ENTECH
ENGINEERING, INC.

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

GEOLOGIC HAZARD STUDY
AND PRELIMINARY
SUBSURFACE SOIL INVESTIGATION
THE RANCH
EL PASO COUNTY, COLORADO

Prepared for

PRI IV, LLC
6385 Corporate Drive, Suite 200
Colorado Springs, Colorado 80919

Attn: Loren Moreland

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Respectfully Submitted,

ENTECH ENGINEERING, INC.

Kristen A. Andrew-Hoeser, P.G.
Engineering Geologist

Reviewed by:

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

COLORADO LICENSED
JOSEPH COLLIN GOODE JR
23725
5.8.19
PROFESSIONAL ENGINEER

KAH/kah

Encl.

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1.0 SUMMARY

Project Location:

The project lies in Section 35, Township 12 South, Range 65 West of the 6th Principal Meridian. The site is located southeast of the intersection of Raygor Road and Stapleton Drive, approximately one mile northwest of Falcon in El Paso County, Colorado.

Project Description:

Total acreage involved in the project is approximately 629 acres. The proposed development consists of single-family residential with a school, park and open space areas.

Scope of Report:

The report presents the results of our geologic investigation and treatment of engineering geologic hazard study. This report presents the results of our geologic reconnaissance, a review of available maps, aerial photographs and our conclusions with respect to the impacts of the geologic conditions on development. Preliminary foundation recommendations are also included.

Land Use and Engineering Geology:

This site was found to be suitable for the proposed residential development. Geologic conditions will impose some constraints on development. These include areas of hydrocompaction, loose soils, potentially expansive soils, seasonal and potentially seasonal shallow groundwater areas, areas of ponded water, and artificial fill. Shallow bedrock will also be encountered on portions of the site. Site conditions will be discussed in greater detail in this report. All recommendations are subject to the limitations discussed in the report.

2.0 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in Section 35 of Township 12 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado. The site is located at the west of Meridian Road and north of Woodmen Road, southeast of the intersection of Raygor Road and Stapleton Drive, approximately one mile northwest of Falcon, Colorado. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the site is generally gently sloping to the south with some moderate slopes along a drainage in the western portion of the site. Drainages on-site flow in a southerly direction. Water was not observed flowing in any of the drainages at the time of this investigation, however, areas of ponded water were observed. The approximate boundaries of the site are indicated on the USGS Map, Figure 2. Previous site uses have included grazing and pasture lands. Vegetation on site consists of field grasses and weeds. Site photographs are included in Appendix A. The approximate locations and directions of the photographs are indicated on Figure 3.

Total acreage involved in the proposed development is approximately 629 acres. The proposed development is to consist of single-family residential lots with a school, park and open space areas. The area will be serviced by central water and sewer. The proposed Sketch Plan is presented in Figure 3. A grading plan was not available at the time of this report.

3.0 SCOPE OF THE REPORT

The scope of this report will include the following:

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

- Preliminary recommendations pertaining to foundations, floor slabs and concrete.

4.0 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of 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 field reconnaissance, measurements and interpretation. The same mapping procedures have also been utilized to produce the Engineering Geology Map which identifies pertinent geologic conditions affecting development.

Additionally, six (6) test borings were drilled as a part of the preliminary subsurface soil investigation for the subdivision. The borings were drilled with a power driven continuous flight auger drill rig to depths of 20 feet. Samples were obtained during drilling using the Standard Penetration Test, ASTM D-1586, utilizing a 2-inch O.D. Split Barrel Sampler and a California Sampler. Results of the penetration tests are shown on the drilling logs to the right of the sampling point. The location of the test borings is shown on the Test Boring Location Map, Figure 3. The drilling logs are included in Appendix B.

Laboratory testing was performed to classify and determine the soils engineering characteristic. Laboratory tests included moisture content, ASTM D-2216, grain size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. FHA Swell Testing was conducted on select samples to evaluate the expansive characteristics of the soils. Soluble sulfate testing was conducted to determine the corrosive characteristics of the soils. 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 14 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 southern edge of a large structural feature known as the Denver Basin. Bedrock in the area tends to be gently dipping in a northerly direction (Reference 1). Bedrock in the area of the site is sedimentary in nature, and typically Tertiary to Cretaceous in age. The bedrock underlying the site itself is the Dawson Formation. Overlying the Dawson are unconsolidated deposits of artificial, residual, alluvial, and eolian soils. The site's stratigraphy will be discussed in more detail in Section 5.3.

5.2 Soil Conservation Service

The Natural Resource Conservation Service (Reference 2), previously the Soil Conservation Service (Reference 3) has mapped three soil types on the site (Figure 4). In general, the soils consist of loamy sand and gravelly sandy loam. Soils are described as follows:

Type	Description
8	Blakeland loamy sand, 1-9% slopes
19	Columbine gravelly sandy loam, 0-3% slopes
71	Pring coarse sandy loam, 3-8% slopes

Complete descriptions of the soils are presented in Appendix D. The soils have generally been described to have rapid to very rapid permeabilities. The majority of the soils have been described by the Soil Conservation Service as good potential for urban development. Limitations include the hazard of flooding on Soil Type 19. 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. The soil blowing hazard is severe if vegetation is removed.

5.3 Site Stratigraphy

The Falcon NW Quadrangle Geology Map showing the site is presented in Figure 5 (Reference 4). The Geology Map prepared for the site is presented in Figure 6. Five mappable units were identified on this site, which are identified as follows:

- **Qaf** **Artificial Fill of Quaternary Age:** These are man-made fill deposits associated with earthen dams and erosion berms on-site.

- **Qal** **Recent Alluvium of Quaternary Age:** These are recent stream deposits in the drainages that exist on-site. These materials consist of silty sands and may contain lenses of silt, clay or gravel. Areas of organic soils will also be encountered.

- **Qao_1** **Old Alluvium One of Quaternary Age:** This is a stream deposited material typically occurring as terrace deposits on portions of the site. The Old Alluvium One typically consists of brown silty to clayey sands and may contain some silt and clay lenses. This deposit likely correlates with the Louviers Alluvium and the Piney Creek Alluvium.

- **Qes** **Eolian Sand of Quaternary Age:** These are deposits are fine to medium grained soil deposited by the action of the prevailing winds from the northwest. They typically occur as large dune deposits or narrow ridges. These soil types are typically tan to brown in color and tend to have a very uniform or well-sorted gradation. These materials tend to have a relatively high permeability and low density.

- **TKda** **Dawson Arkose Formation of Tertiary to Cretaceous Age:** The bedrock underlying the site is the Dawson Formation. This formation consists of arkosic sandstone with interbedded lenses on fine grained sandstone, claystone or siltstone. Typically, it is buff to light brown and light gray in color. Overlying the Dawson is a variable layer of residual soil derived from the in-situ weathering of the bedrock materials. This residual soil layer varied from 1 to 2 feet in

thickness in the test borings drilled in this formation. A table showing the depth to bedrock in all the test borings drilled on the site is presented in Table 2.

The soils listed above were mapped from the *Geologic Map of the Falcon NW Quadrangle* by Madole in 2003 (Figure 5, Reference 4), the *Geologic Map of the Pueblo 1°x2° Quadrangle, South-Central* distributed by the US Geological Survey in 1978 (Reference 5) and site-specific mapping of the site. The test borings from the preliminary subsurface investigation were also used in evaluating the site. The test boring logs are included in Appendix B of this report.

5.4 Soil Conditions

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

Soil Type 1 consists of slightly silty to silty sand (SW-SM, SM) and areas of clayey sand (SC). The sands were encountered in the upper soil profile of all of the test borings at the surface and extending to depths ranging from one foot to the termination of the borings (20 feet). Standard penetration testing on the sands resulted in SPT N-values of 5 to 28 blows per foot (bpf), indicating loose to medium dense states. Water content and grain size testing resulted in water contents of 2 to 17 percent with approximately 5 to 33 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in liquid limits of 28 to no value and plastic indexes of 10 to non-plastic. FHA Swell testing resulted in a swell pressure of 360 psf, indicating low expansion potential. Sulfate testing resulted in less than 0.01 percent soluble sulfate by weight, indicating a negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 consists of the slightly silty to very silty and clayey sandstone bedrock (SM-SW, SM, SC). The sandstone was encountered in four of the six test borings drilled on site at depths ranging from one foot to 16 feet below the surface and extending to the termination of the borings (20 feet). Shallow bedrock was encountered in the northern portion of the site. Standard Penetration Testing on the sandstone resulted in SPT N-values of 50 to greater than 50 bpf, indicating very dense states. Water content and grain size testing resulted in water contents of 6 to 14 percent with approximately 10 to 44 percent of the soil size particles passing the No. 200

sieve. Atterberg limits testing indicated non-plastic results. Sulfate testing resulted in less than 0.01 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

A Summary of Laboratory Results is presented in Table 1. Laboratory results are included in Appendix C. A summary of the depth to bedrock is included in Table 2.

5.5 Groundwater

Groundwater was encountered at depths ranging from 8 to 19 feet in five of the six test borings. Groundwater was not encountered in the other test boring during or subsequent to drilling which was drilled to 20 feet. A table showing the depth to groundwater is presented in Table 2. Areas of seasonal and potentially seasonal groundwater and ponded water have been mapped on the site and 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. Isolated sand layers within the variable soil profile, sometimes only a few feet in thickness and width, can carry water in the subsurface. Water may also flow on top of the sandstone. Contractors should be cognizant of the potential for the occurrence of such subsurface water features during construction on-site.

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 6). This map shows the location of various geologic conditions of which the developers and planners should be cognizant during the planning, design and construction stages of the project. The hazards identified on this site include hydrocompaction, loose soils, artificial fill, potentially expansive soils, seasonal and potentially seasonal shallow groundwater areas and areas of ponded water. The following hazards have been addressed as a part of this investigation:

Expansive Soils

While the majority of the soils encountered in the test borings drilled on-site have low expansion potential, expansive clays and claystone are common in the area and may be encountered in the subsurface on this site. The expansive soils on-site are highly sporadic, therefore, none have been indicated on the map. Expansive clays and claystone, 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 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation which is common in the area. Drilled piers are another option that is used in areas where highly expansive soils are encountered. Typical minimum pier depths are on the order of 25 feet or more and require penetration into the bedrock material a minimum of 4 to 6 feet, depending on building loads. 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.

Subsidence Area

Based on a review of the *Mining Report for the Colorado Springs Coal Field* (Reference 6), a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 7), and the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County* (Reference 8), the site is not undermined. The closest underground mines in the area are 8 miles to the south and 8 miles to the west and the site is not mapped within any potential subsidence zones.

Slope Stability and Landslide Hazard

The slopes on-site are gently to moderately sloping and do not exhibit any past or potential unstable slopes or landslides. Grading plans were not available at the time of this investigation. Slopes should be no steeper than 3:1, if regraded unless specifically evaluated. All topsoil and organics should be removed prior to any regrading or fill placement. All new fill

should be properly benched into native slopes and compacted at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557.

Rockfall Hazards

Based on a site observation, no rock outcrops or areas of rockfall hazard were observed on this site.

Debris Fans

Based on-site observations, debris fans were not observed in this area. Areas of recent sediment deposits were observed in a drainage in the northeastern portion of the site. The drainage areas are discussed below.

Groundwater and Drainage Areas

Groundwater was encountered in five of the six test borings at depths ranging from 8 to 19 feet. Groundwater was not encountered in the other test boring which was drilled to 20 feet. Areas within the drainages on-site have been identified as seasonal and potentially seasonal shallow groundwater. Water was not flowing in the drainages at the time of this investigation, however, areas of ponded water were observed. No areas of the site have been mapped as floodplain zones according to the FEMA Map No. 08041CO535F, Figure 7 (Reference 9). Exact floodplain location and drainage studies are beyond the scope of this report. These groundwater areas are discussed as follows:

- *Seasonal and Potentially Seasonal Shallow Groundwater*

In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and possible frost heave potential, depending on the soil conditions. The majority of the areas mapped with this designation lie within drainages designated as open space and will be avoided by development. Where structures encroach on, or lie within these areas, the following mitigation is recommended:

Mitigation: In these locations, foundations in areas subject to severe frost heave potential should penetrate sufficient depth so as to discourage the formation of ice lenses beneath foundations. At this location and elevation, a foundation depth for frost protection of 30 inches is recommended. In areas where high subsurface moisture conditions are anticipated periodically, a subsurface perimeter drain will be necessary to help prevent the intrusion of water into areas located below grade. A typical perimeter drain detail is presented in Figure 8. Where shallow groundwater is encountered, additional drains, such as capillary breaks and/or interceptor drains may be necessary. Unstable conditions should be expected where excavations approach the groundwater level. The used of shot rock or geo-grids may be necessary to stabilize excavations. Additionally, swales should be created to intercept surface runoff and carry it safely around and away from structures. It is anticipated that the drainages can be avoided or site grading will mitigate the drainages and raise foundations further above the groundwater level. The water table may be of sufficient depth to minimize the effects on buildings. Areas of sedimentation have occurred in a drainage in the northeastern portion of the site due to erosion. Regrading and erosion control may be necessary in this area. Additional investigation is recommended after grading plans are finalized.

