GEOLOGIC HAZARD EVALUATION
STERLING RANCH RESIDENTIAL
EL PASO COUNTY, COLORADO

When project specif report is submitted; staff will review.

Please review Section 8.4.9 of the Code and the pertinent sections of the ECM. Revise report for the preliminary plan. This report was completed for the SKP.

Basements are proposed- Check groundwater for this legal descr. in GEO report- Identify any lots that need mitigated...

ENTECH
ENGINEERING, INC.

ENTECH
ENGINEERING, INC.

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

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GEOLOGIC HAZARD EVALUATION
STERLING RANCH RESIDENTIAL
EL PASO COUNTY, COLORADO

Prepared for

Morley-Bentley Investments, LLC
20 Boulder Crescent Street, Suite 200
Colorado Springs, Colorado 80903

Attn: Virgil Sanchez

January 20, 2009

Respectfully Submitted,

ENTECH ENGINEERING, INC.

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

Reviewed by:

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

COLORADO REGISTERED
JOSEPH COLLIN GOODE JR.
23725
PROFESSIONAL ENGINEER

KAH/mf

Encl.

Entech Job No. 30898
2MSW/rep/2008/Geo/30898GeohazEval

TABLE OF CONTENTS

1.0 SUMMARY

Project Location:

The project lies in portions of Sections 32 and 33, Township 12 South, Range 65 West of the 6th Principal Meridian. The site is located east of Vollmer Road and north of Woodmen Road in El Paso County, Colorado.

Project Description:

Total acreage involved in the project is approximately 200 acres. The proposed development is to consist of single-family residential with a school, parks, and open space. The development will be serviced by Woodmen Hills Metropolitan District.

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.

Land Use and Engineering Geology:

The site was found to be suitable for development. Geologic conditions will impose some constraints on development. These include areas of artificial fill, hydrocompaction and loose or potentially collapsible soils, unstable slopes, potentially unstable slopes, expansive soils, floodplain, areas of ponded water, shallow groundwater, seasonally shallow groundwater areas and potentially seasonally shallow groundwater areas. The unstable slopes, potentially unstable slopes, artificial fill, areas of ponded water, and floodplains are associated with a drainage along the eastern portion of the site. Areas of shallow groundwater may also be encountered in the southwestern portion of the site as well as minor drainages. 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 portions of Sections 32 and 33, Township 12 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is located east of Vollmer Road approximately one mile north of Woodmen Road. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the site is generally gently to moderately sloping to the south with some steep slopes along Sand Creek, which flows in a southerly direction along the eastern boundary of the site. No water was observed flowing in Sand Creek at the time of this investigation; however, areas of ponded water were observed in portions of the drainage. Other minor drainages exist on the site. No water was observed flowing in any of the minor drainages at the time of this investigation. The area of the site is indicated on the USGS Map, Figure 2. Previous site uses have included grazing and pasture lands with roadways that lead to existing sand and gravel quarries to the east of the site. The site contains primarily low field grasses, weeds and with scattered deciduous trees and shrubs in the drainage areas. An Aerial Photograph of the site is presented in Figure 3.

Total acreage involved in the proposed development is approximately 200 acres. The proposed development is single-family residential with a school, parks and open space. The development is to be serviced by Woodmen Hills Metropolitan District. The sketch plan for the entire Sterling Ranch is presented in Figure 4. The single-family residential portion that was evaluated as a part of this study is also indicated on Figure 4. The development plan for the residential portion is presented in Figure 5. Site photographs, taken on September 6, 2006 and December 8, 2008, are included in Appendix A. The approximate locations and directions of the photographs are indicated on Figure 5.It is our understanding there will be some creek bank stabilization with drainage improvements and a regional trail corridor constructed in the area of the existing Sand Creek drainage along the eastern boundary of the site. Grading Plans were not available at the time of this investigation.

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.

4.0 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of bedrock features and significant surficial deposits. The Natural Resources Conservation Service (Reference 1), previously the Soil Conservation Service (Reference 2) survey was reviewed to evaluate the site. Additionally, a Geologic and Engineering Geologic Study prepared by Charles J. Robinson and Associates in 1977 for El Paso County Planning Department was reviewed to evaluate the site (References 3 and 4).

The positions 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, 45 test borings were drilled by Entech Engineering, Inc. as a part of a Geologic Hazard/Land Use and Preliminary Subsurface Soil Investigation for the entire Sterling Ranch Subdivision (Reference 5). Six (6) of these test borings were located on the single-family residential portion of the site. The borings were drilled with a power driven continuous flight auger drill rig to 15 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 Plan, Figure 5 and on the Geology Map, Figure 8. 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. Swell tests included both FHA Swell Testing and Swell/Consolidation Testing. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

Geologic Hazard Studies were performed by Entech Engineering, Inc. for Wolf Ranch which lies west of the site (References 6 and 7). Geologic Hazard Studies were also performed by Entech Engineering, Inc. for Highland Park which lies north and northwest of the site (References 8 and 9). Information from these reports was used in evaluating the site.

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 10 miles to the west is a major structural feature known as 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 northeasterly direction (Reference 10). The rocks in the area of the site are sedimentary in nature, and typically Tertiary to Cretaceous in age. The bedrock underlying the site itself is the Dawson Formation. Overlying the Dawson Formation 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 Survey*

The Natural Resources Conservation Service (Reference 1), previously the Soil Conservation Service (Reference 2) has mapped three soil types on the site (Figure 6). In general, the soils range from sandy and gravelly loam to loamy sand. Soils are described as follows:

Soil Type	Description
8	Blakeland loamy sand, 1-9% slopes: Dark grayish brown loamy sand and grading to pale brown sand. Permeability is rapid. Erosion is moderate with soil blowing hazard severe. Good potential for urban development.
9	Blakeland Complex, 1-9% slopes: Dark grayish brown loamy sand underlain by brown to pale brown loamy sand. This complex includes 60% Blakeland Soils, 30% Fluvaquentic Haplaquolls and 10% other soils. Permeability is rapid. Erosion hazard is moderate. Blakeland Soil has good potential for home sites. Limitation to development on Fluvaquentic Haplaquolls includes the hazard of flooding.
71	Pring coarse sandy loam, 3-8% slopes: Dark grayish brown to brown coarse sandy loam. Permeability is rapid. Erosion hazard is moderate. Good potential for home sites.

Complete descriptions of the soils are presented in Appendix D. The soils have generally been described to have rapid permeabilities. Limitations to development are varied on the different soil types and include frost action potential and the hazard of flooding in areas of soil Type 9. Soil Type 9 exists in the southwestern portion of the site. Possible hazards with soil erosion are present on the site. The erosion potential can be controlled with vegetation. The soils have been described to have moderate erosion hazards, with a severe soil blowing hazard on Soil Type 8.

5.3 *Site Stratigraphy*

The Falcon NW Quadrangle Geologic Map showing the site is presented in Figure 7 (Reference 10). The Geology Map prepared for the site is presented in Figure 8. Seven mappable units were identified on this site, which are identified as follows:

- **Qaf** — **Artificial Fill of Quaternary Age:** These are man-made fill deposits. Some of the fill is associated with earthen dam embankments on-site. Other areas are associated with the quarrying and stockpiling that has occurred on-site.

- **Qal** — **Recent Alluvium of Quaternary Age:** These are recent stream deposits that have been deposited along the valley floors and in the drainages that exist on-site, and in the main channels of Cottonwood Creek and Sand Creek. These materials consist of silty to clayey sands and sandy clays. Some of these alluviums may contain highly organic soils.

- **Qp** — **Piney Creek Alluvium of Quaternary Age:** This is a stream deposited material typically occurring as terrace deposits along the main drainage of Cottonwood Creek and Sand Creek. The Piney Creek typically consists of dark brown silty to clayey sands and sandy clays.

- **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.

- **Qb** — **Broadway Alluvium of Pleistocene Age:** These materials consist of stream terrace deposits. The Broadway Alluvium typically consists of silty to clayey gravelly sands. This deposit is usually highly stratified and may contain lenses of silt, clay or cobbles.

- **Qlo** **Louviers Alluvium of Quaternary Age:** These are alluvial terrace deposits which occur as yellowish brown silty to clayey sands with sandy clay lenses. Generally this deposit is well stratified and may contain lenses of clay, silt and gravel.

- **Tkd** **Dawson Formation of Tertiary to Cretaceous Age:** The Dawson formation typically consists of arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone. Overlying this formation is a variable layer of residual and/or colluvium soils. The residual soils were derived from the in-situ weathering of the bedrock materials on-site. The colluvium soils have been transported by the action of sheetwash and gravity. These soils consisted of silty to clayey sands and sandy clays.

The soils listed above were mapped from site-specific mapping of the site, the *Geologic Map of the Falcon NW Quadrangle* by Madole, 2003 (Reference 10), and the *Reconnaissance Geologic Map of Colorado Springs and Vicinity, Colorado* by Scott and Wobus in 1973 (Reference 12). The Robinson Study prepared for El Paso County Planning Department in 1977 (References 3 and 4) and *The Geologic Map of the Colorado Springs-Castle Rock Area Front Range Urban Corridor, Colorado*, by Trimble and Machette, 1979 (Reference 13) were also used in mapping this site. The test borings from the subsurface investigation by Entech Engineering, Inc. (Reference 1) were used in evaluating the site.

5.4 Soil Conditions

Two soil and two rock types were encountered in the test borings drilled on the site for the preliminary subsurface soil investigation (Reference 1): slightly silty to silty and clayey sand (Type 1); sandy to very sandy clay (Type 2); silty to clayey sandstone bedrock (Type 3); and sandy claystone bedrock (Type 4). Each material type was classified using the results of the laboratory testing and the Unified Soil Classification System (USCS). The bedrock encountered in the borings was classified as soil in that the upper bedrock zone could be penetrated using conventional soil drilling and sampling techniques.

Soil Type 1 was classified as slightly silty to silty and clayey sand (SW-SM, SM, SC). The Type 1 sand was encountered at the ground surface in every boring to depths ranging from 1 to 9 feet. SPT N-values in the Type 1 sand ranged from 12 to 27 blows per foot (bpf) indicating the Type 1 sand to be medium dense in terms of in-place compactness. Water content and grain size testing of Type 1 sand samples resulted in water contents ranging from approximately 2 to 11 percent with approximately 8 percent of the particle sizes being smaller than the No. 200 sieve on the sample tested. One FHA swell test completed on a clayey sample of the Type 1 sands from test borings drilled east of the subject site (Reference 1) resulted in a low expansion potential.

Soil Type 2 was classified as sandy to very sandy clay (CL). The Type 2 sandy clay was encountered in 2 of the 6 borings located on the subject site and was typically observed beneath the Type 1 sand. Thickness of the sandy clay ranged from not present to approximately 7 feet, depending on bore hole location. SPT N-values in the sandy clay ranged from 19 to 20 bpf indicating the Type 2 sandy clay to be generally stiff in terms of in-place consistency. Water content and grain size testing of the sandy clay showed it to have water contents ranging from approximately 6 to 17 percent with approximately 55 percent of the particle sizes smaller than No. 200 sieve on the sample tested. FHA Swell testing of the Type 2 sandy clay showed swell pressures of 455 and 1085 psf which suggests the sandy clay exhibits low to moderate expansion potential.

Soil Type 3 was classified as silty to clayey sandstone bedrock (SM, SC). The sandstone was encountered in 5 of the 6 borings at depths ranging from approximately 4 to 19 feet bgs. The sandstone typically exhibited SPT N-values greater than 50 bpf indicating very dense in-place compactness. FHA Swell Testing of the clayey sandstone in borings drilled east of the site (Reference 1) indicated a typically low expansion potential for the sandstone.

Soil Type 4 was classified as sandy claystone bedrock (CL). The claystone was encountered in 5 of the 6 borings. SPT N-values measured in the claystone typically indicated hard consistencies. Swell/Consolidation testing of the claystone resulted in a swelling strain of 0.9 percent and swelling pressures of 1757 and 1845 psf, which are indicative of a low to high expansion potential.

A summary of the laboratory testing results for each of the soil and rock types is presented in Table 1 and a presentation of the overall laboratory results is included in Appendix C. A summary of the depth to bedrock and depth to groundwater encountered in the borings is included in Table 2.

5.5 Groundwater

Groundwater was encountered in 2 of the 6 borings at depths ranging from 6 feet to 11 feet below the ground surface. Groundwater was not encountered within 15 feet of the ground surface in any of the other test borings during or subsequent to drilling. The depth to ground water measured in the borings is presented in Table 2. Fluctuations in the groundwater conditions may occur due to conditions such as variations in rainfall, precipitation infiltration and development of nearby areas. Areas of floodplains and areas of seasonal and/or potentially seasonal shallow groundwater have been identified on the site. These areas will be discussed in the following section.

