ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

GEOLOGIC HAZARD STUDY
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, COLORADO

Prepared for

Viceroy Development
7025 Tall Oak Drive, Suite 210
Colorado Springs, Colorado 80919

Attn: Mr. Mark Long

November 30, 2020
Revised January 18, 2023

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist

Reviewed by:

Joseph C. Goodee, Jr. P.E.
President

LLL/nc

Encl.
Entech Job No. 202268
AAprojects/2020/202268 geohaz-revised

LAND USE REVIEW DIVISION
PLANNING & COMMUNITY DEVELOPMENT DEPARTMENT

CITY OF COLORADO SPRINGS

APPLICATION FORM FOR GEOLOGIC HAZARD REPORT

Applicant: Viceroy Development Telephone 719-487-8957 Fax _____

Address: 7025 Tall Oak Drive, Suite 210 Zip Code 80919 e-mail mark@vangaurdnewhomes.com

Premises Involved: Development Plan/Subdivision Plat Name: 0 South 8th Street

Tax Schedule No(s). 74242-00-038
(This can be obtained from the El Paso County Tax Assessor located at 27 E. Vermijo Avenue on the 2nd Floor; phone: 520-6600 or at their web site http://www.land.elpasoco.com)

GEOLOGIC HAZARD REPORT REQUIRED: (FIVE (5) PRELIMINARY COPIES)

An application review fee will be required to accompany these applications (make checks payable to City of Colorado Springs). The fee schedule is as follows:

Review of Geologic Hazard Reports	City Planning Fee: $300 plus any Colorado Geological Survey Review Cost Over $300
	City Engineering Fee: $284

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

Development Plan: _____

Landscape Plan (if applicable): _____

Grading Plan: _____

Drainage Report (necessary if debris and/or mud flow hazard is present): _____

ENGINEERS STATEMENT

I hereby attest that I am qualified to prepare a Geologic Hazard Study in accordance with the provisions of Section 504 of the Geologic Hazards Ordinance of Colorado Springs. I am qualified as:

_____X_____ Professional Geologist as defined by CRS 34-1-201(3); or,

_____ Professional Engineer as defined by Board Policy Statement 50.2 - "Engineering in Natural Hazard Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. Board authority as defined by CRS 12-25-107(1).

Submitted by: _____ Date: 1/18/2023
Logan L. Langford, P.G., Entech Engineering, Inc.

This Geologic Hazard Study is filed in accordance with the Zoning Code of the Code of the City of Colorado Springs, 2001, as amended.

City Engineer Date

City Planning Director Date

Table of Contents

1.0 SUMMARY

Project Location:

The project lies in a portion of the SE¼ of the NW¼ of Section 24, Township 14 South, Range 67 West, of the 6th Principal Meridian. The site is located northwest of South Eighth Street and Olympic Village Drive, in the southwestern portion of Colorado Springs, Colorado.

Project Description:

Total acreage involved in the project is approximately 1.7 acres. The proposed development consists of a three-story and four-story apartment buildings, and associated site improvements.

Scope of Report:

The report presents the results of our subsurface soil and geologic investigation and treatment of engineering geologic hazard study. This report presents the results of our subsurface investigation, geologic reconnaissance, a review of available maps, aerial photographs, stability analysis and our conclusions with respect to the impacts of the geologic conditions on development.

Land Use and Engineering Geology:

Geologic conditions will impose constraints on development of the site. These include areas of highly expansive soils, and a downslope creep area. Site conditions will be discussed in greater detail in this report. This site was found to be suitable for the proposed development if the recommendations in this report are implemented. All recommendations are subject to the limitations discussed in the report.

2.0 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in a portion of the SE¼ of the NW¼ of Section 24, Township 14 South, Range 67 West, of the 6th Principal Meridian. The site is located northwest of South Eighth Street and Olympic Village Drive, in the southwestern portion of Colorado Springs, Colorado. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the of the site is generally gradually sloping to the northeast with moderate to steep slope along the extreme northwestern corner of the site. Construction is proposed in the gradually sloping areas. The area of the site is indicated on the USGS Map, Figure 2. The site contains primarily field grasses, and weeds. Site photographs are included in Appendix A. Approximate locations and directions of the photographs are indicated on Figure 3.

The site is currently zoned as OC (Office Complex). The site does not lie within the hillside overlay (Reference 1). Total acreage involved in the proposed development is approximately 1.7 acres. The proposed development consists of a three-story and four-story apartment buildings, and associated site improvements. The proposed Site Map/Test Boring Location Map is presented in Figure 3, and the Site Plan is presented in Figure 3A.

3.0 SCOPE OF THE REPORT

The scope of this report included the following:

- A geologic analysis of the site utilizing published geologic data, and subsurface soils information.
- Detailed site-specific mapping of major geographic and geologic features.
- Identification of geologic hazards and impacts on the proposed development.
- Recommended mitigation of geologic hazards where they affect development.

4.0 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of bedrock features and significant surficial deposits. The position of mappable units within the subject property are shown on the Geologic Map. Our mapping procedures involved field reconnaissance, measurements and interpretation. The same mapping procedures have also been utilized to produce the Engineering Geology Map which identifies pertinent geologic conditions affecting development. The field mapping was performed by personnel of Entech Engineering, Inc. on November 6, 2020.

Three test borings were drilled as a part of a preliminary subsurface soil investigation by Entech Engineering, Inc (Reference 2). The borings were drilled with a power-driven continuous flight auger drill rig to depths of 20 feet below grade surface (bgs). Samples were obtained during drilling using the Standard Penetration Test, ASTM D-1586, utilizing a 2-inch O.D. a California Sampler. Results of the penetration tests are shown on the drilling logs to the right of the sampling point. The locations of the test borings are included on the Site Map/Test Boring Location Map and Site Plan, Figures 3 and 3A. The Test Boring Logs are included in Appendix B.

Laboratory testing was performed to classify and determine the soils engineering characteristics. Laboratory tests included moisture content, ASTM D-2216, grain size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. Swell tests included both FHA and Swell/Consolidation Testing. Sulfate testing was performed to determine the corrosive characteristics of the soils. A Summary of Laboratory Test Results is presented in Table 1, and Laboratory Test Results are included in Appendix C.

The site was reviewed by the Colorado Geological Survey (CGS), dated December 7, 2022 (Reference 3, Appendix D). This report was revised to address the CGS comments.

5.0 SOIL, GEOLOGY AND ENGINEERING GEOLOGY

5.1 General Geology

Physiographically, the site lies in the western portion of the Great Plains Physiographic Province. Approximately 2½ miles to the west is a major structural feature known as the Ute Pass 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 gently dipping in a northeasterly direction. The rocks in the area of the site are sedimentary in nature, and typically Cretaceous in age. The bedrock underlying the site itself is the Pierre Shale Formation. Overlying the Pierre Shale Formation is a thin layer of residual soils. The site's stratigraphy will be discussed in more detail in Section 5.3.

5.2 Site Stratigraphy

The Colorado Springs Quadrangle Geology Map, showing the site, is presented in Figure 4 (Reference 4). The Geology Map prepared for the site is presented in Figure 5. One mappable unit was identified on the site, which is described as follows:

Kp **The Pierre Shale of Cretaceous Age:** These materials consist of a thin layer of residual soils that were derived from the in-situ weathering of the bedrock materials. The bedrock underlying this site consists of olive brown to gray claystone and shale. These are marine deposits associated with the Cretaceous Seaway. They are typically expansive.

The soils listed above were mapped from site-specific mapping, the *Geologic Map of the Colorado Springs Quadrangle* distributed by the Colorado Geological Survey in 2000 (Figure 4, Reference 4). The *Reconnaissance Geologic Map of Colorado Springs and Vicinity* by Scott and Wobus, 1973 (Reference 5), the *Geologic Map of the Colorado Springs - Castle Rock area, Front Range Corridor* by Trimble and Machette, 1979 (Reference 6) and the test borings drilled on the site were also used in evaluating the site.

5.3 Soil Conditions

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

Soil Type 1 classified as a sandy clay (CH). The clay was encountered in all of the test borings at depths ranging from the existing surface grade and extending to depths ranging from 2 to 4 feet. Standard Penetration Testing resulted in a N-value of 24 blows-per-foot (bpf), indicating stiff consistencies. Water content and grain size testing resulted in approximately 19 percent water content with approximately 78 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits Testing on the native clay resulted in a liquid limit of 51 and a plastic index of 28. Swell/Consolidation Testing resulted in a volume change of 5.3 percent, indicating a very high expansion range. Sulfate testing on a sample of the clay resulted in 0.21 percent soluble sulfate by weight, indicating the clay has severe potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 classified as a sandy claystone (CH, CL). The claystone was encountered in all of the test borings at depths ranging from 2 to 4 feet bgs and extending to depths ranging from 6 to 18 feet bgs. Standard Penetration testing on the claystone resulted in N-values of 34 to greater than 50 bpf, indicating very stiff to hard consistencies. Water content and grain size testing resulted in water contents of 13 to 25 percent with approximately 95 to 99 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits Testing resulted in a liquid limit of 57 and a plastic index of 32. FHA Swell Testing resulted in a swell pressure of 1550 psf. Swell/Consolidation Testing resulted in volume changes of 4.6 to 5.3 percent. These results indicate the claystone exhibits moderate to very high expansion potential. Sulfate testing resulted in 0.19 percent soluble sulfate by weight, indicating the claystone exhibits a moderate potential for below grade concrete degradation due to sulfate attack.

Soil Type 3 classified as a shale (CL). The shale was encountered in all of the test borings at depths ranging from 6 to 18 feet bgs and extended to the termination of the borings (20 feet). Standard Penetration testing on the shale resulted in N-values of greater than 50 bpf, indicating hard consistencies. Water content and grain size testing resulted in water contents of 13 to 15 percent with approximately 98 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits Testing resulted in a liquid limit of 67 and a plastic index of 45.

Swell/Consolidation Testing resulted in a volume change of 10.3 percent. These results indicate the shale exhibits very high expansion potential. Sulfate testing resulted in 0.03 percent soluble sulfate by weight, indicating the shale exhibits a negligible potential for below grade concrete degradation due to sulfate attack.

Test Boring Logs are included in Appendix B. Laboratory Test Results are included in Appendix C and summarized in Table 1.

6.0 ENGINEERING GEOLOGY - IDENTIFICATION AND MITIGATION OF GEOLOGIC HAZARDS

As mentioned previously, detailed mapping has been performed on this site to produce an Engineering Geology Map, Figure 5. This map shows the location of various geologic conditions of which the developers and planners should be cognizant during the planning, design and construction stages of the project. The hazards identified on this site include expansive soils, and a downslope creep area. In accordance with the Geologic Hazards Ordinance of the City of Colorado Springs, the following hazards have been addressed.

Expansive Soils

Highly expansive soils were encountered in the test borings that will require mitigation. Expansive clays will be encountered in the subsurface across the entire site. These clays can cause differential movement in the structure foundations if not properly mitigated.

Mitigation: Expansive soils on this site will require mitigation. Due to the highly expansive soils on this site, drilled pier foundations are recommended. Structural floors are recommended for the building. Flatwork on expansive soils should be expected to experience movement. Pier depths a minimum of 25 feet are anticipated for this site. Final recommendations should be determined after additional investigation of the building sites.

Artificial Fill

Fill was not observed on the site.

Landslide Hazard and Slope Stability

The northwestern corner of the site is mapped as landslide susceptible as shown on the *Map of Potential Areas of Landslide Susceptibility in Colorado Springs* by White and Wait, 2003, distributed by the Colorado Geological Survey in 2003 (Figure 6, Reference 7). This area is associated with the moderate to steep slopes along the northwestern side of the site. These slopes are located in the extreme northwest corner of the site and will be avoided by the proposed apartment building.

The slopes in the northwestern corner of the site have been identified as downslope creep areas on the Engineering Geology Map, Figure 5. Additional discussions concerning slope stability are presented in the following section.

- *Downslope Creep Areas*

These areas are acceptable as building sites, however, in areas identified with this hazard classification, we would anticipate accelerated lateral and vertical movement of the near surface soils in the downslope direction. The moderate to steep slopes along northwestern side of the site have been identified as downslope creep. This area lies in the extreme northwestern corner of the site are located a sufficient distance from the proposed buildings that they should not be affected. Proper control of drainage at both the surface and in the subsurface is extremely important. Areas of ponded water at the surface should be avoided that could saturate subsurface materials. We recommend surface drainage be directed away from the slopes to prevent saturation of the slopes that could create unstable conditions. Utility trenches and other subsurface features should not be permitted to become water traps which may promote saturation of the subsurface materials. A full spectrum detention basin and associated retaining walls are proposed along the northern side of the site. It is recommended that the detention pond be lined with an impermeable liner to prevent the oversaturation of the subsurface materials.

Mitigation: Building is possible in these areas if the following engineering and construction mitigation steps are taken: This type of movement will increase lateral pressures against foundation walls on the uphill side of structures. Additionally, downslope creep tends to pull away from foundations requiring tie-beams to stiffen foundation systems. The design of foundations in these areas should account for the downslope creep pressure. Where possible in

areas of downslope creep, structures should be designed to be as compact and rigid as possible. This will help them better tolerate the vertical and lateral movements to which the foundation system may be subjected. Long, rambling, irregular structures should be avoided in these areas as they are associated with a much greater potential for damaging differential movement. Where structures encroach on steeper slopes, stepping foundations into the slope may be required. Specific recommendations should be provided on an individual basis, after building locations are finalized and a site-specific investigation is completed. Tie walls and buttresses are often used to stiffen the foundation system.

- Slope Stability Analysis

Slope Stability Analysis was conducted utilizing the GSTABL7 computer program. The sections analyzed are shown on the Slope Section Map, Figure 8. Slope stability analysis results are included in Appendix F. Soil strength values used for the program were as follows.