- *Areas of Ponded Water*

These are areas where there is standing water observed in drainages or ponded water behind earthen dams. The majority of these areas lie within the drainages designated as open space and will be avoided by construction. Where construction is proposed, the following mitigation is recommended:

Mitigation: The larger of the ponds lie behind earthen dams: one in the southwestern portion of the site within an area designated as open space and another immediately northeast of the site in a dedicated easement. Other areas where ponded water were observed are minor and can be regraded. All soft and organic soils should be removed prior to fill placement. Any drainage into these areas should be rerouted in a non-erosive manner where it does not create areas of ponded water around proposed structures. The same mitigation techniques for the seasonal shallow groundwater areas are recommended for these areas as well.

Artificial Fill

Areas of artificial fill were observed on the site. The majority of the fill is associated with earthen dams and erosion berms. The earthen dams lie within areas designated as open space or easements and will be avoided by construction. The majority of the erosion berms are shallow and may be penetrated by foundations or will likely be removed during site grading. Should any uncontrolled fill be encountered beneath foundations, removal and recompaction at 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 will be required.

Hydrocompaction

Areas in which hydrocompaction have been identified are acceptable as building sites. In areas identified for this hazard classification, however, we anticipate a potential for settlement movements upon saturation of these surficial soils. The low density, uniform grain sized, windblown sand deposits are particularly susceptible to this type of phenomenon.

Mitigation: The potential for settlement is directly related to saturation of the soils below the foundation areas. Therefore, good surface and subsurface drainage is extremely critical in these areas in order to minimize the potential for saturation of these soils. The ground surface around all permanent structures should be positively sloped away from the structure to all points, and water must not be allowed to stand or pond anywhere on the site. We recommend that the ground surface within 10 feet of the structures be sloped away with a minimum gradient of five percent. If this is not possible on the upslope side of the structures, then a well-defined swale should be created to intercept the surface water and carry it quickly and safely around and away from the structures. Roof drains should be made to discharge well away from the structures and into areas of positive drainage. Where several structures are involved, the overall drainage design should be such that water directed away from one structure is not directed against an adjacent building. Planting and watering in the immediate vicinity of the structures, as well as general lawn irrigation, should be minimized.

Collapsible Soils

Areas of loose or potentially collapsible soils were encountered in some of the test borings drilled on-site. Should loose or collapsible soils be encountered beneath foundations, removal and recompaction with thorough moisture conditioning at 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 will be necessary. Typically, the overexcavation extends

to a depth of 2 to 3 feet. Specific recommendations should be made after additional investigation of each building site.

Faults

The closest fault is the Rampart Range Fault, located 14 miles to the west. No faults are mapped on the site itself. Previously Colorado was mapped entirely within Seismic Zone 1, a very low seismic risk. Additionally, the International Residential Code (IRC), 2003, currently places this area in Seismic Design Category B, also a low seismic risk. According to a report by the Colorado Geological Survey by Kirkman and Rogers, 1981, (Reference 10) this area should be designed for Zone 2 due to more recent data on the potential for movement in this area, and any resultant earthquakes.

Dipping Bedrock

The bedrock underlying the site is the Dawson Formation of Tertiary to Cretaceous Age. The Dawson in this area is gently dipping a northerly direction according to the *Geologic Structure Map of the Pueblo 1x2 Quadrangle, South-Central Colorado* (1978) (Reference 1). The bedrock encountered in the test borings and observed on-site did not exhibit steeply dipping characteristics; therefore, mitigation is not necessary.

Shallow Bedrock

Shallow bedrock was encountered in two of the test borings drilled on-site. A Summary of the Depth to Bedrock is included in Table 2. Where shallow sandstone is encountered, higher allowable bearing capacities are anticipated. Shallow claystone may require mitigation for expansive soils. Excavations extending in the sandstone or claystone bedrock may be difficult and require track excavators.

Radioactivity

Radon levels for the area have been reported by the Colorado Geologic Survey in the Open-File, Report No. 91-4 (Reference 11). Radon levels ranging from 0 to 20 pci/l have been measured in the area. The following is a table of radon levels in this area.

0<4 pci/l	0.00
4<10 pci/l	100.00%

10<20 pci/l	0.00
>20 pci/l	0.00

Only one reading has been taken in the area. The minimal information from this report is not sufficient to determine if radon levels are higher for this site. An occurrence of radioactive minerals has been identified approximately 7 miles northwest of the site (Reference 12). This occurrence is associated with a limonite deposit in the Dawson Formation. No known occurrences exist on the site, however, radon gas originating in the bedrock underlying the site could migrate up into the upper soil profile.

Mitigation: The potential exists for radon gas to build up in areas of the site. Build-ups of radon gas can be mitigated by providing increased ventilation of basements and crawlspaces and sealing of joints. Specific requirements for mitigation should be based on-site specific testing after the site is constructed.

7.0 EROSION CONTROL

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

With regard to water erosion, loosely compacted soils will be the most susceptible to water erosion, residually weathered soils and weathered bedrock materials become increasingly less susceptible to water erosion. For the typical soils observed on-site, allowable velocities or unvegetated and unlined earth channels would be on the order of 3 to 4 feet/second, depending upon the sediment load carried by the water. Permissible velocities may be increased through the use of vegetation to something on the order of 4 to 7 feet/second, depending upon the type of vegetation established. Should the anticipated velocities exceed these values, some form of channel lining material may be required to reduce erosion potential. These might consist of some of the synthetic channel lining materials on the market or conventional riprap.

In cases where ditch-lining materials are still insufficient to control erosion, small check dams or sediment traps may be required. The check dams will serve to reduce flow velocities, as well as provide small traps for containing sediment. The determination of the amount, location and placement of ditch linings, check dams and of the special erosion control features should be performed by or in conjunction with the drainage engineer who is more familiar with the flow quantities and velocities.

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

8.0 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 13), the area is mapped as upland deposits. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 14), areas of the site are mapped as A3 – Alluvial fan: sand resource and E3 – wind-deposited sand resource. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 8), the area of the site has been mapped as "Good" for industrial minerals. The sands associated with the eolian and alluvial deposits are considered a sand resource. Considering the silty to clayey nature of much of these materials and abundance of similar materials through the region and 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 8), 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. The *El Paso County Aggregate Resource Map* (Reference 13) has mapped coal resources in the Falcon area approximately ½ mile south of the site; however, the coal resources are estimated at 1,500 feet below the surface (Reference 8). At this depth, mining the coal would not be economical at this time. No metallic mineral resources have been mapped on the site (Reference 8).

The site has been mapped as "Fair" for oil and gas resources (Reference 8). 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 would not be considered a significant resource. Hydraulic fracturing is a new method that is being used 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.

9.0 RELEVANCE OF GEOLOGIC AND SITE CONDITIONS TO LAND USE PLANNING

Site Conditions and Development Considerations

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 hazards associated with the site are those associated with the potential seasonal shallow groundwater conditions. These can be satisfactorily mitigated by either regrading, avoidance, or through proper engineering design, construction and drainage systems. Constraints identified on the site such as hydrocompaction, collapsible soils, artificial fill, and expansive soils can also be mitigated through proper engineering design and construction.

The majority of the soils at typical foundation depths consist of silty sands and sandstone. These soils will provide good support for residential foundations. Areas of clay soils or claystone may be encountered sporadically that would not be suitable for residential foundations resting on these soils. These soils may be expansive and require mitigation. Expansive soils, if encountered, will require special foundation design and/or overexcavation and replacement with non-expansive material compacted at 95% of its maximum Modified Proctor Dry Density ASTM D-1557. These soils will not prohibit development. Loose or collapsible soils, if encountered, will require removal of 2 to 3 feet of the loose soils and recompaction at 95% of its maximum Modified Proctor Dry Density, ASTM D-1557. Any uncontrolled fill encountered beneath foundation members will require complete removal and recompaction. Where shallow bedrock is encountered, higher allowable bearing capacities may be expected. Excavation in the sandstone bedrock may be difficult and require track excavators.

Areas of hydrocompaction have been identified on this site where there is the potential for settlement movements upon saturation of the surficial soils. Good surface and subsurface drainage is critical in these areas and the ground surface should be positively sloped away from structures at all points. Roof drains should be made to discharge well away from structures and planting and watering in the immediate vicinity of structures should be minimized.

Areas of seasonal and potentially seasonal shallow groundwater may be encountered on the site. Areas of ponded water were also observed on the site, primarily behind earthen dams. The seasonal and potentially seasonal shallow groundwater areas and areas of ponded water are mostly associated with drainages on the site that are designated as open space and will be avoided by construction. Where structures encroach on these areas, or construction and regrading is proposed, drains may be necessary in order to prevent the seepage of water below grade. Grading and drain systems can eliminate some of the minor drainage areas.

Preliminary Foundation Recommendations

Shallow foundations are anticipated for the structures on this site including standard spread footing/stemwall systems in conjunction with overexcavation and replacement in areas of expansive soils or recompaction in areas of loose or collapsible soils. Reinforcing for foundations should be designed to span a minimum of 10 feet under the design load and should extend a

minimum of 30 inches below finished grade for frost protection. Interior support columns may be supported by isolated concrete pads. Bearing capacities of 2000 to 2400 psf are anticipated for the foundation members bearing on the medium dense native granular soils or well-compacted sands and 2400 to 2800 psf for structural fill. Undisturbed sandstone will likely have bearing capacities above 3500 psf. Additional subsurface investigation is recommended at each building site as development plans are finalized. Actual soil bearing capacities for each site will be determined after additional investigations.

Foundation walls should be designed to resist lateral pressures generated by the soils on this site. Equivalent hydrostatic fluid pressures (in the active state) of 40 to 50 pcf are anticipated for this site depending on the backfill soils. It should be noted that these values apply to level backfill conditions. Pressures will increase substantially depending on the conditions adjacent to the walls. Surcharge loading, if anticipated, should be considered in wall designs. Equivalent fluid pressures for sloping conditions should be determined on an individual basis.

Floor Slabs

The medium dense granular soils will provide adequate support for floor slabs. Floor slabs placed on expansive clays, loose or collapsible sands should be expected to experience movement. Removal and replacement of clay soils or removal and recompaction of loose granular soils is recommended to minimize slab movement. Floor slabs on grade, if any should be separated from structural portions of the building and allowed to float freely. Interior partitions must be constructed in such a manner that they do not transmit floor slab movement to the roof or overlying floor. Backfill placed below floor slabs should be compacted to the requirements of structural fill at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D- 1557.

Surface and Subsurface Drainage

Positive surface drainage must be maintained around all structures to minimize infiltration of surface water. A minimum gradient of 5% in the first 10 feet adjacent to foundation walls is recommended. The use of drainage swales may be required on the upslope of the structures. All downspouts should be extended to discharge well beyond the backfill zone of the structures. Irrigation adjacent to foundations is not recommended.

Subsurface perimeter drains are recommended for useable space below finished ground surfaces. If expansive clays are encountered in the excavation, perimeter drains are recommended around the entire structure. Depending on groundwater conditions, underslab or interceptor drains may be necessary. Drains should consist of a perforated drainpipe, gravel collector and approved filter fabric. Any drains should be provided with a free gravity outlet. If such an outlet is not available, a sump and pump will be required. Typical drain details are presented in Figures 8 through 10.

Backfill

Backfill placed around the foundations and in utility trenches should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557. Material should be placed in lifts having a compacted thickness of six inches or less and a moisture content conducive to adequate compaction, usually ±2% of optimum Proctor moisture content. Mechanical methods should be used in placement of backfill; however, heavy equipment should be kept away from foundation walls. No water flooding techniques of any type should be used in compaction of backfill on the site. Trench backfill should be performed in accordance with El Paso County specifications. All excavating should be performed in accordance with OSHA guidelines.