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 8). 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 artificial fill, hydrocompaction, collapsible or loose soils, unstable slopes, potentially unstable slopes, expansive soils, floodplains, shallow groundwater, seasonally shallow groundwater areas, potentially seasonal shallow groundwater areas and areas of ponded water. The following hazards will need to be addressed during development of the site:

Expansive Soils

Expansive soils were encountered in some of the test borings drilled on-site. The site is classified in areas of low to moderate swell potential according to the *Map of Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado* by Hart, 1974

(Reference 14); however, highly expansive soils were encountered in some of the test borings drilled on the site. These areas are sporadic; therefore, none have been indicated on the map. Expansive clays and claystone, if encountered, can cause differential movement in the structure foundation.

Mitigation: Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum 92% 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 20 feet or more and require penetration into the bedrock material a minimum of 4 to 6 feet, depending upon building loads. Another option is post tension slabs. 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 can be considered for basement construction on highly expansive clays. Final recommendations should be determined after additional investigation of each subdivision or building site.

Subsidence Area

Based on a review of a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 15) and the mining report for the Colorado Springs coalfield (Reference 16), the site is not undermined. The closest underground mines in the area are 6 miles to the southwest and the site is not mapped within any potential subsidence zones.

Slope Stability and Landslide Hazard

The majority of the slopes on-site are gently to moderately sloping and do not exhibit any past or potential unstable slopes or landslides. Some of the steeper slopes along Sand Creek have been identified as unstable and potentially unstable slopes. The mitigation recommendation for these areas is as follows:

Potentially Unstable Slopes

Some of the very steep slopes along the drainages have been identified as potentially unstable. Considerable care must be exercised in these areas not to create a condition which would tend to activate instability.

<u>Mitigation:</u> Building should be avoided in these areas unless stabilized. A setback of 60 feet from the crest of these slopes is recommended unless stabilized. Stabilization could involve regrading to slope angles no steeper than 3:1 or the use of engineer-designed retaining walls, tiebacks, or buttresses. Where retaining walls are not used, erosion protection may be necessary to prevent undercutting by the creek during periods of high water. Proper control of drainage at both the surface and in the subsurface is extremely important. Areas of ponded water at the surface should be avoided above these slopes. Utility trenches, basement excavations and other subsurface features should not be permitted to become water traps which may promote saturation of the subsurface materials. Some of the lots encroach on the potentially unstable slopes according to the development plan, Figure 8. It is anticipated some regrading or slope stabilization will be necessary in these areas. It is our understanding the project will include drainage improvements and the construction of a regional trail along the Sand Creek drainage and stabilization of the slopes will be a part of the improvements. Specific slope stabilization recommendations are beyond the scope of this report. Further investigation is recommended as grading plans are developed.

<u>Unstable Slopes</u>: Some of the slopes along Sand Creek are mapped as unstable. In these areas, soil materials exist at slope angles too steep to support a load above the slope without failure to the slope. Erosion by the creek is also possible in some areas. Structures should be located a minimum of 60 feet away from the crest of the slopes, unless additional site-specific investigation and slope stability analysis is performed or the slopes are stabilized. Stabilization could involve regrading to a more stable slope angle, or the use of retaining walls, buttresses or tiebacks. Should regrading be considered, slopes should be no steeper than 3:1. Erosion protection may also be required in some areas, particularly on the outside curves of the creek where active erosion takes place during periods of runoff. As with the potentially unstable slopes, some of the proposed lots encroach on the unstable slopes. It is anticipated these slopes will also be stabilized as a part of the proposed drainage improvements. Recommendations for the potentially unstable slopes, as previously discussed, apply to the unstable slopes as well.

<u>Debris Fans</u>

Based on-site observations, debris fans were not observed in this area.

Groundwater and Floodplain Areas

Areas within the drainages on-site have been identified as areas of seasonally high groundwater areas, potentially seasonally high groundwater areas and floodplains. Additionally, areas where ponded water accumulates also exist on-site. The Sand Creek drainage has been mapped as a floodplain zone according to the FEMA Map No. 08041CO535F, Figure 9 (Reference 17). These areas are discussed as follows:

Floodplain: Construction is not anticipated within the main channel of the Sand Creek floodway. The Sand Creek drainage is to be preserved as open space according to the Sketch Plan, Figure 4. It is anticipated any proposed construction considered within the floodplain zone would involve drainage improvements and channelization of the floodplain. Development within the floodplain will require approval of the Drainage Plan prior to construction. Finished floor levels must be one foot above the floodplain level. Exact floodplain locations and drainage studies are beyond the scope of this report.

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 these areas are located within minor drainage swales. It is anticipated these would be filled during site grading. Areas of shallow groundwater may exhibit unstable subgrade conditions in terms of bearing support of construction equipment during overlot grading. Lots immediately adjacent to the Sand Creek drainage may also experience higher subsurface moisture conditions during periods of higher flows.

Mitigation: In these locations, foundations 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 2.5 feet 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 10. Structures should not block drainages. Swales should be created to intercept surface runoff and carry it safely around and away from structures. It is anticipated that the site grading may mitigate the drainages in some areas. The water table may be of sufficient depth to minimize the effects on buildings in some areas.

<u>Seasonal High Groundwater Area</u>: In these areas, high subsurface moisture conditions, frost heave potential and highly organic soils may exist, particularly on a seasonal basis. Seasonal high groundwater areas may also present an unstable subgrade condition in terms of providing bearing support of construction equipment during overlot grading.
<u>Mitigation:</u> In areas where development is desired, overlot grading may mitigate some areas. All organic material, soft or wet soils should be removed prior to any fill placement. The same mitigation recommendations for potentially seasonal shallow groundwater areas as discussed previously should be followed in these areas of seasonal shallow groundwater. In some areas, it may be necessary to dewater the excavation. Underslab drains or interceptor drains may be used in addition to perimeter drains to prevent the intrusion of water into areas below grade. Typical Drain Details are presented in Figures 10 through 12. It may be desirable to build up the building areas to raise the foundation further above the groundwater level. Any grading should be done in a manner that directs surface flow around construction to avoid areas of ponded water. Structures should not block drainages, but swales should be created to intercept surface runoff and carry it safely around and away from structures. Additionally, subsurface water can follow older, filled drainage pathways. Interceptor drains may be necessary in these areas to help prevent concentrated subsurface flows in these areas. Additional investigation will be necessary to determine the water depth and its affect on development. Areas other than those mapped could encounter groundwater that may affect shallow foundations on-site.

<u>Shallow groundwater:</u> These are areas where shallow groundwater was encountered in the test borings or site conditions and vegetation indicate the potential for shallow groundwater. The same mitigation as discussed for seasonal shallow groundwater is recommended for areas of shallow groundwater. Basement construction is not recommended in these areas unless the area is regraded and raised with the placement of fill. Unstable soils should be anticipated where excavations approach the groundwater level. Geo-grids or shotrock may be necessary to stabilize excavations in these areas. Utility trenches will be affected by shallow groundwater in these areas. A typical sewer underdrain detail is presented in Figure 13.

<u>Areas of ponded water</u>: These are areas where water ponds behind earthen dams on-site. It is anticipated these areas will be avoided by development, as they are located in the open

space area. Should construction be considered in these areas, regrading will be necessary in order to fill the area above the groundwater level. All soft or organic soils should be removed prior to filling. The same mitigation techniques for seasonal shallow groundwater areas are also recommended for these potential pond areas.

Artificial Fill

Areas of artificial fill were observed in areas of the site. Some areas of artificial fill are associated with earthen dams that exist on-site. Other areas are associated with stock piling that has occurred on-site.

Mitigation: Where uncontrolled fill is encountered beneath foundations, mitigation will be necessary. Mitigation typically involves removal and recompaction at a minimum of 92% of its maximum Modified Proctor Dry Density, ASTM D-1557.

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. Other material types may also be susceptible.

Mitigation: The potential for settlement movement 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.

Loose or Collapsible Soils

Areas of loose and collapsible soils were encountered in some of the test borings drilled east of the site (Reference 1). These areas are sporadic; therefore, none have been indicated on the map. Areas with low soil density may present unstable conditions in terms of supporting construction equipment during overlot grading.

Mitigation: Should loose or collapsible soils be encountered beneath foundations, removal and recompaction of the upper 2 to 3 feet with thorough moisture conditioning will be necessary. Where fill is required, it will be necessary to remove the loose soils prior to placement of the fill. Specific recommendations should be made after additional investigation of each building site.

Faults

The closest fault is the Rampart Range Fault, located approximately 10 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 Residence Code (IRC), 2003, currently places this area in Design Category B, also a low seismic risk. According to a report by the Colorado Geological Survey by Kirkman and Rogers, 1981, (Reference 18) 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 bedrock in this area is gently dipping a northeasterly direction according to the *Geologic Structure Map of the Pueblo 1x2 Quadrangle*, *South-Central Colorado* (1978) (Reference 11). The bedrock encountered in the test borings did not exhibit steeply dipping characteristics; therefore mitigation is not necessary.

Radioactivity

Radon levels for the Colorado Geologic Survey in the Open-File have reported the area, Report No. 91-4 (Reference 19). Radon levels ranging from 0 to 20 pci/l have been measured in the area. Only two readings have been taken in the area. One reading was between 4 and 10 pci/l and the other was less than 4 pci/l. 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 4 miles northwest of the site (Reference 20).

This occurrence is associated with a limonite deposit in the Dawson Formation. The radioactivity hazard was researched by CTL/Thompson, Inc. for Wolf Ranch, west of the site (Reference 21). It was determined that the area lies within a zone that may have small deposits of low intensity radioactivity. 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 22), portions of the site are mapped as upland and floodplain deposits. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 23), portions of the site are mapped as A3 – Alluvial fan deposits: sand, A4 – Alluvial fan deposit; probable aggregate resource, U3 – Upland deposits: sand, and V3: valley fill deposits: sand. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 24), tracts in the area of the site have been mapped as "Good" for industrial minerals. Quarries exist on the site and in the area of the site for sand and gravel, particularly in the Eolian Sand and Alluvial deposits. Based on the depth of bedrock encountered in the test borings, it appears the majority of the thicker deposits have been excavated from the site. Thirteen out of 45 test borings have greater than 10 feet of sand or gravel materials overlying the bedrock materials.

According to *the Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 24), the tracts in the area of the site have been mapped as "Poor" for coal resources and "Little or no Potential" metallic mineral resources.

The site has been mapped as "Fair" for oil and gas resources (Reference 24). No oil or gas fields have been discovered in the area of the site. The sedimentary rocks in the area lack the essential elements for oil or gas.

9.0 RELEVANCE OF GEOLOGIC AND SITE CONDITIONS TO LAND USE PLANNING

Site Conditions

The existing geologic and geotechnical conditions at the site will likely impose some constraints on the proposed development and construction. Avoidance or regrading can mitigate many hazards such as unstable slopes; low lying floodplain areas; areas of seasonal shallow groundwater and potential seasonal shallow groundwater; and areas where ponded water can occur. Other constraints identified on the site such as hydrocompaction; loose or collapsible soils; expansive soils; artificial fill; and potential shallow groundwater can be mitigated through proper engineering design and construction.

The majority of the soils at typical foundation depths consist of sands, clays, sandstone and claystone. Areas of shallow bedrock will be encountered on the site particularly in locations mapped as Tkd: Dawson Formation. Areas of shallow bedrock may be encountered during development other than those mapped. Excavation of the harder sandstone or claystone bedrock may be more difficult in some areas than others. Difficult excavation is anticipated in areas of shallow bedrock, particularly sandstone. Overlot grading and excavation for utility trenches and foundations will be affected by shallow bedrock. The use of track-mounted equipment will likely be required. Blasting may also be necessary where hard, cemented sandstone is encountered.

Expansive soils may be encountered in areas of this site. The expansive soils encountered in the test borings drilled on-site are sporadic; therefore, none have been indicated on the maps. Expansive soils, if encountered, will require special foundation design and/or overexcavation and replacement with non-expansive soil compacted to a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Other options include drilled piers or post tension slabs.