	Angle of Internal Friction (degrees)	Cohesion (psf)
Clay	28	200
Claystone	16	375 - 500
Shale	12	5000

Soil strength values were based on similar soils in the area (References 8, and 9), and are included in Appendices D and F. Factors of safety were calculated by the Modified Bishop Method for Circular Failure Surfaces. The slope profile was constructed with the soil types encountered in the test borings from the subsurface soil investigation. Although groundwater was not encountered, groundwater levels were evaluated in accordance with levels that may be anticipated in the area and also for sensitivity analysis. Structural loads from the proposed pond were used in the analysis. Based on our drilling, the probability of groundwater up to the excavation level is considered low provided surface and subsurface drainage systems are maintained. Factors of safety of 1.5 are recommended for areas of critical structures such as buildings. Factors of safety of 1.3 are recommended for non-critical areas such as detention ponds. Due to the proximity of the full spectrum detention basin to the slope, we recommend lining the detention pond with an impermeable membrane liner. Slope stability analysis results are included in Appendix E.

Figure No.	Section	Analysis	Water Table	F.O.S	Description
E-1	A-A'	Existing (Circular)	High	2.3	Initiation and termination points of analysis modified to encompass existing slope. Circular failure surface analyzed.
E-2	A-A'	Existing (Circular)	High	1.5	Initiation and termination points of analysis modified to encompass the proposed retaining wall, full spectrum detention basin slope with pond loading and an elevated water table. Circular failure surface analyzed.

Debris Fans

Debris fan deposits were not observed on this site.

Subsidence

Based on review of a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 10), the site is not undermined. The closest underground mines in the area are 4½ miles to the northeast and the area is not mapped within potential subsidence zones.

Groundwater

Groundwater was not encountered in any of the test borings during or subsequent to drilling, which were drilled to 20 feet. Groundwater is not expected to be encountered at the proposed grading depths. Fluctuation in groundwater conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Isolated sand layers within the variable soil profile, sometimes only a few feet in thickness and width, can carry water in the subsurface. Water may also flow on top of the bedrock. Contractors should be cognizant of the potential for the occurrence of such subsurface water features during construction on-site.

Floodplain Areas

The site has not been mapped as any floodplain zones according to FEMA Map Nos. 08041CO729G (Figure 7, Reference 11). Finished floors must be a minimum of one foot above the floodplain levels. Exact floodplain locations and specific drainage studies are beyond the scope of this report.

Faults

The closest fault is the Ute Pass Fault, located approximately 2½ mile 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. Additionally, the International Residential Code (IRC), 2003, currently places this area in Seismic Design Category B, also a low seismic risk. According to a report by the Colorado Geological Survey by Robert M. Kirkman and William P. Rogers, Bulletin 43 (1981) (Reference 12), this area should be designed 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 Pierre Shale Formation of Cretaceous Age. According to the *Geologic Structure Map of Pueblo 1x2 Quadrangle, South-Central Colorado* (1978) (Reference 13), bedrock is gently dipping to the east. According to the *Map of Areas Susceptible to Differential heave in Expansive, Steeply Dipping Bedrock* by Himmelreich and Noe (Reference 14), The site lies east of the steeply dipping bedrock area. Bedrock encountered in the test borings was not steeply dipping, there for it is anticipated mitigation for steeply dipping bedrock will not be required on this site.

7.0 RADIOACTIVITY

Radon levels for the area have been reported by the Colorado Geologic Survey in the open-file, Report No. 91-4 (Reference 15). Average radon levels of 12.53 pci/l have been measured in the area. The following is a table of radon levels in this area.

0 < 4 pci/l	38.89%
4 < 10 pci/l	22.22%
10 < 20 pci/l	22.22%
> 20 pci/l	16.67%

The potential for high radon levels is present for the site. Build-up of radon gas can usually 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.

8.0 EROSION CONTROL

The soil types observed on the site are mildly to moderately 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 and weathered bedrock materials become increasingly less susceptible to water erosion. For the typical soils observed on-site, allowable velocities for 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 re-vegetate 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.

9.0 RELEVANCE OF GEOLOGIC AND SITE CONDITIONS TO LAND USE PLANNING

It is our opinion that the existing geologic and engineering geologic conditions will impose constraints on the proposed development and construction. The most significant issues affecting development will be highly expansive soils and bedrock. The downslope creep area is to be avoided by the proposed structures; however, parking areas will be located near this area. Hazards present on the site can be mitigated through proper engineering design and construction.

The upper soils were encountered at firm to stiff consistencies. Due to the highly expansive soils, it is recommended that the proposed structures be supported on drilled pier foundations bearing on the shale bedrock. Structural floors are also recommended for the building. Specific recommendations are presented in the Preliminary Subsurface Soil Investigation for the site (Reference 2).

The moderate to steep slopes along northwestern side of the site have been identified as downslope creep. This area lies in the extreme northwestern corner of the site are located a sufficient distance from the proposed buildings that they should not be affected. Based on the proposed development plan the buildings are located at a sufficient distance from the slopes. A parking area and full spectrum detention basin is proposed above these slopes. Proper control of drainage at both the surface and in the subsurface is extremely important. Areas of ponded water at the surface should be avoided that could saturate subsurface materials. We recommend surface drainage be directed away from the slopes to prevent saturation of the slopes that could create unstable conditions. Utility trenches and other subsurface features should not be permitted to become water traps which may promote saturation of the subsurface materials. The full spectrum detention basin and associated retaining walls are proposed along the northern side of the site. It is recommended that the detention pond be lined with an impermeable membrane liner to prevent the oversaturation of the subsurface materials.

In summary, land use development and construction on the site is possible if the existing conditions are properly mitigated or avoided. Geologic conditions on-site can be satisfactorily mitigated by either avoidance or proper engineering design and construction practices.

10.0 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 geologic hazards on-site can be either avoided or mitigated using proper engineering design and construction practices.

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. 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. Additional investigation for the building sites is recommended prior to site grading or construction. Planning and design personnel should be made familiar with the contents of this report.

This report has been prepared for Viceroy Development 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 this report has provided you with all the information you required. Should you require additional information, please do not hesitate to contact Entech Engineering, Inc.

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TABLE

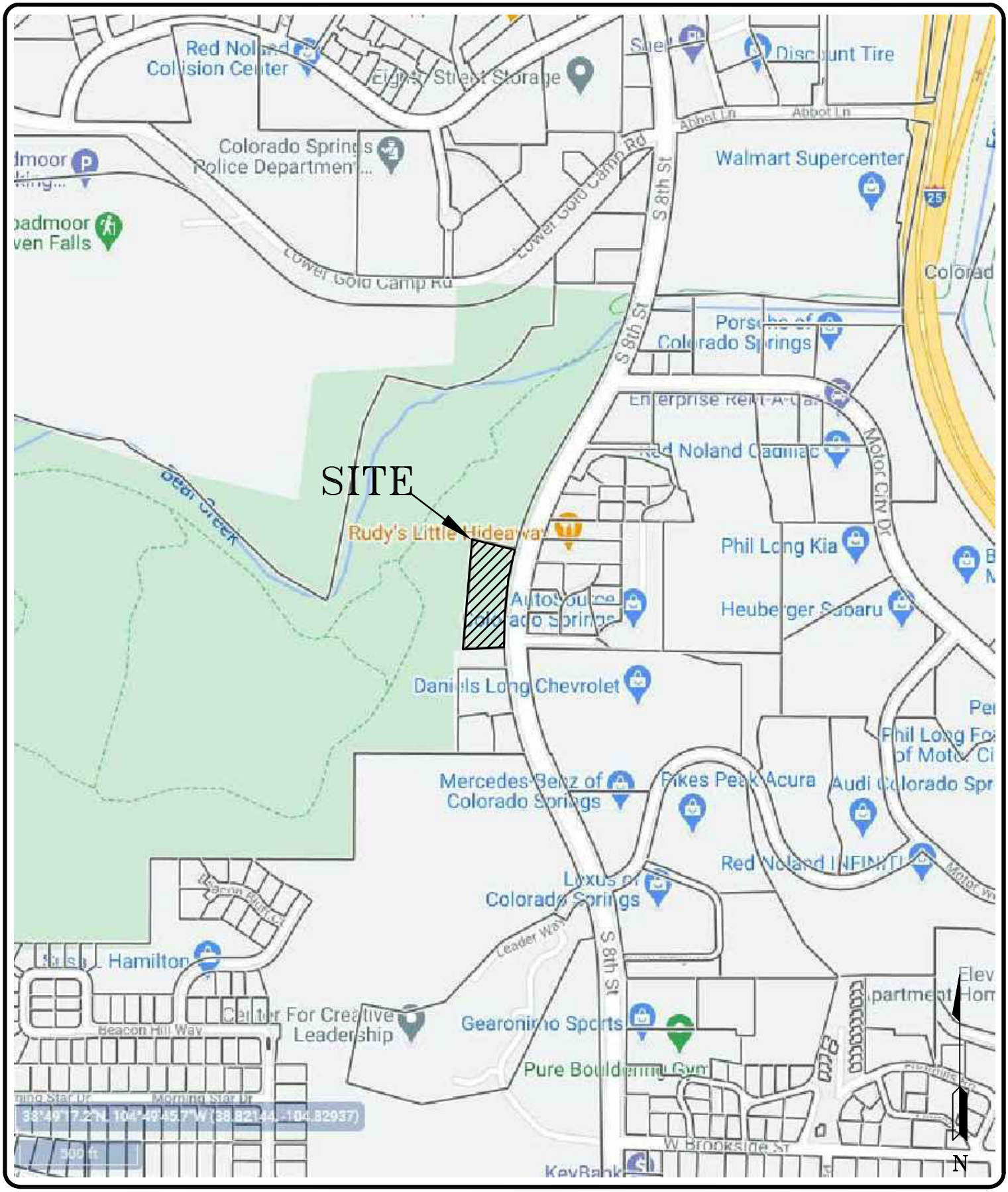
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT VICEROY DEVELOPMENT
PROJECT PARCEL #7424200038
JOB NO. 202268

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	2-3	12.8	108.9	77.7	51	28	0.21		5.3	CH	CLAY, SANDY
2	1	10	20.6	108.3	95.2	57	32	0.19		4.6	CH	CLAYSTONE, SANDY
2	2	5			96.6				1550		CL	CLAYSTONE, SANDY
2	3	10	19.2	108.2	98.7					5.3	CL	CLAYSTONE, SANDY
3	2	15	17.7	110.6	97.8	67	45	0.03		10.3	CH	SHALE

FIGURES



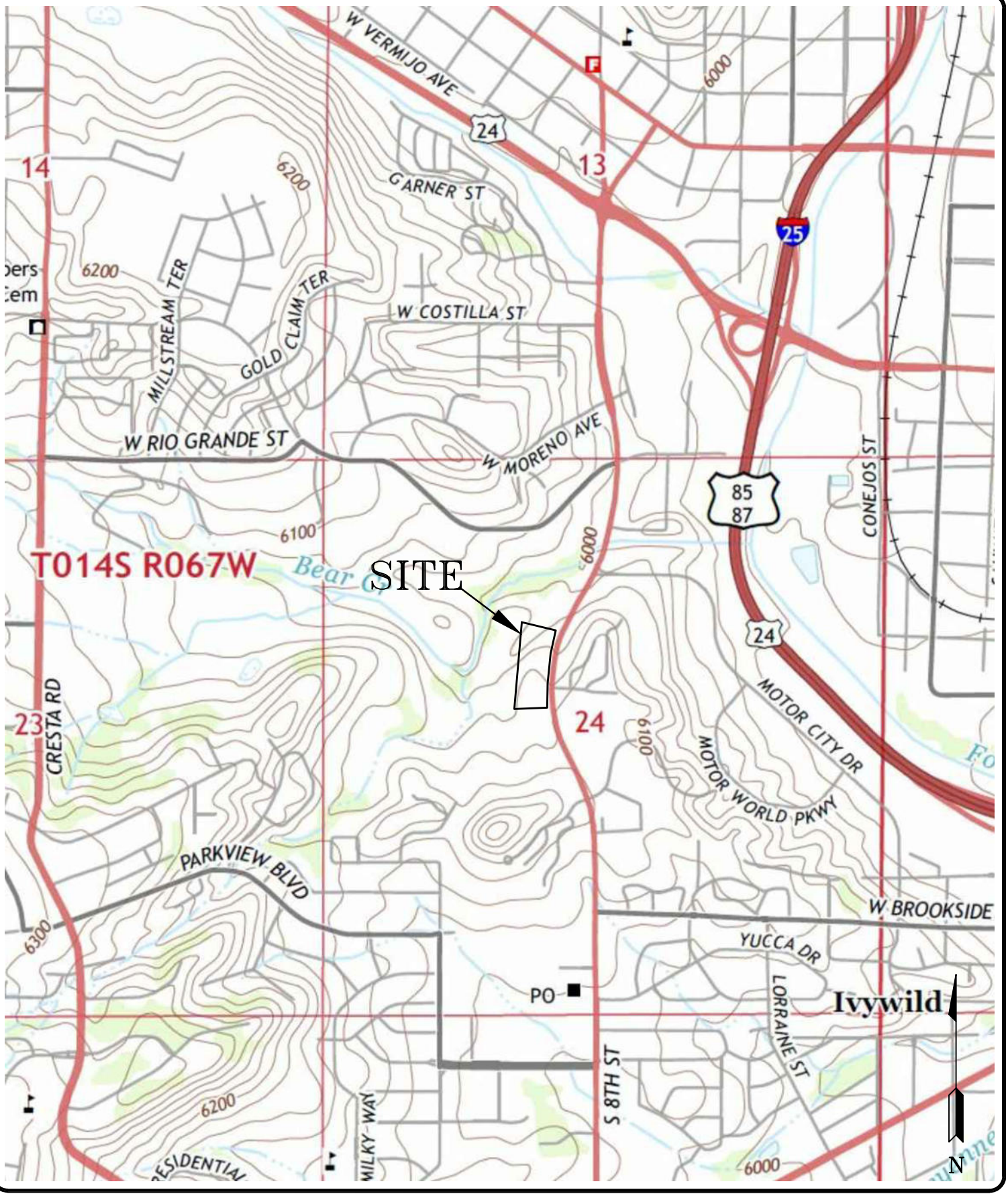
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

