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GEOTECHNICAL REPORT

Native Sun Construction Office
15000 Woodcarver Road
Monument, Colorado

PREPARED FOR:

Native Sun Construction Inc.
16050 Old Denver Road
Monument, CO 80132

JOB NO. 175840

April 17, 2020

Respectfully Submitted,

RMG – Rocky Mountain Group

Kelli Zigler

Kelli Zigler
Project Geologist

Reviewed by,

RMG – Rocky Mountain Group

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

COLORADO LICENSED
GEOFF WEBSTER
4/17/20
45046
PROFESSIONAL ENGINEER

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GENERAL SITE AND PROJECT DESCRIPTION

Location

The proposed construction is to consist of an office building that is to be built on a parcel of land located at 15000 Woodcarver Road in Monument, Colorado. The location of the site is shown on the Site Vicinity Map, Figure 1.

Existing Site Conditions

The site is an undeveloped parcel vegetated with native grasses, shrubs and trees. The elevation of the site is higher on the northwest and slopes downward to the southeast, where a slight drainage feature exists. The parcel is triangular shaped, and the office will be located at the southeast end of the land.

Project Description

According to a site layout plan provided to RMG, improvements include a small modular office building to be placed upon a shallow foundation. Rocky Mountain Group (RMG) was retained to explore the subsurface conditions in the location of the new structure, and develop geotechnical engineering recommendations for design and construction. Pavement design recommendations are included.

FIELD INVESTIGATION AND LABORATORY TESTING

Drilling

The subsurface conditions on the site were investigated by drilling two (2) exploratory test borings within the structure footprint. The approximate location of the test boring is presented in the Test Boring Location Plan, Figure 2.

Test borings for the structures were 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. Samples were returned to RMG's materials testing lab for further analysis. An Explanation of Test Boring Logs is presented in Figure 3. 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 to classify the soil 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-plastic, and therefore swell/consolidation tests were not performed.

SUBSURFACE CONDITIONS

Subsurface Materials

The Test Borings revealed similar subsurface soil conditions. The soil profile through the 20-foot borings is silty sand overlying sandstone bedrock. The soil appears to be native soil in a medium dense state of consolidation. Subsurface soils were classified in accordance with the Unified Classification System. Subsurface conditions can be characterized as follows.

<u>0 to 17-ft</u>: Light brown to gray with rust staining, moist to wet (below the water table), medium dense Well-graded Sand with Silt (SW-SM).

<u>17 to 20-ft</u>: Gray, moist to wet, medium hard, Silty Sandstone bedrock.

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

Groundwater

Groundwater was encountered in both Test Borings at a depth of 8-feet below the ground surface at the time of drilling and when checked 3 days subsequent to drilling. Groundwater at this depth is not anticipated to be a factor in the proposed shallow foundation construction. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Contractors should always be prepared to control groundwater during construction.

CONCLUSIONS AND RECOMMENDATIONS

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

Geotechnical Considerations

The soil encountered in the borings appears to be native soil. Well-graded silty sand is well suited to support shallow foundations. Based upon Standard Penetration Test blow counts, the soil will benefit from additional compactive effort to provide bearing capacity and to minimize settlement. Based upon RMG's subsurface investigation and laboratory testing, conventional shallow foundations will be suitable for the proposed improvements. A deep foundation system will not be necessary on this site.

Soil Parameters

The following table presents estimated in situ soil parameters.

Soil Description	Unit Weight (lb/ft³)	Friction Angle (degree)	Active Earth Pressure Ka	Passive Earth Pressure Kp	At-Rest Earth Pressure Ko	Modulus of Elasticity E_s (lb/in²)	Poisson's Ratio μ_s
SW-SM Well-graded silty sand	115	30	.333	3.0	.50	2,000	.35

Seismic Design Parameters

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

Period (sec)	Mapped MCE Spectral Response Acceleration (g)		Site Coefficients		Adjusted MCE Spectral Response Acceleration (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.187	F_a	1.6	S_{ms}	0.299	S_{ds}	0.199
1.0	S_1	0.061	F_v	2.4	S_{m1}	0.146	S_{d1}	0.097

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

Foundation Recommendations

Structures may be supported on shallow foundations bearing on a minimum of 12-inches of compacted native soil or imported compacted structural fill prepared in accordance with the following recommendations. Site preparation should include clearing and grubbing the site of all vegetation, topsoil, and any other deleterious material within the construction area and disposing this material appropriately. Following clearing and grubbing, the area within the foundation footprint and a 2-foot perimeter beyond should be scarified 6-inches deep and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content). The exposed soil should then be compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557). An Open Excavation Observation should be made at this point to verify soil conditions are as reported in the soil boring logs herein.

