

April 8, 2024

The Equity Group  
90 South Cascade Avenue, Suite 1500  
Colorado Springs, Colorado 80903

Attention: Kelly Nelson

Subject: Review Comment Response  
Geologic Hazards Evaluation and  
Preliminary Geotechnical Investigation  
Crossroads North  
Marksheffel Road and State Highway 24  
El Paso County, Colorado  
Project No. CS18526.001-105

This letter presents our response to review comments regarding our Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for Crossroads North, located in El Paso County, Colorado. The following discussion provides specific items from comments and our responses.

Review Comment, in blue on first page of CTL|T GHE Review Comment Response letter, dated July 12, 2021:

“Update to provide a recommendation for retaining walls shown in developed condition.”

Review Comment in blue on Sheet 8 of 15 of the Crossroads North Early Grading and Erosion Control Plans, prepared by MS Civil Consultants, Inc., dated August 2023:

“Based on the offset between tiered walls the retaining wall design the design does not meet the two highlighted sections of the Pikes Peak Regional Building Code Section RBC105.2.1 and will require building permit through PPRBD.

Provide a reference to the retaining wall construction plans and submit a copy of the retaining plans to regional building for review and approval.

The early grading plans will not be approved until the retaining wall plans are approved.

Unresolved from review 3 and 4.”

CTL/T Response:

We understand that there are retaining walls planned for the development and that some of the walls may be built during the first phase of early grading along Highway 24. The final design has not been developed and information on the number of walls, final location, size, or type of walls was unavailable. A typical gravity block retaining wall section is included on Sheet 8 of 15; however, this detail was provided by a wall manufacturer, not the project wall designer, and designs will vary based on height, surcharges, number of tiers, back slopes, and other factors.

Retaining walls should be designed in conformance with local codes. Retaining walls over 4 feet in exposed height, and retaining walls that are subjected to surcharge loading, such as that exerted by a tiered retaining wall system, should be designed by a professional engineer. Retaining walls designed by a professional engineer should include global stability analysis as part of their design. Part of the retaining wall design process should be a site specific, design-level geotechnical investigation, and should be provided as part of the future site development plan design.

Review Comment, in green on cover sheet of Kimley Horn Preliminary Plan, print date January 10, 2024:

“Previous comments have not been addressed regarding soils & geology notes.”

“These geologic constraints also need to be depicted on the plan.”

“Update this note to the standard format for Soil and Geology Conditions...”

These comments appear to be regarding the Soils & Geology Conditions, Constraints & Hazards Note 2, which reads:

*“There are no significant Geological Hazards; however, the potential for geologic constraints do exist related to the potential for shallow groundwater tables, expansive clay or clayey sandstone, erodible sandy soils. These geological conditions are considered relatively common to the area with mitigation accomplished by implementing common engineering and construction practices. If the previously listed potential Geological Hazards are found to exist, an evaluation shall be performed at the time of final geotechnical investigation for those individual lots.*”

*We did not identify Geologic Hazards that we believe precluded development of the site. The conditions identified at the site that may pose constraints to development included the presence of potentially hydro-compactive soils, existing fill stockpiles, and erosion. Regional geologic conditions that impact the site include seismicity and radioactivity. We believe each of these conditions can be mitigated with engineering design and construction methods commonly employed in this area. \*\**

*\*\* Refer to the soils report for more detailed information.”*

### CTL|T Response:

The information in the second paragraph of Note 2 accurately reflects the Geologic Hazards identified in the Geologic Hazards Evaluation and Preliminary Geotechnical Investigation (CTL|T Project No. CS18526.001-105, dated October 6, 2020). However, the information in the first paragraph is incorrect and was not contained in our report. We recommend removal of the information in the first paragraph of Note 2.

Existing fill stockpiles are mapped on Fig. 2 of the report and labeled as map unit “af”. Potentially hydro-compactive soils may be present anywhere within the development and cannot be mapped with any reasonable degree of accuracy. Attempting to map hydro-compactive soils within the site would falsely suggest the potential presence in some areas and not within other areas.

The standard formatting of Note 2 was provided, and a revision of Note 2 to comply with the standard formatting could look something like this:

The entirety of the proposed development may be impacted by geologic hazards. Mitigation measures and a map of the hazard area can be found in the report “Geologic Hazards Evaluation and Preliminary Geotechnical Investigation Crossroads North”, by CTL|Thompson, Inc., CTL|T Project No. CS18526.001-105, dated October 6, 2020), in file [NAME OF FILE AND FILE NUMBER] available at the El Paso County Planning and Community Development Department:

- Potentially hydro-compactive soils: may be present anywhere within the entire development. Site-specific, design-level geotechnical investigations performed for each planned structure should address the behavior of the on-site sands when wetted.
- Existing fill stockpiles: various locations shown on report Fig. 2 – Surficial Geologic Map, and labeled as map unit “af”.

### **LIMITATIONS**

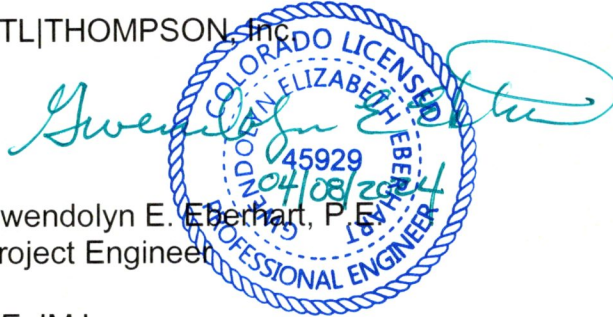
This letter has been prepared for the exclusive use of The Equity Group for the purpose of reviewing existing documentation to determine the suitability of fill

on site for the proposed development. We believe this investigation was conducted with that level of skill and care normally used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this letter, please call.

Sincerely yours,

CTL|THOMPSON, INC



The seal is circular with a rope-like border. The text inside the seal reads: "COLORADO LICENSED PROFESSIONAL ENGINEER" around the top and bottom edges. In the center, it says "Gwendolyn E. Eberhart" and "45929". A date "2014/08/20" is stamped across the seal.

Gwendolyn E. Eberhart, P.E.  
Project Engineer

Reviewed By:



Jeffrey M. Jones, P.E.  
Associate Engineer

GE:JMJ:cw

Via email: [kelly@theequitygroup.net](mailto:kelly@theequitygroup.net)  
[Jim.Houk@kimley-horn.com](mailto:Jim.Houk@kimley-horn.com)

July 12, 2021

The Equity Group  
90 South Cascade Avenue, Suite 1500  
Colorado Springs, Colorado 80903

Attention: Kelly Nelson

Subject: Review Comment Response  
Geologic Hazards Evaluation  
Preliminary Geotechnical Investigation  
Crossroads North  
Marksheffel Road and State Highway 24  
El Paso County, Colorado  
Project No. CS18526.001-105

This report letter presents our response to the Colorado Geological Survey (CGS) review comments regarding our Preliminary Geotechnical Investigation. The following discussion provides specific items from the CGS comments and our responses.

CGS Comment:

“CGS received grading plans with this submittal, while CTL|Thompson indicated they did not review such plans. CGS recommends that the county or developer provide CTL|Thompson with grading plans, and they review the plans for conformance with the geotechnical report recommendations. The geotechnical report states that eolian soils underlie the site. Once wetted and loaded, such soils can settle and cause damages to buildings, pavements, and other infrastructure. CTL|Thompson indicates that the risks to proposed structures form hydrocompactive soils are low for lightly to moderately load structures (one to two-story buildings). The report contains limited soil testing to determine the risk or degree of the potential of hydrocompaction.”

CTL Response:

We have received the preliminary grading plans from Kimley-Horn. As the CGS notes, the sands that underlie the site have the potential to be hydro-compactive. Based on the testing data available on the site the soils classify as having low to moderate collapse potential using the criteria from CGS publication EG-14 “Collapsible Soils in Colorado,” Fig. 4-13. The soils with the higher potentials are generally spread across the site. Limited testing was preformed because the lack of fines and low moisture contents in the natural sands precluded

most of the samples from being suitable for swell/consolidation testing, due to a lack of structure in the soil matrix.

We provided a brief discussion of possible mitigation options in our report. Based on the preliminary grading plans portions of the site will have significant amounts of fill in excess of 15-feet. Deep fill could help mitigate potential differential movements if settlement of natural soils were to occur below the fill. The possible presence of potentially hydro-compactive soils should be further addressed at the time of the design level reports. We did not find any contradictory conditions based on our review of the preliminary grading plans, and hold that the findings of the Preliminary Geotechnical Investigation and Geologic Hazard Evaluation remain valid for the site.

## LIMITATIONS

This letter has been prepared for the exclusive use of The Equity Group for the purpose of reviewing existing documentation to determine the suitability of fill on site for the proposed development. We believe this investigation was conducted with that level of skill and care normally used by geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this letter, please call.

Sincerely yours,

CTL | THOMPSON, Inc

Gwendolyn E. Eberhart, P.E.  
Project Engineer



Reviewed By:

A handwritten signature in blue ink, appearing to read "Timothy A. Mitchell".

Timothy A. Mitchell, P.E.  
Division Manager

GE:TAM:ge

Via email: [kelly@theequitygroup.net](mailto:kelly@theequitygroup.net)  
[Jim.Houk@kimley-horn.com](mailto:Jim.Houk@kimley-horn.com)

**GEOLOGIC HAZARDS EVALUATION AND  
PRELIMINARY GEOTECHNICAL INVESTIGATION  
CROSSROADS NORTH  
MARKSHEFFEL ROAD & STATE HIGHWAY 24  
EL PASO COUNTY, COLORADO**

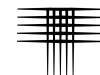
Prepared for:

THE EQUITY GROUP  
90 South Cascade Avenue, Suite 1500  
Colorado Springs, Colorado 80903

Attention: Kelly Nelson

CTL|T Project No. CS18526.001-105

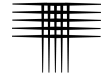
October 6, 2020



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FIG. 4 – PASSIVE DRAIN DETAIL

FIG. 5 – ACTIVE DRAIN DETAIL

APPENDIX A – SUMMARY LOGS OF EXPLORATORY BORINGS

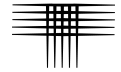
APPENDIX B – LABORATORY TEST RESULTS

TABLE B-1: SUMMARY OF LABORATORY TESTING

APPENDIX C – GUIDELINE SITE GRADING SPECIFICATIONS

CROSSROADS NORTH

EL PASO COUNTY, COLORADO

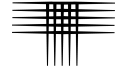


## SCOPE

This report presents the results of our Geologic Hazards Evaluation and Preliminary Geotechnical Investigation for the Crossroads North development in El Paso County, Colorado. The investigated parcel is planned for mixed commercial development. Our purpose was to evaluate the parcel for the occurrence of geologic hazards that may impact development of the site, and to provide preliminary geotechnical design concepts. This report includes a summary of subsurface and groundwater conditions found in our exploratory borings, a description of our engineering analysis of the geologic conditions at the site, and our opinion of the potential influence of the geologic hazards on the planned structures and other site improvements. The scope of our services for the preliminary evaluation was described in our proposal (CS-15-0132) dated November 4, 2015. This report is a revision of our original report CS18526.000 (dated June 14, 2016), which was written for an industrial development. The scope of our revised services was described in our proposal CS-20-0126 dated September 2, 2020.

The report was prepared based on conditions interpreted from field reconnaissance of the site, conditions found in our exploratory borings, results of laboratory tests, engineering analysis, and our experience. Observations made during grading or construction may indicate conditions that require revision or re-evaluation of some of the criteria presented in this report. The criteria presented are for the development as described. Revision in the scope of the project could influence our recommendations. If changes occur, we should review the development plans and the effect of the changes on our preliminary design criteria. Evaluation of the property for the possible presence of potentially hazardous materials (Environmental Site Assessment) was beyond the scope of this investigation. Assessment of the site for the potential for wildfire hazards, corrosive soils, erosion problems, or flooding is also beyond the scope of this investigation.

The following section summarizes the report. A more complete description of the conditions found at the site, our interpretations, and our recommendations are included in the report.

