Architecture
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ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

Materials Testing
Forensic
Civil/Planning

SOILS AND GEOLOGY STUDY

Dwire Storage Yard, Filing No. 1
El Paso County, Colorado

PREPARED FOR:

Dwire Earthmoving & Excavating
6799 Bismark Road, Suite A
Colorado Springs, CO 80922

JOB NO. 168498

March 4, 2020
Revised June 10, 2020

Respectfully Submitted,
RMG – Rocky Mountain Group

Kelli Zigler

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Project Geologist

Reviewed by,
RMG – Rocky Mountain Group

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PROFESSIONAL ENGINEER

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Sr. Geotechnical Project Engineer

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Geotechnical Report, Dwire Office Building 3500 Capital Drive, El Paso County, Colorado, prepared by RMG – Rocky Mountain Group, lasted dated May 3, 2019

1.0 GENERAL SITE AND PROJECT DESCRIPTION

1.1 Project Location

The project lies in the southwest quarter of Section 28, Township 13 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The approximate location of the site is shown on the Site Vicinity Map, Figure 1.

1.2 Existing Land Use

The site currently consists of one parcel. The site is being used as a heavy equipment storage yard and has no permanent structures. The total area of the site is 19.362 acres as denoted on the Final Plat by M&S Civil Consultants, Inc. The parcel included is:

- Schedule No. 5300000552, and consists of 19.362 acres and is currently partially developed.

The current zoning is "I-3 CAD-O" – *Heavy Industrial – Commercial Airport District.*

The Sand Creek East Fork Sub-tributary (SCEFS) parallels the entire western property line. The SCEFS continues from the north to south approximately 85 feet from the western boundary of the site. Based on our observations the existing channel banks appeared to be stable with established vegetation and minimal scour. An existing and abandoned railroad embankment lies approximately 100 feet from the northern boundary of the site and protects the site from the SCEFS and offsite run-off.

1.3 Project Description

The proposed 19.36-acre parcel is to be platted as a single industrial lot and two tracts. Development is to consist of two buildings, one office building and one warehouse building. The warehouse is to have a 10,000 square footprint on a 10,000 square foot concrete pad, and the office building is to be two-stories with a 4,800 square footprint with associated gravel and asphalt parking areas, landscaping, gravel storage yard and full spectrum detention pond. Entrance into the development is from the north end of Capital Drive. The Proposed Lot Layout is presented in Figure 2.

The SCEFS currently extends parallel to the western property line. It is our understanding that the current alignment is to remain and current improvements are not proposed along the SCEFS. Offsite flows reaching this development are contributed in part from the property to the east, Timberline Storage Yard, and from small portions of unplatted property to the north. Flows produced within the development will be collected by the proposed storm sewer improvements, swales, riprap rundowns, and be will routed to the proposed full spectrum detention pond located at the southern boundary of the development. A swale is proposed on the western boundary of the site to capture and route runoff south to the full spectrum detention pond. The outfall into the SCEFS channel is to be armored with a riprap pad and grading away from main flows within the channel. Additional riprap protections are proposed to stabilize the emergency spillway bank.

All parking is to be maintained by the property owners.

The development is to utilize sewer and water services provided by Cherokee Metropolitan District. Neither individual wells nor on-site wastewater treatment systems are proposed.

2.0 QUALIFICATIONS OF PREPARERS

This Geology and Soils Study was prepared by a professional geologist as defined by Colorado Revised Statures section 34-1-201(3) and by a qualified geotechnical engineer as defined by policy statement 15, "Engineering in Designated Natural Hazards Areas" of the Colorado State Board of Registration for Professional Engineers and Professional Land Surveyors. (Ord. 96-74; Ord. 01-42)

The principle investigators for this study are Kelli Zigler P.G., and Geoff Webster, P.E. Ms. Zigler is a Professional Geologist as defined by State Statute (C.R.S 34-1-201) with over 19 years of experience in the geological and geotechnical engineering field. Ms. Kelli Zigler holds a B.S. in Geology from the University of Tulsa. Ms. Zigler has supervised and performed numerous geological and geotechnical field investigations throughout Colorado.

Geoff Webster, P.E. is a licensed Professional Engineer with over 33 years of experience in the structural and geotechnical engineering fields. Mr. Webster is a professional engineer and holds a Master's degree from the University of Central Florida. Mr. Webster has supervised and performed numerous geological and geotechnical field investigation programs in Colorado and other states.

3.0 STUDY OVERVIEW

The purpose of this investigation is to characterize the general geotechnical and geologic site conditions, and present our opinions of the potential effect of these conditions on the proposed development within the referenced site. As such, our services exclude evaluation of the environmental and/or human, health-related work products or recommendations previously prepared, by others, for this project.

Revisions to the conclusions presented in this report may be issued based upon submission of the Development Plan. This study has been prepared in accordance with the requirements outlined in the El Paso County Land Development Code (LDC) specifically Chapter 8 last updated August 27, 2019 applicable sections include 8.4.8 and 8.4.9. and the Engineering Criteria Manual (ECM), specifically Appendix C last updated July 9, 2019.

This report presents the findings of the study performed by RMG relating to the geotechnical and geologic conditions of the above-referenced site. Revisions and modifications to the conclusions and recommendations presented in this report may be issued subsequently by RMG based upon additional observations made during grading and construction that may indicate conditions that require re-evaluation of some of the criteria presented in this report.

3.1 Scope and Objective

The scope of this study is to include a physical reconnaissance of the site and a review of pertinent, publically available documents including (but not limited to) previous geologic and geotechnical reports, overhead and remote sensing imagery, published geology and/or hazard maps, design documents, etc. Our services exclude the evaluation of the environmental and/or human, health-related work products or recommendations previously prepared, by others, for this project.

The objectives of our study are to:

- Identify geologic conditions that are present on this site,
- Analyze the potential negative impacts of these conditions on the proposed site development,

- Analyze the potential negative impacts to the surrounding properties and/or public services resulting from the proposed site development as it relates to existing geologic hazards,
- Provide our opinion of suitable techniques that may be utilized to mitigate the potential negative impacts identified herein.

This report presents the findings of the study performed by RMG relating to the geologic conditions of the above-referenced site. Revisions and modifications to this report may be issued subsequently by RMG, based upon:

- Additional observations made during grading and construction which may indicate conditions that require re-evaluation of some of the criteria presented in this report,
- Review of pertinent documents (development plans, plat maps, drainage reports/plans, etc.) not available at the time of this study,
- Comments received from the governing jurisdiction and/or their consultants subsequent to submission of this document.

3.2 Site Evaluation Techniques

The information included in this report has been compiled from:

- Field reconnaissance
- Geologic and topographic maps
- Review of selected publicly available, pertinent engineering reports
- Available aerial photographs
- Exploratory soil test borings by RMG
- Laboratory testing of representative site soil samples by RMG
- Geologic research and analysis
- Site development plans prepared by others

Geophysical investigations were not considered necessary for characterization of the site geology. Monitoring programs, which typically include instrumentation and/or observations for changes in groundwater, surface water flows, slope stability, subsidence, and similar conditions, are not known to exist and were not considered applicable for the scope of this report.

3.3 Previous Studies and Field Investigation

Reports of previous geotechnical engineering/geologic investigations for this site and nearby sites were available for our review and are listed below:

1. *Geotechnical Report, Dwire Office Building 3500 Capital Drive, El Paso County, Colorado*, prepared by RMG – Rocky Mountain Group, lasted dated May 3, 2019.
2. *Geotechnical Investigation, Timberline Landscaping Office and Warehouse, Capital Drive and Industry Road, Colorado Springs, Colorado,* prepared by CTL Thompson, Project No. CS18748-125, last dated May 5, 2017.

3.4 Additional Documents

Additional documents reviewed during the performance of this study are included in Appendix A.

4.0 SITE CONDITIONS

4.1 Existing Site Conditions

The site is being used as a heavy equipment storage yard and has no permanent structures. The SCEFS continues from the north to south approximately 85 feet from the western boundary of the site. Based on our observations the existing channel banks appeared to be dry and stable with established vegetation and minimal scour. An existing and abandoned railroad embankment lies approximately 100 feet from the northern boundary of the site and protects the site from the SCEFS and offsite run-off.

4.2 Topography

Based on the *Grading and Erosion Control Plan* referenced herein, the site topography is generally gently sloping and does not contain slopes other than the banks of the SCEFS embankments and along the northern property boundary. The approximate elevation varies approximately 20 feet across the site. The overall slope of the site is from the north to the south.

4.3 Vegetation

The majority of the site consists of low lying native grasses and weeds, ranging in density from fair to good. Deciduous trees are located near the northwest and southeast corner of the property and sparsely along the SCEFS.

4.4 Aerial photographs and remote-sensing imagery

Personnel of RMG reviewed aerial photos available through Google Earth Pro dating back to 1999, CGS surficial geologic mapping, and historical photos by historicaerials.com dating back to 1947. Prior to 1947, a shallow landslide feature is visible on the property to the west, this feature did not encroach onto the subject property. The property to the west was developed prior to 1999 and the landslide feature is no longer visible. The SCEFS alignment was also reworked from its native meandering state to a more defined narrow straight channel that we see today as the current alignment. The subject site remained generally undisturbed prior to 2005. Since 2009 to the present, the property has been used as a storage yard.

5.0 FIELD INVESTIGATION AND LABORATORY TESTING

The subsurface conditions within the property were explored by drilling two exploratory borings on April 1, 2019, extending to depths of approximately 20 below the existing ground surface. Test borings TB-1 and TB-2 were originally performed to obtain soil information for the proposed office building. The test borings were then used to meet the minimum of one test boring per 10 acres of development up to 100 acres and one additional boring for every 25 acres of development above 100 acres as required by the ECM, Section C.3.3. The Proposed Development is presented in Figure 3.

The test borings were drilled with a power-driven, continuous-flight auger drill rig. Samples were obtained during drilling of the test borings in general accordance with ASTM D-1586, utilizing a 2-inch O.D. Split Barrel Sampler. An Explanation of Test Boring Logs and the Test Boring Logs are presented in Appendix B.

