

An aerial photograph of a landscape. The top half of the image shows a large, irregularly shaped area of green vegetation, possibly a wetland or marsh, surrounded by a light brown, sandy or silty area. The bottom half of the image shows a paved road with yellow lane markings and a crosswalk. A few cars are visible on the road. In the bottom right corner, there is a building with a flat roof and a parking lot with several cars.

Land Suitability Analysis Report  
for  
**RidgeView Town Center**  
Planning Development  
December 2024

## **Table of Contents**

|                                          |   |
|------------------------------------------|---|
| Table of Contents                        | 1 |
| Introduction                             | 2 |
| Location                                 | 2 |
| Methodology                              | 2 |
| Slope Analysis                           | 3 |
| Geologic Hazards                         | 3 |
| Vegetation/Cover                         | 3 |
| Wildfire Mitigation Zones                | 4 |
| Wildlife Habitat/Migration               | 4 |
| Composite Analysis                       | 4 |
| Opportunity and Constraints / Conclusion | 4 |

## **Appendices**

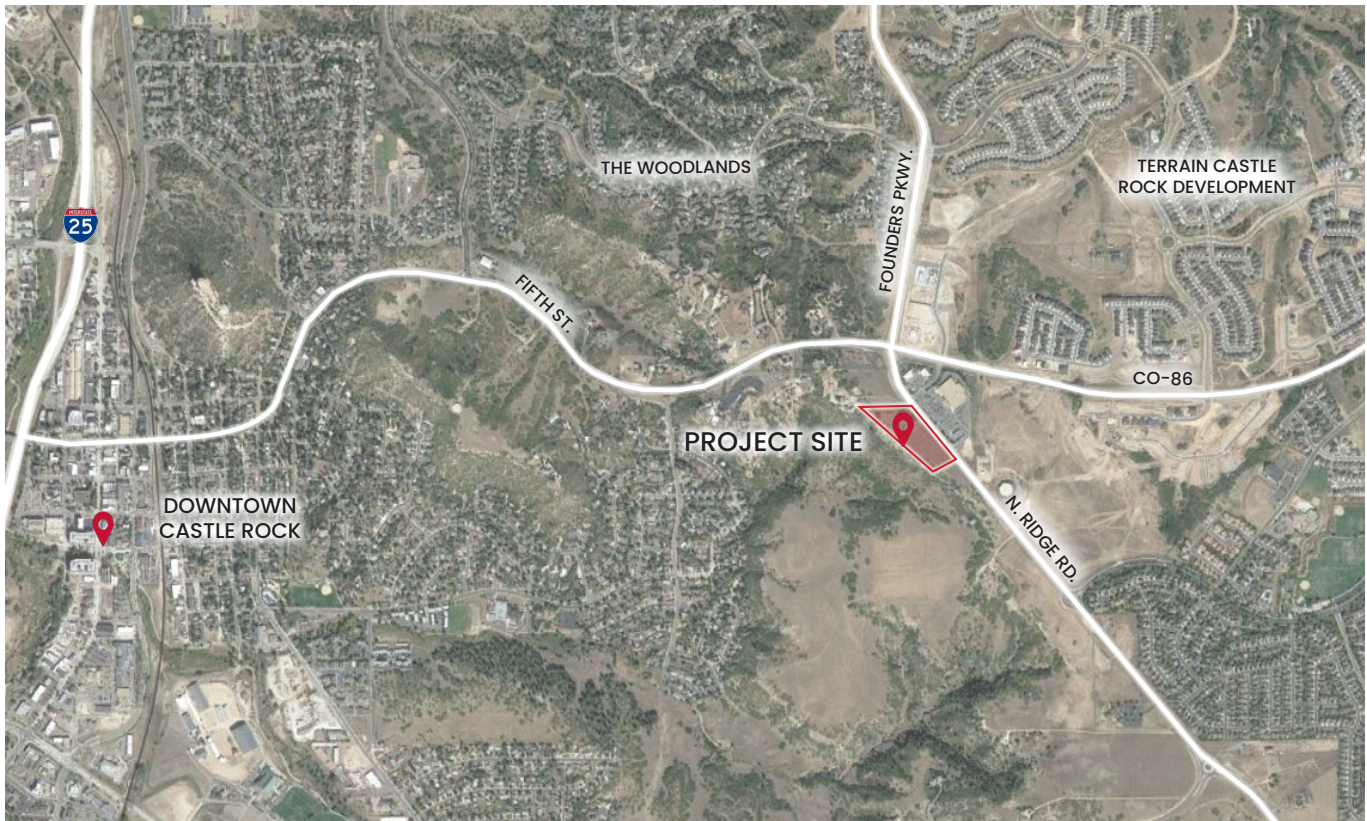
|                                     |            |
|-------------------------------------|------------|
| Slope Analysis Map                  | Appendix A |
| Composite Analysis Map              | Appendix B |
| Geologic Hazards Study              | Appendix C |
| General Ecological Resources Survey | Appendix D |
| Preliminary Geotechnical Report     | Appendix E |



## Introduction

This Land Suitability Analysis Report (LSAR) has been prepared for the RidgeView Towncenter. The property comprises approximately 10.18 acres and is planned for a shopping center, general office, and restaurant. It is located south of State Highway 86. This analysis explores the property's opportunities and constraints for development by identifying prominent ridges and drainages, slope of the topography, existing vegetation, existing man-made improvements, and other unique natural features found on the site.

## Vicinity Map



## Location

This site is located 2 miles east of Interstate 25, south of Highway 86 and west of N. Ridge Rd. in Castle Rock, Colorado. The site is bordered by a King Soopers and residential development to the east.

## Methodology

This LSAR has been compiled utilizing a number of existing reports and maps, supplemented by on-site review of existing conditions. There have been multiple field investigations to determine any site environmental opportunities and constraints for the process required to compile this LSAR report. Based on review of the existing documents and the on-site analysis, a composite analysis map was created to illustrate the site's opportunities and constraints. That map is included in the Appendices of this document.

Sources of information researched in the development of this LSAR include:

- General Ecological Resources Survey Land Suitability Analysis Report, June 1st, 2023, Western Environment and Ecology, Inc.
- Geologic Hazards Study, October 24th, 2023, Kumar & Associates, Inc.
- Preliminary Geotechnical Engineering Report, February 7th, 2022

## Slope Analysis

The slope analysis uses color ranges to depict various slope percentages throughout the site. The site is relatively flat besides the steep slope along the south western portion of the site where there is exposed rock. Based on the slope analysis, in certain areas there are nearly vertical spots with slopes between 20% - 50%. As for the rest of the site, the slope range is typically between 0% - 10% and some areas with scattered across the site between 10% - 20%.

## Geologic Hazards

The subsurface of the site is underlain with clay loam underlain by weathered to comparatively unweathered clay stone.

Geological hazards to consider include expansive soils and bedrock, areas of shallow groundwater, unstable slopes, erosion potential and the regional issues of seismic and naturally occurring radioactive materials. Expansive soils and bedrock are expected to be present on site. The clay loam soil is expected to have low to high shrink-swell potential, the clay stone in the region tends to have more expansive properties. This can cause potential damage to structures and buildings .

The subsurface materials and characteristics vary across the site and should be further evaluated through the geotechnical study for the development.

Sheet wash erosion, smaller erosional scarps and rills, and headword eroding gullies are in process of forming on site along the areas of exposed Castle Rock Conglomerate cap rock and overburden soils, east of the bedrock. These formations will continue if not mitigated. There is also many areas on site subject to wind erosion. Water flow over these features during site development may accelerate the erosion and methods of mitigation will need to be considered.

Rockfall is also a potential hazard on the southwest portion of the site. The slope is nearly vertical and contains the Castle Rock Conglomerate caprock. Rockfalls are considered a Class 3 hazard and as falling, rolling, and/or bouncing. This can cause a damage to property and injury.

The nearest flooding hazard is 2,000 ft. east of the site and does not pose a threat to the site.

## Vegetation/Cover

Vegetation consists mostly of native and invasive grasses and weeds. This would include smooth brome (*Bromus inermis*), alyssum, prickly pear cactus. Woody vegetation on site consists of gamble oak, golden currant, ponderosa pine and juniper. To the southwest portion of the site the vegetation is dispersedly spaced and includes rocky slopes. The landscape surrounding the single residence present on site is irrigated and includes bristle cone pine and ponderosa pine trees.



## **Wildfire Mitigation**

The property is generally covered by native grasses on the future develop able areas with shrubs and pines on the southwestern edge of the site. The proposed development will remove some of the potential wildfire fuels and will create new irrigated areas which may contribute to the creation of fuel breaks in certain locations. For other wild fire mitigation efforts, the planned development will follow the requirements of the Castle Rock 2022 Community Wildfire Protection Plan.

## **Wildlife Habitat/Migration**

Wildlife on site will be mammals that live in short grass habitats. This would include large mammals like coyotes, mule deer, pronghorn, prairie dogs, and red fox. Small mammals would include voles, pocket gopher, and thirteen-lined ground squirrels.

All state threatened species (Mexican spotted owl, whooping crane, least tern, boreal toad, northern leopard frog, greenback cutthroat trout, Colorado butterfly plant, and western prairie fringed orchid) mentioned in the report were not observed on site at the time of the survey.

There are no habitats that are currently on site that are deemed to be threatened or endangered by the development along with no other ecological issues were found. Additionally, no wetlands or Waters of the U.S. subject to regulation under Section 404 of the Clean Water Act occur on the project.

## **Composite Analysis**

Natural and man-made conditions that affect this site are shown in the Composite Analysis (Appendix B). The composite analysis represents the opportunities and constraints to the development of the site.

The composite analysis features the planning areas as defined in the PD:

- Rockfall Hazard Areas and Outcroppings
- Potential access points and Main Roads
- View Corridors and Skylines
- Erosional Features

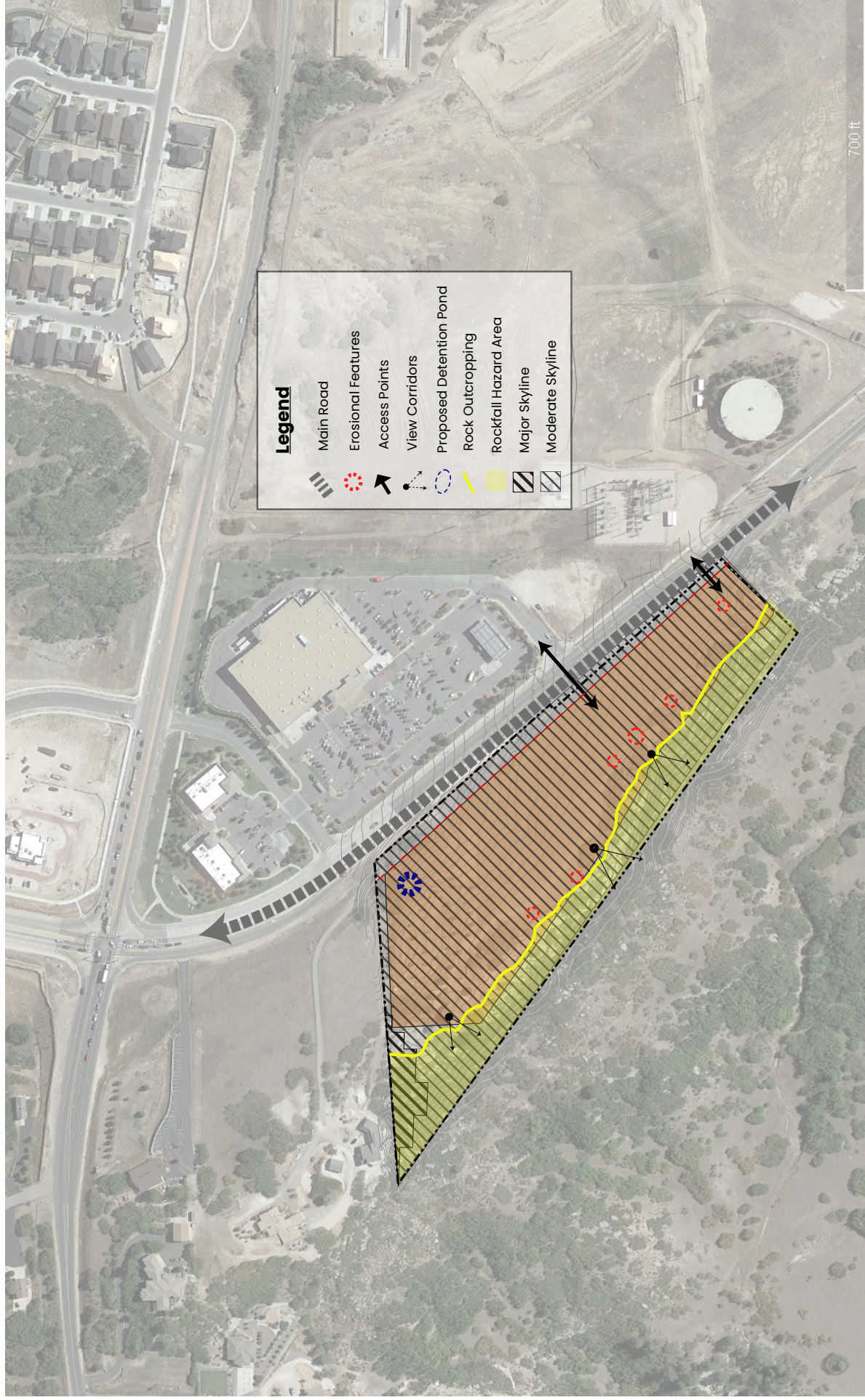
## **Opportunities and Constraints / Conclusion**

In summary, the design and location of the proposed development does not have a significant impact on environmentally sensitive areas. Geological hazards are in areas primarily located to the west of the proposed development and consists of heavily vegetated areas, steep slopes, rock outcroppings which have been largely preserved as undisturbed areas. The significant rock outcropping located on the southwest portion of the site will be undisturbed. The development of this property, as designed, will not have a significant impact on wildlife, vegetation or natural features. This Land Suitability Analysis Report determines that this site is suitable for development as proposed.

[illegible]



## Appendix B - Composite Analysis



**Appendix C**  
Geologic Hazards Study





**Kumar & Associates, Inc.®**  
Geotechnical and Materials Engineers  
and Environmental Scientists

6735 Kumar Heights  
Colorado Springs, CO 80918  
phone: (719) 632-7009  
fax: (719) 632-1049  
email: [kacolospgs@kumarusa.com](mailto:kacolospgs@kumarusa.com)  
[www.kumarusa.com](http://www.kumarusa.com)

**An Employee Owned Company**

Office Locations: Denver (HQ), Parker, Colorado Springs, Fort Collins, Glenwood Springs, and Summit County, Colorado

**GEOLOGIC HAZARDS STUDY  
895 NORTH RIDGE ROAD  
PROPOSED MULTI-USE DEVELOPMENT  
SOUTH OF NORTH RIDGE ROAD AND FIFTH STREET**

*Prepared by:*

**Rob A. Yeoman**  
Staff Geologist

*Reviewed by:*

**Robert L. Duran, P.E.**



**PREPARED FOR:**

**Brightlighter Engineering LLC  
1 Broadway, A225  
Denver, CO 80203**

**Attn: Mr. Charlie Keener**

## TABLE OF CONTENTS

|                                                      |   |
|------------------------------------------------------|---|
| PURPOSE AND SCOPE OF STUDY.....                      | 1 |
| PROPOSED DEVELOPMENT .....                           | 1 |
| SITE CONDITIONS .....                                | 1 |
| GEOLOGIC SETTING .....                               | 2 |
| NRCS SOIL SURVEY .....                               | 3 |
| POTENTIAL MINERAL RESOURCES .....                    | 3 |
| GEOLOGIC SITE ASSESSMENT .....                       | 3 |
| POTENTIAL FLOODING.....                              | 3 |
| SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE..... | 4 |
| PRE-EXISTING MAN-PLACED FILL .....                   | 4 |
| EXPANSIVE/COLLAPSIBLE SOILS AND BEDROCK .....        | 4 |
| SUBSURFACE MINING.....                               | 5 |
| SEISMICITY.....                                      | 5 |
| EROSIONAL FEATURES .....                             | 5 |
| ROCKFALL.....                                        | 6 |
| RADIOACTIVE GASES .....                              | 6 |
| DEVELOPMENT CONSIDERATIONS .....                     | 7 |
| PRE-EXISTING MAN-PLACED FILL .....                   | 7 |
| EXPANSIVE/COLLAPSIBLE SOILS AND BEDROCK .....        | 7 |
| EROSIONAL FEATURES .....                             | 7 |
| SLOPES GREATER THAN 25 PERCENT .....                 | 7 |
| ROCKFALL.....                                        | 8 |
| SITE GRADING AND SURFACE DRAINAGE.....               | 8 |
| LIMITATIONS .....                                    | 8 |
| REFERENCES .....                                     | 9 |
|                                                      |   |
| FIGURE 1A – Project Site & Vicinity Map              |   |
| FIGURE 1B – Proposed Development                     |   |
| FIGURE 2 – Mapped Features                           |   |
| FIGURE 3 – NRCS Soil Survey Soils                    |   |



## PURPOSE AND SCOPE OF STUDY

This report presents the results of a Geologic Hazards Study for the proposed multi-use development at 895 North Ridge Road. A map showing the project site extents is shown on Figure 1A and the proposed development is shown in more detail on Figure 1B. The purpose of the study was to evaluate the geologic conditions and assess their potential impact on the project and surrounding properties. The study was conducted in accordance with our proposal to Brightlighter Engineering LLC, dated August 31, 2023, Proposal No. C23-285.

A reconnaissance of the project site was conducted on September 26, 2023, to obtain information on the geologic conditions of the site. Aerial photographs and published regional geologic, engineering geology, and mineral extraction maps were also reviewed. This report summarizes the data obtained during this study and presents our conclusions, recommendations, and other geologic considerations based on the proposed construction and geologic conditions observed.

## PROPOSED DEVELOPMENT

We understand the proposed development may include a mixed-use commercial, office, and restaurant development. We understand the project will involve about 30,000 square feet of commercial retail space across 4 separate buildings, approximately 10,000 square feet of office space between two buildings, and a restaurant building of about 8,000 square feet. Approximately 49 percent of the overall 10.54-acre property is planned to remain as open space, including about 20,000 square feet for a detention basin. We assume that construction methods will be standard for the region, and that cuts and fills on the order of up to 6 feet may be necessary for the development.

If conditions are significantly different from those described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

## SITE CONDITIONS

The subject site is located south of the intersection of North Ridge Road and Fifth Street at 895 North Ridge Road. The property is mostly contained within the west half of the northwest quarter of Section 07 in Township 8 south, Range 66 west, Sixth Meridian of the Public Land Survey System. The northwest corner of the site extends into the northeast quarter of the northeast quarter of Section 12 in Township 8 south, Range 67 west, Sixth Meridian of the Public Land Survey System. North Ridge Road bounds the site to the east, while vacant land borders the development to the south and west. A residential property is on the north end of the site, with the rest of the subject site to the south remaining vacant. A cliff of exposed bedrock trending northwest to southeast forms a ridgeline located along the west property line, with scrub oak and

native bushes and grasses above and below the cliff, bordering and within the outcrop. East of the exposed bedrock, the site is nearly level to gently sloping and undulating, with topography generally sloping down to the north-northwest. This east portion of the site is vegetated with native grasses and weeds.

## GEOLOGIC SETTING

The subject site is located within the Colorado Piedmont of the Great Plains physiographic province. The region consists of the Denver Basin, which is a geological structural depression situated east of the Front Range, and covers a large portion of eastern Colorado. The site is located within the Plum Creek drainage basin, which is tributary to the South Platte River. The various lithologies of the Castle Rock region are best described as a series of erosion and deposition. Geologic lithologies mapped in the field are shown on Figure 2, and include the Castle Rock Conglomerate, as well as alluvial deposits.

The Castle Rock Conglomerate, dating to the late Eocene epoch, is the youngest bedrock unit in the region. It is a pebble, cobble, and boulder sized arkosic conglomerate composed mainly of granite and quartz parent material, with lesser amounts of gneissic metamorphic rocks, quartzite, sandstone, and chert in a sandy matrix. Larger grains are found to be rounded to subrounded in a coarse to very coarse matrix. Similar in appearance to the conglomerate of Larkspur Butte, the Castle Rock Conglomerate is distinguished by the presence of up to boulder size fragments of the Wall Mountain Tuff. This unit was deposited as a sheet across the eroded surface of previous lithologies at various elevations trending north-northwest, which may indicate that it occurred as a valley filling deposit following the path of the present-day Plum Creek valley. Permeability of the Castle Rock Conglomerate varies, being well drained in some areas, and less so in others. It has good foundation characteristic, but excavation may be difficult. Rock falls from cliffs at the edges of plateaus pose slope stability risks, particularly where the less competent and easily eroded sandstone and claystone beds of the Dawson Formation supports the unit.

In addition to Castle Rock Conglomerate, the subject site contains Older alluvial deposits, particularly in the area east of the exposed bedrock. This alluvium is composed of sand, silt, gravel, and clay that was transported and deposited by flowing water, and is generally sourced from the Castle Rock Conglomerate and the Dawson Formation, although other parent sources such as the Wall Mountain Tuff have been observed. This alluvium may have a thickness of 45 to 60 feet in the region.

## NRCS SOIL SURVEY

The United States Department of Agriculture Natural Resource Conservation Service (NRCS) Web Soil Survey indicates the subject site as overlain with 2 separate soil units. These units include the Fondis clay loam (FoD) and Stony steep land (Sv). A map of the soil units is presented on Figure 3. Both soil units are well drained, and have a high runoff potential. The Fondis clay loam is found within hydrologic group C, while Stony steep land is classified within hydrologic group D. The Fondis clay loam has a parent material of eolian deposits over coarse-silty outwash derived from arkose, while Stony steep land does not have parent materials listed on the Soil Survey, although its location generally correlates with the location of the Castle Rock Conglomerate. These soils are found within geomorphic positions that range from mesas, buttes, and ridges.

## POTENTIAL MINERAL RESOURCES

According to the “Sand, Gravel, and Quarry Aggregate Resources of the Colorado Front Range Counties” (1974) map, from the Douglas County Mineral Extraction Plan, a sub-element of the Comprehensive Master Plan, the subject site is not indicated to contain any commercial mineral resources.

The United States Department of Agriculture Natural Resource Conservation Service (NRCS) Web Soil Survey indicates the subject site as overlain with the Fondis clay loam and Stony steep land. These soil units have been rated for their use as roadfill, as a gravel source, and as a sand source by the Soil Survey. The Fondis clay loam is rated as a fair source of roadfill, while Stony steep land is rated as a poor source of roadfill material. Both units were rated as a poor source of gravel. The Stony steep land soil unit was rated as a fair source of sand, while Fondis clay loam was rated as a poor sand source. Evaluation of commercial feasibility of gravel, sand, or roadfill mining on the subject site is beyond the scope of this study.

## GEOLOGIC SITE ASSESSMENT

There are several conditions of a geologic nature that should be considered at the subject site. These conditions, their potential risks, and suggestions to mitigate the potential risks are discussed below.

## POTENTIAL FLOODING

According to the “Flood Insurance Rate Map” (FIRM), map number 08035C0302G produced by the Federal Emergency management Agency (FEMA, 2016), the entirety of the subject site is located in an unshaded region of Zone X, which are areas determined to be outside the 0.2 percent annual chance floodplain, also known as the 500-year floodplain. The nearest flooding



hazard is located over 2,000 feet east of the subject site, associated with McMurdo Gulch. Floodplain migration can occur over time as a result of man-induced change, erosional processes or other natural factors. No flood modeling was performed as a part of this study.

#### SEASONALLY SHALLOW GROUNDWATER/SEASONAL SEEPAGE

Groundwater is anticipated to fluctuate over time. Fluctuations in water level may occur, particularly after precipitation events and as a result of nearby irrigation practices after development. Based on our experience with the lithologies found at the subject site, shallow groundwater is not expected to be a constraint to the proposed development. If seepage is encountered, it may need to be collected and diverted away from structures. Water may become perched upon impermeable layers, such as bedrock, and is particularly likely to be present within the overburden materials above the less permeable bedrock layer during and after precipitation events, and during wet periods. The extent and amount of perched water beneath the site as a result of precipitation and inadequate surface drainage is difficult, if not impossible, to foresee. Recommendations pertaining to shallow groundwater within an applicable geotechnical engineering report should be followed. Long term water monitoring is beyond the scope of this study.

#### PRE-EXISTING MAN-PLACED FILL

Pre-existing fill associated with the construction on Ridge Road was observed staged along the northeast border of the site. The presence of this pre-existing fill is expected to be corrected during site grading of the site. Pre-existing man-placed fill should be considered unsuitable for support of the proposed foundations, structures, and pavements unless documentation is available stating the site fills were properly controlled to the compaction criteria presented in the applicable geotechnical engineering report. Any pre-existing man-placed fill should be evaluated prior to use as foundation support or other site grading uses. Uncontrolled or inadequately compacted fill presents risks of excessive or differential settlement of foundations or roadways constructed on the fill. Additionally, expansive clays within the fill could present the risk of heave upon wetting. Engineering risk from uncontrolled fill is typically mitigated by removal and replacement of the material. The vertical and lateral extent of man-placed fill on the development was not determined and is beyond the scope of our work for this report.

