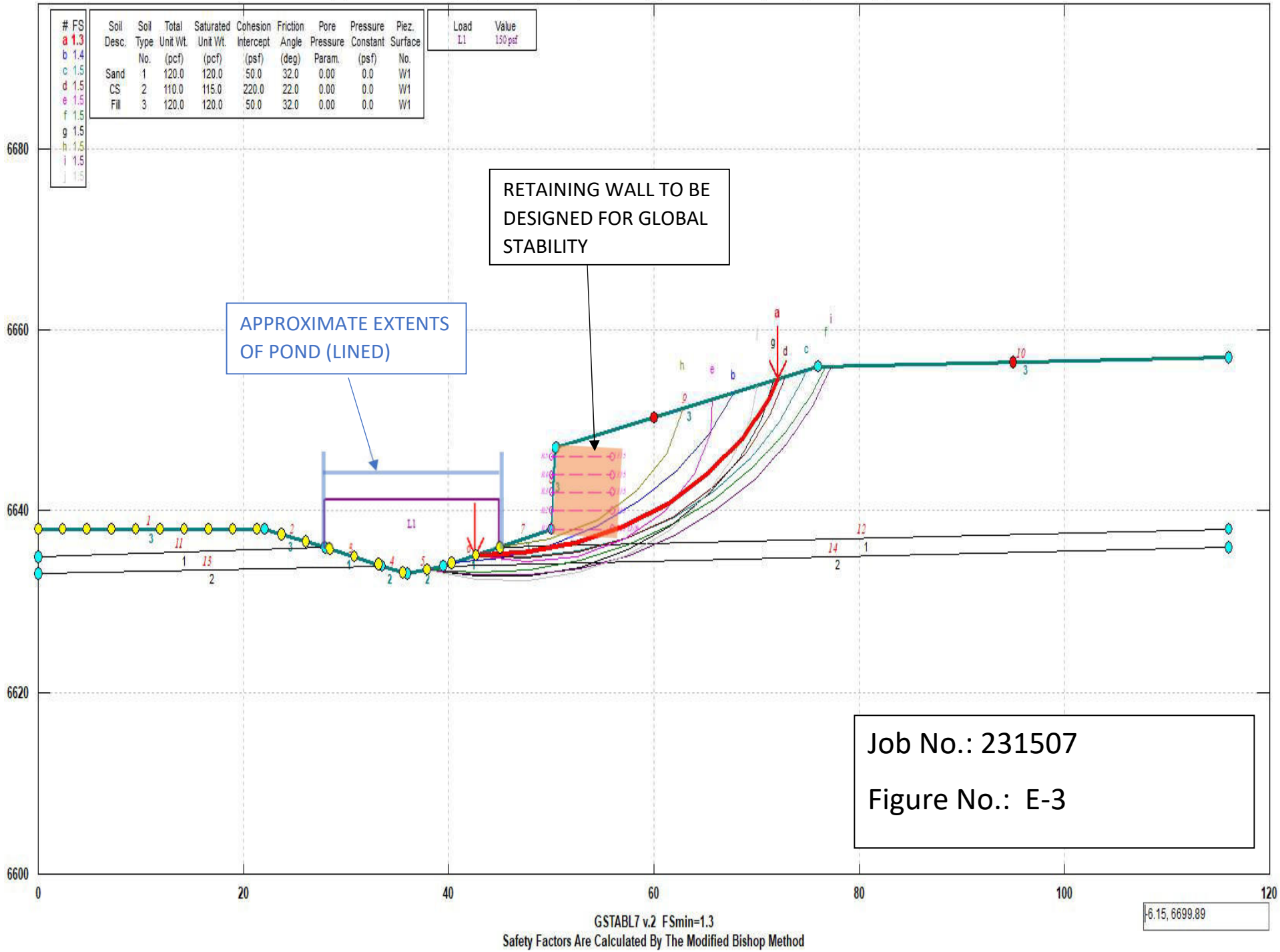
Job No.: 231507

Figure No.: E-1

ADVANCED STORAGE BARNES – 5560 BARNES – A-A



ADVANCED STORAGE BARNES – 5560 BARNES – B-B



#	FS
a	1.3
b	1.4
c	1.5
d	1.5
e	1.5
f	1.5
g	1.5
h	1.5
i	1.5
j	1.5

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand	1	120.0	120.0	50.0	32.0	0.00	0.0	W1
CS	2	110.0	115.0	220.0	22.0	0.00	0.0	W1
Fill	3	120.0	120.0	50.0	32.0	0.00	0.0	W1