5.1 Laboratory Testing

Soil laboratory testing was performed as part of the Geotechnical Investigation. The laboratory tests included moisture content, grain-size analyses, and Atterberg Limits. A Summary of Laboratory Test Results and Soils Classification Data are presented in Appendix B.

5.2 Groundwater

Groundwater was not encountered in the test borings performed for the Geotechnical Investigation during the field exploration or when checked eight days subsequent to drilling. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

6.0 SOIL, GEOLOGY, AND ENGINEERING GEOLOGY

6.1 Geologic Conditions

The site is located within the western flank of the Colorado Piedmont section of the Great Plains physiographic province. The Colorado Piedmont, formed during Late Tertiary and Early Quaternary time (approximately 2,000,000 years ago), is a broad, erosional trench that separates the Southern Rocky Mountains from the High Plains. During the Late Mesozoic and Early Cenozoic Periods (approximately 70,000,000 years ago), intense tectonic activity occurred, causing the uplifting of the Front Range and associated downwarping of the Denver Basin to the east. Relatively flat uplands and broad valleys characterize the present-day topography of the Colorado Piedmont in this region.

6.2 Subsurface Soil Conditions

The subsurface materials encountered in the test borings performed for the Geotechnical Investigation were classified within the laboratory using the Unified Soil Classification System (USCS). The materials were identified and classified as native well-graded silty sand (SW-SM).

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs, in Appendix B. The classifications shown on the logs are based upon the engineer's classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

6.3 Bedrock Conditions

In general, the bedrock (as mapped by Colorado Geologic Survey - CGS) beneath the area is considered part of the Dawson Formation. Bedrock was not encountered in the test boring performed for the Geotechnical Investigation. Based on review of the CTL Thompson geotechnical report, referenced herein, for the property to the east, the sandstone bedrock was encountered at depths of 27 feet below the existing ground surface. Bedrock is not anticipated to be encountered in the foundation excavations, utility trenches or full spectrum detention pond.

6.4 U.S. Soil Conservation Service

The U.S. Soil Conservation Service along with United States Department of Agriculture (USDA) has identified the soils on the property as:

- 10 – Blendon sandy loam, 0 to 3 percent slopes. The Blendon sandy loam was mapped by the USDA to encompass the entire property. Properties of the sandy loam include, well-drained soils, depth of the water table is anticipated to be greater than 6.5 feet, runoff is anticipated to be low, frequency of flooding and/or ponding is none, and landforms include terraces, alluvial fans.

The USDA Soil Survey Map is presented in Figure 5.

6.5 General Geologic Conditions

Based on our field observations and the Geologic Map of the Falcon NW Quadrangle, an interpreted geologic map of significant surficial deposits and features was mapped for the site. The identified geologic conditions affecting the development are presented in the Engineering and Geology Map, Figure 4.

The site generally consists of sand with various amounts of silt and gravel (alluvium). Two geologic units were mapped at the site as:

- *Af – Artificial fill (late Holocene)* – stock piles of debris to include concrete and soil scattered across the property.

- *Qam – Middle alluvium (early Holocene and late Pleistocene)* – generally poorly sorted sand, silty and clayey sand with beds of very fine to medium pebble-gravel. The alluvium was encountered in the test borings performed by RMG to a depth of 20 feet.

6.6 Structural Features

Structural features such as schistocity, folds, zones of contortion or crushing, joints, shear zones or faults were not observed on the site, in the surrounding area, or in the soil samples collected for laboratory testing.

6.7 Surficial (Unconsolidated) Deposits

Lake and pond sediments, swamp accumulations, sand dunes, marine terrace deposits, talus accumulations, creep, or slope wash were not observed on the site. Slump and slide debris were also not observed on the site.

6.8 Engineering Geology

Charles Robinson and Associates (1977) have mapped two environmental engineering units at the site as:

- 2A – Stable alluvium, colluvium and bedrock on flat to gentle to moderate slopes (5 to 12%).
- 7A – Physiographic floodplain where erosion and deposition presently occur and is generally subject to recurrent flooding. Includes 100-year floodplain along major streams where floodplain studies have been conducted.

The Engineering Geology is presented in the Engineering and Geology Map, Figure 4.

6.9 Features of Special Significance

Features of special significance such as accelerated erosion, (advancing gully head, badlands, or cliff reentrants) were not observed on the property. Features indicating settlement or subsidence such as fissures, scarplets, and offset reference features were not observed on the property or surrounding areas.

Features indicating creep, slump, or slide masses in bedrock and surficial deposits were not observed on the property.

6.10 Drainage of Water and Groundwater

The overall topography of the site slopes down from the north to the south, towards SCEFS which is the defined drainageway extending along the western boundary. It is anticipated the direction of groundwater is also towards Sand Creek. The creek is not anticipated to adversely impact the placement of the structures on the properties. Construction during land development and of the structures (proposed and future) are not to encroach with in the creek.

Groundwater was not encountered in the test borings performed for the Geotechnical Investigation during the field exploration or checked eight days subsequent to drilling. If shallow groundwater conditions are found to exist at the time of the lot-specific subsurface soil investigations, the feasibility of basement construction and/or any recommended mitigation measures are to be addressed at that time.

7.0 ECONOMIC MINERAL RESOURCES

Under the provision of House Bill 1529, it was made a policy by the State of Colorado to preserve for extraction commercial mineral resources located in a populous county. Review of the *El Paso Aggregate Resource Evaluation Map, Master Plan for Mineral Extraction*, *Map 2* indicates the site is identified as valley fill comprised of sand and gravel with silt and clay deposited by water in one or a series of stream valley. Extraction of the sand and gravel resources are not considered to be economical compared to materials available elsewhere within the county.

According to the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands*, the site is mapped within the Denver Basin Coal Region. However, the area of the site has been mapped "Poor" for coal resources, no active or inactive mines have been mapped in the area of the site. No metallic mineral resources have been mapped on the site.

8.0 IDENTIFICATION AND MITIGATION OF POTENTIAL GEOLOGIC CONDITIONS

The El Paso County Engineering Criteria Manual recognizes and delineates the difference between hazards and constraints. A geologic hazard is one of several types of adverse geologic conditions capable of causing significant damage or loss of property and life. Geologic hazards are defined in Section C.2.2 Sub-section E.1 of the ECM. A geologic constraint is one of several types of adverse geologic conditions capable of limiting or restricting construction on a particular site. Geologic constraints are defined in Section C.2.2 Sub-section E.2 of the ECM (1.15 Definitions of Specific Terms

and Phrases). The following geologic constraints were considered in the preparation of this report, and are not are not anticipated to pose a significant risk to the proposed development:

- Avalanches
- Debris Flow-Fans/Mudslides
- Floodplains
- Ground Subsidence
- Landslides
- Rockfall
- Ponding water
- Steeply Dipping Bedrock
- Unstable or Potentially Unstable Slopes
- Scour, Erosion, accelerated erosion along creek banks and drainageways
- Springs and High Groundwater
- Corrosive Minerals

The following sections present geologic constraints that have been identified on the property:

8.1 Hydrocompactive Soils (Moisture Sensitive Soils)

Based on the test borings performed by RMG for the Geotechnical Investigation and the previous geotechnical engineering/geologic investigations referenced above, the well graded sand with various amounts of silt and gravel generally possesses low to moderate hydrocompactive potential. It is anticipated that potentially hydrocompactive soils will be encountered at depths anticipated to affect foundations. These materials are readily mitigated with typical construction practices common to this region of El Paso County, Colorado.

<u>Mitigation</u>
Shallow foundations are anticipated for the structures proposed on Lot 1. Foundation design and construction typically can be adjusted for hydrocompactive soils. If loose or hydrocompactive sands are encountered, mitigation can be accomplished by overexcavation and replacement with structural fill, subexcavation and replacement with on-site moisture-conditioned soils, the installation of deep foundation systems (not anticipated), and/or the use of a geogrid reinforced fill, all of which are considered common construction practices for this area. The final determination of mitigation alternatives and foundation design criteria for the proposed warehouse and any future structures are to be determined in site-specific subsurface soil investigations for each lot.

Provided that appropriate mitigations and/or foundation design adjustments are implemented, the presence of hydrocompactive soils is not considered to pose a risk to the proposed structures.

8.2 Drainageways – Sand Creek East Fork Sub-tributary

The SCEFS is located along the western property boundary for the site and has been designated a regulatory floodway with determined Base Flood Elevations (BFE). Based on the FEMA Map Panel number 08041C0543G, effective December 7, 2018, the majority of the lot lies outside the designated floodway. A portion of the floodway does encroach near the northwest corner. The current FEMA Map is presented in Figure 7.

Mitigation
If development is to occur on the lot in the future, it is recommended that all construction is to remain outside this area, as shown on the Engineering and Geology Map, Figure 4. Additional mitigation for the lot is not required at this time. As noted herein, the foundation drainage measures for the office building are determined in the Geotechnical Investigation presented in Appendix B. Additional drainage measures for the warehouse and any future structures are to be determined by the site-specific subsurface soil investigations performed at the time of construction.

8.3 Faults and Seismicity

Based on review of the Earthquake and Late Cenozoic Fault and Fold Map Server provided by CGS located at http://dnrwebmapgdev.state.co.us/CGSOnline/ and the recorded information dating back to November of 1900, Colorado Springs has not experienced a recorded earthquake with a magnitude greater than 1.6 during that time period. The nearest recorded earthquakes over 1.6 occurred in December of 1995 in Manitou Springs, which experienced magnitudes ranging between 2.8 to 3.5. Additional earthquakes over 1.6 occurred between 1926 and 2001 in Woodland Park, which experienced magnitudes ranging from 2.7 to 3.3. Both of these locations are in the vicinity of the Ute Pass Fault, which is greater than 10 miles from the subject site.

Earthquakes felt at this site will most likely result from minor shifting of the granite mass within the Pikes Peak Batholith, which includes pull from minor movements along faults found in the Denver basin. It is our opinion that ground motions resulting from minor earthquakes may affect structures (and the surrounding area) at this site if minor shifting were to occur.