Areas of shallow and seasonal shallow groundwater may be encountered on the site. Shallow groundwater was encountered in the southwestern portion of the site. Seasonal shallow groundwater is associated with minor drainages. Shallow and potentially shallow groundwater areas may present localized unstable subgrade conditions with respect to supporting construction equipment during overlot grading. Basement construction is not recommended in areas of shallow groundwater unless the area is raised with overlot grading. Shallow groundwater areas may also affect utility installation. Geo-grids or shotrock may be necessary to stabilize excavation. In shallow groundwater areas, drains may be necessary to control seepage within the foundation zone. Additional subsurface investigation is recommended when grading plans are available to determine the depth to groundwater and its affects on construction. Site surface grading can eliminate some of the minor drainages/wet areas. Any soft, unstable, or organic soils should be removed prior to any fill placement or foundation construction. Additionally, subsurface water can follow older, filled drainage pathways. Interceptor drains may be necessary to help prevent concentrated subsurface flows in these areas.

The floodplain areas of the Sand Creek drainage exist on portions of the site. According to the Sketch Plan, Figure 4, this area is to be preserved as open space. Should development be considered in the floodplain, channelization and drainage improvements would be necessary as well as raising building site grades above the floodplain level. Finished floor elevations must be a minimum of one foot above the floodplain level and drains may be necessary to help prevent the intrusion of water into areas below grade. Soft, potentially unstable soils were encountered in areas of the floodplain and will need mitigation in advance of building construction. Approval of a Drainage Plan will be necessary prior to construction in the floodplain zone. Specific floodplain location and drainage studies are beyond the scope of this report.

Areas of hydrocompaction were identified on the site where there is potential for soil settlement upon saturation. Good surface and subsurface drainage is critical in these areas to avoid accumulation of standing water and saturated conditions. The ground surface should be positively sloped away from structures at all points. Roof drains and gutter down spouts should be made to discharge well away from structures and planting and watering in the immediate vicinity of structures should be minimized.

Soft and/or collapsible soils were encountered in some of the test borings drilled on the Sterling Ranch phases east of the subject site (Reference 1). These soils are sporadic; therefore, none have been indicated on the maps. All soft, collapsible, or wet soils should be mitigated prior to any construction or fill placement. Areas of soft, collapsible unstable or wet soils may present localized difficulties during overlot grading with respect to subgrade support for construction equipment.

Unstable slopes and potentially unstable slopes exist along Sand Creek. A minimum building setback of 60 feet is recommended from the crest of these slopes unless site-specific investigation or slope stability analysis is performed. Another option is to stabilize the slopes. Unstable and potentially unstable slopes can be typically mitigated by regrading to angles no steeper than 3 horizontal to 1 vertical or by construction of engineer-designed retaining walls. According to the development plan, Figure 8, some of the lots encroach on these slopes and it is anticipated some stabilization will be necessary in these areas. Erosion protection may be necessary along these slopes to prevent further erosion. It is our understanding there will be drainage improvements that will incorporate slope stabilization and the construction of a regional trail corridor along the Sand Creek drainage. Further investigation is recommended as grading plans are developed.

Areas of erosion (gullies) were observed along some of the tributary drainages on the site. Regrading and establishing vegetation may mitigate the majority of erosion potential after site grading and construction. Where erosion is more severe or continues, the use of check dams or sediment traps in the drainage ways may be necessary. Erosion control has been discussed in Section 7.0 of this report.

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. Grading Plans should be reviewed prior to final approval.

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

This report has been prepared for Morley – Bentley Investments, 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

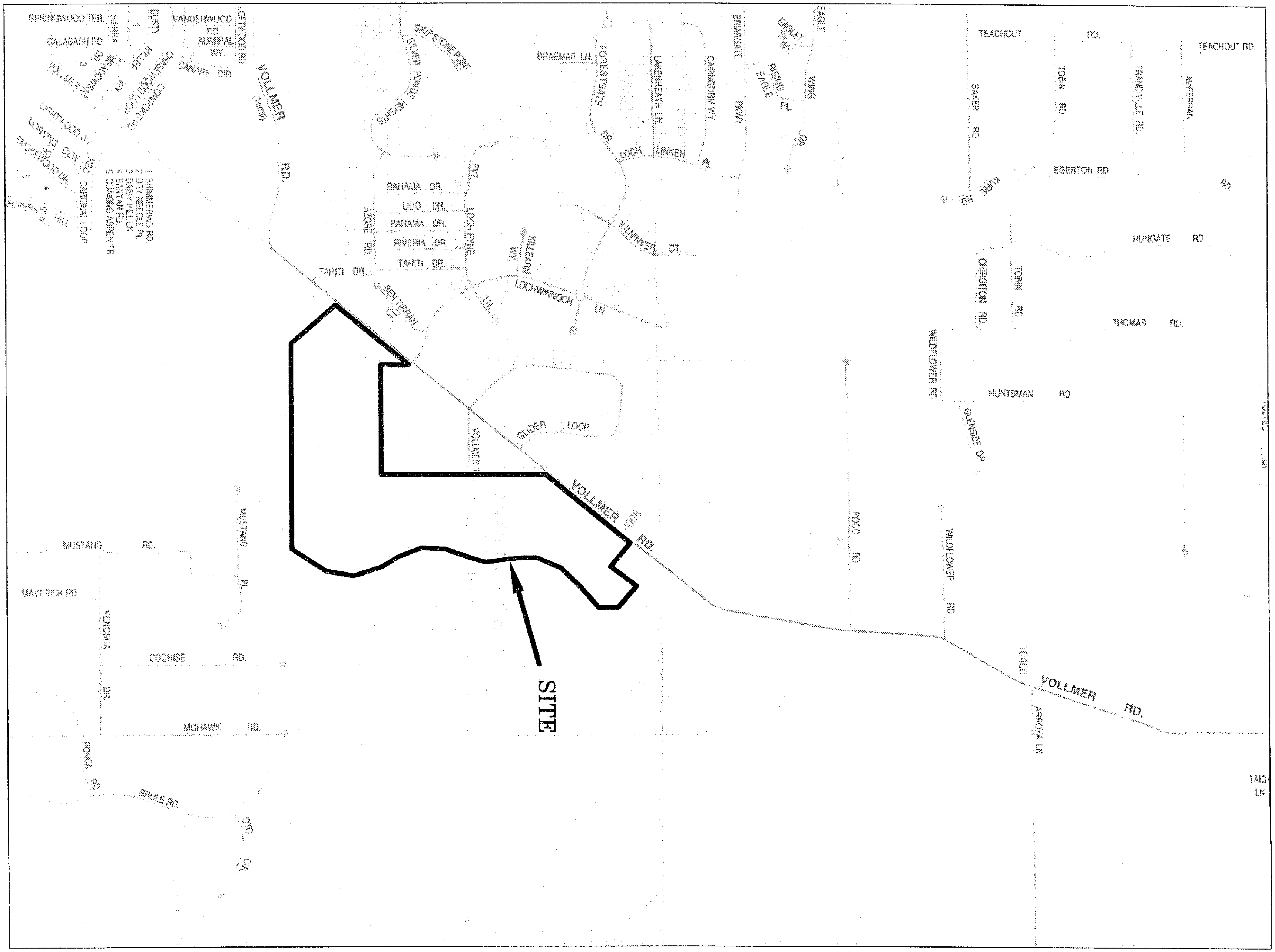
CLIENT MORLEY-BENTLEY INVESTMENTS
PROJECT STERLING RANCH RESIDENTIAL
JOB NO. 30898

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	6	2-5			8.4						SM-SW	SAND, SLIGHTLY SILTY
2	3	2-3			54.6				455		CL	CLAY, VERY SANDY
2	5	7							1085		CL	CLAY, SANDY
3	3	10			36.0						SM	SANDSTONE, SILTY
4	1	5	13.4	117.8	68.1					0.9	CL	CLAYSTONE, SANDY
4	4	2-3							1757		CL	WEATHERED CLAYSTONE, SANDY
4	6	10							1845		CL	CLAYSTONE, SANDY

Table 2: Summary of Depth to Groundwater and Bedrock

Test Boring No.	Depth of Bedrock (ft.)	Depth to Groundwater (ft.)	Upper Soil Type	Geologic Unit
1	2	6	SM/CL	Qes/Tkd
2	4	11	SM/CL	Qb
3	8	>15	CL/SC	Qb
4	2	>15	SM/CL	Tkd
5	8	>15	SC	Qb
6	9	>15	SM-SW	Tkd

Figures

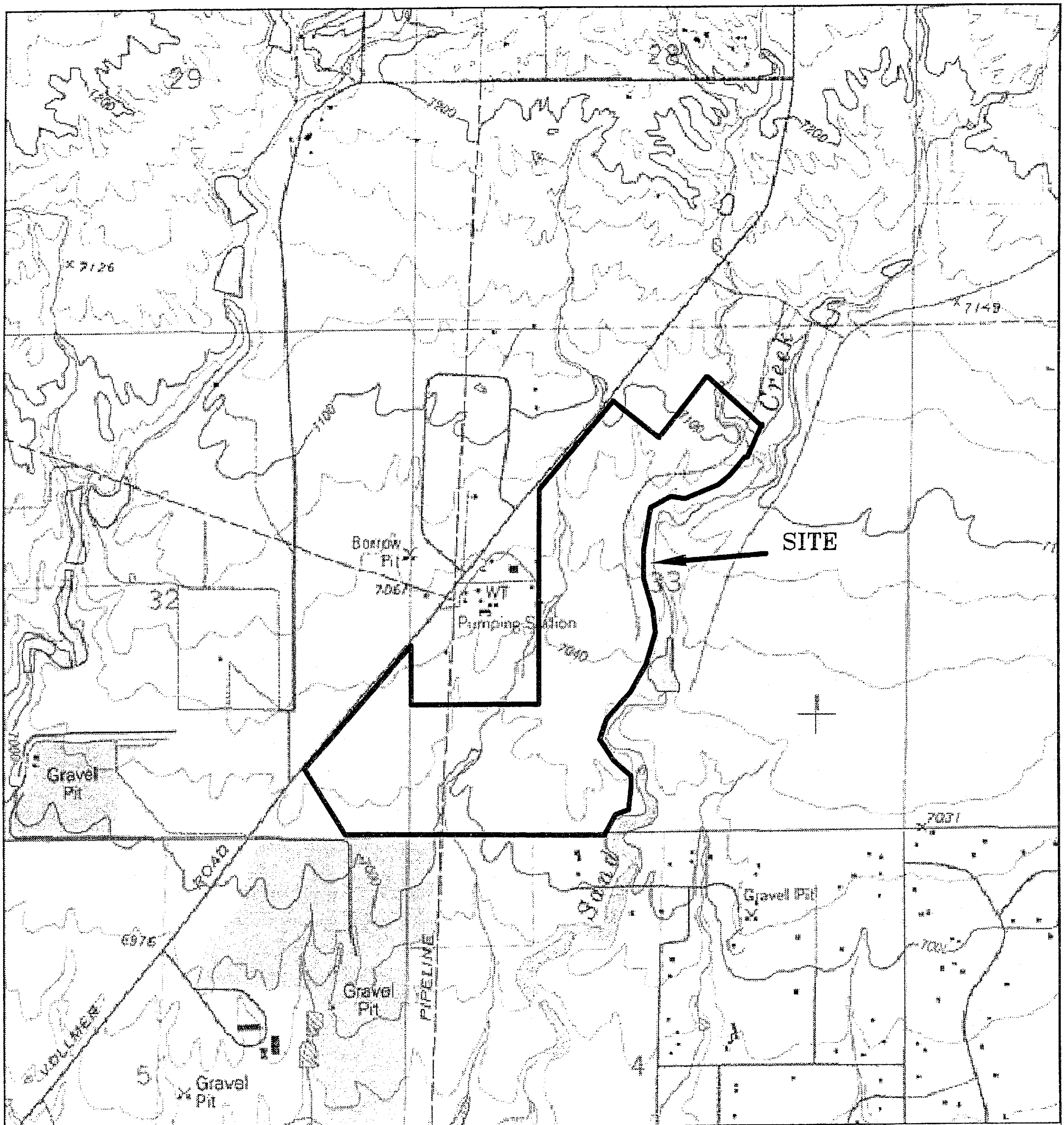


ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907
(719) 531-5599

Vicinity Map
Sterling Ranch Residential
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	12/2/08		

JOB NO.: 30898
FIG NO.: 1



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

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USGS Map
Sterling Ranch Residential
El Paso County, CO.
For: Morley-Bentley Investments, LLC

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KAH	12/2/08		

JOB NO.: 30898

FIG NO.: 2

F:\Drafting\2008\GEOHAZ MAPS\30898 (Sterling Ranch)\30898 Geo Map Set HP.dwg, AERIAL PHOTO, 1/21/2009 11:29:36 AM, \\STA9\HP Officejet Pro L7500 Series

