ROCKY MOUNTAIN GROUP

GEOTECHNICAL REPORT

Carriage Meadows North Filing No. 1
Detention Pond SSI
El Paso County, Colorado

PREPARED FOR:

Lorson Ranch Metropolitan District 1
212 N. Wahsatch Avenue, Ste 301
Colorado Springs, CO 80903

JOB NO. 161943

January 19, 2018

Respectfully Submitted,

RMG – Rocky Mountain Group

Kelli Zigler
Project Geologist

Reviewed by,

RMG – Rocky Mountain Group

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PROFESSIONAL ENGINEER

01/19/2018

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

SF 17-023

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1.0 GENERAL SITE AND PROJECT DESCRIPTION

1.1 Project Location

Carriage Meadows North Filing No. 1 is located east of the intersection of Marksheffel Road and Fontaine Boulevard in El Paso County, Colorado. The project lies in portions of the southwest ¼ of Section 14 and the southeast ¼ of Section 15, Township 15 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. The East Tributary of Jimmy Camp Creek forms the eastern border of the development. The location of the site is shown on the Site Vicinity Map, Figure 1.

1.2 Existing Land Use

At the time of our investigation, the site consisted of approximately 30 acres of undeveloped land. Overlot grading activities have been performed. Prior use of the land appears to have been range land for grazing livestock. Residential development is located to the east and to the west. South flowing Jimmy Camp Creek extends along the eastern boundary of the site. Topography generally slopes gently to moderately from northwest to southeast. Vegetation at the site generally consists of native grasses and weeds to scattered stands of brush and trees.

1.3 Project Description

Carriage Meadows North Filing No. 1 includes a stormwater detention pond located in the southeast portion of the development. The location of this pond is shown on Figure 2. The pond, designated CMN-1, is designed as Full Spectrum pond and will include constructed embankment and control structures.

Rocky Mountain Group - RMG was retained to explore the subsurface conditions at the site and develop geotechnical engineering recommendations for the proposed detention pond.

2.0 REPORT OVERVIEW

The purpose of this investigation is to characterize the subsurface soils pertinent to embankment construction, and to provide recommendations regarding embankment construction. This report has been prepared in accordance with the requirements outlined in the El Paso County Land Development Code (LDC), the Engineering Criteria Manual (ECM) Section 2.2.6 and Appendix C.3.2.B, and the El Paso County (EPC) Drainage Criteria Manual, Volume 1 Section 11.3.3.

2.1 Detention Storage Criteria

Detention pond embankments that impound water above the natural grade of the land are considered dams under rules and regulation promulgated by the State of Colorado Department of Natural Resources. Rules and Regulations for Dam Safety and Dam Construction have been developed to provide guidance to design engineers and constructors. Dams are regulated as jurisdictional dams or non-jurisdictional dams. In accordance with El Paso County Drainage Criteria Manual, Volume 1, Section 6.6, embankments associated with Carriage Meadows North filing No. 1 detention pond CMN-1 qualifies as a **non-jurisdictional, minor dam, with a Class III hazard rating.**

The purpose of our report is to comply with the referenced guidelines and provide pertinent geotechnical information upon which to base the design and construction of pond embankments. This report presents

the findings of the investigation performed by RMG and our recommendations regarding detention pond construction.

2.2 Site Evaluation Techniques

The subsurface conditions on the site were investigated by drilling one (1) exploratory test boring near the center of the proposed pond. The approximate location of the test boring is presented in the Test Boring Location Plan, Figure 2.

The test boring was advanced with a power-driven, continuous-flight auger drill rig to a depth of 20 feet below the existing ground surface. Samples were obtained in general accordance with ASTM D-1586 utilizing a 2-inch OD split-barrel sampler or in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Samples were returned to RMG's materials testing lab for further analysis. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figure 4.

Laboratory Testing

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

In conjunction with our experience working with the soil at Lorson Ranch, the included subsurface data has been collected and is presented in conformance with DCM1 Section 11.2.2 and Attachment A of that document. The information included in this report has been compiled from:

- Field reconnaissance and review of geologic and topographic maps
- Available aerial photographs
- Geologic research and analysis

2.3 Previous Studies and Field Investigation

Reports of previous geotechnical engineering/geologic investigations at Carriage Meadows North Filing 1 were available for our review and are listed below:

1. *Preliminary Subsurface Soil Investigation,* RMG Job Number 114121, dated August 4, 2006.

Detention pond grading details are included in Final Grading / Erosion Control Plans prepared by Core Engineering Group.