Mitigation
The Pikes Peak Regional Building Code, 2017 Edition, indicates maximum considered earthquake spectral response accelerations of 0.185g for a short period (S_s) and 0.059g for a 1-second period (S_1). Based on the results of our experience with similar subsurface conditions, we recommend the site be classified as Site Class B, with average shear wave velocities ranging from 2,500 to 5,000 feet per second for the materials in the upper 100 feet.

8.4 Radon

"Radon Act 51 *passed by Congress set the natural outdoor level of radon gas (0.4 pCi/L) as the target radon level for indoor radon levels.*

Southern El Paso County and the 80939 zip code which the site is located in, has an EPA assigned Radon Zone of 1. A radon zone of 1 predicts an average indoor radon screening level greater than 4 pCi/L, which is above the recommended levels assigned by the EPA. Black Forest is located in a high risk area of the country. *The EPA recommends you take corrective measures to reduce your exposure to radon gas.*

Most of Colorado is generally considered to have the potential of high levels of radon gas, based on the information provided at: http://county-radon.info/CO/El_Paso.html. There is not believed to be unusually hazardous levels of radon from naturally occurring sources at this site.

Mitigation
Radon hazards are best mitigated at the building design and construction phases. Providing increased ventilation of basements and crawlspaces, creating slightly positive pressures within structures, and

sealing of joints and cracks in the foundations, slabs, and below-grade walls can help mitigate radon hazards.

8.5 Erosion

Due to the fine-grained nature of the soils on the site, the upper sands encountered at the site are susceptible to erosion by wind and flowing water. However, based on the relatively limited flows that have historically been conveyed through the SCEFS and its vegetated banks, significant erosion and/or scouring of the tributary is not anticipated.

Mitigation:
Minor wind erosion and dust problems may arise during and immediately after construction. If the problem becomes severe during this time, watering of the cut areas may be implemented to reduce the occurrence of dust. Installation of erosion protection or vegetation after completion of the structures is anticipated to mitigate the majority of the erosion and dust problems.

8.6 Proposed Grading, Erosion Control, Cuts and Masses of Fill

Fill Soils

Fill soils were not encountered at the time of drilling. If fill soils are encountered, they may be considered unsuitable for a variety of reasons. These include (but are not limited to) non-engineered fills, fill soils containing trash or debris, fill soils that appear to have been improperly placed and/or compacted, etc. If unsuitable soils are encountered during the site-specific Subsurface Soil Investigation and/or the open excavation observation, they may require removal (overexcavation) and replacement with compacted structural fill.

Mitigation
Based on the test borings for the Geotechnical Investigation performed by RMG, the excavations are anticipated encounter well graded sand with various amounts of silt and gravel.

The *Grading and Erosion Control Plan for Dwire Yard*, referenced herein, was reviewed and considered in the preparation of this report. Minimal fills are proposed on Lot 1. Proposed fills located within the proposed building envelopes are anticipated to vary between 0 and 3 feet. Proposed embankment fills located within the full spectrum detention pond will range up to 3 feet.

Prior to placement of overlot fill or removal and recompaction of the existing materials, topsoil, low-density native soil, fill and organic matter should be removed from the fill area. The subgrade should be scarified, moisture conditioned to within 2% of the optimum moisture content, and recompacted to the same degree as the overlying fill to be placed. The placement and compaction of fill should be periodically observed and tested by a representative of RMG during construction.

If unsuitable fill soils are encountered during overlot grading, they should be removed (overexcavated) and replaced with compacted structural fill. Structural fill may consist of the onsite material as it is reworked, moisture conditioned and recompacted.

We anticipate that the deepest excavation cuts for shallow foundation construction will be approximately 3 to 4 feet below the existing ground surface, basement level construction is not currently proposed. We believe the surficial soils will classify as Type C materials as defined by OSHA in

29CFR Part 1926, dated January 2, 1990. OSHA requires temporary slopes made in Type C materials be laid back at ratios no steeper than 1.5:1 (horizontal to vertical) unless the excavation is shored or braced. Long term cut slopes in the upper soil should be limited to no steeper than 3:1 (horizontal to vertical). Flatter slopes will likely be necessary should groundwater conditions occur. It is recommended that long term fill slopes be no steeper than 3:1 (horizontal to vertical).

9.0 BEARING OF GEOLOGIC CONDITIONS UPON PROPOSED DEVELOPMENT

Geologic hazards (as described in Section 8.0 of this report) were not found to be present at this site. Geologic constraints (also as described in section 8.0 of this report) such as hydrocompactive soils, faults, seismicity, erosion and radon, were found on the site. Where avoidance is not feasible, it is our opinion that the existing geologic and engineering conditions can be satisfactorily mitigated through proper engineering, design, and contraction practices.

10.0 BURIED UTILITIES

Based upon the conditions encountered in the test borings, we anticipate that the soils encountered in individual utility trench excavations will consist of native well graded sand with various amounts of silt and gravel. It is anticipated the sands will be encountered at loose to medium dense condition. Bedrock is anticipated to be encountered within the utility trenches.

We believe the sand will classify as Type C materials and the clay as Type B materials, as defined by OSHA in 29 CFR Part 1926. OSHA requires that temporary excavations made in Type B and C materials be laid back at ratios no steeper than 1:1 (horizontal to vertical) and 1½:1 (horizontal to vertical), respectively, unless the excavation is shored and braced. Excavations deeper than 20 feet, or when water is present, should always be braced or have the slope designed by a professional engineer.

11.0 PAVEMENTS

The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described. If the subsurface conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and modify them, if necessary. The conclusions and recommendations presented in this report should be verified by RMG during construction.

11.1 Pavement Design

Parking lot pavement is typically designed using the Colorado Asphalt Pavement Association's *A Guideline for the Design and Construction of Asphalt Parking Lots in Colorado*. The following recommendations are for preliminary planning purposes only. We suggest evaluating the soil conditions after site grading and pavement layout to assess our recommendations.

11.2 Subgrade Preparation

On-site soils encountered in the test borings are suitable as subgrade material. All subgrade material placed below pavements should be moisture conditioned and compacted in accordance with the

Structural Fill – General section of this report. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted. The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle. Areas that deform under wheel loads should be removed and replaced. Base course should be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D1557).

11.3 Pavement Thickness

Recommended pavement sections for the normally loaded paved areas and for heavy vehicle loading areas are presented below.

Estimated Hot-Mix Asphalt Pavement Section	
Traffic Level	**HMA over ABC (inches)**
Moderate Traffic / Some Trucks	4.0 / 6.0
Heavy Vehicles with Turning Motions	6.0 / 6.0

As an alternative to the HMA section above, Rigid Concrete Pavements are recommended in areas where heavy vehicle loading is expected. These areas include drop-off/pick-up areas, loading docks, trash pick-up areas, and other locations where heavy trucks will be making frequent turning and braking movements. Rigid pavements may be constructed directly on proof-rolled non-expansive granular subgrade, the top one foot of which has been compacted to a minimum of 95% of maximum dry density as determined by ASTM D1557.

Minimum Rigid Concrete Pavement Section	
Traffic Level	**Portland Cement Concrete (in.)**
Heavy Vehicles with Turning Motions	5.0 in.

11.4 Pavement Materials

Pavement materials should be selected, prepared, and placed in accordance with the above referenced document and the *Pikes Peak Region Asphalt Paving Specifications*. Tests should be performed in accordance with the applicable procedures presented in the specifications.

11.5 Surface Drainage

Surface drainage is important for the satisfactory performance of pavement. Wetting of the subgrade soils or base course will cause a loss of strength that can result in pavement distress. Surface drainage should provide for efficient removal of storm-water runoff. Water should not pond on the pavement or at the edges of the pavement.

12.0 ANTICIPATED FOUNDATION SYSTEMS

Based on the information presented previously, conventional shallow foundation systems consisting of standard spread footings/stemwalls are anticipated to be suitable for the proposed office and warehouse

structures. The anticipated excavation cuts are approximately 3 to 4 feet below the final ground surface for shallow foundations.

If loose sands are encountered, they may require additional compaction to achieve the allowable bearing pressure as indicated in the Geotechnical Investigation performed for the office building. In some cases, removal and recompaction may be required for loose soils.

If undocumented fill is encountered during construction of the structures, it will be assumed that this fill was not moisture conditioned and compacted in a manner consistent with the **Structural Fill** recommendations contained within this report, unless appropriate documentation can be provided. If such fill is encountered, it is not considered suitable for support of shallow foundations. This unsuitable fill will require removal (overexcavation) and replacement with non-expansive, granular structural fill below foundation components and floor slabs. The structural fill should be observed and tested during placement as indicated under the **Structural Fill** section of this report, to ensure proper compaction.

The foundation systems for the proposed warehouse and any future structures should be designed and constructed based upon recommendations developed in a site-specific subsurface soil investigation. The recommendations presented in the *Subsurface Soil Investigation* report for each lot should be verified following the excavations of each structure and evaluation of the building loads.

12.1 Foundation Drains

A subsurface perimeter drain is recommended around portions of the structures which will have habitable or storage space located below the finished ground surface. This includes crawlspace areas but not the walkout trench, if applicable.

Shallow groundwater conditions were not encountered in the test boring performed for this study or the previously reviewed geotechnical engineering/geologic investigations. Depending on the conditions encountered during the site-specific subsurface soil investigations and the conditions observed at the time of construction, additional subsurface drainage systems may be recommended.

One such system is an underslab drainage layer to help intercept groundwater before it enters the slab area should the groundwater levels rise. In general, if groundwater was encountered within 4 to 6 feet of the proposed basement slab elevation, an underslab drain should be anticipated. Another such system would consist of a subsurface drain and/or vertical drain board placed around the perimeter of the overexcavation to help intercept groundwater and allow for proper placement and compaction of the replacement structural fill. Careful attention should be paid to grade and discharge of the drain pipes of these systems.

