



**ENTECH**  
ENGINEERING, INC.

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

**SOIL, GEOLOGY, AND GEOLOGIC HAZARD  
THE RETREAT AT TIMBER RIDGE  
2.5+ ACRE LOTS  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, COLORADO**

Prepared for

**Arroya Investments**  
P.O. Box 50223  
Colorado Springs, Colorado 80949

Attn: Peter Martz

April 12, 2017

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford  
Geologist

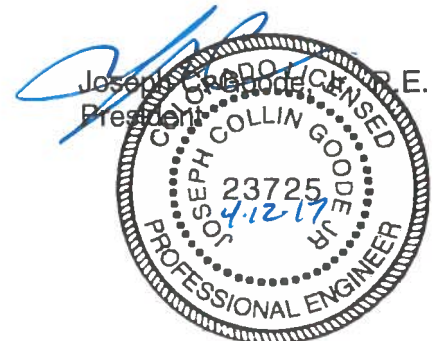
LLL/rm

Encl.

Entech Job No. 170209

AAprojects/2017/170209 countysoil/geo/wastewater

Reviewed by:



**TABLE OF CONTENTS**

1.0 SUMMARY .....	1
2.0 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION .....	2
3.0 SCOPE OF THE REPORT .....	2
4.0 FIELD INVESTIGATION .....	3
5.0 SOIL, GEOLOGY AND ENGINEERING GEOLOGY .....	3
5.1 General Geology .....	3
5.2 Soil Conservation Survey .....	4
5.3 Site Stratigraphy .....	4
5.4 Soil Conditions .....	5
5.5 Groundwater .....	6
6.0 ENGINEERING GEOLOGY – IDENTIFICATION AND MITIGATION OF GEOLOGIC HAZARDS .....	6
6.1 Relevance of Geologic Conditions to Land Use Planning .....	8
7.0 ECONOMIC MINERAL RESOURCES .....	9
8.0 EROSION CONTROL .....	12
9.0 CLOSURE .....	13
BIBLIOGRAPHY .....	14

**TABLES**

Table 1: Summary of Laboratory Test Results

Table 2: Summary of Percolation Test Results

**FIGURES**

Figure 1: Vicinity Map

Figure 2: USGS Map

Figure 3: Preliminary Concept Plan

Figure 4: Development Plan/Test Boring Location Map

Figure 5: Soil Survey Map

Figure 6: Falcon Northwest Quadrangle Geology Map

Figure 7: Geology Map/Engineering Geology

Figure 8: Floodplain Map

Figure 9: Typical Perimeter Drain Details

Figure 10: Septic Suitability Map

APPENDIX A: Site Photographs

APPENDIX B: Test Boring Logs and Profile Hole Logs

APPENDIX C: Laboratory Test Results

APPENDIX D: Soil Survey Descriptions

APPENDIX E: Percolation Test Results

## **1.0 SUMMARY**

### ***Project Location***

The project lies in portions of the SW¼ of Section 22 and the NE¼ of Section 28, Township 12 South, Range 65 West of the 6<sup>th</sup> Principal Meridian in El Paso County, Colorado. The site is located approximately 3 miles northeast of Colorado Springs, Colorado.

### ***Project Description***

Total acreage involved in the project is approximately forty-two acres. The proposed site development consists of twelve single-family residential lots. Ten lots are located north of Arroya Lane, and two lots are located west of Vollmer Road just south of Arroya Lane. The development will utilize individual water wells and on-site wastewater treatment systems.

### ***Scope of Report***

This report presents the results of our geologic evaluation and treatment of engineering geologic hazard study.

### ***Land Use and Engineering Geology***

This site was found to be suitable for the proposed development. Areas were encountered where the geologic conditions will impose some constraints on development and land use. These include areas of shallow bedrock, expansive soils, artificial fill, seasonal shallow groundwater and potentially seasonally shallow groundwater areas. 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.

## **2.0 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION**

The site is located in portions of the SW¼ of Section 22 and the NE¼ of Section 28, Township 15 South, Range 65 West of the 6<sup>th</sup> Principal Meridian in El Paso County, Colorado. The site is located approximately 3 miles northeast of Colorado Springs, Colorado, at Vollmer Road and Arroya Lane. The location of the site is as shown on the Vicinity Map, Figure 1.

The topography of the site is generally gradually to moderately sloping to the southeast and southwest towards Sand Creek. The drainages on site flow in southerly and direction through the central portion of the site. Water was not observed in the drainages on-site at the time of this investigation. The site boundaries are indicated on the USGS Map, Figure 2. Previous land uses have included grazing and pasture land. The site contains primarily field grasses, weeds, cacti, and yuccas, and ponderosa pine trees. Site photographs, taken March 9 and 28, 2017, are included in Appendix A.

Total acreage involved in the proposed development is approximately forty-two acres. Twelve single-family rural residential lots are proposed. The proposed lots will be approximately 2.5+ acres. The area will be serviced individual water wells and on-site wastewater treatment systems. The proposed Preliminary Concept Plan and the proposed Development Plan is presented in Figures 3 and 4.

## **3.0 SCOPE OF THE REPORT**

The scope of the report will include the following:

- 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.
- The site will be evaluated for on-site wastewater treatment systems in accordance with El Paso Land Development Code.

## **4.0 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 March 9 and 28, 2017.

Two Test Borings were performed for the percolation test profile holes, and three test pits were excavated across the site to determine general soil and bedrock characteristics. The locations of the profile holes and test pits are indicated on the Development Plan/Test Boring Location Map, Figure 4. The Test Boring and Test Pit Logs are presented in Appendix B. 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 FHA Swell Testing and Swell/Consolidation test. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

## **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 12 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 northeasterly direction (Reference 1). 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-made, and alluvial soils of Quaternary Age. The alluvial soils were deposited by water on site and as stream deposits along the drainages on-site. 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 2), previously the Soil Conservation Service (Reference 3) has mapped three soil types on the site (Figure 5). In general, the soils classify as gravelly loamy sand and coarse sandy loam. The soils are described as follows:

<u>Type</u>	<u>Description</u>
40	Kettle Gravelly Loamy Sand, 3 to 8% slopes
41	Kettle Gravelly Loamy Sand, 8 to 40% slopes
71	Pring Coarse Sandy Loam, 3 to 8% 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 slight to moderate erosion hazards.

## **5.3 Site Stratigraphy**

The Falcon NW Quadrangle Geology Map showing the site is presented in Figure 6 (Reference 4). The Geology Map prepared for the site is presented in Figure 7. Three mappable units were identified on this site which are described as follows:

- Qaf Artificial Fill of Holocene Age:** These are recent deposits of man-made fill. They are associated with the erosion berm located on the two lots west of Vollmer Road.
- Qal Recent alluvium of Holocene Age:** These are recent deposits that have been deposited along the drainages on-site.

**Tkd Dawson Formation of Tertiary to Cretaceous Age:** The Dawson Formation typically consist of arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone. Overlying this formation is a variable layer of 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 sandy clays.

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 4), the *Geologic Map of the Colorado Springs-Castle Rock Area*, distributed by the US Geological Survey in 1979 (Reference 5), and the *Geologic Map of the Denver 1° x 2° Quadrangle*, distributed by the US Geological Survey in 1981 (Reference 6). The Test Borings and Profile Holes were also used in evaluating the site and are included in Appendix B. The Geology Map prepared for the site is presented in Figure 7.

#### **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). The test pit soils were classified using the USDA Textural Soil Classification.

Soil Type 1 clayey to very clayey sand and silty to slightly silty sand (SC, SM, SM-SW), encountered in both of Test Borings and all of the test pits at the existing ground surface and extending to depths ranging from 1 foot to 14 feet bgs. These soils were encountered at loose to dense states and at moist conditions. The majority of the soils were encountered and medium dense states. Samples tested had 11 to 34 percent passing the No. 200 Sieve.

Soil Type 2 silty sandstone and clayey to very clayey sandstone (SM, SC), encountered in both of Test Borings and all of the Test Pits at depths ranging from 1 foot to 14 feet bgs and extending to the termination of the test borings (15 feet). The sandstone was encountered at dense to very dense states and at moist conditions. Samples tested had 48 percent passing the No. 200 Sieve. Swell/Consolidation Testing on a sample of the very clayey sandstone resulted in a swell of 0.2 percent, which is in the low expansion range.

Soil Type 3 sandy claystone and siltstone (CL, MH), encountered in Test Pit Nos. 2 and 3 at depths ranging from 5 to 6.5 feet and extended to the termination test pit (8 feet). The claystone and siltstone were encountered at hard consistencies and at moist conditions. Samples tested had 60 to 77 percent passing the No. 200 Sieve. FHA Swell Testing resulted in an expansion pressure of 1280 psf, which is in the moderate expansion range.

The Test Boring and Test Pit Logs are presented in Appendix B. Laboratory Test Results are presented in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

### **5.5 Groundwater**

Groundwater was not encountered in the test borings, which were drilled to 15 feet. Signs of seasonally occurring groundwater were observed in Test Pit Nos. 2 and 3 at depths of 5 to 6 feet. Areas of water, seasonal shallow groundwater water, and potential seasonal shallow groundwater have been mapped along the drainages on-site. These areas are 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 problem as necessary at the time of construction.

## **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 7. 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

These are recent man-made fill deposits associated with the erosion berm located across the two lots west of Vollmer Road.

Mitigation: The erosion berms can either be avoided or penetrated by foundations. The fill on this site is considered uncontrolled for construction purposes. Any uncontrolled fill encountered beneath foundations will require removal and recompaction at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557.

#### Collapsible Soils

The majority of the soils encountered on-site do not exhibit collapsible characteristics, however, areas of loose soils were encountered in the test borings drilled on site. Should loose or collapsible soils be encountered beneath foundations, recompaction and moisture conditioning of the upper 2 feet of soil at 95% of its maximum Modified Proctor Dry Density ASTM D-1557 will be required. Exterior flatwork and parking areas may also experience movement. Proofrolling and recompaction of soft areas should be performed during site work.