3.0 SITE CONDITIONS

3.1 General Physiographic Setting

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

3.2 Topography

The ground surface generally slopes gently down to the south and southwest across the entire site. The elevation difference across the site from northeast to southwest is less than 50 feet. Jimmy Camp Creek's east tributary runs along the eastern property line. Detention pond CMN-1 is adjacent to the east tributary of Jimmy Camp Creek.

3.3 Vegetation

Vegetation across the site generally consists of native grasses, shrubs, and weeds.

4.0 SUBSURFACE CONDITIONS

5.1 General Soil Types

The general geology of the area is typically stream terrace deposits and alluvium soils overlying the Pierre Shale. Samples from the Soil Test Boring exhibited characteristics of the general geology. The subsurface conditions can be characterized by describing two geologic units that were mapped in the vicinity of the site identified (Morgan, et al., 2003) as:

- al: alluvium is loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a non-marine setting. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel.

- Kp: Pierre Shale – (Upper Cretaceous) Underlain by the Piney Creek Alluvium. Permeability is generally low, excavation and compaction generally easy. Foundation stability is less than fair. The majority of the formation has low to high swell potential. Slope stability is generally poor and slopes steeper than 5 degrees may slide, if the toe of the slope is removed.

5.2 Subsurface Materials

The subsurface materials encountered in the test boring were classified using the Unified Soils Classification System (USCS) and the materials were grouped into the general category of silty. These

soils classified as SP-SM, poorly-graded silty sand. It is anticipated that subgrade foundations for embankments will be in alluvial material, and that the embankments themselves will be constructed from on-site alluvial material. Embankments are not anticipated to be constructed directly upon or built up from claystone or shale bedrock.

5.3 Groundwater

Groundwater was not encountered in the soil test boring. Groundwater should not be a factor in detention pond embankment design and construction, nor should it influence the global stability of embankments.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Soil and Rock Design Parameters

In addition to the current soil test boring, RMG has performed numerous laboratory tests of soil from across the Lorson Ranch development, including moisture-density relationship curves (Proctor Tests) for similar soil as referenced in this report. Based upon field and laboratory testing, the following soil and rock parameters are typical for the soils likely to be encountered, and are recommended for use in detention pond embankment design.

Soil Description	Unit Weight (lb/ft^3)	Friction Angle (degree)	Active Earth Pressure, Ka	Passive Earth Pressure, Kp	At Rest Earth Pressure, Ko	Unconfined compressive Strength (kip/ft^2)
Alluvial Soil	110	30	0.33	3.0	0.50	-

6.2 Seismic Design

In accordance with the International Building Code, 2012/2015, seismic design parameters have been determined for this site. The Seismic Site Class has been interpreted from the results of the soil test boring drilled within the project site. The USGS seismic design tool has been used to determine the seismic response acceleration parameters. USGS output is presented in Appendix B. The soil on this site is not considered susceptible to liquefaction. The following recommended Seismic Design Parameters are based upon Seismic Site Class D, and a 2 percent probability of exceedance in 50 years. The Seismic Design Category is "B".

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.168	F_a	1.6	S_{ms}	0.269	S_{ds}	0.179
1.0	S_1	0.059	F_v	2.4	S_{m1}	0.142	S_{d1}	0.095

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

6.3 Embankment Recommendations

From Carriage Meadows North Filing 1 development plans, it appears embankments in detention pond CMN-1 may be as much as 6-feet or so above the existing ground surface elevation. Embankments are to be constructed with 4:1 slopes. Embankments should be constructed in accordance with applicable sections of the El Paso County Engineering Criteria Manual, the El Paso County Drainage Criteria Manual, and the El Paso County Land Development Manual. The following recommendations are in accordance with the El Paso county DCM Volume 2, Extended Detention Basin (EDB), Design Procedure and Criteria, paragraph 8.

The ground area to receive embankments should be cleared and grubbed to a minimum depth of two-feet to remove grass, shrubs, trees, roots, stumps, and other organic material. The exposed soil should be moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557). The prepared surface should present a firm and stable condition.

Embankment should be constructed as structural fill on a prepared stable base. On-site native soil when screened of all deleterious material and cobbles greater than 6-inches in any dimension is suitable for embankment construction. Structural fill should be placed in 10-inch loose lifts and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557).

Structural fill placed on slopes should be benched into the slope. Maximum bench heights should not exceed 4 feet, and bench widths should be wide enough to accommodate compaction equipment. Structural fill should not be placed on frozen subgrade or allowed to freeze during moisture conditioning and placement. To verify the condition of the compacted soils, density tests should be performed during placement. The first density tests should be conducted when 24 inches of fill have been placed.