#### EXPANSIVE/COLLAPSIBLE SOILS & BEDROCK

Based on our experience in the area and the literature reviewed, expansive soils and bedrock are expected to be present at the subject site. The NRCS Soil Survey indicates the Fondis clay loam present at the site to have a low to high shrink-swell potential. Claystone in the region is known to have expansive properties, and soils derived from this bedrock unit may also have expansive

properties. Soils composed of these materials are stable at their natural moisture content but will undergo high volume changes with changes in moisture content. Expansive materials may cause distress to structures or pavement if changes in moisture content occur. Overexcavation and replacement or moisture conditioning of expansive materials are standard construction practices commonly used in this area for mitigation of moisture sensitive soils. Swell/consolidation characteristics of the soil and bedrock are expected to vary across the development and should be evaluated as part of the geotechnical study for the proposed development.

### SUBSURFACE MINING

The Colorado Geological Survey does not indicate any historic mines in the vicinity of the subject site. The subject site displayed no evidence of mine subsidence at the surface, and the risk is considered minimal as the site is not close to any known historic subsurface mines.

### SEISMICITY

The Rampart Range Fault, a high-angle generally north-south trending reverse fault, is mapped approximately 10 miles west of the subject site. According to the “Preliminary Quaternary Fault and Fold Map and Database of Colorado” by Widmann, Kirkham and Rogers (1998), there is evidence that the Rampart Range Fault may have moved between 600,000 and 30,000 years ago. The largest historic earthquake in the project region occurred in 1882. It was located in the northern Front Range and had an estimated magnitude of  $M_{6.4} \pm 0.2$  and a maximum intensity of VII. Historic ground shaking at the project site does not appear to have exceeded Modified Mercalli Intensity VI (Kirkham and Rogers, 2000). Modified Mercalli Intensity VI ground shaking should be expected during a reasonable exposure time for the development, but the probability of stronger ground shaking is low. Intensity VI ground shaking is felt by most people and causes general alarm, but results in negligible damage to structures of good design and construction. According to the Colorado Geological Survey (Kirkham and Rogers, 1981), Douglas County should be considered as Zone 2 in the Uniform Building Code (UBC) scheme of seismic zonation.

Based on our experience in the region, and the literature reviewed, the subject site displays properties that indicate the seismic soil profile within the upper 100 feet at the subject site should be considered Class C, *very dense soil and soft rock*, as described in the 2015 International Building Code, unless site specific shear wave velocity studies show otherwise. Based on anticipated ground conditions, liquefaction is not a design consideration.

### EROSIONAL FEATURES

Erosion is a prominent geologic process which is often associated with and caused by other hazards. Erosional Features are shown on Figure 2. Sheetwash erosion, smaller erosional

scarps and rills, and headward eroding gullies in the early phases of formation were observed on the subject site, particularly along the contact between the exposed Castle Rock Conglomerate caprock and the overburden soils, just east of the exposed bedrock. The progression of these erosional features is anticipated to continue if not mitigated by site grading, landscaping, or other means. Several areas in the center of the site are subjected to wind-related erosion, although development is expected to mitigate erosion in these areas. If site development concentrates surface water flow over these features, accelerated erosion should be expected and the project civil engineer should evaluate possible methods to mitigate the potential for erosion.

## ROCKFALL

Map 8.1 from the Douglas County 2040 Master Plan shows a western portion of the site to contain areas of Class 3 Hazards, specifically potential rockfall-rockslide/debris avalanche areas. Rockfalls and slides occur on steep slopes where a source of rock exists above the slope. Rockfalls are considered as a Class 3 Hazard as falling, rolling, and/or bouncing rocks and boulders can cause significant property damage and may threaten injury or loss of life. Rockfalls generally originate on slopes greater than 70 percent, although they can occur on less-steep slopes. Rockfalls are caused by a range of variables, which include, but are not limited to: rainfall and changes in groundwater conditions, weathering and erosion, root growth, and freeze/thaw processes. This hazard area has a rockfall source material consisting of rock from the Castle Rock Conglomerate caprock, and has slopes greater than 70 percent, up to near vertical. See the Rockfall section below for further discussion.

## RADIOACTIVE GASES

According to the Environmental Protection Agency (EPA) and the Colorado Environmental Public Health Tracking website, elevated levels of radon gas (4pCi/L or more) have been found in 49 percent of radon tests within Douglas County, with a county-wide average of 3.8pCi/L. Radon is a radioactive gas that forms from the natural breakdown of uranium in soil, rock, and water. Radon tends to accumulate in poorly ventilated areas below ground level; however, radon may accumulate inside any above or below grade construction. According to the EPA, radon levels in buildings can be reduced by several methods, including pressurization of the building using a heating, ventilation and air-conditioning system, sealing of cracks in the foundation walls and floor slabs which may allow entry of radon, and using active soil depressurization (ASD) systems. Radon risk and potential mitigation measures should be evaluated by an industry professional based on structure type and potential risk in accordance with established guidelines.



## DEVELOPMENT CONSIDERATIONS

Presented below is a discussion of geologic and geotechnical engineering related development considerations, including identified geologic hazards.

### Pre-existing Man-placed Fill:

Pre-existing man-placed fill was not observed during our site visit, other than the surficial fill stockpile associated with active construction on Ridge Road, which is expected to be corrected during site grading activities. Given the unknown history of the fill placement, should it be encountered, it is our opinion that it should be considered unsuitable for support of the proposed roadways unless documentation is available stating the site fills were properly controlled to the compaction criteria presented in the applicable geotechnical engineering report. The recommendations of the applicable geotechnical engineering report for the proposed development should be followed.

### Expansive/Collapsible Soils/Bedrock:

Clay soils, clayey sand soils, and claystone bedrock at the subject site are expected to have a low to high swell potential. Development placed directly on or near expansive materials similar to the clayey materials at this site can experience movement causing structural distress if the materials are subjected to changes in moisture content. Typically, a structural fill layer is intended to provide separation between the expansive materials and thereby reduce the potential for movement. Swelling soils and bedrock is considered a geologic hazard, and mitigation should take place to prevent undesirable movement. Recommendations for mitigation of expansive soils/bedrock from the applicable geotechnical engineering report for the proposed development should be followed.

### Erosional Features:

Erosional features should be protected from further accelerated erosion. It may be feasible for accelerated erosion to be mitigated by re-grading the slopes to 3:1 (horizontal to vertical) or flatter, and revegetating or otherwise protecting the new slopes from erosion. These areas may cause concentrated surface flow over erosional features and through the subject site. If this is the case, concentrated surface flows should be collected or diverted away from development areas. Recommendations from the Site Grading and Surface Drainage section below should be followed to reduce impacts resulting from concentrated surface flow over erosional features.

### Slopes Greater Than 25 Percent:

Development is not planned on pre-existing slopes greater than 25 percent, nor are there steep slopes shown on the development plan. Permanent slopes should not be steeper than 3:1

(horizontal to vertical), and should not exceed 30 feet in height. Recommendations pertaining to slopes and site grading from an applicable geotechnical engineering report should be followed.

#### Rockfall:

A rockfall hazard area has been identified along the southwest edge of the site, as shown on Figure 2. Plans reviewed as part of this study do not propose development within this area. If development is planned in this area, or below the rockfall hazard area, further investigation including rockfall modeling should be performed.

#### Site Grading and Surface Drainage:

Proper surface drainage is very important for acceptable performance of the development during the proposed construction and after construction has been completed. Development plans should attempt to place structures relatively high with respect to the surrounding ground. Grading to accommodate the collection and diversion of surface drainage away from building and pavement locations is recommended, and wetting of subgrade soils should be prevented. Site grading recommendations presented in the applicable geotechnical engineering report for the proposed development should be followed.

Permanent slopes should not be steeper than 3:1 (horizontal to vertical). The risk of slope instability will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Fills should be benched into hillsides that exceed 4:1 (horizontal to vertical). Site grading should be planned to provide positive surface drainage away from all building and pavement areas. No formal stability analyses were performed to evaluate the slopes recommended above. If a detailed stability analysis is required, we should be notified.

#### LIMITATIONS

This study has been conducted for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and preliminary recommendations submitted in this report are based upon the data obtained from the exploratory borings, the site reconnaissance, published regional geology information, the proposed type of construction and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted.

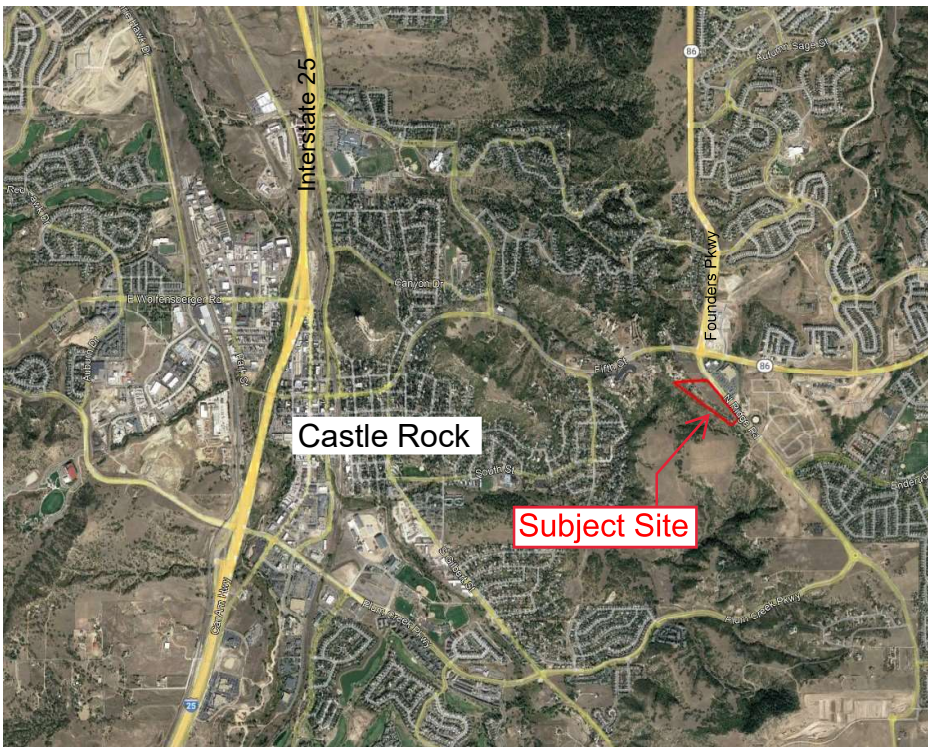
This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, bedrock, or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

RAY\sw

## REFERENCES

- Thorson, J.P., 2005, *Geologic Map of the Castle Rock North Quadrangle, Douglas County, Colorado*: Colorado Geological Survey, Open-File Report 05-2.
- Thorson, J.P., 2004, *Geologic Map of the Castle Rock South Quadrangle, Douglas County, Colorado*: Colorado Geological Survey, Open-File Report 04-5.
- Trimble, D.E., and Machette, M.N., 1979, *Geologic Map of the Colorado Springs-Castle Rock Area, Front Range Urban Corridor, Colorado*: United States Geological Survey.
- Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: <https://websoilsurvey.sc.egov.usda.gov/>. Accessed [9/27/2023].
- Schwochow, S.D., Shroba, R.R., Wicklein, P.C., Gast, R.H., *Sand, Gravel, and Quarry aggregate resources of the Colorado Front Range Counties*: Mineral Extraction Plan, Douglas County Comprehensive Master Plan, Appendix B.
- Federal Emergency Management Agency (FEMA), March 16, 2016, Flood Insurance Rate Map (FIRM): Map No. 08035C0302G.
- Widmann, B.L., and Others, 1998, *Preliminary Quaternary Fault and Fold Map and Data Base of Colorado*: Colorado Geological Survey, Open-File Report 98-8.
- Kirkham, R.M., and Rogers, W.P., 2000, *Colorado Earthquake Information, 1867-1996*: Colorado Geological Survey, 52.
- Kirkham, R.M., and Rogers, W.P., 1981, *Earthquake Potential in Colorado*: Colorado Geological Survey, Bulletin 43.
- International Code Council, 2015, *International Building Code*: Falls Church, Va, International Code Council.
- U.S. Environmental Protection Agency (EPA), *Radon*: EPA, Available online at the following link: <https://epa.gov/radon/>. Accessed 3/1/2023].
- Colorado Environmental Public Health Tracking, *Radon data*: CDPHE, Available online at the following link: <https://coepht.colorado.gov/radon-data>. Accessed [8/18/2023].
- Douglas County Comprehensive Master Plan 2040, July 18, 2019, *Map 8.1 Class 3 Hazards and Environmental Constraints*: Douglas County, Colorado.





250 0 250 500  
APPROXIMATE SCALE - FEET



VICINITY MAP - NOT TO SCALE

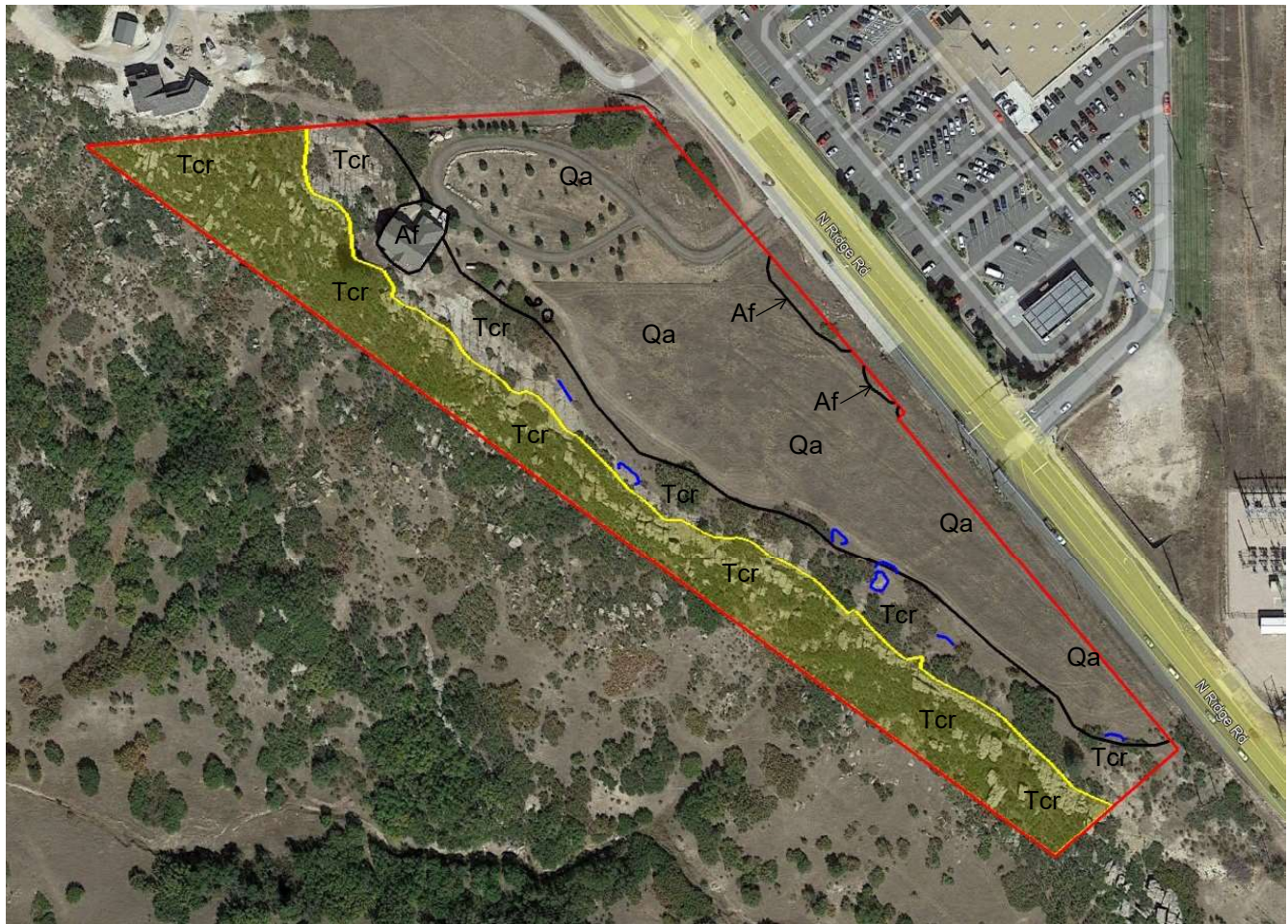




250 0 250 500  
 APPROXIMATE SCALE - FEET







250 0 250 500  
APPROXIMATE SCALE - FEET

Af: Artificial Fill

Qa: Older Alluvial deposit

Tcr: Castle Rock Conglomerate

 Rockfall Hazard Area

 Erosional Features

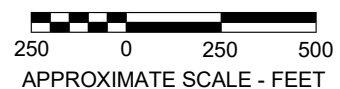




FoD: Fondis clay loam

Sv: Stony steep land

Fu: Fondis-Kutch association





**Appendix D**  
General Ecological Resources Survey

# GENERAL ECOLOGICAL RESOURCES SURVEY

## Land Suitability Analysis Report

895 North Ridge Road,  
Douglas County, Colorado 80104



Prepared for:



200 Kalamath Street  
Denver, Colorado 80223

WESTERN ENVIRONMENT AND ECOLOGY, INC.

2217 West Powers Avenue  
Littleton, Colorado 80120  
(303) 730 3452 (phone)  
(303) 730-3461 (fax)  
westernenvironment.com

# GENERAL ECOLOGICAL RESOURCES SURVEY

## Land Suitability Analysis Report

---

895 North Ridge Road,  
Castle Rock, Colorado 80104

---

Western Environment and Ecology, Inc.  
Project Number: 943-001-01

June 1<sup>st</sup>, 2023

Prepared for:



200 Kalamath Street  
Denver, Colorado 80223

Prepared by:



Brendan Calonge  
Senior Staff Scientist

Reviewed by:



Greg D. Sherman, P.G.  
President

### **WESTERN ENVIRONMENT AND ECOLOGY, INC.**

2217 West Powers Avenue  
Littleton, Colorado 80120  
(303) 730 3452 (phone)  
(303) 730-3461 (fax)  
westernenvironment.com



## **TABLE OF CONTENTS**

|     |                                       |    |
|-----|---------------------------------------|----|
| 1.0 | INTRODUCTION                          | 1  |
| 2.0 | STUDY AREA                            | 2  |
| 3.0 | METHODS                               | 5  |
| 4.0 | RESULTS AND DISCUSSION                | 7  |
| 4.1 | Wetlands                              | 7  |
| 4.2 | Species Eliminated from Consideration | 8  |
| 4.3 | Species Included in Survey            | 9  |
|     | Western Burrowing Owl                 | 9  |
|     | Bald Eagle                            | 9  |
|     | Mountain Plover                       | 9  |
|     | Piping Plover                         | 10 |
|     | Plains Sharp Tailed Grouse            | 10 |
|     | Lesser Prairie Chicken                | 10 |
|     | Ferruginous Hawk                      | 11 |
|     | Preble's Meadow Jumping Mouse         | 11 |
|     | Black-tailed Prairie Dog              | 11 |
|     | Ute Ladies'-Tresses Orchid            | 12 |
|     | Pawnee montane skipper                | 12 |
|     | Other Wildlife                        | 13 |
| 5.0 | CONCLUSIONS AND RECOMMENDATIONS       | 14 |
| 6.0 | LITERATURE CITED                      | 15 |

## **FIGURES**

|          |                   |   |
|----------|-------------------|---|
| FIGURE 1 | Site Location Map | 3 |
| FIGURE 2 | Site Map          | 4 |

## **TABLES**

|         |                                                     |   |
|---------|-----------------------------------------------------|---|
| TABLE 1 | Threatened and Endangered Species of Douglas County | 6 |
|---------|-----------------------------------------------------|---|

## 1.0 INTRODUCTION

Western Environment and Ecology, Inc. (Western Environment) was retained by Mr. Liam Hogan of PCS Group Company to conduct a general survey of ecological resources, including threatened and endangered species, wetlands, and other significant habitats, on approximately 10.381 acres in Section 7, Township 8 South, Range 67 West, and Section 12, Township 8 South, Range 66 West, Douglas County, Colorado addressed 895 North Ridge Road. Mr. Hogan indicated that this study was in response to the potential development of the site.

The objectives of this study were to (1) establish presence/absence and potential habitat of any federal or state threatened and endangered species, (2) identify any wetlands or other ecologically sensitive areas, and (3) make practical recommendations based on the results of the study.



View of the property from the south

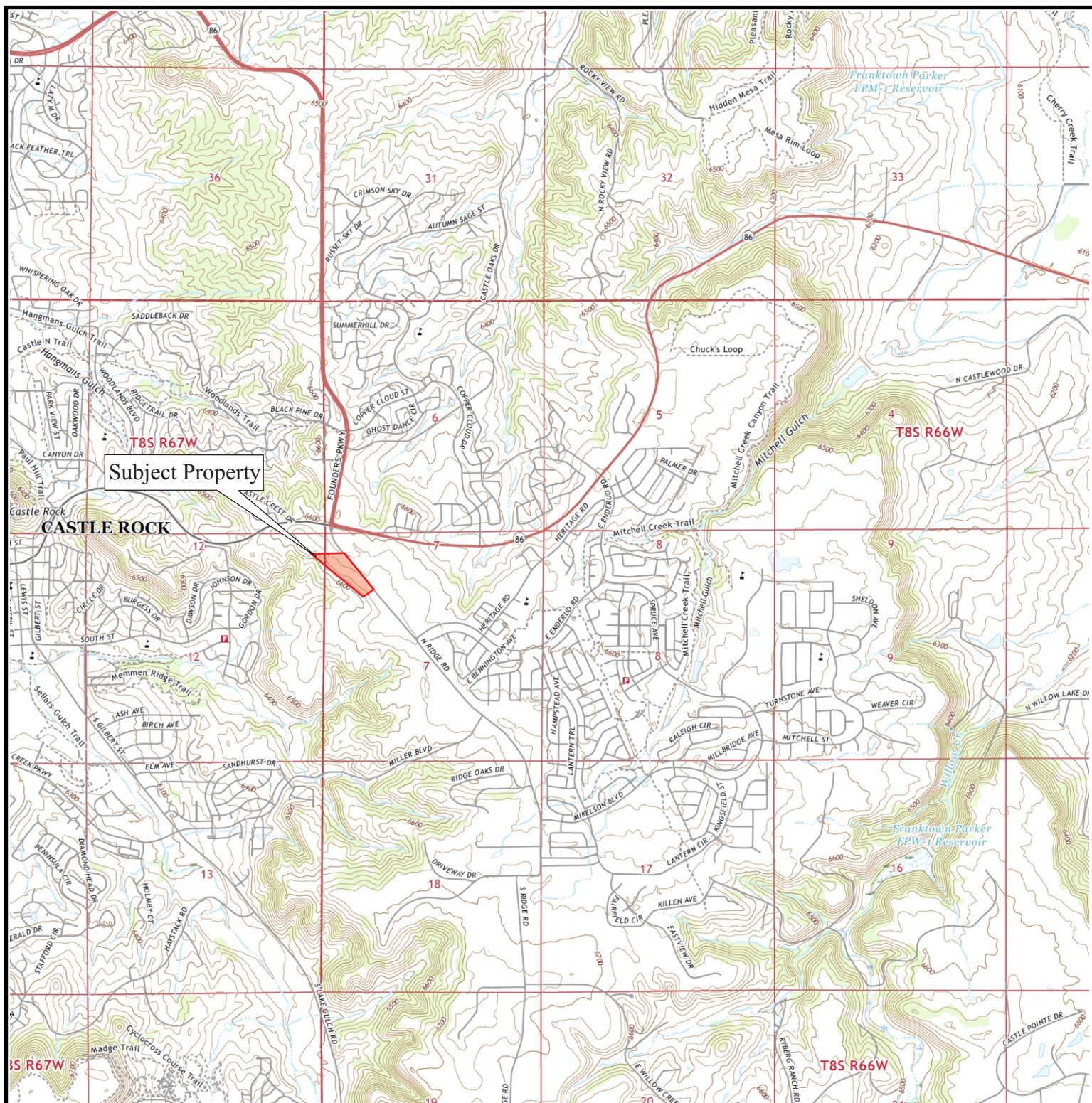
## 2.0 STUDY AREA

The project consists of approximately 10.381 acres in Section 7, Township 8 South, Range 67 West, and Section 12, Township 8 South, Range 66 West, Douglas County, Colorado addressed 895 North Ridge Road (Figure 1). The subject site is located approximately 675 feet south of the intersection of North Ridge Road and Fifth Street (Figure 2). According to the Douglas County Assessor's Office, the property contains a 3,869 square foot residence constructed in 1999. Surrounding properties are occupied by residences to the northwest and southeast, commercial and retail development to the northeast, and vacant land to the southwest. A Town of Castle Rock water storage facility and a CORE Electric substation are located adjacent to the east, across North Ridge Road.