#### 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. These clays, claystones and siltstones, if encountered beneath foundations, can cause differential movement in the structure foundation. These occurrences should be identified and dealt with on an individual basis.

Mitigation Should expansive soils be encountered beneath the foundation, mitigation will be necessary. Mitigation of expansive soils will require special foundation design. Overexcavation 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. The use of structural floors should be considered for basement construction on highly expansive clays. Final recommendations should be determined after additional investigation of each building site.

### Groundwater and Floodplain Areas

Areas within the drainages on-site have been identified as areas of seasonally high groundwater areas. Water was not flowing in the any of the drainages at the time of this investigation. The site is not mapped within floodplain zones according to the FEMA Map No. 08041CO764F, Figure 8 (Reference 7). These areas are discussed as follows:

#### Seasonal Shallow Groundwater Area

In these areas, we would anticipate periodic high subsurface moisture conditions and frost heave potential on a seasonal basis. Additional, highly organic soils could be encountered in these areas. These areas lie within defined drainages and it is anticipated they will be avoided by development. Any structures in or adjacent to these areas should follow the mitigation discussed below.

Mitigation: Foundations must have a minimum 30-inch depth for frost protection. In areas where high subsurface moisture conditions are anticipated periodically, subsurface perimeter drains are recommended to help prevent the intrusion of water into areas below grade. Typical drain details are presented in Figure 9. Any grading in these areas should be done to direct surface flow around construction to avoid areas of ponded water. Structures should not block drainages. All organic material should be completely removed prior to any fill placement. Finished floor levels must be located a minimum of one foot above floodplain levels.

#### Potentially Seasonal Shallow Groundwater Area

In these areas, we would anticipate the potential for periodically high subsurface moisture conditions, frost heave potential and highly organic soils. The majority of these areas lie within defined drainages which can likely be avoided by the proposed development. The same mitigation recommendations for the seasonal shallow groundwater areas apply to the potentially seasonal shallow groundwater areas.

## **6.1 Relevance of Geologic Conditions to Land Use Planning**

As mentioned earlier in this report, we understand that the development will be single family residential. 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 drainages on site that can be

properly mitigated. Other hazards on site may be satisfactorily mitigated through proper engineering design and construction practices.

The upper materials are typically at loose to dense states. The granular soils encountered in the upper soil profiles of the test borings and test pits should provide good support for foundations. Loose soils if encountered at foundation depth will require mitigation. Foundations anticipated for the site are standard spread footings possibly in conjunction with overexcavation in areas of expansive soils or loose soils. Excavation is anticipated to be moderate with rubber tired equipment for the site sand materials, and will require track mounted equipment for the dense sandstone, and hard claystone and siltstone. Expansive layers may also be encountered in the soil and bedrock on this site. Areas of expansive soils encountered on site are sporadic; therefore, none have been indicated on the maps. Expansive soils, if encountered, will require special foundation design and/or overexcavation. These soils will not prohibit development.

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.

## **7.0 ECONOMIC MINERAL RESOURCES**

Some of the sandy materials on-site could be considered a low-grade sand resource. According to the *El Paso County Aggregate Resource Evaluation Map* (Reference 8), the area is not mapped with any aggregate deposits. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 9), areas of the site are not mapped with any resources. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 10), the area of the site has been mapped as "Fair" for industrial minerals. However, considering the silty nature of much of these materials and abundance of similar materials through the region and the close proximity to developed land, they would be considered to have little significance as an economic resource.

According to the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 10), the site is mapped within the Denver Basin Coal Region.

However, the area of the site has been mapped as “Poor” for coal resources. No active or inactive mines have been mapped in the area of the site. No metallic mineral resources have been mapped on-site (Reference 10).

The site has been mapped as “Fair” for oil and gas resources (Reference 10). No oil or gas fields have been discovered in the area of the site. The sedimentary rocks in the area may lack the geologic structure for trapping oil or gas; therefore, it may not be considered a significant resource. Hydraulic fracturing is a new method that is being used to extract oil and gas from rocks. It utilizes pressurized fluid to extract oil and gas from rocks that would not normally be productive. The area of the site has not been explored to determine if the rocks underlying the site would be commercially viable utilizing hydraulic fracturing. The practice of hydraulic fracturing has come under review due to concerns about environmental impacts, health and safety.

## **8.0 ON-SITE WASTEWATER TREATMENT**

The site was evaluated for on-site wastewater treatment systems for the proposed lots in accordance with El Paso Land Development Code. Two (2) percolation tests and three (3) tactile test pits were performed across the site. Percolation test and tactile test pits were located in anticipated locations of proposed on-site wastewater treatment system (OWTS) for the development. The approximate locations of the profile holes and test pits are indicated on Figure 4 and 7, and on the Septic Suitability Map, Figure 10. The locations were chosen to determine a general understanding of the soil and bedrock conditions across the site. The results of the percolation tests and test pits are presented in Table 2. The specific test results are presented in Appendix E of this report.

The Natural Resource Conservation Service (Reference 2), previously the Soil Conservation Service (Reference 3) has been mapped with three soil descriptions. The Soil Survey Map (Reference 2) is presented in Figure 5, and the Soil Survey Descriptions are presented in Appendix D. The soils are described as having moderate to moderately rapid percolation rates.

The percolation rates varied from 44 (PH-2) to 133 (PH-1) minutes per inch. The percolation rate for PH-1 is not suitable for conventional OWTS, the rate for PH-2 is suitable for a conventional OWTS. Percolation rates slower than 60 minutes per inch will require designed

systems. Shallow bedrock was also encountered in the profile holes and test pits, and will also required a designed system. Additional drilling may identify areas where faster rates are encountered that are suitable for conventional systems.

Standard penetration testing, ASTM D-1586, was performed in each profile hole to evaluate the density of the soil and the presence of bedrock. Bedrock was encountered in The Profile Holes at 3 to 14 feet. Designed systems are required in areas of shallow bedrock.

Soils encountered in the tactile test pits consisted of sandy loam to gravelly sandy loam, gravelly loamy sand, and gravelly sandy clay loam with underlying clayey to silty sandstone, sandy claystone and sandy siltstone. The limiting layers encountered in the test pits are the sandy clay loam, silty to clayey sandstone, sandy claystone and sandy siltstone, which corresponds to an LTAR values of 0.15 to 0.20 gallons per day per square foot. The bedrock was encountered at 1 to 5 feet in the test pits. The conditions encountered in the test pits will require a designed system. Signs of seasonal shallow groundwater were observed at depths ranging from 5 to 6 feet in Test Pit Nos. 2 and 3.

Absorption fields must be maintained a minimum of 4 feet above groundwater or bedrock. Groundwater was not encountered in the profile holes which was drilled to 15 feet, however; signs of seasonally shallow groundwater were observed in Test Pit Nos. 2 and 3 at depths ranging from 5 to 6 feet. Shallow bedrock was encountered in the profile holes and test pits at depths ranging from 1 to 14 feet.

In summary, it is our opinion the site is suitable for individual on-site wastewater treatment systems (OWTS) and that contamination of surface and subsurface water resources should not occur provided the OWTS sites are evaluated and installed according to El Paso County Guidelines and properly maintained. Based on the testing performed as part of this investigation and the type of project designed systems will likely be required for the majority of the lots. A Septic Suitability Map is presented in Figure 10. Absorption fields must be located a minimum of 100 feet from any well, including those on adjacent properties. Absorption fields must also be located a minimum of 50 feet from any ponded areas and 25 feet from dry gulches. It should be noted that additional testing will be required for the individual lots prior to construction.

## **9.0 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 on 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.

## **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 majority of these conditions can be mitigated through proper engineering design and construction practices. The proposed development and use is 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. Individual investigations for building sites will be required 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 Arroya Investments. 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.

## BIBLIOGRAPHY

1. Bryant, Bruce; McGrew, Laura W, and Wabus, Reinhard A. 1981. *Geologic Structure Map of the Denver 1° x 2° Quadrangle, North-Central Colorado*. Sheet 2. U.S. Geologic Survey. Map I-1163.
2. Natural Resource Conservation Service, September 22, 2015. *Web Soil Survey*. United States Department Agriculture, <http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.
3. United States Department of Agriculture Soil Conservation Service. June 1981. *Soil Survey of El Paso County Area, Colorado*.
4. Madole, Richard F., 2003. *Geologic Map of the Falcon NW Quadrangle, El Paso County, Colorado*. Colorado Geological Survey. Open-File Report 03-8.
5. Trimble, Donald E. and Machette, Michael N. 1979. *Geologic Map of the Colorado Springs-Castle Rock Area, Front Range Urban Corridor, Colorado*. USGS, Map I-857-F.
6. Bryant, Bruce; McGrew, Laura W. and Wobus, Reinhard A. 1981. *Geologic Map of the Denver 1° x 2° Quadrangle, North-Central Colorado*. U.S. Geologic Survey. Map 1-1163.
7. Federal Emergency Management Agency. March 17, 1997. *Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas*. Map Number 08041CO535F
8. El Paso County Planning Development. December 1995. *El Paso County Aggregate Resource Evaluation Maps*.
9. Schwochow, S.D.; Shroba, R.R. and Wicklein, P.C. 1974. *Atlas of Sand, Gravel, and Quarry Aggregate Resources, Colorado Front Range Counties*. Colorado Geological Survey. Special Publication 5-B.
10. Keller, John W.; TerBest, Harry and Garrison, Rachel E. 2003. *Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands Administered by the Colorado State Land Board*. Colorado Geological Survey. Open-File Report 03-07.