Structural Fill

Any areas to receive fill should have all topsoil, organic material, or debris removed. Any uncontrolled fill should be recompacted prior to placing new fill. The surface should be scarified and moisture conditioned to within 2% of optimum moisture content and compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557, prior to placing new fill. New fill should be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95% of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be free of vegetation or other unsuitable material and shall not contain rocks or pieces greater than six (6) inches. Top soil and strippings should not be mixed in the structural fill. Fill material should be placed at a moisture content conducive to compaction, usually ±2% of Proctor optimum moisture content. Fill slopes should be constructed at no steeper than 3:1 and properly benched into native soils. The placement and compaction of fill should be observed and tested by the Soils Engineer during construction. Any import materials should be approved by the Soils Engineer prior to hauling to the site.

10.0 CLOSURE

It is our opinion that the existing geologic engineering and geologic conditions will impose some constraints on development and construction of the site. The geologic hazards identified on the site can either be avoided by development or satisfactorily mitigated through proper engineering design and construction practices. The report was prepared for the proposed development plan. Additional soils investigation is recommended as the development and grading plans are prepared to provide more detailed information on soil, groundwater and bedrock. In addition, foundation recommendations for the lots will be provided.

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. Discrepancies should be reported to Entech Engineering, Inc. soon after they are discovered so that the evaluation and recommendations presented can be reviewed and revised if necessary. Planning and design personnel should be made familiar with the contents of this report.

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

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

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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

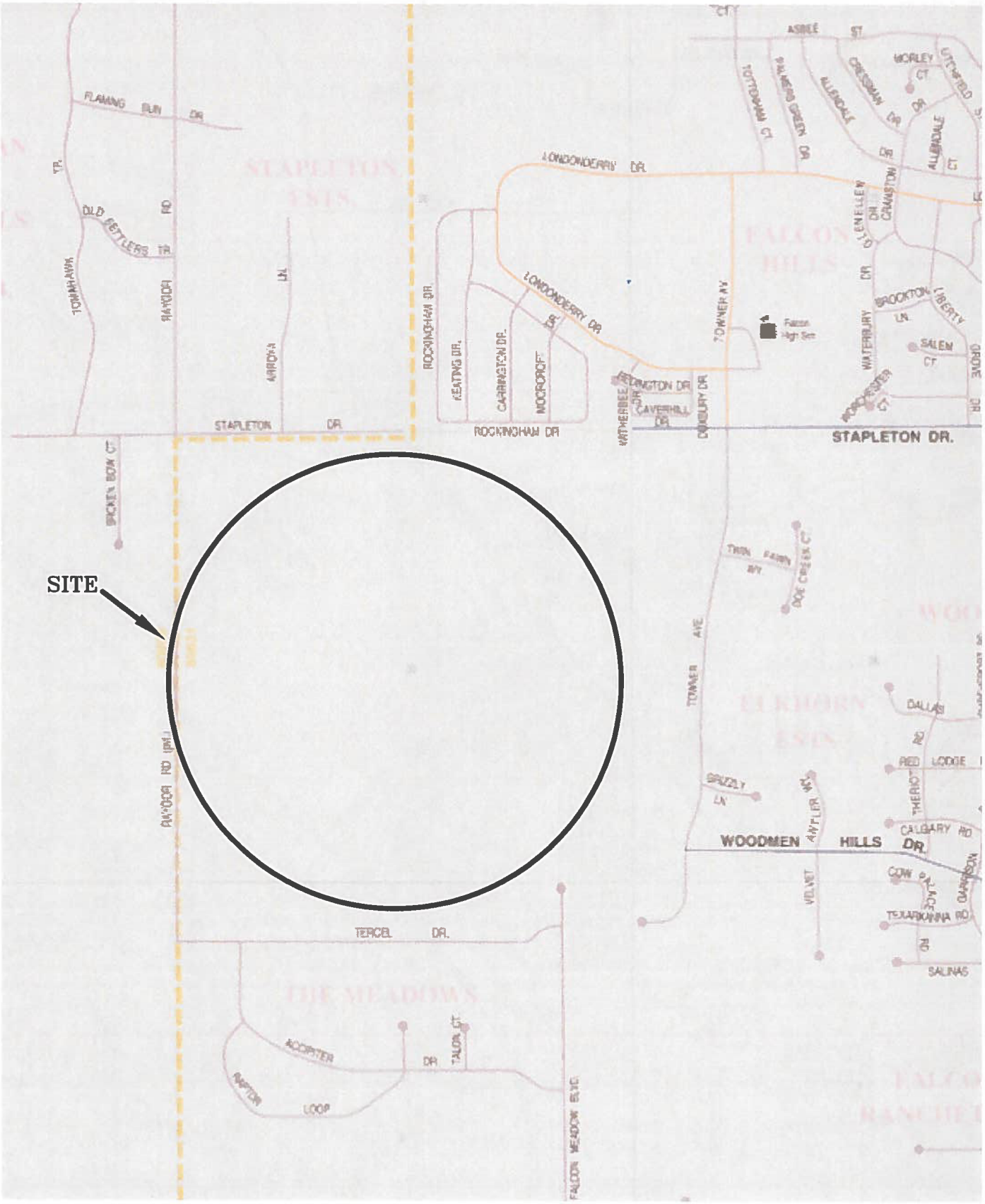
CLIENT PRI IV, LLC
PROJECT ELKHORN
JOB NO. 180549

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			5.2	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	3	5			7.0			<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	4	10			9.3						SM-SW	SAND, SLIGHTLY SILTY
1	4	15			32.6	28	10		360		SC	SAND, CLAYEY
2	2	20			22.7						SM	SANDSTONE, SILTY
2	5	5			10.0	NV	NP				SM-SW	SANDSTONE, SLIGHTLY SILTY
2	6	10			44.1			<0.01			SM	SANDSTONE, VERY SILTY

Table 2: Summary of Depth to Bedrock and Groundwater

Test Boring No.	Depth to Bedrock (ft.)	Depth to Groundwater (ft.)
1	>20	17
2	16	>20
3	>20	19
4	16	11
5	1	18.5
6	2	8

FIGURES



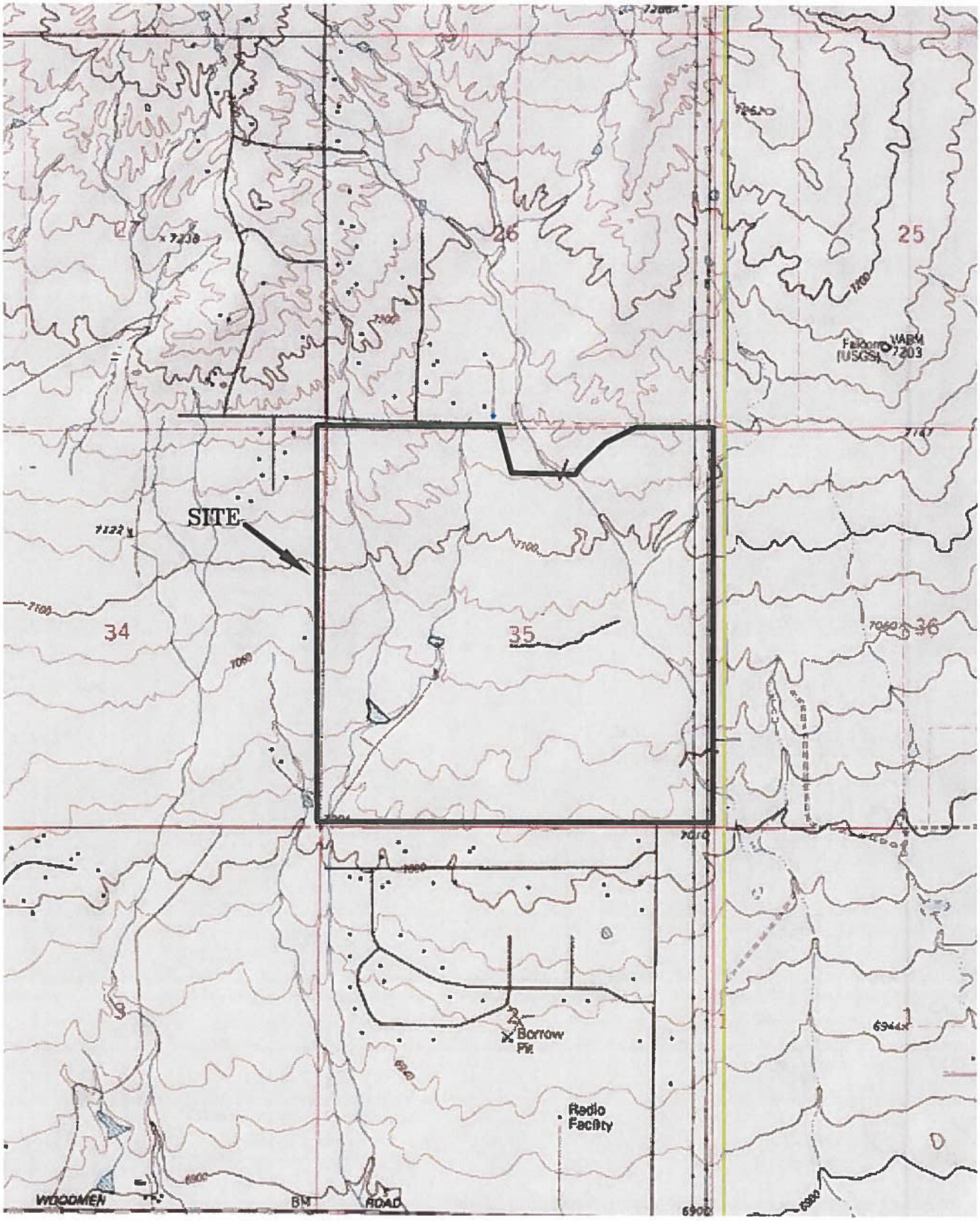
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

Vicinity Map
The Ranch
El Paso County, CO.
For: PRI IV, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	5/18/18		5/23/18

JOB NO.: 180549

FIG NO.: 1



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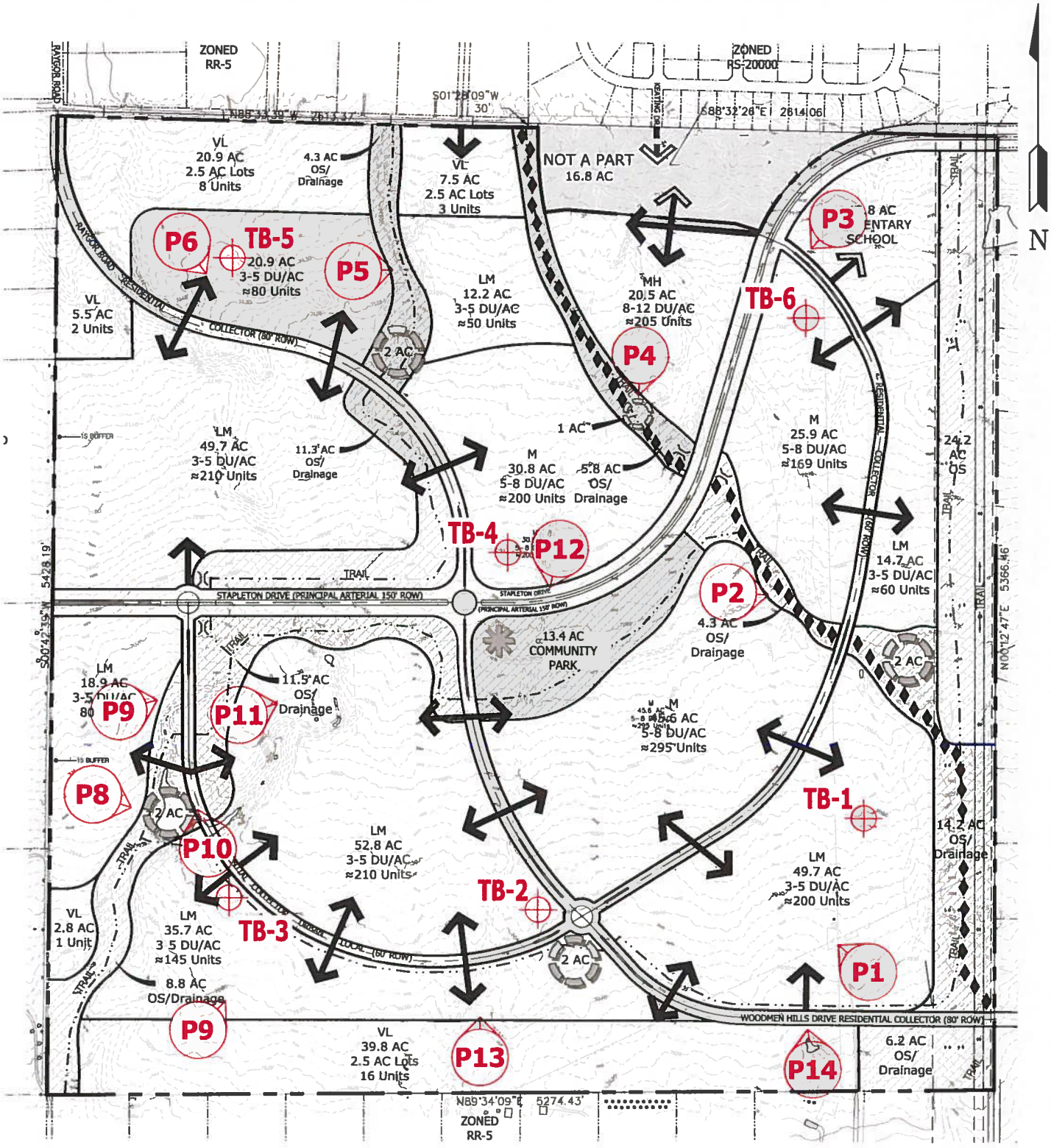
COLORADO SPRINGS, CO. 80907 (719) 531-5599