The site occurs at an approximate elevation range of 6,610 to 6,660 feet above sea level (USGS Castle Rock North and Castle Rock South 7.5 Minute Quadrangles, 2019). The majority of the property slopes to the southwest; however, the southwest border of the property consists of a steep rocky slope to the southwest. The US Natural Resource Conservation Service (NCRS) classifies the site soils as a majority Fondis clay loam on 3 to 9 percent slopes. Fondis clay loam is described as highly expansive, deep, well drained soils with slow to medium runoff, slow to moderately slow permeability, and moderate erosion. The soils are classified by the NCRS as Hydrologic Group C, as "soils that have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure." The southwest border of the site consists of steep stony land, with slopes between 9 and 65 percent. Steep stony land is described as well drained soils with high runoff, shallow restrictive layer, and high erosion. The soils are classified by the NCRS as Hydrologic Group D as "soils that have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material."

Site Geology consists of the Tertiary Age White Formation or Group, including ashy claystone and sandstone and Castle Rock Conglomerate (Tweto 1979.) Review of flood insurance maps from the Federal Emergency Management Agency (FEMA) indicate that the property does not occur within the 100-year floodplain.





USGS Castle Rock North and Castle Rock South  
7.5 Minute Quadrangles, 2019



Approximate Scale in Miles

0 0.50 1.0

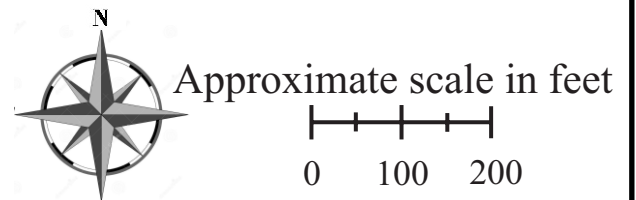
WESTERN ENVIRONMENT  
AND ECOLOGY, INC.  
2217 West Powers Avenue  
Littleton, Colorado 80120

Figure 1: Project Location Map  
895 North Ridge Road  
Douglas County, Colorado 80104





Google Earth Image



WESTERN ENVIRONMENT  
AND ECOLOGY, INC.  
2217 West Powers Avenue  
Littleton, Colorado 80120

Figure 2: Site Map  
895 North Ridge Road  
Douglas County, Colorado 80104



### 3.0 METHODS

Species that are federally or state listed as threatened or endangered, including federally proposed and candidate species, occurring or having historically occurred in Douglas County were considered for this study (Table 1). The county classification was determined by following the Colorado Field Office of the U.S. Fish and Wildlife Service's county checklist (USFWS, 2018). The list was narrowed based on habitat requirements of the species relative to existing habitats on the property.

The site was surveyed on May 25<sup>th</sup>, 2023. Information was collected on topography, ecosystems, and species of flora and fauna found on and adjacent to the property. Photographs were taken, and emphasis was placed on potential habitat of threatened and endangered species, and the presence of wetlands. During the inspection the majority of the site consisted of grazed agricultural land. Vegetation was dominated by native and invasive grasses and weeds, including smooth brome (*Bromus inermis*), alyssum, prickly pear cactus. Woody vegetation included gambels oak, golden currant, ponderosa pine, and juniper. The southwest border of the site consisted of sparsely vegetated steep, rocky slopes. A single family residence was present on the northern portion of the property. The residence was surrounded by irrigated landscaping, including bristlecone pine and ponderosa pine trees.



View of southwest border of the site



Table 1. Common name, scientific name, and status of federal and state threatened and endangered species that could occur or historically occurred in the Colorado Piedmont (CDOW, 2018; USFWS, 2018).

| Common Name                    | Scientific Name                         | Status <sup>1</sup> |
|--------------------------------|-----------------------------------------|---------------------|
| <b>Birds</b>                   |                                         |                     |
| Bald eagle                     | <i>Haliaeetus leucocephalus</i>         | ST                  |
| Whooping crane                 | <i>Grus americana tabida</i>            | FE, SE              |
| Least Tern                     | <i>Sterna antillarum</i>                | FE, SE              |
| Mountain plover                | <i>Charadrius montanus</i>              | FPT, SC             |
| Piping plover                  | <i>Charadrius melodus</i>               | FT, ST              |
| Mexican spotted owl            | <i>Strix occidentalis lucida</i>        | FT, ST              |
| Plains Sharp-Tailed Grouse     | <i>Tympanuchus phasianellus jamesii</i> | SE                  |
| Western burrowing owl          | <i>Athene cunicularia</i>               | ST                  |
| Lesser Prairie Chicken         | <i>Tympanuchus pallidicinctus</i>       | ST                  |
| Ferruginous Hawk               | <i>Buteo regalis</i>                    | SC                  |
| <b>Mammals</b>                 |                                         |                     |
| Preble's meadow jumping mouse  | <i>Zapus hudsonius preblei</i>          | FT, ST              |
| Black-tailed prairie dog       | <i>Cynomys ludovicianus</i>             | SC                  |
| <b>Amphibians</b>              |                                         |                     |
| Boreal Toad                    | <i>Bufo boreas boreas</i>               | SE                  |
| Northern Leopard Frog          | <i>Rana pipiens</i>                     | SC                  |
| <b>Plants</b>                  |                                         |                     |
| Ute ladies'-tresses            | <i>Spiranthes diluvialis</i>            | FT                  |
| Western prairie fringed orchid | <i>Platanthera praeclara</i>            | FT                  |
| <b>Fish</b>                    |                                         |                     |
| Greenback cutthroat trout      | <i>Oncorhynchus clarki stomias</i>      | FT                  |
| <b>Insects</b>                 |                                         |                     |
| Pawnee montane skipper         | <i>Hesperia leonardus montana</i>       | FT                  |

<sup>1</sup>Status Codes: FE = Federally Endangered, FT = Federally Threatened, FPT = Federally Proposed as Threatened, FC = Federal Candidate, SE = State Endangered, ST = State Threatened, SC = State Concerned

## 4.0 RESULTS AND DISCUSSION

### 4.1 Wetlands

No perennial waters, wetlands or obvious wetland habitat was observed on the project. Stormwater drainage appears to flow overland to the southwest, towards a small drainage approximately 260 feet southwest of the site.

The U.S. Army Corps of Engineers (Corps) regulates the discharge of dredged or fill materials into Waters of the U.S. or within the 100-year flood plain, under the authority of Section 404 of the Clean Water Act. Waters of the U.S. include ephemeral, intermittent and perennial streams, their surface connected wetlands and adjacent wetlands, certain lakes, ponds, drainage ditches and irrigation ditches that have a nexus to interstate commerce.

Western Environment evaluated, to the best of our ability based upon site conditions at the time of the survey, the three components of a jurisdictional wetland as defined in the US Army Corp of Engineers, (ACOE) Wetland Delineation Manual (1987). These components are: 1) Vegetation, 2) Soil and 3) Hydrology. The ACOE Manual defines *Nonwetlands* as “including upland areas that are neither deepwater aquatic habitats, wetlands, nor other special aquatic sites. They are seldom or never inundated, or if frequently inundated, they have saturated soils for only brief periods during the growing season, and, if vegetated, they normally support a prevalence of vegetation typically adapted for life only in aerobic soil conditions.” **It is the opinion of Western Environment that no Waters of the U.S. subject to Corps regulations under Section 404 of the Clean Water Act occur on the property.**

## **4.2 Species Eliminated from Consideration as Occurring on the Project**

The following threatened and endangered species that have historically been thought to occur in Douglas County were immediately ruled out of serious consideration for this project based on available habitat: Mexican spotted owl, whooping crane, least tern, boreal toad, northern leopard frog, greenback cutthroat trout, Colorado butterfly plant, and western prairie fringed orchid.

The Mexican spotted owl was eliminated because it requires forests that are not present on the project. The whooping crane was also eliminated due to rarity in Colorado, and no known nesting or feeding habitat exists on or adjacent to the property. Less than 20 sightings of whooping cranes along the eastern plains and mountainous regions of Colorado have been recorded since 1931 (Andrews and Righter, 1992). The least tern inhabits sandy shorelines of reservoirs, lakes, and rivers with bare sandy shorelines. This shore bird is a casual to very rare spring and fall migrant on the northeastern plains of Colorado, and is unlikely to occur on the subject project.

Colorado's only alpine species of toad, the boreal toad, has been found in spruce-fir forests and alpine meadows at elevations between 7,000 and 12,000 feet. The toad also requires lakes, marshes, ponds, or bogs with shallow water for breeding. These habitats do not exist on the property. The northern leopard frog has a distribution throughout 19 states, including Colorado. In 2011 it was removed from the federal threatened or endangered species however, it remains as a State Species of Concern. Typical habitat for the northern leopard frog include wet meadows and the banks and shallows of marshes, ponds, glacial kettle ponds, beaver ponds, lakes, reservoirs, streams and irrigation ditches. Due to the lack of streams or ponds, no habitat for the greenback cutthroat trout exist on the project site.

The Colorado butterfly plant has only been found in northern Colorado and is generally associated with streams that do not exist onsite (Colorado Native Plant Society 1997). The western prairie fringed orchid is restricted to west of the Mississippi River, however only currently occurs in Iowa, Kansas, Minnesota, Nebraska, North Dakota and in Manitoba, Canada (USFWS, 2001).



### 4.3 Species Included in Survey

#### Western Burrowing Owl (*Athene cunicularia*)

##### *State Threatened*

The burrowing owl is found primarily in eastern Colorado as a summer resident. Two aspects of the biology of the western burrowing owl appear to influence both its regional and local abundance: 1) it prefers areas of short vegetation, and 2) it rarely, if ever, digs its own burrows. This migratory species is most often seen in Colorado during the summer months. Historically, burrowing owls were common wherever there were prairie dog colonies in northeastern Colorado. **During the inspection of the site no burrowing owl habitat was observed on the property.**



Western Burrowing Owl.  
Photo acquired from [wildearthguardians.org](http://wildearthguardians.org)

#### Bald Eagle (*Haliaeetus leucocephalus*)

##### *State Threatened*

The bald eagle was removed from the Federal Endangered and Threatened Species List on July 9<sup>th</sup>, 2007, however it does remain a State Threatened species and is protected under Section 4 of the 1940 Bald and Golden Eagle Protection Act (16 USC 668-668c). In winter bald eagles are transient and use areas that provide feeding and roosting opportunities. Western Environment reviewed the Natural Diversity Information Source (NDIS), and identified no active or inactive bald eagle nests on or adjacent to the project. **Bald Eagle habitat was not observed on the subject property.**

#### Mountain Plover (*Charadrius montanus*)

##### *State Concerned Species*

Typical habitat characteristics of the mountain plover are a mixture of short vegetation, bare ground, and a flat topography at both breeding and wintering locations. This small shorebird breeds in Colorado, and in parts of its breeding range the species commonly shows a preference for prairie dog towns and sites that are heavily grazed by domestic livestock. Prairie dog grazing promotes the short grasses that the plover prefers, and their digging creates areas of bare soil important for plover nesting. Mountain plovers were proposed for federal listing as threatened on February 16, 1999 (USFWS, 1999b), however the U.S. Fish and Wildlife Service

withdrew the proposal on September 8, 2003. Mountain plovers breed in Eastern Colorado from approximately April 1<sup>st</sup> through August 1<sup>st</sup>. **No habitat conducive to plover breeding was observed on the property.**

### **Piping Plover (*Charadrius melodus*)**

*Federally Threatened, State Threatened*

This small shorebird can be found on very sparsely vegetated beaches, mudflats and sandy areas near water on shores and islands. Piping Plovers usually arrive in Colorado in late April or early May, and leave when the nesting cycle is completed, or by late August. Nesting populations have been documented in eastern Colorado along the South Platte and Arkansas River drainages. Food sources for Piping Plovers include insects, crustaceans and other small aquatic animals. Plovers feed along beaches, especially in areas where waves have washed up debris (CPW, 1994). **Due to the lack of sandbars or mud-flats in the vicinity of the project, Piping Plover are unlikely to occur.**

### **Plains Sharp-Tailed Grouse (*Tympanuchus phasianellus jamesii*)**

*State Endangered*

The Plains Sharp-Tailed Grouse historically occurred on Colorado's eastern grasslands. Grouse habitat is characterized by rolling hills with Gambel oak, sage brush, service berries and grassy glades. This grouse was a resident from Alaska east to the Hudson Bay, and south to northern New Mexico. Historical populations were documented in Douglas County within the Woodhouse State Wildlife Area. **However, no known populations of the Plains Sharp-Tailed Grouse are known to occur in proximity to the subject project (CPW, 2021).**

### **Lesser Prairie Chicken (*Tympanuchus pallidicinctus*)**

*State Threatened*

Historically, this bird occupied the grasslands of Texas, Oklahoma, New Mexico, Kansas and southeastern Colorado. It prefers sandy grassland areas abundant in midgrasses, sand sage and yucca. The majority of Colorado breeding pairs occur in the southeastern portion of the state in Baca, Prowers, Kiowa and Cheyenne Counties, and for the most part, on the Comanche National Grasslands near Campo. **No known populations of the Lesser Prairie Chicken are known to occur in proximity to the subject project (CPW, 2018).**

### **Ferruginous Hawk (*Buteo regalis*)**

#### *State Concerned*

This hawk is known to occur throughout eastern Colorado and in northwestern Colorado. In Colorado, the species is a common winter resident, but is considered an uncommon summer resident on the eastern plains (Andrews and Righter, 1992). Areas that could be potential nesting sites include large trees, rock outcrops, manmade structures such as windmills and power poles, or the ground. These birds often can be seen associated with prairie dog colonies, which they utilize for foraging. **At the time of this survey, no ferruginous hawks were observed. This hawk, as are all birds of prey, is federally protected under the Migratory Bird Species Act.**

### **Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*)**

#### *Federally Threatened, State Threatened*

Typical Preble's habitat has been described as "well-developed plains riparian vegetation with relatively undisturbed grassland and a water source in close proximity," and "dense herbaceous vegetation consisting of a variety of grasses, forbs and thick shrubs" (Armstrong et al., 1997). Although any vegetation could offer cover and hibernacula for Preble's, the species is mostly known from habitat containing shrub cover, such as willow or narrow-leaf cottonwood.



Preble's meadow jumping mouse  
Photo acquired from usafla.sportsman.net

Preble's are known to regularly range outward into adjacent uplands to feed and hibernate. For this reason, the U.S. Fish and Wildlife Service (FSW) generally requires a 300 foot development buffer from the edge of the 100 year flood plain. **Riparian habitat with a permanent water source likely suitable to Preble's was not observed on or adjacent to the project.**

### **Black-tailed Prairie Dog (*Cynomys ludovicianus*)**

#### *Former Candidate for Federal Listing, State Concerned*

The U.S. Fish and Wildlife Service was petitioned to list the black-tailed prairie dog as a threatened species in July of 1998. The agency determined on February 3<sup>rd</sup>, 2000, that listing the species was warranted, but it was precluded because other species were in greater need of

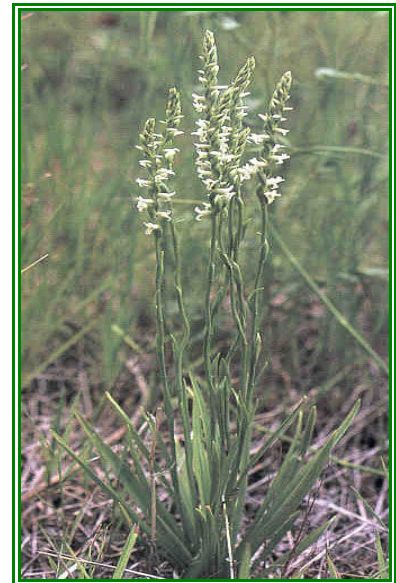


protection (USFWS, 2000). The black-tailed prairie dog was added to the candidate list, and the species' status was reviewed annually. On August 12<sup>th</sup>, 2004 the USFWS determined that the black-tailed prairie dog no longer meets the Endangered Species Act definition as threatened, and was removed as a candidate for federal listing. **No prairie dogs or their burrows were observed on or adjacent to the property.**

### **Ute Ladies'-Tresses Orchid (*Spiranthes diluvialis*)**

#### *Federally Threatened*

This orchid usually occurs in "...old stream channels, alluvial terraces, wet meadows, and other sites where the soil is saturated to within 18" of the surface at least temporarily during the growing seasons" (USFWS, 1992). The eastern Colorado populations of species are located in mesic riparian meadows in relict tall grass prairie areas near Boulder Creek, South Boulder Creek, and Saint Vrain Creek in Boulder County, Colorado, and in mesic meadows in the riparian woodland under story along Clear Creek in Jefferson County, Colorado (USFWS 50 CFR Part 17). One population was historically identified in Weld County east of Greeley near Crow Creek in 1856, but is now considered extirpated. Soil conditions and vegetation composition of known *Spiranthes* sites suggest that wetlands regulated by the Corps under the Clean Water Act qualify as potential *Spiranthes* habitat. **No known populations of *Spiranthes* occur near the subject site.**



Ute Ladies'-Tresses Orchid

### **Pawnee montane skipper (*Hesperia leonardus montana*)**

#### *Federally Threatened*

This butterfly occurs in dry, open Ponderosa pine woodlands at an elevation range of 6,000 to 7,000 feet within the Pikes Peak Granite formation. Assessment of the skipper indicates that the insect's habitat is centered near Deckers, Colorado, with their range estimated to be 37.9 square miles (USFWS, 1998). The adult butterflies emerge from their pupae in late July for

feeding and mating. The females then deposit their eggs on the leaves of blue grama grass, the larval food supply. Little is known about the larval and pupal stages of the species. Recent surveys of the skipper suggest that their populations may be at an all time high (recorded) after the Hayman Fire of 2002 (Colorado Natural Heritage Program, January 2005). This is likely due to the necessity of fire to remove trees, and promote herbaceous grass growth including blue grama and gayfeather on the forest floor. **The subject project does not occur in known Pawnee montane skipper habitat.**

### **Other Wildlife**

No other wildlife were observed during the inspection.

---

## **5.0 CONCLUSIONS AND RECOMMENDATIONS**

At the time of the survey, no threatened or endangered species or their obvious habitat were seen on the subject site. Additionally, no wetlands or Waters of the U.S. subject to regulation under Section 404 of the Clean Water Act occur on the project.

**No other Ecological Issues were found.**



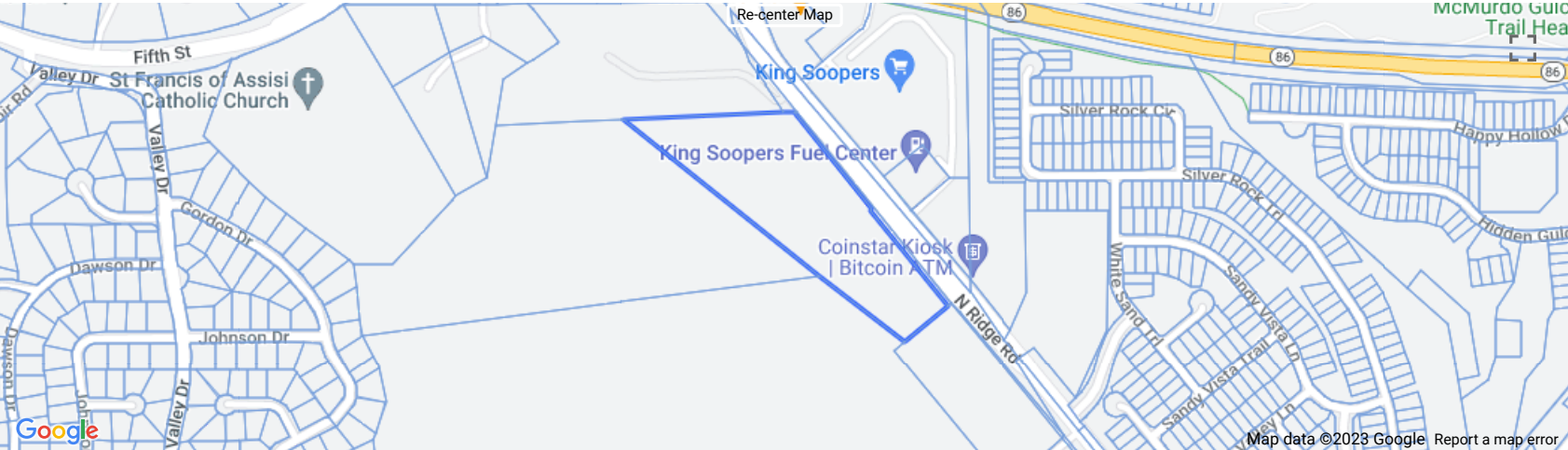
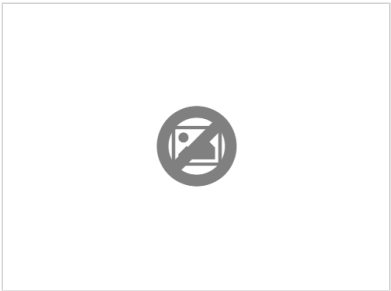
## 6.0 LITERATURE CITED

- Andrews, R. and R. Righter. 1992. Colorado birds: a reference to their distribution and habitat. Denver Museum of Natural History. Denver. 442 pp.
- Armstrong, D.M., M.E. Bakeman, A. Deans, C.A. Meaney, and T.R. Ryon. 1997. Conclusions and recommendations *in*: Report on habitat findings on the Preble's meadow jumping mouse. Edited by M. E. Bakeman. Report to USFWS and Colorado Division of Wildlife.
- Colorado Division of Wildlife. 1999. Endangered, Threatened, and Special Concern Wildlife
- Colorado Division of Wildlife. November 2003. Conservation Plan for Grassland Species in Colorado. Colorado Grassland Species Working Group. November 2003. Denver, Co.
- Colorado Native Plant Society. 1997. Rare plants of Colorado, 2<sup>nd</sup> edition. Falcon Press® Publishing Co., Inc. and Rocky Mountain Nature Association in cooperation with Colorado Native Plant Society. Helena, Montana and Estes Park, Colorado. 105 pp.
- Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado. Niwot, Colorado. 467 pp.
- Graul, W.D. 1975. Breeding biology of the mountain plover. Wilson Bulletin 87:6-31.
- Hoogland, John L. 1995. The Black-tailed Prairie Dog. The University of Chicago Press, Chicago and London.
- Jennings, W.F. 1989. Final report. Species studied: *Eustoma grandiflorum*, *Spiranthes diluvialis*, *Malaxis brachypoda*, *Hypoxis hirsuta*, *Physaria bellii*, *Aletes humilis*. Unpublished report prepared for the Nature Conservancy under the Colorado Natural History Small Grants Program. The Nature Conservancy, Boulder, Colorado. 48 pp.
- Jennings, W.F. 1990. Final report. Species studied: *Spiranthes diluvialis*, *Sisyrinchium pallidum*. Unpublished report prepared for The Nature Conservancy under the Colorado Natural History Small Grants Program. The Nature Conservancy, Boulder, Colorado. 29 pp.
- Jones, S.R. 1998. Burrowing owl. Pages 220-221 *in* H.E. Kingery, ed. Colorado breeding bird atlas. Colorado Bird Atlas Partnership. Denver.
- Kingery, H.E. 1998. Colorado breeding bird Atlas. Colorado Bird Atlas Partnership. Denver.
- Long, Kim. Prairie Dogs, A Wildlife Handbook, Johnson Books, Boulder, 2002.
- National List of Plant Species That Occur in Wetlands, Region 4, 5, and 8, Resource Management Group, Inc., Michigan, 1994.
- Nichols, F.E. and J.A. Daley. 1995. 1995 Prairie Dog Counts on the Cathy Fromme Prairie.

- Professional report submitted to the Fort Collins Natural Resources Department. 8p.
- Remote Sensing Research. 1996. 1996 Coyote Ridge Prairie Dog Study. Professional report submitted to the City of Fort Collins Natural Resources Department.
- Sibley, David Allen. 2000. The Sibley Guide to Birds. Alfred A. Knopf, Inc. New York.
- Tileston, J.V., and R.R. Lechleitner. 1966. Some Comparisons of the Black-tailed and White-tailed Prairie Dogs in North-central Colorado. *American Midland Naturalist* 75:292-316.
- U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey of Adams County, Colorado. Historical Replica, October 1974.
- U.S. Department of Agriculture, NRCS. 2001. The PLANTS Database, Version 3.1 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA 70874-4490 USA
- U.S. Department of Agriculture. No date. Midwestern wetland flora: Field office guide to plant species. USDA Soil Conservation Service, Midwest National Technical Center, Lincoln, Nebraska. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page <http://www.npwrc.usgs.gov/resource/othrdata/plntguid/plntguid.htm> (Version 16JUL97).
- U.S. Fish and Wildlife Service Ecological Services Colorado Field Office, Federally Listed and Candidate Species and Their Status in Colorado, August 21, 2001.
- U.S. Fish and Wildlife Service. 1999. Interim Survey Guidelines for Preble's Meadow Jumping Mouse.
- U.S. Fish and Wildlife Service. 1992. Interim Survey Requirements for *Spiranthes Diluvialis*.
- U.S. Fish and Wildlife Service. 1999b. Services proposes to list mountain plover as threatened. News Release 99-02.
- U.S. Fish and Wildlife Service. Fish and Wildlife Service Proposes to Remove the Preble's Meadow Jumping Mouse from the Endangered Species List, News Release. Jan. 28, 2005.
- Whitson, Tom D. et al. 2000. Weeds of the West. 9<sup>th</sup> Edition. Western Society of Weed Science, Newark, CA.