## TABLES

**TABLE 1**  
**SUMMARY OF LABORATORY TEST RESULTS**

CLIENT ARROYA INVESTMENTS  
PROJECT THE RETREAT AT TIMBER RIDGE  
JOB NO. 170209

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			34.3						SC	SAND, CLAYEY
1	2	2-3			11.2						SM-SW	SAND, SLIGHTLY SILTY
1	TP-3	4-5			16.4						SM	SAND, CLAYEY
2	1	5	14.9	108.3	47.6					0.2	SC	SANDSTONE, VERY CLAYEY
3	TP-2	5-6			76.6				1280		CL	CLAYSTONE, SANDY
3	TP-3	6-8			60.6						CL	CLAYSTONE, VERY SANDY

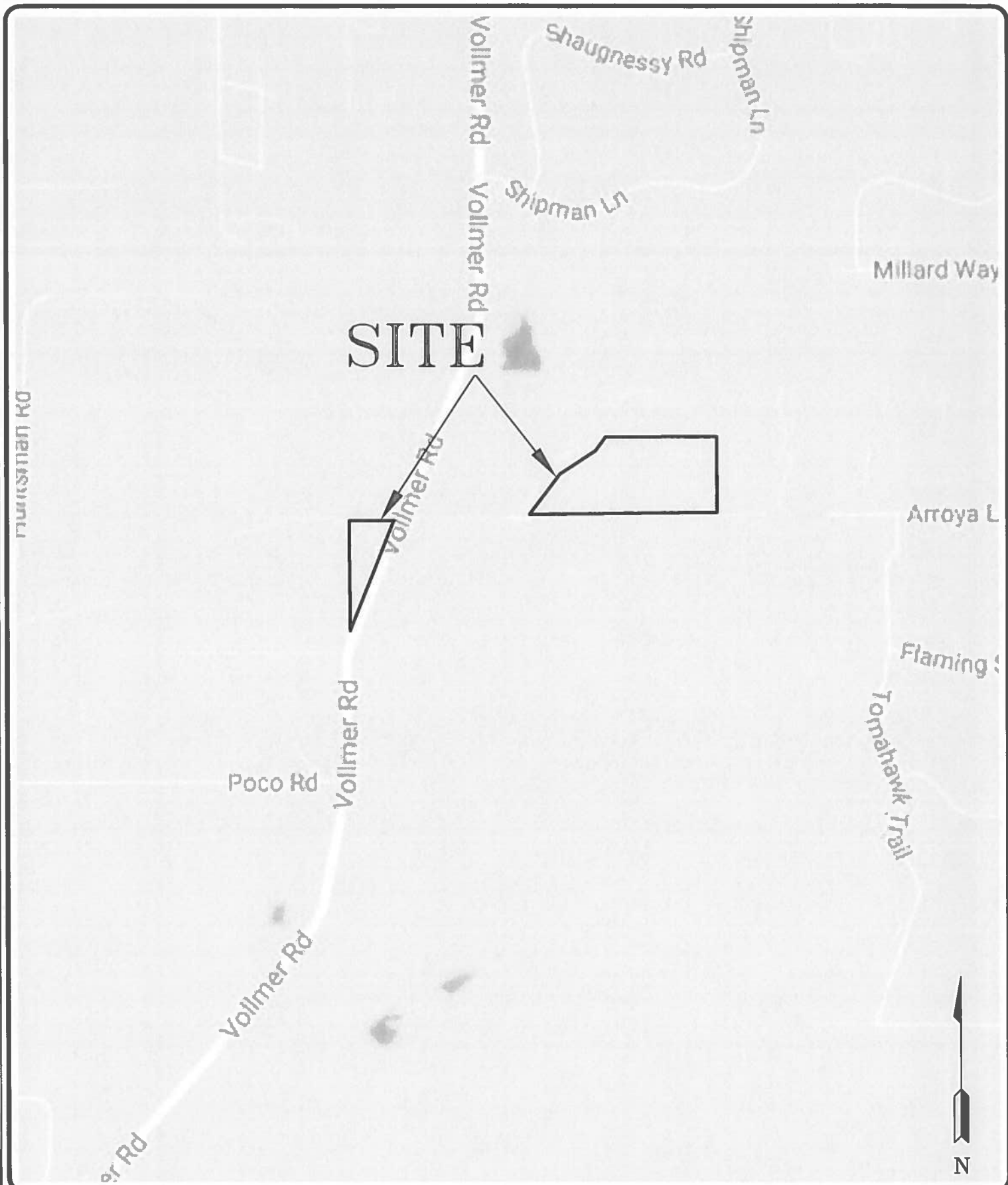
**Table 2: Summary of Percolation Test and Tactile Test Pit Results**

<b>Percolation Test No.</b>	<b>Percolation Rate (min/in)</b>	<b>Depth to Bedrock (ft.)</b>	<b>Depth to Groundwater (ft.)</b>
1	133*	N/A	N/A
2	44	N/A	N/A

<b>Test Pit No.</b>	<b>USDA Soil Type Limiting Layer</b>	<b>LTAR Value</b>	<b>Depth to Bedrock (ft.)</b>	<b>Depth to Groundwater (ft.)</b>
1	4*	0.20	1	N/A
2	4A*	0.15	3.5	N/A
3	4A*	0.15	5	N/A

\*- Conditions that will require an engineered OWTS

## FIGURES



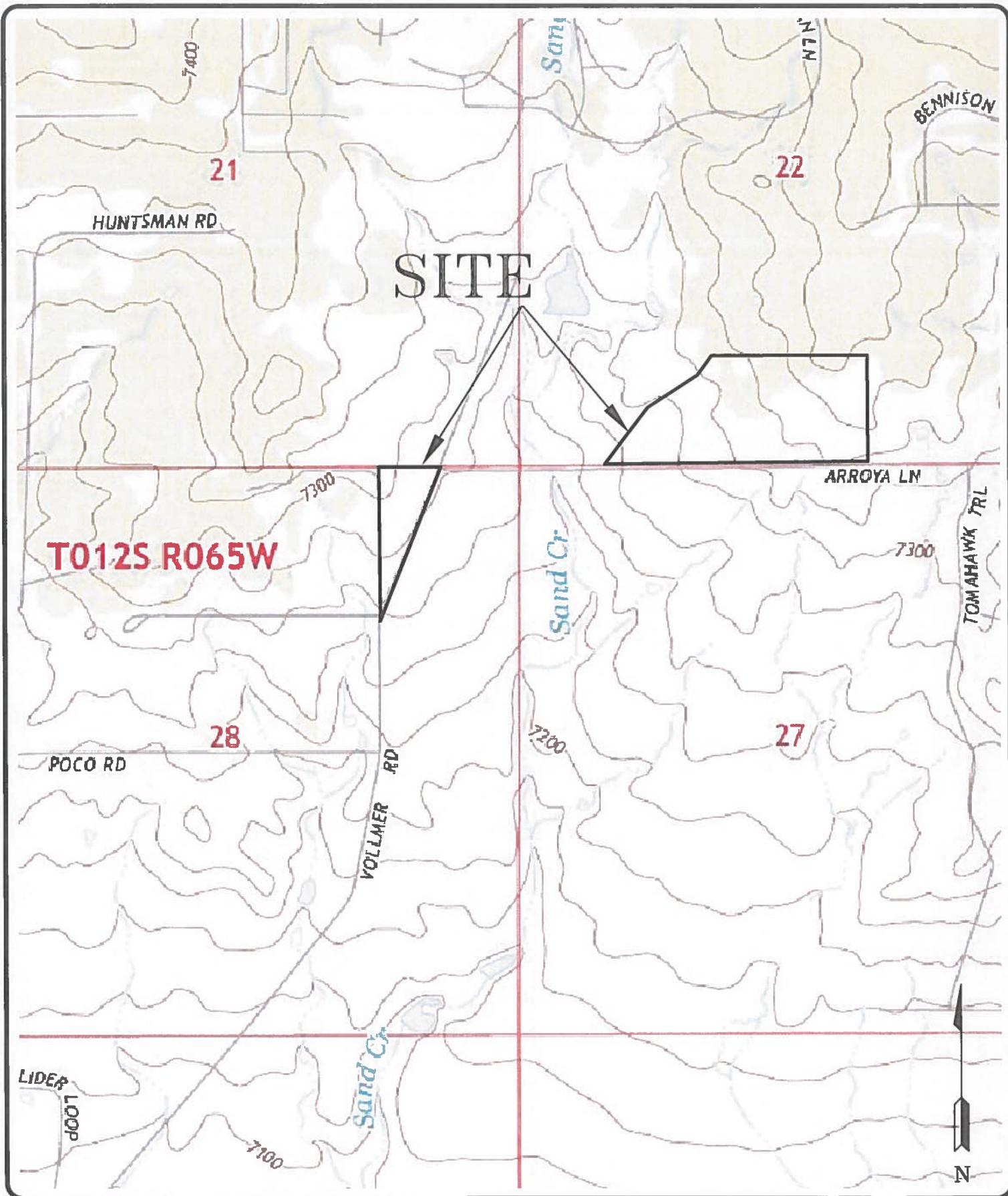
**ENTECH**  
ENGINEERING, INC.  
505 ELKTON DRIVE  
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DRAWN: LLL	DATE: 3/31/17	CHECKED:	DATE:
---------------	------------------	----------	-------

JOB NO.:  
170209

FIG NO.:  
1



**ENTECH**  
ENGINEERING, INC.

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

USGS MAP  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DRAWN:  
LLL

DATE:  
3/31/17

CHECKED:

DATE:

JOB NO.:  
170209

FIG NO.:  
2



# SITE

TRACT A  
URE RESIDENTIAL  
(5-ACRE LOTS)

ARROYA LANE

50' Buffer

3.4 AC

3.4 AC

50' Buffer

VOLLMER RD.