USGS Map
The Ranch
El Paso County, CO.
For: PRI IV, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	5/18/18		5/22/18

JOB NO.: 180549

FIG NO.: 2



P1 – APPROXIMATE LOCATION AND DIRECTION OF PHOTOS

TB-2 – APPROXIMATE LOCATION AND NUMBER OF TEST BORINGS

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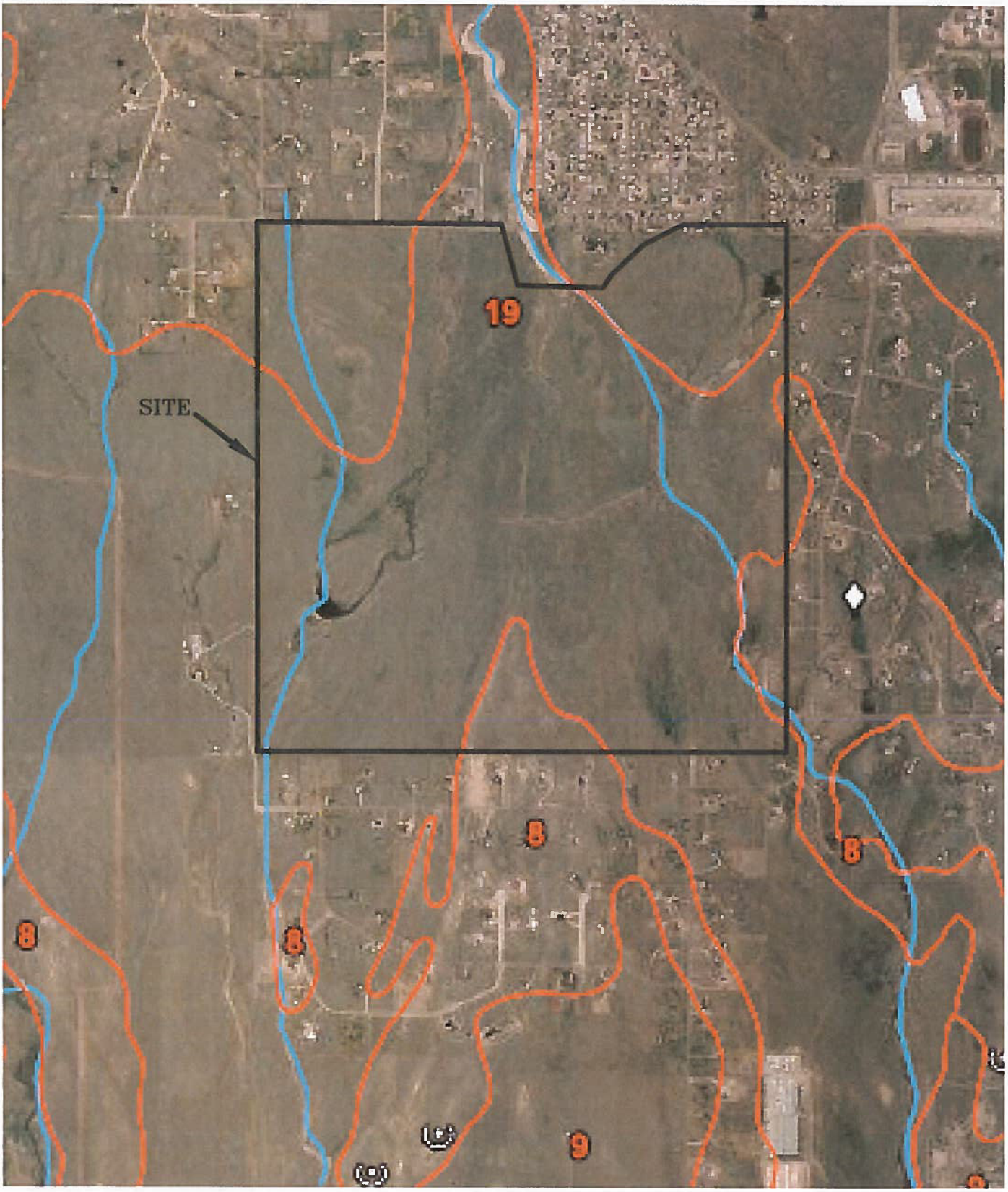
SKETCH PLAN/TEST BORING PLAN
THE RANCH
EL PASO COUNTY, CO
FOR: PRI IV, LLC

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
TLC	5/29/18	KAH	KAH

JOB NO.: 180549

FIG. NO.: 3



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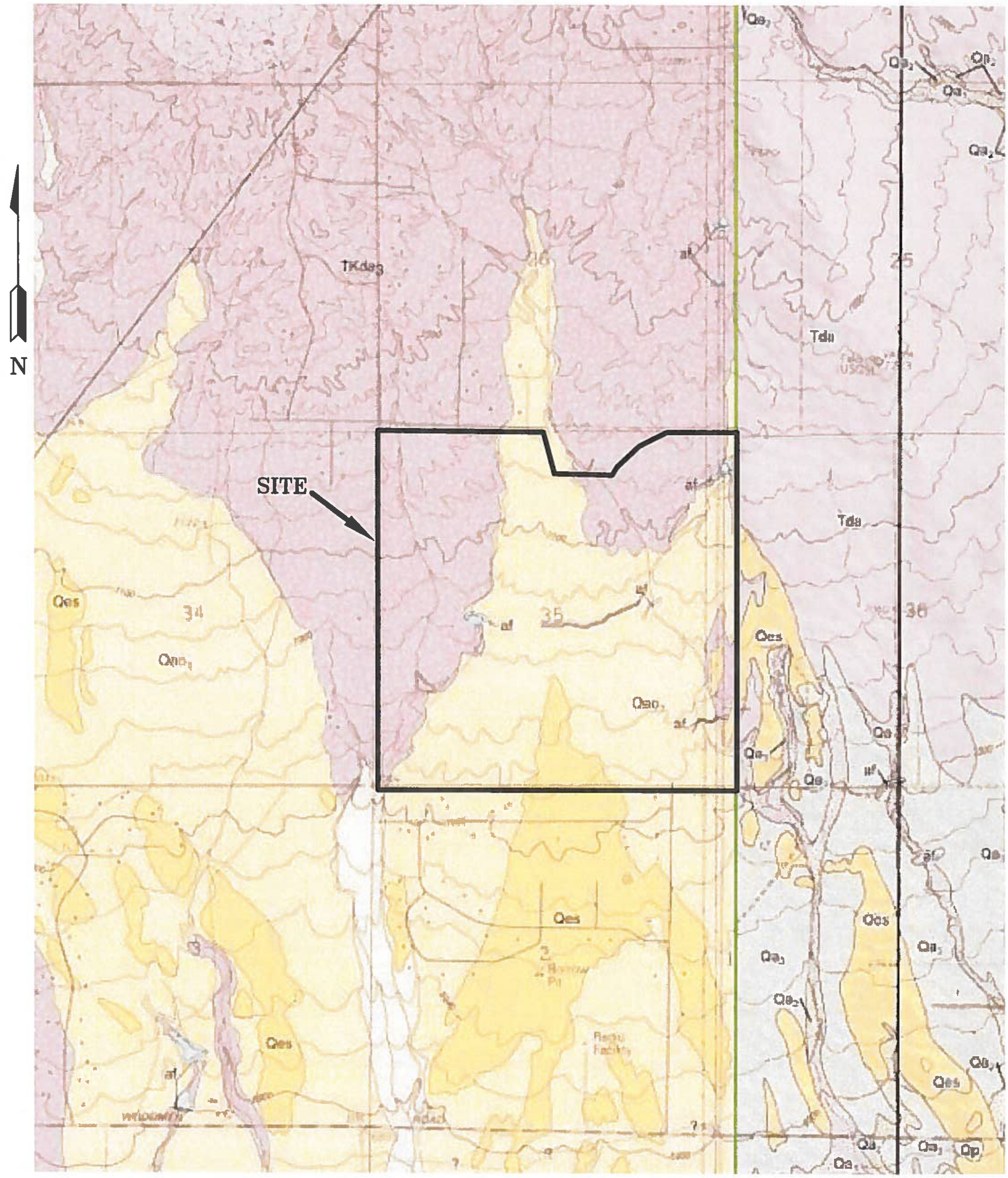
COLORADO SPRINGS, CO. 80907 (719) 531-5599

Soil Survey Map
The Ranch
El Paso County, CO.
For: PRI IV, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	5/18/18		5/23/18

JOB NO.: 180549

FIG NO.: 4



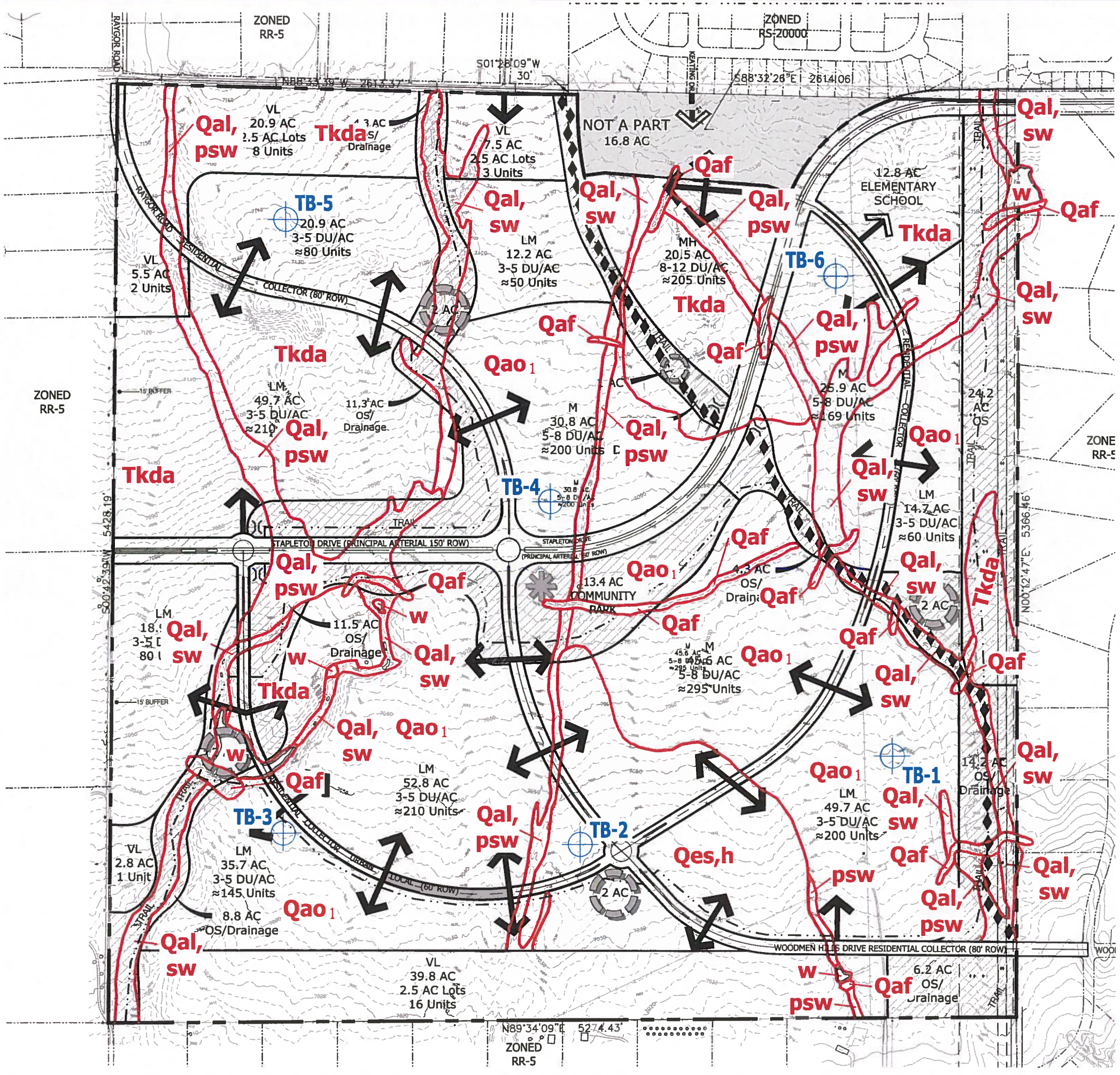
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