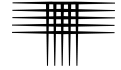


## SUMMARY

1. We identified no geologic hazards that we believe preclude development of the site for construction of the planned, mixed-commercial development. The presence of some potentially hydro-compactive soils at the site, existing fill stockpiles, and erosion, and regional issues of seismicity and naturally-occurring radioactive materials are conditions that may affect the proposed development. These conditions can be mitigated with engineering design and construction methods commonly employed in the area.
2. Subsurface conditions encountered in the nine exploratory borings drilled at the site consisted of natural, slightly silty to silty sand with occasional layers of clayey sand to the maximum depth explored of 25 feet. End-dumped piles of soil were stockpiled at several locations spread across the property.
3. At the time of drilling, groundwater was not encountered in any of the exploratory borings. When water levels were checked again several days after the completion of drilling operations, the borings were again found to be dry. Groundwater levels will vary with seasonal precipitation and landscaping irrigation.
4. In our opinion, site grading and utility installation across the site can be accomplished using conventional, heavy-duty construction equipment.
5. We believe conventional spread footings and mat foundations underlain by the on-site, natural sands and grading fill will be appropriate for lightly to moderately-loaded buildings at the site. Moderately to more heavily-loaded structures may require modification of the near-surface sand soils (sub-excavation and dense compaction under controlled conditions), prior to construction of footing foundations. A deep foundation such as drilled bedrock piers may be an appropriate option for heavily-loaded structures, if the bedrock formation is encountered at a reasonable depth.
6. We believe a low risk of poor, long-term slab performance (movement and damage) will exist for conventional slab-on-grade floors underlain by the natural, on-site sand soils and/or densely compacted, granular fill.
7. Overall plans should provide for the rapid conveyance of surface runoff to the storm drain system and centralized drainage channels.

## SITE CONDITIONS

The Crossroads North property consists of about 40 acres of land located south of the intersection of Marksheffel Road and US Highway 24 (eastern half of Section 8,



Township 14 South, Range 65 West of the 6<sup>th</sup> Principal Meridian) in El Paso County, Colorado. The development plan is shown in Fig. 1.

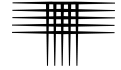
The property is currently undeveloped. The land to the north of the site is developed with small commercial structures. Directly to the south are several undeveloped parcels owned by the City of Colorado Springs. The new Southern Delivery System Water Treatment Plant is situated east of Marksheffel Road. U.S. Highway 24 and Marksheffel Road form the west and east boundaries of the parcel, respectively. The ground surface at the site generally slopes downward at gentle to moderate grades of about 3 to 7 percent from the U.S. Highway 24 right-of-way toward the southeast. The southern edge of the parcel slopes downward to the north and northeast which creates a bowl-like depression near the center of the property. It is our understanding the lots lining the southern edge of the property are owned by the City of Colorado Springs and are in the City limits. The proposed grading plan includes these lots; however, this report only covers areas of the development within the County.

End-dumped mounds of soil are stockpiled at several locations spread across the site (see Fig. 2). The maximum height of the stockpiles is typically about 3 to 5 feet. Vegetation on the property consists primarily of a moderate stand of grasses, weeds, yucca plants, and cactus. Several deciduous trees and two electrically powered wells are present near the center of the site.

## **PROPOSED DEVELOPMENT**

Our original report for this property was for a development of industrial facilities and an automobile recycling center. At the time of our investigation site grading plans were not available for our review.

We understand the property will now be a mixed commercial development. Foundation loads are expected to generally be light to moderate for the anticipated single-story structures. Paved roads will provide access to the various facilities. The site grading plan provided to us includes the parcels to the south of the new roadway, within City limits. It is our understanding the southern parcels are not being developed at this



time, but may be included in the over-lot grading of the development. This report does not address development considerations for the southern parcels.

## **SUBSURFACE INVESTIGATION**

Subsurface conditions at the site were investigated by drilling nine exploratory borings at the approximate locations shown in Fig. 1. At the time of our investigation grading plans were not available and based on the description of the previously planned development the borings were extended to a depth of 25-feet. Graphical logs of the conditions found in our exploratory borings, the results of field penetration resistance tests, and some laboratory data are presented in Appendix A. Gradation test results are shown in Appendix B. Laboratory test data are summarized in Table B-1.

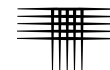
Soil samples obtained during this study were returned to our laboratory and visually classified. Laboratory testing was then assigned to representative samples. Testing included moisture content and dry density, gradation analysis, and water-soluble sulfate content tests.

## **SUBSURFACE CONDITIONS**

Subsurface conditions encountered in the nine exploratory borings drilled at the site consisted of natural, slightly silty to silty sand with occasional layers of clayey sand. Some of the pertinent engineering characteristics of the soils encountered and ground-water conditions are discussed in the following paragraphs.

### **Natural Sand**

The predominant soil encountered in each of the borings consisted of poorly graded, slightly silty to silty sand with occasional layers of clayey sand. The sand layer extended to the maximum depth explored of 25 feet below the existing ground surface. The sand was loose to medium dense based on the results of field penetration resistance tests. Sixteen samples of the sand tested in our laboratory contained 5 to 31 percent clay and silt-sized particles (passing the No. 200 sieve). Our experience indicates the sands are typically non-expansive when wetted.



## **Groundwater**

At the time of drilling, groundwater was not encountered in any of the exploratory borings. When water levels were checked again several days after the completion of drilling operations, the borings were again found to be dry. The moisture contents of the samples obtained from the borings suggest the groundwater level has historically been situated below the elevations of the bottoms of our exploratory borings. Water levels should be expected to fluctuate in response to seasonal precipitation and irrigation of landscaping.

## **SITE GEOLOGY**

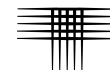
The geology of the site was evaluated for our original report within the county by our Geologist (David A. Glater, P.E, C.P.G) through the review of published geologic maps, field reconnaissance, and exploratory borings spread across the site. Information from these sources was used to produce our interpretation of surficial geologic conditions, as shown in Fig. 2. A list of references is included at the end of this report. The following sections discuss the mapped units.

### **Surficial Deposits**

The surficial deposits encountered at the site consisted of at least 25 feet of slightly silty to silty sand or clayey sand. End-dumped piles of soil were stockpiled at several locations spread across the property. The various deposits are described in more detail in the following sections. Figure 2 summarizes our interpretation of surficial geologic conditions at the site.

Man-made Fill (Map Unit “af”): The areas mapped as Man-made Fill typically consisted of end-dumped piles of sand and clay soils that often contained construction debris. The piles were usually about 3 to 5 feet (or less) in height.

Eolian Deposits (Map Unit “Qes<sub>1</sub>”): A Holocene-age mantle of wind-deposited soil, at least 25 feet thick, is present across the site. These materials consist of slightly silty to clayey sand.



## POTENTIAL GEOLOGIC HAZARDS AND ENGINEERING CONSTRAINTS

We did not identify geologic hazards that we believe preclude development of the site. The conditions identified at the site that may pose hazards or constraints to development include the presence of potentially hydro-compactive soils, existing fill stockpiles, and erosion. Regional geologic conditions that impact the site include seismicity and radioactivity. We believe each of these conditions can be mitigated with engineering design and construction methods commonly employed in this area. These conditions are discussed in greater detail in the sections that follow.

Our interpretation of the surficial geology is presented in Fig. 2 and is described previously. Our interpretation of the engineering conditions is presented in Fig. 3. The engineering geology classification system shown in Fig. 3 is adapted from the classification system of Robinson, 1977 as described below.

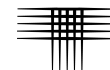
Map Unit 2D depicts eolian deposits generally on flat to gentle slopes of upland areas.

### **Existing Fill Stockpiles**

End-dumped mounds of soil are stockpiled at several locations spread across the site. It may be possible to incorporate portions of the stockpiles that are essentially free of deleterious materials such as construction debris, trash, organic material, etc., into the site grading fill. Geochemical testing of the stockpiles for the presence of potentially hazardous materials is beyond the scope of this investigation.

### **Hydro-Compactive Soils**

Soils that compress/collapse when wetted could be encountered on the site. This potentially detrimental behavior can be mitigated by excavating the soil, moisture conditioning, and placing the material back into the excavation as densely compacted fill, where necessary. Grading may impact the collapse potential of the hydro-compactive soils. Site-specific Geotechnical Investigations performed for each planned structure



should address the behavior of the on-site sands when wetted and provide recommendations for mitigation, as needed.

### **Erosion**

The site contains surficial sandy soils that are susceptible to the effects of wind and water erosion. Concentrated water flow can result in erosion. The surficial soils are relatively stable and resistant to wind erosion where vegetation is established. Disturbance of the vegetative cover and long-term exposure to the erosive power of wind and water increases the potential for erosion. Maintaining vegetative cover and providing engineered surface drainage will reduce the potential for erosion from wind and water.

### **Expansive Bedrock**

The near-surface sand soils are non-expansive. Moderate to high-swelling claystone bedrock from the Upper Cretaceous to Eocene-age Dawson Formation underlies the project site at least 25 feet below the existing ground surface. Problems associated with expansive materials can be mitigated by careful planning of site grading to maintain as much of the existing layer of sand as possible between finished grades and the bedrock formation. This approach will diminish the detrimental effects of the expansive claystone. Geotechnical Investigations conducted for each structure should address procedures for mitigating the issues associated with expansive bedrock, on a site-specific basis.

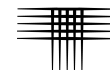
### **Unstable Slopes**

No areas of unstable or potentially unstable slopes were observed within the property, at the time of our field study.

### **Economic Minerals**

We found no evidence that the site contains sand and gravel that could be economically mined. Underground coal mining occurred within the Laramie Formation about 1.5 miles east of the site. No coal mines are known to exist under the subject parcel. Therefore, it is doubtful the site has been undermined. An old oil and gas well is





mapped near the northeast corner of Section 3, about two miles northeast of the site. The site lies close to the contact between the Denver Formation and the overlying Dawson Formation. Rocks containing uranium have been recognized near the base of the Dawson Formation in the Black Forest region. Occurrences of low-grade, uranium-bearing rock have also been found in the Briargate area to the northwest of the site. These deposits were first recognized in a regional study for uranium in the mid-1970s. Accounts of uranium occurrences in the Denver Formation can be found in publications of the Colorado Geological Survey. Energy fuels such as coal, uranium, oil and gas may or may not be present in economic quantities.

### **Flooding**

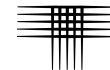
Information presented on the “Flood Insurance Rate Map” (FIRM), Map Nos. 08041C0752G and 08041C0756G, dated December 7, 2018 (Revised), indicates the proposed development is in an area determined to be outside of the 100-year flood plain. The project Civil Engineer will determine the flood potential and design surface drainage.

### **Seismicity**

This area, like most of central Colorado, is subject to a degree of seismic activity. Geologic evidence has been interpreted to indicate that movement along some Front Range faults has occurred during the last two million years (Quaternary). This includes the Rampart Range Fault, which is located about ten miles west of the site. We believe the soils on the property classify as Site Class D (stiff soil profile) according to the 2015 International Building Code (2015 IBC).

### **Radon and Radioactivity**

We believe no unusual hazard exists from naturally occurring sources of radioactivity on this site. However, the materials found in our borings can be associated with the production of radon gas and concentrations in excess of EPA guidelines can occur. Radon tends to collect in below-grade areas due to limited outside air exchange and interior ventilation. Passive and active mitigation procedures are commonly employed in



this region to effectively reduce the buildup of radon gas. Measures that can be taken after a structure is enclosed during construction include installing a blower connected to the foundation drain (if present) and sealing the joints and cracks in concrete floors and foundation walls. If the occurrence of radon is a concern, we recommend the structure be tested after it is enclosed, and mitigation systems installed to reduce the risk.

Low-level gamma radiation levels were measured in the cuttings from our exploratory borings using a LUDLUM Micro R Meter (Model 19). The meter provides readings of low-level gamma radiation in terms of micro R/Hr (micro Roentgens per hour). Background readings which represent “means” ranged between 14 and 17 micro R/Hr. Readings on the drill cuttings ranged between 15 and 17 micro R/Hr. The readings are shown in Fig. 2. We did not observe any of the dark brown conglomeratic sandstone at the site that is commonly associated with high radioactivity readings.

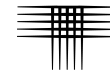
The “background” level of low-level gamma radiation in the state generally ranges from 15 to 20 micro R/Hr with the level of concern being established at about twice background. This would imply remediation should be performed for materials which exceed about 30 to 40 micro R/Hr at this site.

## **SITE DEVELOPMENT CONSIDERATIONS**

We previously recommended site grading be designed to minimize cuts as much as feasible to maintain as much of the existing layer of sand as possible between finished grades and the underlying bedrock formation. This was intended to reduce the likelihood of encountering expansive materials at depths that will impact the proposed structures.