CLOSING

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

This report has been prepared for the exclusive use by **Lorson Ranch Metropolitan District 1** for application as an aid in the design and construction of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from test borings, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

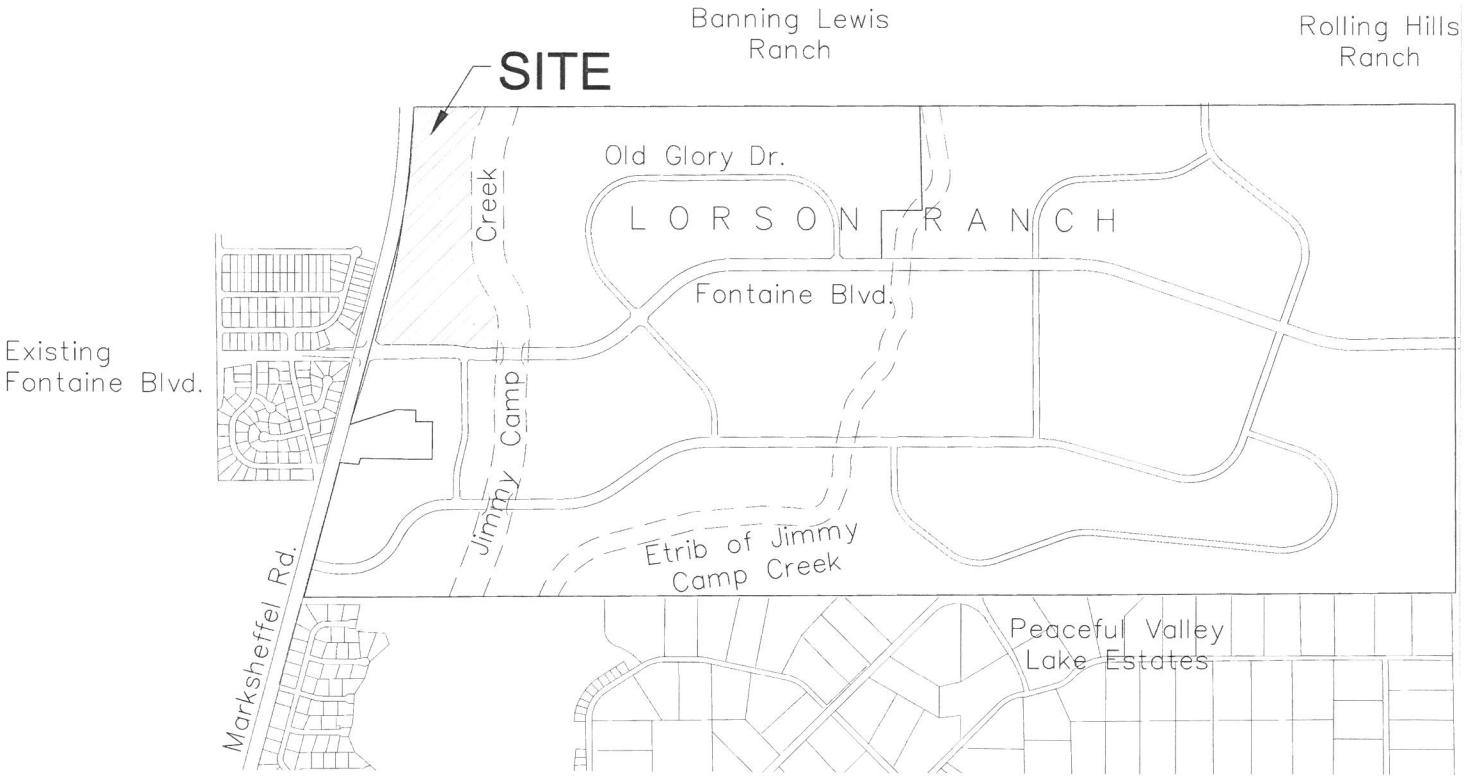
Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made by the

preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

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

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

FIGURES



NOT TO SCALE

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SITE VICINITY MAP

CARRIAGE MEADOWS NORTH FILING NO. 1
EL PASO COUNTY, COLORADO
LORSON RANCH METRO DISTRICT NO. 1

JOB No. 161943

FIG No. 1

DATE 01-18-2018

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⊕ DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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TEST BORING LOCATION PLAN