OPEN SPACE

PARCEL A

PARCEL B

PARCEL D

PARCEL E

PARCEL C

RESIDENTIAL  
LOTS  
(2.5+ AC)

Detention /  
Water  
Quality

25' Buffer / Trail

FLOODWAY

Drainage /  
Open  
Space  
Tract

FLOODWAY

Park

FLOODWAY

Detention /  
Water  
Quality

Detention /  
Water  
Quality

PARCEL A  
(Varies)  
100 Lots

PARCEL C  
(Varies)  
82 Lots

PARCEL B  
(60 by 120-130')  
98 Lots

PARCEL D and E  
(60-70' by 125')  
190 Lots

TOTAL LOTS:  
470

## LEGEND

- 2.5 AC LOTS
- 1 AC LOTS
- <1 AC LOTS
- OPEN SPACE / PARK
- PROPOSED TRAILS

N



**ENTECH**  
ENGINEERING, INC.

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

PRELIMINARY CONCEPT PLAN  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DRAWN:  
LLL

DATE:  
3/31/17

CHECKED:

DATE:

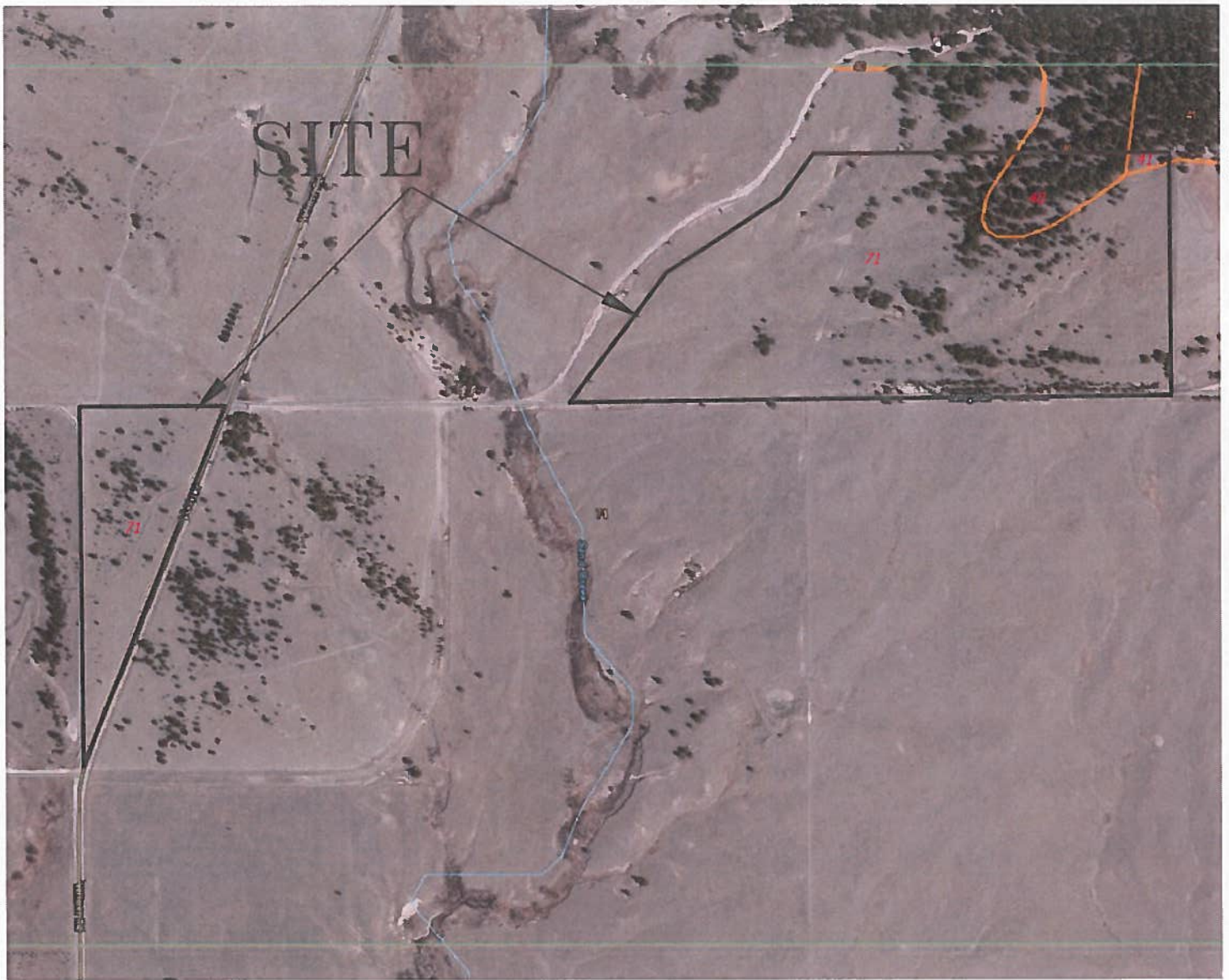
JOB NO.:  
170209

FIG NO.:  
3









**ENTECH**  
ENGINEERING, INC.  
505 ELKTON DRIVE  
COLORADO SPRINGS, CO. 80907 (719) 531-5399

SOIL SURVEY MAP  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DRAWN:  
LLL

DATE:  
3/31/17

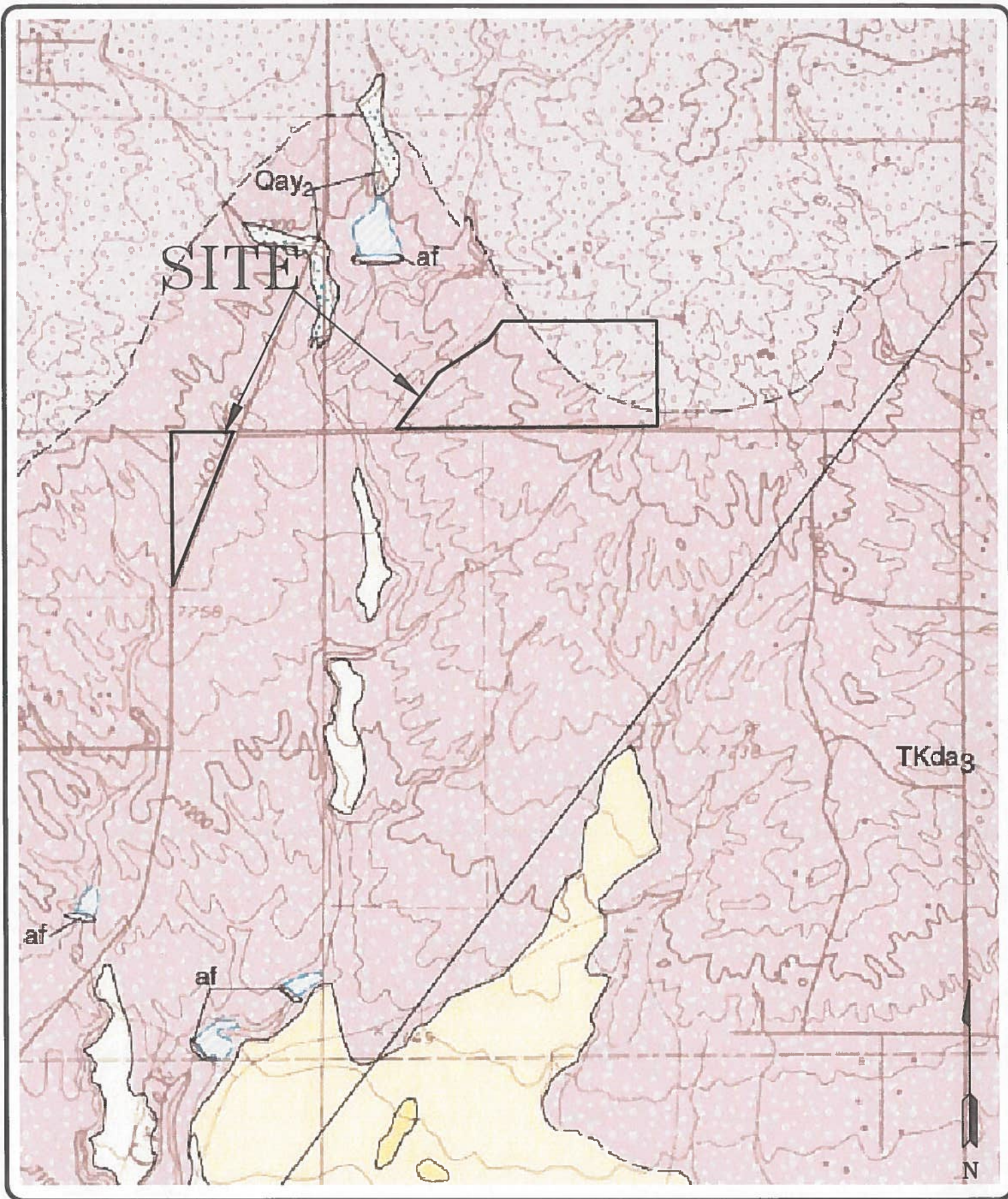
CHECKED:

DATE:

JOB NO.:  
170209

FIG NO.:  
5





**ENTECH**  
ENGINEERING, INC.  
505 ELKTON DRIVE  
COLORADO SPRINGS, CO. 80907 (719) 531-5399

FALCON NW QUADRANGLE GEOLOGY MAP  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DRAWN:  
LLL

DATE:  
3/31/17

CHECKED:

DATE:

JOB NO.:  
170209

FIG NO.:  
6







LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, AV, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually short flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decreed. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE AV Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot, or with discharge areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Base Flood Elevation line and velocity elevation in feet

Base Flood Elevation value where uniform within area; elevation in feet

Referenced to the National Geodetic Vertical Datum of 1929

Trans section line

Traced line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

1000-meter Universal Transverse Mercator grid tick values, zone 4

5000-foot grid tick values: 11wall State Plane coordinate system, zone 3 (FIPSZONE 5103), Transverse Mercator projection