### **Site Grading**

No grading plans were available for our review at the time of the initial report. Cut/fill mapping and proposed grading were provided and reviewed for this report. We expect cuts up to 29 feet and fills of up to 16 feet will be necessary to achieve the proposed grading. We believe site grading can be accomplished using conventional heavy-duty earthmoving equipment. If bedrock is encountered, grading recommendations may



need to be altered to increase moisture content to mitigate swell. We recommend grading plans consider long-term cut and fill slopes no steeper than 3:1 (horizontal to vertical). This ratio considers that no seepage of groundwater occurs. If groundwater seepage does occur, a drain system and flatter slopes may be appropriate.

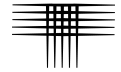
Vegetation and organic materials should be removed from the ground surface in areas to be filled. Soft or loose soils, if encountered, should be stabilized or removed to stable material prior to placement of fill. Organic soils should be wasted in landscaping areas. If insufficient landscaping areas are planned, topsoil can be mixed with clean fill soils at a ratio of 15:1 (fill:topsoil) and placed as fill deeper than 8 feet below final grade.

The existing soil stockpiles should be removed from the ground surface prior to the placement of any fill. It may be possible to incorporate portions of the stockpiles that are essentially free of deleterious materials such as construction debris, trash, organic material, etc., into the site grading fill. Stockpiles contaminated with deleterious materials may have to be removed from the site or placed in deep fills outside of proposed building footprints and pavement areas. The final determination of the suitability of the stockpiles for use during site grading will have to occur at the time of construction, once the material is exposed.

The ground surface in areas to receive fill should be scarified, moisture conditioned and compacted. We recommend overlot grading fill composed of the on-site sands be placed in thin, loose lifts, moisture conditioned to within 2 percent of optimum moisture content, and compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). Placement and compaction of the grading fill should be observed and tested by our representative during construction. Guideline specifications for overlot grading are presented in Appendix C.

### **Buried Utilities**

We believe utility trench excavation can be accomplished using heavy-duty track hoes. Excavations for utilities should be braced or sloped to maintain stability and should meet applicable local, state, and federal safety regulations. The contractor



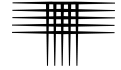
should identify the soils and bedrock encountered in trench excavations and refer to Occupational Safety and Health Administration (OSHA) standards to determine appropriate slopes. We anticipate the near-surface sands and sand grading fill will classify as Type C material. Temporary excavations in Type C materials require a maximum slope inclination of 1.5:1 (horizontal to vertical), unless the excavation is shored or braced. If groundwater seepage occurs, a flatter slope will likely be required. Excavations deeper than 20 feet should be designed by a professional engineer.

Water and sewer lines are usually constructed beneath paved roads. Compaction of trench backfill will have a significant effect on the life and serviceability of pavements. We recommend trench backfill be moisture conditioned and compacted in accordance with El Paso County specifications. Personnel from our firm should observe and test the placement and compaction of the trench backfill during construction.

### **Underdrain Systems**

Underdrains incorporated into the design of sanitary sewer systems can provide a positive gravity outlet for individual, below-grade foundation drains, if desired. Where no groundwater is encountered in sanitary sewer excavations, “passive” underdrains may be used. A conceptual drain detail is shown in Fig. 4. The drain pipe should consist of smooth wall, rigid PVC pipe placed at a minimum slope of 0.5 percent. An “active” section of smooth, perforated or slotted, rigid PVC pipe should be placed for a minimum distance of one pipe length upstream of manholes. The perforated pipe should be encased in at least 6 inches of free-draining gravel, separated from the surrounding trench backfill by geotextile fabric. Seepage collars should be constructed at the manhole locations to force water flowing through pipe bedding into the underdrain. The seepage collars can be constructed of concrete or clay.

If high moisture conditions or groundwater are encountered in the sanitary sewer trench, we recommend an active underdrain system with perforated or slotted pipe for these areas. A conceptual drain detail is shown in Fig. 5. A cutoff collar should be constructed around the sewer pipe and underdrain pipe immediately downstream of the point where the underdrain pipe exits the sewer trench or changes from active to pas-



sive. Solid pipe should be used down gradient of this cutoff collar to the point of discharge. The underdrain should be maintained at least 3 to 5 feet below the lowest nearby foundation elevation.

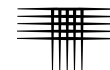
As-built plans for the underdrain system should be prepared including location, elevations, and cleanouts. The entity responsible for maintenance of the underdrain system should retain the as-built plans for future reference.

The appropriate sizes of underdrain pipes are dependent on the actual alignments, area served, and gradients. We can review grading, drainage, and underground utility plans and provide suggested pipe sizing recommendations, if requested. For preliminary planning purposes, we expect pipe diameters of 4 to 8 inches will be appropriate. If active seepage exists, 8-inch diameter or larger pipes will be appropriate. These pipe sizes consider an average gradient of 1 percent. The use of active drains could potentially be limited due to water rights.

## **FOUNDATION AND FLOOR SYSTEM CONCEPTS**

In our opinion, conventional spread footings or mat foundations will be appropriate for lightly to moderately-loaded buildings constructed across the majority of the site, where natural sands and sand grading fill are encountered. Some moderately to more heavily-loaded structures may require modification of the near-surface sand soils (sub-excavation and dense compaction under controlled conditions) to increase the allowable soil pressure exerted on the subgrade by a spread footing foundation. A deep foundation such as drilled bedrock piers may be an appropriate option for heavily-loaded structures, if the bedrock formation is encountered at a reasonable depth. We anticipate temporary casing would be needed to properly install the drilled piers through the clean sand soils and into the bedrock formation.

We anticipate slab-on-grade floors will perform satisfactorily at the site where granular soils and/or sand grading fill are encountered at depths expected to influence floor slab performance. Overall, the risk of slab movement and cracking is expected to be low. Geotechnical Investigation reports prepared after completion of overlot grading



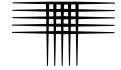
should address appropriate foundation systems and floor system alternatives on a site-by-site basis.

## **PAVEMENTS**

Natural sands and granular grading fill are expected to be the predominant pavement subgrade materials. These materials exhibit generally good subgrade support for pavements. For the granular materials, we anticipate composite asphalt concrete and aggregate base course pavement sections on the order of 4 inches of asphalt over 6 inches of base course may be needed for parking lot stalls. A composite section of 4 to 5 inches of asphalt over 6 to 8 inches of base course may be needed for the access streets. These pavement thicknesses may not be sufficient for construction traffic and some maintenance and repair work may be needed prior to completion of the project. A subgrade investigation and pavement design should be performed after overlot grading and utility installation are complete.

## **CONCRETE**

Concrete in contact with soils can be subject to sulfate attack. We measured the water-soluble sulfate concentration in two samples from the site at less than 0.1 percent. Sulfate concentrations of less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to ACI 201.2R-01, as published in the 2008 American Concrete Institute (ACI) Manual of Concrete Practice. For this level of sulfate concentration, the ACI indicates Type I cement can be used for concrete in contact with the subsoils. In our experience, superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high-water tables. Concrete subjected to freeze-thaw cycles should be air entrained.



## **SURFACE DRAINAGE AND IRRIGATION**

The performance of structures, flatwork, and roads within the development will be influenced by surface drainage. When developing an overall drainage scheme, consideration should be given to drainage around each structure and pavement area. Drainage should be planned such that surface runoff is directed away from foundations and is not allowed to pond adjacent to or between structures or over pavements. Ideally, slopes of at least 6 inches in the first 10 feet should be planned for the areas surrounding buildings, where possible. Roof downspouts and other water collection systems should discharge well beyond the limits of all backfill around the structures. Proper control of surface runoff is also important to prevent the erosion of surface soils. Concentrated flows should not be directed over unprotected slopes. Permanent slopes should be seeded or mulched to reduce the potential for erosion. Backfill soils behind the curb and gutter adjacent to streets and in utility trenches should be compacted. If surface drainage between preliminary development and construction phases is neglected, performance of the roadways, flatwork, and foundations may be compromised.

## **RECOMMENDED FUTURE INVESTIGATIONS**

Based on the results of this study, we recommend the following investigations and services be provided by our firm:

1. Site-specific Geotechnical Investigations for foundation design.
2. Subgrade Investigation and Pavement Design for on-site pavements.
3. Construction materials testing and observation services during site development and construction.

## **LIMITATIONS**

The recommendations and conclusions presented in this report were prepared based on conditions disclosed by our exploratory borings, geologic reconnaissance, engineering analyses, and our experience. Variations in the subsurface conditions not indicated by the borings are possible and should be expected.



We believe this report was prepared with that level of skill and care ordinarily used by geologists and geotechnical engineers practicing under similar conditions. No warranty, express or implied, is made.

Should you have any questions regarding the contents of this report or the project from a geotechnical engineering point-of-view, please call.

CTL | THOMPSON, INC

Gwendolyn E. Eberhart, P.E.  
Project Engineer



Reviewed by:

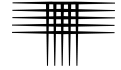
Timothy A. Mitchell, P.E.  
Division Manager

GE:TAM:cw

(3 copies sent)

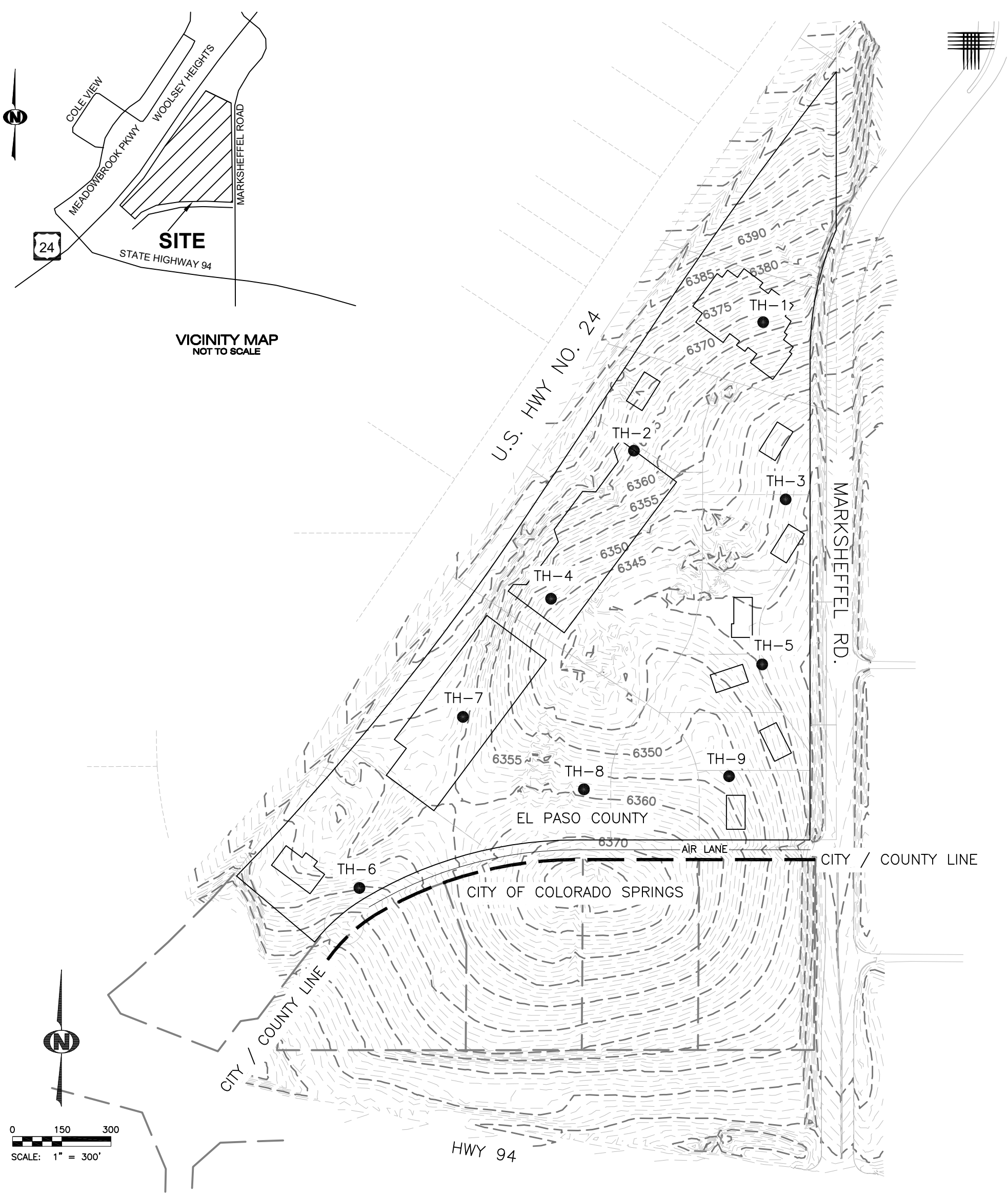
Via email: [kelly@theequitygroup.net](mailto:kelly@theequitygroup.net)