CARRIAGE MEADOWS NORTH
FILING NO. 1
EL PASO COUNTY, COLORADO
LORSON RANCH METRO
DISTRICT NO. 1

JOB No. 161943

FIG No. 2

DATE 01-18-2018

SOILS DESCRIPTION


FILL: SAND, SILTY TO CLAYEY


SANDY CLAY


SILTY SAND


SILTY TO CLAYEY SAND

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

SYMBOLS AND NOTES


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


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

FREE WATER TABLE


DEPTH AT WHICH BORING CAVED


BULK — DISTURBED BULK SAMPLE


AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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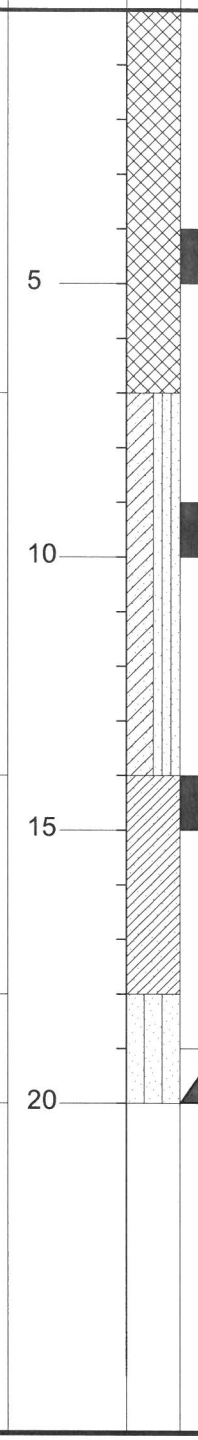
EXPLANATION OF TEST BORING LOGS

JOB No. 161943

FIGURE No. 3

DATE 1/17/18

TEST BORING: **1**
DATE DRILLED:
1/9/18
REMARKS:
NO GROUNDWATER ON
1/9/18



	BLOWS PER FT.	WATER CONTENT %
FILL: SAND, SILTY TO CLAYEY, with sandy clay seams, dark brown, dense, moist	40	8.2
SAND, SILTY TO CLAYEY, tan to brown, loose, moist	5	9.8
CLAY, SANDY, tan to gray, medium stiff, moist	8	14.8
SAND, SILTY TO CLAYEY, tan to gray, loose, moist	17	3.7

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TEST BORING LOGS

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FIGURE No. 4

DATE 1/17/18

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	FHA Expansion Pressure (psf)	% Swell/ Collapse	USCS Classification
1	4.0	8.2		NP	NP	0.0	17.2			SM
1	9.0	9.8		NP	NP	0.0	32.3			SM
1	14.0	14.8		NP	NP	0.0	62.9			ML
1	19.0	3.7		NP	NP	0.0	16.3			SM

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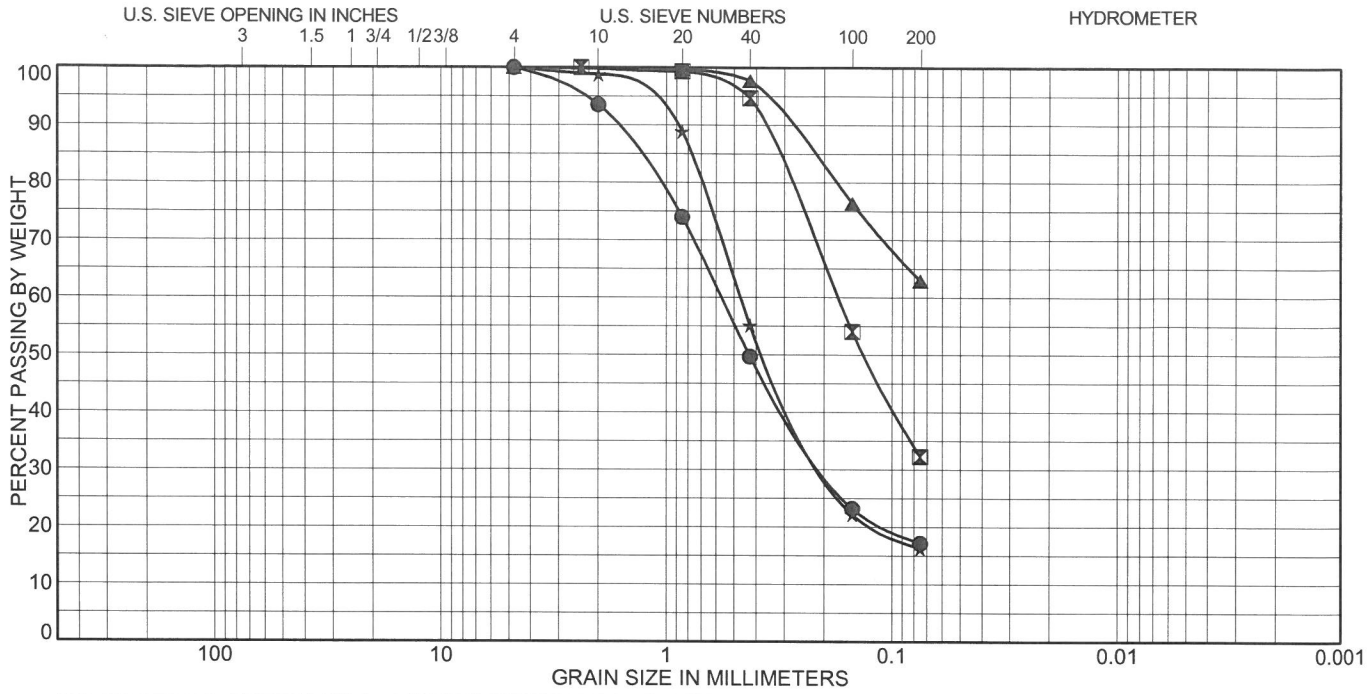
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 161943
FIGURE No. 5
PAGE 1 OF 1
DATE 1/17/18