It must be understood that the drain systems are designed to intercept some types of subsurface moisture and not others. Therefore, the drains could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area.

13.0 EARTHWORK

13.1 Structural Fill - General

Areas to receive granular (non-expansive) structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test (ASTM D-698) or to a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing structural fill.

Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill shall consist of granular, non-expansive material. It should be placed in loose lifts not exceeding 8 to 12 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 92 percent of the maximum dry density as determined by the Modified Proctor test, ASTM D-1557. The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

14.0 DETENTION STORAGE CRITERIA

This section has been prepared in accordance with the requirements outlined in the El Paso County Land Development Code (LDC), the Engineering Criteria Manual (ECM) Section 2.2.6 and Appendix C.3.2.B, and the El Paso County (EPC) Drainage Criteria Manual, Volume 1 Section 11.3.3.

14.1 Soil and Rock Design Parameters

Additional test borings were not performed for the proposed full spectrum detention pond. TB-1 was performed in the general vicinity of the proposed detention pond. RMG has performed laboratory tests of soil from across the proposed office location. Based upon field and laboratory testing, the following soil parameters are typical for the soils likely to be encountered, and are recommended for use in detention pond embankment design.

Soil Description	Unit Weight (lb/ft^3)	Friction Angle (degree)	Active Earth Pressure, Ka	Passive Earth Pressure, Kp	At Rest Earth Pressure, Ko
Well-Graded Silty Sand (SW-SM)	115	28	0.361	2.77	0.531

14.2 Detention Pond Considerations

Based on a review of the *Grading and Erosion Control Plans*, the proposed detention pond will be excavated below the existing ground surface. As such, it is anticipated impounded stormwater runoff will be not be stored above the natural ground surface. Detention pond side slopes are to be constructed with a maximum 3:1 slope. Side slopes should be constructed in accordance with applicable sections of the El Paso County Engineering Criteria Manual, the El Paso County Drainage Criteria Manual, and the El Paso County Land Development Code.

15.0 ADDITIONAL STUDIES

The findings, conclusions and recommendations presented in this report were provided to evaluate the suitability of the site development. Unless indicated otherwise, the test borings, laboratory test results, conclusions and recommendations presented in this report are only intended for the use of design and construction of the 4,800 square foot office and are *not intended* for use for design and construction of the proposed warehouse building or for any future proposed structures. We recommend that a *lot-specific* **Subsurface Soil Investigation** be performed for any future structures. The extent of any fill soils encountered during the lot-specific investigation(s) should be evaluated for suitability to support the proposed structures prior to construction.

Future lot-specific subsurface soil investigations should consider the proposed structure type, anticipated foundation loading conditions, location within the property, and local construction methods. Recommendations resulting from the investigations should be used for design and confirmed by on-site observation and testing during development and construction.

16.0 CONCLUSIONS

Based upon our evaluation of the geologic conditions, it is our opinion that the proposed development is feasible. The geologic conditions identified (hydrocompactive soils, seismicity, radon, and erosion) are not considered unusual for the Front Range region of Colorado. Mitigation of geologic conditions is most effectively accomplished by avoidance. However, where avoidance is not a practical or acceptable alternative, geologic conditions should be mitigated by implementing appropriate planning, engineering, and local construction practices.

In addition to the previously identified mitigation alternatives, surface and subsurface drainage systems should be implemented. Exterior, perimeter foundation drains should be installed around below-grade habitable or storage spaces. Surface water should be efficiently removed from the building area to prevent ponding and infiltration into the subsurface soil.

The foundation and floor slabs of the structure should be designed using the recommendations provided in the lot-specific subsurface soil investigation performed for each lot. In addition, appropriate surface drainage should be established during construction and maintained by the homeowner.

We believe the surficial sand soils will classify as Type C materials and the clay soils will classify as Type B as defined by OSHA in 29CFR Part 1926, date January 2, 1990. OSHA requires temporary slopes made in Type C materials be laid back at ratios no steeper than 1.5:1 (horizontal to vertical) and slopes made in Type B materials be laid back at ratios no steeper than 1:1 (horizontal to vertical) unless

the excavation is shored or braced. Flatter slopes will likely be necessary should groundwater conditions occur.

Long term cut slopes in the upper soil should be limited to no steeper than 3:1 (horizontal to vertical). Flatter slopes will likely be necessary should groundwater conditions occur. It is recommended that long term fill slopes be no steeper than 3:1 (horizontal to vertical).

Revisions and modifications to the conclusions and recommendations presented in this report may be issued subsequently by RMG based upon additional observations made during grading and construction which may indicate conditions that require re-evaluation of some of the criteria presented in this report.

It is important for the Owner(s) of these properties read and understand this report, as well as the previous reports referenced above, and to carefully to familiarize themselves with the geologic hazards associated with construction in this area. This report only addresses the geologic constraints contained within the boundaries of the site referenced above.

17.0 CLOSING

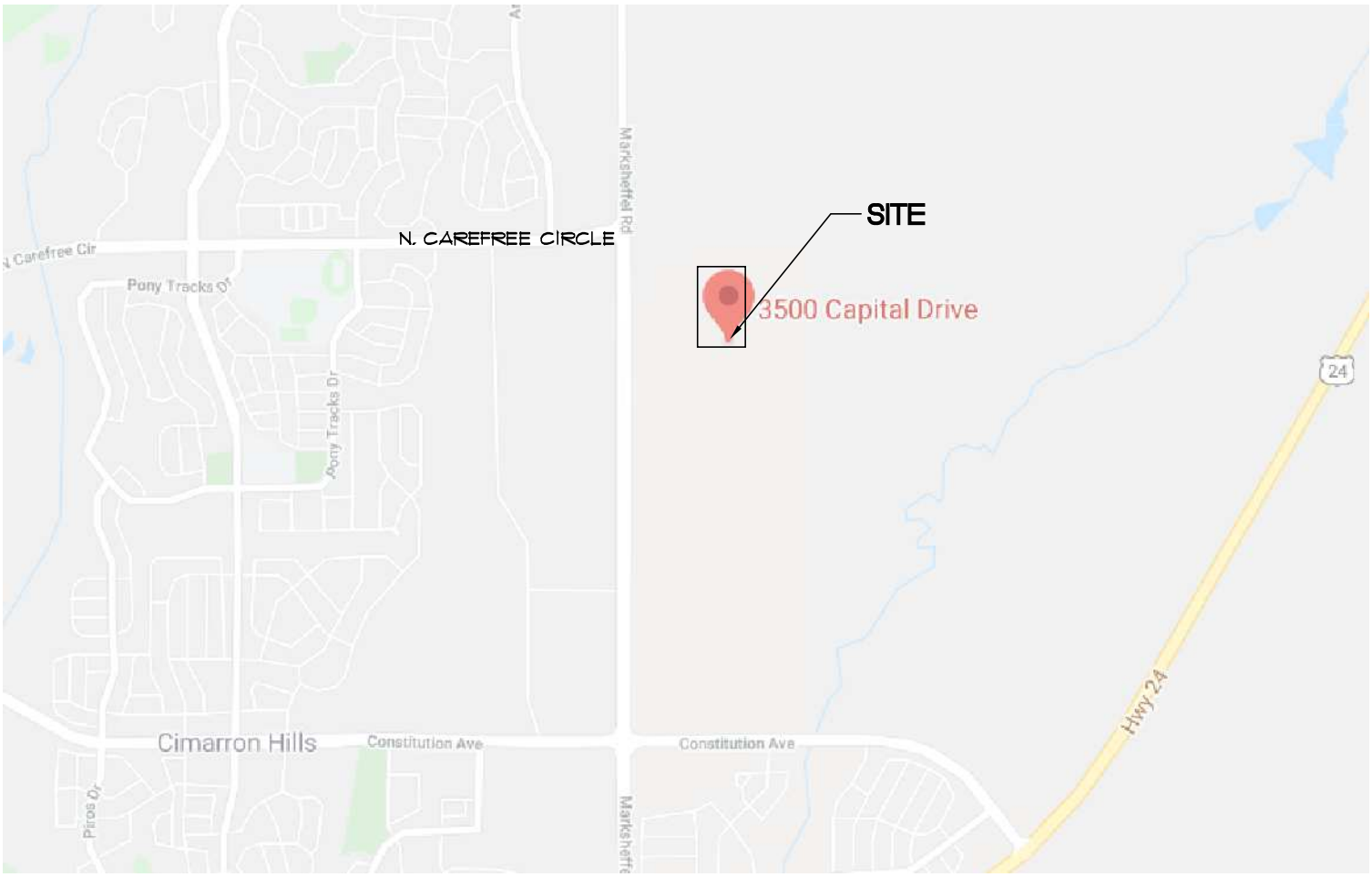
This report is for the exclusive purpose of providing geologic hazards information and preliminary geotechnical engineering recommendations. The scope of services did not include, either specifically or by implication, evaluation of wild fire hazards, environmental assessment of the site, or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to, biological or toxicological issues, are beyond the scope of this report. If the owner is concerned about the potential for such contamination or conditions, other studies should be undertaken.