FIG NO.: 1



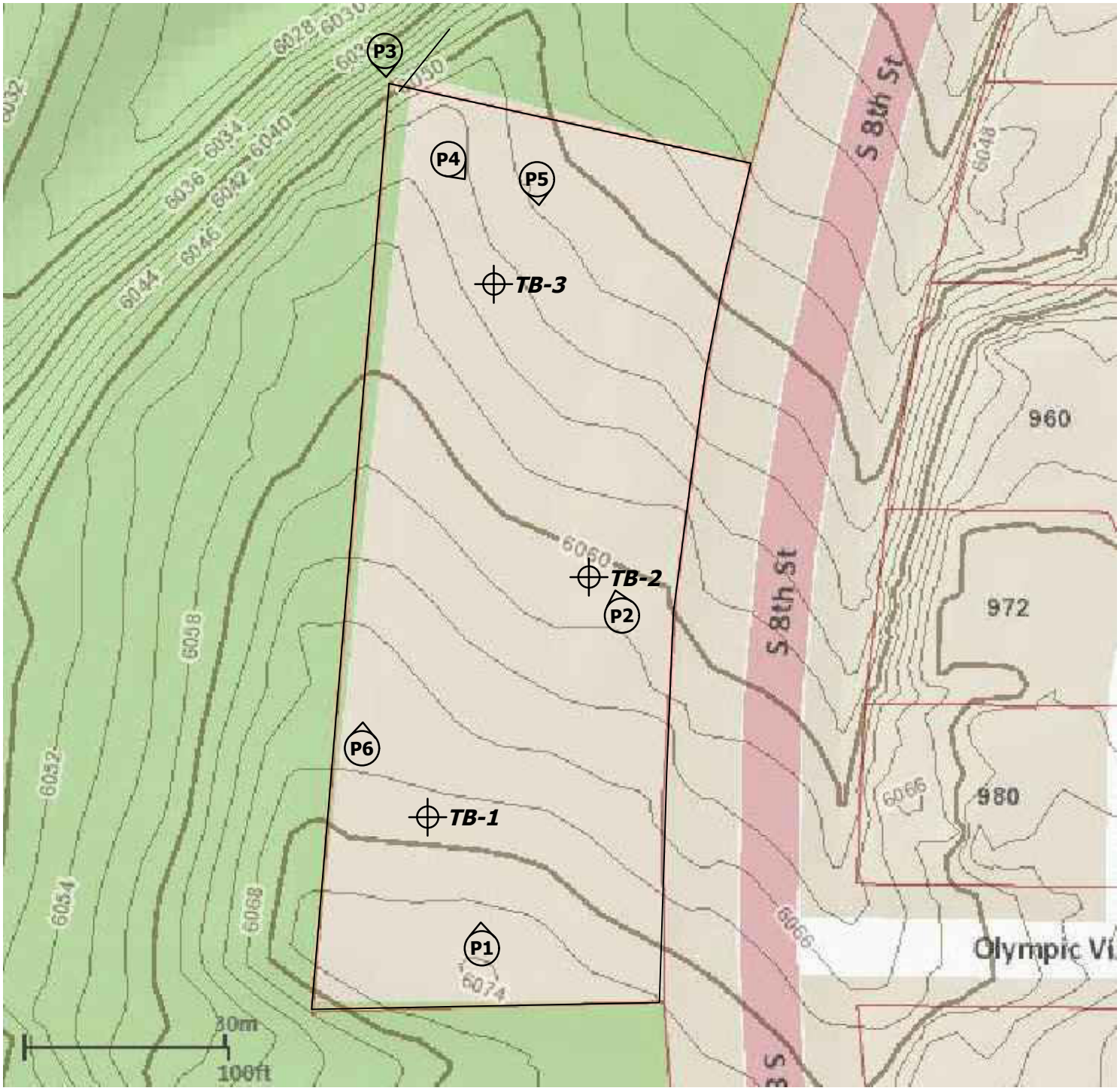
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

USGS MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

FIG NO.: 2



TB- approximate test boring location and number

P2 - approximate location and number of photograph

N

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

SITE PLAN/TEST BORING LOCATION MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

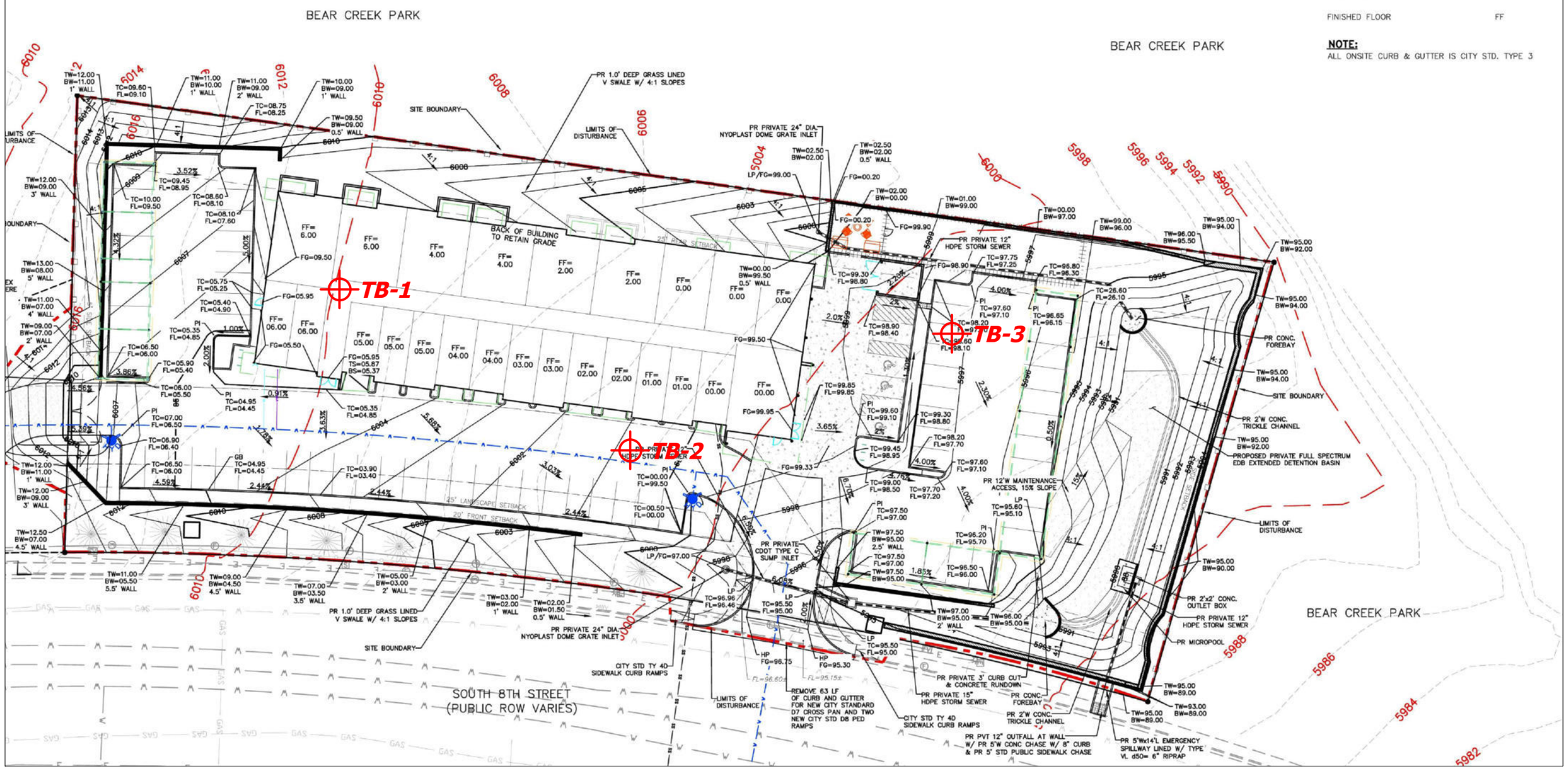
JOB NO.: 202268

FIG NO.: 3

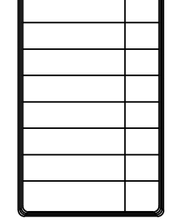
VUE DE LA PARC
COLORADO SPRINGS, CO
DEVELOPMENT PLAN
PRELIMINARY GRADING

BLE ROUTES, INCLUDING RAMPS AND SIDEWALKS, WITHIN THE PUBLIC RIGHT OF WAY
BE PER THE CITY'S STANDARD DRAWINGS AND SPECIFICATIONS.CITY ENGINEERING DEVELOPMENT
INSPECTOR WILL HAVE THE FINAL AUTHORITY ON ACCEPTING THE PUBLIC IMPROVEMENTS

NOT FOR CONSTRUCTION.



TB- approximate test boring location and number



LEGEND

5' EX CONTOUR	6810
1' EX CONTOUR	6802
5' PR CONTOUR	6810
1' PR CONTOUR	6802
PROPOSED FLOW DIRECTION	
HIGH POINT	HP
LOW POINT	LP
FINISHED FLOOR	FF

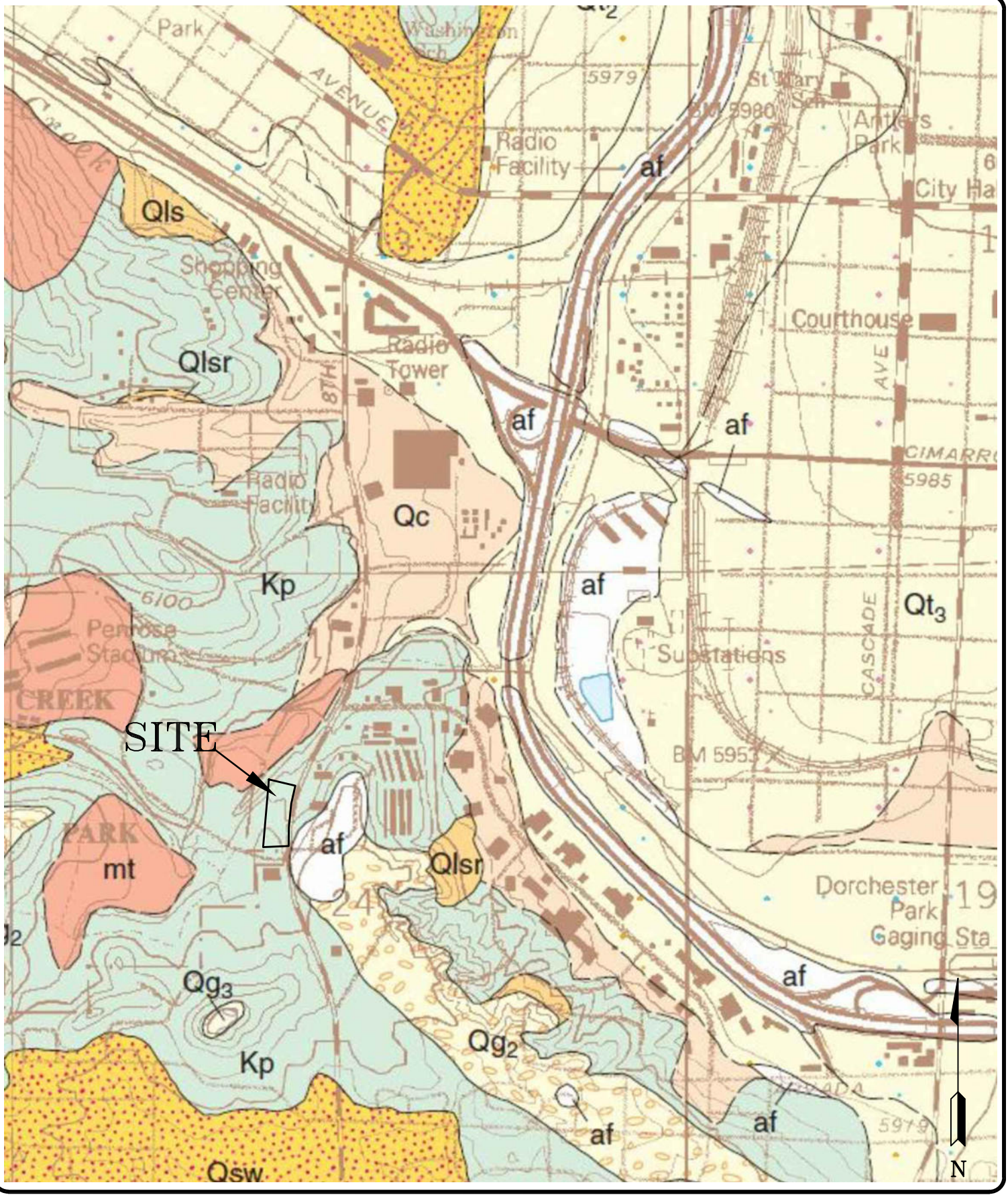
NOTE:
ALL ONSITE CURB & GUTTER IS CITY STD. TYPE 3

REVISION	BY

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

SITE DEVELOPMENT PLAN
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN	LLL
CHECKED	
DATE	12/21/22
SCALE	AS SHOWN
JOB NO.	202268
FIGURE No.	4