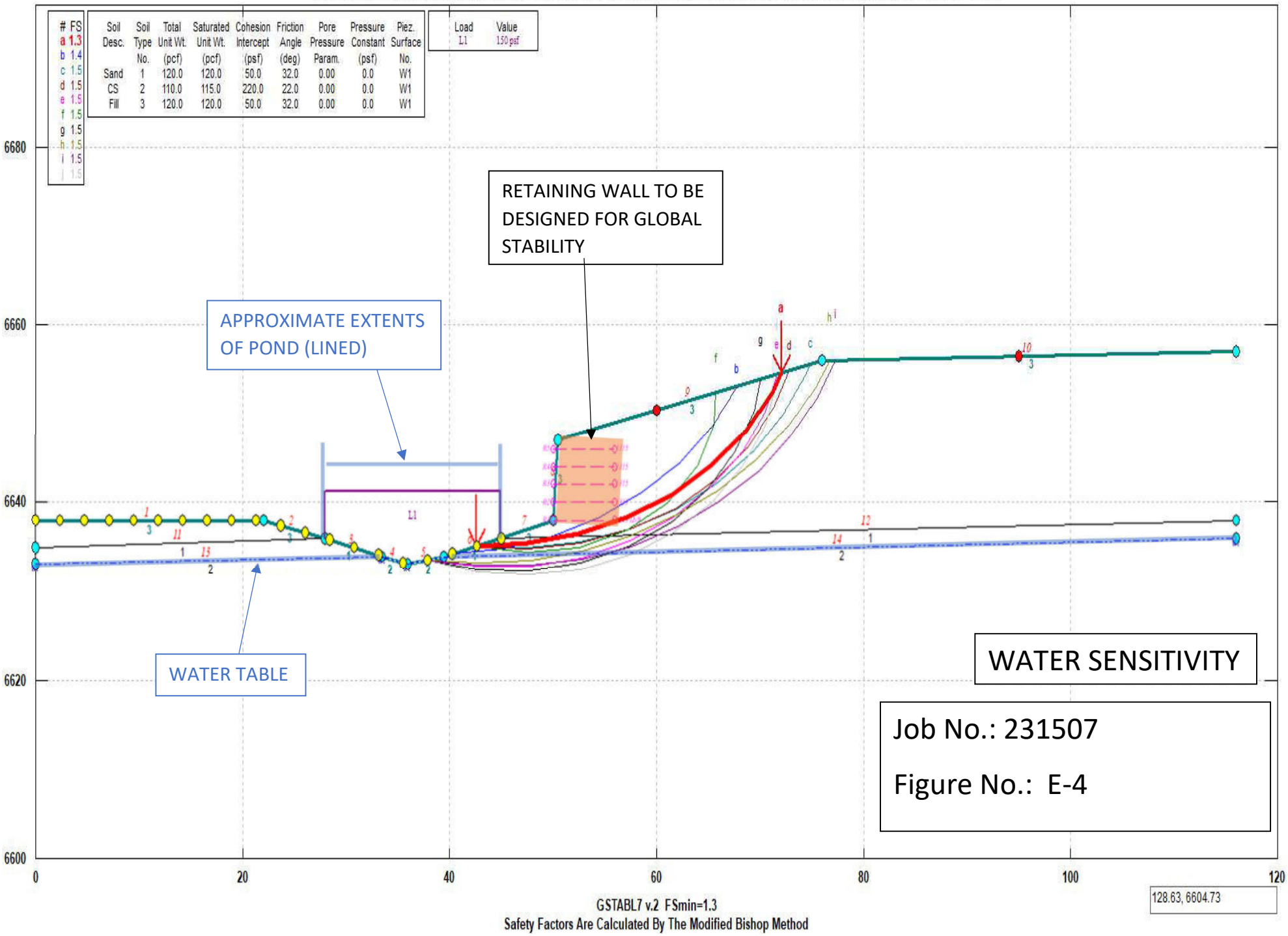
Load	Value
L1	150 psf

GSTABL7 v.2 FSmin=1.3
Safety Factors Are Calculated By The Modified Bishop Method