This report has been prepared for **Dwire Earthmoving & Excavating** in accordance with generally accepted geotechnical engineering and engineering geology practices. The conclusions and recommendations in this report are based in part upon data obtained from review of available topographic and geologic maps, review of available reports of previous studies conducted in the site vicinity, a site reconnaissance, and research of available published information, soil test borings, soil laboratory testing, and engineering analyses. The nature and extent of variations may not become evident until construction activities begin. If variations then become evident, RMG should be retained to re-evaluate the recommendations of this report, if necessary.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers and engineering geologists practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied, is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

FIGURES



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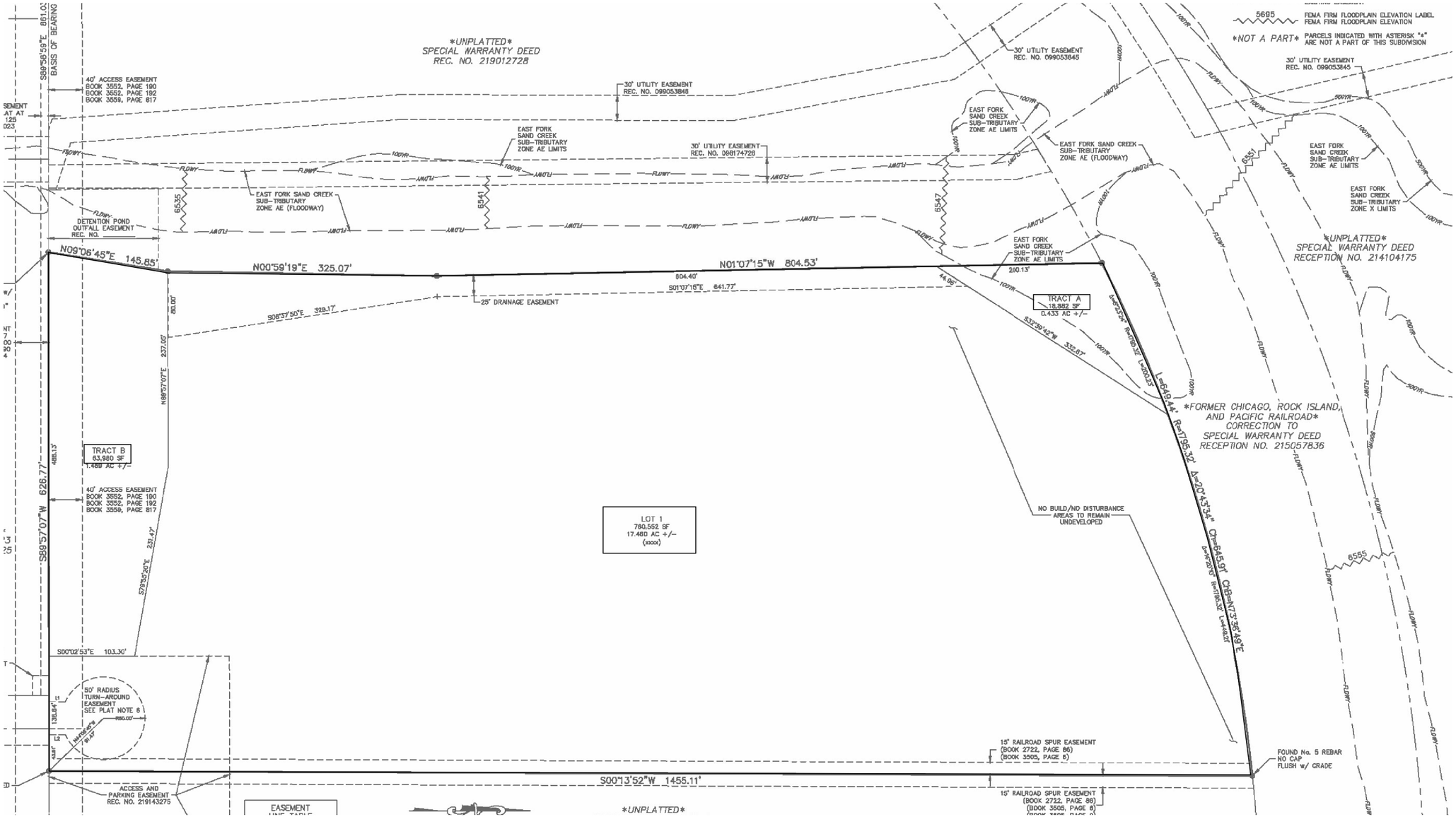
SITE VICINITY MAP

DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, COLORADO
DWIRE EARTHMOVING AND EXCAVATING

JOB No. 168498

FIG No. 1

DATE 3-4-2020



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BASE MAP PROVIDED BY: M&S CONSULTANTS, INC.

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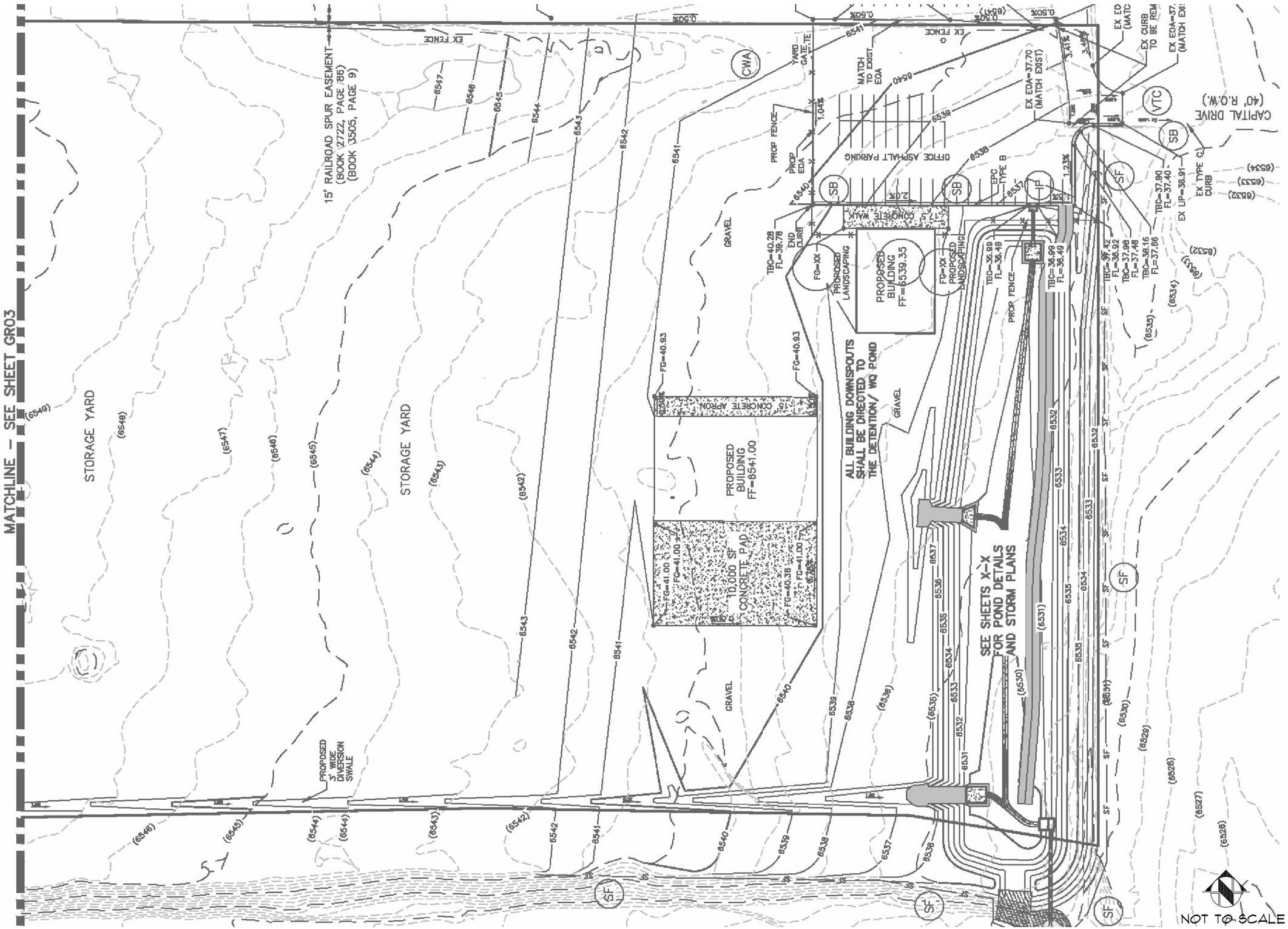
DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, CO
DWIRE EARTHMOVING AND EXCAVATING

ENGINEER:	GGW
DRAWN BY:	KMZ
CHECKED BY:	GGW
ISSUED:	3.4.2020
REVISED:	6.10.2020
UPDATED SITE PLAN	

PROPOSED LOT LAYOUT

SHEET No.
FIG-2



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DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, CO
DWIRE EARTHMOVING AND EXCAVATING

ENGINEER:	GGW
DRAWN BY:	KMZ
CHECKED BY:	GGW
ISSUED:	3.4.2020

PROPOSED LOT 1 DEVELOPMENT

SHEET No.
FIG-3

Geologic

Af - Artificial fill (late Holocene) - stockpiles of debris to include concrete and soils

Qam - Middle alluvium (early Holocene and late Plesitocene) - generally poorly sorted sand, silty and clayey sand with beds of very fine to medium pebble-gravel. The alluvium was encountered up to 20 feet.

Engineering

2A - Stable alluvium, colluvium and bedrock on gentle to moderate slopes (5 to 12%).

7A - Physiographic floodplain where erosion and deposition presently occur and is generally subject to recurrent flooding. Includes 100-year floodplain along majoy streams where floodplain studies have been conducted.