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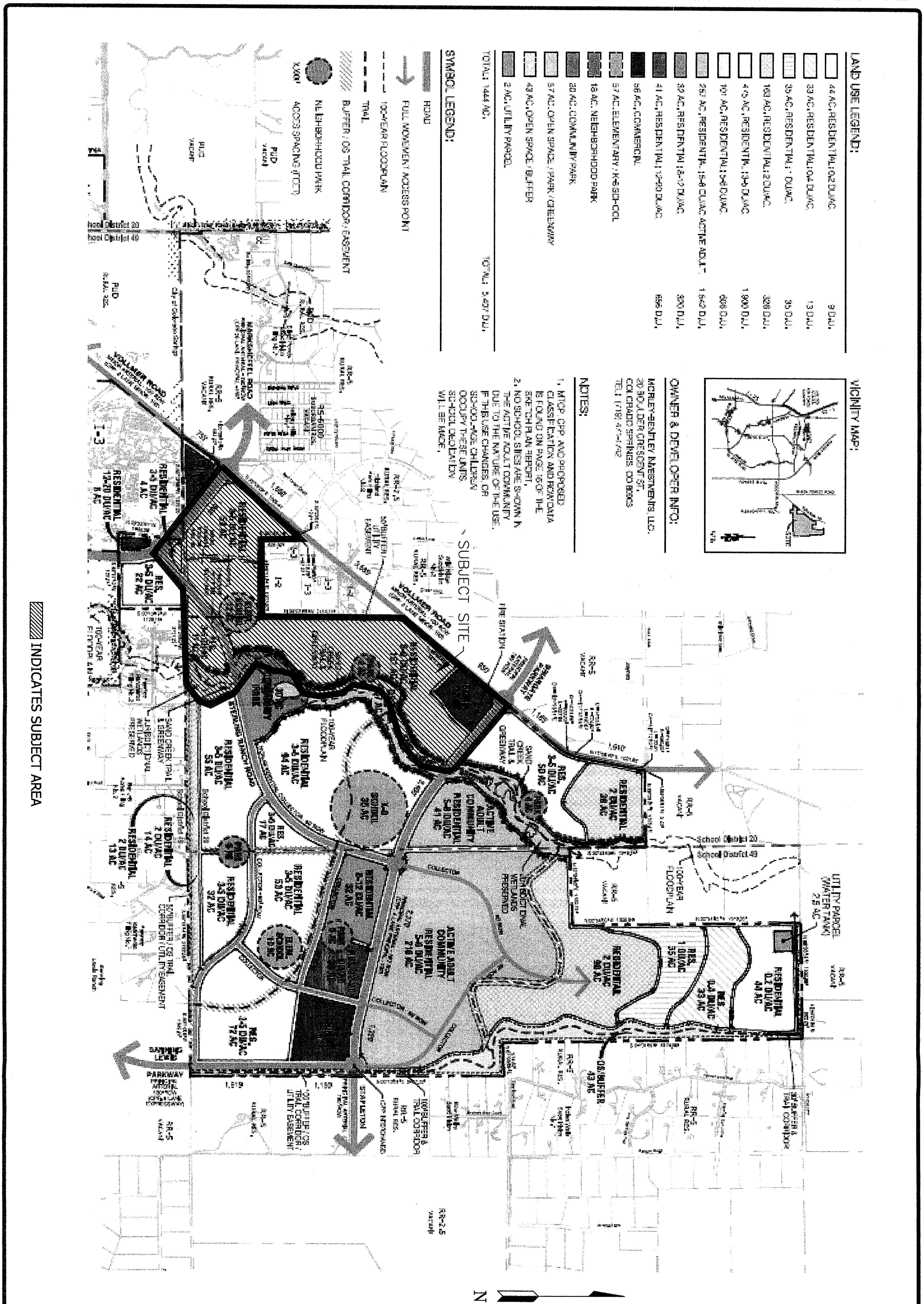
Aerial Photograph
Sterling Ranch Residential
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	12/2/08		

JOB NO.: 30898

FIG NO.: 3



SKETCH PLAN
STERLING RANCH RESIDENTIAL
COLORADO SPRINGS, CO
FOR: MORLEY-BENTLY INVESTMENTS

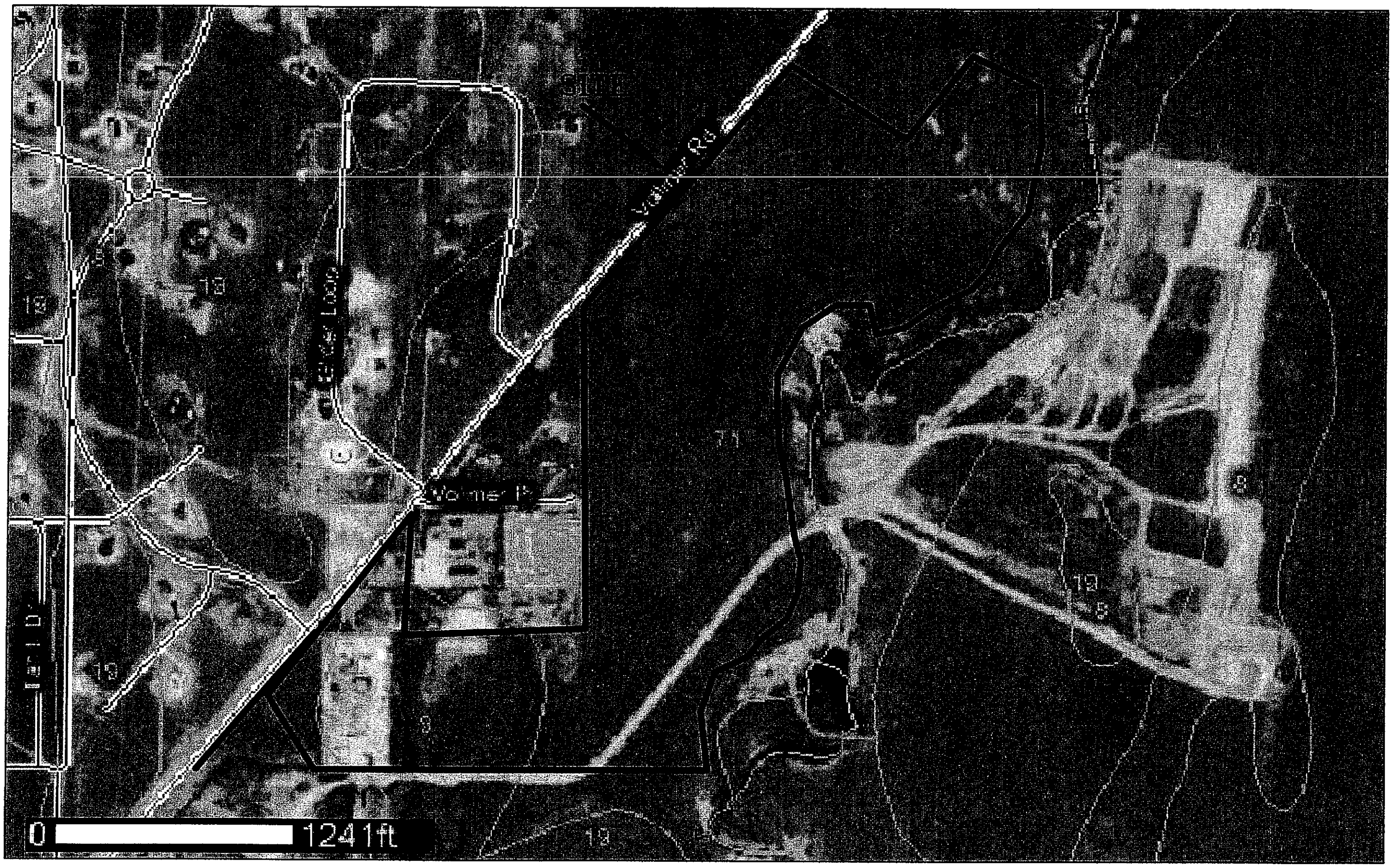
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

DRAWN BY: M. WELLS
DESIGNED BY: KAH
CHECKED BY:
DATE: 12/22/08
SCALE: N.T.S.
JOB NO: 30898
SHEET NO: 4

REVISIONS | BY

Insert
map
Scanned

ENTECH
ENGINEERING, INC.



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

Soil Survey Map
Sterling Ranch Residential
El Paso County, CO.
For: Morley-Bentley Investments, LLC

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KAH	12/2/08		

JOB NO.: 30898

FIG NO.: 6

Insert map Scanned

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ENGINEERING, INC.

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.

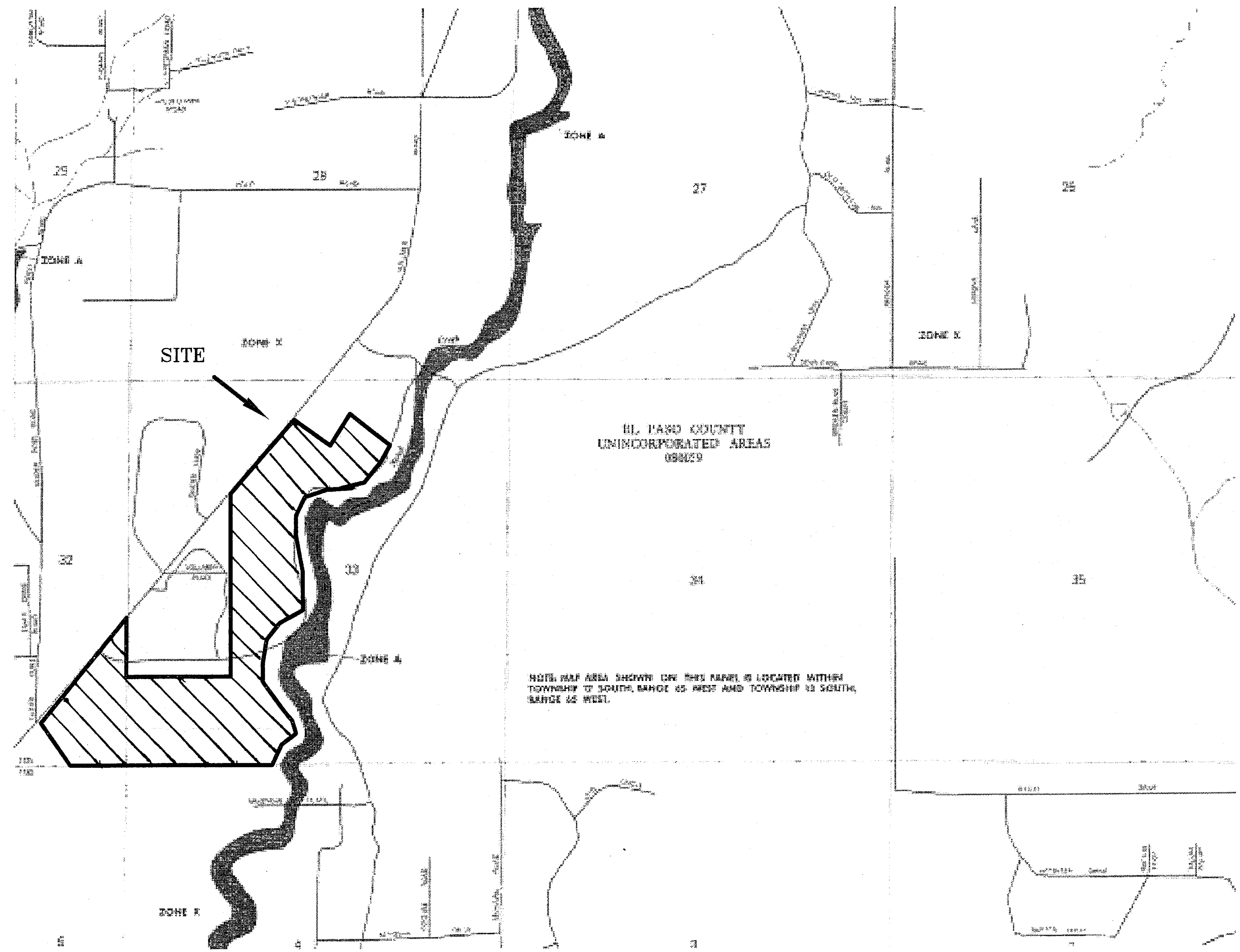
(D)——(D) Cross Section Line

(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.