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI
●	1	4.0	**SILTY SAND(SM)**	**NP**	**NP**	**NP**
⊠	1	9.0	**SILTY SAND(SM)**	**NP**	**NP**	**NP**
▲	1	14.0	**SANDY SILT(ML)**	**NP**	**NP**	**NP**
★	1	19.0	**SILTY SAND(SM)**	**NP**	**NP**	**NP**

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	4.0	**0.0**	**82.8**	**17.2**	
⊠	1	9.0	**0.0**	**67.7**	**32.3**	
▲	1	14.0	**0.0**	**37.1**	**62.9**	
★	1	19.0	**0.0**	**83.7**	**16.3**	

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SOIL CLASSIFICATION DATA

JOB No. 161943

FIGURE No. 6

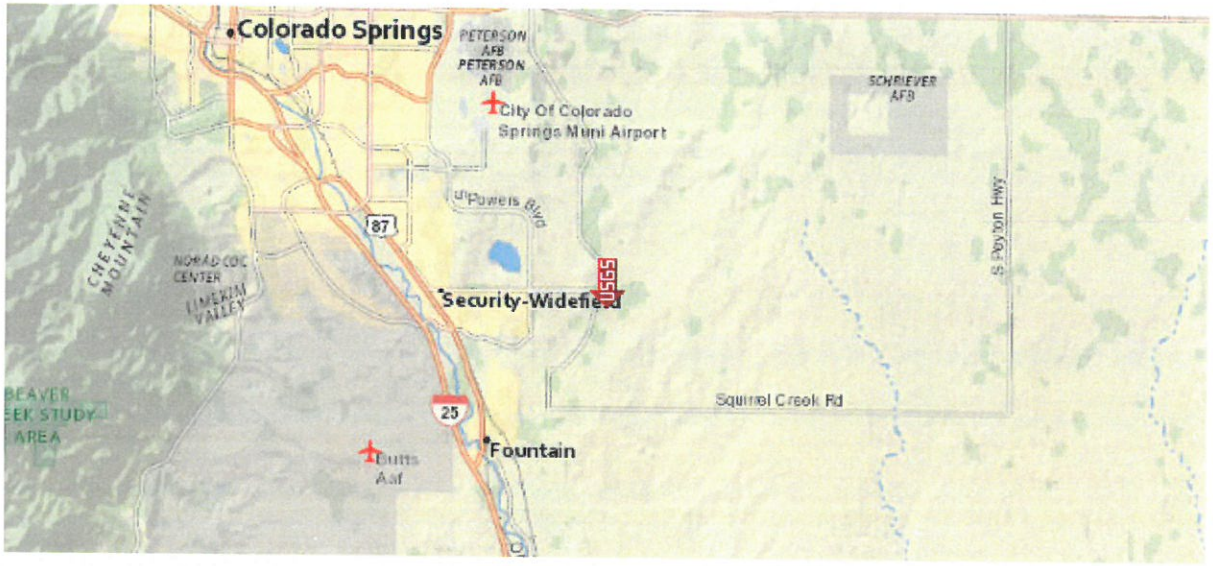
DATE 1/17/18

APPENDIX A

USGS Design Maps Summary Report

User–Specified Input

Report Title	Carriage Meadows North Filing 1 Fri January 19, 2018 16:12:30 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	38.74011°N, 104.6471°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III



USGS–Provided Output

S_S =	0.168 g	S_{MS} =	0.269 g	S_{DS} =	0.179 g
S_1 =	0.059 g	S_{M1} =	0.142 g	S_{D1} =	0.095 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.