Falcon NW Quadrangle Geology Map
The Ranch
El Paso County, CO.
For: PRI IV, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	5/18/18	[signature]	5/23/18

JOB NO.: 180549

FIG NO.: 5



LEGEND

- Qaf - **Artificial Fill Deposits of Holocene Age:** Man-made fill deposits
- Qal - **Recent Alluvium of Holocene Age:** Recent water deposited materials
- Qao_1 - **Old Alluvium One of Quaternary Age:** Water deposited sand, terrace deposits
- Qes - **Eolian Sand of Quaternary Age:** Wind blown sand deposits
- Tkda - **Dawson Formation of Tertiary and Cretaceous Age:** Arkosic sandstone with siltstone and claystone lenses
- h - hydrocompaction
- psw - potentially seasonal shallow groundwater area
- sw - seasonal shallow groundwater area
- w - areas of ponded water

N

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

GEOLOGY/ENGINEERING
GEOLOGY MAP
THE RANCH
EL PASO COUNTY, CO.
FOR: PRI IV, LLC

DRAWN	TLC
CHECKED	KAH
DATE	5/29/18
SCALE	NTS
JOB NO.	180549
FIGURE No.	6

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR 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 sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

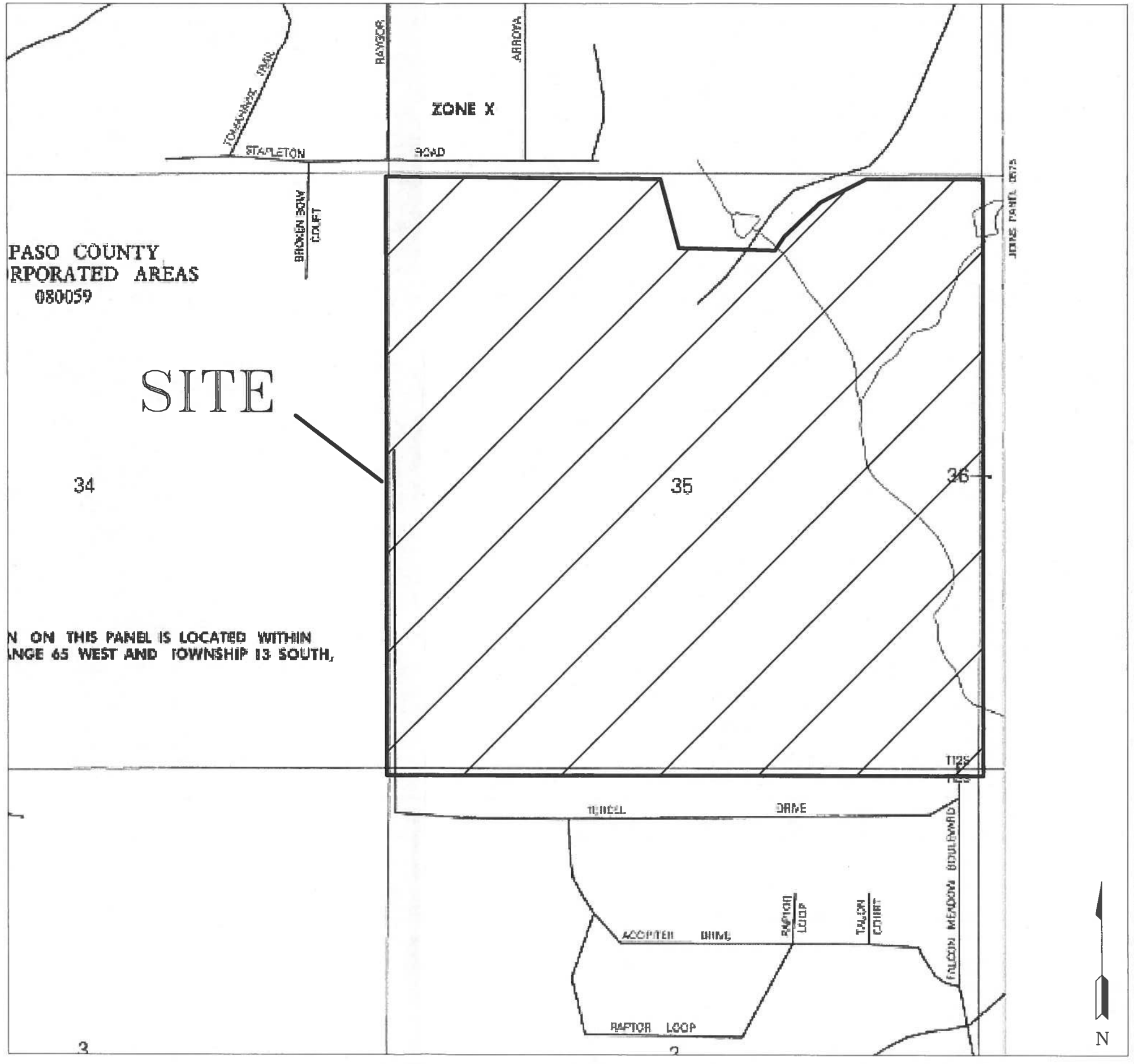
D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × — Elevation Reference Mark

● M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.



N ON THIS PANEL IS LOCATED WITHIN
NGE 65 WEST AND TOWNSHIP 13 SOUTH,

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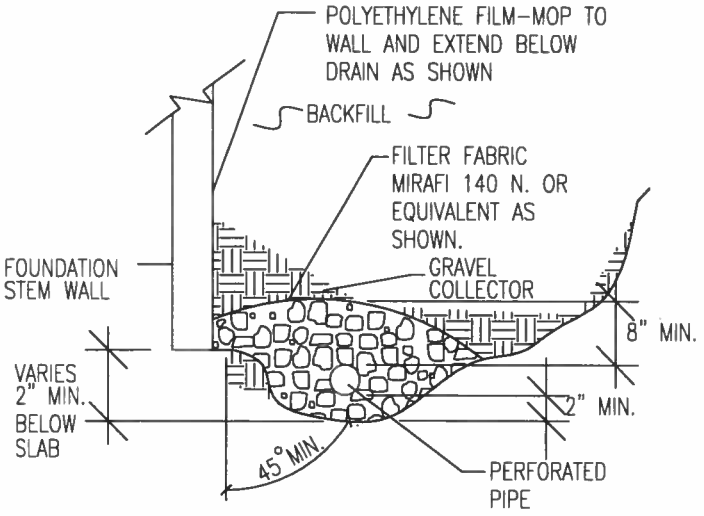
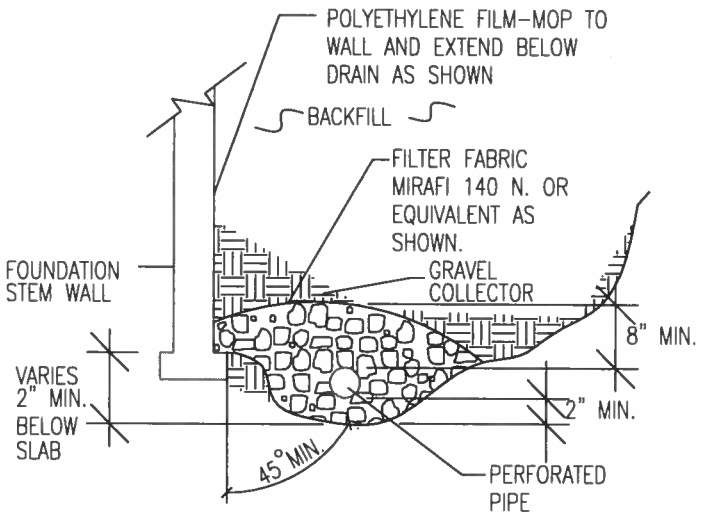
COLORADO SPRINGS, CO. 80907

Floodplain Map
The Ranch
El Paso County, CO.
For: PRI IV, LLC

DRAWN	KAH
CHECKED	
DATE	5/16/18
SCALE	AS SHOWN
JOB NO.	180549
FIGURE No.	7





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.

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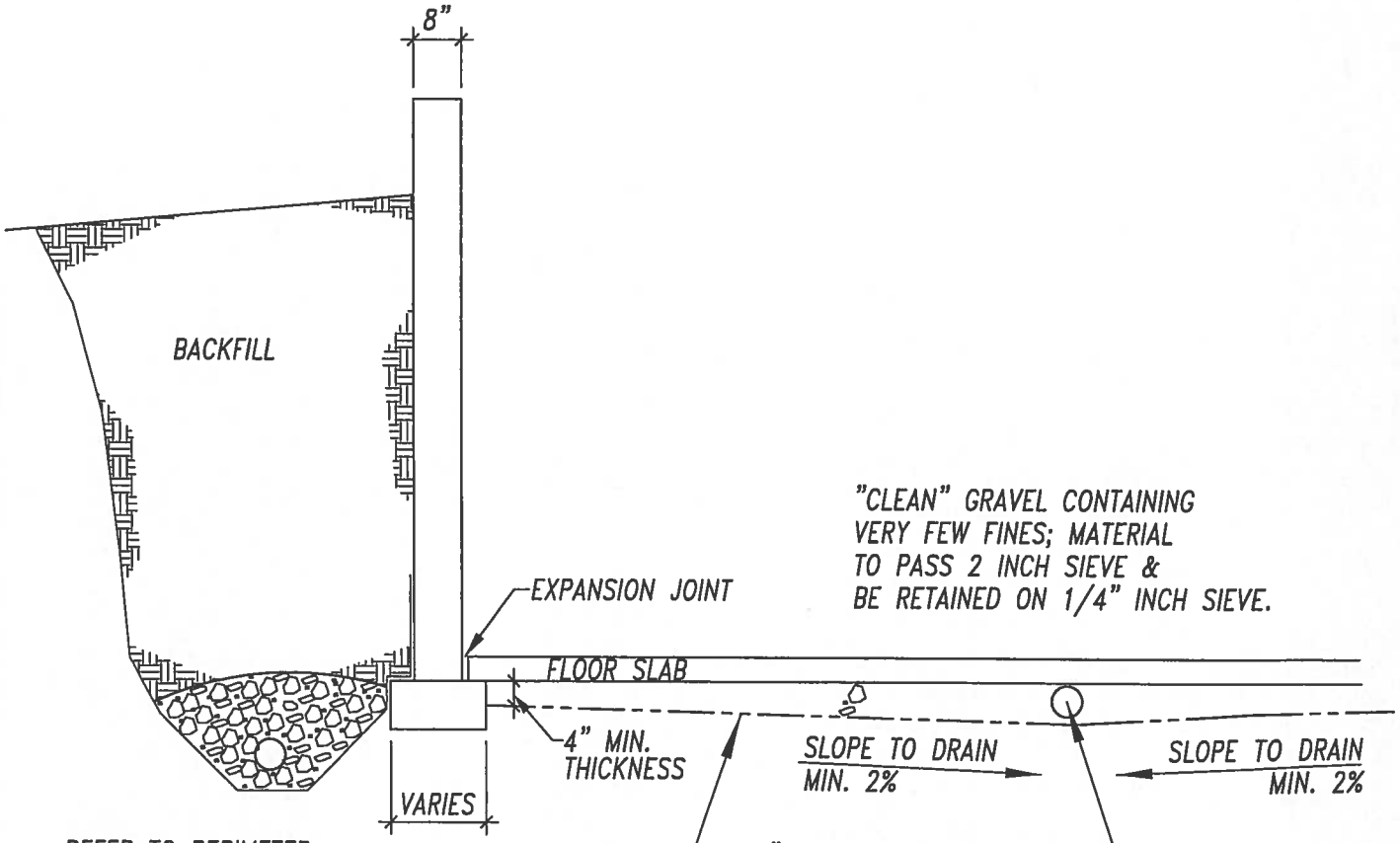
PERIMETER DRAIN DETAIL