Displaying data for the year 2023  
**895 N RIDGE RD**  
**CASTLE ROCK, CO 80104**

**Ownership Information**  
PARKER CENTER LLC  
53 CHARLOU CIR  
CHERRY HILLS VILLAGE, CO 80111



Account #: R0617713  
State Parcel #: 2507-072-00-031  
Account Type: Agricultural  
Tax District: 0151  
Neighborhood-Ext: 480-00

**Owner Info**  
PARKER CENTER LLC  
53 CHARLOU CIR  
CHERRY HILLS VILLAGE, CO 80111

**Public Land Survey System (PLSS) Location**  
Quarter: NW; Section: 7; Township: 8; Range: 66

Building Count: 1  
Building Permit Authority: Douglas County  
Phone: 303-660-7497  
**Subdivision**  
Name: METES AND BOUNDS  
Reception No: 0000051

**Location Description**  
TR PARTLY IN NW1/4 7-8-66 & PARTLY IN NE1/4 12-8-67 10.381AM/L

**Disclaimer**  
The location description may not be a complete legal description of the property.

**Valuation Info**

| Year | Actual Value | Assessed Value | Tax Rate | Est. Tax Amount |
|------|--------------|----------------|----------|-----------------|
|------|--------------|----------------|----------|-----------------|



|      |           |          |         |         |
|------|-----------|----------|---------|---------|
| 2023 | \$944,845 | \$64,370 | 8.1993% | \$5,278 |
| 2022 | \$710,696 | \$49,720 | 8.1993% | \$4,077 |

Sales History

| Reception No. | Sale Date  | Sale Price  | Deed Type             | Grantor                    | Grantee           |
|---------------|------------|-------------|-----------------------|----------------------------|-------------------|
| 2022018716    | 03/14/2022 | \$3,500,000 | Special Warranty Deed | JAMES DEAN BERTELSEN TRUST | PARKER CENTER LLC |

Disclaimer

The transaction history may not be a complete history of transfer and ownership records.

Building Details

Building 1

|                                      |                        |                         |                                                                  |
|--------------------------------------|------------------------|-------------------------|------------------------------------------------------------------|
| Property Type:                       | Residential            | Building Use:           | Single Family Residential on Ag                                  |
| Year Built:                          | 1999                   | Building Use %:         | 100%                                                             |
| Quality:                             | Good                   | Actual Value:           | \$727,524                                                        |
| % Complete:                          | 100%                   | Class Code:             | 1277                                                             |
| Style:                               | Ranch 1 Story          | Class Code Description: | PROP NOT INTEGRAL TO AG OP - IMPROVEMENTS                        |
| Stories:                             | 1                      | Square Footage:         | 2,385 sqft                                                       |
| Bedrooms (above ground):             | 2                      | Assessor's Building ID: | 1                                                                |
| Bathrooms (above ground):            | 2                      | Walkout:                | Y                                                                |
| Basement Area:                       | 2,363 sqft             | Fireplaces:             | 2                                                                |
| Finished Bsmt. Area:                 | 1,484 sqft (62%) (62%) | Porch/Deck Area:        | 395 sqft                                                         |
| Total Finished Area:                 | 3,869 sqft             | Garage Type             | Garage Area                                                      |
| Interior:                            | Drywall                | Attached:               | 706 sqft                                                         |
| Exterior:                            | Frame Siding           | Detached:               | 0 sqft                                                           |
| Roofing:                             | Composition Shingle    | Assessor's Building ID: | 1                                                                |
| Heating:                             | Central Air to Air     | Type                    | Description                                                      |
| Additional Features: Fireplace - Gas |                        | Porch                   | Open Slab                                                        |
|                                      |                        | Porch                   | Slab Roof Ceil                                                   |
|                                      |                        | Porch                   | Wood Deck                                                        |
|                                      |                        | Fixtures:               | Bath 4, Bath 6, Bsmnt Bath 4, K Sink W Htr Laundry, Laundry Sink |

Land Details

|            |             |
|------------|-------------|
| Land Type: | Residential |
|------------|-------------|

Class Code: 1177  
 Class Code Descr.: PROP NOT INTEGRAL TO AG OP - LAND  
 Acreage: 2.000 acres  
 LEA Code: 9CC

**Land Valuation**

Actual Value: \$215,000

Land Type: Agricultural  
 Class Code: 4124  
 Class Code Descr.: DRY AG  
 Acreage: 8.381 acres  
 LEA Code: 9CC

**Land Valuation**

Actual Value: \$2,321

Land Attributes: Trees-M, Powerline-M, Arterial Road Proximity, View Superior-M, Powerline-M High Impact, Road Proximity Medium Impact

## Tax Authorities

| ID                    | Authority Name                             | Mills  | Tax Rate | Est. Tax Amount |
|-----------------------|--------------------------------------------|--------|----------|-----------------|
| 2001                  | Douglas County Re-1 School District        | 36.136 | 3.6136%  | \$2,326         |
| 0001                  | Douglas County Government                  | 18.524 | 1.8524%  | \$1,192         |
| 4034                  | Castle Rock Fire Protection District       | 12.000 | 1.2000%  | \$772           |
| 2004                  | Douglas County Schools - Debt Service      | 6.700  | 0.6700%  | \$431           |
| 0002                  | Douglas County Law Enforcement             | 4.500  | 0.4500%  | \$290           |
| 4390                  | Douglas Public Library District            | 4.008  | 0.4008%  | \$258           |
| 4012                  | Cedar Hill Cemetery Association            | 0.125  | 0.0125%  | \$8             |
| 2002                  | Douglas County Schools - Cap Reserve       | 0.000  | 0.0000%  | \$0             |
| 2003                  | Douglas County Schools - Insurance Reserve | 0.000  | 0.0000%  | \$0             |
| 4077                  | Douglas County Soil Conservation District  | 0.000  | 0.0000%  | \$0             |
| Total: 10 Authorities |                                            | 81.993 | 8.1993%  | \$5,278         |

## Notifications

---

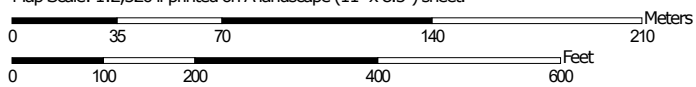
1. The 2023 actual value for this account was updated as a result of the 2023 reassessment. The value is reflective of the appraisal date of June 30, 2022.
2. The 2023 actual value for this account will have an amount of \$15,000 exempt from taxation. This exemption is in accordance with SB22-238 and will be reflected on the 2023 taxes payable in 2024.



# Soil Map—Castle Rock Area, Colorado



Map Scale: 1:2,520 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84



**Natural Resources  
Conservation Service**

Web Soil Survey  
National Cooperative Soil Survey

5/25/2023  
Page 1 of 3

## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Castle Rock Area, Colorado

Survey Area Data: Version 15, Sep 1, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

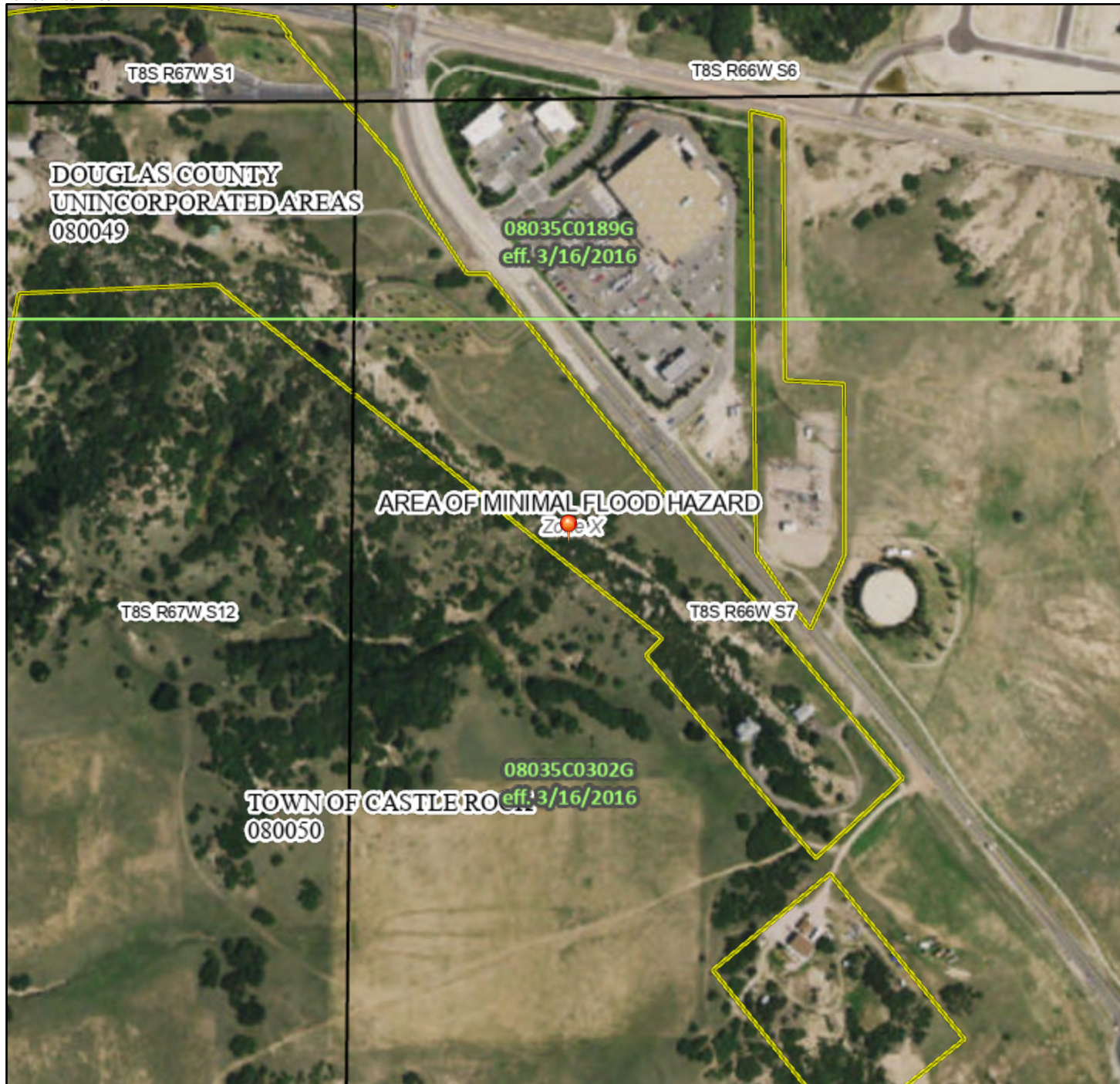
| Map Unit Symbol                    | Map Unit Name                           | Acres in AOI | Percent of AOI |
|------------------------------------|-----------------------------------------|--------------|----------------|
| FoD                                | Fondis clay loam, 3 to 9 percent slopes | 7.2          | 62.7%          |
| Sv                                 | Stony steep land                        | 4.3          | 37.3%          |
| <b>Totals for Area of Interest</b> |                                         | <b>11.5</b>  | <b>100.0%</b>  |



# National Flood Hazard Layer FIRMMette



104°50'W 39°22'38"N



0 250 500 1,000 1,500 2,000 Feet

1:6,000

104°49'23"W 39°22'10"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

|                             |  |                                                                                                                                                                   |
|-----------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPECIAL FLOOD HAZARD AREAS  |  | Without Base Flood Elevation (BFE)<br>Zone A, V, A99                                                                                                              |
|                             |  | With BFE or Depth Zone AE, AO, AH, VE, AR                                                                                                                         |
|                             |  | Regulatory Floodway                                                                                                                                               |
| OTHER AREAS OF FLOOD HAZARD |  | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X |
|                             |  | Future Conditions 1% Annual Chance Flood Hazard Zone X                                                                                                            |
|                             |  | Area with Reduced Flood Risk due to Levee. See Notes. Zone X                                                                                                      |
|                             |  | Area with Flood Risk due to Levee Zone D                                                                                                                          |
| OTHER AREAS                 |  | NO SCREEN Area of Minimal Flood Hazard Zone X                                                                                                                     |
|                             |  | Effective LOMRs                                                                                                                                                   |
| GENERAL STRUCTURES          |  | Area of Undetermined Flood Hazard Zone D                                                                                                                          |
|                             |  | Channel, Culvert, or Storm Sewer                                                                                                                                  |
|                             |  | Levee, Dike, or Floodwall                                                                                                                                         |
| OTHER FEATURES              |  | 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation                                                                                                 |
|                             |  | 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation                                                                                                 |
|                             |  | Coastal Transect                                                                                                                                                  |
|                             |  | Base Flood Elevation Line (BFE)                                                                                                                                   |
|                             |  | Limit of Study                                                                                                                                                    |
|                             |  | Jurisdiction Boundary                                                                                                                                             |
|                             |  | Coastal Transect Baseline                                                                                                                                         |
|                             |  | Profile Baseline                                                                                                                                                  |
|                             |  | Hydrographic Feature                                                                                                                                              |
| MAP PANELS                  |  | Digital Data Available                                                                                                                                            |
|                             |  | No Digital Data Available                                                                                                                                         |
|                             |  | Unmapped                                                                                                                                                          |



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.



This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **5/25/2023 at 5:00 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.





U.S. Fish and Wildlife Service

# National Wetlands Inventory

## Wetlands



U.S. Fish and Wildlife Service, National Standards and Support Team,  
wetlands\_team@fws.gov

May 31, 2023

### Wetlands

|  |                                |  |                                   |  |       |
|--|--------------------------------|--|-----------------------------------|--|-------|
|  | Estuarine and Marine Deepwater |  | Freshwater Emergent Wetland       |  | Lake  |
|  | Estuarine and Marine Wetland   |  | Freshwater Forested/Shrub Wetland |  | Other |
|  | Freshwater Pond                |  | Riverine                          |  |       |

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

**Appendix F**  
Preliminary Geotechnical Report



# ***Preliminary Geotechnical Engineering Report***

**Proposed Mixed-Use Development  
895 North Ridge Road  
Castle Rock, Colorado**

**Prepared for:**

Parker Center, LLC  
53 Charlou Circle  
Cherry Hills Village, CO 80111

**Prepared by:**

**Cole Garner Geotechnical**

CGG Project No.: 21.22.318

**February 7, 2022**





February 7, 2022

Parker Center, LLC  
53 Charlou Circle  
Cherry Hills Village, Colorado 80111

Attn: Mr. George Mattione  
720.236.8500  
g.mattione@comcast.net

**Re: Preliminary Geotechnical Engineering Report  
Proposed Mixed-Use Development  
895 North Ridge Road  
Castle Rock, Colorado  
CGG Project No. 21.22.318**

Cole Garner Geotechnical (CGG) has completed a preliminary geotechnical engineering investigation for the proposed mixed-use development to be located at the referenced address in Castle Rock, Colorado. The scope of services for this study include a general evaluation of subsurface conditions in order to identify main geotechnical issues or concerns that may affect land development. Supplemental design-level geotechnical exploration (with additional structure-specific borings) will be required in order to develop design-level recommendations for individual structures and to confirm and/or modify the preliminary recommendations and conclusions contained in this report.

This geotechnical summary should be used in conjunction with the entire report for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled General Comments should be read for an understanding of the report limitations.

- **Subsurface Conditions:** In general, subsurface conditions at the site consisted of native lean clay with varying amounts of sand overlying interbedded claystone to sandstone bedrock that extended to the full depth of exploration. Sedimentary bedrock was encountered at depths ranging from about 2 to 6 feet below existing site grades. Where the formation consisted mainly of sandstone was (4 of the 6 borings), the bedrock was typically very hard and led to auger refusal at depths ranging from 10 to 13 feet below existing site grades. Where claystone was predominant (2 of the 6 borings), it was typically medium hard to very hard and the borings were able to be advanced to full depth (35 feet). Groundwater was not encountered in our borings during drilling. When checked thirteen days after drilling, groundwater was encountered in Boring No. 6 at a depth of 31 feet



below existing site grades. Other details regarding the subsurface conditions are shown on the Boring Logs included in Appendix A.

- **Difficult Bedrock Excavation:** As discussed, the sandstone portions of the bedrock formation are dense and well-cemented. The drilling equipment encountered practical auger refusal at depths ranging from about 10 to 13 feet below existing site grades within the sandstone. Depending on planned site grading, difficult excavation conditions are likely to be encountered during installation of underground utilities and in foundation excavations. ***Pneumatic rock-breaking, blasting, and/or ripping could be required during earthwork, overexcavation, and foundation excavations. Difficult excavation should be accounted for in the project budget in these areas. The bedrock materials are highly variable and interbedded, therefore, additional exploration via test pits would be required to attempt to further delineate these areas.***
- **Expansive Soil and Bedrock Mitigation:** The clay soils and claystone lenses of the bedrock formation exhibited moderate expansive potential at existing moisture contents. ***Post-construction wetting of these expansive materials can potentially result in excessive or uneven movement of shallow foundations, floor slabs, exterior flatwork, pavements, etc. We have provided recommendations to reduce the risk of movement and distress, however, eliminating the risk of movement and cosmetic distress is generally not considered feasible. It may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction.***

***If the use of spread footing foundations and slab-on-grade floors is desired, these conditions will require mitigation.*** The most common method of swell mitigation involves subexcavation of expansive soils/bedrock to create a zone of engineered fill beneath foundations and floor slabs. ***We recommend the expansive overburden soils be subexcavated down to low-expansive sandstone bedrock within each building footprint. Where claystone bedrock materials are predominant, the subexcavation process should extend to a depth of 10 feet below the lowest foundation element. on each building. Subexcavation for each structure should also extend a minimum of 5 feet outside of each foundation footprint. We also recommend that this process be performed to a depth of 5 feet below pavements during site grading and land development, prior to installation of underground utilities.***

***Even if the recommendations in this report are followed, some movement and at least minor cracking of foundations, floor slabs, flatwork and pavements should be anticipated as drier lenses of the clay/bedrock experience swell due to post-construction wetting. The severity of cracking and other cosmetic damage such as uneven floor slabs, pavement cracking, etc. will probably increase if site improvements result in excessive wetting or drying of the expansive soils/bedrock. Eliminating the risk of movement and distress is generally not considered feasible but can be reduced using measures that could add significant cost to the project. We would be pleased to discuss other construction alternatives with you upon request.***

- **Preliminary Structural Considerations:** Drilled pier foundations and structural floors are commonly used for construction on moderately to highly expansive sites. However, typical drilled pier foundations may not be feasible given the very hard bedrock encountered in our borings. As a result, the use of these systems may be cost prohibitive for the types of projects proposed for this site. As an alternative, the swell mitigation described above will generally allow for the use of spread footing foundations and slab-on-grade floors.

The owner must acknowledge and accept the risk of movement and distress outlined in the report. In our experience, the goal of swell mitigation would be to limit foundation movement to 1 inch or less and movement of slab-on-grade floors to about 1 to 2 inches. Additional details are discussed in the report.

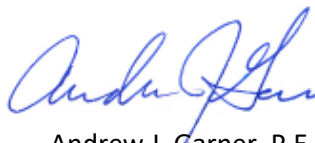
- **Surface Drainage:** The amount of movement associated with foundations, floor slabs, pavements, etc. will be related to the wetting of underlying supporting soils. Therefore, it is imperative that surface water be directed away from foundations and other critical elements where movement must be held to a minimum. The recommendations outlined in the “Surface Drainage” section of this report should be used by the project Civil Engineer to develop grading plans that promote rapid runoff of storm water. Landscaping should be designed to minimize the amount of irrigation needed in proximity of the foundations.
- **Required Additional Geotechnical Studies:** Supplemental exploration is required for the structures within the development (typically one boring per structure is recommended in this geologic region). This additional study should also be completed after approval of platted building locations. These additional services will be used to develop final structural design parameters and to confirm and/or modify the preliminary recommendations and conclusions contained in this report, if necessary.

We appreciate being of service to you in the geotechnical engineering phase of this project, and are prepared to assist you during the construction phases as well. Please do not hesitate to contact us if you have any questions concerning this report or any of our testing, inspection, design and consulting services.

Sincerely,

**Cole Garner Geotechnical**

  
Patrick Maloney, G.I.T.  
Project Manager/Geologist

  
Andrew J. Garner, P.E.  
Principal, COO





*Preliminary Geotechnical Engineering Report*  
*Proposed Mixed-Use Development – 895 N. Ridge Rd., Castle Rock, CO*  
*CGG Project No. 21.22.318*

---

**TABLE OF CONTENTS**

|                                                              | Page No. |
|--------------------------------------------------------------|----------|
| Letter of Transmittal .....                                  | ii       |
| <b>INTRODUCTION</b> .....                                    | 1        |
| <b>PROJECT INFORMATION</b> .....                             | 1        |
| <b>SITE EXPLORATION PROCEDURES</b> .....                     | 2        |
| Field Exploration .....                                      | 2        |
| Laboratory Testing .....                                     | 2        |
| <b>SITE CONDITIONS</b> .....                                 | 3        |
| <b>SUBSURFACE CONDITIONS</b> .....                           | 3        |
| Geology .....                                                | 3        |
| Soil and Bedrock Conditions .....                            | 4        |
| Field and Laboratory Test Results .....                      | 4        |
| Groundwater Conditions .....                                 | 4        |
| <b>ENGINEERING RECOMMENDATIONS</b> .....                     | 5        |
| Geotechnical Considerations.....                             | 5        |
| Earthwork and Site Development.....                          | 6        |
| General Considerations .....                                 | 6        |
| Site Preparation.....                                        | 7        |
| Difficult Bedrock Excavation.....                            | 7        |
| Expansive Soil and Bedrock Mitigation .....                  | 8        |
| Fill Materials .....                                         | 9        |
| Fill Placement and Compaction Requirements .....             | 9        |
| Excavation and Trench Construction.....                      | 10       |
| Conceptual Structural Considerations .....                   | 10       |
| Below-grade Construction .....                               | 11       |
| Interior Floor Slabs.....                                    | 12       |
| Seismic Considerations .....                                 | 12       |
| Preliminary Pavement Thickness Design .....                  | 12       |
| Final Grading, Landscaping, and Surface Drainage .....       | 15       |
| Additional Design and Construction Considerations .....      | 16       |
| Exterior Slabs.....                                          | 16       |
| Underground Utilities.....                                   | 17       |
| Concrete Corrosion Protection.....                           | 17       |
| <b>GENERAL COMMENTS</b> .....                                | 18       |
| <br><b>APPENDIX A: BORING LOCATION DIAGRAM, BORING LOGS,</b> |          |
| <b>APPENDIX B: LABORATORY TEST RESULTS</b>                   |          |
| <b>APPENDIX C: GENERAL NOTES, FOUNDATION DRAIN DETAILS</b>   |          |



## **PRELIMINARY GEOTECHNICAL ENGINEERING REPORT**

### **PROPOSED MIXED-USE DEVELOPMENT**

**895 NORTH RIDGE ROAD**

**CASTLE ROCK, COLORADO**

**CGG Project No. 21.22.318**

**February 7, 2022**

## **INTRODUCTION**

This report contains the results of our geotechnical engineering exploration for the proposed mixed-use development to be constructed at the referenced address in Castle Rock, Colorado. This study was performed in general accordance with our proposal number P21.22.232 executed December 22, 2021.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Geologic considerations
- Subsurface soil and bedrock conditions
- Groundwater conditions
- Site preparation and earthwork
- Preliminary structure foundation alternatives
- Below-grade construction
- Surface and subsurface drainage

The recommendations contained in this report are based upon the results of field and laboratory testing, engineering analyses, our experience with similar subsurface conditions and structures, and our understanding of the proposed project.

## **PROJECT INFORMATION**

We understand that the project will include development of approximately 9 acres of mostly vacant property located at the subject address in Castle Rock, Colorado. An existing single-family residence is present in the northernmost site extents and we understand that this structure and associated improvements is to remain. As currently planned, development will include site grading, underground utility installation, and the construction of paved public or private drives, parking areas, and fire lanes to support mixed-use residential and commercial development. Development plans were not available when preparing this proposal, but we assume that the residential structures will consist of conventional



wood-framing supported by reinforced concrete foundations. We assume that below-grade spaces (basements or crawlspace) may be considered for some residential buildings and that excavations could extend to maximum depths on the order of about 8 to 10 feet below current site grades to construct these subsurface areas. We assume that commercial building construction will include a CMU and/or metal-frame structure, supported on a reinforced concrete foundation. Below-grade construction is not planned. Although grading plans were not provided, we assume that cut and fill on the order of about 3 to 5 feet could be required to bring the site to final construction grade, exclusive of any swell mitigation required.