Bench mark (see explanation in Notes to Users section of this FRM) panel

Coastal mile marker

M 2

MAP REPOSITORY

Refer to listing of Map Repositories on Map Index

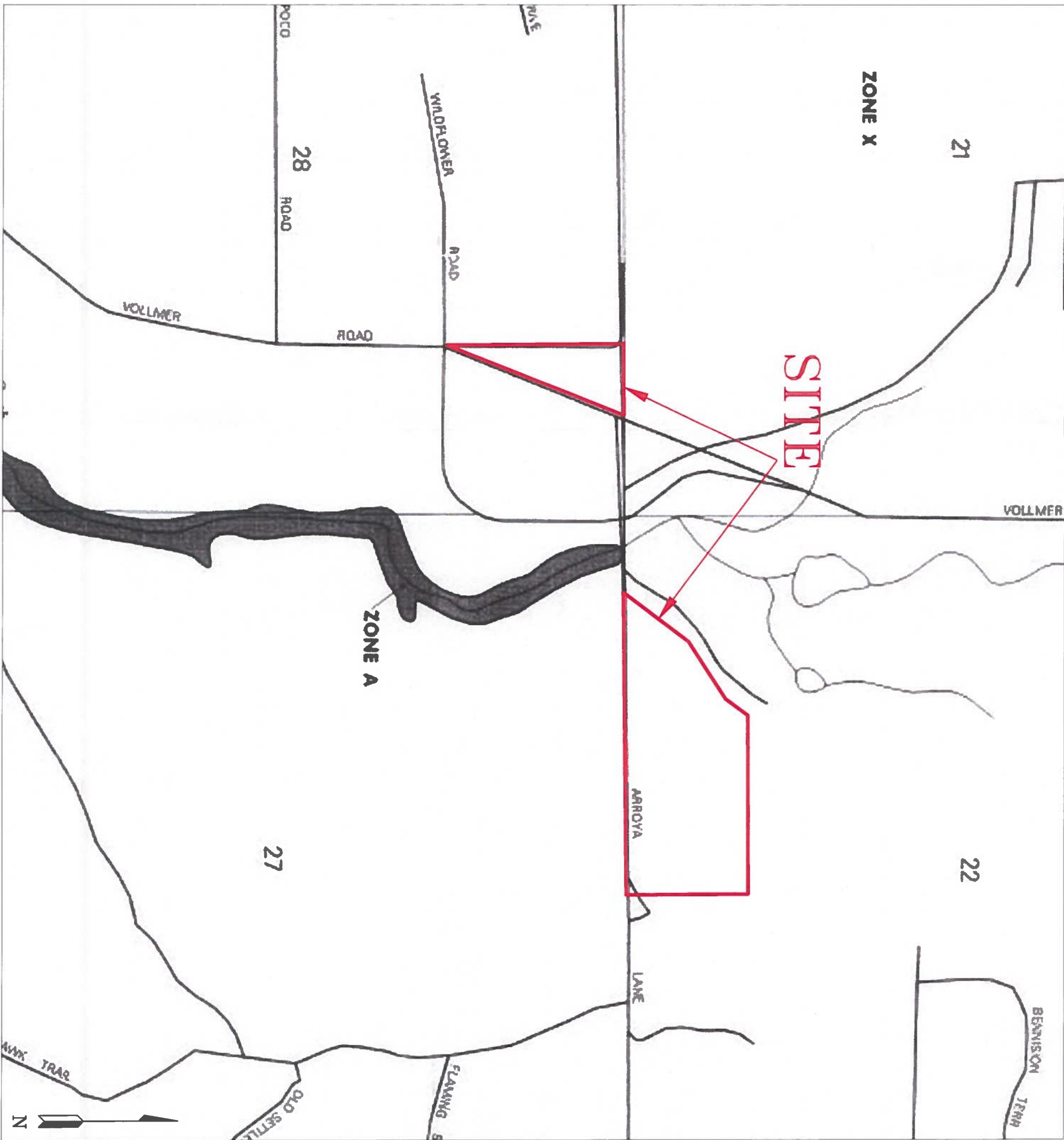
EFFECTIVE DATE OF COUNTWIDE

FLOOD INSURANCE RATE MAP

November 20, 2000

EFFECTIVE DATES OF REVISIONS TO THIS PANEL

September 30, 2004 - to change Special Flood Hazard Areas, to update map format, to reflect revised shoreline and to incorporate previously issued Letters of Map Revision.



REVISION BY




**ENTECH**  
ENGINEERING, INC.

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

FLOODPLAIN MAP  
THE RETREAT AT TIMBER RIDGE  
VOLLMER ROAD AND ARROYA LANE  
EL PASO COUNTY, CO.  
FOR: ARROYA INVESTMENTS

DATE  
CHECKED

DATE

DATE

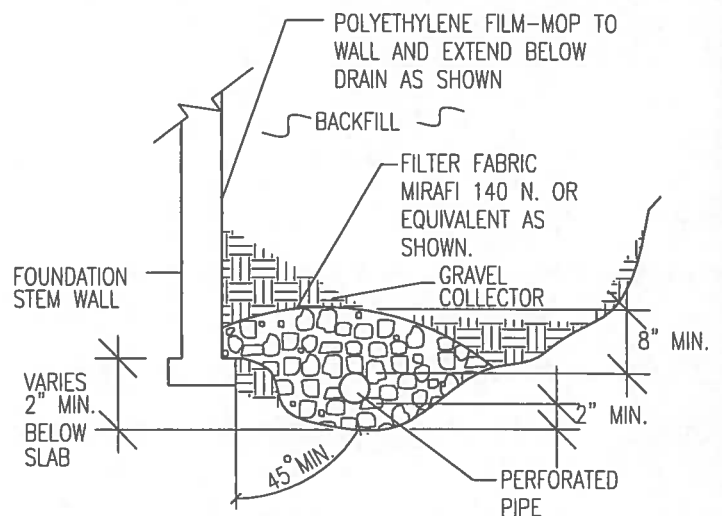
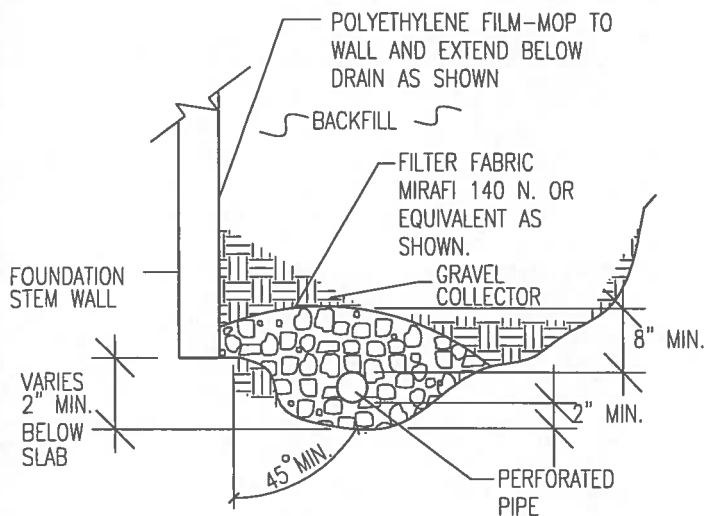
DATE

DATE

DATE

DATE

DATE



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

#### PERIMETER DRAIN DETAIL

DRAWN:

DATE:

DESIGNED:

DS

CHECKED:

LLL

JOB NO.:

170209

FIG NO.:

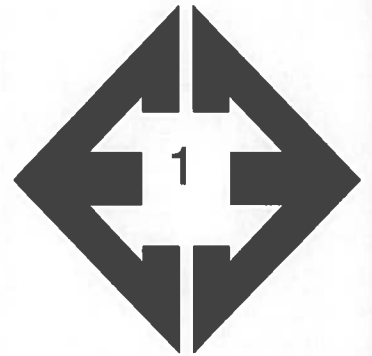
9





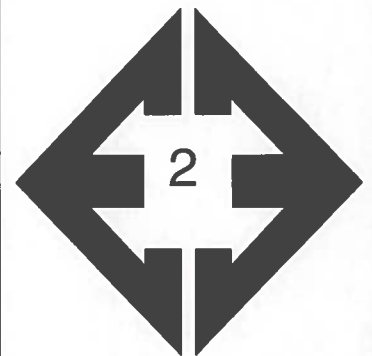


## **APPENDIX A: Site Photographs**



**Looking east from the  
southern portion of the  
site.**

March 9, 2017



**Looking north from the  
southern portion of the  
site.**

March 9, 2017





**Looking northeast  
from the southwestern  
portion of the site on  
the north side of  
Arroya Lane.**

March 9, 2017



**Looking west central  
portion of the site.**

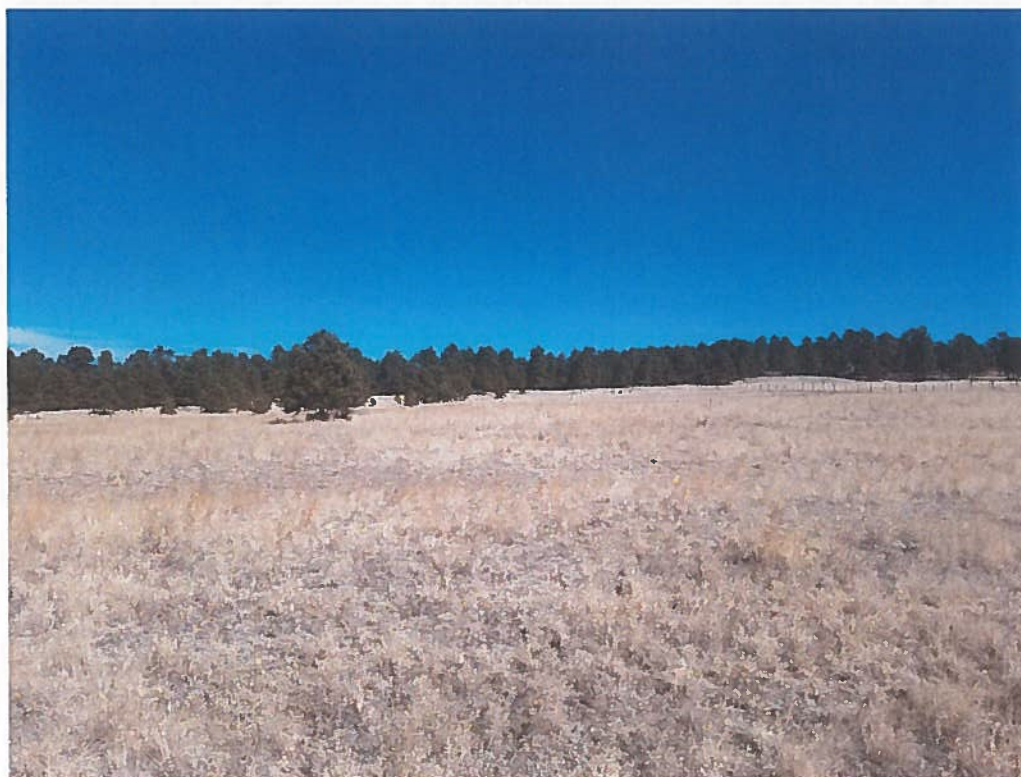
March 9, 2017





**Looking east from the  
area of Profile Hole No.  
2.**

March 9, 2017



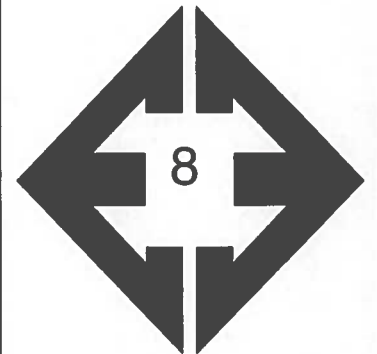
**Looking north from the  
southeast portion of  
the site.**