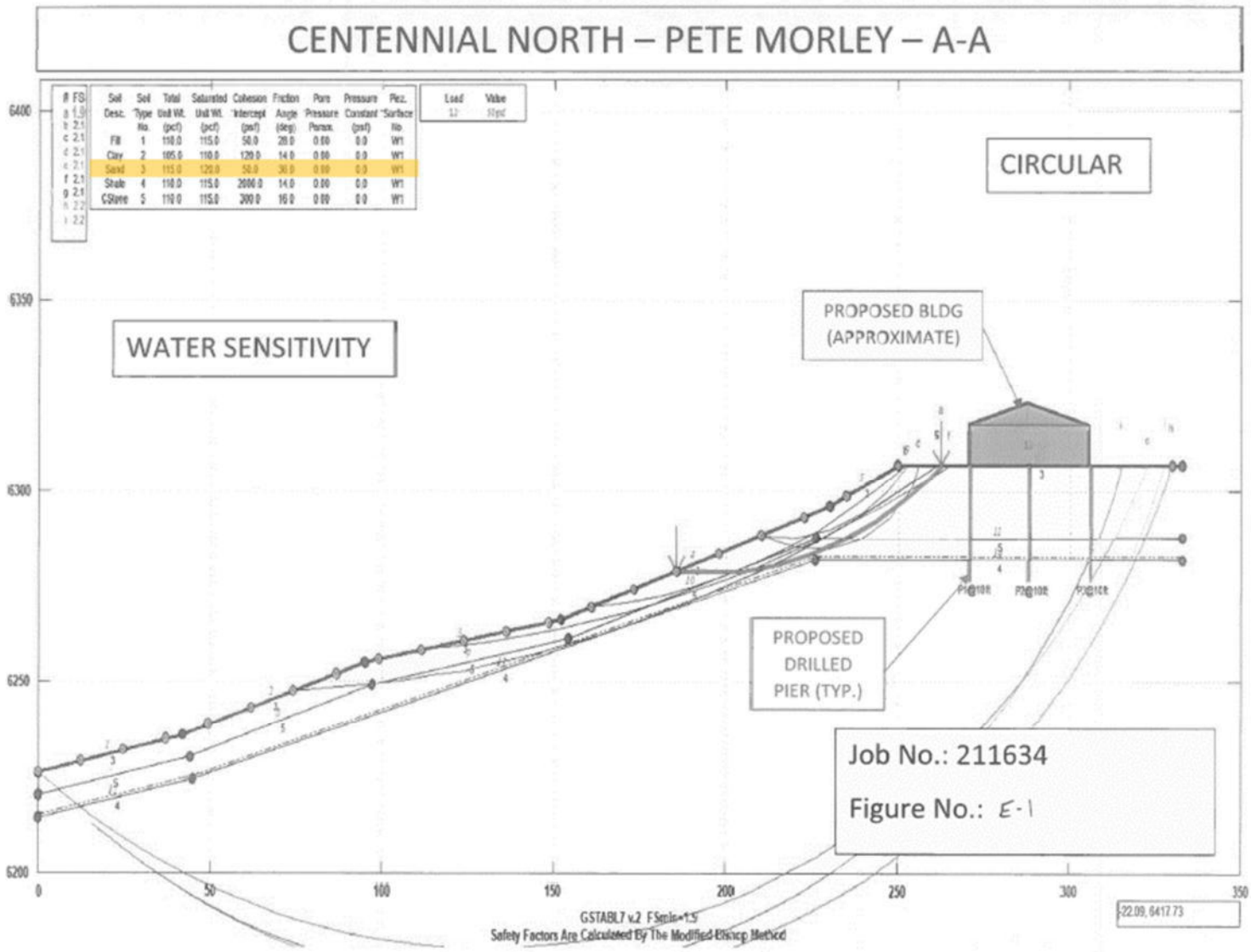
Job No.: 231507

Figure No.: E-3

ADVANCED STORAGE BARNES – 5560 BARNES – B-B

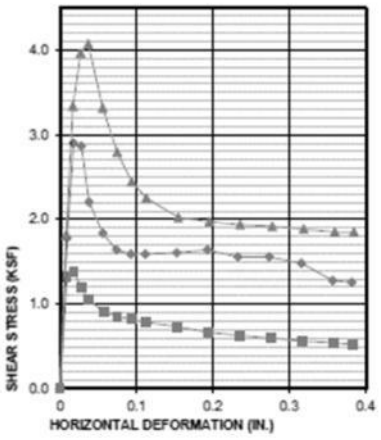


Sand



August 19, 2021
Revised October 21, 2022
Entech Engineering, Inc.
Geologic Hazard Study
Centennial North
Tax Schedule No. 73363-01-015
Colorado Springs, Colorado
Entech Job No. 211634

Claystone

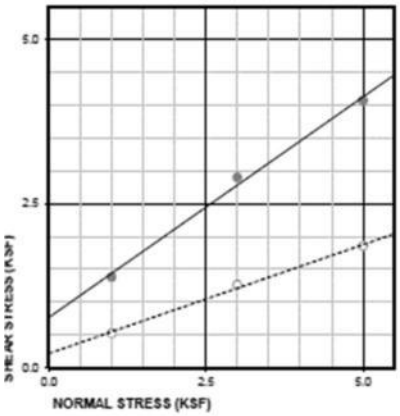


Sample No.	Boring No.	Depth (FT)	Moisture Content (%) Before	Moisture Content (%) After	Dry Density (PCF)
1 ■	TH-11	9'&14'	19.2	26.9	109.7
2 ◆	TH-11	9'&14'	19.2	24.3	110.5
3 ▲	TH-11	9&14'	19.2	22.4	108.3

LL: 48 PI: 31 -200: 96 Clay Content, % 44

Thickness (in): 1.0 Diameter (in): 1.935

Shearing Rate (in/min): 0.0016



Sample No.	Normal Stress (KSF)	Peak Shear Stress (KSF) ●	Large Displacement Shear Stress (KSF) ○	Large Displacement Displacement (IN.) ○
1 ■	1	1.38	0.52	0.38
2 ◆	3	2.9	1.26	0.38
3 ▲	5	4.07	1.85	0.39

Peak ϕ (DEG): 34

Large Displacement, ϕ (DEG): 18

Peak C (PSF): 770

Large Displacement C (PSF): 220

ample Description: Interbedded Claystone/Sandstone, Hard, M. Moist, Brown, L. Brown, Rust

ample Type: California

emarks:

Direct Shear Test Results

TITAN PEAK, LLC
ALLASO PEAK, FILING 1
CTL|T PROJECT NO. CS19492-125

FIG. B-40

February 4, 2022
CTL Thompson, Inc.
Geotechnical Investigation and Geologic Hazard Evaluation
Allaso Peak, Filing 1, Apartments
Centennial Boulevard and West Van Buren Street
Colorado Springs, Colorado
CTL Project No. CS-19492-12