If our assumptions above are not accurate, or if you have additional useful information, please inform us as soon as possible.

### **SITE EXPLORATION PROCEDURES**

The scope of the services performed for this project included a preliminary-phase subsurface exploration program, laboratory testing, and engineering analysis.

**Field Exploration:** Our scope of services for this study included geotechnical exploration of the subsurface materials at six (6) locations on the site, as shown on the Boring Location Diagram included in Appendix A.

We planned to advance borings to depths ranging from about 25 to 35 feet below existing site grades, however, our truck-mounted drilling equipment utilizing 4-inch diameter, solid-stem auger could not penetrate the very hard sandstone bedrock to those depths in most borings. Refusal to the drilling equipment was encountered at depths ranging from about 10 to 13 feet below existing site grade in 4 of the 6 borings.

Our field personnel recorded a lithologic log of each boring during the drilling operations. At selected intervals, samples of the subsurface materials were obtained by driving Modified California samplers. Penetration resistance measurements were obtained by driving the sample barrels into the subsurface materials with a 140-pound automatic (or manual, as noted on the boring logs) hammer falling 30 inches. The penetration resistance value is a useful index to the consistency, relative density or hardness of the materials encountered.

Groundwater measurements were made in each boring at the time of site exploration and again several days later. Borings were backfilled with the auger cuttings upon completion of groundwater measurements.

**Laboratory Testing:** Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer, and were classified in general accordance with the

Unified Soil Classification System described in Appendix C. Bedrock was classified according to the General Notes for Rock Classification. At that time, an applicable laboratory-testing program was formulated to determine engineering properties of the subsurface materials. Following the completion of the laboratory testing, the field descriptions were confirmed or modified as necessary, and Boring Logs were prepared. These logs are presented in Appendix A.

Laboratory test results are presented in Appendix B. These results were used for the geotechnical engineering analyses and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable local or other accepted standards.

Selected soil and bedrock samples were tested for the following engineering properties:

- Water content
- Dry density
- Swell/Consolidation
- Grain size
- Plasticity Index
- Water-soluble sulfates

## **SITE CONDITIONS**

The subject site consists of approximately 9 acres of largely vacant land located southwest of North ridge road near the southwestern corner of the intersection of Fifth Street and North Ridge Road in Castle Rock, Colorado. An existing single-family residence and driveway is present in the northernmost extents of the parcel. A prominent rock outcrop forms a “cliff” along the western site boundary, and the site is bound by additional residential property to the north and south, and North Ridge Road to the east.

Topographically, the site appears to slope downward generally away from the cliff toward the north and northeast with approximately 30 feet of vertical relief across the site (6620 feet to 6650 feet). Site drainage was generally in the form of sheet surface flow directed generally to the north-northeast.

## **SUBSURFACE CONDITIONS**

**Geology:** Surficial geologic conditions at the site as mapped by the U.S. Geological Survey (USGS) (<sup>1</sup>Thorson, 2004), consist of Older Alluvium (Qp<sub>3</sub>) of Early to Middle Pleistocene Age. This category includes sand, silt, and clay.

Bedrock underlying the surface units (as mapped in the vicinity) consists of the Castle Rock Conglomerate of Late Eocene Age. This formation consists of arkosic coarse sand and granules along

---

<sup>1</sup> Thorson, J.P., 2004, *Geologic Map of the Castle Rock South Quadrangle, Douglas County, Colorado*, Colorado Geological Survey, Open-File Report OF04-05.



with pebble- to boulder-sized clasts that vary in abundance. Thickness of the unit in the area is reported to be up to 230 feet.

We did not identify other geologic hazards that would preclude development of the site using building techniques common to the area. Seismic activity in the area is anticipated to be low. With proper site grading around proposed structures, erosional problems at the site should be reduced.

**Soil and Bedrock Conditions:** In general, subsurface conditions at the site consisted of native lean clay with varying amounts of sand overlying interbedded claystone to sandstone bedrock that extended to the full depth of exploration. The bedrock formation was encountered at depths ranging from about 2 to 6 feet below existing site grades. Where sandstone was predominant (4 of the 6 borings), it was typically very hard and led to auger refusal at depths ranging from 10 to 13 feet below existing site grades. Where claystone was predominant (2 of the 6 borings), it was typically medium hard to very hard and the borings were able to be advanced to full depth (35 feet). Other details regarding the subsurface conditions are shown on the Boring Logs included in Appendix A.

**Field and Laboratory Test Results:** Field test results indicated that the clay overburden soils varied from stiff to hard in relative consistency. The claystone bedrock generally varied from medium hard to very hard in hardness based on penetration resistance, while the sandstone bedrock generally varied from weathered to very hard (typically very hard).

Samples of the clayey soils are of moderate plasticity and exhibited moderate expansive potential upon wetting in our laboratory. Select samples of the claystone bedrock were also of moderate plasticity and exhibited moderate expansive potential at existing moisture contents. ***Based on our experience in the area, blending of the soils/bedrock, moisture conditioning and recompactng these materials to above optimum moisture content typically results in a low expansive fill material.*** The sandstone bedrock materials are generally considered to be low expansive. Water-soluble sulfate testing indicated a concentration of 400 parts per million (ppm).

**Groundwater Conditions:** Groundwater was not encountered in our borings during drilling. When checked thirteen days after drilling, groundwater was encountered in Boring No. 6 at a depth of 31 feet below existing site grades.

Based upon review of U.S. Geological Survey Maps (<sup>2</sup>Hillier, et al, 1979), regional groundwater beneath the project is in an area where water-table conditions predominate in the Dawson Aquifer at depths generally more than 20 feet below the present ground surface and commonly more than 100 feet.

---

<sup>2</sup> Hillier, Donald E.; and Schneider, Paul A., Jr., 1979, ***Depth to Water Table (1976-1977) in the Boulder-Fort Collins-Greeley Area, Front Range Urban Corridor, Colorado***, United States Geological Survey, Map I-855-I.

The above groundwater observations are only representative of the locations explored at the time(s) of exploration(s). Seasonal fluctuations in groundwater elevation beyond those indicated above should be expected, therefore, the possibility of groundwater fluctuations should be considered when developing design and construction plans for the project.

## **ENGINEERING RECOMMENDATIONS**

**Geotechnical Considerations:** Based on the information obtained from our subsurface exploration, laboratory testing, and a cursory review of geologic conditions, it is our opinion that the site appears suitable for development of the proposed project provided the recommendations in this report are followed. The following primary geotechnical considerations were identified:

- **Difficult Bedrock Excavation:** As discussed, the sandstone portions of the bedrock formation are dense and well-cemented. The drilling equipment encountered practical auger refusal at depths ranging from about 10 to 13 feet below existing site grades within the sandstone. Depending on planned site grading, difficult excavation conditions are likely to be encountered during installation of underground utilities and in foundation excavations. ***Pneumatic rock-breaking, blasting, and/or ripping could be required during earthwork, overexcavation, and foundation excavations. Difficult excavation should be accounted for in the project budget in these areas. The bedrock materials are highly variable and interbedded, therefore, additional exploration via test pits would be required to attempt to further delineate these areas.***
- **Expansive Soil and Bedrock Mitigation:** The clay soils and claystone lenses of the bedrock formation exhibited moderate expansive potential at existing moisture contents. ***Post-construction wetting of these expansive materials can potentially result in excessive or uneven movement of shallow foundations, floor slabs, exterior flatwork, pavements, etc. We have provided recommendations to reduce the risk of movement and distress, however, eliminating the risk of movement and cosmetic distress is generally not considered feasible. It may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction.***

***If the use of spread footing foundations and slab-on-grade floors is desired, these conditions will require mitigation.*** The most common method of swell mitigation involves subexcavation of expansive soils/bedrock to create a zone of engineered fill beneath foundations and floor slabs. ***We recommend the expansive overburden soils be subexcavated down to low-expansive sandstone bedrock within each building footprint. Where claystone bedrock materials are predominant, the subexcavation process should extend to a depth of 10 feet below the lowest foundation element. on each building. Subexcavation for each structure should also extend a minimum of 5 feet outside of each foundation footprint. We also recommend that this process be performed to a depth of 5 feet below pavements during site grading and land development, prior to installation of underground utilities.***

*Even if the recommendations in this report are followed, some movement and at least minor cracking of foundations, floor slabs, flatwork and pavements should be anticipated as drier lenses of the clay/bedrock experience swell due to post-construction wetting. The severity of cracking and other cosmetic damage such as uneven floor slabs, pavement cracking, etc. will probably increase if site improvements result in excessive wetting or drying of the expansive soils/bedrock. Eliminating the risk of movement and distress is generally not considered feasible but can be reduced using measures that could add significant cost to the project. We would be pleased to discuss other construction alternatives with you upon request.*

- **Preliminary Structural Considerations:** Drilled pier foundations and structural floors are commonly used for construction on moderately to highly expansive sites. However, typical drilled pier foundations may not be feasible given the very hard bedrock encountered in our borings. As a result, the use of these systems may be cost prohibitive for the types of projects proposed for this site. As an alternative, the swell mitigation described above will generally allow for the use of spread footing foundations and slab-on-grade floors.

The owner must acknowledge and accept the risk of movement and distress outlined in the report. In our experience, the goal of swell mitigation would be to limit foundation movement to 1 inch or less and movement of slab-on-grade floors to about 1 to 2 inches. Additional details are discussed in the report.

- **Surface Drainage:** The amount of movement associated with foundations, floor slabs, pavements, etc. will be related to the wetting of underlying supporting soils. Therefore, it is imperative that surface water be directed away from foundations and other critical elements where movement must be held to a minimum. The recommendations outlined in the “Surface Drainage” section of this report should be used by the project Civil Engineer to develop grading plans that promote rapid runoff of storm water. Landscaping should be designed to minimize the amount of irrigation needed in proximity of the foundations.
- **Required Additional Geotechnical Studies:** Supplemental exploration is required for the structures within the development (typically one boring per structure is recommended in this geologic region). This additional study should also be completed after approval of platted building locations. These additional services will be used to develop final structural design parameters and to confirm and/or modify the preliminary recommendations and conclusions contained in this report, if necessary.

#### **Earthwork and Site Development:**

- **General Considerations:** The following presents our initial recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project based on typical

construction methods. As the design plans are finalized, these recommendations should be refined accordingly.

All earthwork on the project should be observed and evaluated by CGG. The evaluation of earthwork should include observation and testing of engineered fills, subgrade preparation, foundation bearing soils and other geotechnical conditions exposed during construction of the project.

- **Site Preparation:** Strip and remove existing vegetation along with any other deleterious materials from the site. Stripped materials consisting of vegetation and organic materials should be wasted from the site.

We anticipate the subgrade soils will be relatively stable during earthwork operations. The stability of the site subgrade may be affected by precipitation, proximity to drainages, repetitive construction traffic, or other factors. If unstable conditions are encountered or develop during construction, workability may be improved by scarifying and aeration. Gravel augmentation or chemical treatment could also be considered for very soft areas.

In areas where subgrade soils are very soft/yielding, gravel augmentation (mechanically compacting/kneading crushed rock into the subgrade soils) may be cost-effective. In our experience, crushed rock or recycled concrete materials on the order of 3 to 6 inches in size would be effective in most situations. As an alternative, chemical treatment by blending fly ash, lime or Portland cement into the subgrade could also be considered. ***The actual mitigation methods used should be based on observation of exposed conditions by the geotechnical engineer.***

- **Difficult Bedrock Excavation:** As discussed, the bedrock formations present across the site are typically very hard in density and led to auger refusal in several of the borings. ***These formations are present near the ground surface over much of the site and will impact excavations, requiring special equipment and procedures for site grading, swell mitigation, and underground utility installation.***

***Pneumatic rock-breaking, blasting, and/or ripping could be required during earthwork, overexcavation, and foundation excavations. Difficult excavation should be accounted for in the project budget in these areas. Additional exploration via test pits could further document and delineate the extent and depth of these areas.***

***Reuse of the bedrock as fill on the site will require special methods to confirm that bedrock materials are well processed and blended. The contractor should plan on ripping the bedrock with dozers in order to advance excavations using scrapers. Excavated materials will need to be broken down using discs in order to prepare a uniformly moisture conditioned and processed fill zone.***



Excavation of the bedrock at the site will likely generate several larger fragments of claystone and sandstone bedrock. These fragments are likely to be on the order of about 18 to 24 inches in size and not able to be broken down further using the conventional earthwork equipment and methods common to the region. Rather than exporting these fragments, these materials may be strategically placed and compacted only in the deeper sections of the fill used to backfill the subexcavations within the lots. The fragments should be placed within the lower 5 feet of the fill zone and blended into the backfill soil matrix such that “nesting” of the fragments is avoided.

- **Expansive Soil and Bedrock Mitigation:** The clay soils and claystone lenses of the bedrock formation exhibited moderate expansive potential at existing moisture contents. These materials will require mitigation in order to utilize spread footings and slab-on-grade floors. ***As discussed, mitigation of these expansive soils and claystone bedrock lenses should include subexcavation of the clay soils down to the non- to low-expansive sandstone bedrock. Where claystone bedrock is predominant, subexcavation should extend a minimum of 10 feet below the lowest foundation element. Additional exploration and evaluation will be required to help determine the lateral extents of these areas.*** The base of subexcavations should also extend a minimum of 5 feet beyond the foundation edges. New fill used to raise site grades can be considered part of this zone.

***We also recommend that this process be performed to a depth of 5 feet below pavements (extending at least 1 foot beyond the back of curb/detached walk) during site grading and land development, prior to installation of underground utilities. Where more than 5 feet of fill is placed to raise the roadways, no additional subexcavation would be needed.*** A final pavement design will include drilling and testing within all public roadway alignments per current Town of Castle Rock standards.

In order to confirm that the process is properly completed, we recommend surveying of the base of the subexcavation to confirm both vertical and lateral extents prior to backfill. In addition, observation and testing should be performed by a representative of the geotechnical engineer on an essentially full-time basis. Foundation movement will be directly related to the depth and extents of subsurface wetting beneath foundations. We have provided recommendations to help limit wetting due to storm runoff and irrigation and these measures should be maintained throughout the life of the project. Failure to maintain proper surface drainage surrounding the buildings may result in movement and distress in excess of our estimates.

**Preliminary Geotechnical Engineering Report**  
**Proposed Mixed-Use Development – 895 N. Ridge Rd., Castle Rock, CO**  
**CGG Project No. 21.22.318**

---

- **Fill Materials:** Clean on-site soils or approved imported materials may be used as fill material. We should be contacted to evaluate samples of any proposed fill materials prior to importation. Imported soils (if required) should conform to the following:

| <u>Gradation</u>                         | <u>Percent finer by weight<br/>(ASTM C136)</u> |
|------------------------------------------|------------------------------------------------|
| 6" .....                                 | 100                                            |
| 3" .....                                 | 70-100                                         |
| No. 4 Sieve .....                        | 50-100                                         |
| No. 200 Sieve .....                      | 65 maximum                                     |
| • Liquid Limit .....                     | 40 (max)                                       |
| • Plasticity Index .....                 | 20 (max)                                       |
| • Maximum expansive potential (%)* ..... | 0.5                                            |

\*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density near optimum water content. The sample is confined under a 500 psf surcharge and submerged.

- **Fill Placement and Compaction Requirements:** Clean on-site soils or approved imported materials may be used as fill material. We should be contacted to evaluate samples of any proposed fill materials prior to importation, if needed. General site fill and fill placed below foundations and floor slabs should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift.

Engineered fill for site development and grading should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill soils, trench backfill, and subgrade soils below flatwork should be compacted in accordance with the following criteria:

| Item                     | Description                                                                                                                                                                                                                                                            |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fill Materials           | <ul style="list-style-type: none"><li>• On-site soils or processed bedrock materials (3 to 4 inch fragments max, larger fragments within lower 5 feet of fill zone, if necessary)</li><li>• Imported fill, if required, should meet the specifications above</li></ul> |
| Fill Lift Thickness      | 8 to 12 inches or less in loose thickness                                                                                                                                                                                                                              |
| Compaction Requirements* | <ul style="list-style-type: none"><li>• Clayey soils/processed bedrock: 95% of standard Proctor dry density (ASTM D698)</li><li>• Processed sandstone or imported granular soils: 95% of modified Proctor dry density (ASTM D1557)</li></ul>                           |

**Preliminary Geotechnical Engineering Report**  
**Proposed Mixed-Use Development – 895 N. Ridge Rd., Castle Rock, CO**  
**CGG Project No. 21.22.318**

| Item             | Description                                                                                                                                                                                                                                                                                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Moisture Content | <ul style="list-style-type: none"><li>• Clayey soils/processed bedrock: Optimum to +4% above optimum moisture content</li><li>• On-site or Imported granular soils: -2% below to +2% above of optimum</li><li>• Pavement Subgrade: Optimum to +2% above optimum in pavement areas</li></ul> |

\* Care should be used when compacting against basement walls. Foundation backfill soils in these areas should be compacted to a minimum of 90 percent of standard Proctor dry density.

At a minimum, fill soils placed for site grading/subexcavation, utility trench backfill, foundation backfill, and floor slab and pavement subgrade soils should be tested to confirm that earthwork is being performed according to our recommendations and project specifications. Subsequent lifts of fill should not be placed on previous lifts if the moisture content or dry density is determined to be less than specified. We also recommend that the in-place fill materials comprised of on-site clay/claystone be tested for expansion potential frequently to confirm that the fill mass is low expansive.

The compacted soils should not be allowed to dry out prior to foundation/floor slab construction. Construction traffic over the completed subgrade should be avoided to the extent practical. A loss of moisture or overcompaction could result in an increase in the expansive potential of clayey soils. Subsequent wetting of these materials could result in undesirable movement.

- **Excavation and Trench Construction:** Excavations into the on-site clays and bedrock will likely stand on relatively steep temporary slopes, however, the sandier soils may be subject to caving. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards. Individual contractors are responsible for the safety of excavations on the site.

The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

As a safety measure, it is recommended that all vehicles and soil piles be kept to a minimum lateral distance from the crest of the slope equal to no less than the slope height. The exposed slope face should be protected against the elements.

**Conceptual Structural Considerations:** Based on the subsurface conditions across the site and the nature of the proposed structures, the site is suitable for foundation systems commonly used in the region. ***Actual foundation designs should be based on additional geotechnical exploration and***

***evaluation of the soil conditions for each structure, typically completed after mass site grading and swell mitigation is complete.***

We assume that the use of spread footing foundations is preferred for the structures associated with the project. ***As discussed, moderately expansive lean clay soils and claystone bedrock materials are present at the site. Subexcavation will be required to reduce the expansive potential of these materials and allow for the use of spread footing foundations.***

The subexcavation process outlined previously would involve removal, processing, moisture-conditioning and recompacting these materials in order to construct a low-expansive engineered fill zone below all foundations. Foundations bearing on a zone of engineered fill, as recommended, may be preliminarily designed for bearing pressures on the order of 2,500 to 3,000 pounds per square foot (psf). Footings may also need to be designed to maintain a minimum dead load, which may require the use of foundation void forms between sections of continuous wall footings. Foundations along exterior walls should bear a minimum of 36 inches below finished exterior grade for frost protection.

Slab-on-grade floors will be subject to movement, even when bearing on the recommended zone of properly moisture-conditioned and recompacted fill. In general, we estimate the process described above will help reduce movements to the range of about 1 to 2 inches, and help make movement more uniform. If further reducing movement is desired, the upper three feet of the supporting soils could be replaced with CDOT Class 1 structural fill. However, we recommend this granular soil type only be used on the interior of the foundation and not extend below footings (as it could be a conduit for exterior, surface water to enter the supporting soils).

Based on our experience, foundation movements due to expansion of the supporting soils could result in periodic, and possibly seasonal, cosmetic distress to drywall, window frames, door frames and other features. These cases are generally limited to sites where surface drainage has been altered and water is allowed to pond in close proximity to foundations. In order to limit wetting and associated foundation movement and distress, ***it is imperative that irrigation be limited in proximity to the foundations and good surface drainage be maintained.*** We have provided preliminary recommendations to site drainage in this report. If these measures are not incorporated into the design and maintenance of the project, additional and excessive foundation movement and distress could occur.

Final foundation design information will need to be developed on the basis of additional subsurface exploration and analyses on each lot subsequent to the completion of mass site grading and swell mitigation.

**Below-grade Construction:** We understand that basement and/or crawlspace is being considered for residential portions of the project, but not for the commercial portions. Based on the groundwater



conditions at the site, we believe that below-grade construction will be feasible on the site. However, difficult bedrock excavation could add considerable cost to the construction of below-grade areas.

***Even in areas where perched groundwater was not encountered, subsurface drain systems should be installed around all basements/crawlspace to prevent the development of perched water resulting from irrigation and downspout flows. Drain outflows should be discharged to a suitable outfall well away from the structure(s).***

Foundation drainage systems typically include a perforated pipe, embedded in gravel, placed in a trench that is sloped to a low point. Based on current groundwater levels, exterior drains would be appropriate for the majority of the site. We are available to discuss what types of drainage systems are appropriate as design concepts are finalized. The final design of the foundation drainage system(s) for the structure(s) should be based on design-level geotechnical study for each structure.

**Interior Floor Slabs:** As discussed, variably expansive clays and bedrock were encountered on the site. Provided mitigation of the expansive soils and bedrock is performed, these materials are anticipated to be suitable for support for interior (non-structural) slab-on-grade floors with low risk of post-construction movement.

***Floor slabs bearing on approved soils or moisture-conditioned and compacted engineered fill will still experience movement when subjected to typical post-construction wetting, even with the recommended site preparation, however, we expect movement to be within normally tolerable levels.***

Typical precautions used to manage this movement include isolating plumbing and HVAC equipment, providing void space beneath partition walls, proper construction of closely spaced control joints, etc. Cosmetic distress such as drywall cracking, racking of door frames, etc. may result from slab movement in finished basements. These floor slab design and construction methods are common in the region and final recommendations should be included in design-level geotechnical studies.

**Seismic Considerations:** Based on the soil conditions encountered in the test holes drilled on the site, we estimate that a Site Class C is appropriate for the site according to the 2015 International Building Code (Section 1613.3.2 referencing Table 20.3-1 of ASCE 7, Chapter 20). This parameter was estimated based on extrapolation of data beyond the deepest depth explored, using methods allowed by the code. Actual shear wave velocity testing/analysis and/or exploration to 100 feet was not performed.

**Preliminary Pavement Thickness Design:** The preliminary design of private pavements for the project is based on the procedures outlined by the ***Castle Rock Transportation Design Criteria Manual***, December 2018 (Standards). These Standards generally require the use of methods outlined in the 1993 ***AASHTO Guide for Design of Pavement Structures*** and ***CDOT Pavement Design Manual***. These methods are based on subgrade support and traffic volume/loads over a given design life. ***For all public roadway improvements,***

*the Town of Castle Rock will require submittal of a pavement thickness design report based on completion of additional geotechnical exploration and analyses after completion of site grading.*

- **Subgrade Soils:** As discussed, sandy lean clay overburden soils were encountered near the surface in some of our borings and clayey bedrock materials in the others. ***At a minimum, we recommend subexcavation of all roadways to a depth of 5 feet during mass site grading.*** Where more than 5 feet of fill is placed to raise the roadways, no additional subexcavation would be needed. ***These clayey subgrade soils are considered to provide poor support for pavements.*** Based on the properties of the poorest quality subgrade soils, we have estimated an R-value of 5, corresponding to a resilient modulus of 3,025 psi using the CDOT correlation. A modulus of subgrade reaction (K-value) of 100 pounds per cubic inch (pci) was used for design of rigid concrete pavements.
- **Design Traffic:** The following traffic designation criteria were used for determining pavement thicknesses using a design life of 20 years, as outlined in the Standards:

| Town of Castle Rock Roadway Classification | Equivalent (18-kip) Single Axle Loads (ESAL <sub>20</sub> )* |
|--------------------------------------------|--------------------------------------------------------------|
| Private Light-Duty                         | 36,500                                                       |
| Private Heavy-Duty                         | 73,000                                                       |
| Local Mixed-Use                            | 750,000                                                      |

- **Design Criteria:** We utilized the following criteria for design of private pavements, which meet or exceed the Standards.

| Roadway Classification | Reliability (%) | Standard Deviation | Terminal Serviceability Index | Design SN 20-year design life |
|------------------------|-----------------|--------------------|-------------------------------|-------------------------------|
| Private Light-Duty     | 75              | 0.44               | 2.0 ( $\Delta$ PSI = 2.5)     | <b>2.54</b>                   |
| Private Heavy-Duty     | 80              | 0.44               | 2.0 ( $\Delta$ PSI = 2.5)     | <b>2.82</b>                   |
| Local Residential      | 85              | 0.44               | 2.0 ( $\Delta$ PSI = 2.5)     | <b>4.25</b>                   |

**Preliminary Geotechnical Engineering Report**  
**Proposed Mixed-Use Development – 895 N. Ridge Rd., Castle Rock, CO**  
**CGG Project No. 21.22.318**

- **Pavement Sections:** Using the above information and other criteria outlined in the current Standards, the following conceptual pavement sections were developed for project planning:

| Traffic Area                                                        | Alternative* | Preliminary Pavement Thickness (Inches) |                       |                          |
|---------------------------------------------------------------------|--------------|-----------------------------------------|-----------------------|--------------------------|
|                                                                     |              | Asphalt Concrete Surface                | Aggregate Base Course | Portland Cement Concrete |
| <b>Private Light-Duty</b><br>Two-lane<br>ESAL <sub>20</sub> =36,500 | A            | 4                                       | 6                     | --                       |
|                                                                     | B*           | 6                                       | --                    | --                       |
|                                                                     | C            | --                                      | --                    | 5                        |
| <b>Private Heavy-Duty</b><br>Two-lane<br>ESAL <sub>20</sub> =73,000 | A            | 5                                       | 7                     | --                       |
|                                                                     | B*           | 7                                       | --                    | --                       |
|                                                                     | C            | --                                      | --                    | 6                        |
| <b>Local Mixed-Use</b><br>Two-lane<br>ESAL <sub>20</sub> =750,000   | A            | 6                                       | 12                    | --                       |
|                                                                     | B*           | 9-½                                     | --                    | --                       |
|                                                                     | C            | --                                      | --                    | 8                        |
| <b>Castle Rock Industrial/Commercial Default Minimum</b>            | A            | 4                                       | 8                     | --                       |
|                                                                     | B*           | --                                      | --                    | --                       |
|                                                                     | C            | --                                      | --                    | 6                        |

\*Full-depth pavement is only allowed over chemically treated subgrade.