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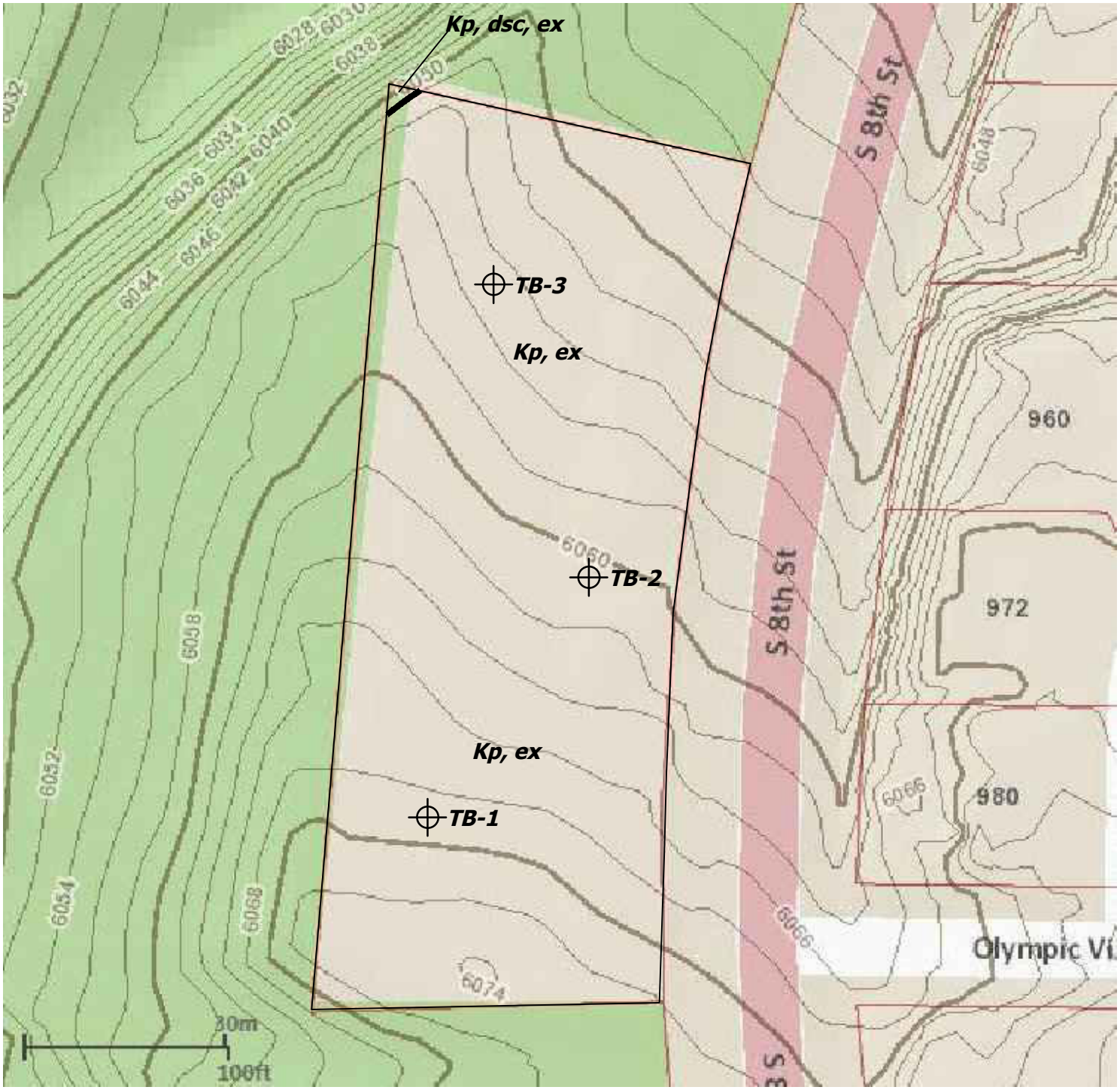
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

COLORADO SPRINGS QUADRANGLE
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

FIG NO.: 5



Legend:

Kp - **The Pierre Shale of Cretaceous Age:**
residual soil deposits overlying claystone and shale

dsc - **downslope creep**
ex - **expansive soil**

approximate location of test boring

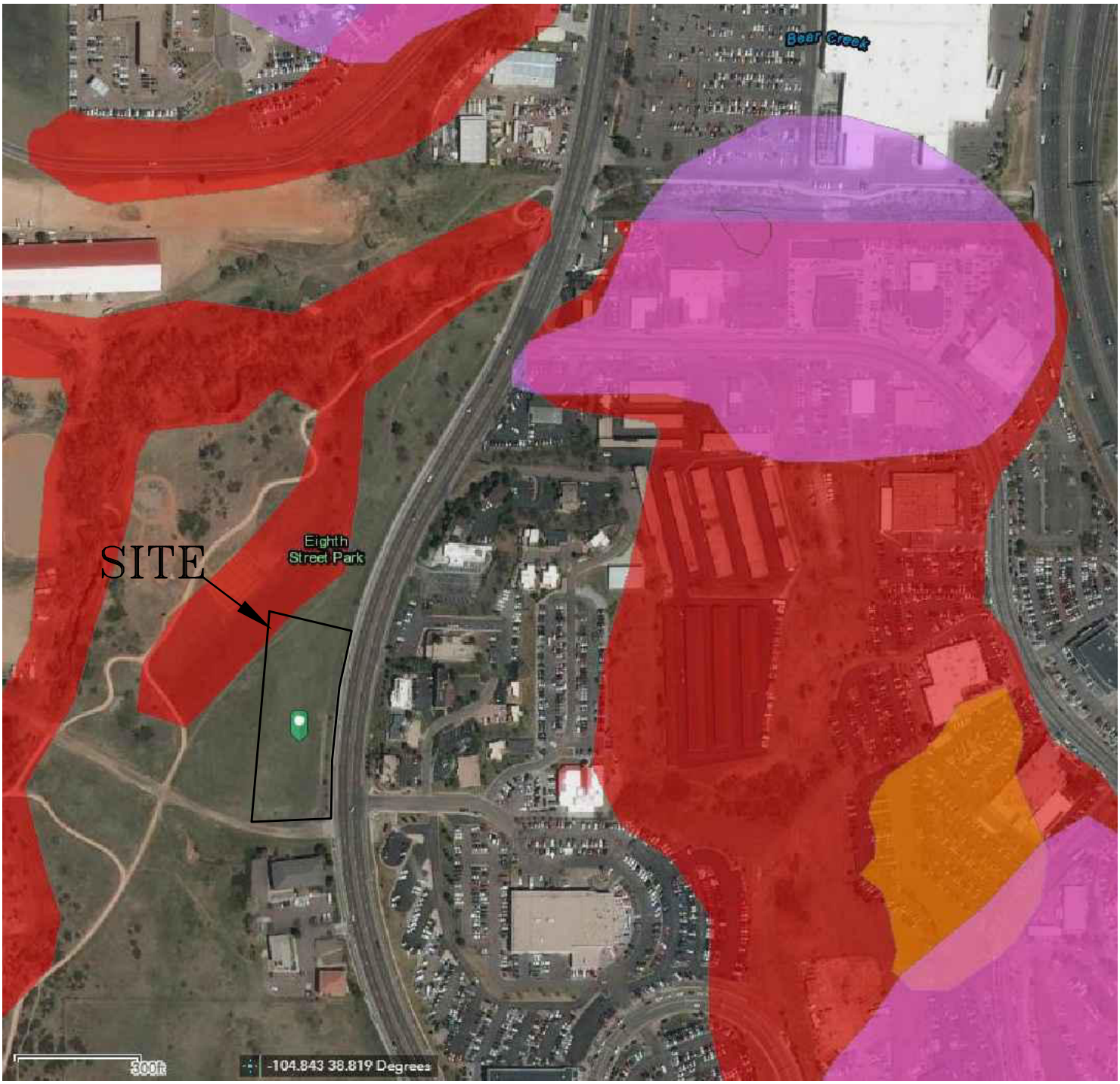
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

ENGINEERING GEOLOGY/ GEOLOGY MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

FIG NO.: 6



N

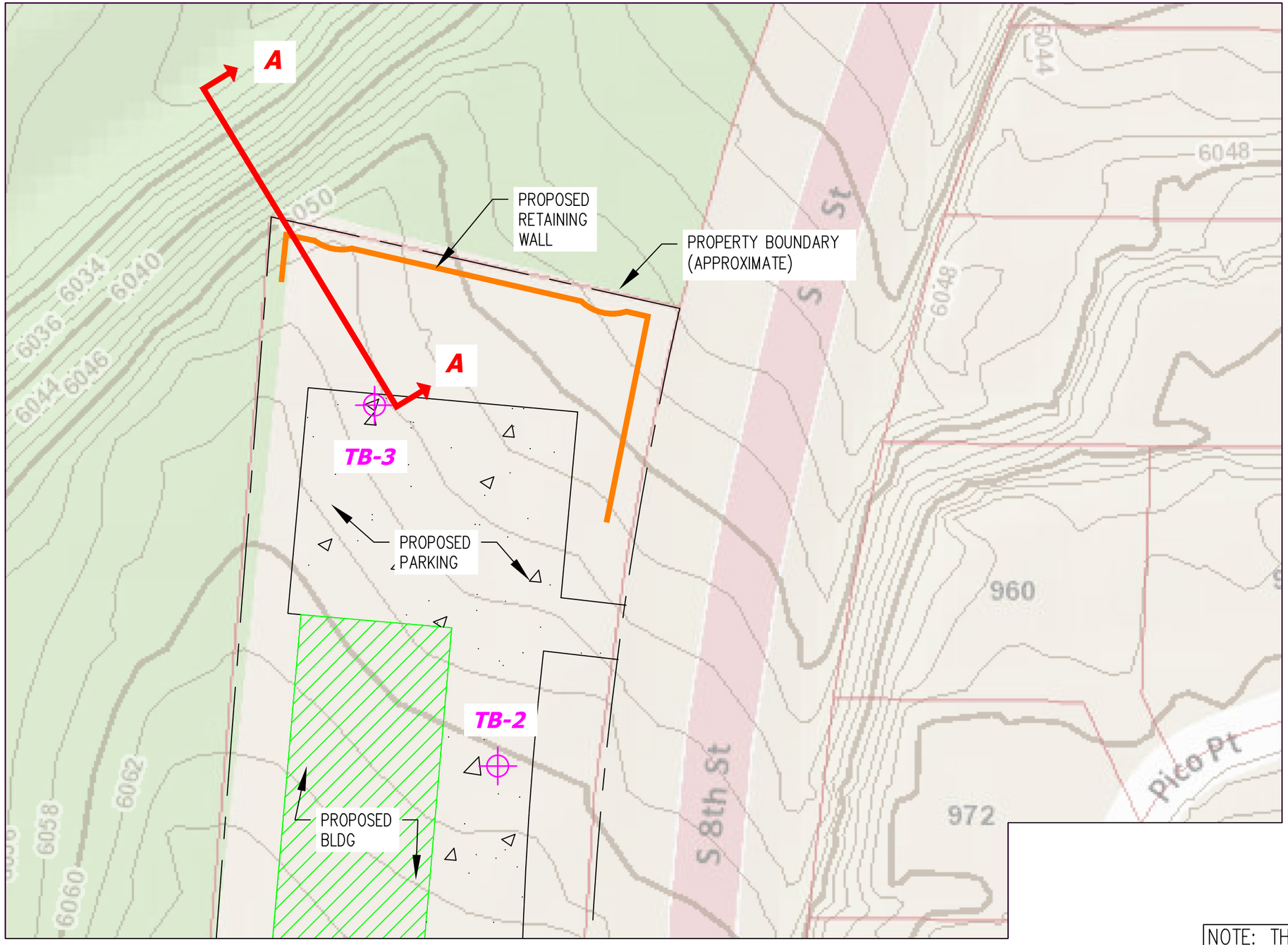
ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

LANDSLIDE SUSCEPTIBILITY MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

FIG NO.: 7



SLOPE STABILITY SECTION

TB- approximate test boring location and number (EEI)

Proposed Building Location

Proposed Retaining Wall Location

NOTE: THIS SHEET CONTAINS COLORED LINEWORK & MUST BE PRINTED IN COLOR TO UNDERSTAND.

REVISIONS	BY:

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

SLOPE SECTION MAP
VUE DE LA PARC
COLORADO SPRINGS, CO
FOR: VICEROY DEVELOPMENT

DRAWN BY:	AMN
DESIGNED BY:	AMN
CHECKED BY:	
DATE:	12/16/22
SCALE:	AS SHOWN
JOB NO.:	202268
FIGURE NO.:	8

N

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

FEMA FLOODPLAIN MAP
SOUTH 8TH STREET
PARCEL NO. 74242-00-038
COLORADO SPRINGS, CO.
FOR: VICEROY DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	11/13/20		

JOB NO.: 202268

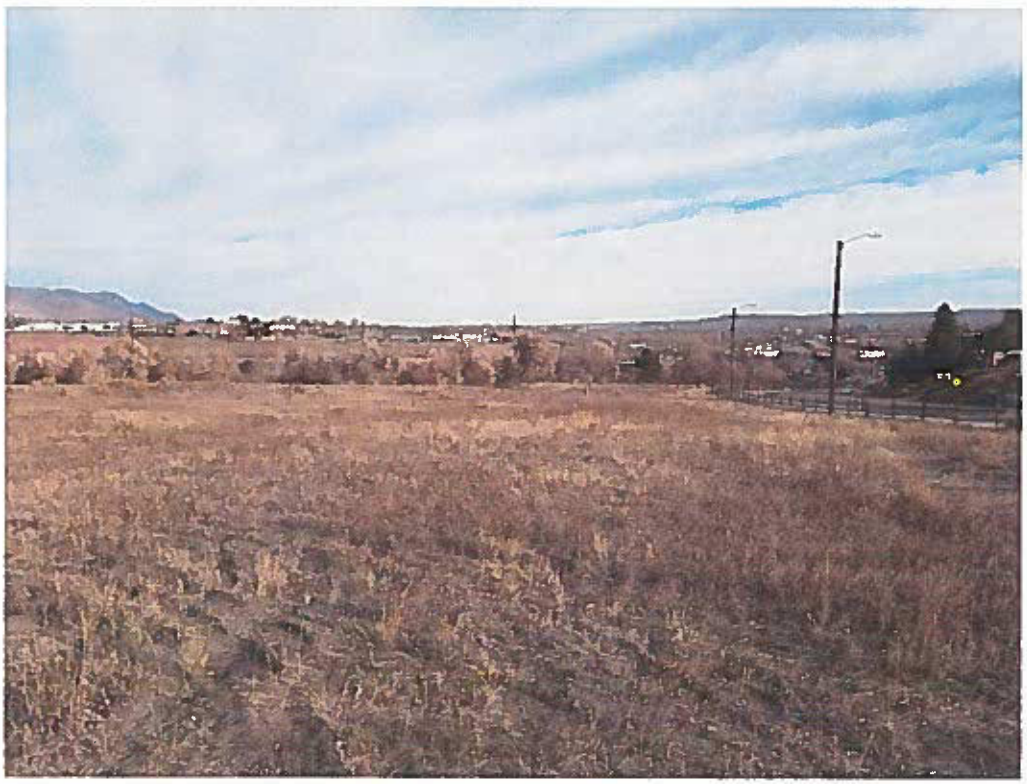
FIG NO.: 9

APPENDIX A: Site Photographs

1

Looking north from the southern portion of the site.