March 28, 2017



**Looking east from the  
northwestern portion  
of the western lots  
towards Arroya Lane.**

March 28, 2017



**Looking south from  
the central portion of  
the western lots along  
Vollmer Road.**

March 28, 2017

**APPENDIX B: Test Boring Logs from the Profile Holes  
and Test Pit Logs**

PROFILE HOLE NO. 1  
 DATE DRILLED 2/16/2017  
 Job # 170209

PROFILE HOLE NO. 2  
 DATE DRILLED 2/16/2017  
 CLIENT ARROYA INVESTMENTS  
 LOCATION THE RETREAT AT TIMBER RIDGE

REMARKS

DRY TO 14.5', 2/17/17

SAND, CLAYEY, FINE GRAINED,  
 GREEN BROWN, DENSE, MOIST

SANDSTONE, VERY CLAYEY TO  
 CLAYEY, FINE TO COARSE  
 GRAINED, GREEN BROWN,  
 VERY DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			30	13.0	
			50	13.1	
			11"		
10			50	13.4	
			7"		
15			50	9.2	
			7"		
20					

REMARKS

DRY TO 14', 2/17/17

SAND, SLIGHTLY SILTY, FINE  
 TO COARSE GRAINED, TAN,  
 MEDIUM DENSE TO LOOSE,  
 MOIST

SANDSTONE, CLAYEY, FINE  
 GRAINED, TAN, VERY DENSE,  
 MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			19	2.3	
			7	7.4	
10			6	5.5	
15			50	12.5	
20					



**ENTECH**  
 ENGINEERING, INC.

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

PROFILE HOLE LOG

DRAWN:

DATE:

CHECKED:

DATE:

LLL

3/31/17

JOB NO.:

170209

FIG NO.:

B-1

TEST PIT NO. 1  
 DATE EXCAVATED 2/15/2017  
 Job # 170209

TEST PIT NO. 2  
 DATE EXCAVATED 2/15/2017  
 CLIENT ARROYA INVESTMENTS  
 LOCATION VOLLMER ROAD & ARROYA LANE

REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil, sandy loam, brown	1	*		gr	w	2A	topsoil, sandy loam, brown	1	*		gr	w	2a
weathered to formational silty sandstone, fine to coarse grained, reddish-tan	2			ma		4	gravelly loamy sand, fine to coarse grained, tan	2			sg		1
	3						weathered silty sandstone, fine to coarse grained, reddish-tan	3			ma		4
	4						sandy claystone, olive-gray	4			ma		4A
	5							5					
	6							6					
	7							7					
	8							8					
	9							9					
	10							10					

Soil Structure Shape

granular - gr  
 platy - pl  
 blocky - bl  
 prismatic - pr  
 single grain - sg  
 massive - ma

Soil Structure Grade

weak - w  
 moderate - m  
 strong - s  
 loose - l



**ENTECH**  
**ENGINEERING, INC.**

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

**TEST PIT LOG**

DRAWN:

DATE:

CHECKED:

DATE:  
 3/31/17

JOB NO.:

170209

FIG NO.:

B-2

TEST PIT NO. 3  
 DATE EXCAVATED 3/28/2016  
 Job # 170209

TEST PIT NO.  
 DATE EXCAVATED  
 CLIENT ARROYA INVESTMENTS  
 LOCATION VOLLMER ROAD & ARROYA LANE

REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type	REMARKS	Depth (ft)	Symbol	Samples	Soil Structure Shape	Soil Structure Grade	USDA Soil Type
topsoil, sandy loam, brown	1			gr	w	2A		1					
gravelly loamy sand, fine to coarse grained, tan	2			sg		1		2					
	3							3					
	4							4					
sandy clay loam, very fine to coarse grained, tan-gray	5			ma		3A		5					
weathered clayey sandstone, very fine to coarse grained, tan-gray	6			ma		4A		6					
	7							7					
siltstone, very fine to fine grained, tan to reddish-tan	8			ma		4A		8					
	9							9					
	10							10					

#### Soil Structure Shape

granular - gr  
 platy - pl  
 blocky - bl  
 prismatic - pr  
 single grain - sg  
 massive - ma



**ENTECH  
 ENGINEERING, INC.**

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

#### TEST PIT LOG

DRAWN:

DATE:

CHECKED:

DATE:  
 3/31/17

JOB NO.:

170209

FIG NO.:

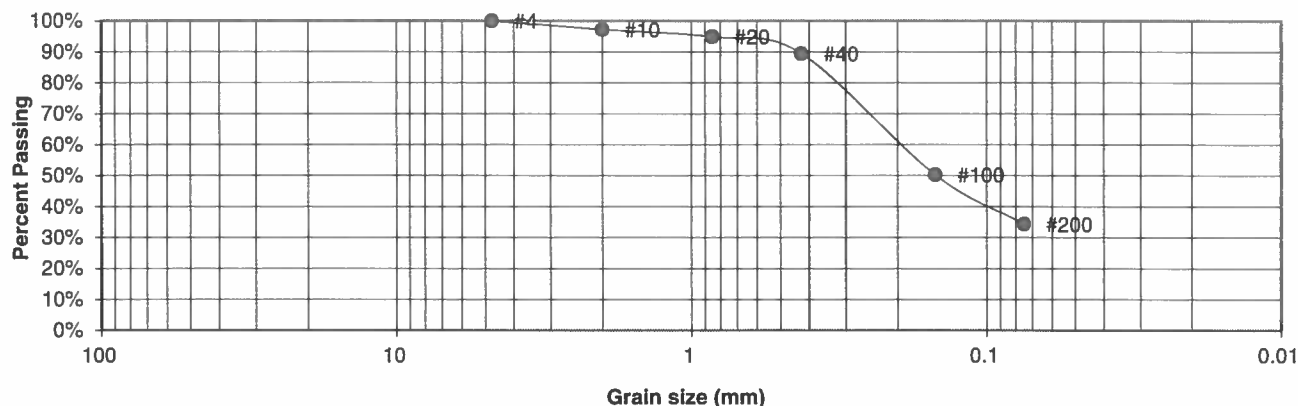
B-3

## **APPENDIX C: Laboratory Test Results**



BORING NO.	1	UNIFIED CLASSIFICATION	SC	TEST BY	BL
DEPTH(ft)	2-3	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				

### Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.2%
20	94.9%
40	89.5%
100	50.3%
200	34.3%

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:

LL

3/31/17

JOB NO.:

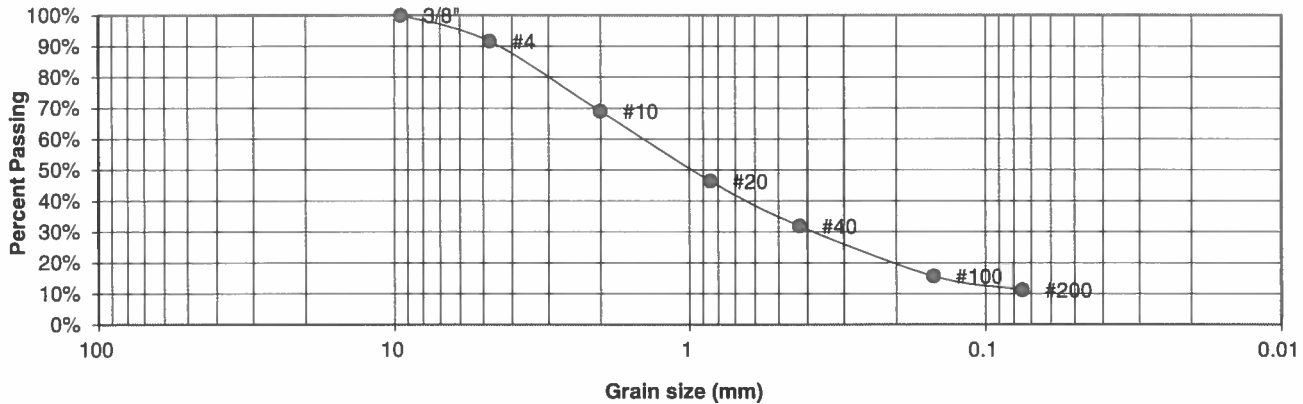
170209

FIG NO.:

C-1

BORING NO.	2	UNIFIED CLASSIFICATION	SM-SW	TEST BY	BL
DEPTH(ft)	2-3	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				

### Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.6%
10	69.0%
20	46.4%
40	31.9%
100	15.7%
200	11.2%

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:

LL

3/31/17

JOB NO.:

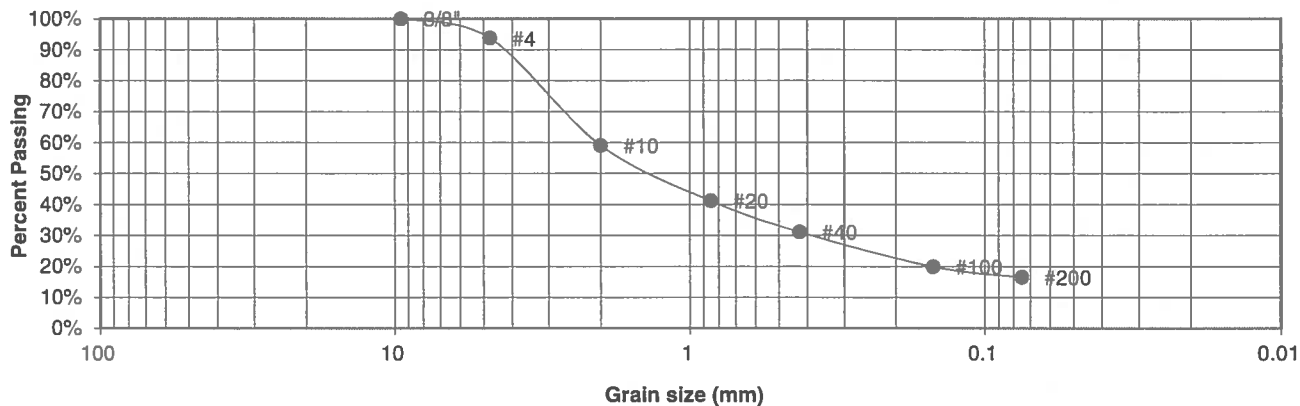
170209

FIG NO.:

C-2

BORING NO.	TP-3	UNIFIED CLASSIFICATION	SM	TEST BY	BL
DEPTH(ft)	4-5	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				

### Sieve Analysis Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	59.1%
20	41.1%
40	31.1%
100	19.9%
200	16.4%

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:

LL

3/31/17

JOB NO.:

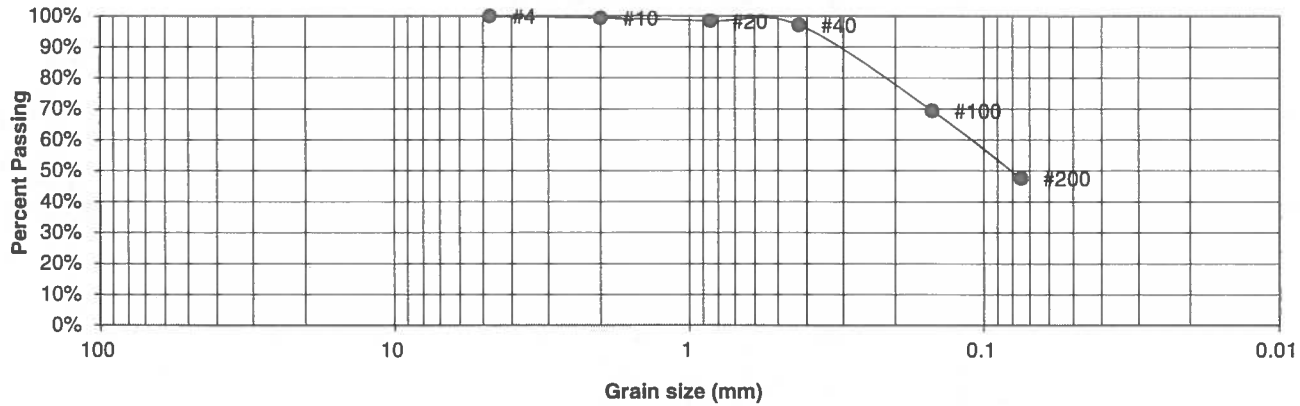
170209

FIG NO.:

C-3

BORING NO.	1	UNIFIED CLASSIFICATION	SC	TEST BY	BL
DEPTH(ft)	5	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				

**Sieve Analysis  
Grain Size Distribution**



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.4%
20	98.4%
40	97.1%
100	69.4%
200	47.6%

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:

LL

3/31/17

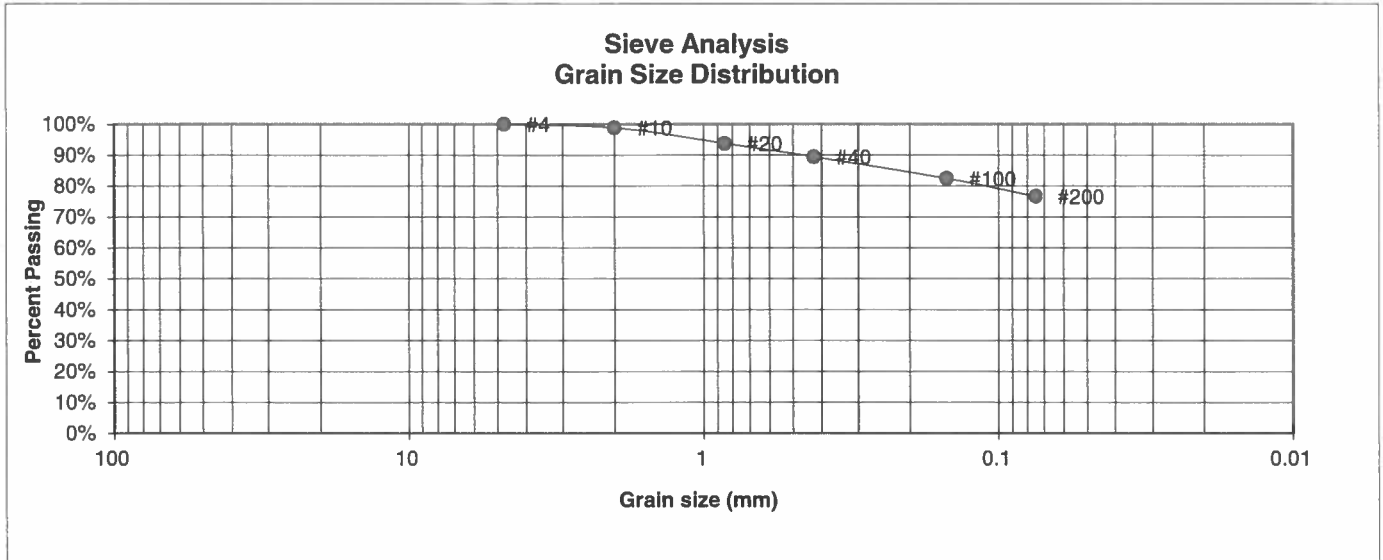
JOB NO.:

170209

FIG NO.:

C-4

BORING NO.	TP-2	UNIFIED CLASSIFICATION	CL	TEST BY	BL
DEPTH(ft)	5-6	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.9%
20	93.8%
40	89.4%
100	82.4%
200	76.6%

Atterberg  
Limits  
Plastic Limit  
Liquid Limit  
Plastic Index

<u>Swell</u>	
Moisture at start	11.5%
Moisture at finish	20.8%
Moisture increase	9.4%
Initial dry density (pcf)	103
Swell (psf)	1280



**ENTECH  
ENGINEERING, INC.**

505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

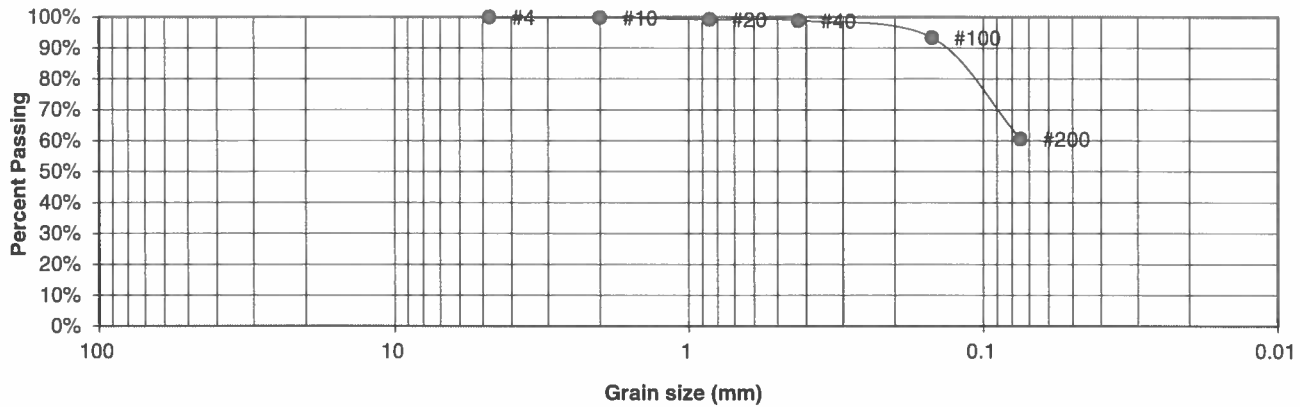
### LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LL	3/3/17

JOB NO.:  
170209  
FIG NO.:  
C-5

BORING NO.	TP-3	UNIFIED CLASSIFICATION	CL	TEST BY	BL
DEPTH(ft)	6-8	AASHTO CLASSIFICATION		JOB NO.	170209
CLIENT	ARROYA INVESTMENTS				
PROJECT	THE RETREAT AT TIMBER RIDGE				

**Sieve Analysis  
Grain Size Distribution**



U.S.  
Sieve #

Percent  
Finer

Atterberg

Limits

Plastic Limit

Liquid Limit

Plastic Index

3"

1 1/2"

3/4"

1/2"

3/8"

4

100.0%

10

99.8%

20

99.3%

40

98.9%

100

93.3%

200

60.6%

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:

L L L

3/31/17

JOB NO.:

170209

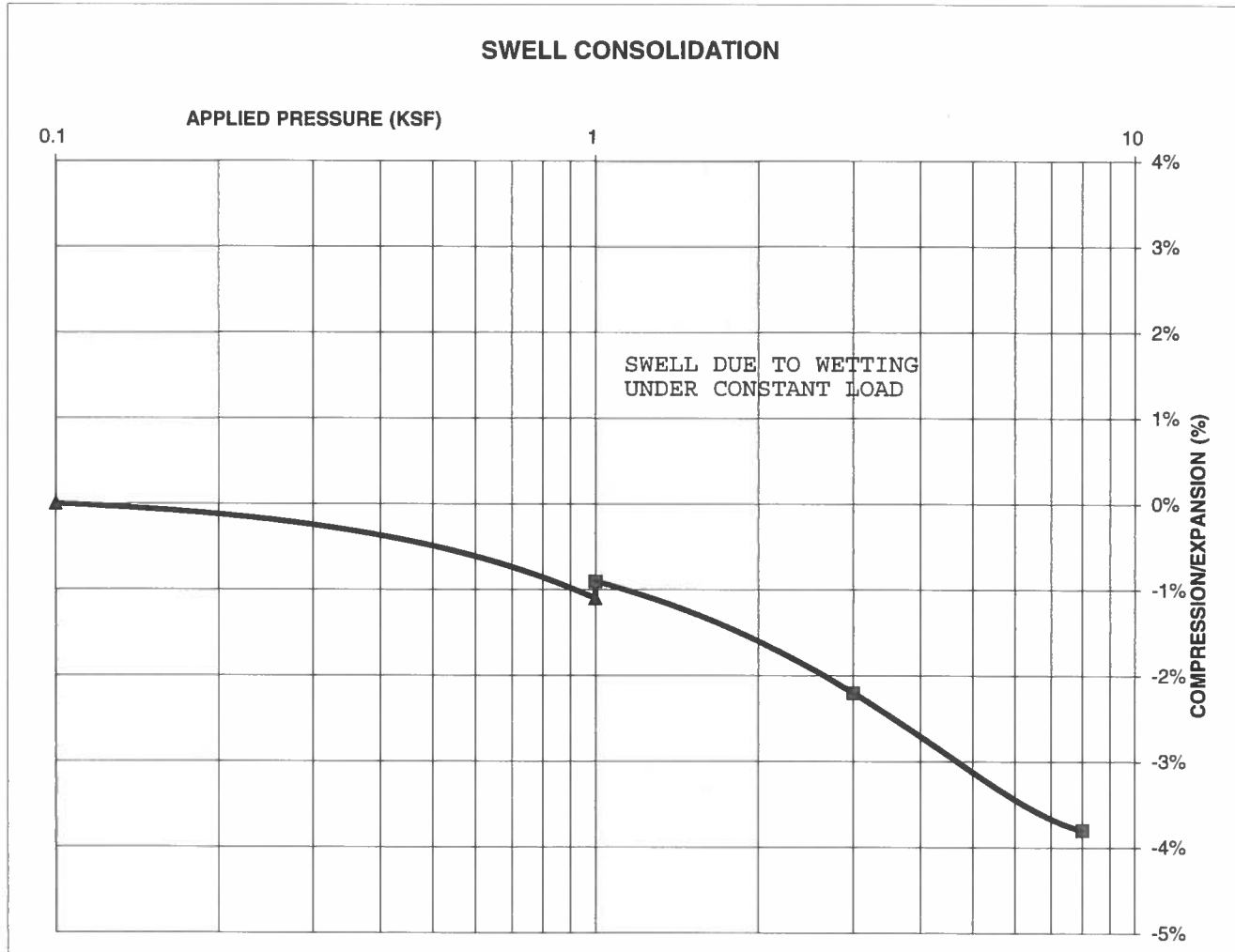
FIG NO.:

C-6

### CONSOLIDATION TEST RESULTS

SAMPLE FROM:	1	DEPTH(ft)	5
DESCRIPTION	SAND, VERY CLAYEY		
NATURAL UNIT DRY WEIGHT (PCF)	108		
NATURAL MOISTURE CONTENT	14.9%		
SWELL/CONSOLIDATION (%)	0.2%		

JOB NO.	170209
CLIENT	ARROYA INVESTMENTS
PROJECT	THE RETREAT AT TIMBER RIDGE



**ENTECH  
ENGINEERING, INC.**

505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

### SWELL CONSOLIDATION TEST RESULTS

DRAWN:

DATE:

CHECKED:

DATE:

LLL

3/31/17

JOB NO.:  
170209

FIG NO.:  
C-7

## **APPENDIX D: Soil Survey Descriptions**



## El Paso County Area, Colorado

### 40—Kettle gravelly loamy sand, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* 368g

*Elevation:* 7,000 to 7,700 feet

*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Kettle and similar soils:* 85 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Kettle

##### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Sandy alluvium derived from arkose

##### Typical profile

*E - 0 to 16 inches:* gravelly loamy sand

*Bt - 16 to 40 inches:* gravelly sandy loam

*C - 40 to 60 inches:* extremely gravelly loamy sand

##### Properties and qualities

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Somewhat excessively 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 storage in profile:* Low (about 3.4 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4e

*Hydrologic Soil Group:* B

*Hydric soil rating:* No

#### Minor Components

##### Other soils

*Percent of map unit:*

*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

**Data Source Information**

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 14, Sep 23, 2016

## El Paso County Area, Colorado

### 41—Kettle gravelly loamy sand, 8 to 40 percent slopes

#### Map Unit Setting

*National map unit symbol:* 368h

*Elevation:* 7,000 to 7,700 feet

*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Kettle and similar soils:* 85 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Kettle

##### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Sandy alluvium derived from arkose

##### Typical profile

*E - 0 to 16 inches:* gravelly loamy sand

*Bt - 16 to 40 inches:* gravelly sandy loam

*C - 40 to 60 inches:* extremely gravelly loamy sand

##### Properties and qualities

*Slope:* 8 to 40 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Somewhat excessively drained

*Runoff class:* Medium

*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 storage in profile:* Low (about 3.4 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 7e

*Hydrologic Soil Group:* B

*Hydric soil rating:* No

#### Minor Components

##### Other soils

*Percent of map unit:*

*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

**Data Source Information**

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 14, Sep 23, 2016

## El Paso County Area, Colorado

### 71—Pring coarse sandy loam, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* 369k

*Elevation:* 6,800 to 7,600 feet

*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Pring and similar soils:* 85 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Pring

##### Setting

*Landform:* Hills

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Arkosic alluvium derived from sedimentary rock

##### Typical profile

*A - 0 to 14 inches:* coarse sandy loam

*C - 14 to 60 inches:* gravelly sandy loam

##### Properties and qualities

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* More than 80 inches

*Natural 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 storage in profile:* Low (about 6.0 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Ecological site:* Loamy Park (R048AY222CO)

*Hydric soil rating:* No

#### Minor Components

##### Pleasant

*Percent of map unit:*

*Landform:* Depressions

*Hydric soil rating:* Yes

**Other soils**

*Percent of map unit:*

*Hydric soil rating:* No

**Data Source Information**

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 14, Sep 23, 2016



## **APPENDIX E: Percolation Test Results**

Client: Arroya Investments  
Test Location: The Retreat at Timber Ridge

Job Number: 170209

## PERCOLATION HOLES - #1

Date Holes Prepared: 2/16/2017

Date Hole Completed: 2/17/2017

Hole No. 1

Depth: 34"

<u>Trial</u>	<u>Time (min.)</u>	<u>Water Level Change (in.)</u>
1	10	1/8
2	10	0
3	10	1/8

Hole No. 2

Depth: 36"

<u>Trial</u>	<u>Time (min.)</u>	<u>Water Level Change (in.)</u>
1	10	0
2	10	0
3	10	1/8

Hole No. 3

Depth: 34"

<u>Trial</u>	<u>Time (min.)</u>	<u>Water Level Change (in.)</u>
1	10	0
2	10	0
3	10	0

Perc Rate (min./in.): 80

Perc Rate (min./in.): 80

Perc Rate (min./in.): 240

Average Perc Rate (min./in.) 133

## PROFILE HOLE

Date Profile Hole Completed: 2/16/2017

Depth

0-3'

3-15'

Visual Classification

Sand, clayey, fine grained, green brown

Sandstone, very clayey, fine grained, green brown

Remarks

Sandstone Bedrock at 3'  
No Groundwater

30 Blows / ft. @ 2'  
50 Blows / 11" @ 4'  
50 Blows / 7" @ 9'

LTAR = 0.1 gallons per square foot per day.

Remarks:

\* - Due to slow percolation rate and shallow bedrock, a designed system or additional drilling is recommended

GPS Coordinates: 38° 59' 03.3" N, 104° 39' 17.6" W

Observer: Graham Espenlaub

By:



**ENTECH**  
**ENGINEERING, INC.**

505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

## PERCOLATION TEST RESULTS

DRAWN:

DATE:

CHECKED:  
LLL

DATE:  
3/31/17

JOB NO.:

170209

FIG NO.:

E-1

Client: Arroya Investments  
Test Location: The Retreat at Timber Ridge

Job Number: 170209

## PERCOLATION HOLES - #2

Date Holes Prepared: 2/16/2017

Date Hole Completed: 2/17/2017

Hole No. 1

Depth: 36"

	Time (min.)	Water Level Change (in.)
Trial		
1	10	1/8
2	10	0
3	10	1/8

Hole No. 2

Depth: 36"

	Time (min.)	Water Level Change (in.)
Trial		
1	10	1/8
2	10	3/8
3	10	3/8

Hole No. 3

Depth: 31"

	Time (min.)	Water Level Change (in.)
Trial		
1	10	7/8
2	10	5/8
3	10	3/8

Perc Rate (min./in.): 80

Perc Rate (min./in.): 27

Perc Rate (min./in.): 27

Average Perc Rate (min./in.): 44

## PROFILE HOLE

Date Profile Hole Completed: 2/16/2017

Depth

0-14'

14-15'

Visual Classification

Sand, slightly silty, fine to coarse grained, tan

Sandstone, clayey, fine to coarse grained, brown

Remarks

Sandstone Bedrock at 14'  
No Groundwater

19 Blows / ft. @ 2'

7 Blows / ft. @ 4'

6 Blows / ft. @ 9'

LTAR = 0.35 gallons per square foot per day.

Soil Treatment Area (Soil Type 3) = 2.7 square feet per gallon.

Remarks:

GPS Coordinates: 38° 59' 07.0" , 104° 39' 29.2" W

Observer: Graham Espenlaub

By:



**ENTECH**  
**ENGINEERING, INC.**

505 ELKTON DRIVE  
COLORADO SPRINGS, COLORADO 80907

## PERCOLATION TEST RESULTS

DRAWN:

DATE:

CHECKED:  
L L L

DATE:  
3/31/17

JOB NO.:

170209

FIG NO.:

E-2