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Floodplain Map
Sterling Ranch Residential
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN KAH
CHECKED
DATE 12/2/08
SCALE AS SHOWN
JOB NO. 30898
FIGURE No. 9
~~~
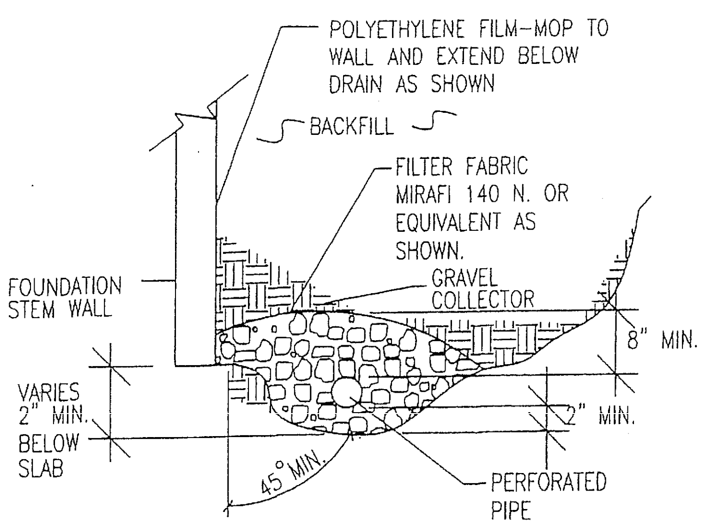
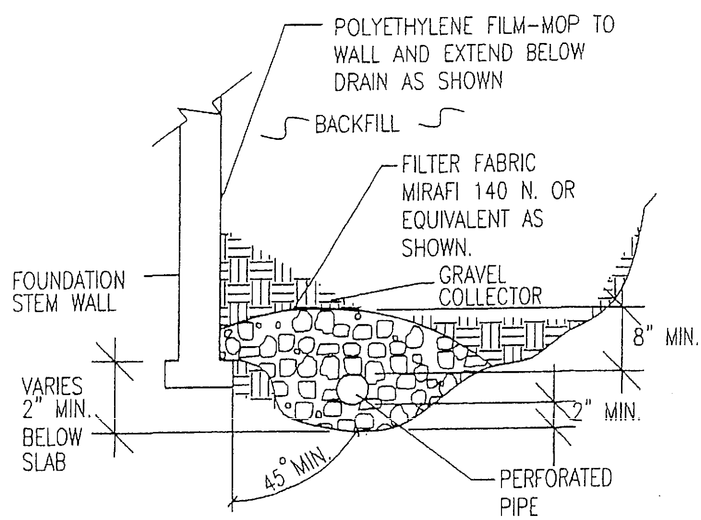

_Detail Book\Drains\Exterior Perimeter drain.dwg, 9/1/2006 8:42:19 AM, 0.25:12





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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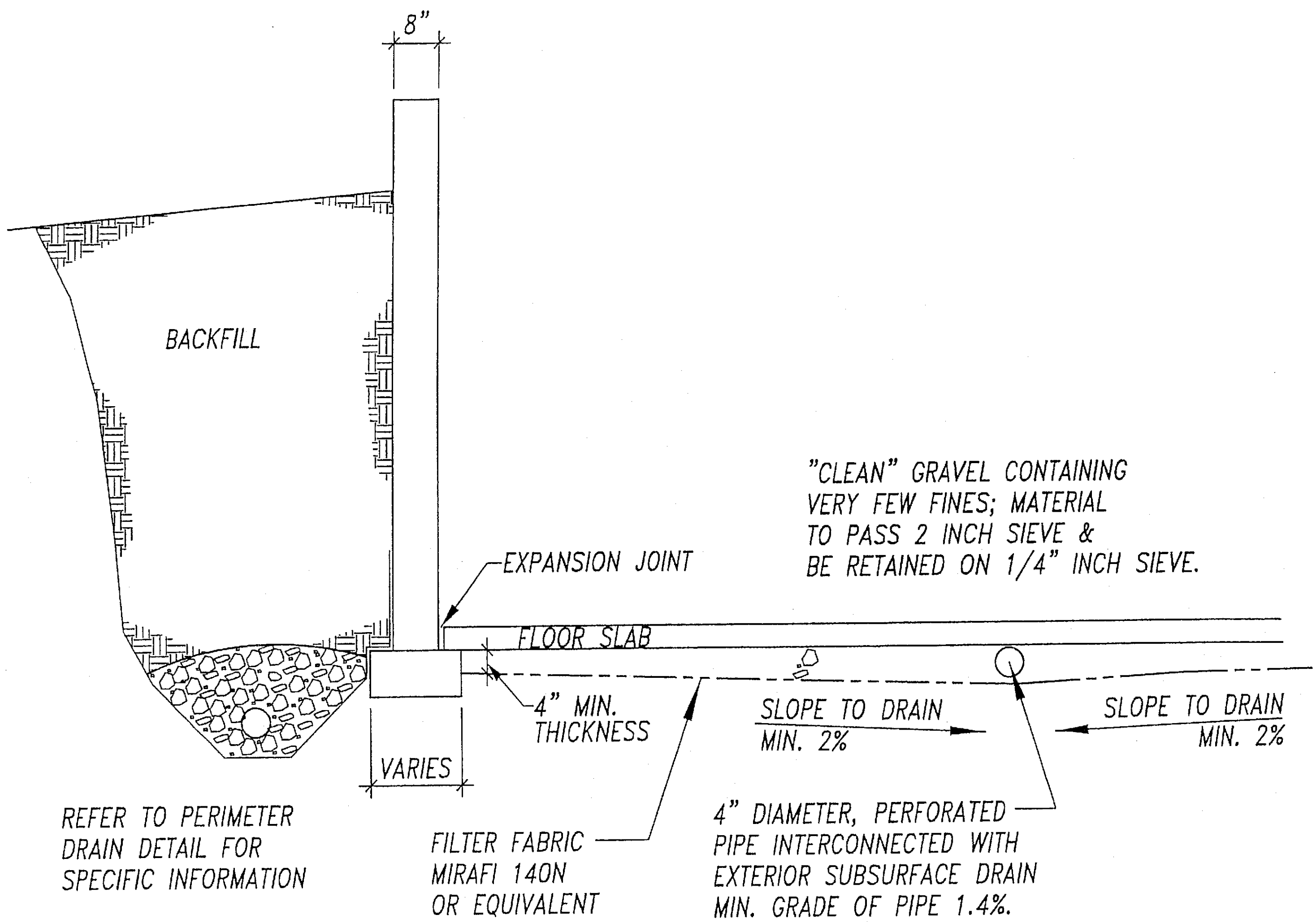
EXTERIOR PERIMETER DRAIN DETAIL

DRAWN:	DATE:	DESIGNED:	CHECKED:
M. VAN KAMPEN			

JOB NO.: 30898

FIG NO.: 10



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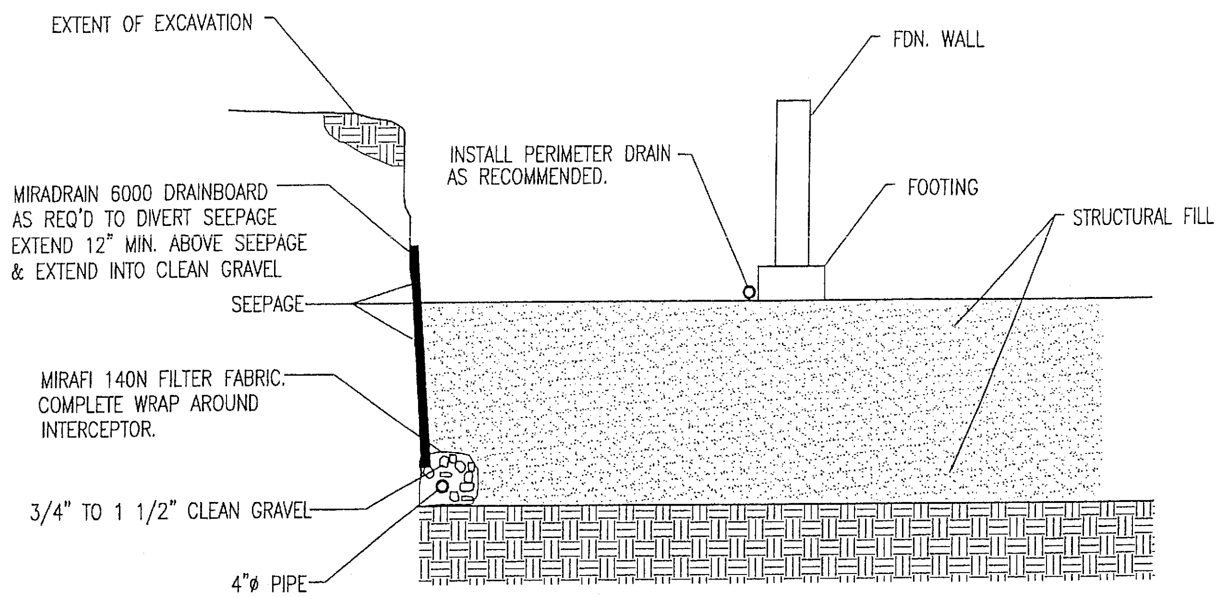
TYP. UNDERSLAB DRAINAGE LAYER (CAPILLARY BREAK)

DRAWN:	DATE:	DESIGNED:	CHECKED:

JOB NO.: 30898

FIG NO.: 11



NOTE:
EXTEND INTERCEPTOR DRAIN TO DAYLIGHT

INTERCEPTOR DRAIN DETAIL

N.T.S.

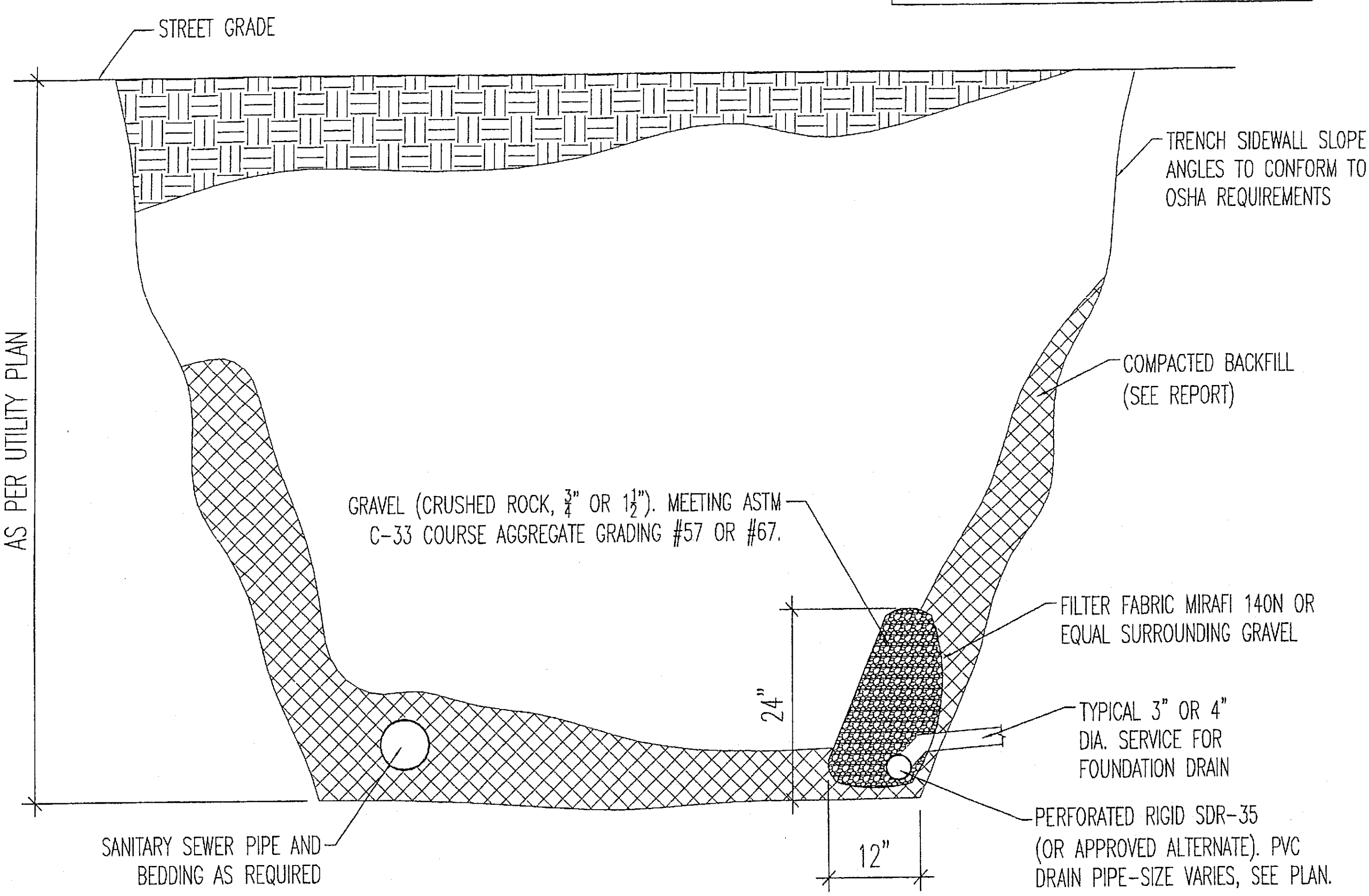
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

INTERCEPTOR DRAIN DETAIL			
DRAWN BY:	DATE DRAWN:		CHECKED:

JOB NO.: 30898

FIG. NO.: 12

NOTE:
TO BE USED IN CASES WHERE GROUNDWATER IS FOUND DURING TRENCHING OR WHERE SHALLOW GROUNDWATER IS KNOWN TO EXIST.



ACTIVE DRAIN BESIDE SEWER

N.T.S.

SIZE NUMBER	NOMINAL SIZE (SLEAVES WITH SQUARE OPENINGS)	AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE-OPENINGS), WEIGHT PERCENT											
		4" (100MM)	3 1/2" (90MM)	3" (75MM)	2 1/2" (63MM)	2" (50MM)	1 1/2" (37.5MM)	1" (25.0MM)	3/4" (19.0MM)	1/2" (12.5MM)	3/8" (9.5MM)	#4 (4.5MM)	#8 (2.36MM)
67	3/4" TO #4 (19.0 TO 4.75 MM)	- -	- -	- -	- -	- -	- -	100	90 TO 100	- -	20 TO 55	0 TO 10	0 TO 5
57	1" TO #4 (25.0 TO 9.5 MM)	- -	- -	- -	- -	- -	100	95 TO 100	- -	25 TO 60	- -	0 TO 10	0 TO 5

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ACTIVE DRAIN BESIDE SEWER

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
J. MEIERHENRY	23MAY06	KAH	

JOB NO.: 30898

FIG. NO.: 13

APPENDIX A: Site Photogaphs

1

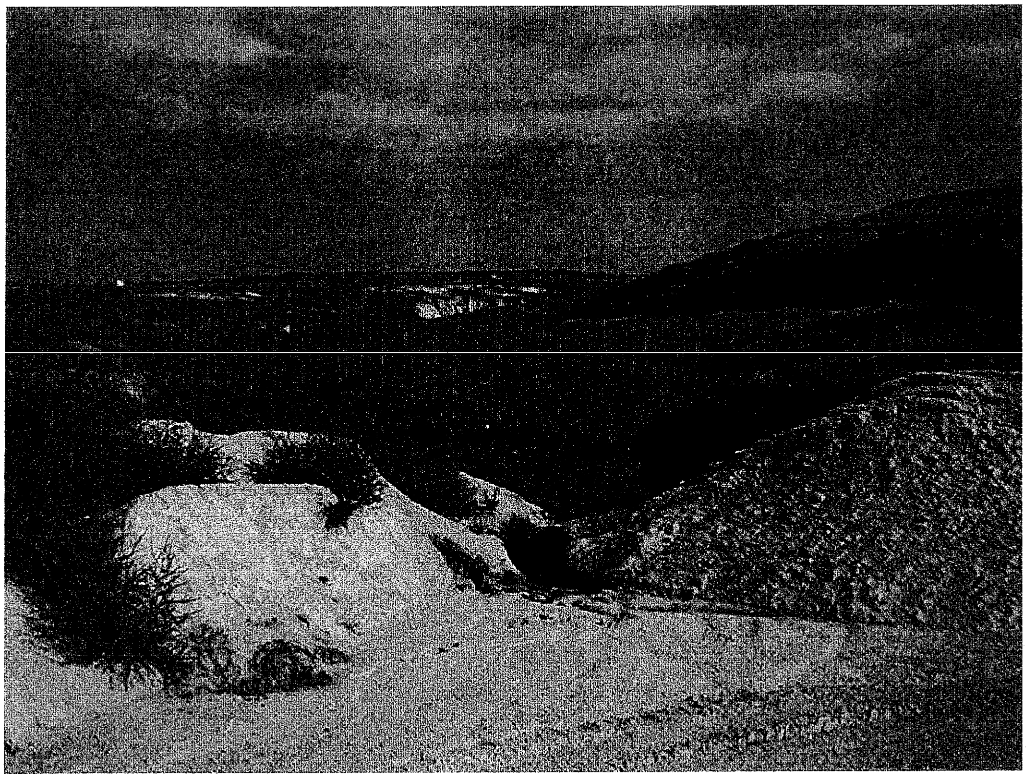
Looking northeast from southern portion of site.

September 6, 2008

2

Looking east from southern portion of the site.

September 6, 2008



3

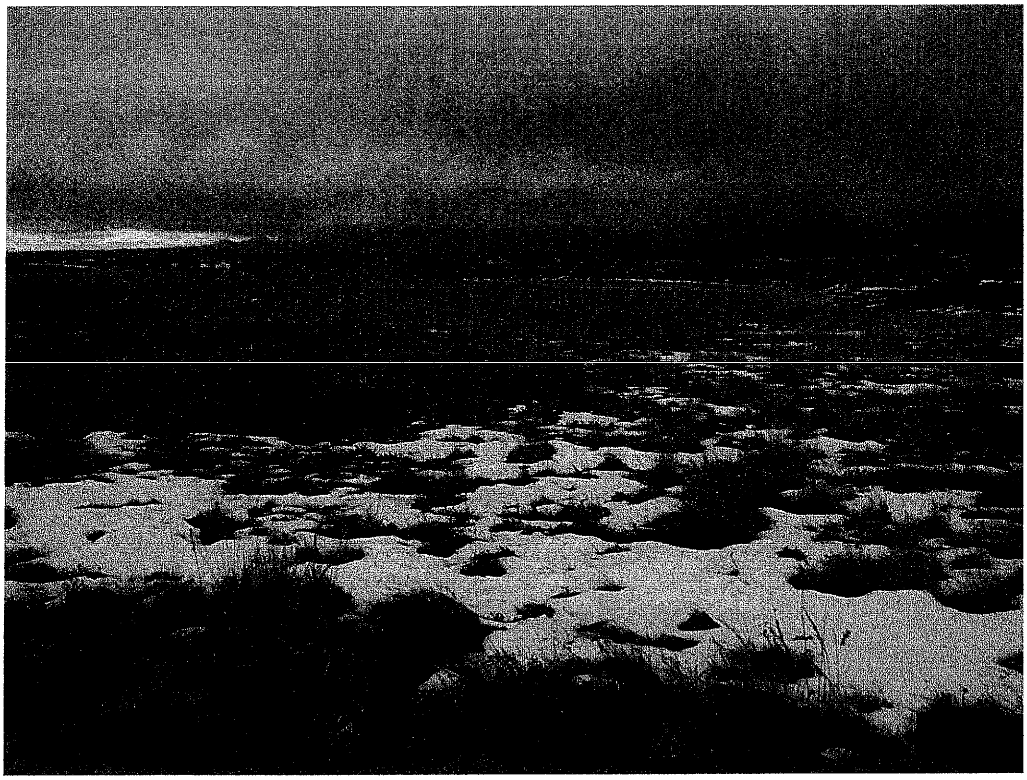
Looking north from western portion of the site.

September 6, 2008

4

Looking east at drainages in west central portion of the site.

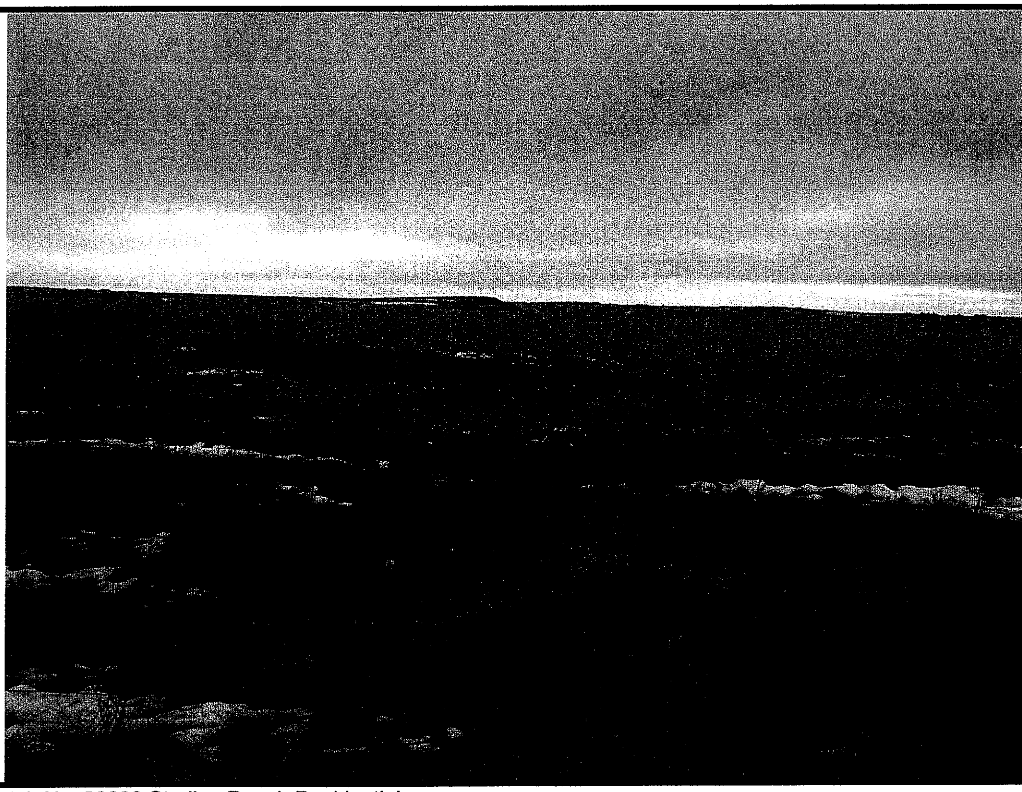
September 6, 2008



7

Looking south from east-central portion of the site.

December 8, 2008



8

Looking southeast from northwest portion of the site.

December 8, 2008

APPENDIX B: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 8/23/2006
Job # 30898

REMARKS

WATER @ 6', 8/25/06

Depth (ft)	Remarks	Blows per foot	Watercontent %	Soil Type
0–2	SAND, SILTY, TAN			1
2–15	CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST	50	12.1	4
5		50/6"	11.2	4