November 6, 2020



2

Looking north from the east central portion of the site.

November 6, 2020

Job No. 202268

3

Looking south from the northwest corner of the site.

November 6, 2020

4

Looking southeast from the northwestern portion of the site.

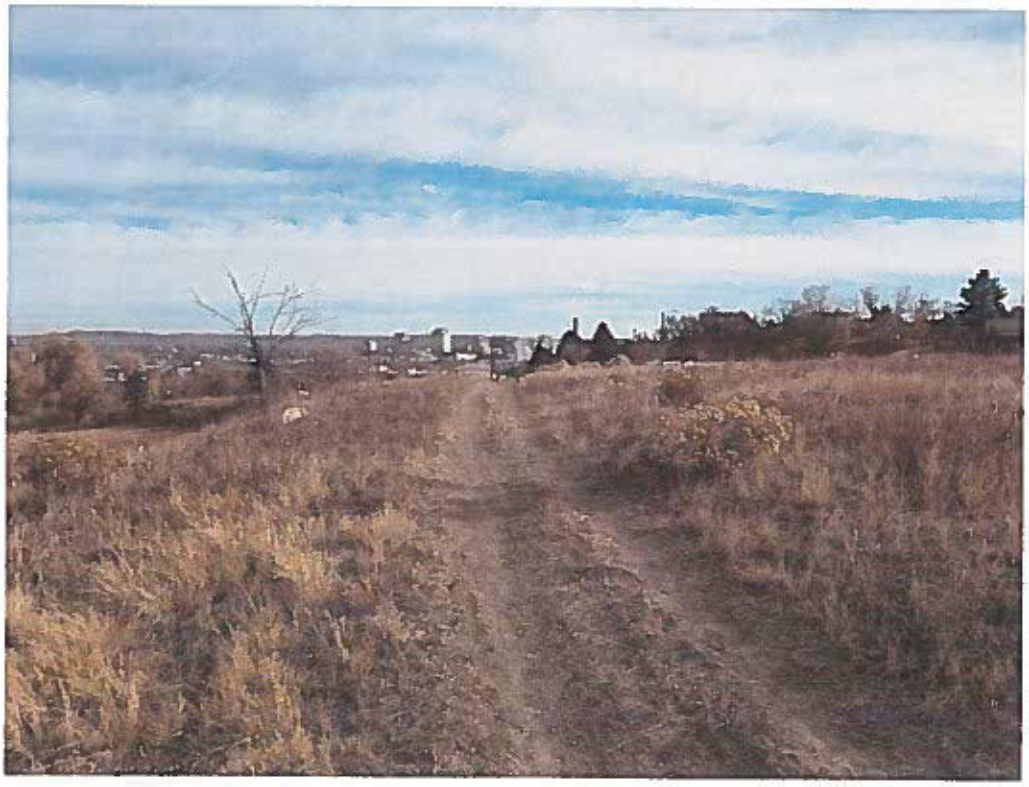
November 6, 2020

Job No. 202268

5

Looking south from the northern portion of the site.

November 6, 2020



6

Looking north from the southwestern portion of the site.

November 6, 2020

Job No. 202268

APPENDIX B: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 10/22/2020
Job # 202268

REMARKS

DRY TO 20', 10/26/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	CLAY, SANDY, DARK BROWN, STIFF, MOIST		24	19.0	1
5	WEATHERED TO FORMATIONAL CLAYSTONE, SANDY, DARK GRAY BROWN, VERY STIFF TO HARD, MOIST		39	22.1	2
10			50/11"	24.5	2
15	SHALE, DARK GRAY, HARD, MOIST		50/10"	18.3	2
20			50/5"	14.1	3

TEST BORING NO. 2
DATE DRILLED 10/22/2020
CLIENT VICEROY DEVELOPMENT
LOCATION PARCEL #7424200038

REMARKS

DRY TO 19', 10/26/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	CLAY, SANDY, BROWN				1
	WEATHERED TO FORMATIONAL CLAYSTONE, SANDY, DARK GRAY		46	13.2	2
5	BROWN, VERY STIFF TO HARD, MOIST		50/6"	13.9	2
	SHALE, DARK GRAY, HARD, MOIST				
10			50/4"	13.4	3
15			50/4"	12.8	3
20			50/3"	12.9	3

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			10/22/20

JOB NO.: 202268
FIG NO.: B-1

TEST BORING NO. 3
DATE DRILLED 10/22/2020
Job # 202268

TEST BORING NO.
DATE DRILLED
CLIENT VICEROY DEVELOPMENT
LOCATION PARCEL #7424200038

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 19', 10/26/20						
CLAY, SANDY, BROWN						1
WEATHERED TO FORMATIONAL CLAYSTONE, SANDY, DARK GRAY BROWN, VERY STIFF TO HARD, MOIST				34	16.6	2
	5			47	18.1	2
	10			50 10"	19.3	2
	15			47	21.8	2
SHALE, DARK GRAY, HARD, MOIST	20			50 5"	14.7	3

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

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

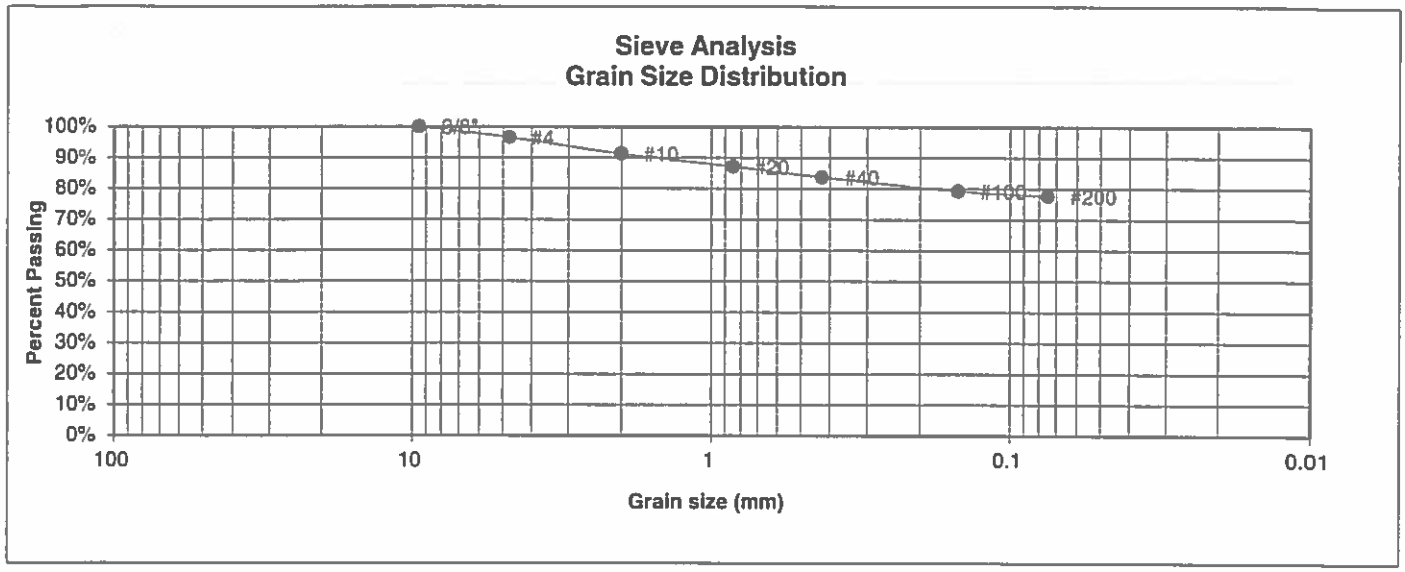
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			10/28/20

JOB NO: 202268
FIG NO: B-2

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	CH	CLIENT	VICEROY DEVELOPMENT
SOIL TYPE #	1	PROJECT	PARCEL #7424200038
TEST BORING #	1	JOB NO.	202268
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.6%
10	91.3%
20	87.2%
40	83.7%
100	79.3%
200	77.7%

Atterberg Limits	
Plastic Limit	23
Liquid Limit	51
Plastic Index	28

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

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

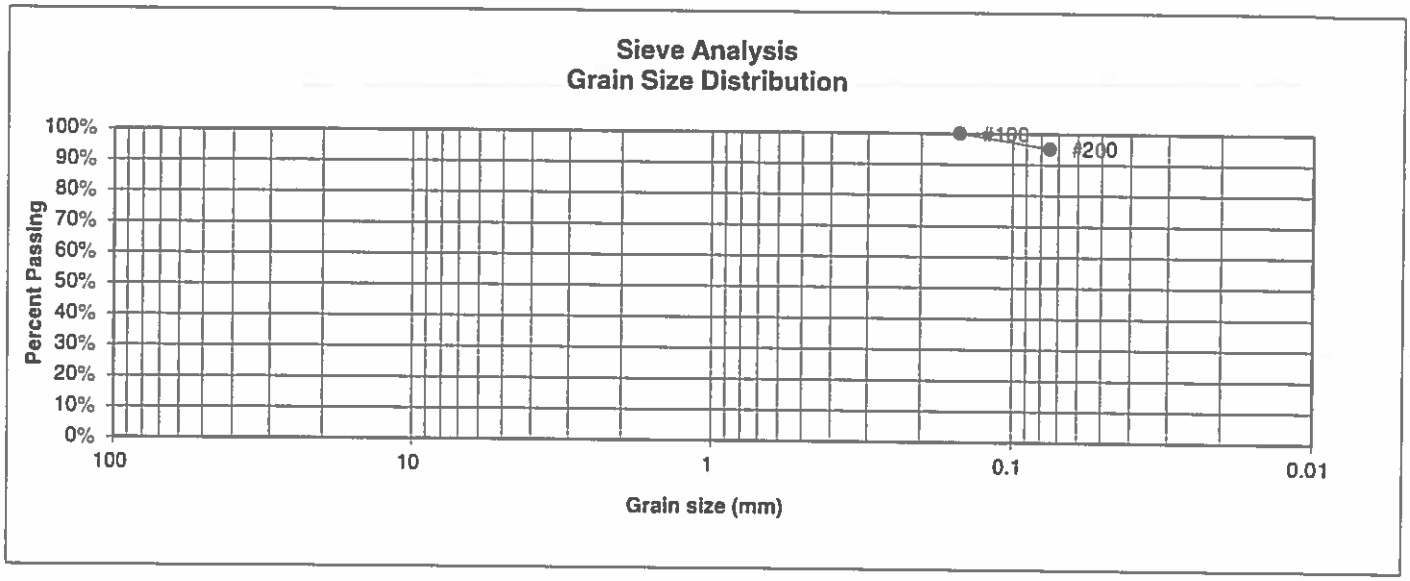
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/28/20

JOB NO.: 202268

FIG NO.: C-1

UNIFIED CLASSIFICATION	CH	CLIENT	VICEROY DEVELOPMENT
SOIL TYPE #	2	PROJECT	PARCEL #7424200038
TEST BORING #	1	JOB NO.	202268
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	100.0%
200	95.2%

Atterberg Limits	
Plastic Limit	25
Liquid Limit	57
Plastic Index	32

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

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

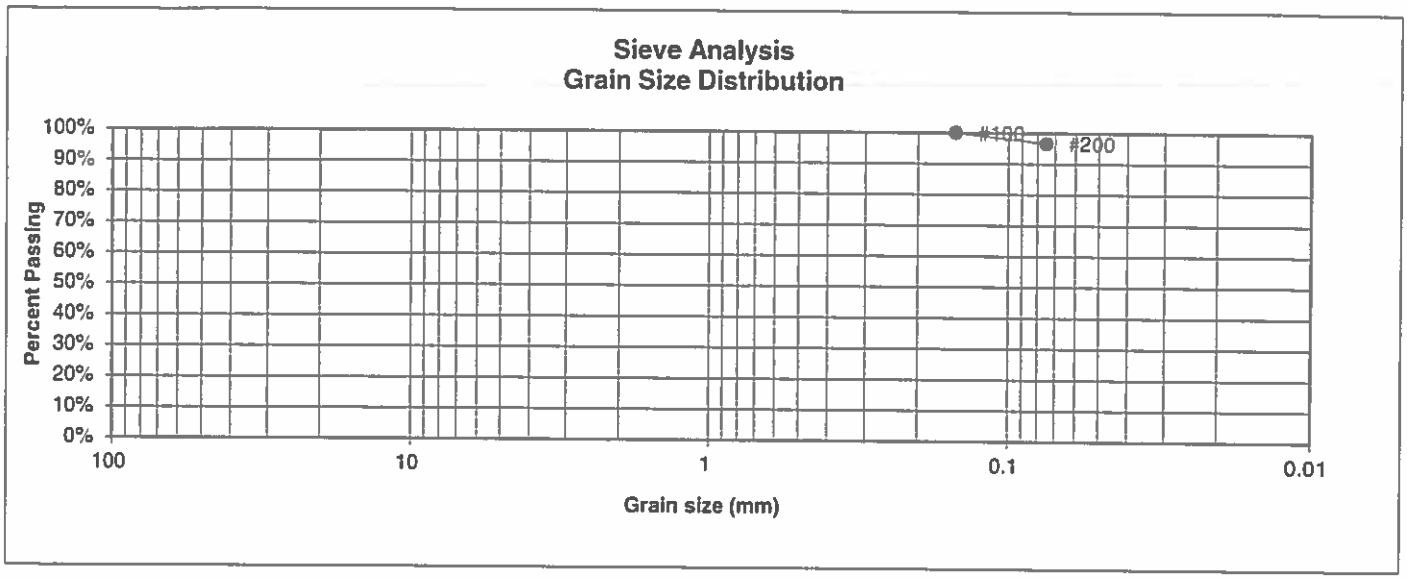
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 10/29/20

JOB NO.: 202268

FIG NO.: C-2

UNIFIED CLASSIFICATION	CL	CLIENT	VICEROY DEVELOPMENT
SOIL TYPE #	2	PROJECT	PARCEL #7424200038
TEST BORING #	2	JOB NO.	202268
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	100.0%
200	96.6%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	14.7%
Moisture at finish	26.9%
Moisture increase	12.2%
Initial dry density (pcf)	94
Swell (psf)	1550