DRAWN:	DATE: 5/23/18	DESIGNED:	CHECKED:

JOB NO.: 180549

FIG NO.: 8



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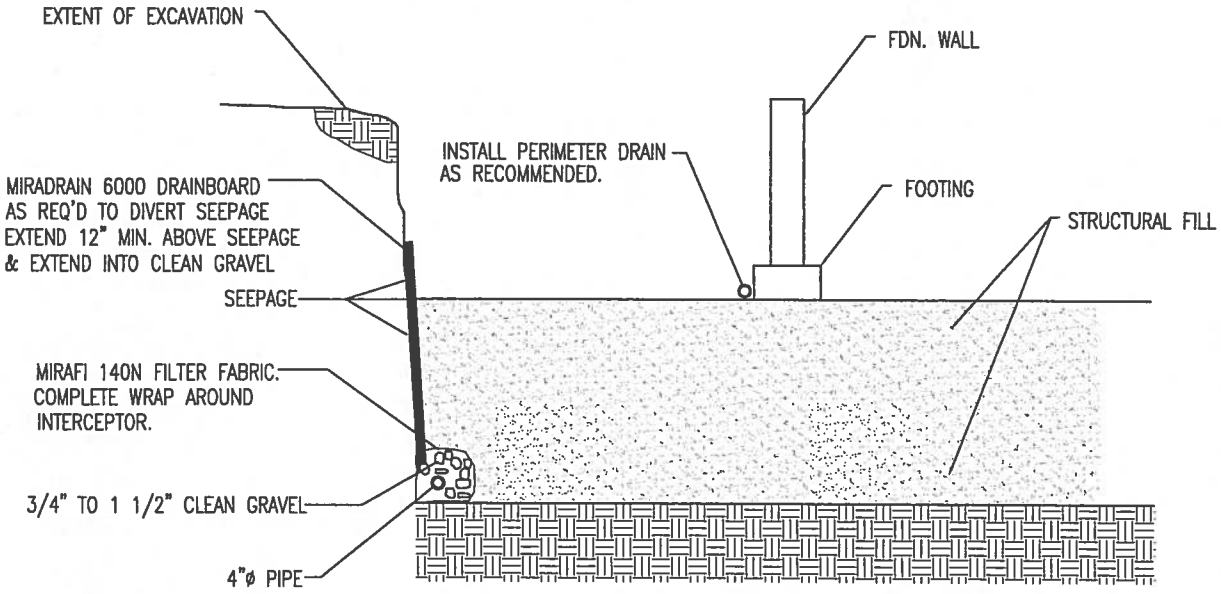
TYP. UNDERSLAB DRAINAGE
LAYER (CAPILLARY BREAK)

DRAWN:	DATE: 5/23/18	DESIGNED:	CHECKED:

JOB NO.: 180549

FIG NO.: 9



NOTE:
EXTEND INTERCEPTOR DRAIN TO DAYLIGHT

INTERCEPTOR DRAIN DETAIL

N.T.S.

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

INTERCEPTOR DRAIN DETAIL			
DRAWN BY:	DATE DRAWN:		CHECKED:

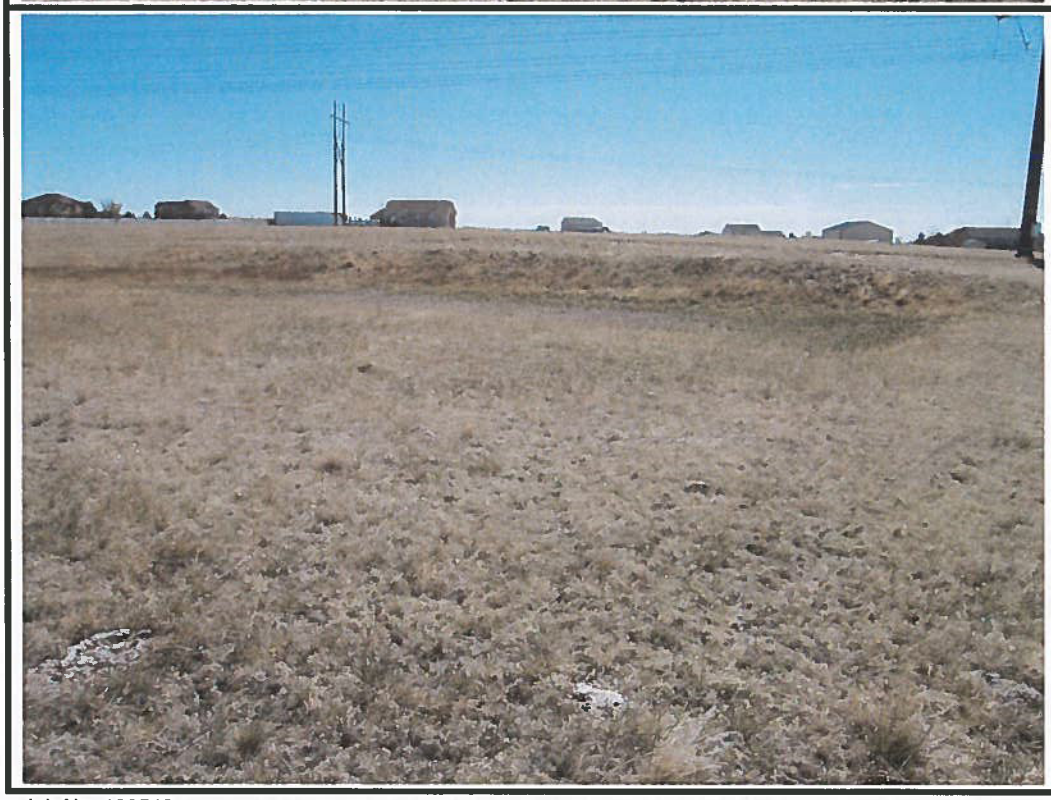
JOB NO.: 180549
FIG. NO.: 10

APPENDIX A: Site Photographs

1

Looking northwest from southeast portion of the site.

May 8, 2018



2

Looking southeast at dam in east-central portion of the site.

May 8, 2018

Job No. 180549

3

Looking southwest from northeast portion of the site.

May 8, 2018

4

Looking south from the north-central portion of the site.

May 8, 2018

Job No. 180549

5

Looking east from the northwest portion of the site.

May 8, 2018

6

Looking southeast from the northwest portion of the site.

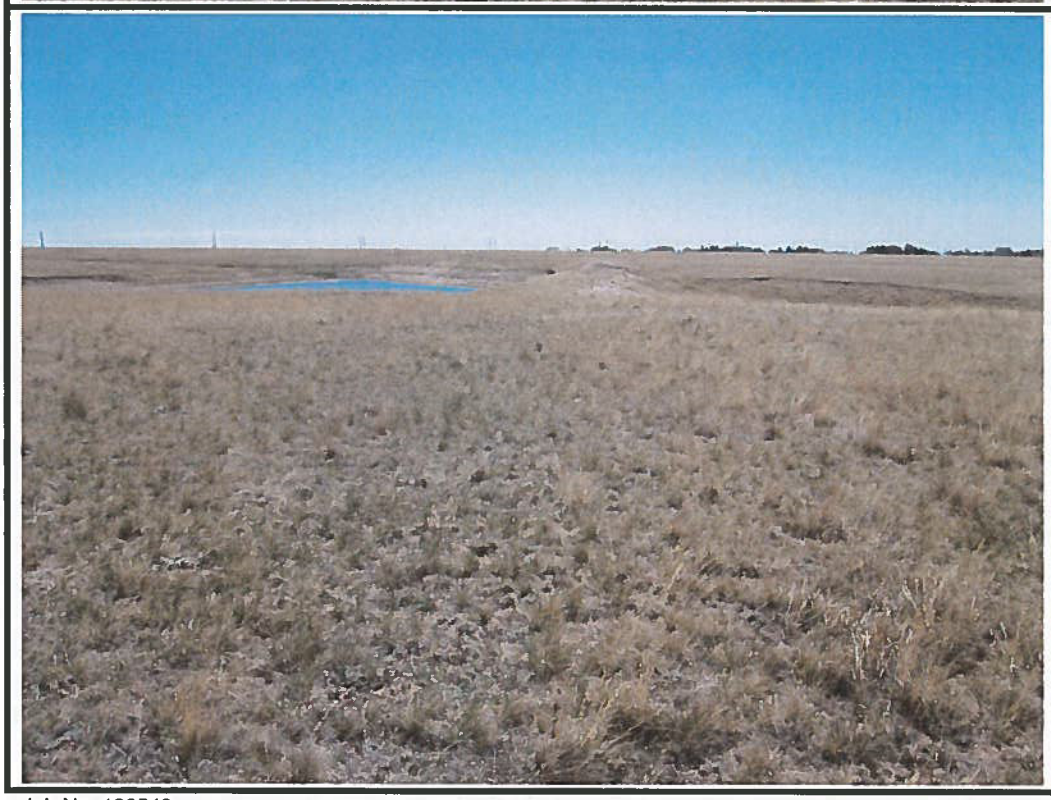
May 8, 2018

Job No. 180549

7

Looking northeast at drainage in the southwest portion of the site.

May 8, 2018



8

Looking east towards pond in the southwest portion of the site.

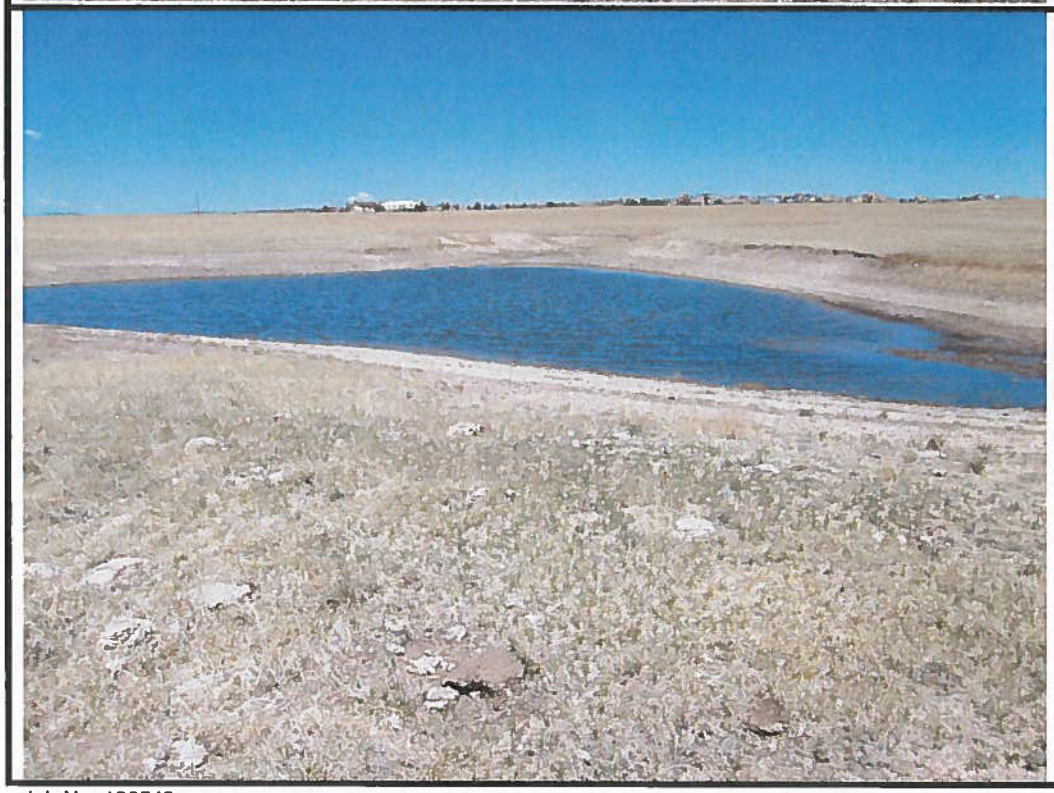
May 8, 2018

Job No. 180549

9

Looking northeast from the southwest portion of the site.

May 8, 2018



10

Looking northwest at pond in the southwest portion of the site.

May 8, 2018

Job No. 180549

11

Looking east at drainage in the southwest portion of the site.

May 8, 2018

12

Looking south from the central portion of the site.

May 8, 2018

Job No. 180549

13

Looking north from the central portion of the site.

May 8, 2018

14

Looking north at ponded water in the southeast portion of the site.