10		50/7"	13.1	4
15		50/5"	9.8	4

TEST BORING NO. 2
DATE DRILLED 8/23/2006
CLIENT MORLEY-BENTLEY INVESTMENTS
LOCATION STERLING RANCH RESIDENTIAL

REMARKS

WATER @ 11', 8/25/06

Depth (ft)	Remarks	Blows per foot	Watercontent %	Soil Type
0–4	SAND, SILTY, FINE TO COARSE GRAINED, DARK BROWN TO BROWN, MEDIUM DENSE, MOIST	12	2.0	1
4–9	WEATHERED CLAYSTONE, SANDY, GRAY, VERY STIFF, MOIST	30	13.3	4
9–15	SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, LIGHT BROWN, VERY DENSE, MOIST TO VERY MOIST	50/6"	11.1	3
15		50/5"	18.9	3

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:
FIG NO.:

TEST BORING NO. 3
DATE DRILLED 8/23/2006
Job # 30898

REMARKS

DRY TO 15',
8/23/06
CAVED TO 13.5',
8/25/06, DRY

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, BROWN						1
CLAY, VERY SANDY, BROWN, STIFF, MOIST			■	20	5.6	2
	5		■	19	8.0	2
SANDSTONE, SILTY, FINE GRAINED, LIGHT GRAY, VERY DENSE, MOIST	10		■	50/6"	12.8	3
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	15		■	50/5"	8.5	3
	20					

TEST BORING NO. 4
DATE DRILLED 8/16/2006
CLIENT MORLEY-BENTLEY INVESTMENTS
LOCATION STERLING RANCH RESIDENTIAL

REMARKS

DRY TO 15',
8/16/06
CAVED TO 14.5',
8/17/06, DRY

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, BROWN						1
WEATHERED CLAYSTONE, SANDY, TAN, VERY STIFF, MOIST			■	39	16.2	4
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GRAY, VERY DENSE, MOIST	5		■	50/5"	10.3	3
	10		■	50/5"	9.7	3
CLAYSTONE, SANDY, GRAY BROWN						4
SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, TAN, VERY DENSE, MOIST	15		■	50/5"	13.9	3
	20					

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN: DATE: CHECKED: [signature] DATE: 12/30/08

JOB NO.:
FIG NO.:

TEST BORING NO. 5
DATE DRILLED 8/16/2006
Job # 30898

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/17/06						
SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST				19	4.1	1
SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST	5			27	11.1	1
CLAY, SANDY, BROWN, MOIST				*	17.2	2
CLAYSTONE, SANDY, GREEN BROWN, HARD, MOIST	10			50/10"	18.6	4
SANDSTONE, CLAYEY, FINE GRAINED, LIGHT BROWN, VERY DENSE, MOIST	15			50/6"	11.9	3
	20					

TEST BORING NO. 6
DATE DRILLED 8/16/2006
CLIENT MORLEY-BENTLEY INVESTMENTS
LOCATION STERLING RANCH RESIDENTIAL

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 15', 8/16/06 CAVED TO 13.5', 8/17/06, DRY						
SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST				15	2.2	1
	5			16	2.6	1
WEATHERED TO FORMATIONAL CLAYSTONE, SANDY, GREEN BROWN, VERY STIFF TO HARD, MOIST	10			48	15.9	4
				50/10"	15.6	4
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BLUE GRAY, VERY DENSE, MOIST	15			50/3"	10.1	3
	20					

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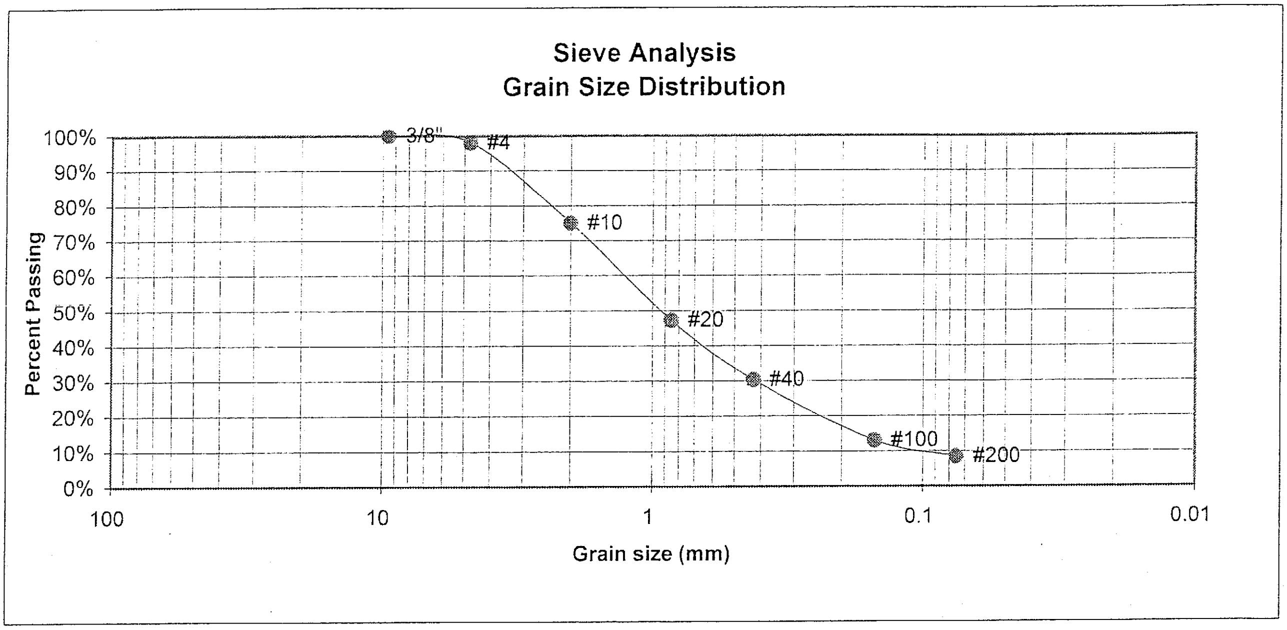
TEST BORING LOG

DRAWN: DATE: CHECKED: [signature] DATE: 12/30/08

JOB NO.:
FIG NO.:

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	1	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	6	JOB NO.	30898
DEPTH (FT)	2-5	TEST BY	DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.0%
10	74.9%
20	47.2%
40	30.3%
100	13.0%
200	8.4%

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

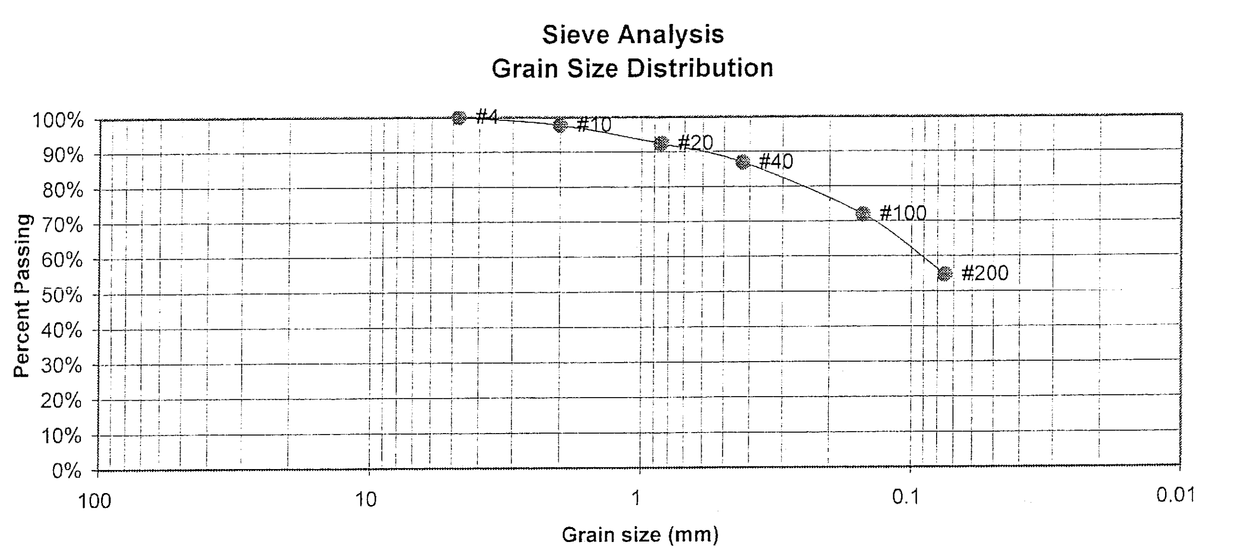
LABORATORY TEST
RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	2	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	3	JOB NO.	30898
DEPTH (FT)	2-3	TEST BY	DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.6%
20	92.3%
40	86.8%
100	71.8%
200	54.6%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	

Swell	
Moisture at start	11.2%
Moisture at finish	19.4%
Moisture increase	8.2%
Initial dry density (pcf)	100
Swell (psf)	455

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COLORADO SPRINGS, COLORADO 80907

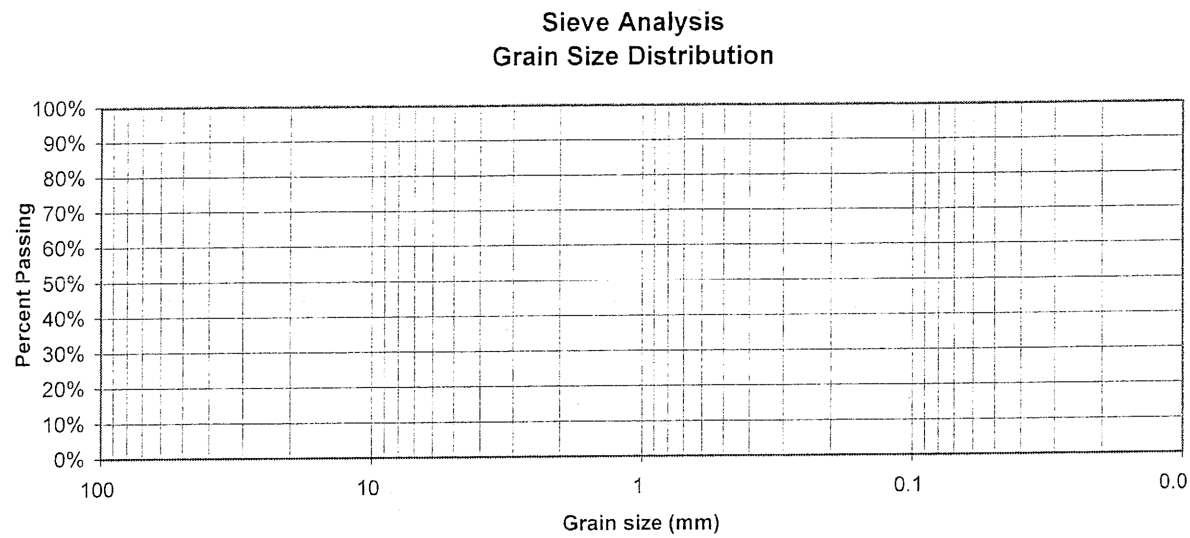
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	2	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	5	JOB NO.	30898
DEPTH (FT)	7	TEST BY	DG



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

Atterberg Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	10.8%
Moisture at finish	23.4%
Moisture increase	12.6%
Initial dry density (pcf)	102
Swell (psf)	1085

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COLORADO SPRINGS, COLORADO 80907

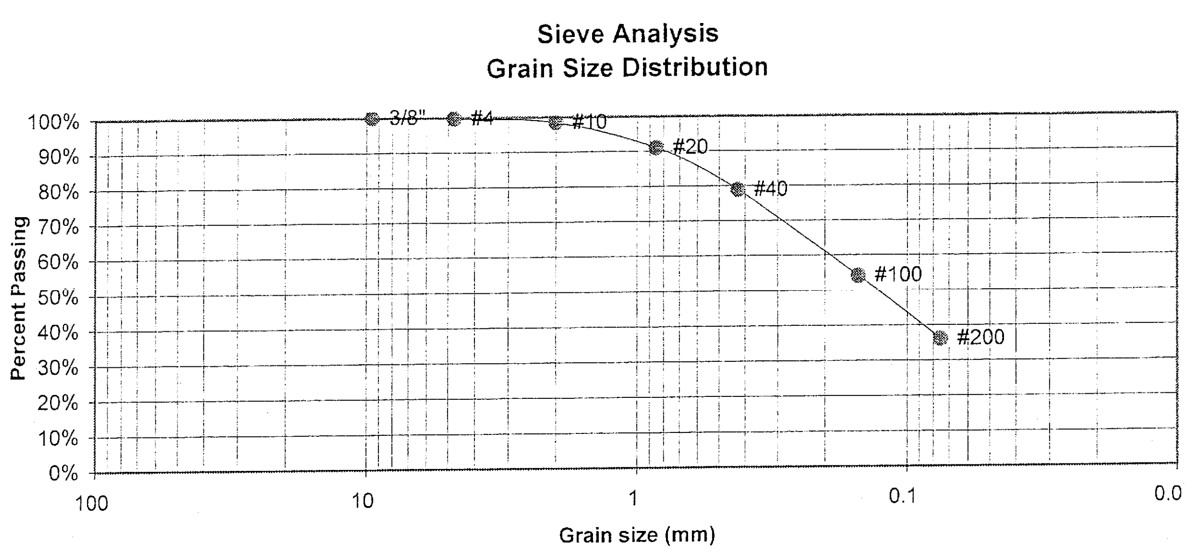
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	SM	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	3	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	3	JOB NO.	30898
DEPTH (FT)	10	TEST BY	DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.8%
10	98.4%
20	90.9%
40	78.7%
100	54.1%
200	36.0%

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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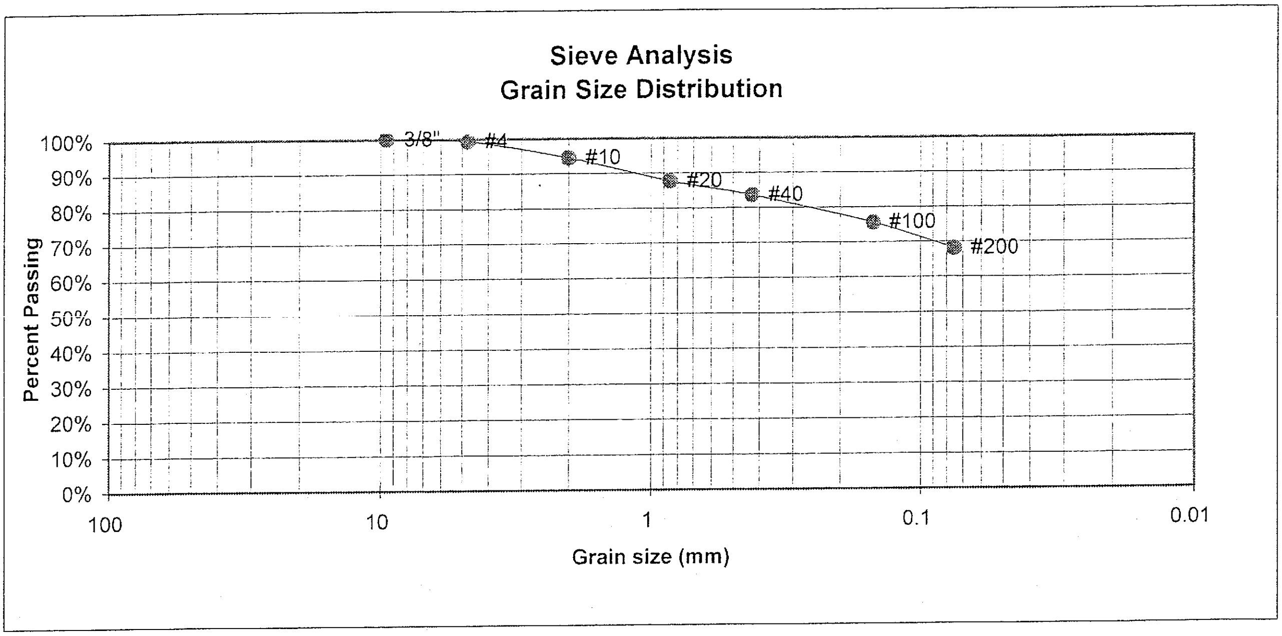
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	4	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	1	JOB NO.	30898
DEPTH (FT)	5	TEST BY	DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.2%
10	94.4%
20	87.7%
40	83.5%
100	75.5%
200	68.1%

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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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

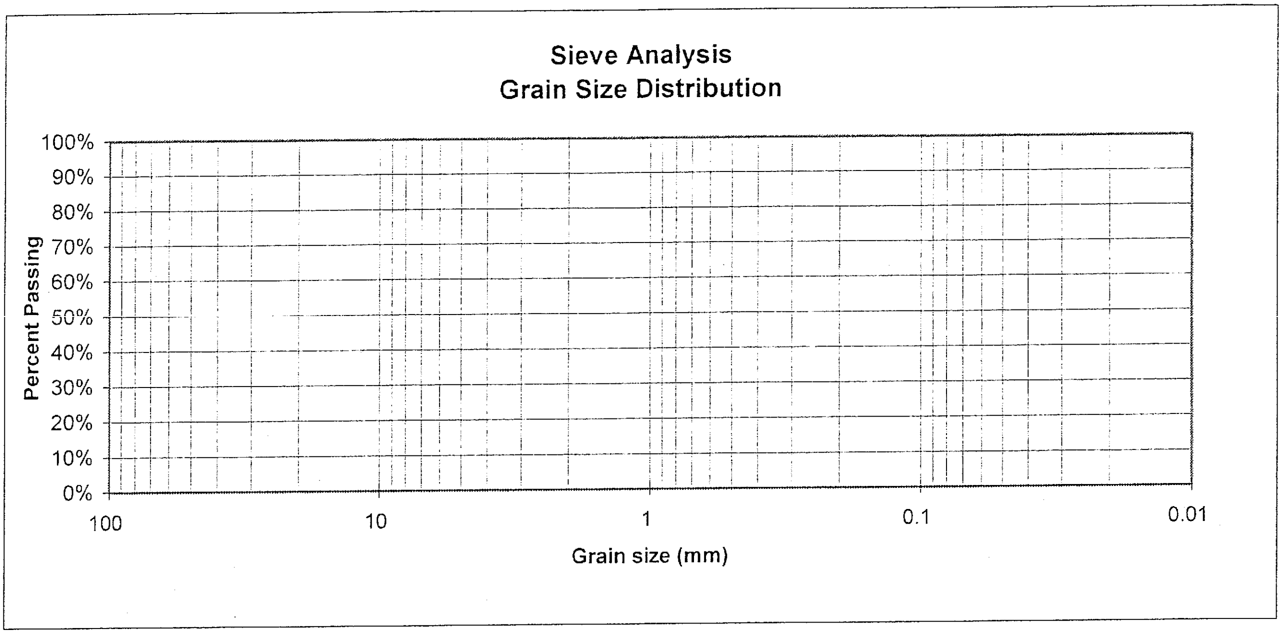
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	4	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	4	JOB NO.	30898
DEPTH (FT)	2-3	TEST BY	DG



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

Atterberg
Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	13.0%
Moisture at finish	25.1%
Moisture increase	12.1%
Initial dry density (pcf)	97
Swell (psf)	1757

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

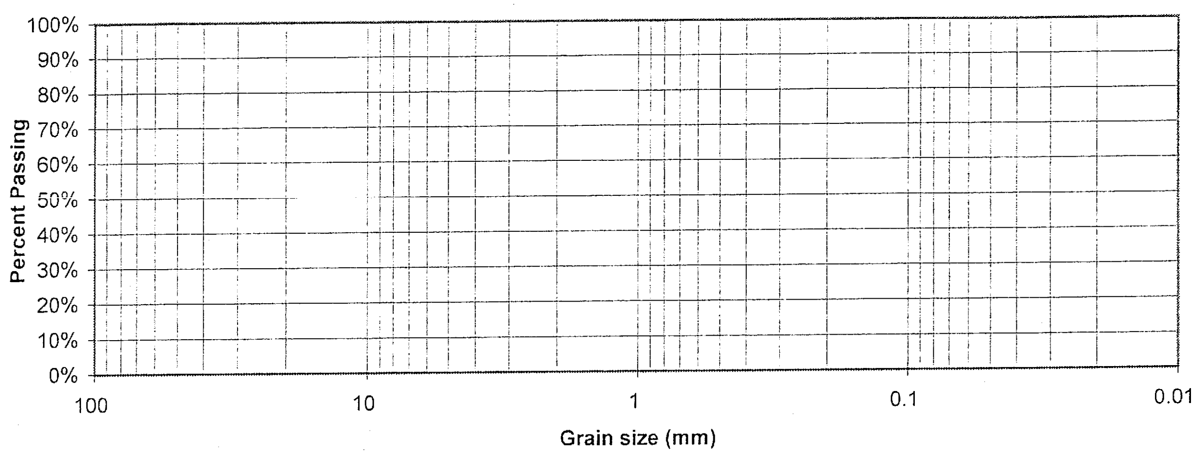
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	4	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	6	JOB NO.	30898