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

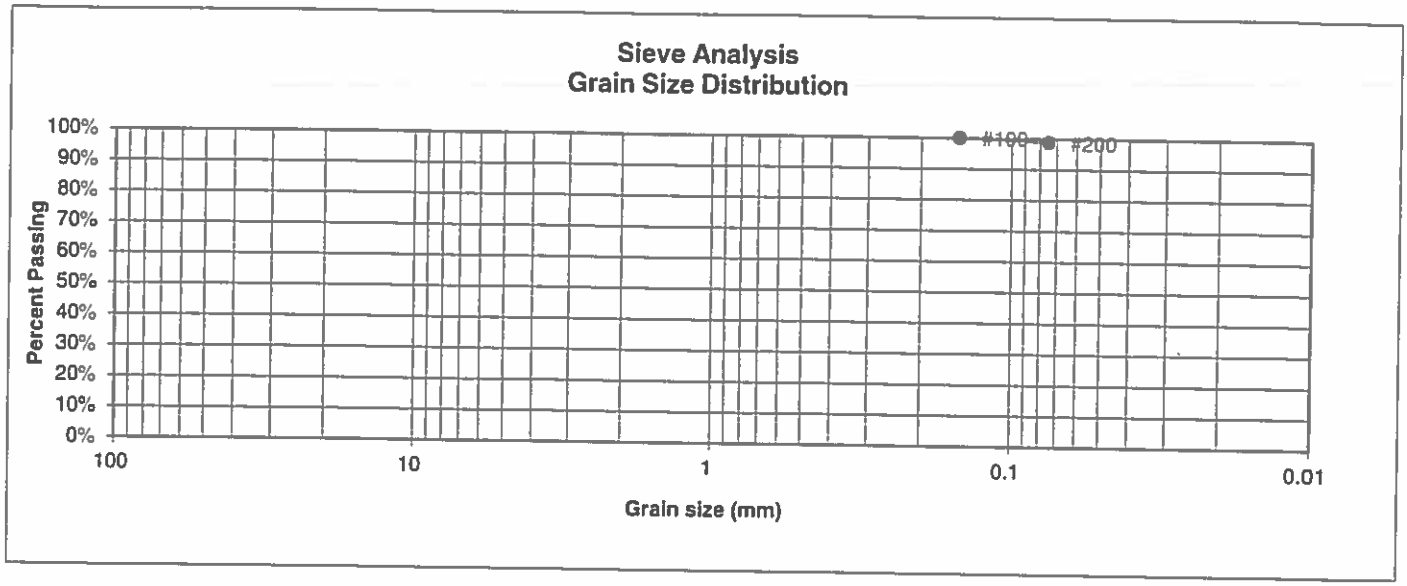
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		A	10/26/20

JOB NO.: 202268

FIG NO.: C-3

UNIFIED CLASSIFICATION	CL	CLIENT	VICEROY DEVELOPMENT
SOIL TYPE #	2	PROJECT	PARCEL #7424200038
TEST BORING #	3	JOB NO.	202268
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	100.0%
200	98.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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

LABORATORY TEST RESULTS

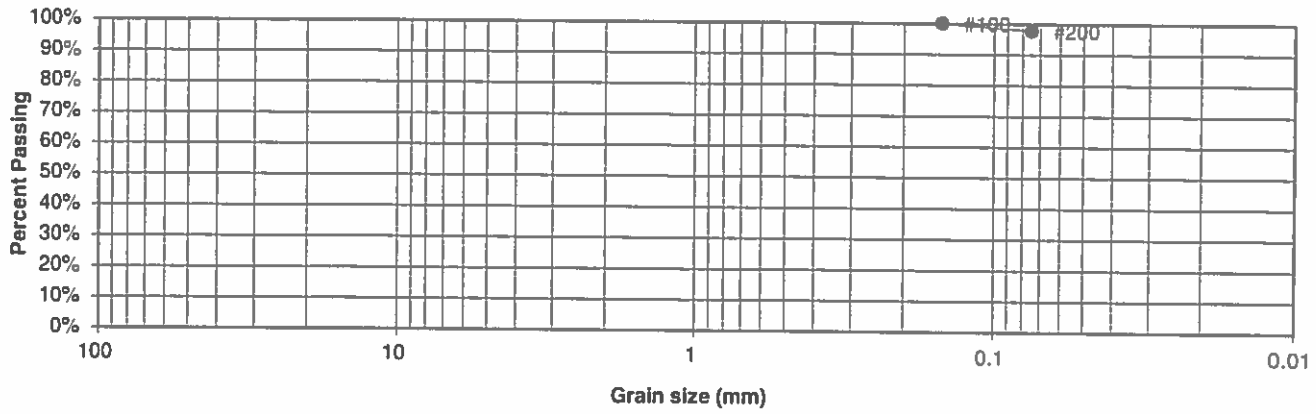
DRAWN:	DATE	CHECKED:	DATE:
			10/20/20

JOB NO.: 202268

FIG NO.: C-4

UNIFIED CLASSIFICATION	CH	CLIENT	VICEROY DEVELOPMENT
SOIL TYPE #	3	PROJECT	PARCEL #7424200038
TEST BORING #	2	JOB NO.	202268
DEPTH (FT)	15	TEST BY	BL

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	100.0%
200	97.8%

Atterberg Limits	
Plastic Limit	22
Liquid Limit	67
Plastic Index	45

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

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

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		h	10/28/20

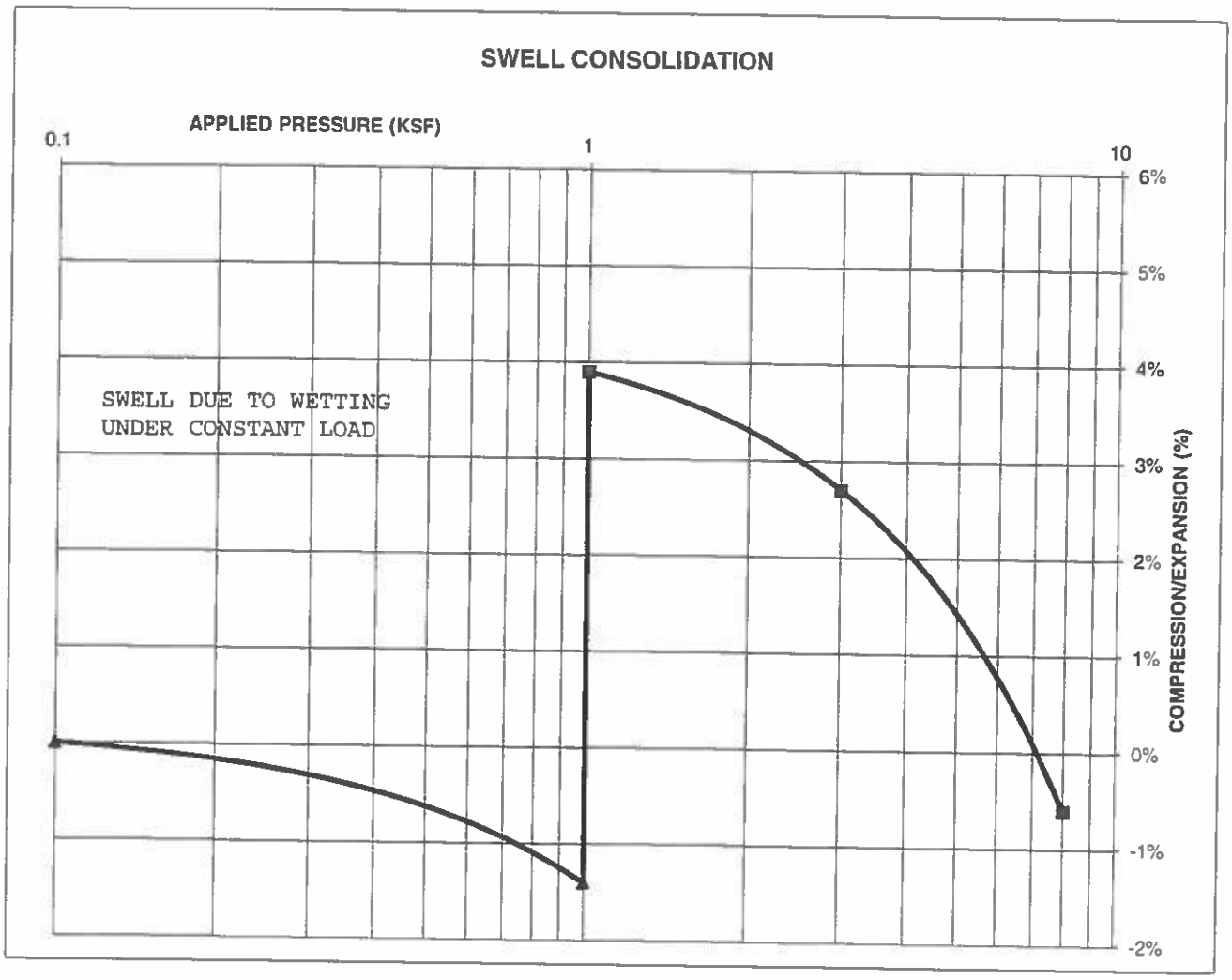
JOB NO.: 202268

FIG NO.: C-5

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	2-3
DESCRIPTION	CH	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			12.8%
SWELL/CONSOLIDATION (%)			5.3%

JOB NO. 202268
CLIENT VICEROY DEVELOPMENT
PROJECT PARCEL #7424200038



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

SWELL CONSOLIDATION
TEST RESULTS

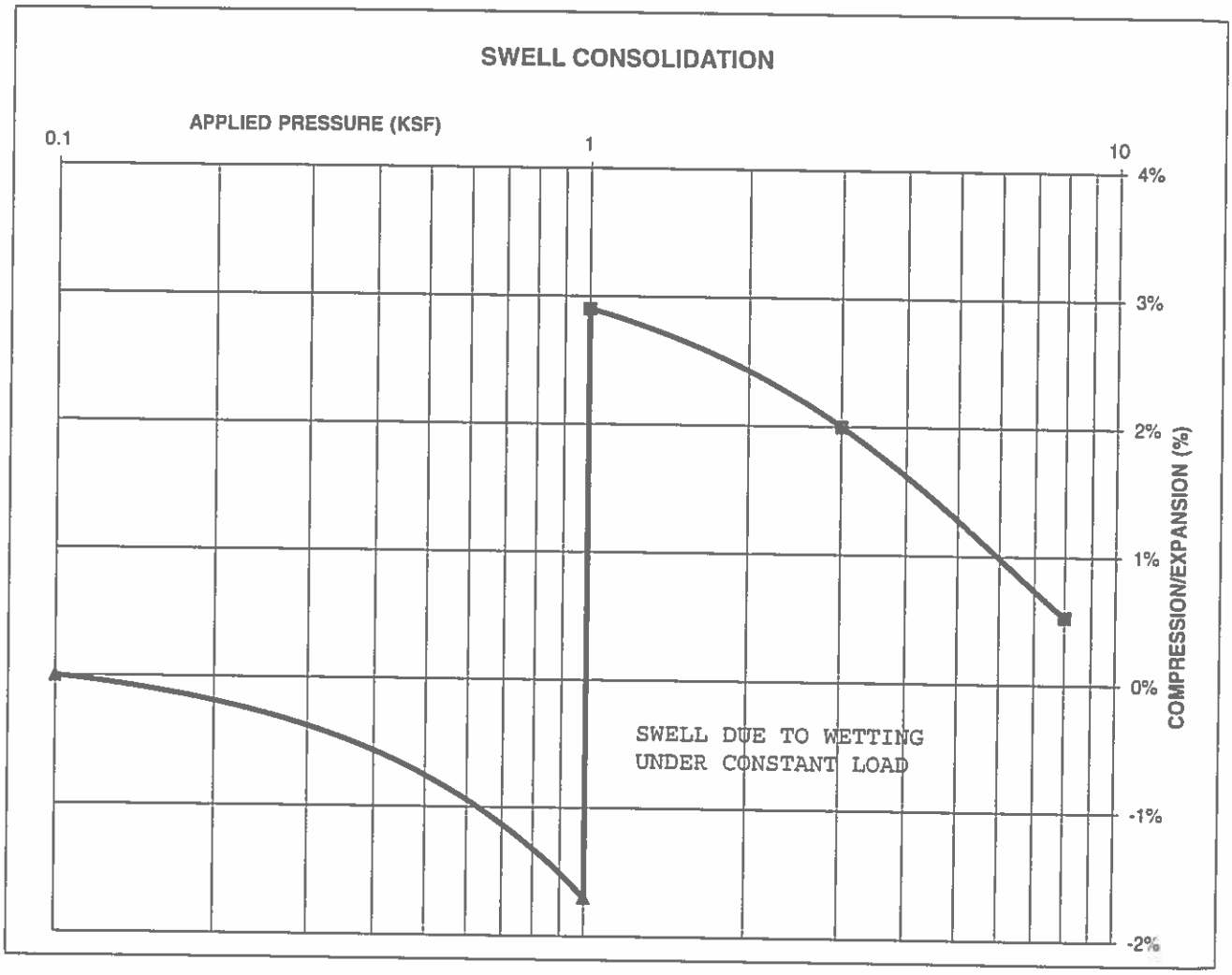
DRAWN:	DATE:	CHECKED:	DATE:
			10/23/20

JOB NO.: 202268
FIG NO.: C-6

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	10
DESCRIPTION	CH	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			108
NATURAL MOISTURE CONTENT			20.6%
SWELL/CONSOLIDATION (%)			4.6%