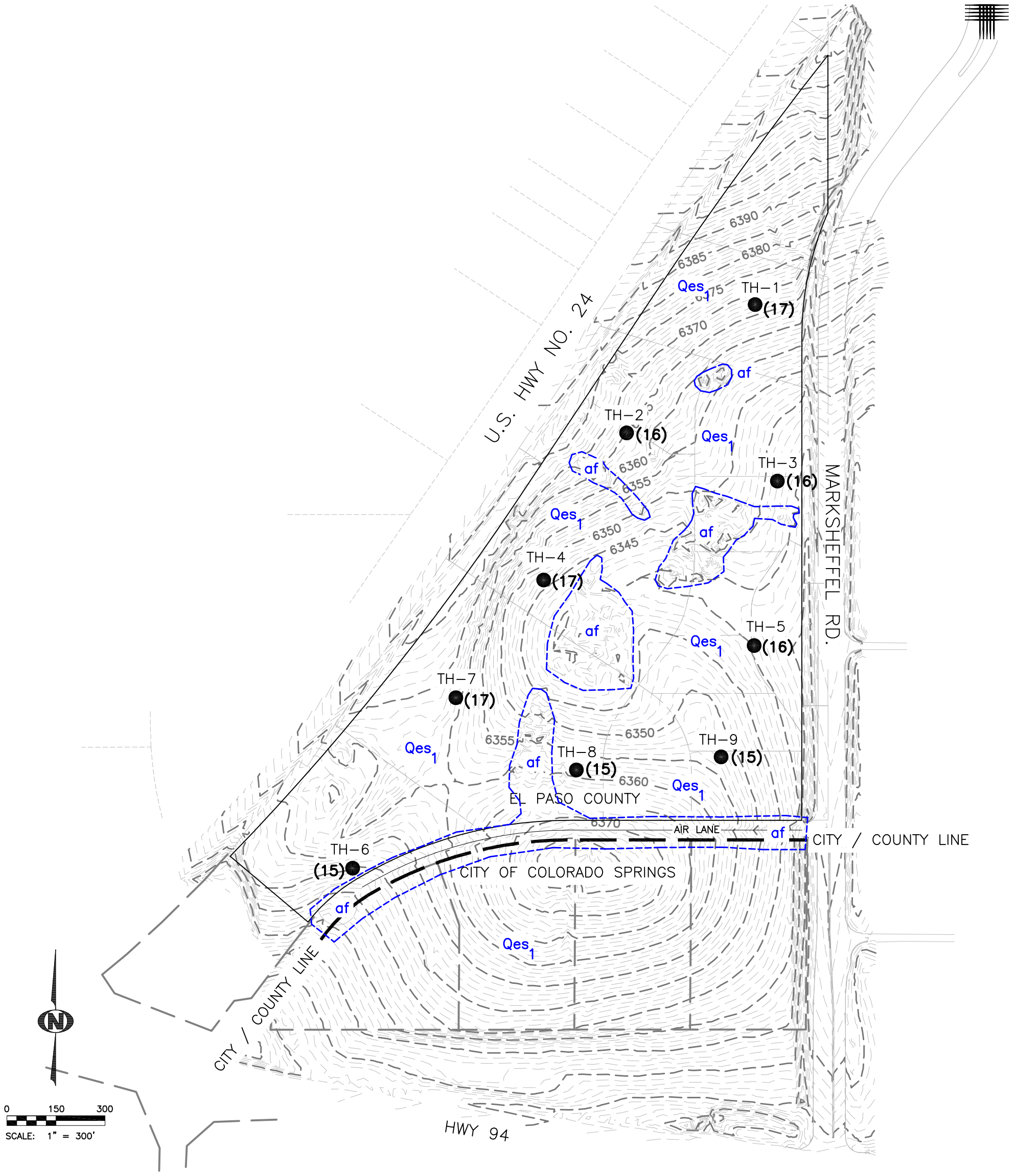
## REFERENCES

1. Colorado Geological Survey. (1991). Results of the 1987-88 EPA Supported Radon Study in Colorado, with a Discussion on Geology, Colorado Geological Survey Open File Report 91-4.
2. Federal Emergency Management Agency, Flood Insurance Rate Map, Map Numbers 08041C0752G and 08041C0756G, Panels 752 and 756 of 1300, dated December 7, 2018 (Revised).
3. International Building Code (2015 IBC).
4. Kirkham, R.M. & Rogers, W.P. (1981). Earthquake Potential in Colorado. Colorado Geological Survey, Bulletin 43.
5. Robinson and Associates, Inc. (1977). El Paso County, Colorado - Potential Geologic Hazards and Surficial Deposits, Environmental and Engineering Geologic Maps and Tables for Land Use.
6. State of Colorado, Division of Mined Land Reclamation (April 1985). Prepared by Dames and Moore. Colorado Springs Subsidence Investigation.
7. Madole, Richard F. and Thorson, Jon P. Geologic Map of the Elsmere Quadrangle, El Paso County, Colorado, Colorado Geological Survey (2002).
8. Hillside and Airport Overlay Map, Planning Department, City of Colorado Springs.
9. Streamside Overlay Map, Planning Department, City of Colorado Springs.



LEGEND:

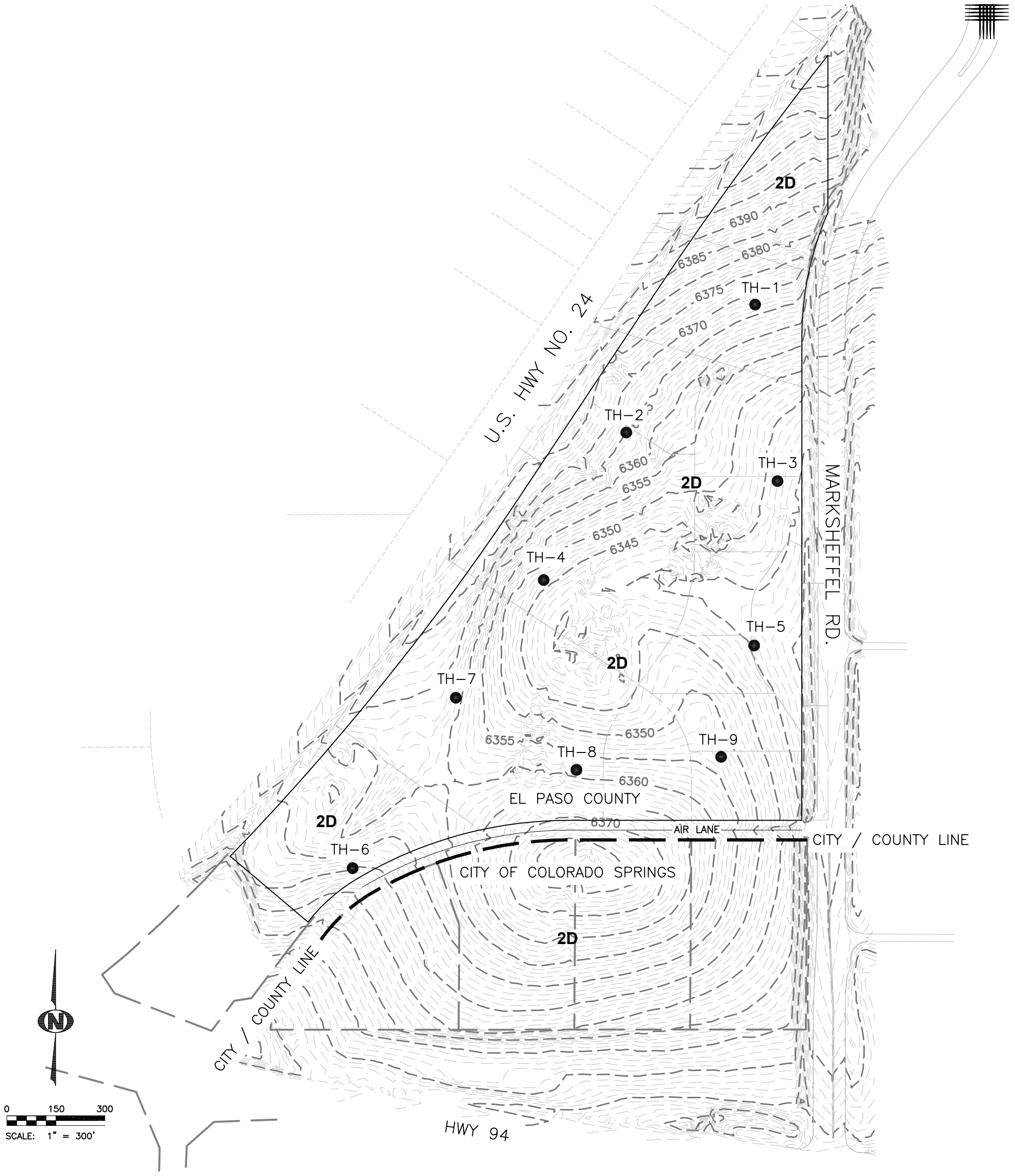
- TH-1 APPROXIMATE LOCATION OF EXPLORATORY BORING.
- ≡≡≡ EXISTING TOPOGRAPHY
- PROJECT LOT BOUNDARY
- LOCATION OF PROPOSED BUILDING FOOTPRINT.



- NOTES:
1. BASE DRAWING WAS PROVIDED BY THOMAS AND THOMAS (PROJECT NO. 3532.01, DATED MAY 18, 2016).
  2. ALL BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF PUBLISHED MAPS (MADOLE AND THORSON, COLORADO GEOLOGICAL SURVEY, 2002), AERIAL PHOTOGRAPHS, AND A BRIEF FIELD RECONNAISSANCE. CHANGES IN THE MAPPED BOUNDARIES SHOWN ARE POSSIBLE AND SHOULD BE EXPECTED WITH MORE DETAILED WORK AND FURTHER INFORMATION. ALL INTERPRETATIONS AND CONDITIONS SHOWN ARE PRELIMINARY AND FOR LAND-USE PLANNING ONLY.

- LEGEND:
- TH-1 APPROXIMATE LOCATION OF EXPLORATORY BORING.
  - PROJECT BOUNDARY
  - ~ EXISTING TOPOGRAPHY
  - (17) GAMMA READING (MICRO R/HR.) AT BORING CUTTINGS.

- GEOLOGIC UNITS AND (MODIFIERS)
- - - SURFICIAL GEOLOGIC CONTACTS
  - af MAN-MADE FILL CONSISTING OF END-DUMPED SOIL STOCKPILES TYPICALLY 3 TO 5 FEET IN MAXIMUM HEIGHT.
  - Qes<sub>1</sub> YOUNGER EOLIAN SAND (MIDDLE AND EARLY HOLOCENE AND LATE? PLEISTOCENE).