NOT TO SCALE

BASE MAP PROVIDED BY:
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DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, CO
DWIRE EARTHMOVING AND EXCAVATING

ENGINEER:	GGW
DRAWN BY:	KMZ
CHECKED BY:	GGW
ISSUED:	3-4-2020

ENGINEERING AND GEOLOGY MAP

SHEET No.
FIG-4

NOT TO SCALE
BASE MAP PROVIDED BY:USDA

10 - BLENDON sandy loan, 0 to 3% slopes

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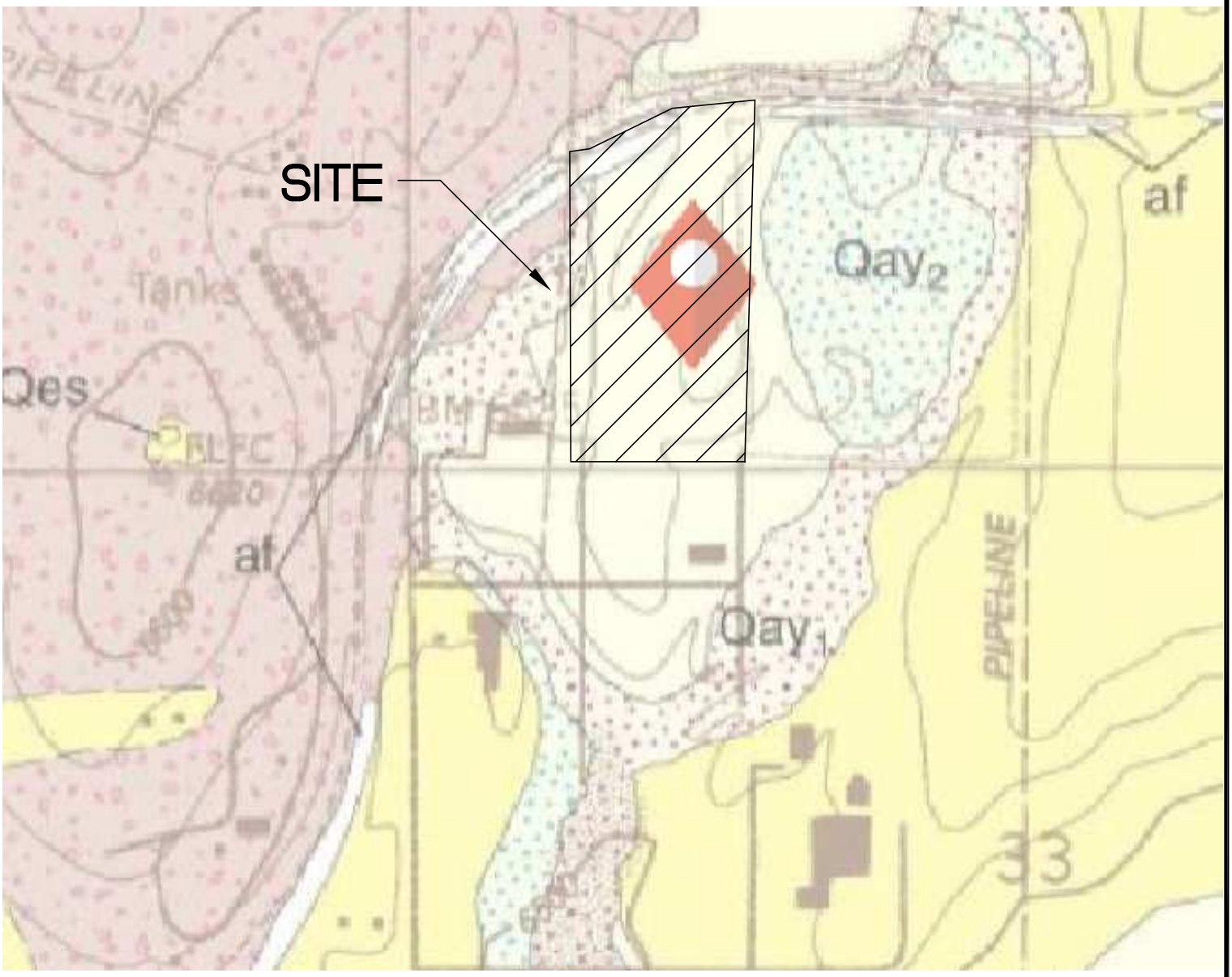
USDA SOILS SURVEY MAP

DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, COLORADO
DWIRE EARTHMOVING AND EXCAVATING

JOB No. 168498

FIG No. 5

DATE 3-4-2020



Qam - Middle alluvium (early Holocene to late Pleistocene)

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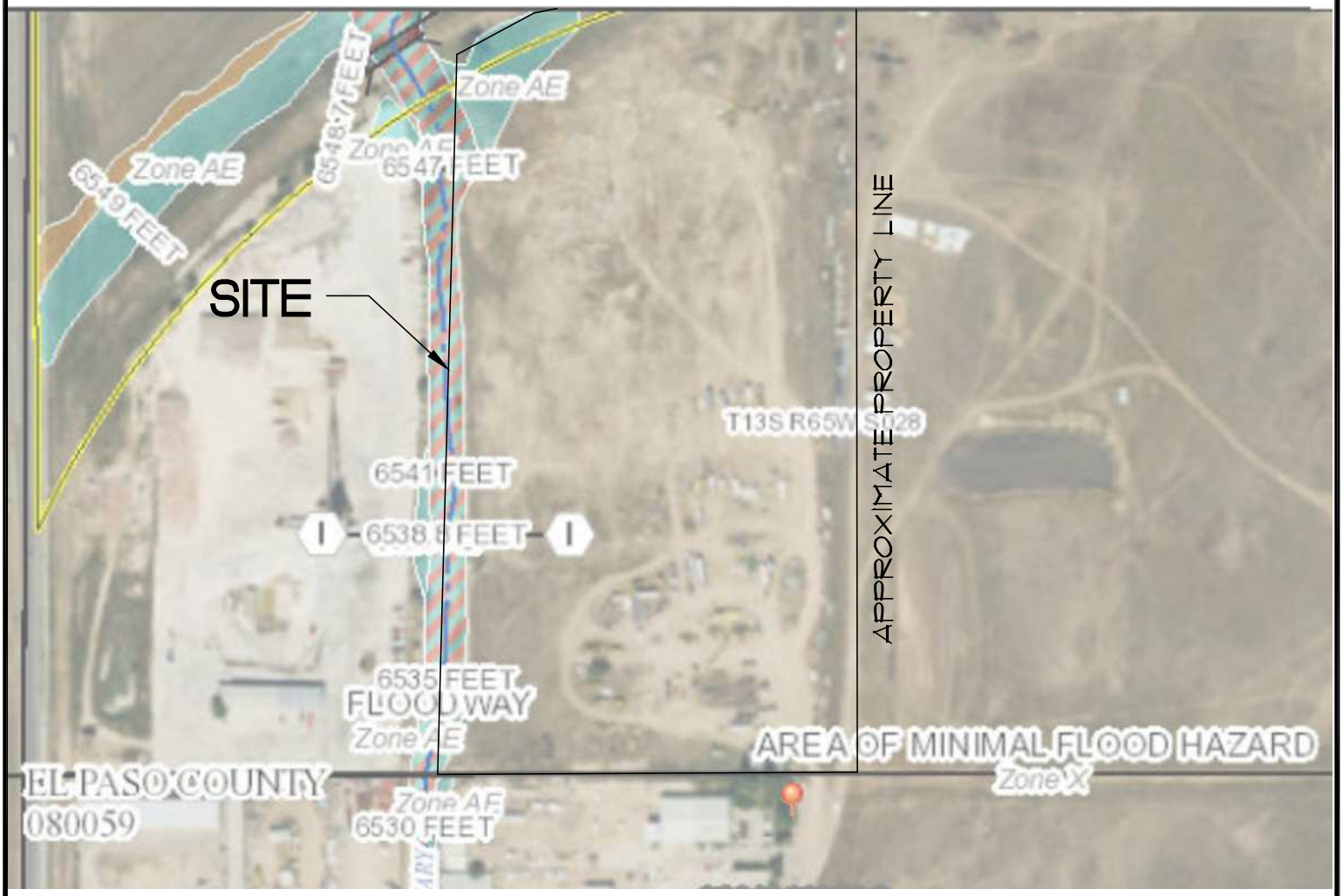
FALCON NW QUADRANGLE

DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, COLORADO
DWIRE EARTHMOVING AND EXCAVATING

JOB No. 168498

FIG No. 6

DATE 3-4-2020



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FEMA MAP

DWIRE STORAGE YARD
FILING NO. 1
EL PASO COUNTY, COLORADO
DWIRE EARTHMOVING AND EXCAVATING

JOB No. 168498

FIG No. 7

DATE 3-4-2020

APPENDIX A
Additional Reference Documents

1. *Dwire Storage Yard Filing No. 1, El Paso County, Colorado,* prepared by M&S Civil Consultants, Inc., last dated June 2, 2020.
2. *Site Plan, Dwire Yard, El Paso County, Colorado*, prepared by M&S Civil Consultants, Inc., Job No. 43-117, last dated December 1, 2018.
3. *Dwire Yard, Grading and Erosion Control Plan, El Paso County Colorado,* prepared by M&S Civil Consultants, Inc., Job No. 43-117, last dated October 16, 2018.
4. *Dwire Yard, Utility Service Plan, El Paso County Colorado,* prepared by M&S Civil Consultants, Inc., Job No. 43-117, last dated October 16, 2018
5. *Final Drainage Report for Dwire Storage Yard Filing No.1, El Paso County, Colorado*, prepared by M&S Civil Consulting, Inc., Job # 43-117, last dated January 2020.
6. *Geotechnical Investigation, Timberline Landscaping Office and Warehouse, Capital Drive and Industry Road, Colorado Springs, Colorado,* prepared by CTL Thompson, Project No. CS18748-125, last dated May 5, 2017.
7. *Flood Insurance Rate Map, El Paso County, Colorado and Unincorporated Areas, Community Panel No. 081041C0543G,* Federal Emergency Management Agency (FEMA), effective December 7, 2018.
8. *Geologic Map of the NW Falcon Quadrangle, El Paso County, Colorado*, Jonathan L. White, Kassandra O. Lindsey, Matthew L. Morgan, and Shannon A. Mahan. Colorado Geological Survey Open-File Report OF-17-05.
9. *Falcon NW, Quadrangle, Environmental and Engineering Geologic Map for Land Use*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
10. *Falcon NW, Quadrangle, Map of Potential Geologic Hazards and Surficial Deposits*, compiled by Dale M. Cochran, Charles S. Robinson & Associates, Inc., Golden, Colorado, 1977.
11. *Pikes Peak Regional Building Department:* https://www.pprbd.org/.
12. https://property.spatialest.com/co/elpaso/#/property/5300000552Schedule No.: 5300000552.
13. *Colorado Geological Survey, USGS Geologic Map Viewer*: http://coloradogeologicalsurvey.org/geologic-mapping/6347-2/.
14. *Historical Aerials:* https://www.historicaerials.com/viewer, Images dated 1947, 1960, 1969, 1999, 2005, 2009, 2011, 2013, and 2015.
15. *USGS Historical Topographic Map Explorer:* http://historicalmaps.arcgis.com/usgs/ Colorado Springs Quadrangles dated 1950, 1951, 1958, 1963, 1969, 1970, 1975, 1978, 1981, 1994, 2013 and 2016.
16. *Google Earth Pro*, Imagery dated 1999, 2003, 2004, 2005, 2006, 2011, 2015, and 2017.