JOB NO. 202268
CLIENT VICEROY DEVELOPMENT
PROJECT PARCEL #7424200038



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

SWELL CONSOLIDATION
TEST RESULTS

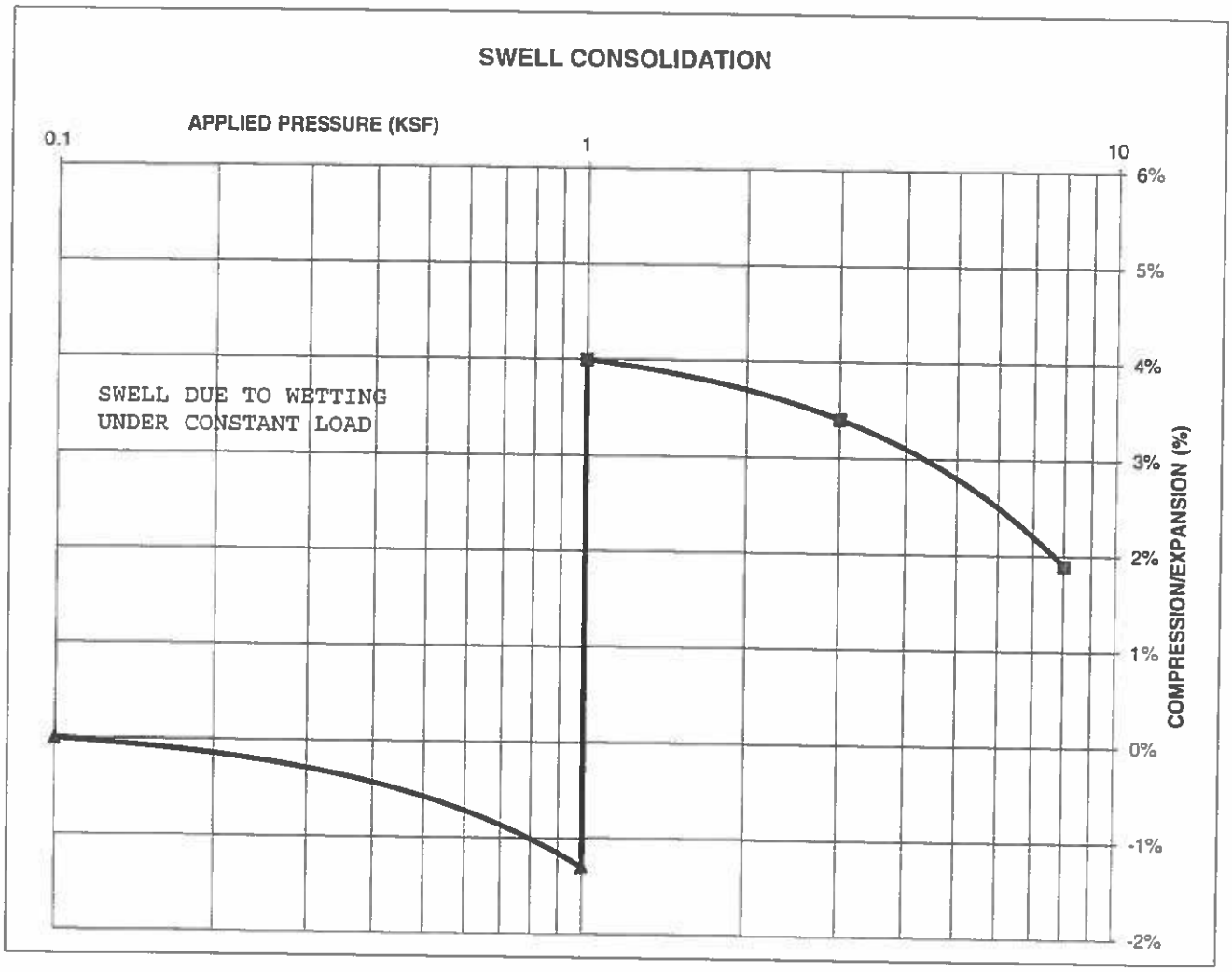
DRAWN:	DATE:	CHECKED:	DATE:
			10/28/20

JOB NO.: 202268
FIG NO.: C-7

CONSOLIDATION TEST RESULTS

TEST BORING #	3	DEPTH(ft)	10
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			108
NATURAL MOISTURE CONTENT			19.2%
SWELL/CONSOLIDATION (%)			5.3%

JOB NO. 202268
CLIENT VICEROY DEVELOPMENT
PROJECT PARCEL #7424200038



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

SWELL CONSOLIDATION
TEST RESULTS

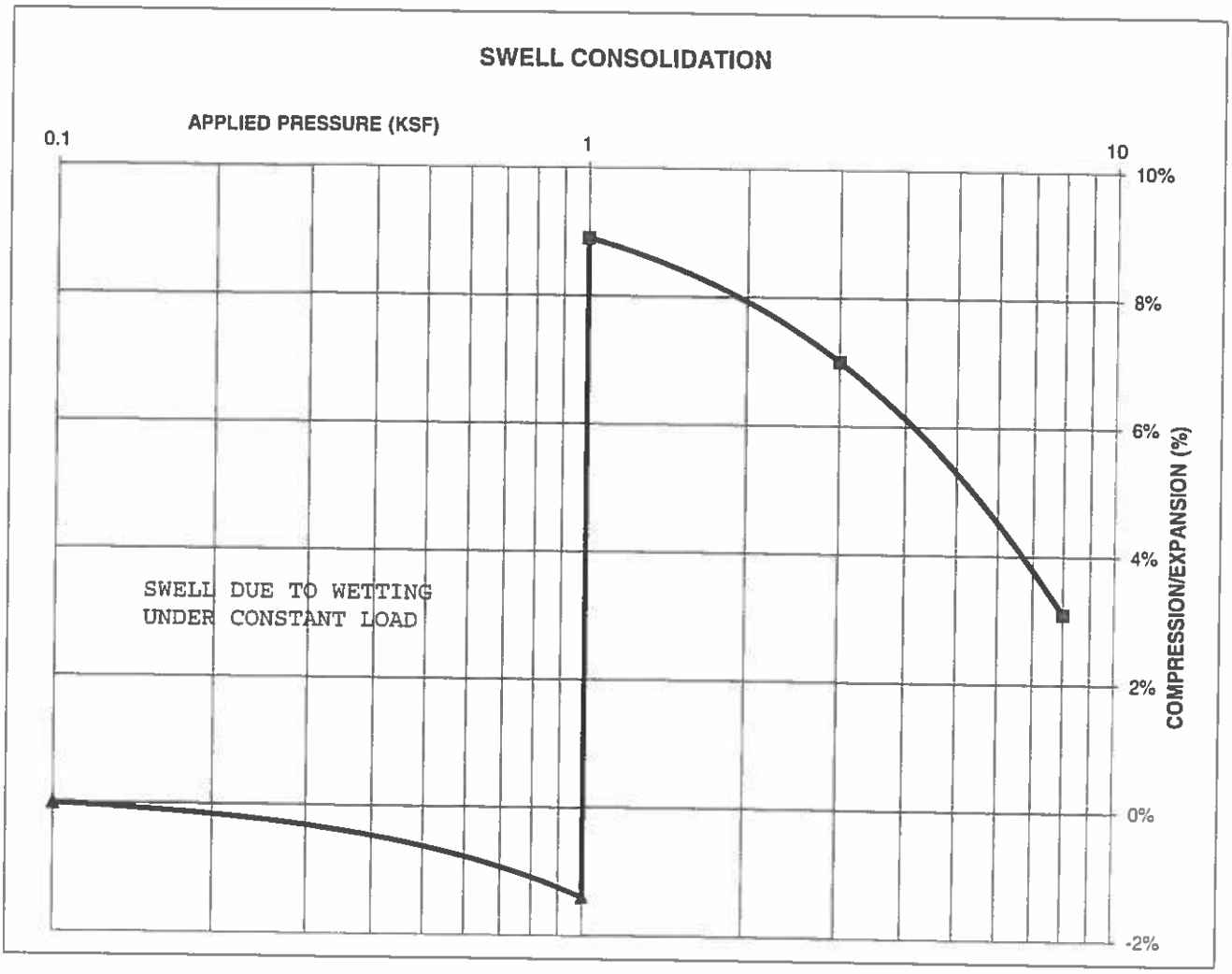
DRAWN:	DATE:	CHECKED:	DATE:
			10/29/20

JOB NO. 202268
FIG NO. C-3

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	15
DESCRIPTION	CH	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			17.7%
SWELL/CONSOLIDATION (%)			10.3%

JOB NO. 202268
CLIENT VICEROY DEVELOPMENT
PROJECT PARCEL #7424200038



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

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE
		/\	10/28/20

JOB NO. 202268
FIG NO. C-9

CLIENT	VICEROY DEVELOPMENT	JOB NO.	202268
PROJECT	PARCEL #7424200038	DATE	10/27/2020
LOCATION	PARCEL #7424200038	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1	CH	0.21
TB-1	10	2	CH	0.19
TB-2	15	3	CH	0.03

QC BLANK PASS

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

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			10/28/20

JOB NO.: 202268

FIG NO.: C-10

APPENDIX D: Colorado Geological Survey Review Letter, CGS Unique No. EP-23-0032 dated December 7, 2022

COLORADO GEOLOGICAL SURVEY

1801 Moly Road
Golden, Colorado 80401

Matthew L. Morgan
State Geologist

December 7, 2022

Matthew Alcuran
Planning and Community Development
30 S. Nevada Ave, Suite 701
Colorado Springs, CO 80901

Location:
SE 1/4 of NW 1/4 of S24
T14S R67W of the 6th PM
38.8196°, -104.8431°

Subject: **Gold Hill Filing 12**
Colorado Springs, El Paso County, CO
CGS Unique No. EP-23-0032

Matthew:

The Colorado Geological Survey (CGS) has reviewed the referral. We understand the applicant is proposing a 53-unit, 4-story apartment building on a 1.7-acre lot. For this submittal we received: a city request for review (email, November 16, 2022), 2nd review comments revised December 22, 2021, and a Geologic Hazard Study (Entech Engineering, Inc., Job No. 202268, November 30, 2020). We obtained additional documents necessary for our review from the LDRS web page, including the site plan (Terra Nova, Job Number 2089.00, November 10, 2021). We offer the following observations and recommendations.

CGS agrees with some of the geologic interpretation and identification of geologic hazards presented in Entechs report. However, they discuss downslope creep but not the potentially unstable nature of the slope that is mapped as landslide susceptible. This has important implications for the retention pond shown at the top of these slopes and the retaining walls greater than 4 feet in height in this location. Entech states on p. 11 *"Additional investigation may be recommended after site development plans and grading plans have been prepared.."* CGS recommends that Entech be provided the opportunity to comment on the proposed development, specifically on impacts to the project from the potentially unstable slopes along the north and northwest portion of the lot. We recommend that Entech expand their discussion on slope creep to include the identified landslide susceptibility in this area and provide slope stability analysis to determine any constraints on the detention pond and retaining walls planned at the crest of the potentially unstable slopes.
Before approval of the development plan CGS recommends Entech's report be expanded to include:

- Discussion and analysis of the potentially unstable slopes.
- Analysis of any impacts of potentially unstable slopes on the detention pond and retaining walls greater than 4 feet in height.
- The potential necessity of lining the detention pond due to potentially unstable slopes.
- The Geologic Hazard Disclosure Statement on the plans include potentially unstable slopes in the list of identified geologic hazards at this location.

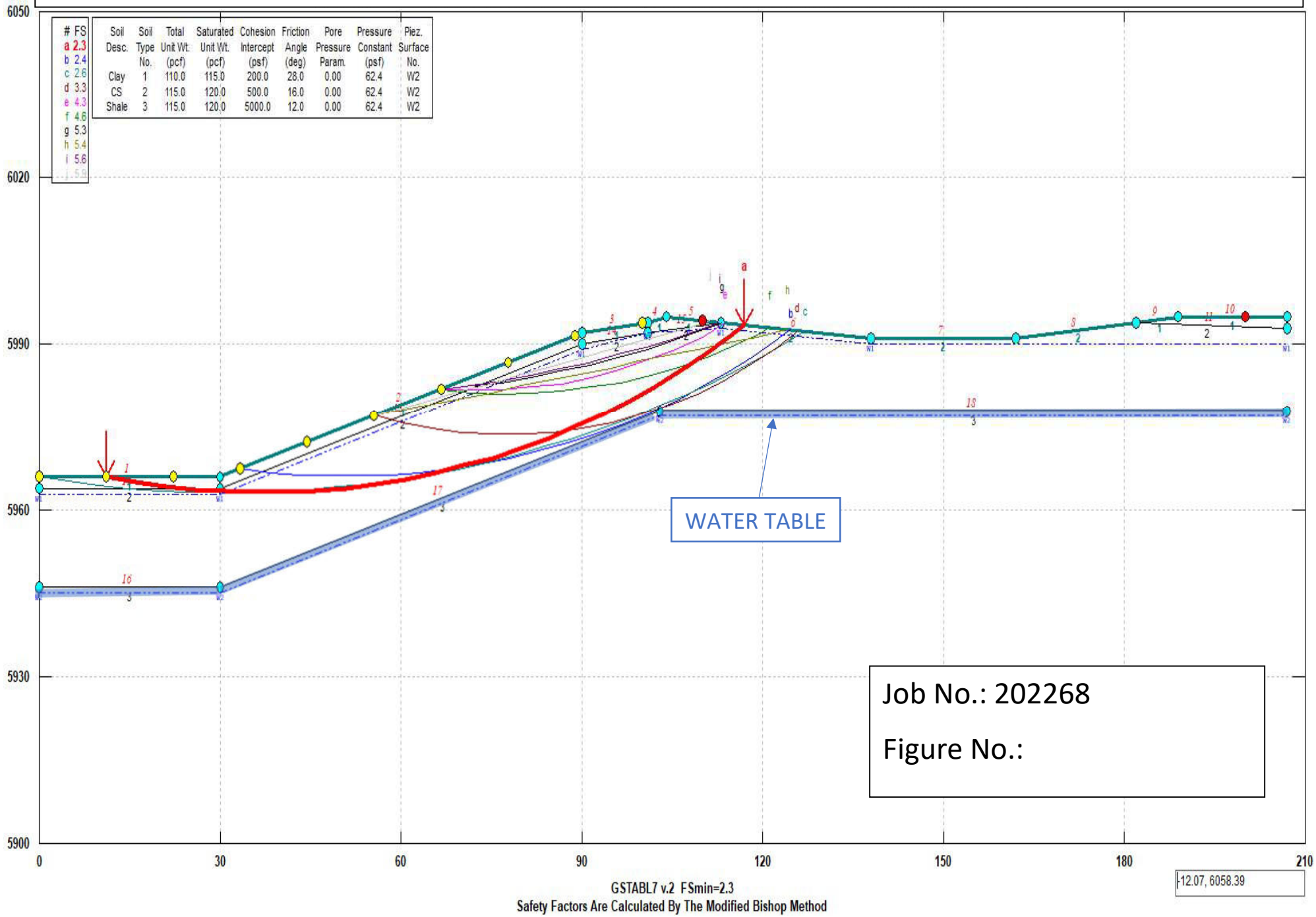
Thank you for the opportunity to comment on this project. If you have questions or require further review, please email me at jlovekin@mines.edu.