Pavement thicknesses recommended are based on approved subgrade materials being properly moisture conditioned and compacted prior to paving. A proofroll of the subgrade soils should also be performed prior to paving and any soft/yielding areas remediated. Paving materials used at the site should meet current City of Castle Rock and/or CDOT specifications.

- **Pavement Maintenance and Performance:** Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade such as the soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. It is, therefore, important to minimize moisture changes in the subgrade to reduce shrink/swell movements.

Future performance of pavements constructed on the clay soils at this site will be dependent upon several factors, including:

- maintaining stable moisture content of the subgrade soils.
- providing for a planned program of preventative maintenance.

Since the clay soils on the site have shrink/swell characteristics, pavements could crack in the future primarily because of expansion of the soils when subjected to an increase in moisture content to the subgrade. The cracking, while not desirable, does not necessarily constitute structural failure of the pavement.

The performance of all pavements can be enhanced by minimizing excess moisture which can reach the subgrade soils. The following recommendations should be considered at minimum:

- place compacted, low permeability backfill against the exterior side of curb and gutter as soon as possible.
- Soils behind the curb should be sloped at a minimum 2 percent grade to facilitate flow over the top of the curb or toward drainage collection points away from the pavements.
- the subgrade and the pavement surface have a minimum 1/4 inch per foot slope to promote proper surface drainage.
- consider appropriate edge drainage and pavement underdrain systems in areas anticipated for frequent wetting (e.g., heavily irrigated sod, snow removal areas, etc.). Edge drains may be required by the City and should conform to applicable Standards.
- install joint sealant and seal cracks immediately.
- compaction of any utility trenches for landscaped areas to the same criteria as the pavement subgrade.
- seal all landscaped areas in or adjacent to pavements to minimize or prevent moisture migration to subgrade soils.
- place curb, gutter and/or sidewalk directly on subgrade soils without the use of base course materials.

**Final Grading, Landscaping, and Surface Drainage:** All grades must be adjusted to provide positive drainage away from structures during construction and maintained throughout the life of the proposed project. ***Water permitted to pond near or adjacent to the perimeter of the structures (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade.*** Infiltration of water into utility or foundation excavations must be prevented during construction.

***Exposed ground should be sloped at a minimum of 10 percent grade for at least 10 feet beyond the perimeter of the buildings, where possible.*** We understand that this may not be feasible in all unpaved areas due to ADA access requirements and other required design features. In these areas, exterior



grades should be sloped as much as possible down to area drain systems, swales, and/or sidewalk chases to facilitate drainage.

***Downspouts could also be connected to area drain systems to help reduce wetting. If this is not possible, roof drain flows should be directed onto pavements or discharge a minimum of 5 feet away from the structure through the use of splash blocks or downspout extensions.***

Backfill against foundations, exterior walls and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration. After building construction and prior to project completion, we recommend that verification of final grading be performed to document that positive drainage, as described above, has been achieved. This is especially important in areas where heating and cooling units are placed in close proximity to the buildings.

Planters located adjacent to the structure should preferably be self-contained (planter boxes, potted landscaping, etc.). ***Landscaped irrigation adjacent to foundations should be eliminated where possible or minimized to only limited drip irrigation.*** Sprinkler mains and spray heads should be located a minimum of 5 feet away from the buildings. We recommend the use of Xeric landscaping, requiring little or no irrigation, be used within 5 feet of foundations. If drip irrigation is required in this zone, systems should be timed to provide only the amount of water needed to sustain growth. Irrigation systems should be frequently checked for proper performance and any breakages fixed as soon as possible.

#### **Additional Design and Construction Considerations:**

- **Exterior Slabs: *Flatwork and pavements will be subject to post-construction movement.*** Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post-construction movement of flatwork, particularly if such movement would be critical. Where paving or flatwork abuts the structure, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Portions of the flatwork adjacent to the home will likely also bear on foundation backfill that is prone to settlement. In areas where settlement of flatwork cannot be tolerated, slabs should be integrated into the foundation or supported structurally by haunches.

Additional considerations to reduce the potential for damage caused by movement are:

- supporting exterior slabs directly on-site subgrade soils (not base course) with no, or very low expansion potential;
- strict moisture-density control during placement of subgrade fills;

**Preliminary Geotechnical Engineering Report**  
**Proposed Mixed-Use Development – 895 N. Ridge Rd., Castle Rock, CO**  
**CGG Project No. 21.22.318**

---

- placement of effective control joints on relatively close centers and isolation joints between slabs and other structural elements;
  - provision for adequate drainage in areas adjoining the slabs;
  - use of designs which allow vertical movement between the exterior slabs and adjoining structural elements.
- 
- **Underground Utilities:** Subexcavation and recompaction is also generally required below underground utilities installed in steeply dipping bedrock. We recommend that the subgrade supporting utility lines within the bedrock formation be subexcavated to a depth of 2 feet below the pipe. These materials should be moisture conditioned and recompacted

All underground piping within or near the proposed structure should be designed with flexible couplings, so minor deviations in alignment do not result in breakage or distress. Utility knockouts in foundation walls should be oversized to accommodate differential movements.

It is strongly recommended that a representative of the geotechnical engineer provide full-time observation and compaction testing of trench backfill within building and pavement areas.

- **Concrete Corrosion Protection:** Select soil samples likely to be in contact with project concrete were tested for the presence of water-soluble sulfates in order to determine corrosion characteristics and the appropriate concrete mixtures. Results of testing along with the associated American Concrete Institute (ACI) sulfate exposure class are listed in the table below.

| Boring | Depth (ft) | Material            | Water-Soluble Sulfates (ppm) | ACI Sulfate Exposure Class |
|--------|------------|---------------------|------------------------------|----------------------------|
| 3      | 2          | Lean Clay with Sand | 100                          | S0                         |

The soils likely to be in contact with project concrete exhibited soluble sulfates in ACI sulfate exposure class S0. For additional protection, project concrete should be designed for ACI sulfate exposure class S1 in accordance with Chapter 19 of the ACI design manual, *Building Code Requirements for Structural Concrete (ACI 318-14)*. Requirements for project concrete (placed on or below grade) are also listed in the table below.

| ACI Sulfate Exposure Class | Portland Cement Type (ASTM C150) | Maximum Water/Cement Ratio | Minimum Concrete Compressive Strength (psi) |
|----------------------------|----------------------------------|----------------------------|---------------------------------------------|
| S1                         | II or equivalent                 | 0.50                       | 4,000                                       |

## **GENERAL COMMENTS**

Supplemental exploration and analyses should be performed in order to develop final design parameters and to confirm and/or modify the preliminary recommendations and conclusions contained in this report.

CGG should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. CGG should also be retained to provide testing and observation during the excavation, grading, foundation and construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include, either specifically or by implication, any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes are planned in the nature, design, or location of the project as outlined in this report, the conclusions and recommendations contained in this report shall not be considered valid unless CGG reviews the changes, and either verifies or modifies the conclusions of this report in writing.

## **APPENDIX A**

### **BORING LOCATION DIAGRAM BORING LOGS**







 **1** APPROXIMATE BORING LOCATIONS



**BORING LOCATION DIAGRAM  
PROPOSED MIXED-USE DEVELOPMENT  
895 NORTH RIDGE ROAD  
CASTLE ROCK, COLORADO  
CGG PROJECT NO. 21.22.318**



**Cole Garner Geotechnical**  
1070 W. 124<sup>th</sup> Ave., Suite 300  
Westminster, CO 80234  
(303) 996-2999



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

# BORING NUMBER 1

PAGE 1 OF 1

|                     |                           |                      |                                              |
|---------------------|---------------------------|----------------------|----------------------------------------------|
| CLIENT              | Parker Center, LLC        | PROJECT NAME         | Proposed Mixed-Use Development               |
| PROJECT NUMBER      | 21.22.318                 | PROJECT LOCATION     | 895 North Ridge Road - Castle Rock, Colorado |
| DATE STARTED        | 1/5/22                    | COMPLETED            | 1/5/22                                       |
| DRILLING CONTRACTOR | Vine Laboratories         | GROUND SURFACE ELEV. | Not Provided                                 |
| DRILLING METHOD     | CME-55 / Solid Stem Auger | PROPOSED ELEV.       | Not Provided                                 |
| HAMMER TYPE         | Automatic                 | SURFACE CONDITIONS   | Low to tall growth of grass and weeds        |
| LOGGED BY           | TMC                       | CHECKED BY           | AG                                           |
|                     |                           | GROUND WATER LEVELS: |                                              |
|                     |                           | ▽ DURING DRILLING    | None                                         |
|                     |                           | ▽ AFTER DRILLING     | None - 1/18/22                               |

| GRAPHIC LOG | MATERIAL DESCRIPTION                                                                              | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|-------------|---------------------------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|             |                                                                                                   | 0          |             |             |            |                      |                      |                    |                                    |
|             | <b>SANDY LEAN CLAY</b> , with gravel, light to dark brown, iron-stained, dry to moist, very stiff |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                   |            | CL          | CB          | 100        | 19 / 12              | 9.7                  |                    |                                    |
|             | <b>SANDY CLAYSTONE BEDROCK</b> , light brown, grey, dry to moist, hard                            |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                   | 5          | -           | CB          | 100        | 50 / 9               | 9.8                  | 119                | +3.9/500                           |
|             |                                                                                                   |            |             |             |            |                      |                      |                    |                                    |
|             | <b>SANDSTONE BEDROCK</b> , tan, light grey, dry to moist, very hard                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                   | 10         | -           | CB          | 100        | 50 / 2               | 8.2                  |                    |                                    |
|             |                                                                                                   |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                   | 13         |             |             |            |                      |                      |                    |                                    |

Refusal at 13.0 feet.  
Approximate bottom of borehole at 13.0 feet.





Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

## BORING NUMBER 2

PAGE 1 OF 1

CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

DATE STARTED 1/5/22 COMPLETED 1/5/22

GROUND SURFACE ELEV. Not Provided PROPOSED ELEV. Not Provided

DRILLING CONTRACTOR Vine Laboratories

SURFACE CONDITIONS Low to tall growth of grass and weeds

DRILLING METHOD CME-55 / Solid Stem Auger

GROUND WATER LEVELS:

HAMMER TYPE Automatic

▽ DURING DRILLING None

LOGGED BY TMC CHECKED BY AG

▽ AFTER DRILLING None - 1/18/22

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ

| GRAPHIC LOG | MATERIAL DESCRIPTION                                                          | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|-------------|-------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|             |                                                                               | 0          |             |             |            |                      |                      |                    |                                    |
|             | <b>SANDY LEAN CLAY</b> , brown to dark brown, moist, hard                     |            | CL          | CB          | 0          | 50 / 0               |                      |                    |                                    |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 5          | CL          | CB          | 100        | 45 / 12              | 17.5                 | 110                | +3.1/500                           |
|             | <b>CLAYSTONE BEDROCK</b> , olive-brown, grey, moist, medium hard to very hard |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 10         | -           | CB          | 100        | 43 / 12              | 23.9                 | 103                |                                    |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 15         | -           | CB          | 100        | 50 / 10              | 24.9                 | 95                 | +2.0/1000                          |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 20         | -           | CB          | 100        | 50 / 9               | 24.8                 | 101                |                                    |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 25         | -           | CB          | 100        | 50 / 9               | 28.5                 | 96                 |                                    |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 30         | -           | CB          | 100        | 50 / 11              | 22.7                 | 105                |                                    |
|             |                                                                               |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                               | 35         | -           | CB          | 100        | 50 / 6               | 15.6                 | 114                |                                    |

Approximate bottom of borehole at 35.0 feet.



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

BORING NUMBER 3

PAGE 1 OF 1

CLIENT Parker Center, LLC  
PROJECT NUMBER 21.22.318  
DATE STARTED 1/5/22 COMPLETED 1/5/22  
DRILLING CONTRACTOR Vine Laboratories  
DRILLING METHOD CME-55 / Solid Stem Auger  
HAMMER TYPE Automatic  
LOGGED BY TMC CHECKED BY AG

PROJECT NAME Proposed Mixed-Use Development  
PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado  
GROUND SURFACE ELEV. Not Provided PROPOSED ELEV. Not Provided  
SURFACE CONDITIONS Low to tall growth of grass and weeds  
GROUND WATER LEVELS:  
▽ DURING DRILLING None  
▽ AFTER DRILLING None - 1/18/22

| GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|-------------|-----------------------------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|             |                                                                                                     | 0          |             |             |            |                      |                      |                    |                                    |
|             | <u>LEAN CLAY with SAND</u> , light to dark brown, dry to moist, stiff                               |            | CL          | CB          | 100        | 16 / 12              |                      |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     |            | CL          | CB          | 100        | 15 / 12              | 4.7                  |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     | 5          | -           | CB          | 100        | 22 / 12              | 12.2                 | 107                |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     | 7          |             |             |            |                      |                      |                    |                                    |
|             | <u>SANDSTONE BEDROCK</u> , varies clayey, coarse-grained, tan, light brown, dry to moist, very hard |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                     | 10         | -           | CB          | 100        | 50 / 3               | 7.3                  |                    |                                    |
|             |                                                                                                     |            |             |             |            |                      |                      |                    |                                    |

Refusal at 10.5 feet.  
Approximate bottom of borehole at 10.5 feet.

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ





Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

# BORING NUMBER 4

PAGE 1 OF 1

|                     |                           |                      |                                              |
|---------------------|---------------------------|----------------------|----------------------------------------------|
| CLIENT              | Parker Center, LLC        | PROJECT NAME         | Proposed Mixed-Use Development               |
| PROJECT NUMBER      | 21.22.318                 | PROJECT LOCATION     | 895 North Ridge Road - Castle Rock, Colorado |
| DATE STARTED        | 1/5/22                    | COMPLETED            | 1/5/22                                       |
| DRILLING CONTRACTOR | Vine Laboratories         | GROUND SURFACE ELEV. | Not Provided                                 |
| DRILLING METHOD     | CME-55 / Solid Stem Auger | PROPOSED ELEV.       | Not Provided                                 |
| HAMMER TYPE         | Automatic                 | SURFACE CONDITIONS   | Low to tall growth of grass and weeds        |
| LOGGED BY           | TMC                       | CHECKED BY           | AG                                           |
|                     |                           | GROUND WATER LEVELS: |                                              |
|                     |                           | ▽ DURING DRILLING    | None                                         |
|                     |                           | ▽ AFTER DRILLING     | None - 1/18/22                               |

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ

| GRAPHIC LOG | MATERIAL DESCRIPTION                                                                                              | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|-------------|-------------------------------------------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|             |                                                                                                                   | 0          |             |             |            |                      |                      |                    |                                    |
|             | <b>SANDY LEAN CLAY</b> , with some gravel, brown, dark brown, dry to moist, very stiff                            |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                                                   |            | CL          | CB          | 100        | 28 / 12              | 10.5                 |                    |                                    |
|             | <b>CLAYSTONE to SANDSTONE BEDROCK</b> , interbedded, fine- to medium-grained, tan, brown, dry to moist, very hard | 5          | -           | CB          | 100        | 50 / 4               | 10.6                 |                    |                                    |
|             |                                                                                                                   | 10         | -           | CB          | 0          | 50 / 0               |                      |                    |                                    |

Refusal at 10.0 feet.  
Approximate bottom of borehole at 10.0 feet.



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

# BORING NUMBER 5

PAGE 1 OF 1

|                     |                           |                      |                                              |
|---------------------|---------------------------|----------------------|----------------------------------------------|
| CLIENT              | Parker Center, LLC        | PROJECT NAME         | Proposed Mixed-Use Development               |
| PROJECT NUMBER      | 21.22.318                 | PROJECT LOCATION     | 895 North Ridge Road - Castle Rock, Colorado |
| DATE STARTED        | 1/5/22                    | COMPLETED            | 1/5/22                                       |
| DRILLING CONTRACTOR | Vine Laboratories         | GROUND SURFACE ELEV. | Not Provided                                 |
| DRILLING METHOD     | CME-55 / Solid Stem Auger | PROPOSED ELEV.       | Not Provided                                 |
| HAMMER TYPE         | Automatic                 | SURFACE CONDITIONS   | Low to tall growth of grass and weeds        |
| LOGGED BY           | TMC                       | CHECKED BY           | AG                                           |
|                     |                           | GROUND WATER LEVELS: |                                              |
|                     |                           | ▽ DURING DRILLING    | None                                         |
|                     |                           | ▽ AFTER DRILLING     | None - 1/18/22                               |

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ

| GRAPHIC LOG                                                                        | MATERIAL DESCRIPTION                                                                                                                  | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|                                                                                    |                                                                                                                                       | 0          |             |             |            |                      |                      |                    |                                    |
|   | <b>SANDY LEAN CLAY</b> , dark brown, dry to moist, very stiff                                                                         |            | CL          | CB          | 100        | 19 / 12              | 8.5                  |                    |                                    |
|   | <b>CLAYSTONE to SANDSTONE BEDROCK</b> , interbedded, fine-to coarse-grained, light tan to tan, dry to moist, medium hard to very hard |            | -           | CB          | 100        | 37 / 12              | 8.6                  |                    |                                    |
|                                                                                    |                                                                                                                                       | 5          | -           | CB          | 100        | 50 / 3               | 9.9                  | 112                |                                    |
|                                                                                    |                                                                                                                                       |            |             |             |            |                      |                      |                    |                                    |
|  |                                                                                                                                       | 10         | -           | CB          | 100        | 50 / 2               |                      |                    |                                    |

Refusal at 10.0 feet.  
Approximate bottom of borehole at 10.0 feet.



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

# BORING NUMBER 6

PAGE 1 OF 1

CLIENT Parker Center, LLC  
PROJECT NUMBER 21.22.318  
DATE STARTED 1/5/22 COMPLETED 1/5/22  
DRILLING CONTRACTOR Vine Laboratories  
DRILLING METHOD CME-55 / Solid Stem Auger  
HAMMER TYPE Automatic  
LOGGED BY TMC CHECKED BY AG

PROJECT NAME Proposed Mixed-Use Development  
PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado  
GROUND SURFACE ELEV. Not Provided PROPOSED ELEV. Not Provided  
SURFACE CONDITIONS Low to tall growth of grass and weeds  
GROUND WATER LEVELS:  
▽ DURING DRILLING None  
▽ AFTER DRILLING 31.00 ft - 1/18/22

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ

| GRAPHIC LOG | MATERIAL DESCRIPTION                                                             | DEPTH (ft) | USCS SYMBOL | SAMPLE TYPE | RECOVERY % | PENETRATION blows/in | MOISTURE CONTENT (%) | DRY UNIT WT. (pcf) | SWELL-CONSOL /SURCHARGE LOAD, %psf |
|-------------|----------------------------------------------------------------------------------|------------|-------------|-------------|------------|----------------------|----------------------|--------------------|------------------------------------|
|             |                                                                                  | 0          |             |             |            |                      |                      |                    |                                    |
|             | <b>SANDY LEAN CLAY</b> , brown, dry to moist, very stiff                         |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  |            | CL          | CB          | 100        | 32 / 12              | 11.1                 | 93                 | +3.3/200                           |
|             | <b>SANDSTONE BEDROCK</b> , fine- to medium-grained, tan, dry to moist, very hard | 5          | -           | CB          | 100        | 50 / 4               | 6.3                  | 110                |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  | 10         | -           | CB          | 100        | 50 / 1               | 5.4                  |                    |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  | 15         | -           | CB          | 100        | 50 / 2               | 5.4                  | 125                |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  | 20         | -           | CB          | 100        | 50 / 2               | 6.4                  | 123                |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             | <b>CLAYSTONE BEDROCK</b> , brown, olive-brown, moist, hard to very hard          | 25         | -           | CB          | 100        | 50 / 6               | 23.0                 | 103                |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  | 30         |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  |            |             |             |            |                      |                      |                    |                                    |
|             |                                                                                  | 35         | -           | CB          | 100        | 50 / 7               | 26.3                 | 100                |                                    |

Approximate bottom of borehole at 35.0 feet.

## **APPENDIX B**

### **LABORATORY TEST RESULTS**







Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

## SWELL/CONSOLIDATION TEST

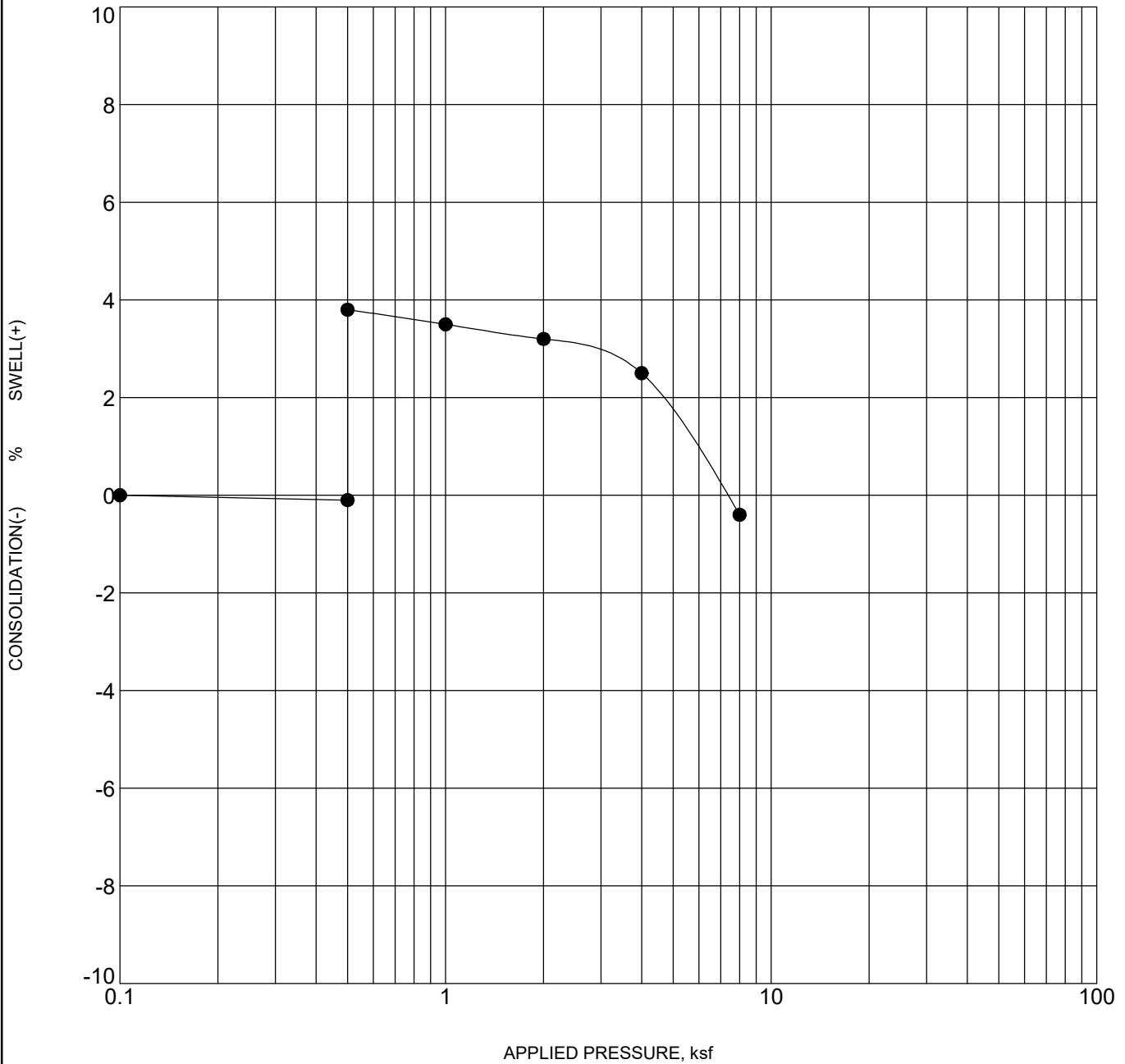
CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

CONSOL STRAIN SINGLE - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ



| BOREHOLE | DEPTH | Classification          | $\gamma_d$ | MC% |
|----------|-------|-------------------------|------------|-----|
| ● 1      | 4.0   | SANDY CLAYSTONE BEDROCK | 119        | 10  |

Note: Water Added to Sample at 500 psf.