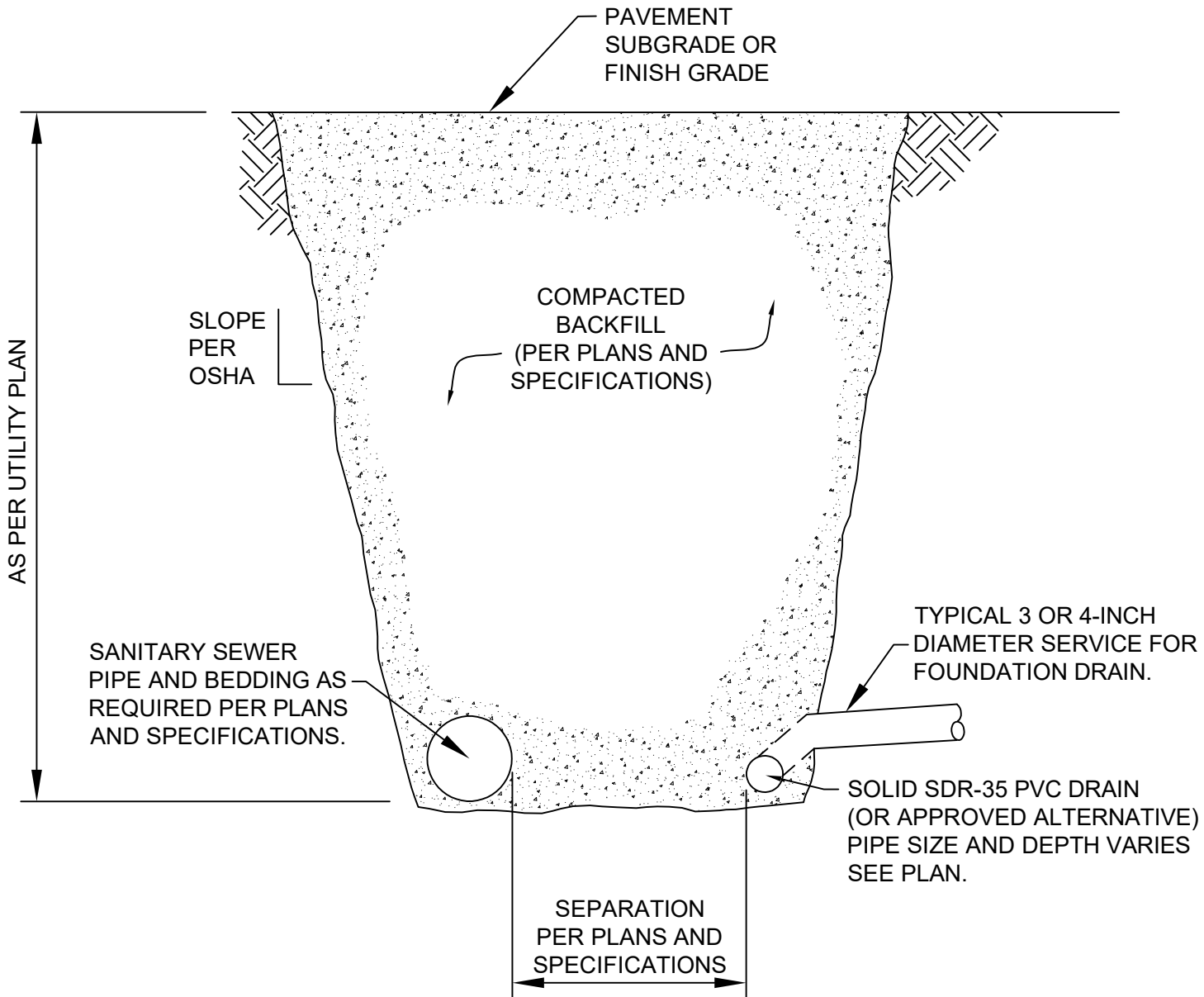
- NOTES:
1. BASE DRAWING WAS PROVIDED BY THOMAS AND THOMAS (PROJECT NO. 3532.01, DATED MAY 18, 2016).
  2. ALL BOUNDARIES SHOWN SHOULD BE CONSIDERED APPROXIMATE. THEY ARE BASED UPON A SUBJECTIVE INTERPRETATION OF PUBLISHED MAPS, AERIAL PHOTOGRAPHS, AND AN INITIAL FIELD RECONNAISSANCE. CHANGES IN THE MAPPED BOUNDARIES SHOWN ARE POSSIBLE AND SHOULD BE EXPECTED WITH MORE DETAILED WORK AND FURTHER INFORMATION. ALL INTERPRETATIONS AND CONDITIONS SHOWN ARE PRELIMINARY AND FOR INITIAL LAND-USE PLANNING ONLY.
  3. MAP LEGEND IS MODIFIED FROM CHARLES S. ROBINSON & ASSOCIATES, INC., GOLDEN, COLORADO, DATED 1977.

LEGEND:

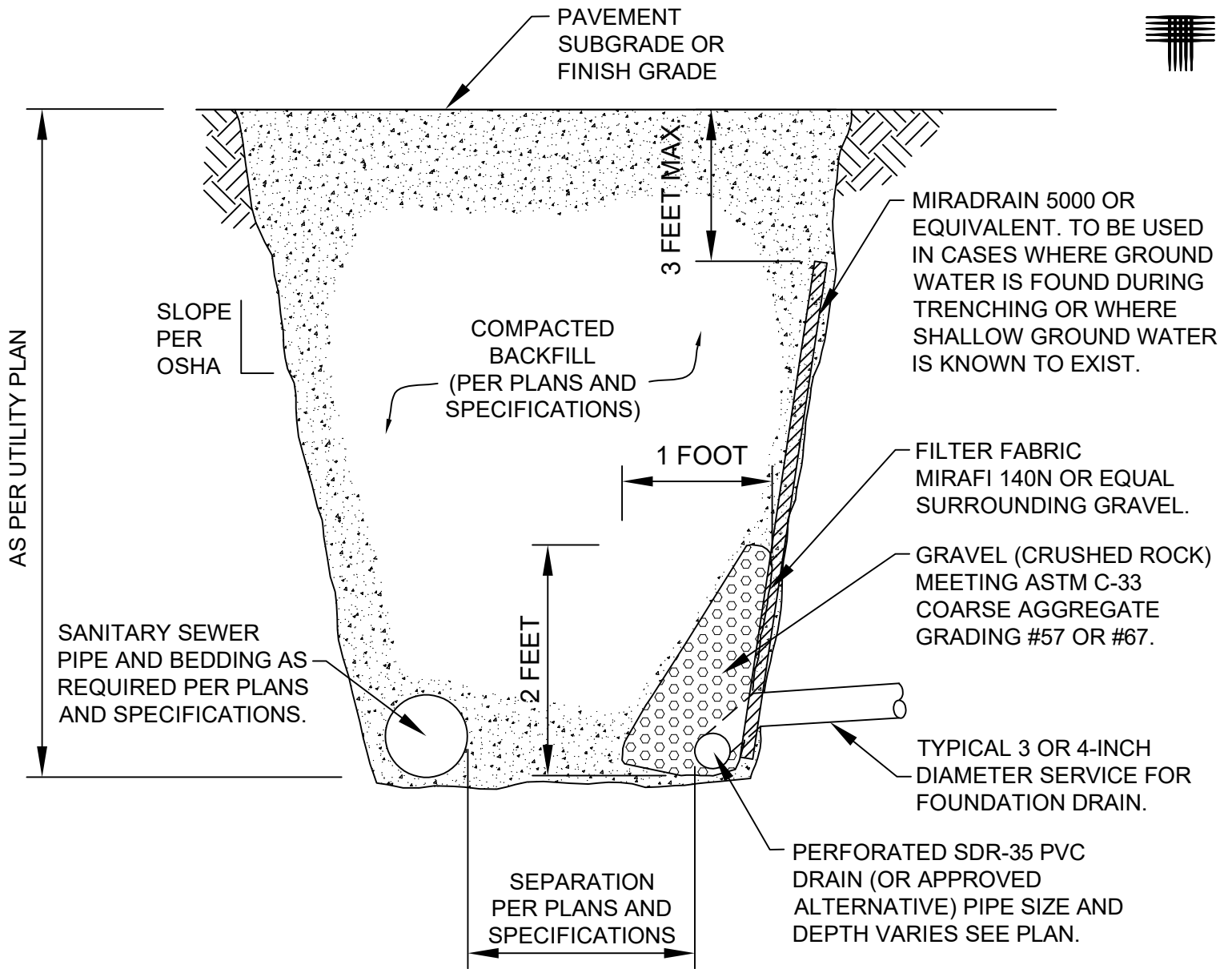
- TH-1      APPROXIMATE LOCATION OF EXPLORATORY BORING.
- 
- PROJECT BOUNDARY
- ~~~~~      EXISTING TOPOGRAPHY

ENGINEERING UNITS AND (MODIFIERS)

- 2D**      EOLIAN DEPOSITS GENERALLY ON FLAT TO GENTLE SLOPES OF UPLAND AREAS.



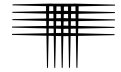
NOTE:  
TO BE USED IN CASES WHERE NO  
GROUND WATER IS KNOWN TO EXIST.



GRADING REQUIREMENTS FOR COARSE AGGREGATES PER ASTM C-33

SIZE NUMBER	NOMINAL SIZE (SIEVES WITH SQUARE OPENINGS)	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS), WEIGHT PERCENT						
		1 1/2 INCH (37.5 mm)	1 INCH (25.0 mm)	3/4 INCH (19.0 mm)	1/2 INCH (12.5 mm)	3/8 INCH (9.5 mm)	NO. 4 (4.5 mm)	NO. 8 (2.36 mm)
67	3/4 INCH TO NO. 4 (19.0 TO 4.75 mm)	--	100	90 TO 100	--	20 TO 55	0 TO 10	0 TO 5
57	1 INCH TO NO. 4 (25.0 TO 9.5 mm)	100	95 TO 100	--	25 TO 60	--	0 TO 10	0 TO 5

NOTE:  
TO BE USED IN CASES WHERE GROUND WATER IS  
FOUND DURING TRENCHING OR WHERE SHALLOW  
GROUND WATER IS KNOWN TO EXIST, AND  
UPSTREAM OF MANHOLES.



## **APPENDIX A**

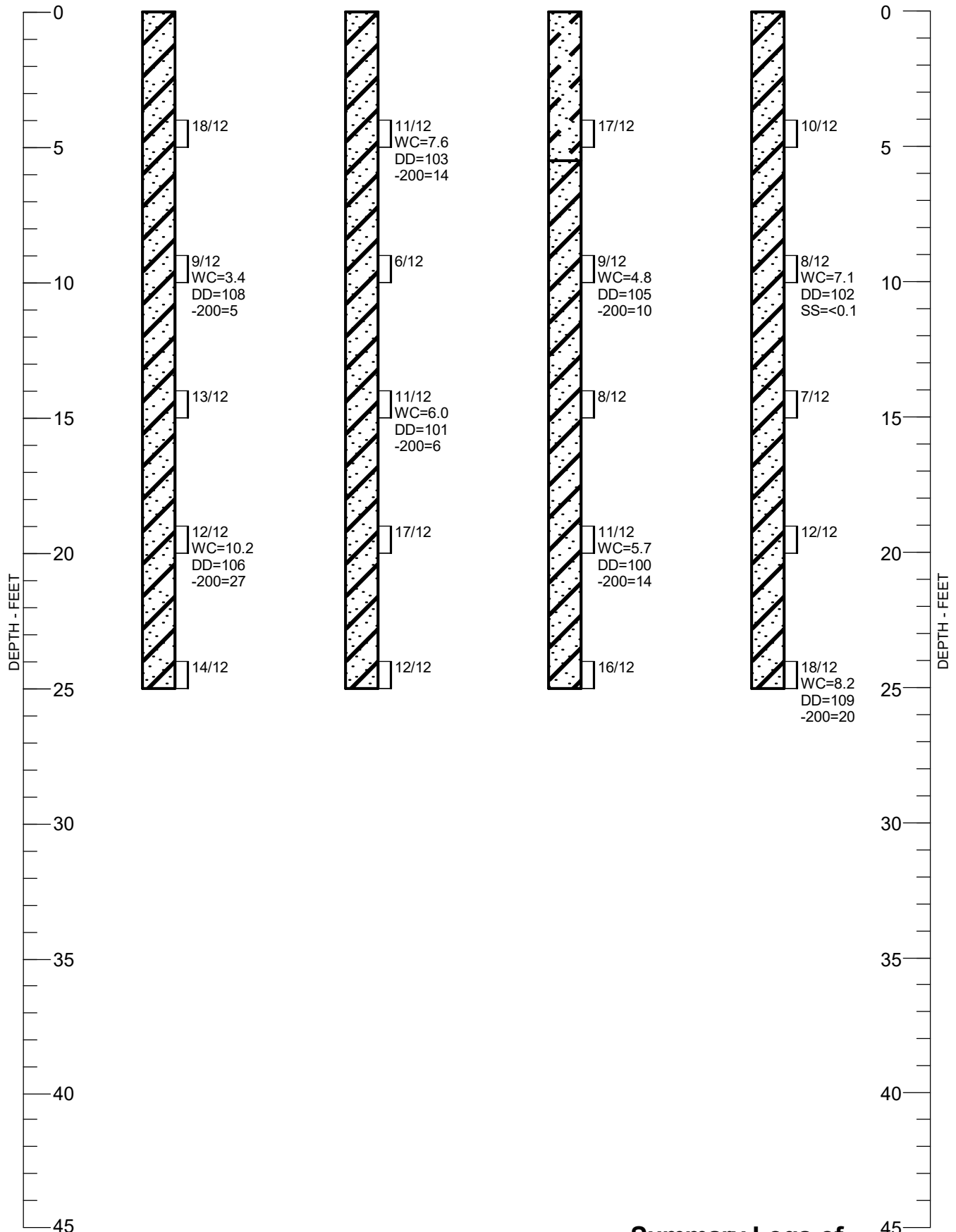
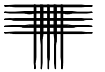
### **SUMMARY LOGS OF EXPLORATORY BORINGS**

TH - 1

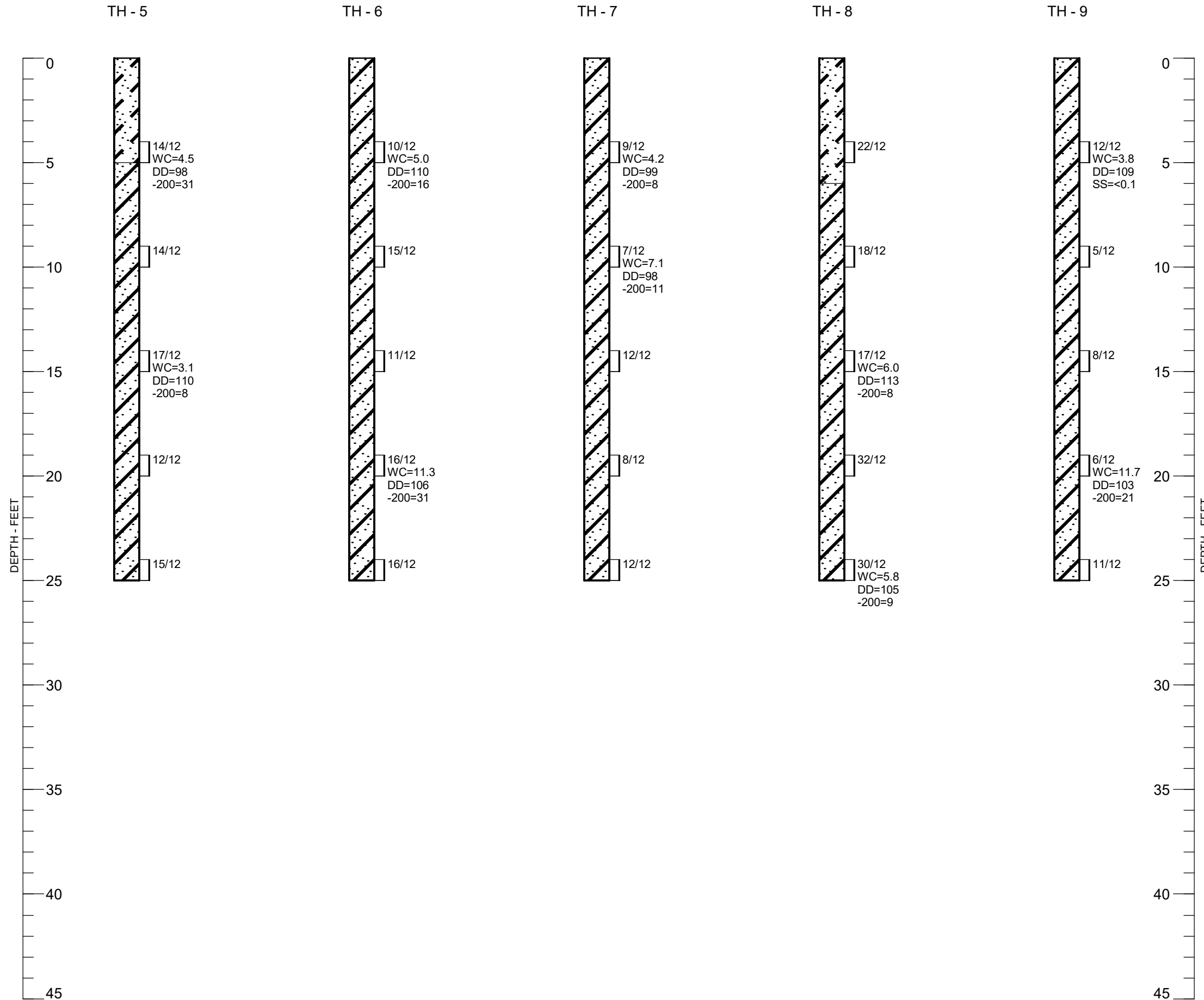
TH - 2

TH - 3

TH - 4





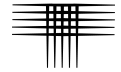


**LEGEND:**

- SAND, CLAYEY, MEDIUM DENSE, SLIGHTLY MOIST, LIGHT TO MEDIUM BROWN. (SC)
- SAND, SLIGHTLY SILTY TO SILTY, LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, LIGHT TO MEDIUM BROWN. (SP-SM, SM)
- DRIVE SAMPLE. THE SYMBOL 18/12 INDICATES 18 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

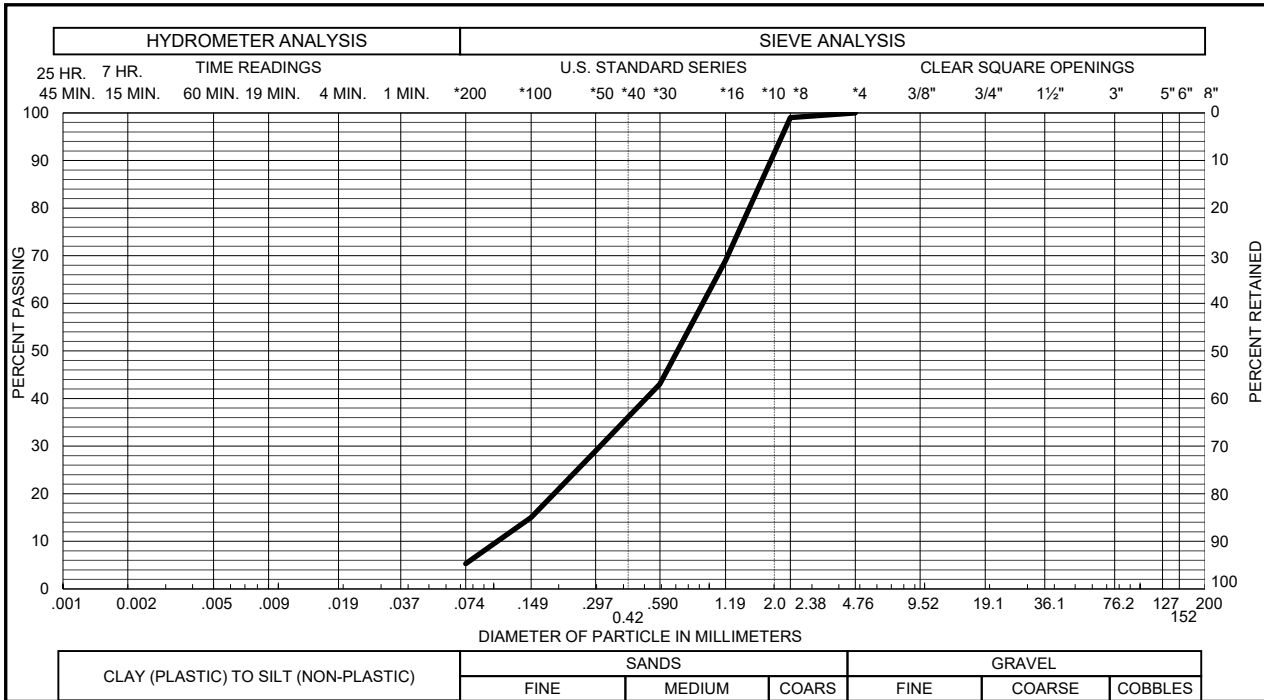
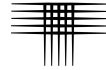
**NOTES:**

1. THE BORINGS WERE DRILLED DECEMBER 17, 2015 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-55, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.
4. WC - INDICATES MOISTURE CONTENT. (%)  
 DD - INDICATES DRY DENSITY. (PCF)  
 -200 - INDICATES PASSING NO. 200 SIEVE. (%)  
 SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

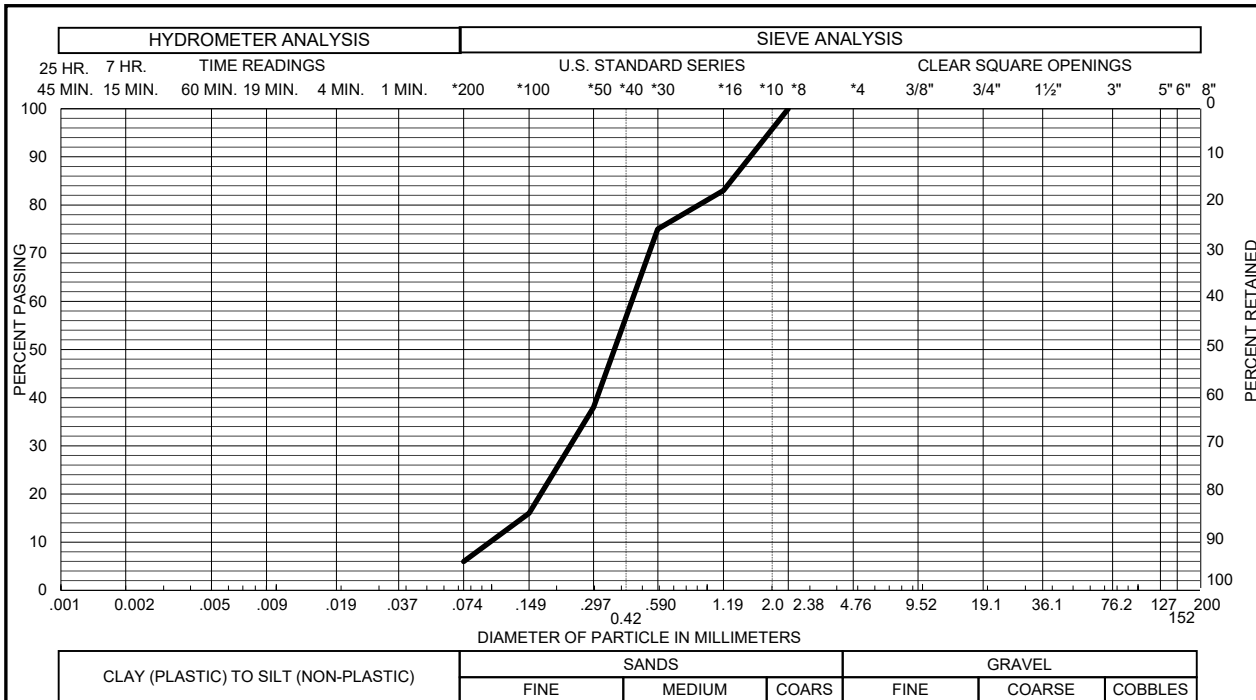


## **APPENDIX B**

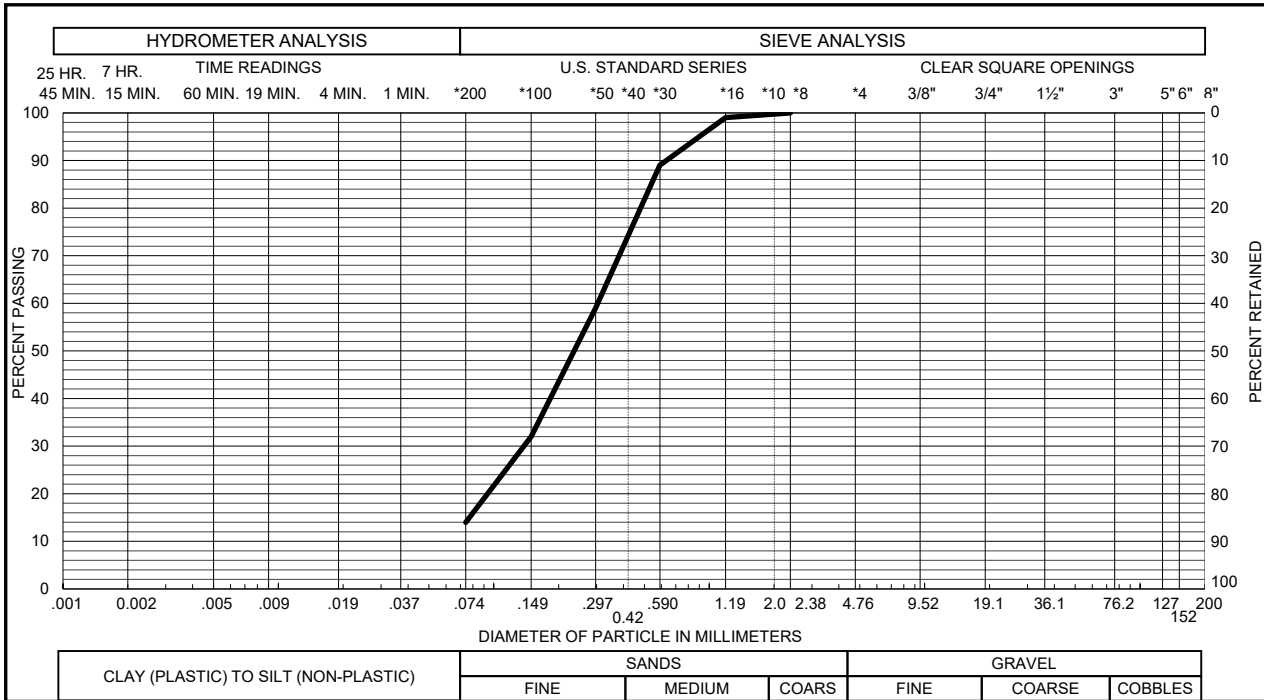
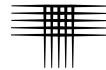
### **LABORATORY TEST RESULTS TABLE B-1: SUMMARY OF LABORATORY TESTING**



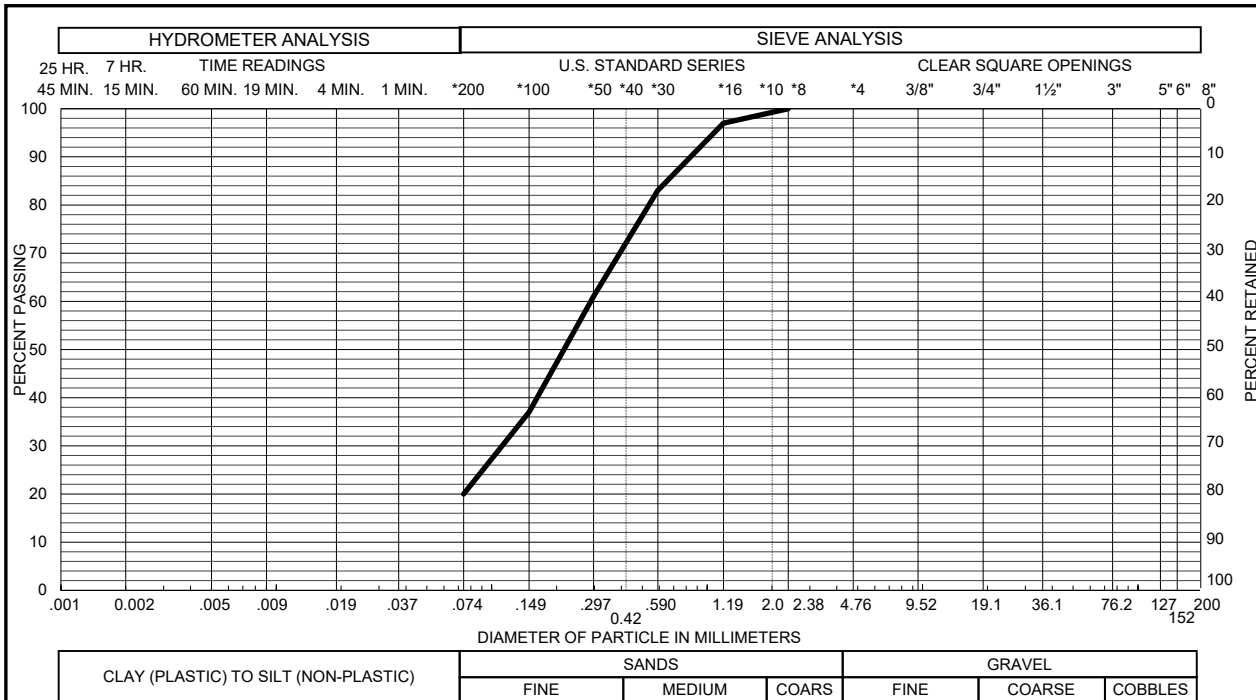
Sample of SAND, SLIGHTLY SILTY (SP-SM) GRAVEL 0 % SAND 95 %  
 From TH - 1 AT 9 FEET SILT & CLAY 5 % LIQUID LIMIT      %  
 PLASTICITY INDEX      %



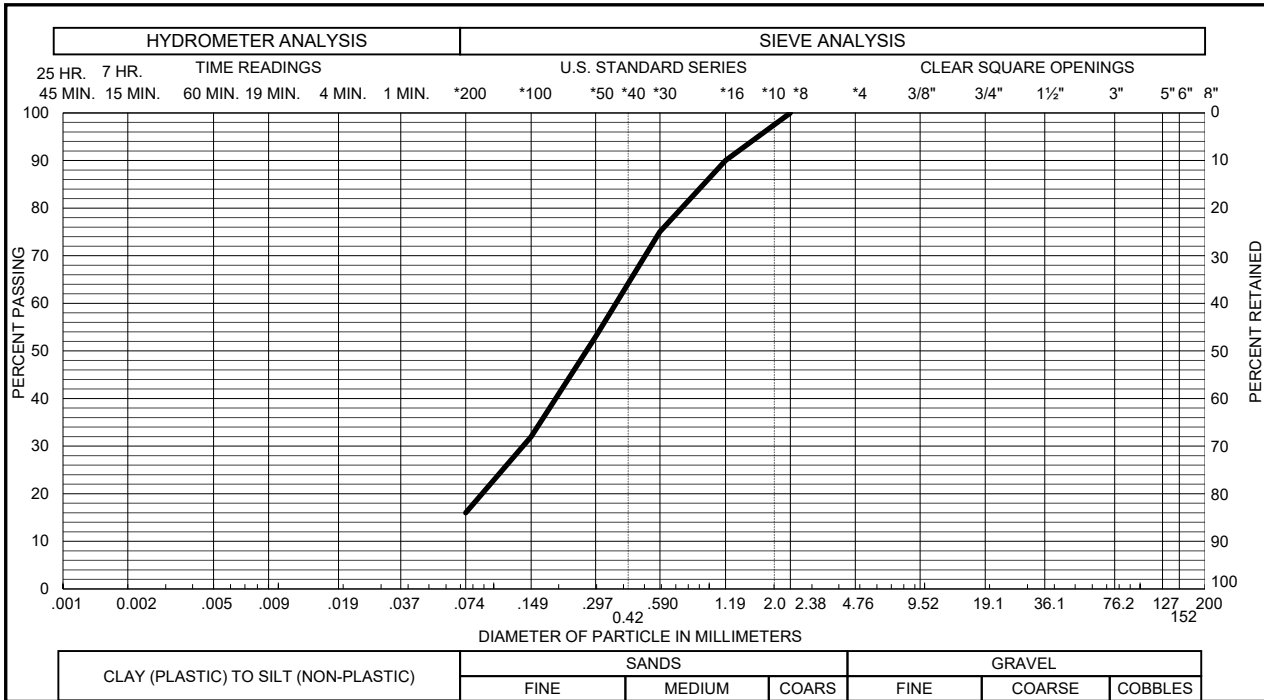
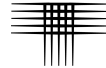
Sample of SAND, SLIGHTLY SILTY (SP-SM) GRAVEL 0 % SAND 94 %  
 From TH - 2 AT 14 FEET SILT & CLAY 6 % LIQUID LIMIT      %  
 PLASTICITY INDEX      %



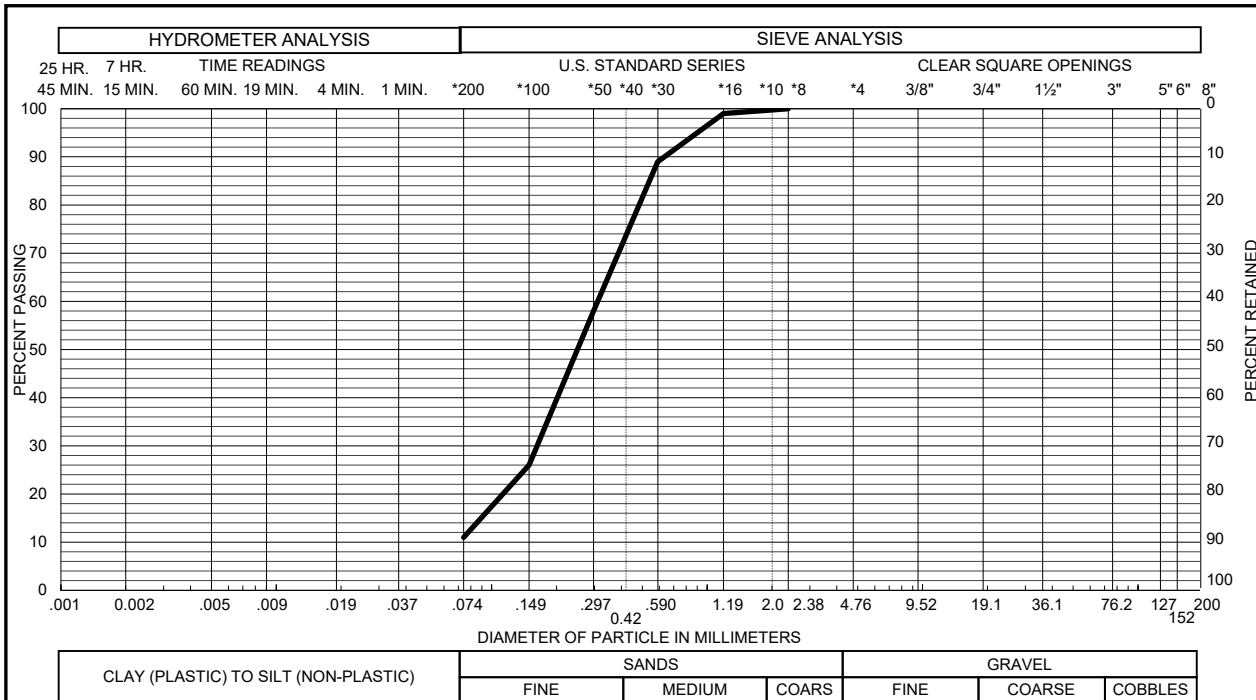
Sample of SAND, SILTY (SM) GRAVEL 0 % SAND 86 %  
 From TH - 3 AT 19 FEET SILT & CLAY 14 % LIQUID LIMIT     %   
 PLASTICITY INDEX     %



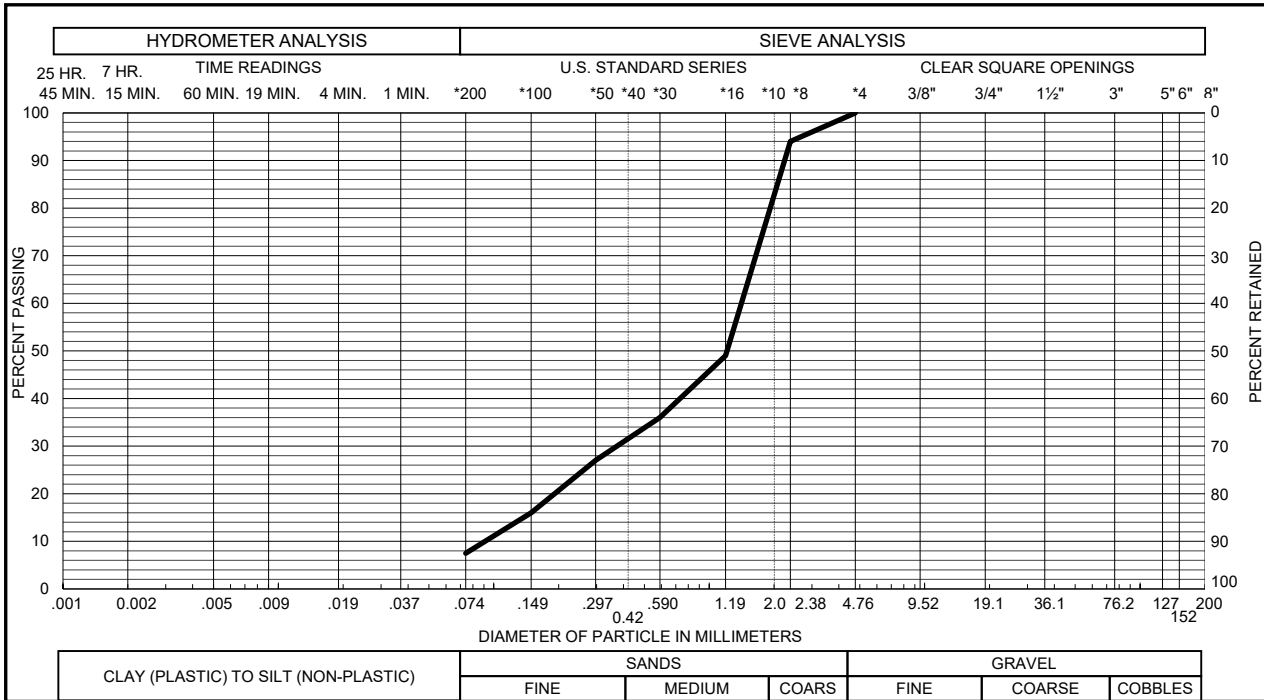
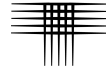
Sample of SAND, SILTY (SM) GRAVEL 0 % SAND 80 %  
 From TH - 4 AT 24 FEET SILT & CLAY 20 % LIQUID LIMIT     %   
 PLASTICITY INDEX     %



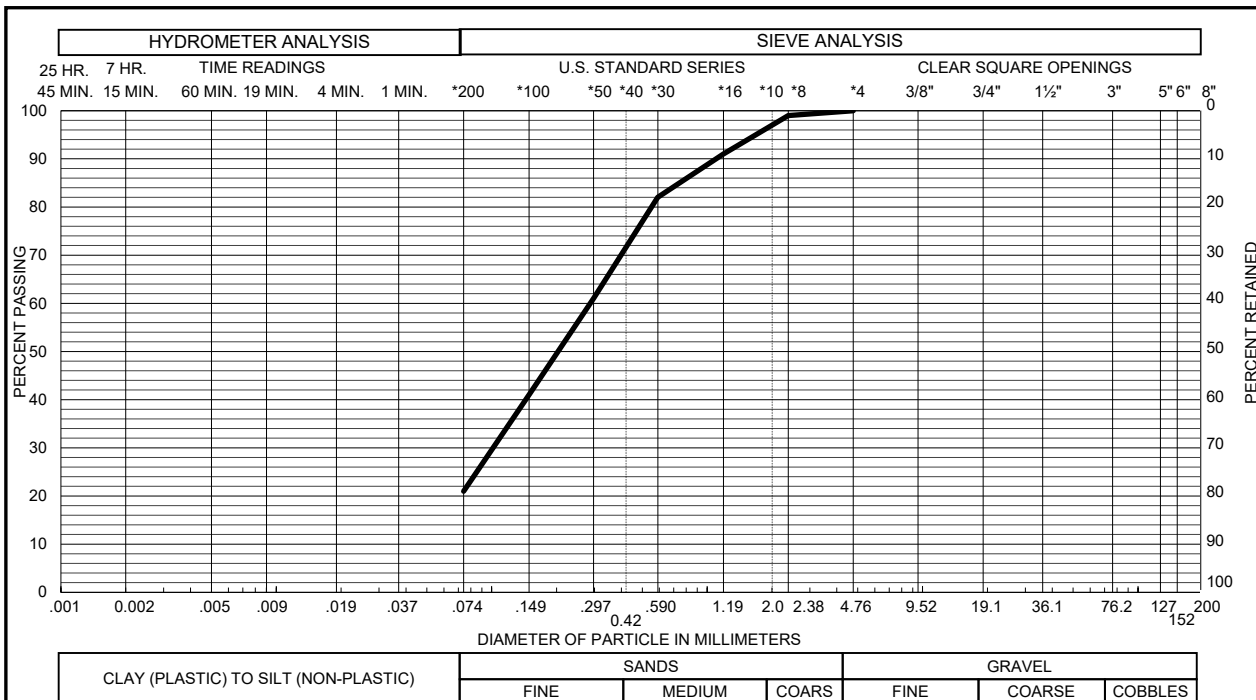
Sample of SAND, SILTY (SM) GRAVEL 0 % SAND 84 %  
 From TH - 6 AT 4 FEET SILT & CLAY 16 % LIQUID LIMIT     %   
 PLASTICITY INDEX     %



Sample of SAND, SLIGHTLY SILTY (SP-SM) GRAVEL 0 % SAND 89 %  
 From TH - 7 AT 9 FEET SILT & CLAY 11 % LIQUID LIMIT     %   
 PLASTICITY INDEX     %



Sample of SAND, SLIGHTLY SILTY (SP-SM) GRAVEL 0 % SAND 92 %  
 From TH - 8 AT 14 FEET SILT & CLAY 8 % LIQUID LIMIT      %  
 PLASTICITY INDEX      %



Sample of SAND, SILTY (SM) GRAVEL 0 % SAND 79 %  
 From TH - 9 AT 19 FEET SILT & CLAY 21 % LIQUID LIMIT      %  
 PLASTICITY INDEX      %

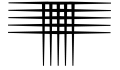
**TABLE B-1**

**SUMMARY OF LABORATORY TESTING  
CTLJT PROJECT NO. CS18526.001-105**



BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*			PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)	SWELL (%)	APPLIED PRESSURE (PSF)	SWELL PRESSURE (PSF)			
TH-1	9	3.4	108						5		SAND, SLIGHTLY SILTY (SP-SM)
TH-1	19	10.2	106						27		SAND, SILTY (SM)
TH-2	4	7.6	103						14		SAND, SILTY (SM)
TH-2	14	6.0	101						6		SAND, SLIGHTLY SILTY (SP-SM)