DEPTH (FT)	10	TEST BY	DG



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

Atterberg Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	11.2%
Moisture at finish	23.2%
Moisture increase	12.0%
Initial dry density (pcf)	99
Swell (psf)	1845

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

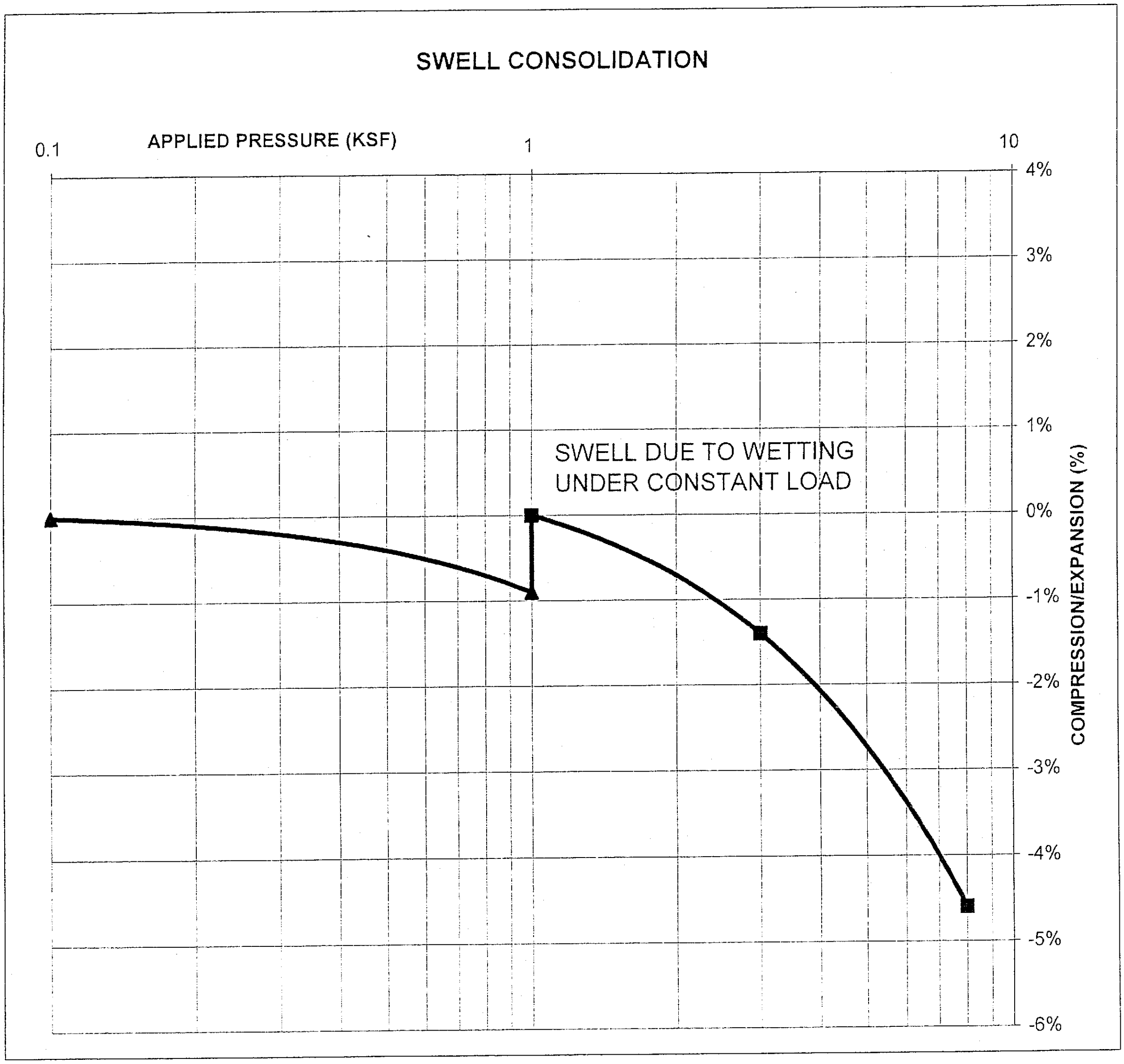
JOB NO.:

FIG NO.:

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	5
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)			118
NATURAL MOISTURE CONTENT			13.4%
SWELL/CONSOLIDATION (%)			0.9%

JOB NO. 30898
CLIENT MORLEY-BENTLEY INVESTMENTS
PROJECT STERLING RANCH RESIDENTIAL



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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		[signature]	12/30/08

JOB NO.:

FIG NO.:

APPENDIX D: SCS Soil Descriptions

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.

ENTECH ENGINEERING, INC.

SCS SOIL DESCRIPTION

Drawn	Date	Checked	Date

Job No.

Fig. No.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. 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 or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are 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.

The Blakeland soil is well 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. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

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SCS SOIL DESCRIPTION

Drawn	Date	Checked	Date

Job No.

Fig. No.

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.

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ENGINEERING, INC.

SCS SOIL DESRIPTION

Drawn	Date	Checked	Date

Job No.

Fig. No.

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.

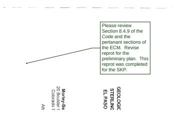
Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation 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.

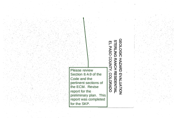
Markup Summary

dsdparsons (4)



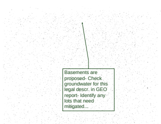
Subject: Callout
Page Label: 2
Author: dsdparsons
Date: 4/4/2019 11:10:00 AM
Color: ■

Please review Section 8.4.9 of the Code and the pertanant sections of the ECM. Revise reprot for the preliminary plan. This reprot was completed for the SKP.



Subject: Callout
Page Label: 1
Author: dsdparsons
Date: 4/4/2019 11:12:15 AM
Color: ■

Please review Section 8.4.9 of the Code and the pertinent sections of the ECM. Revise report for the preliminary plan. This report was completed for the SKP.



Subject: Callout
Page Label: 1
Author: dsdparsons
Date: 4/4/2019 3:24:45 PM
Color: ■

Basements are proposed- Check groundwater for this legal descr. in GEO report- Identify any lots that need mitigated...

Subject: Callout
Page Label: 1
Author: dsdparsons
Date: 4/4/2019 3:31:38 PM
Color: ■

When project specif report is submitted; staff will review.