APPENDIX B

Geotechnical Report, Dwire Office Building 3500 Capital Drive, El Paso County, Colorado, prepared by RMG – Rocky Mountain Group, lasted dated May 3, 2019

Architecture
Structural
Geotechnical

ROCKY MOUNTAIN GROUP
EMPLOYEE OWNED

Materials Testing
Forensic
Civil/Planning

GEOTECHNICAL REPORT

Dwire Office Building
3500 Capital Drive
El Paso County, Colorado

PREPARED FOR:

Dwire Earthmoving & Excavating
6799 Bismark Road, Suite C
Colorado Springs, CO 80922

JOB NO. 168498

May 3, 2019

Respectfully Submitted,

RMG – Rocky Mountain Group

Kelli Zigler
Project Geologist

Reviewed by,

RMG – Rocky Mountain Group

Geoff Webster, P.E.
Sr. Geotechnical Project Manager

COLORADO LICENSED
GEOFF WEBSTER
5/3/19
45046
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

GENERAL SITE AND PROJECT DESCRIPTION

Location

The Dwire Construction yard is located at 3500 Capital Drive in El Paso County, Colorado. The location of the site is generally east of Marksheffel Road and north of Constitution Avenue as shown on the Site Vicinity Map, Figure 1.

Existing Site Conditions

The site is currently used as a construction yard, and is a fairly level area mostly devoid of vegetation trees and shrubs. The site is used for storage of construction equipment and materials.

Project Description

According to information provided to RMG, improvements include a two-story office building with a basement. Rocky Mountain Group (RMG) was retained to explore the subsurface conditions in the location of the new structures, and develop geotechnical engineering recommendations for design and construction. Preliminary pavement design recommendations are included.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling two (2) exploratory test borings to 20-feet depth in the generally vicinity of the proposed building. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 2.

The test borings were advanced with a power-driven, continuous-flight auger drill rig. Soil samples were obtained in general accordance with ASTM D-1586 utilizing a 2-inch OD split-barrel sampler or in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Samples were returned to RMG's materials testing laboratory for testing and analysis. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figure 4.

Laboratory Testing

The moisture content for the recovered samples was obtained in the laboratory. Grain-size analysis, Atterberg Limits, and Denver Swell/Consolidation tests were performed on selected samples for purposes of classification and to develop pertinent engineering properties. A Summary of Laboratory Test Results is presented in Figure 5. Soil Classification Data are presented in Figure 6. The soil was deemed to be non-plastic and therefore swell/Consolidation Tests were not performed.

SUBSURFACE CONDITIONS

Subsurface Materials

Test Borings 1 and 2 performed within the building footprint are discussed below. These borings revealed the soil strata across the site to be consistent from boring to boring. The subsurface materials were classified by laboratory testing in accordance with the Unified Soils Classification System (USCS), and can be described as follows.

0 to 20- feet: Tan to brown, moist, medium dense to dense, Silty Sand. This soil classifies throughout its depth as SW-SM, well graded silty sand. Standard Penetration Test blow counts ranged from 13 to 27 in the top 15-feet of this material with an average N-value of 20 blows per foot of penetration.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented on the Test Boring Logs. The classifications shown on the logs are based upon the engineer's classification of the samples at the depths indicated. Stratification lines shown on the logs represent the approximate boundaries between material types and the actual transitions may be gradual and vary with location.

Groundwater

Groundwater was not encountered in the Test Borings at the time of drilling nor when checked after letting the water level stabilize over several days. Groundwater is not expected to be a significant factor in foundation design. Fluctuations in groundwater and subsurface moisture conditions may occur due to seasonal variations in rainfall and other factors not readily apparent at this time.

Soil Parameters

The following table presents estimated in situ soil parameters.

Soil Description	Unit Weight (lb/ft^3)	Friction Angle (degree)	Active Earth Pressure Ka	Passive Earth Pressure Kp	At-rest Earth Pressure Ko	Modulus of Elasticity E_s (lb/in^2)	Poisson's Ratio μ_s
Well-graded silty sand	120	30	0.333	3.0	0.5	2000	.3

Seismic Design

In accordance with the International Building Code, 2012/2015, seismic design parameters have been determined for this site. The Seismic Site Class has been interpreted from the results of the soil test borings drilled within the project site. The USGS seismic design tool has been used to determine the seismic response acceleration parameters. The soil on this site is not considered susceptible to liquefaction.

The following recommended Seismic Design Parameters are based upon Seismic Site Class D, and a 2 percent probability of exceedance in 50 years. The Seismic Design Category is "B".

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	.172	F_a	1.6	S_{ms}	.276	S_{ds}	.184
1.0	S_1	.059	F_v	2.4	S_{m1}	.142	S_{d1}	.094

Notes: MCE = Maximum Considered Earthquake
g = acceleration due to gravity

CONCLUSIONS AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the test borings and on the project characteristics previously described. If conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and adjust them, if necessary.

Geotechnical Considerations

Subsurface soil conditions are suitable for a shallow foundation system on this site. Assuming typical loads for office structures of the type proposed a deep foundation system should not be necessary. Soil improvement to support loads is discussed below. The site soil appears to be native soil in a medium dense condition. This type of soil will require compactive effort to prepare it for foundation loads.

Site Preparation

The on-site material is suitable as structural backfill. Site preparation should include clearing and grubbing the site of all vegetation, topsoil, and any other deleterious material within the construction area and disposing this material appropriately. Following clearing and grubbing, the area within the foundation footprint and a 3-foot perimeter beyond should be overexcavated two (2) feet below the bottom of footing elevation. The excavated material may be stockpiled for reuse as structural backfill. An Open Excavation Observation should be made at this point to verify soil conditions are as reported in the soil boring logs herein.

Upon verification the upper 6 inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing structural fill.

After compaction, the native material previously removed may be used as structural backfill to bring the site to bottom of footing grade. The material should not be excessively wet, should be free of organic matter and construction debris, and contain no rock fragments greater than 3-inches in any dimension. Fill material should be placed in ten-inch loose lifts with moisture content within 2 percent of optimum as determined by ASTM D-1557. Each loose lift should be compacted to a minimum of 95 percent of

Modified Proctor maximum dry density as determined by ASTM D-1557. Each lift of soil should be density tested to verify compaction meets these requirements.

Foundation Recommendations

Structures may be supported on shallow foundations bearing on the onsite soils when prepared in accordance with the recommendations above. When so prepared, a maximum allowable bearing pressure of 2,500 psf with no minimum dead load requirement may be used for design. The foundation design should be prepared by a qualified Colorado Registered Professional Engineer using the recommendations presented in this report. This foundation system should be designed to span a minimum of 10 feet under the design loads. The bottoms of exterior foundations should be at least 30 inches below finished grade for frost protection. When prepared and properly compacted, total settlement of 1-inch or less with differential settlement on the order of ½ inch or less is estimated. Settlement in granular material will occur relatively rapidly with construction loads. Long term consolidation settlement should not be an issue in the site material if prepared as recommended above.

Open Excavation Observations

As referenced above, foundation excavations should be observed by RMG prior to placing structural fill, forms, or concrete to verify the foundation bearing conditions for each structure. Based on the conditions observed in the foundation excavation, the recommendations made at the time of construction may vary from those contained herein. In the case of differences, the Open Excavation Observation report shall be considered to be the governing document to be used to modify the site preparation recommendations as necessary.

Floor Slabs

The in-situ sand soil is non-expansive and should be stable at its natural moisture content. The onsite soil is suitable as backfill material. Any fill material used to bring the site to grade should be non-expansive granular material to control slab movement.

Soil for interior floor slabs (basement slab) should be prepared in a manner similar to foundations above. Areas under floor slabs should be overexcavated a minimum of 1-foot and the upper 6 inches of the exposed subsurface soils should then be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing structural fill. Floor slabs should bear upon a minimum of 1-foot of structural backfill compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by ASTM D-1557. Non-structural slabs should be isolated from foundation members with expansion material. To reduce the possibility of capillary rise of groundwater into the floor slab, and to reduce the potential for concrete curling, a minimum 3-inch layer of ¾-inch crushed stone over 6-mil vapor retarder may be placed atop the compacted structural fill.

Exterior Concrete Flatwork

Reinforced concrete exterior slabs should be constructed similarly to floor slabs on 6-inches of compacted structural fill, with the additional caveat they be isolated from the building with expansion material, and have a downturned reinforced thickened edge.

Lateral Earth Pressures

Foundation and basement walls should be designed to resist lateral pressures. For non-expansive backfill materials, we recommend an equivalent fluid pressure of 40 pcf for design. Expansive soils or bedrock should not be used as backfill against walls. The above lateral pressure applies to level, drained backfill conditions. Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual basis.

CONSTRUCTION CONSIDERATIONS

Surface Grading and Drainage

A contributing factor to foundation settlement and floor slab heave in Colorado Front Range soils is the introduction of excess water. Improper site grading and irrigation water are respectively the most common cause and source of excess water. The ground surface should be sloped from the building with a minimum gradient of 2 percent. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure. Future maintenance operations should include activities to maintain the surface grading and drainage recommendations herein to help prevent water from being directed toward and/or ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended. Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to maintain vegetation. Application of excess water will increase the likelihood of slab and foundation movements.

Perimeter Drain

The site soil is well draining and groundwater was not encountered. A subsurface perimeter drain is recommended, however, around portions of the structure which will have habitable or storage space located below the finished ground surface. This includes basement areas.