TH-3	9	4.8	105						10		SAND, SLIGHTLY SILTY (SP-SM)
TH-3	19	5.7	100						14		SAND, SILTY (SM)
TH-4	9	7.1	102							<0.1	SAND, SILTY (SM)
TH-4	24	8.2	109						20		SAND, SILTY (SM)
TH-5	4	4.5	98						31		SAND, CLAYEY (SC)
TH-5	14	3.1	110						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-6	4	5.0	110						16		SAND, SILTY (SM)
TH-6	19	11.3	106						31		SAND, SILTY (SM)
TH-7	4	4.2	99						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-7	9	7.1	98						11		SAND, SLIGHTLY SILTY (SP-SM)
TH-8	14	6.0	113						8		SAND, SLIGHTLY SILTY (SP-SM)
TH-8	24	5.8	105						9		SAND, SLIGHTLY SILTY (SP-SM)
TH-9	4	3.8	109							<0.1	SAND, SLIGHTLY SILTY (SP-SM)
TH-9	19	11.7	103						21		SAND, SILTY (SM)

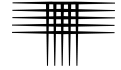
\* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.  
NEGATIVE VALUE INDICATES COMPRESSION.



## **APPENDIX C**

### **GUIDELINE SITE GRADING SPECIFICATIONS CROSSROADS NORTH EL PASO COUNTY, COLORADO**





**GUIDELINE SITE GRADING SPECIFICATIONS  
CROSSROADS NORTH  
EL PASO COUNTY, COLORADO**

**1. DESCRIPTION**

This item consists of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Civil Engineer, as necessary to achieve preliminary pavement and building pad elevations. These specifications also apply to compaction of materials that may be placed outside of the project.

**2. GENERAL**

The Geotechnical Engineer will be the Owner's representative. The Geotechnical Engineer will approve fill materials, method of placement, moisture contents and percent compaction.

**3. CLEARING JOB SITE**

The Contractor shall remove all trees, brush and rubbish before excavation or fill placement is begun. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures of any kind.

**4. SCARIFYING AREA TO BE FILLED**

All topsoil, vegetable matter, and existing fill shall be removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified until the surface is free from ruts, hummocks or other uneven features that would prevent uniform compaction by the equipment to be used.

**5. PLACEMENT OF FILL ON NATURAL SLOPES**

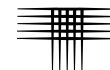
Where natural slopes are steeper than 20 percent (5:1, horizontal to vertical) and fill placement is required, horizontal benches shall be cut into the hillside. The benches shall be at least 12 feet wide or 1-1/2 times the width of the compaction equipment and be provided at a vertical spacing of not more than 5 feet (minimum of two benches). Larger bench widths may be required by the Geotechnical Engineer. Fill shall be placed on completed benches as outlined within this specification.

**6. COMPACTING AREA TO BE FILLED**

After the foundation for the fill has been cleared and scarified, it shall be disced or bladed until it is free from large clods, brought to a workable moisture content and compacted.

**7. FILL MATERIALS**

Fill soils shall be free from vegetable matter or other deleterious substances and shall not contain rocks or lumps having a diameter greater than six (6) inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Civil Engineer or imported to the site.



## 8. MOISTURE CONTENT

For fill material classifying as CH or CL, the fill shall be moisture treated to between 1 and 4 percent above optimum moisture content as determined by ASTM D 698 if it is to be placed within 15 feet of the final grade. For deep cohesive fill (greater than 15 feet below final grade) it shall be moisture conditioned to within  $\pm 2$  percent of optimum. Soils classifying as SM, SC, SW, SP, GP, GC and GM shall be moisture treated to within 2 percent of optimum moisture content as determined by ASTM D 1557. Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Geotechnical Engineer, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disc the fill soils to provide uniform moisture content throughout the soils.

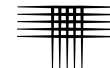
The application of water to embankment materials shall be made with any type of watering equipment approved by the Geotechnical Engineer, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction to be obtained, all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