Date: 1/13/21



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

## SWELL/CONSOLIDATION TEST

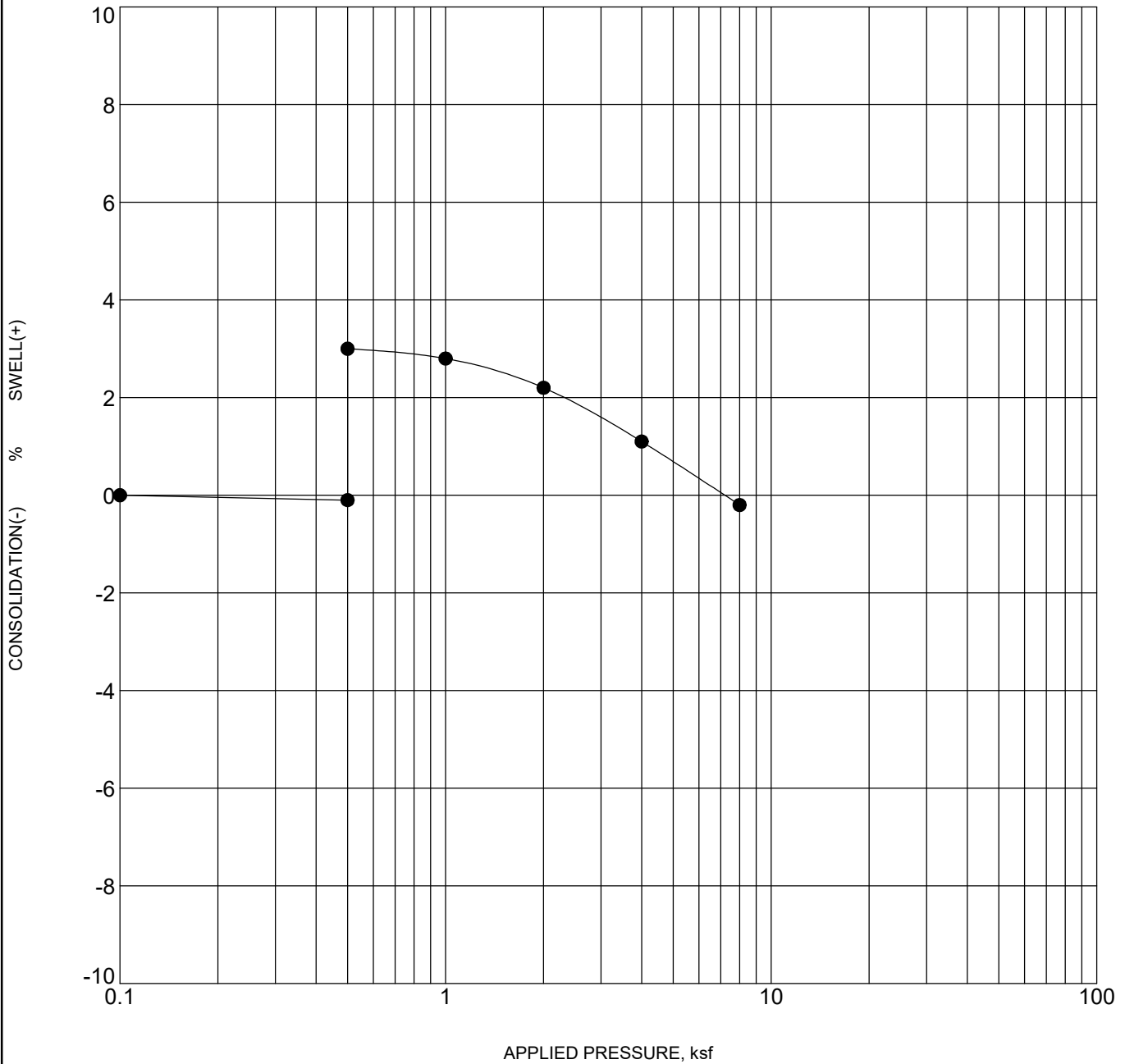
CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

CONSOL STRAIN SINGLE - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ



| BOREHOLE | DEPTH | Classification  | $\gamma_d$ | MC% |
|----------|-------|-----------------|------------|-----|
| ● 2      | 4.0   | SANDY LEAN CLAY | 110        | 17  |

Note: Water Added to Sample at 500 psf.

Date: 1/14/21



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

## SWELL/CONSOLIDATION TEST

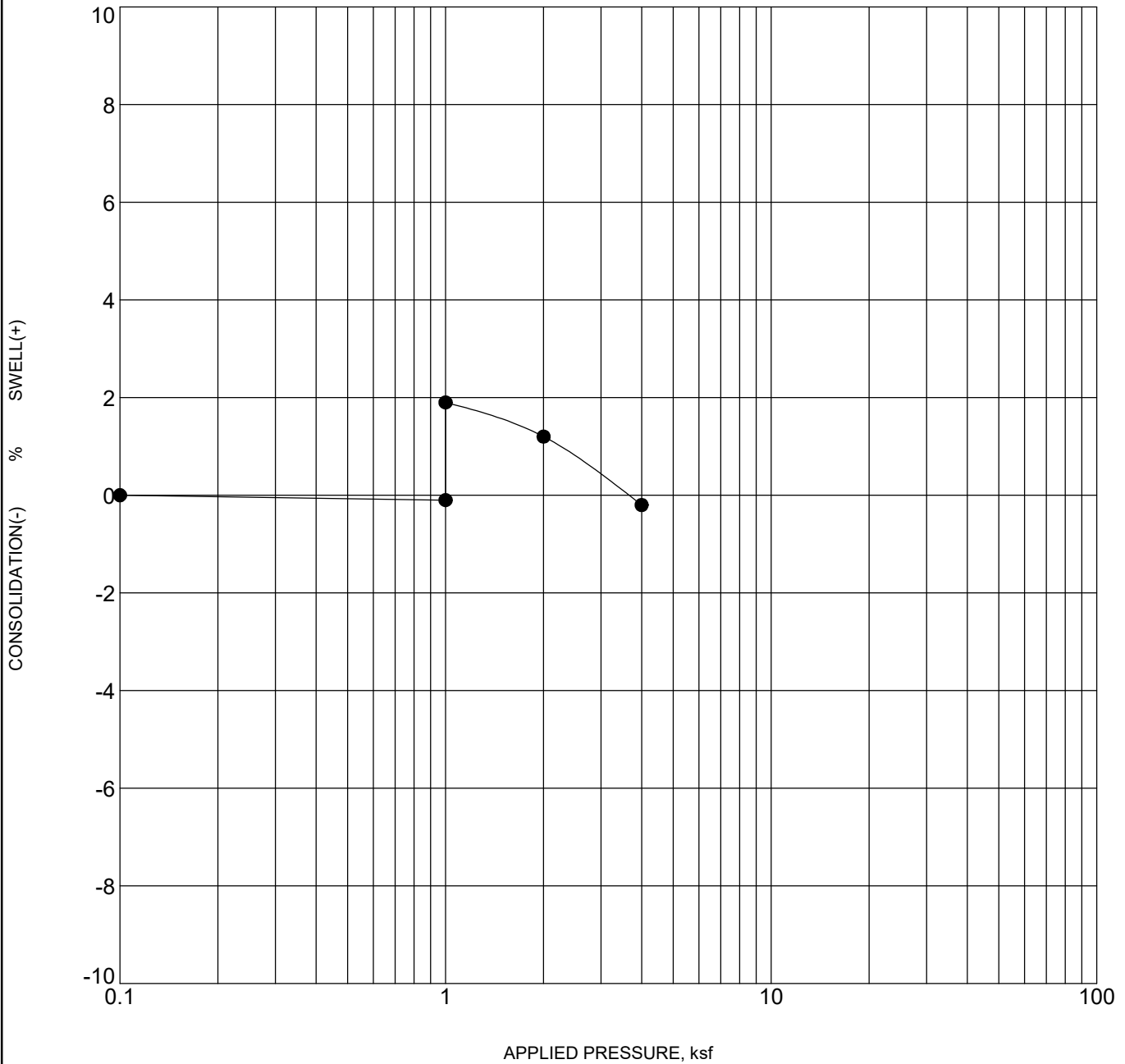
CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

CONSOL STRAIN SINGLE - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ



| BOREHOLE | DEPTH | Classification    | $\gamma_d$ | MC% |
|----------|-------|-------------------|------------|-----|
| ● 2      | 14.0  | CLAYSTONE BEDROCK | 95         | 25  |

Note: Water Added to Sample at 1000 psf.

Date: 1/14/21



Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

## SWELL/CONSOLIDATION TEST

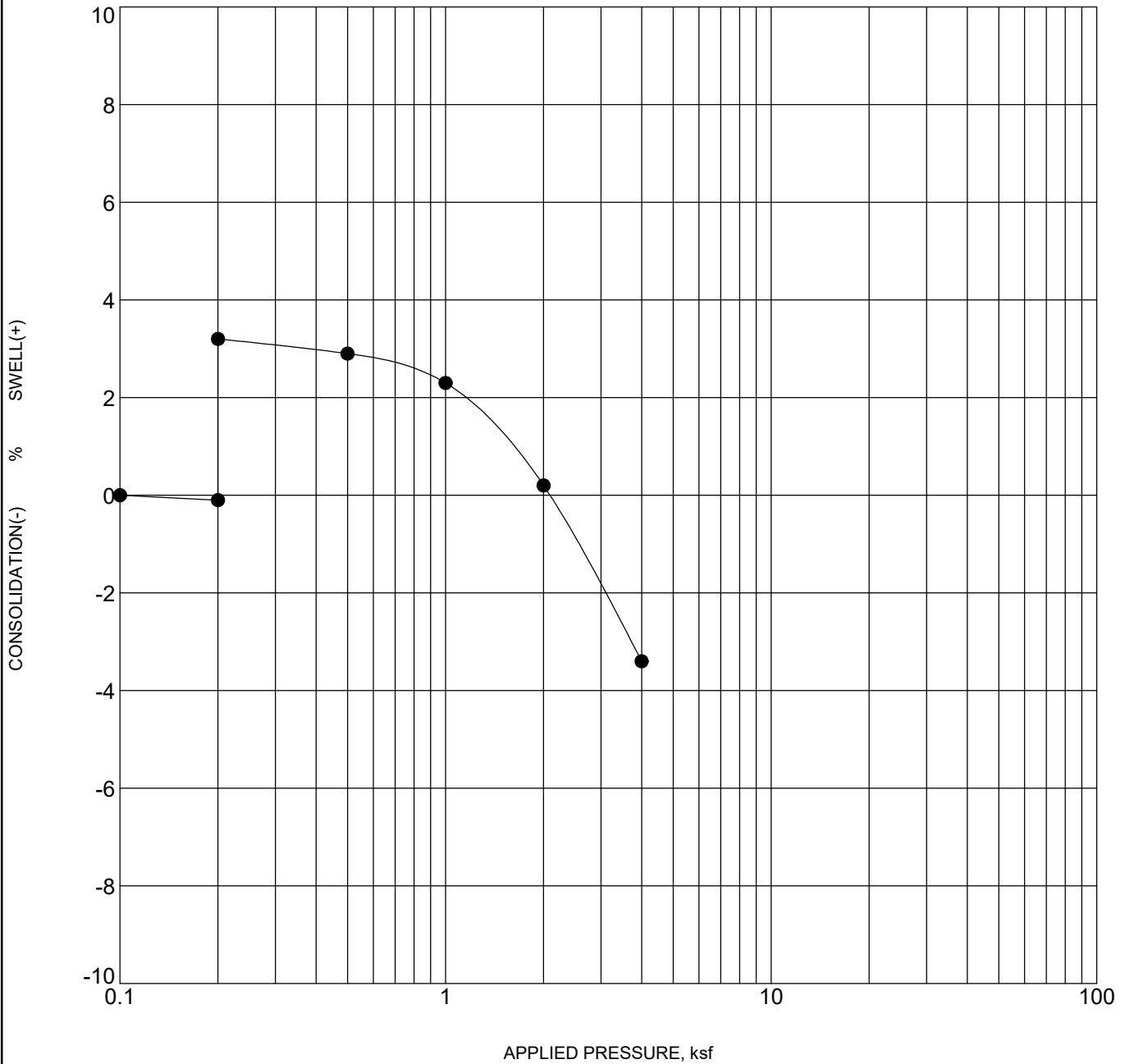
CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

CONSOL STRAIN SINGLE - GINT STD US LAB.GDT - 2/3/22 15:35 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ



| BOREHOLE | DEPTH | Classification  | $\gamma_d$ | MC% |
|----------|-------|-----------------|------------|-----|
| ● 6      | 2.0   | SANDY LEAN CLAY | 93         | 11  |

Note: Water Added to Sample at 200 psf.

Date: 1/14/21





Cole Garner Geotechnical  
1070 W 124th Ave Suite 300  
Westminster, CO 80234  
Telephone: 303-996-2999

# SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

CLIENT Parker Center, LLC

PROJECT NAME Proposed Mixed-Use Development

PROJECT NUMBER 21.22.318

PROJECT LOCATION 895 North Ridge Road - Castle Rock, Colorado

| Borehole | Depth | Soil Description               | Water Content (%) | Dry Density (pcf) | Swell (+) or Consolidation (-)/ Surcharge (%/psf) | Water Soluble Sulfates (ppm) | Passing #200 Sieve (%) | Atterberg Limits |               |                  |
|----------|-------|--------------------------------|-------------------|-------------------|---------------------------------------------------|------------------------------|------------------------|------------------|---------------|------------------|
|          |       |                                |                   |                   |                                                   |                              |                        | Liquid Limit     | Plastic Limit | Plasticity Index |
| 1        | 2     | SANDY LEAN CLAY                | 9.7               |                   |                                                   |                              |                        |                  |               |                  |
| 1        | 4     | SANDY CLAYSTONE BEDROCK        | 9.8               | 119.1             | +3.9/500                                          |                              |                        |                  |               |                  |
| 1        | 9     | SANDSTONE BEDROCK              | 8.2               |                   |                                                   |                              |                        |                  |               |                  |
| 2        | 4     | SANDY LEAN CLAY                | 17.5              | 110.4             | +3.1/500                                          |                              |                        |                  |               |                  |
| 2        | 9     | CLAYSTONE BEDROCK              | 23.9              | 103.2             |                                                   |                              |                        |                  |               |                  |
| 2        | 14    | CLAYSTONE BEDROCK              | 24.9              | 94.7              | +2.0/1000                                         |                              |                        |                  |               |                  |
| 2        | 19    | CLAYSTONE BEDROCK              | 24.8              | 101.2             |                                                   |                              |                        |                  |               |                  |
| 2        | 24    | CLAYSTONE BEDROCK              | 28.5              | 96.3              |                                                   |                              |                        |                  |               |                  |
| 2        | 29    | CLAYSTONE BEDROCK              | 22.7              | 105.1             |                                                   |                              |                        |                  |               |                  |
| 2        | 34    | CLAYSTONE BEDROCK              | 15.6              | 114.0             |                                                   |                              |                        |                  |               |                  |
| 3        | 2     | LEAN CLAY with SAND(CL)        | 4.7               |                   |                                                   | 100                          | 72                     | 42               | 19            | 23               |
| 3        | 4     | WEATHERED SANDSTONE BEDROCK    | 12.2              | 106.6             |                                                   |                              |                        |                  |               |                  |
| 3        | 9     | SANDSTONE BEDROCK              | 7.3               |                   |                                                   |                              |                        |                  |               |                  |
| 4        | 2     | SANDY LEAN CLAY                | 10.5              |                   |                                                   |                              |                        |                  |               |                  |
| 4        | 4     | CLAYSTONE BEDROCK              | 10.6              |                   |                                                   |                              | 60                     | 39               | 20            | 19               |
| 5        | 0     | SANDY LEAN CLAY                | 8.5               |                   |                                                   |                              |                        |                  |               |                  |
| 5        | 2     | CLAYSTONE BEDROCK              | 8.6               |                   |                                                   |                              | 57                     | 36               | 20            | 16               |
| 5        | 4     | CLAYSTONE to SANDSTONE BEDROCK | 9.9               | 111.8             |                                                   |                              |                        |                  |               |                  |
| 6        | 2     | SANDY LEAN CLAY                | 11.1              | 93.1              | +3.3/200                                          |                              |                        |                  |               |                  |
| 6        | 4     | SANDSTONE BEDROCK              | 6.3               | 110.4             |                                                   |                              |                        |                  |               |                  |
| 6        | 9     | SANDSTONE BEDROCK              | 5.4               |                   |                                                   |                              |                        |                  |               |                  |
| 6        | 14    | SANDSTONE BEDROCK              | 5.4               | 124.6             |                                                   |                              |                        |                  |               |                  |
| 6        | 19    | SANDSTONE BEDROCK              | 6.4               | 123.5             |                                                   |                              |                        |                  |               |                  |
| 6        | 24    | CLAYSTONE BEDROCK              | 23.0              | 103.4             |                                                   |                              |                        |                  |               |                  |
| 6        | 34    | CLAYSTONE BEDROCK              | 26.3              | 99.8              |                                                   |                              |                        |                  |               |                  |

LAB SUMMARY - GINT STD US LAB.GDT - 2/3/22 15:37 - Y:\GINT BACKUPS\MAIN TRANSFER 10.28\PROJECTS GEO 2021\21.22.318 895 N RIDGE PRELIM.GPJ

## **APPENDIX C**

### **GENERAL NOTES FOUNDATION DRAIN DETAILS**



## GENERAL NOTES

### DRILLING & SAMPLING SYMBOLS:

|     |                                                                   |     |                           |
|-----|-------------------------------------------------------------------|-----|---------------------------|
| SS: | Split Spoon - 1½" I.D., 2" O.D., unless otherwise noted           | HS: | Hollow Stem Auger         |
| ST: | Thin-Walled Tube – 2.5" O.D., unless otherwise noted              | PA: | Power Auger               |
| RS: | Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted        | HA: | Hand Auger                |
| CB: | California Barrel - 1.92" I.D., 2.5" O.D., unless otherwise noted | RB: | Rock Bit                  |
| BS: | Bulk Sample or Auger Sample                                       | WB: | Wash Boring or Mud Rotary |

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". For 2.5" O.D. California Barrel samplers (CB) the penetration value is reported as the number of blows required to advance the sampler 12 inches using a 140-pound hammer falling 30 inches, reported as "blows per inch," and is not considered equivalent to the "Standard Penetration" or "N-value".

### WATER LEVEL MEASUREMENT SYMBOLS:

|      |              |      |                       |
|------|--------------|------|-----------------------|
| WL:  | Water Level  | WS:  | While Sampling        |
| WCI: | Wet Cave in  | WD:  | While Drilling        |
| DCI: | Dry Cave in  | BCR: | Before Casing Removal |
| AB:  | After Boring | ACR: | After Casing Removal  |

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

**DESCRIPTIVE SOIL CLASSIFICATION:** Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

#### FINE-GRAINED SOILS

| <u>(CB)</u><br><u>Blows/Ft.</u> | <u>(SS)</u><br><u>Blows/Ft.</u> | <u>Consistency</u> |
|---------------------------------|---------------------------------|--------------------|
| < 3                             | 0-2                             | Very Soft          |
| 3-5                             | 3-4                             | Soft               |
| 6-10                            | 5-8                             | Medium Stiff       |
| 11-18                           | 9-15                            | Stiff              |
| 19-36                           | 16-30                           | Very Stiff         |
| > 36                            | > 30                            | Hard               |

#### COARSE-GRAINED SOILS

| <u>(CB)</u><br><u>Blows/Ft.</u> | <u>(SS)</u><br><u>Blows/Ft.</u> | <u>Relative</u><br><u>Density</u> |
|---------------------------------|---------------------------------|-----------------------------------|
| 0-5                             | < 3                             | Very Loose                        |
| 6-14                            | 4-9                             | Loose                             |
| 15-46                           | 10-29                           | Medium Dense                      |
| 47-79                           | 30-50                           | Dense                             |
| > 79                            | > 50                            | Very Dense                        |

#### BEDROCK

| <u>(CB)</u><br><u>Blows/Ft.</u> | <u>(SS)</u><br><u>Blows/Ft.</u> | <u>Consistency</u> |
|---------------------------------|---------------------------------|--------------------|
| < 24                            | < 20                            | Weathered          |
| 24-35                           | 20-29                           | Firm               |
| 36-60                           | 30-49                           | Medium Hard        |
| 61-96                           | 50-79                           | Hard               |
| > 96                            | > 79                            | Very Hard          |

#### RELATIVE PROPORTIONS OF SAND AND GRAVEL

| <u>Descriptive Terms of</u><br><u>Other Constituents</u> | <u>Percent of</u><br><u>Dry Weight</u> |
|----------------------------------------------------------|----------------------------------------|
| Trace                                                    | < 15                                   |
| With                                                     | 15 – 29                                |
| Modifier                                                 | > 30                                   |

#### GRAIN SIZE TERMINOLOGY

| <u>Major Component</u><br><u>of Sample</u> | <u>Particle Size</u>                 |
|--------------------------------------------|--------------------------------------|
| Boulders                                   | Over 12 in. (300mm)                  |
| Cobbles                                    | 12 in. to 3 in. (300mm to 75 mm)     |
| Gravel                                     | 3 in. to #4 sieve (75mm to 4.75 mm)  |
| Sand                                       | #4 to #200 sieve (4.75mm to 0.075mm) |
| Silt or Clay                               | Passing #200 Sieve (0.075mm)         |

#### RELATIVE PROPORTIONS OF FINES

| <u>Descriptive Terms of</u><br><u>Other Constituents</u> | <u>Percent of</u><br><u>Dry Weight</u> |
|----------------------------------------------------------|----------------------------------------|
| Trace                                                    | < 5                                    |
| With                                                     | 5 – 12                                 |
| Modifiers                                                | > 12                                   |

#### PLASTICITY DESCRIPTION

| <u>Term</u> | <u>Plasticity Index</u> |
|-------------|-------------------------|
| Non-plastic | 0                       |
| Low         | 1-10                    |
| Medium      | 11-30                   |
| High        | 30+                     |

# UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests<sup>A</sup>

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup> |                                                                     |                                                           |                                                    |    | Soil Classification               |                         |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------|----|-----------------------------------|-------------------------|
|                                                                                          |                                                                     |                                                           |                                                    |    | Group Symbol                      | Group Name <sup>B</sup> |
| Coarse Grained Soils<br><br>More than 50% retained on No. 200 sieve                      | Gravels<br>More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels<br>Less than 5% fines <sup>C</sup>          | Cu ≥ 4 and 1 ≤ Cc ≤ 3 <sup>E</sup>                 | GW | Well graded gravel <sup>F</sup>   |                         |
|                                                                                          |                                                                     |                                                           | Cu < 4 and/or 1 > Cc > 3 <sup>E</sup>              | GP | Poorly graded gravel <sup>F</sup> |                         |
|                                                                                          |                                                                     | Gravels with Fines More than 12% fines <sup>C</sup>       | Fines classify as ML or MH                         | GM | Silty gravel <sup>F,G,H</sup>     |                         |
|                                                                                          |                                                                     |                                                           | Fines classify as CL or CH                         | GC | Clayey gravel <sup>F,G,H</sup>    |                         |
|                                                                                          | Sands<br>50% or more of coarse fraction passes No. 4 sieve          | Clean Sands<br>Less than 5% fines <sup>D</sup>            | Cu ≥ 6 and 1 ≤ Cc ≤ 3 <sup>E</sup>                 | SW | Well graded sand <sup>I</sup>     |                         |
|                                                                                          |                                                                     |                                                           | Cu < 6 and/or 1 > Cc > 3 <sup>E</sup>              | SP | Poorly graded sand <sup>I</sup>   |                         |
|                                                                                          |                                                                     | Sands with Fines<br>More than 12% fines <sup>D</sup>      | Fines classify as ML or MH                         | SM | Silty sand <sup>G,H,I</sup>       |                         |
|                                                                                          |                                                                     |                                                           | Fines classify as CL or CH                         | SC | Clayey sand <sup>G,H,I</sup>      |                         |
| Fine-Grained Soils<br>50% or more passes the No. 200 sieve                               | Silts and Clays<br>Liquid limit less than 50                        | Inorganic                                                 | PI > 7 and plots on or above “A” line <sup>J</sup> | CL | Lean clay <sup>K,L,M</sup>        |                         |
|                                                                                          |                                                                     |                                                           | PI < 4 or plots below “A” line <sup>J</sup>        | ML | Silt <sup>K,L,M</sup>             |                         |
|                                                                                          |                                                                     | Organic                                                   | <b>Liquid limit - oven dried</b> < 0.75            | OL | Organic clay <sup>K,L,M,N</sup>   |                         |
|                                                                                          |                                                                     |                                                           | <b>Liquid limit - not dried</b>                    |    | Organic silt <sup>K,L,M,O</sup>   |                         |
|                                                                                          | Silts and Clays<br>Liquid limit 50 or more                          | Inorganic                                                 | PI plots on or above “A” line                      | CH | Fat clay <sup>K,L,M</sup>         |                         |
|                                                                                          |                                                                     |                                                           | PI plots below “A” line                            | MH | Elastic silt <sup>K,L,M</sup>     |                         |
|                                                                                          |                                                                     | Organic                                                   | <b>Liquid limit - oven dried</b> < 0.75            | OH | Organic clay <sup>K,L,M,P</sup>   |                         |
|                                                                                          |                                                                     |                                                           | <b>Liquid limit - not dried</b>                    |    | Organic silt <sup>K,L,M,Q</sup>   |                         |
| Highly organic soils                                                                     |                                                                     | Primarily organic matter, dark in color, and organic odor |                                                    | PT | Peat                              |                         |

<sup>A</sup>Based on the material passing the 3-in. (75-mm) sieve

<sup>B</sup>If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup>Gravels with 5 to 12% fines require dual symbols: GW-GM well graded gravel with silt, GW-GC well graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

<sup>D</sup>Sands with 5 to 12% fines require dual symbols: SW-SM well graded sand with silt, SW-SC well graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

<sup>F</sup>If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>G</sup>If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup>If fines are organic, add "with organic fines" to group name.