Concrete

Type I/II cement is recommended for concrete in contact with the subsurface materials. Calcium chloride should be used with caution for soils with high sulfate contents. The concrete should not be placed on frozen ground. If placed during periods of cold temperatures, the concrete should be kept from freezing. This may require covering the concrete with insulated blankets and heating. Concrete work should be completed in accordance with the latest applicable guidelines and standards published by ACI.

Exterior Backfill

Backfill around foundation stemwalls and other buried structures should be placed in loose lifts of 10-inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture

content) and compacted to 85 percent of the maximum dry density as determined by the Modified Proctor test, ASTM D-1557 on exterior sides of walls in landscaped areas. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 95 percent of the maximum dry density.

Fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

The appropriate government/utility specifications should be used for fill placed in utility trenches. If material is imported for backfill, the material should be approved by the Geotechnical Engineer prior to hauling it to the site.

The backfill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. Backfill should be compacted by mechanical means, and foundation walls should be braced during backfilling and compaction.

Structural Fill - General

Except as discussed above for foundations and slab support, areas to receive structural fill should have topsoil, organic material, or debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557) prior to placing structural fill. Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment.

Structural fill should be placed in loose lifts of 10-inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557). The materials should be compacted by mechanical means.

Materials used for structural fill should be approved by the RMG prior to use. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement.

To verify the condition of the compacted soils, density tests should be performed during placement. The first density tests should be conducted when 24 inches of fill have been placed.

PAVEMENT DESIGN

The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described. If the subsurface conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and modify them, if necessary. The conclusions and recommendations presented in this report should be verified by RMG during construction.

Pavement Design

The pavement recommendations follow the Colorado Asphalt Pavement Association's *A Guideline for the Design and Construction of Asphalt Parking Lots in Colorado*.

Subgrade soil on this site will most likely consist of well-graded silty sand. This soil typically classifies as A-1-b in accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification system. This soil is considered "excellent to good" as subgrade material.

Pavement Thickness

Preliminary pavement recommendations for the majority of paved areas and for heavy vehicle loading areas are presented below.

Estimated Hot-Mix Asphalt Pavement Section	
Traffic Level	**HMA over ABC (inches)**
Moderate Traffic / Some Trucks	4.0 / 6.0
Heavy Vehicles with Turning Motions	6.0 / 6.0

As an alternative to the HMA section above, Rigid Concrete Pavements are recommended in areas where heavy vehicle loading is expected. These areas include drop-off/pick-up areas, loading docks, trash pick-up areas, and other locations where heavy trucks will be making frequent turning and braking movements. Rigid pavements may be constructed directly on proof-rolled non-expansive granular subgrade, the top one foot of which has been compacted to a minimum of 95% of maximum dry density as determined by ASTM D1557.

Minimum Rigid Concrete Pavement Section	
Traffic Level	**Portland Cement Concrete (in.)**
Heavy Vehicles with Turning Motions	5.0 in.

These recommendations are for preliminary planning purposes only. We suggest evaluating the soil conditions after site grading and pavement layout to assess our recommendations.

Pavement Materials

Pavement materials should be selected, prepared, and placed in accordance with the above referenced document and the *Pikes Peak Region Asphalt Paving Specifications*. Tests should be performed in accordance with the applicable procedures presented in the specifications.

Subgrade Preparation

All subgrade fill material placed below pavements should be moisture conditioned and compacted in accordance with the ***Structural Fill – General*** section of this report. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted. The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle. Areas which deform under wheel loads should be removed and replaced. Base

course should be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D1557).

Surface Drainage

Surface drainage is important for the satisfactory performance of pavement. Wetting of the subgrade soils or base course will cause a loss of strength which can result in pavement distress. Surface drainage should provide for efficient removal of storm-water runoff. Water should not pond on the pavement or at the edges of the pavement.

CLOSING

This report has been prepared for the exclusive purpose of providing geotechnical engineering information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

This report has been prepared for the exclusive use by **Dwire Earthmoving & Excavating** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from test borings, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed development, from a geotechnical engineering point-of-view, please feel free to contact us.

FIGURES

NOT TO SCALE

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ENGINEERS
ROCKY MOUNTAIN GROUP

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Colorado Springs,CO
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(719) 548-0600
Central Office:
Englewood, CO 80112
(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
(970) 330-1071

SITE VICINITY MAP

3500 CAPITAL DRIVE
DWIRE SUBDIVISION
EL PASO COUNTY, CO
DWIRE EARTHMOVING & EXCAVATING

JOB No. 168498

FIG No. 1

DATE 5-3-2019

NOT TO SCALE

DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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Central Office:
Englewood, CO 80112
(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
(970) 330-1071

TEST BORING LOCATION PLAN

3500 CAPITAL DRIVE
DWIRE SUBDIVISION
EL PASO COUNTY, CO
DWIRE EARTHMOVING & EXCAVATING

JOB No. 168498

FIG No. 2

DATE 5-3-2019

SOILS DESCRIPTION

SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
2910 AUSTIN BLUFFS PARKWAY
COLORADO SPRINGS, COLORADO

SYMBOLS AND NOTES

XX — STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).

XX — UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).

FREE WATER TABLE

DEPTH AT WHICH BORING CAVED

BULK — DISTURBED BULK SAMPLE

AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

EXPLANATION OF TEST BORING LOGS

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FIGURE No. 3

DATE 5/3/19

TEST BORING: **1** DATE DRILLED: 4/1/19 ELEVATION (FT): NO GROUNDWATER ON 4/9/19	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan to brown, medium dense to dense, moist					
	5		■	17	2.8
	10		■	27	7.9
	15		■	26	10.5
	20		■	31	5.1

TEST BORING: **2** DATE DRILLED: 4/1/19 ELEVATION (FT): NO GROUNDWATER ON 4/9/19	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, with gravel, tan to brown, medium dense to dense, moist					
	5		■	14	2.7
	10		■	13	5.5
	15		■	24	10.1
	20		■	33	8.1

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TEST BORING LOG

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FIGURE No. 4

DATE 5/3/19

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell @ 1000 psf	USCS Classification
1	4.0	2.8								
1	9.0	7.9		NP	NP	4.8	8.0			SW-SM
1	14.0	10.5								
1	19.0	5.1								
2	4.0	2.7		NP	NP	14.4	3.2			SW
2	9.0	5.5								
2	14.0	10.1		NP	NP	4.3	10.2			SW-SM
2	19.0	8.1								

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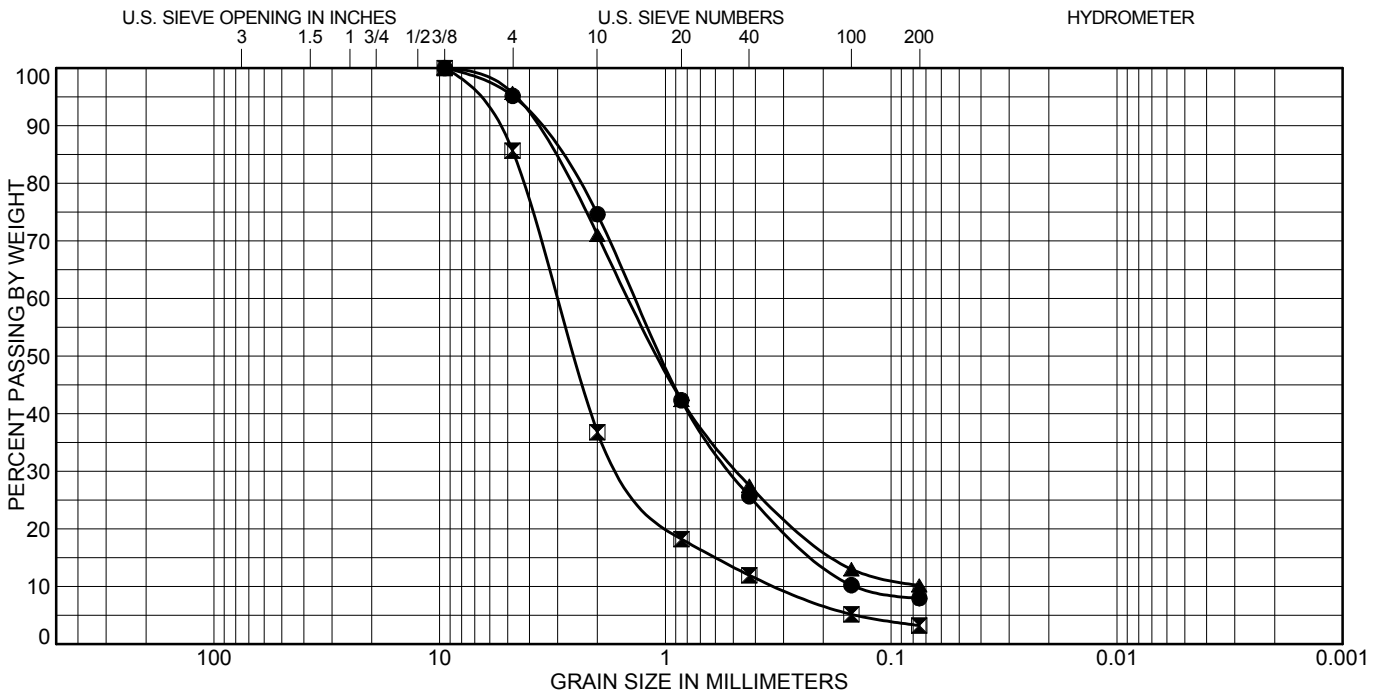
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 168498
FIGURE No. 1
PAGE 1 OF 1
DATE 5/3/19



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	1	9.0	**WELL-GRADED SAND with SILT(SW-SM)**	**NP**	**NP**	**NP**
⧗	2	4.0	**WELL-GRADED SAND(SW)**	**NP**	**NP**	**NP**
▲	2	14.0	**WELL-GRADED SAND with SILT(SW-SM)**	**NP**	**NP**	**NP**

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	9.0	4.8	87.2	8.0	
⧗	2	4.0	14.4	82.4	3.2	
▲	2	14.0	4.3	85.5	10.2	

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SOIL CLASSIFICATION DATA

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FIGURE No. 6

DATE 5/3/19