May 8, 2018

Job No. 180549

APPENDIX B: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 3/21/2018
Job # 180549

REMARKS

WATER @ 17', 3/22/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			14	1.5	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST TO WET
5			15	2.9	1	
10			11	5.6	1	
15			15	10.5	1	
20			19	16.8	1	

TEST BORING NO. 2
DATE DRILLED 3/21/2018
CLIENT PRI IV, LLC
LOCATION ELKHORN

REMARKS

DRY TO 20', 3/22/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			5	5.5	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, LOOSE, MOIST TO VERY MOIST
5			5	6.9	1	
10			8	5.2	1	
15			9	10.6	1	CLAYEY LENSES
						SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST
20			50/9"	10.3	2	

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549
FIG NO.: B-1

TEST BORING NO. 3
DATE DRILLED 3/21/2018
Job # 180549

REMARKS

WATER @ 19', 3/22/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			6	4.9	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, LOOSE TO MEDIUM DENSE, MOIST TO VERY MOIST
5			8	4.4	1	
10			17	3.1	1	
15			16	4.1	1	
20			28	11.4	1	

TEST BORING NO. 4
DATE DRILLED 3/21/2018
CLIENT PRI IV, LLC
LOCATION ELKHORN

REMARKS

WATER @ 11', 3/22/18

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			9	3.2	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, LOOSE TO MEDIUM DENSE, MOIST TO WET
5			12	4.1	1	
10			12	7.3	1	
15			10	14.6	1	SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, WET
20			50/11"	11.5	2	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST

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COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549
FIG NO.: B-2

TEST BORING NO. 5
DATE DRILLED 3/21/2018
Job # 180549

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 18.5', 3/22/18						
SAND, SILTY, TAN						1
SANDSTONE, SLIGHTLY SILTY TO SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST TO WET				50	7.9	2
	5			50 9"	9.2	2
	10			50 10"	10.6	2
	15			50 7"	9.3	2
	20			50 7"	14.4	2

TEST BORING NO. 6
DATE DRILLED 3/21/2018
CLIENT PRI IV, LLC
LOCATION ELKHORN

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 8', 3/22/18						
SAND, SILTY, TAN						1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST				50	5.9	2
	5			50 10"	11.9	2
SANDSTONE, VERY SILTY, FINE GRAINED, TAN, VERY DENSE, MOIST TO WET						
	10			50 7"	12.4	2
SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, WET						
	15			50 6"	11.2	2
	20			50 5"	11.3	2

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COLORADO SPRINGS, COLORADO 80907

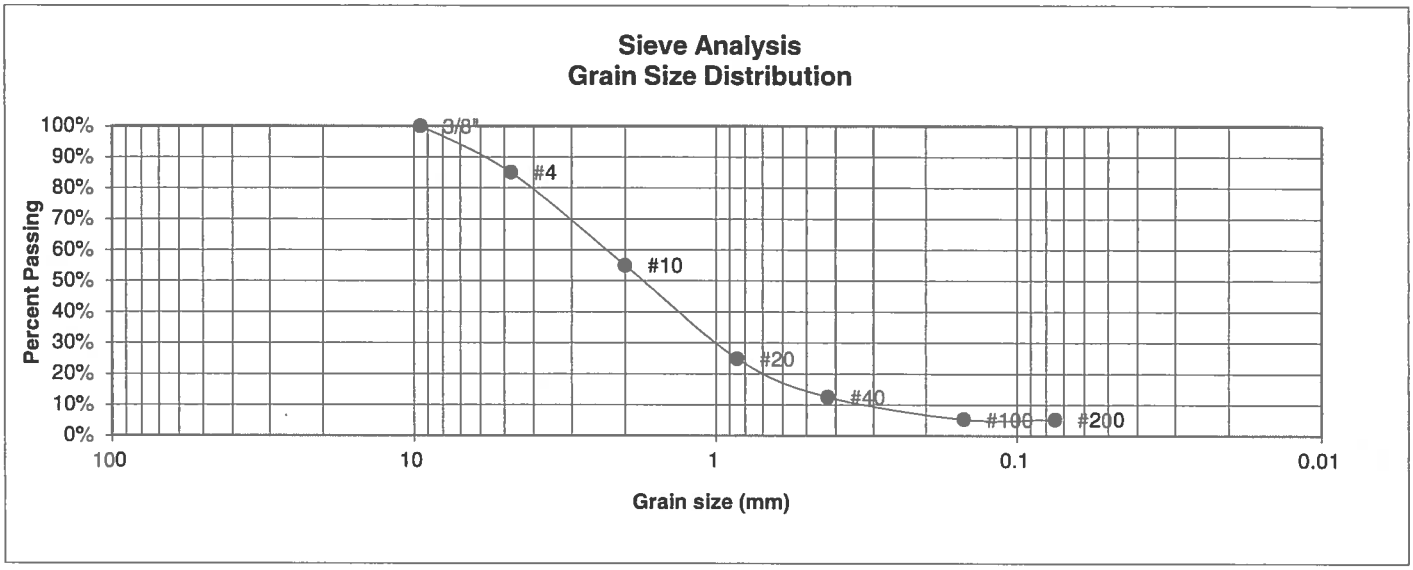
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549
FIG NO.: B-3

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PRI IV, LLC
SOIL TYPE #	1	PROJECT	ELKHORN
TEST BORING #	1	JOB NO.	180549
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	85.0%
10	55.0%
20	24.9%
40	12.5%
100	5.3%
200	5.2%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

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

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

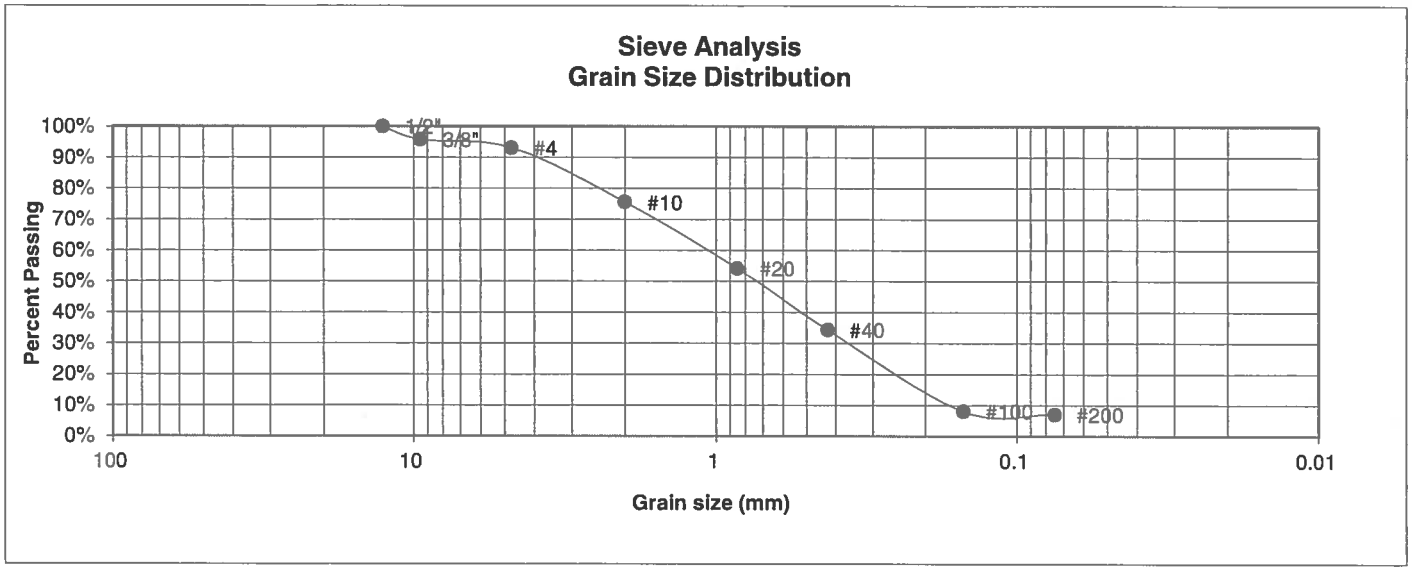
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549

FIG NO.: C-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PRI IV, LLC
SOIL TYPE #	1	PROJECT	ELKHORN
TEST BORING #	3	JOB NO.	180549
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.8%
4	93.1%
10	75.6%
20	54.2%
40	34.3%
100	8.1%
200	7.0%

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

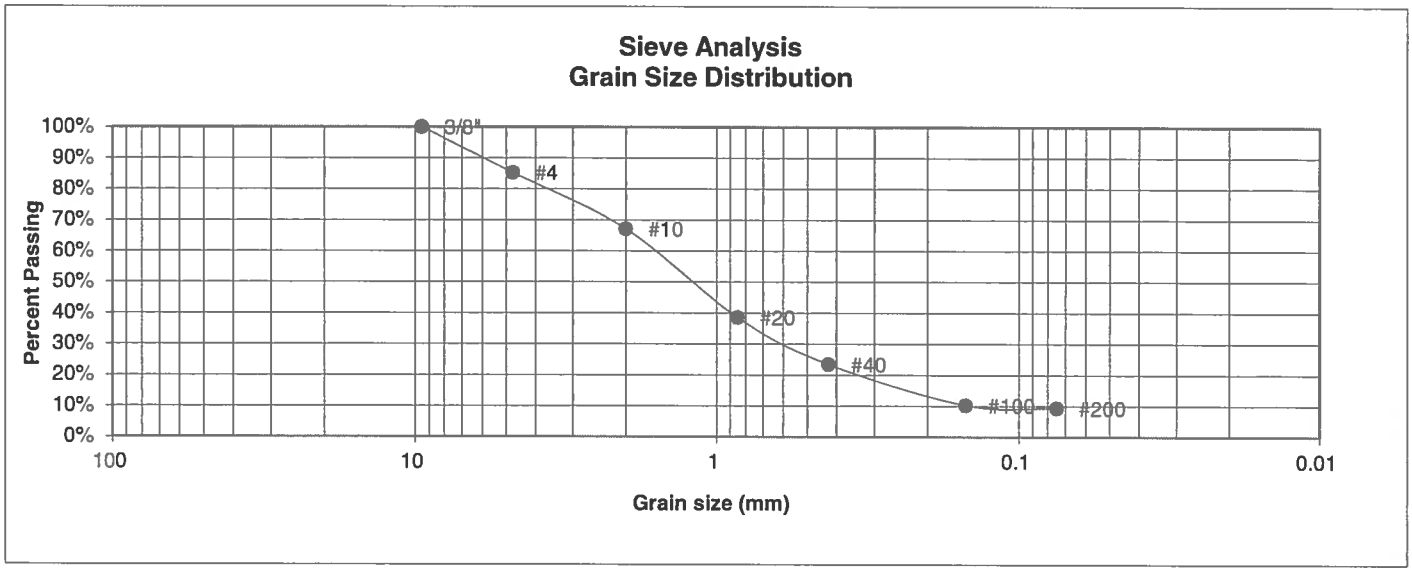
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549

FIG NO.: C-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PRI IV, LLC
SOIL TYPE #	1	PROJECT	ELKHORN
TEST BORING #	4	JOB NO.	180549
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	85.2%
10	67.1%
20	38.6%
40	23.4%
100	10.3%
200	9.3%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

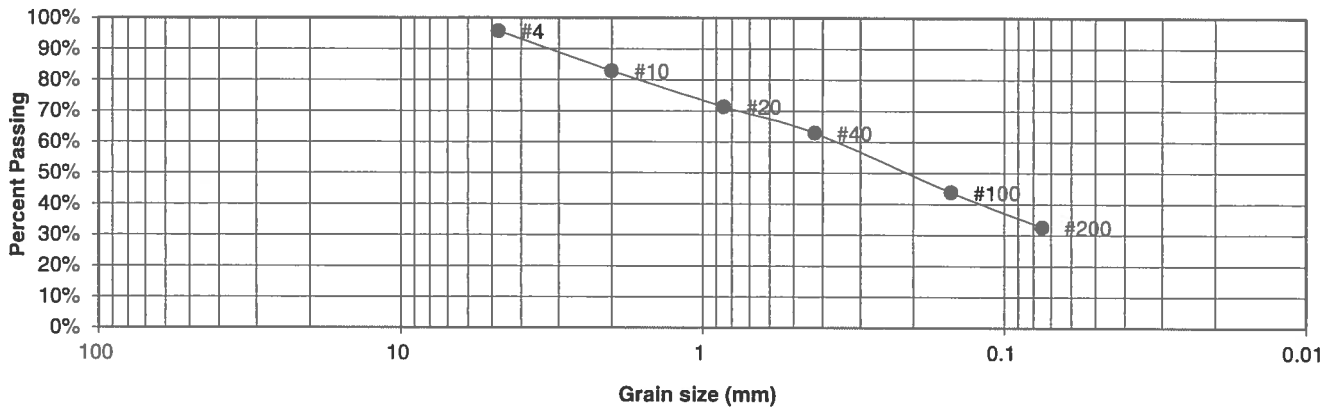
DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549