<sup>I</sup>If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>J</sup>If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

<sup>K</sup>If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>L</sup>If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.

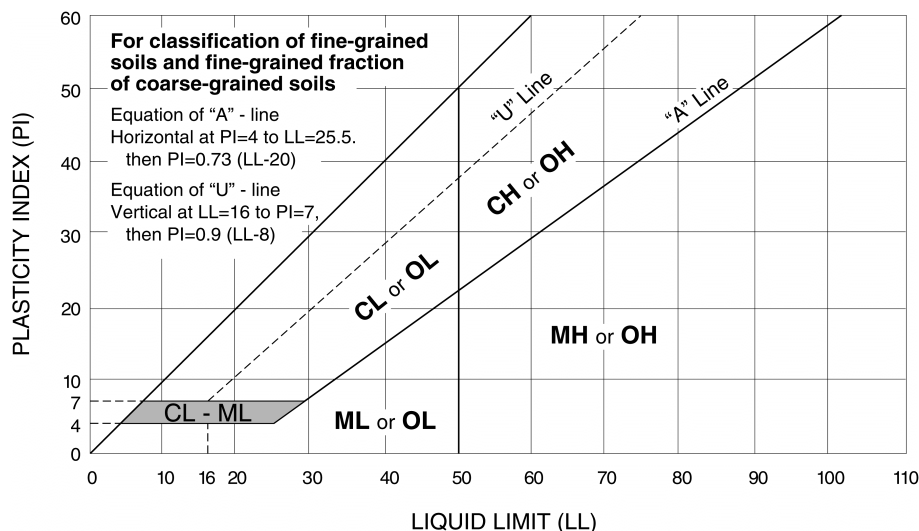
<sup>M</sup>If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup> $PI \geq 4$  and plots on or above "A" line.

<sup>O</sup> $PI < 4$  or plots below "A" line.

<sup>P</sup> $PI$  plots on or above "A" line.

<sup>Q</sup> $PI$  plots below "A" line.





# ROCK CLASSIFICATION

(Based on ASTM C-294)

## Sedimentary Rocks

Sedimentary rocks are stratified materials laid down by water or wind. The sediments may be composed of particles or pre-existing rocks derived by mechanical weathering, evaporation or by chemical or organic origin. The sediments are usually indurated by cementation or compaction.

|                     |                                                                                                                                                                                                                                                                                  |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Chert</b>        | Very fine-grained siliceous rock composed of micro-crystalline or cryptocrystalline quartz, chalcedony or opal. Chert is various colored, porous to dense, hard and has a conchoidal to splintery fracture.                                                                      |
| <b>Claystone</b>    | Fine-grained rock composed of or derived by erosion of silts and clays or any rock containing clay. Soft massive and may contain carbonate minerals.                                                                                                                             |
| <b>Conglomerate</b> | Rock consisting of a considerable amount of rounded gravel, sand and cobbles with or without interstitial or cementing material. The cementing or interstitial material may be quartz, opal, calcite, dolomite, clay, iron oxides or other materials.                            |
| <b>Dolomite</b>     | A fine-grained carbonate rock consisting of the mineral dolomite $[\text{CaMg}(\text{CO}_3)_2]$ . May contain noncarbonate impurities such as quartz, chert, clay minerals, organic matter, gypsum and sulfides. Reacts with hydrochloric acid (HCL).                            |
| <b>Limestone</b>    | A fine-grained carbonate rock consisting of the mineral calcite ( $\text{CaCO}_3$ ). May contain noncarbonate impurities such as quartz, chert, clay minerals, organic matter, gypsum and sulfides. Reacts with hydrochloric acid (HCL).                                         |
| <b>Sandstone</b>    | Rock consisting of particles of sand with or without interstitial and cementing materials. The cementing or interstitial material may be quartz, opal, calcite, dolomite, clay, iron oxides or other material.                                                                   |
| <b>Shale</b>        | Fine-grained rock composed of or derived by erosion of silts and clays or any rock containing clay. Shale is hard, platy, of fissile may be gray, black, reddish or green and may contain some carbonate minerals (calcareous shale).                                            |
| <b>Siltstone</b>    | Fine grained rock composed of or derived by erosion of silts or rock containing silt. Siltstones consist predominantly of silt sized particles (0.0625 to 0.002 mm in diameter) and are intermediate rocks between claystones and sandstones and may contain carbonate minerals. |

**LABORATORY TEST  
SIGNIFICANCE AND PURPOSE**

| <b>TEST</b>                                                | <b>SIGNIFICANCE</b>                                                                                                                                                                    | <b>PURPOSE</b>                                                         |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| <b><i>California Bearing Ratio</i></b>                     | Used to evaluate the potential strength of subgrade soil, subbase, and base course material, including recycled materials for use in road and airfield pavements.                      | <b><i>Pavement Thickness Design</i></b>                                |
| <b><i>Consolidation</i></b>                                | Used to develop an estimate of both the rate and amount of both differential and total settlement of a structure.                                                                      | <b><i>Foundation Design</i></b>                                        |
| <b><i>Direct Shear</i></b>                                 | Used to determine the consolidated drained shear strength of soil or rock.                                                                                                             | <b><i>Bearing Capacity, Foundation Design, and Slope Stability</i></b> |
| <b><i>Dry Density</i></b>                                  | Used to determine the in-place density of natural, inorganic, fine-grained soils.                                                                                                      | <b><i>Index Property Soil Behavior</i></b>                             |
| <b><i>Expansion</i></b>                                    | Used to measure the expansive potential of fine-grained soil and to provide a basis for swell potential classification.                                                                | <b><i>Foundation and Slab Design</i></b>                               |
| <b><i>Gradation</i></b>                                    | Used for the quantitative determination of the distribution of particle sizes in soil.                                                                                                 | <b><i>Soil Classification</i></b>                                      |
| <b><i>Liquid &amp; Plastic Limit, Plasticity Index</i></b> | Used as an integral part of engineering classification systems to characterize the fine-grained fraction of soils, and to specify the fine-grained fraction of construction materials. | <b><i>Soil Classification</i></b>                                      |
| <b><i>Permeability</i></b>                                 | Used to determine the capacity of soil or rock to conduct a liquid or gas.                                                                                                             | <b><i>Groundwater Flow Analysis</i></b>                                |
| <b><i>pH</i></b>                                           | Used to determine the degree of acidity or alkalinity of a soil.                                                                                                                       | <b><i>Corrosion Potential</i></b>                                      |
| <b><i>Resistivity</i></b>                                  | Used to indicate the relative ability of a soil medium to carry electrical currents.                                                                                                   | <b><i>Corrosion Potential</i></b>                                      |
| <b><i>R-Value</i></b>                                      | Used to evaluate the potential strength of subgrade soil, subbase, and base course material, including recycled materials for use in road and airfield pavements.                      | <b><i>Pavement Thickness Design</i></b>                                |
| <b><i>Soluble Sulfate</i></b>                              | Used to determine the quantitative amount of soluble sulfates within a soil mass.                                                                                                      | <b><i>Corrosion Potential</i></b>                                      |
| <b><i>Unconfined Compression</i></b>                       | To obtain the approximate compressive strength of soils that possess sufficient cohesion to permit testing in the unconfined state.                                                    | <b><i>Bearing Capacity Analysis for Foundations</i></b>                |
| <b><i>Water Content</i></b>                                | Used to determine the quantitative amount of water in a soil mass.                                                                                                                     | <b><i>Index Property Soil Behavior</i></b>                             |

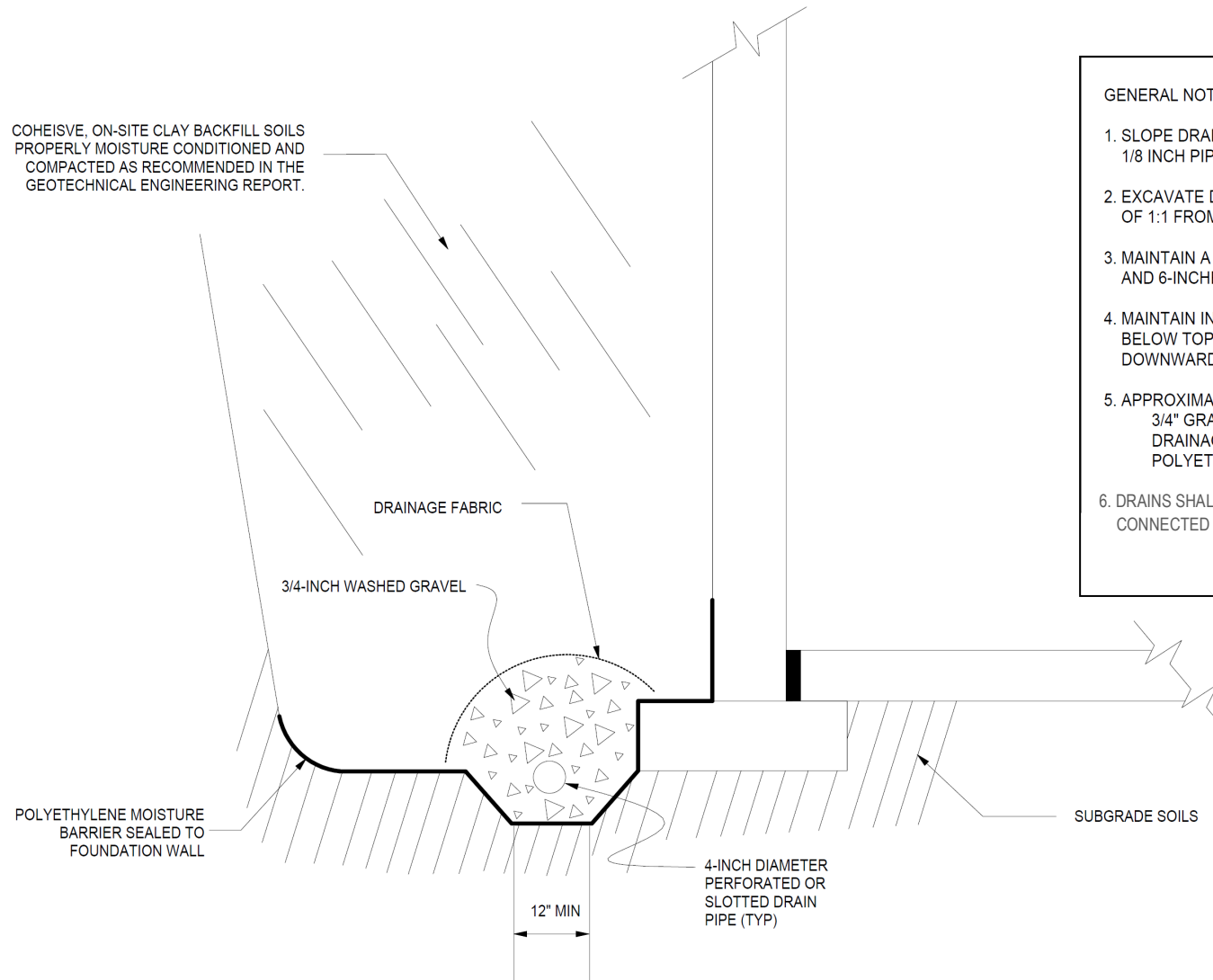
## REPORT TERMINOLOGY (Based on ASTM D653)

|                                                |                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>Allowable Soil Bearing Capacity</i></b>  | The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.                                                                                                                                                                                                                |
| <b><i>Alluvium</i></b>                         | Soil, the constituents of which have been transported in suspension by flowing water and subsequently deposited by sedimentation.                                                                                                                                                                                                       |
| <b><i>Aggregate Base Course</i></b>            | A layer of specified material placed on a subgrade or subbase usually beneath slabs or pavements.                                                                                                                                                                                                                                       |
| <b><i>Backfill</i></b>                         | A specified material placed and compacted in a confined area.                                                                                                                                                                                                                                                                           |
| <b><i>Bedrock</i></b>                          | A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.                                                                                                                                           |
| <b><i>Bench</i></b>                            | A horizontal surface in a sloped deposit.                                                                                                                                                                                                                                                                                               |
| <b><i>Caisson (Drilled Pier or Shaft)</i></b>  | A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier or drilled shaft.                                                                                                                                                                            |
| <b><i>Coefficient of Friction</i></b>          | A constant proportionality factor relating normal stress and the corresponding shear stress at which sliding starts between the two surfaces.                                                                                                                                                                                           |
| <b><i>Colluvium</i></b>                        | Soil, the constituents of which have been deposited chiefly by gravity such as at the foot of a slope or cliff.                                                                                                                                                                                                                         |
| <b><i>Compaction</i></b>                       | The densification of a soil by means of mechanical manipulation                                                                                                                                                                                                                                                                         |
| <b><i>Concrete Slab-on-Grade</i></b>           | A concrete surface layer cast directly upon a base, subbase or subgrade, and typically used as a floor system.                                                                                                                                                                                                                          |
| <b><i>Differential Movement</i></b>            | Unequal settlement or heave between, or within foundation elements of structure.                                                                                                                                                                                                                                                        |
| <b><i>Earth Pressure</i></b>                   | The pressure exerted by soil on any boundary such as a foundation wall.                                                                                                                                                                                                                                                                 |
| <b><i>ESAL</i></b>                             | Equivalent Single Axle Load, a criteria used to convert traffic to a uniform standard, (18,000 pound axle loads).                                                                                                                                                                                                                       |
| <b><i>Engineered Fill</i></b>                  | Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a geotechnical engineer.                                                                                                                                                                              |
| <b><i>Equivalent Fluid</i></b>                 | A hypothetical fluid having a unit weight such that it will produce a pressure against a lateral support presumed to be equivalent to that produced by the actual soil. This simplified approach is valid only when deformation conditions are such that the pressure increases linearly with depth and the wall friction is neglected. |
| <b><i>Existing Fill (or Man-Made Fill)</i></b> | Materials deposited throughout the action of man prior to exploration of the site.                                                                                                                                                                                                                                                      |
| <b><i>Existing Grade</i></b>                   | The ground surface at the time of field exploration.                                                                                                                                                                                                                                                                                    |

## REPORT TERMINOLOGY (Based on ASTM D653)

|                                          |                                                                                                                                                                                    |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>Expansive Potential</i></b>        | The potential of a soil to expand (increase in volume) due to absorption of moisture.                                                                                              |
| <b><i>Finished Grade</i></b>             | The final grade created as a part of the project.                                                                                                                                  |
| <b><i>Footing</i></b>                    | A portion of the foundation of a structure that transmits loads directly to the soil.                                                                                              |
| <b><i>Foundation</i></b>                 | The lower part of a structure that transmits the loads to the soil or bedrock.                                                                                                     |
| <b><i>Frost Depth</i></b>                | The depth at which the ground becomes frozen during the winter season.                                                                                                             |
| <b><i>Grade Beam</i></b>                 | A foundation element or wall, typically constructed of reinforced concrete, used to span between other foundation elements such as drilled piers.                                  |
| <b><i>Groundwater</i></b>                | Subsurface water found in the zone of saturation of soils or within fractures in bedrock.                                                                                          |
| <b><i>Heave</i></b>                      | Upward movement.                                                                                                                                                                   |
| <b><i>Lithologic</i></b>                 | The characteristics which describe the composition and texture of soil and rock by observation.                                                                                    |
| <b><i>Native Grade</i></b>               | The naturally occurring ground surface.                                                                                                                                            |
| <b><i>Native Soil</i></b>                | Naturally occurring on-site soil, sometimes referred to as natural soil.                                                                                                           |
| <b><i>Optimum Moisture Content</i></b>   | The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.                                                                      |
| <b><i>Perched Water</i></b>              | Groundwater, usually of limited area maintained above a normal water elevation by the presence of an intervening relatively impervious continuous stratum.                         |
| <b><i>Scarify</i></b>                    | To mechanically loosen soil or break down existing soil structure.                                                                                                                 |
| <b><i>Settlement</i></b>                 | Downward movement.                                                                                                                                                                 |
| <b><i>Skin Friction (Side Shear)</i></b> | The frictional resistance developed between soil and an element of the structure such as a drilled pier.                                                                           |
| <b><i>Soil (Earth)</i></b>               | Sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter. |
| <b><i>Strain</i></b>                     | The change in length per unit of length in a given direction.                                                                                                                      |
| <b><i>Stress</i></b>                     | The force per unit area acting within a soil mass.                                                                                                                                 |
| <b><i>Strip</i></b>                      | To remove from present location.                                                                                                                                                   |
| <b><i>Subbase</i></b>                    | A layer of specified material in a pavement system between the subgrade and base course.                                                                                           |
| <b><i>Subgrade</i></b>                   | The soil prepared and compacted to support a structure, slab or pavement system.                                                                                                   |

COHESIVE, ON-SITE CLAY BACKFILL SOILS  
PROPERLY MOISTURE CONDITIONED AND  
COMPACTED AS RECOMMENDED IN THE  
GEOTECHNICAL ENGINEERING REPORT.



#### GENERAL NOTES:

1. SLOPE DRAIN TRENCH AND PIPE AT A MINIMUM OF 1/8 INCH PER LINEAL FOOT TO SUITABLE OUTFALL.
2. EXCAVATE DRAIN TRENCH AT A MAXIMUM SLOPE OF 1:1 FROM EDGE OF FOOTING.
3. MAINTAIN A MINIMUM OF 3-INCHES OF GRAVEL BELOW AND 6-INCHES ABOVE DRAIN PIPES.
4. MAINTAIN INVERT OF DRAIN PIPE A MINIMUM OF 6 INCHES BELOW TOP OF FOOTING. PERFORATIONS SHOULD BE FACING DOWNWARD.
5. APPROXIMATE QUANTITIES (PER LINEAL FOOT):  
3/4" GRAVEL - 1 1/2 CUBIC FT.  
DRAINAGE FABRIC - 2 SQUARE FT.  
POLYETHYLENE - 6 SQUARE FT.
6. DRAINS SHALL BE INSTALLED IN WINDOW WELLS AND CONNECTED TO DISCHARGE INTO FOUNDATION DRAIN SYSTEM

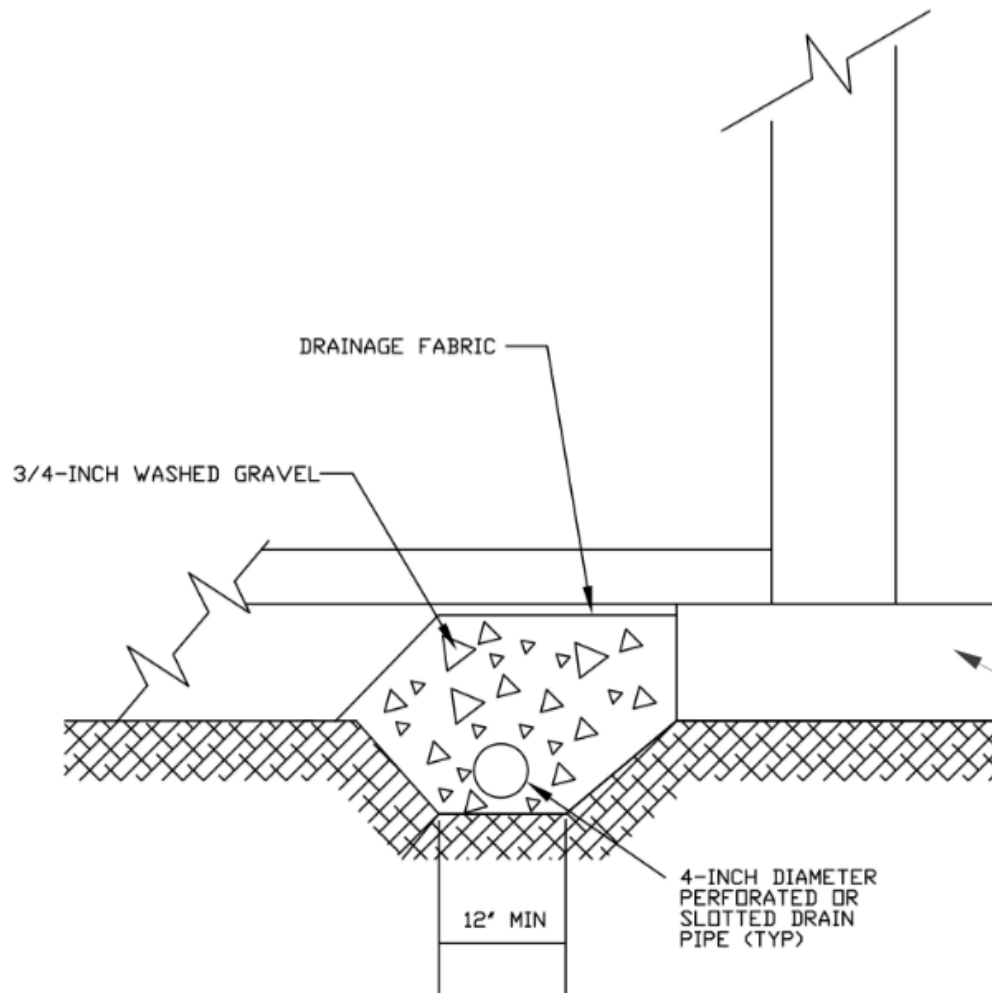
NOT TO SCALE

#### TYPICAL EXTERIOR PERIMETER DRAIN DETAIL FOOTING FOUNDATION



**Cole Garner Geotechnical**  
1070 W. 124<sup>th</sup> Ave., Suite 300  
Westminster, CO 80234  
(303) 996-2999





GENERAL NOTES:

1. SLOPE DRAIN TRENCH AND PIPE AT A MINIMUM OF 1/8 INCH PIPE PER LINEAL FOOT TO SUITABLE OUTFALL.
2. EXCAVATE DRAIN TRENCH AT A MAXIMUM SLOPE OF 1:1 FROM EDGE OF FOOTING.
3. MAINTAIN A MINIMUM OF 3-INCHES OF GRAVEL BELOW AND 6-INCHES ABOVE DRAIN PIPES.
4. MAINTAIN INVERT OF DRAIN A MINIMUM OF 6 INCHES BELOW TOP OF FLOOR SLAB.
5. APPROXIMATE QUANTITIES (PER LINEAL FOOT):  
3/4" GRAVEL - 1 1/2 CUBIC FT.  
FABRIC - 2 SQUARE FT.
6. DRAINS SHALL BE INSTALLED IN WINDOW WELLS AND CONNECTED TO DISCHARGE INTO FOUNDATION DRAIN SYSTEM

NOT TO SCALE

**TYPICAL INTERIOR  
PERIMETER DRAIN DETAIL  
FOOTING FOUNDATION**



**Cole Garner Geotechnical**  
1070 W. 124<sup>th</sup> Ave., Suite 300  
Westminster, CO 80234  
(303) 996-2999