Sincerely,

Jonathan R. Lovekin, P.G.
Senior Engineering Geologist

APPENDIX E: Slope Stability Analysis

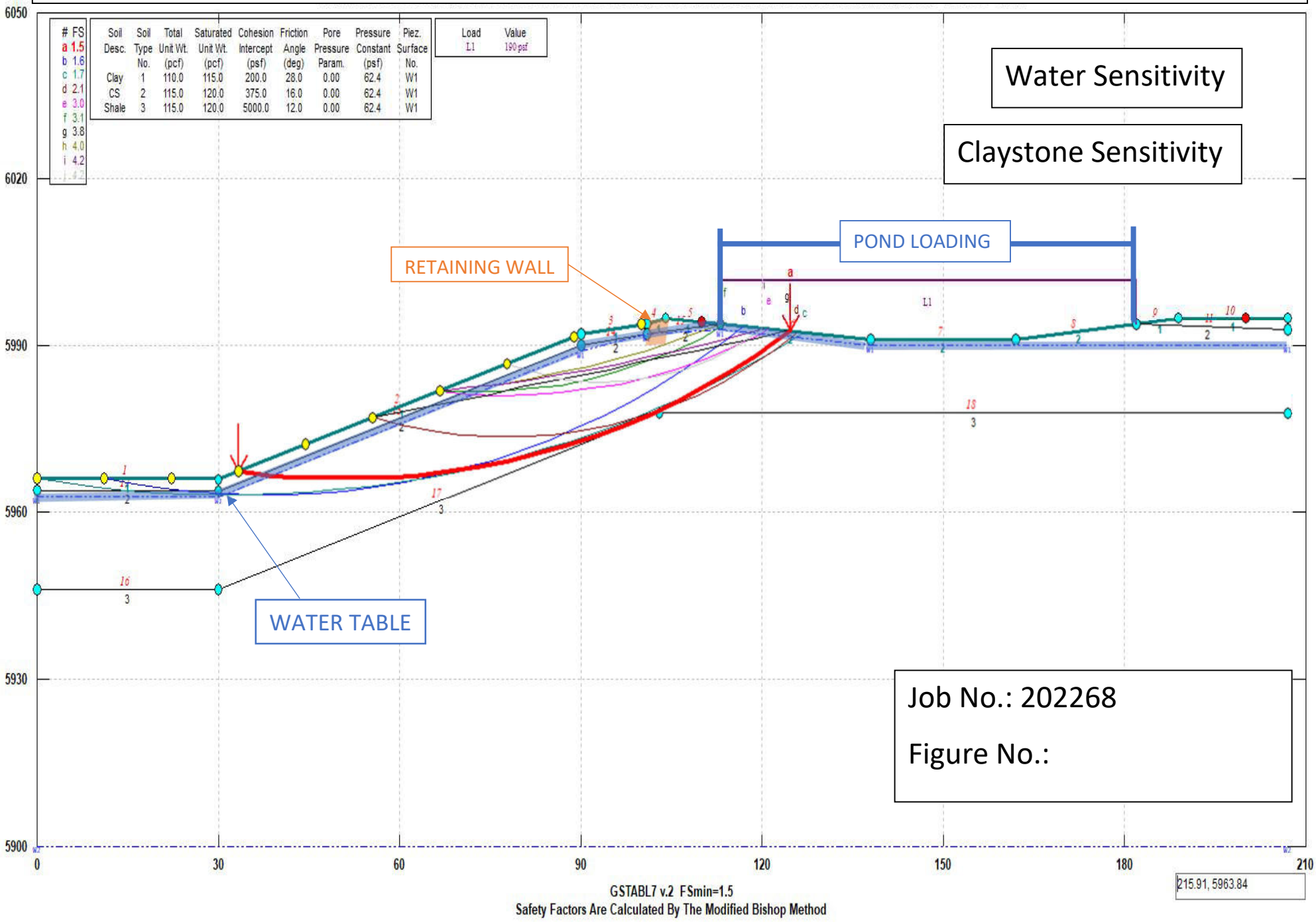
VICEROY – VUE DE LA PARC – A-A PROPOSED



Job No.: 202268

Figure No.:

VICEROY – VUE DE LA PARC – A-A PROPOSED



Water Sensitivity

Claystone Sensitivity

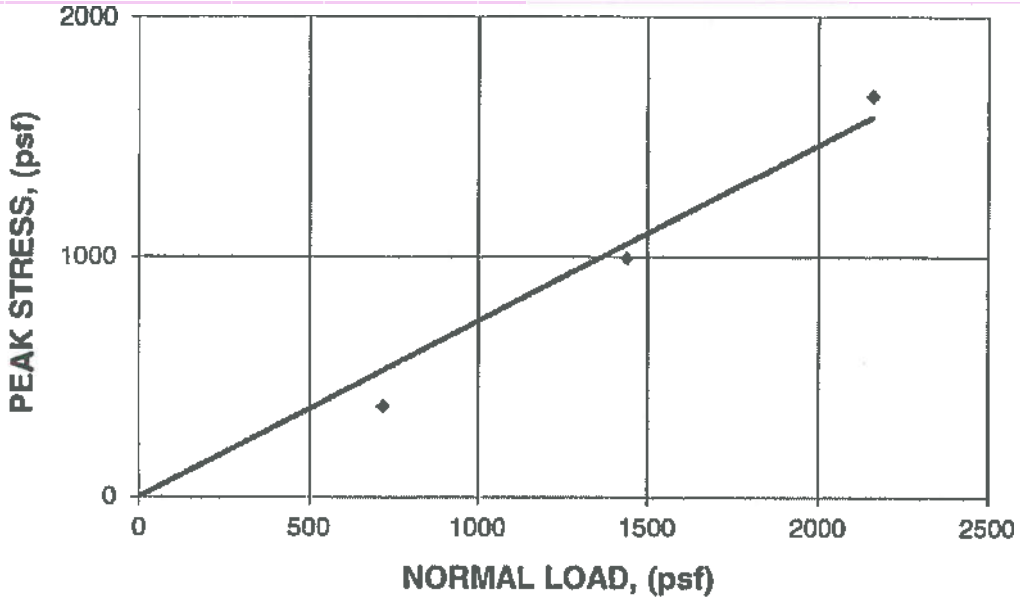
Job No.: 202268

Figure No.:

APPENDIX F: Slope Stability Analysis Soil Strength Parameters

CLIENT ADAMO HOMES JOB NO 180636
PROJECT UINTAH BLUFFS
LOCATION TB-1 @ 0-3'

$C = 0$
$\phi = 36°$ psf



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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

FRICTION ANGLES

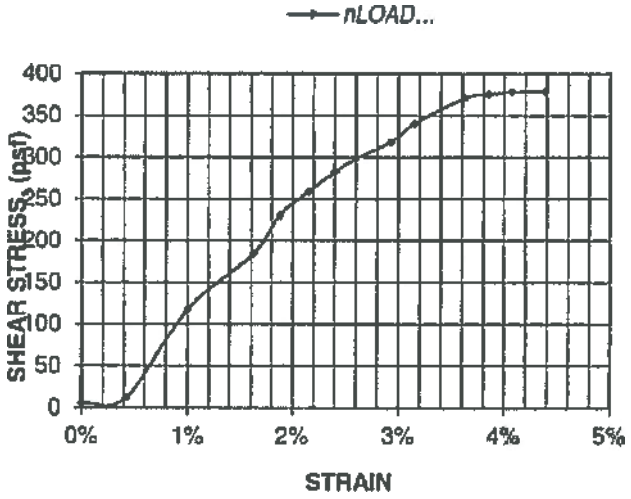
DRAWN:	DATE:	CHECKED:	DATE:
		MV	5-3-18

JOB NO.: 180636
FIG NO.: C-1.17

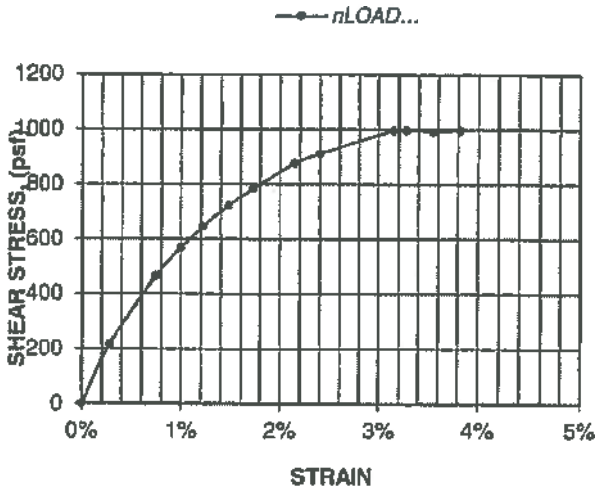
CLIENT ADAMO HOMES
PROJECT UINTAH BLUFFS
LOCATION TB-1 @ 0-3'

JOB NO 180636

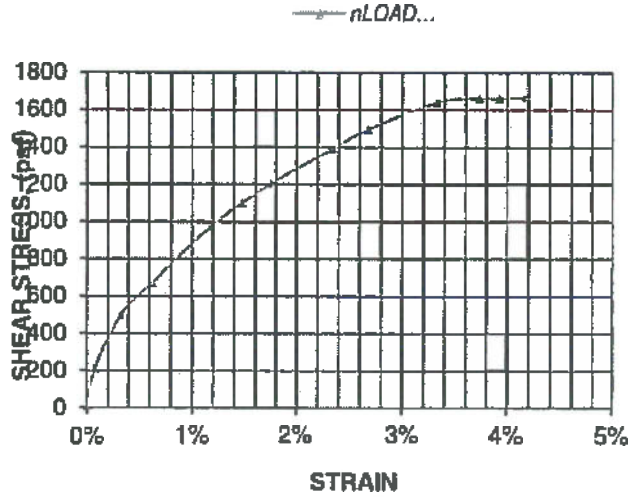
SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



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INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		MN	5-3-18

JOB NO.: 180636
FIG NO.: C-2.17

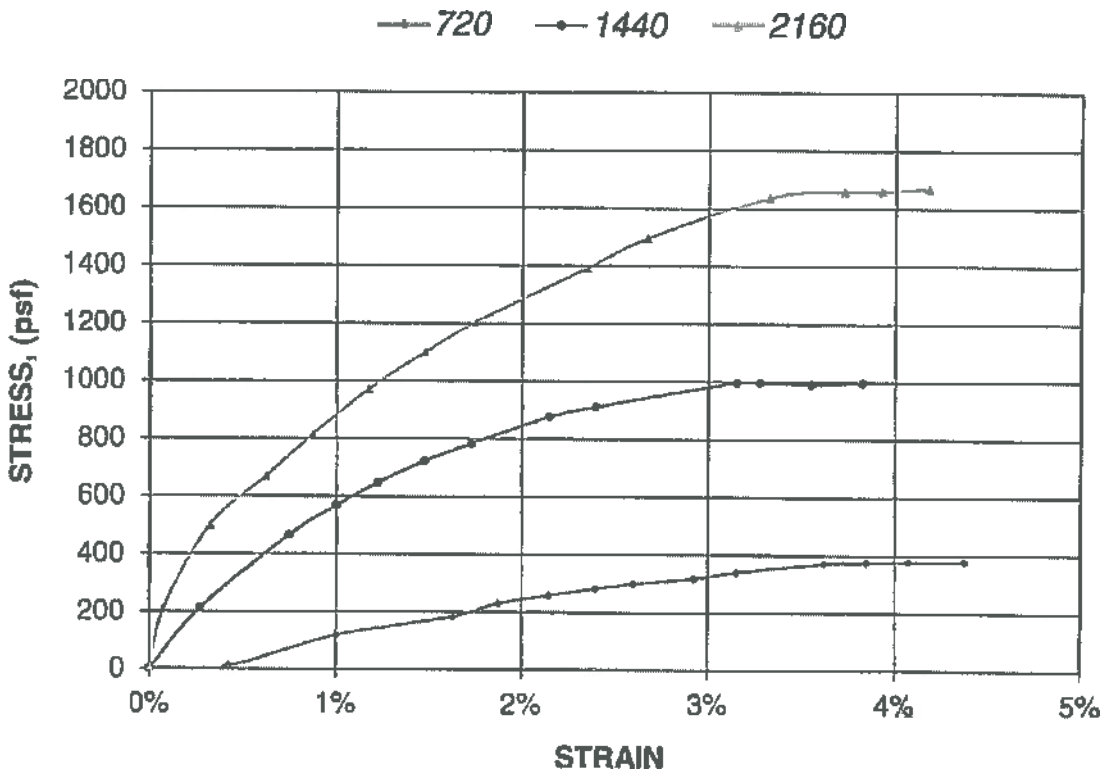
CLIENT ADAMO HOMES

PROJECT UINTAH BLUFFS

LOCATION TB-1 @ 0-3'

JOB NO 180636

SHEAR STRESS vs SAMPLE STRAIN



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DIRECT SHEAR COMPOSITE

DRAWN	DATE	CHECKED	DATE
		AN	5-3-18

JOB NO.: 180636

FIG NO.: C-3.17

SOIL STRENGTH PARAMETERS

(CTL THOMPSON)

Soil Type	Angle of Internal Friction (degrees)	Cohesion (psf)	Unit Weight (pcf)
Controlled Fill	34	150	130
Debris Containing Uncontrolled Fill	30	50	120
Substantial Debris Laden Fill	31*	100*	125
Clay and Claystone Fill	16	250	125
Sand and Gravel	34	0	125
Weathered Claystone	16	500	125
Weathered Claystone - Failure	11	0	125
Shale	12	5000	135
New Fill (Clayey Sand)	34	150	130
New Fill (Clay and Claystone)	16	500	125

*multiple trial