## 9. COMPACTION OF FILL AREAS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density. Granular fill placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 1557. Cohesive fills placed less than 15 feet below final grade shall be compacted to at least 95 percent of maximum dry density as determined in accordance with ASTM D 698. For deep, cohesive fill (to be placed 15 feet or deeper below final grade), the material shall be compacted to at least 98 percent of maximum standard Proctor dry density (ASTM D 698). Granular fill placed more than 15 feet below final grade shall be compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). Deep fills shall be placed within 2 percent of optimum moisture content. Fill materials shall be placed such that the thickness of loose materials does not exceed 10 inches and the compacted lift thickness does not exceed 6 inches.

Compaction, as specified above, shall be obtained by the use of sheepfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Geotechnical Engineer for soils classifying as claystone, CL, CH or SC. Granular fill shall be compacted using vibratory equipment or other equipment approved by the



Geotechnical Engineer. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to ensure that the required density is obtained.

#### 10. COMPACTION OF SLOPES

Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and there is no appreciable amount of loose soil on the slopes. Compaction of slopes may be done progressively in increments of 3 to 5 feet in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

#### 11. DENSITY TESTS

Field density tests will be made by the Geotechnical Engineer at locations and depths of his/her choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests will be taken in compacted material below the disturbed surface. When density tests indicate the density or moisture content of any layer of fill or portion thereof is below that required, the particular layer or portion shall be reworked until the required density or moisture content has been achieved. The criteria for acceptance of fill shall be:

##### A. Moisture:

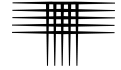
The allowable ranges for moisture content of the fill materials specified above in "Moisture Content" are based on design considerations. The moisture shall be controlled by the Contractor so that moisture content of the compacted earth fill, as determined by tests performed by the Geotechnical Engineer, shall be within the limits given. The Geotechnical Engineer will inform the Contractor when the placement moisture is less than or exceeds the limits specified above and the Contractor shall immediately make adjustments in procedures as necessary to maintain placement moisture content within the specified limits.

##### B. Density:

1. The average dry density of all material shall not be less than the dry density specified.
2. No more than 20 percent of the material represented by the samples tested shall be at dry densities less than the dry density specified.
3. Material represented by samples tested having a dry density more than 2 percent below the specified dry density will be rejected. Such rejected materials shall be reworked until a dry density equal to or greater than the specified dry density is obtained.

#### 12. SEASONAL LIMITS

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill



operations shall not be resumed until the Geotechnical Engineer indicates the moisture content and density of previously placed materials are as specified.

**13. NOTICE REGARDING START OF GRADING**

The Contractor shall submit notification to the Geotechnical Engineer and owner advising them of the start of grading operations at least three (3) days in advance of the starting date. Notification shall also be submitted at least three days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

**14. REPORTING OF FIELD DENSITY TESTS**

Density tests made by the Geotechnical Engineer, as specified under “Density Tests” above, will be submitted progressively to the Owner. Dry density, moisture content and percent compaction will be reported for each test taken.