FIG NO.: C-3

UNIFIED CLASSIFICATION	SC	CLIENT	PRI IV, LLC
SOIL TYPE #	1	PROJECT	ELKHORN
TEST BORING #	4	JOB NO.	180549
DEPTH (FT)	15	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	95.8%
10	82.9%
20	71.3%
40	62.9%
100	43.8%
200	32.6%

Atterberg Limits	
Plastic Limit	18
Liquid Limit	28
Plastic Index	10

Swell	
Moisture at start	10.1%
Moisture at finish	17.3%
Moisture increase	7.2%
Initial dry density (pcf)	109
Swell (psf)	360

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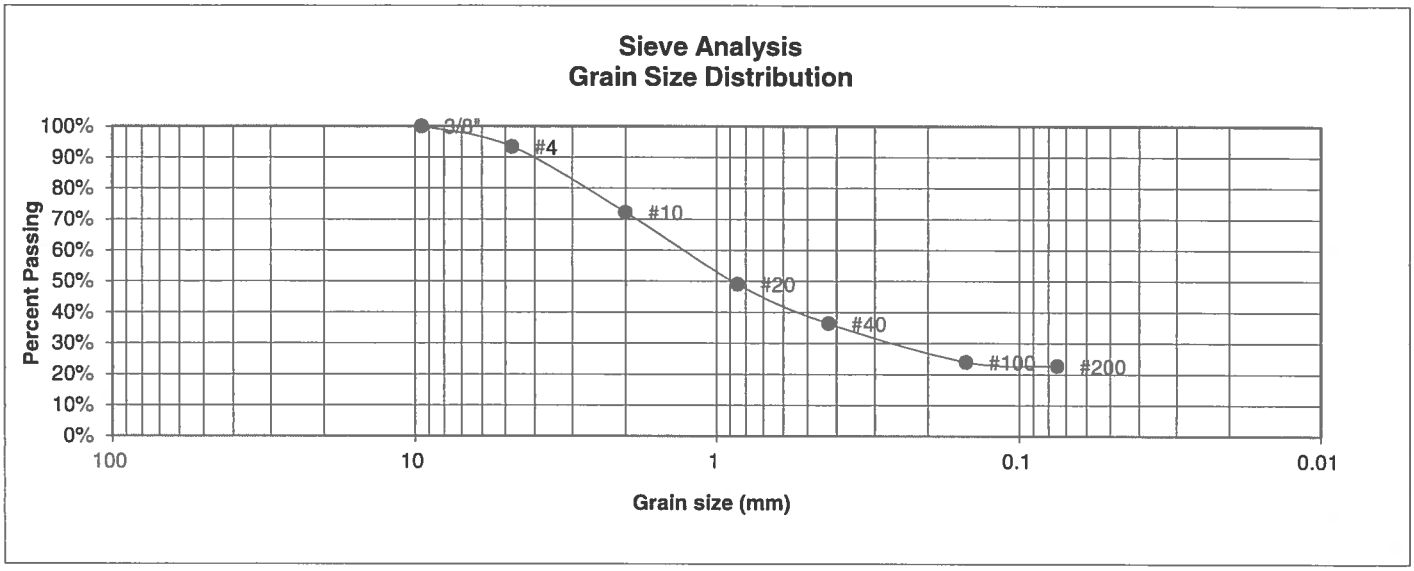
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/4/18

JOB NO.: 180549

FIG NO.: C-4

UNIFIED CLASSIFICATION	SM	CLIENT	PRI IV, LLC
SOIL TYPE #	2	PROJECT	ELKHORN
TEST BORING #	2	JOB NO.	180549
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.4%
10	72.2%
20	49.0%
40	36.4%
100	24.0%
200	22.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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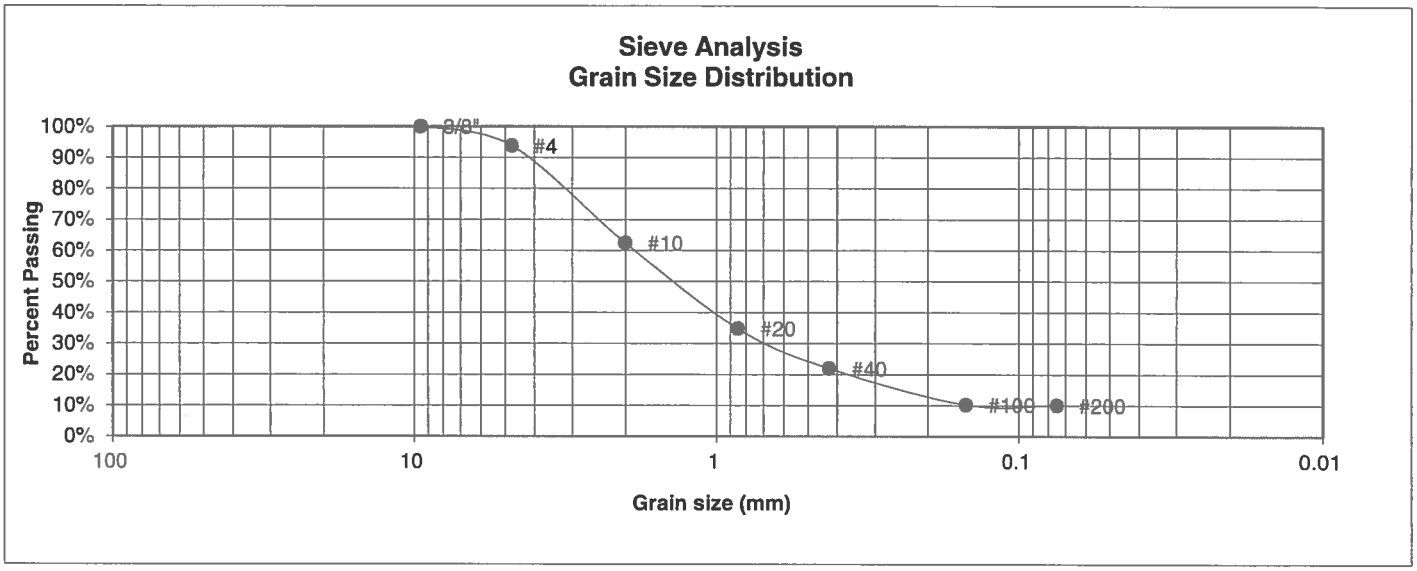
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/4/18

JOB NO.: 180549

FIG NO.: C-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PRI IV, LLC
SOIL TYPE #	2	PROJECT	ELKHORN
TEST BORING #	5	JOB NO.	180549
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.8%
10	62.5%
20	34.8%
40	21.9%
100	10.2%
200	10.0%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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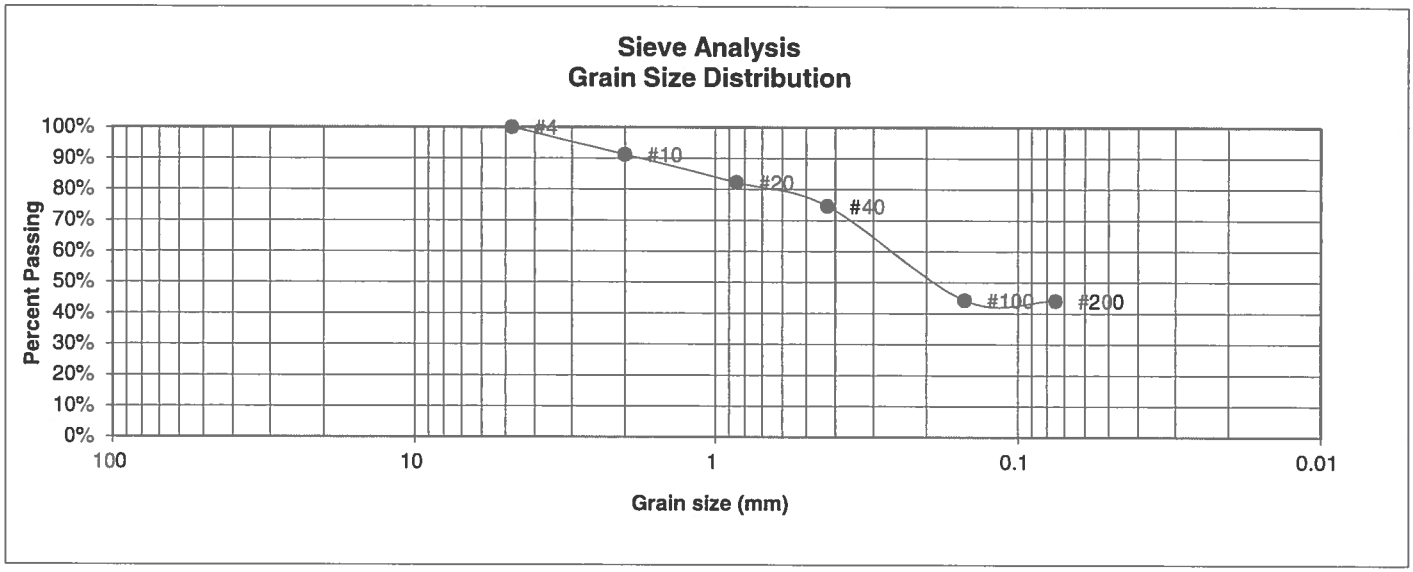
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549

FIG NO.: C-6

UNIFIED CLASSIFICATION	SM	CLIENT	PRI IV, LLC
SOIL TYPE #	2	PROJECT	ELKHORN
TEST BORING #	6	JOB NO.	180549
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	91.2%
20	82.2%
40	74.6%
100	44.3%
200	44.1%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/11/18

JOB NO.: 180549

FIG NO.: C-7

CLIENT	PRI IV, LLC	JOB NO.	180549
PROJECT	ELKHORN	DATE	4/2/2018
LOCATION	ELKHORN	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	5	1	SM-SW	<0.01
TB-6	10	2	SM	<0.01

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			4/4/18

JOB NO.: 180549

FIG NO.: C-8

APPENDIX D: Soil Survey Descriptions

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 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 to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
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 15, Oct 10, 2017

El Paso County Area, Colorado

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Fan terraces, fans, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Gravelly Foothill (R049BY214CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit:
Landform: Swales

Hydric soil rating: Yes

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 15, Oct 10, 2017

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

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 15, Oct 10, 2017

8—Blakeland loamy sand, 1 to 9 percent slopes. This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

19—Columbine gravelly sandy loam, 0 to 3 percent slopes. This deep, well drained to excessively drained soil formed in coarse textured material on alluvial terraces and fans and on flood plains. Elevation ranges from 6,500 to 7,300 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown gravelly sandy loam about 14 inches thick. The underlying material is light yellowish brown very gravelly loamy sand.

Included with this soil in mapping are small areas of Stapleton sandy loam, 3 to 8 percent slopes; Blendon sandy loam, 0 to 3 percent slopes; Louviers silty clay loam, 3 to 18 percent slopes; and Fluvaquentic Haplaquolls, nearly level. In places the parent arkose beds of sandstone or shale are at a depth of 0 to 40 inches.

Permeability of this Columbine soil is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is slow, and the hazard of erosion is slight to moderate.

This soil is used mainly for grazing livestock and for wildlife habitat. It is also used for homesites.

Native vegetation is mainly western wheatgrass, sideoats grama, needleandthread, and little bluestem. The main shrub is true mountainmahogany.

Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the principal limitations to the establishment of trees and shrubs. The soil is so loose that trees need to be planted in the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

Rangeland wildlife, such as pronghorn antelope, cottontail, coyote, and scaled quail, is best adapted to life on this droughty soil. Forage production is typically loam, and proper livestock grazing management is necessary if wildlife and livestock share the range. Livestock watering developments are also important and are used by various wildlife species.

The main limitation of this soil for urban development is a hazard of flooding in some areas. Care must be taken when locating septic tank absorption fields because of possible pollution as a result of the very rapid permeability of this soil. Capability subclass VIe.

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes, along drainageways; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkose beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil is well suited for use as homesites. Erosion control practices are needed to control soil blowing and water erosion on construction sites where the ground cover has been removed. Capability subclass IVe.