After verification of the site soils, the excavation should then be backfilled in compacted lifts to bottom of footing elevation with native soil or structural fill consisting of well-graded non-cohesive granular material. The material should not be excessively wet, should be free of organic matter and construction debris, and contain no rock fragments greater than 3-inches in any dimension. Structural fill material should be placed in 8-inch loose lifts with moisture content within 2 percent of optimum as determined by ASTM D-1557. Each loose lift should be compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by ASTM D-1557. The compacted soil should be density tested to verify compaction meets these requirements.

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

Open Excavation Observations

During construction, foundation excavations should be observed by RMG prior to placing structural fill, forms, or concrete to verify the foundation bearing conditions for each structure. Based on the conditions observed in the foundation excavation, the recommendations made at the time of construction may vary from those contained herein. In the case of differences, the Open Excavation Observation report shall be considered the governing document. The recommendations presented herein are intended only as preliminary guidelines to be used for interpreting the subsurface soil conditions exposed in the excavation and determining the final recommendations for foundation construction.

Floor Slabs

We understand a modular building will be placed upon the foundation elements. If, however, a concrete floor slab is utilized, then the floor slab should bear upon a minimum of 12-inches of structural backfill compacted to a minimum of 95 percent of Modified Proctor maximum dry density as determined by ASTM D-1557. Non-structural slabs should be isolated from foundation members with expansion material. To reduce the possibility of capillary rise of groundwater into the floor slab, and to reduce the potential for concrete curling, a minimum 3-inch layer of ¾-inch crushed stone may be placed atop the compacted structural fill. The use of a 6-mil vapor retarder over the crushed stone may be considered.

Exterior Concrete Flatwork

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

Lateral Earth Pressures

Foundation walls should be designed to resist lateral pressures. For non-expansive backfill materials, we recommend an equivalent fluid pressure of 45 pcf for design. Expansive soils or bedrock should not be used as backfill against walls. The above lateral pressure applies to level, drained backfill conditions.

Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual basis.

CONSTRUCTION CONSIDERATIONS

Structural Fill - General

Except as described above for foundations, areas to receive structural fill should have topsoil, organic material, and debris removed. The upper 6 inches of the exposed surface soils should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557).

Structural fill should be placed in loose lifts not exceeding 8-inches 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.

Surface Grading and Drainage

The ground surface should be sloped from the building with a minimum gradient of 2 percent to direct surface water away from the structure. Roof drains should extend across backfill zones and landscaped areas to a region that is graded to direct flow away from the structure. Water should be kept from ponding near the foundations.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements and irrigated grass should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended.

Irrigation devices should not be placed within 5 feet of the foundation. Irrigation should be limited to the amount sufficient to maintain vegetation. Excess water may increase the likelihood of slab and foundation movements.

Perimeter Drain

A subsurface perimeter drain is recommended around portions of the structure that will have habitable space, storage space, or crawlspaces located below the finished ground surface. Where main level slab-on-grade foundation systems (stiffened, monolithic, or isolated) are utilized, a subsurface perimeter drain is typically not necessary around the foundation.

Concrete

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

Exterior Backfill

Backfill on exterior walls and in landscaped areas should be placed in loose lifts not exceeding 8 to 12 inches, moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to 85 percent of the maximum dry density as determined by the Modified Proctor test, ASTM D-1557. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 95 percent of the maximum dry density.

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

The appropriate government/utility specifications should be used for fill placed in utility trenches. If material is imported for backfill, the material should be non-expansive granular soil.

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

PAVEMENT RECOMMENDATIONS

The information below is provided in the event the client elects to install permanent asphalt or concrete pavement on the site.

Pavement Design

Parking lot pavement is typically designed using the Colorado Asphalt Pavement Association's *A Guideline for the Design and Construction of Asphalt Parking Lots in Colorado*. The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described. If the subsurface conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and modify them, if necessary.

Subgrade Preparation

On-site soils encountered in the Test Borings are suitable as subgrade material. All subgrade material placed below pavements should be moisture conditioned and compacted in accordance with the **Structural Fill – General** section of this report. Prior to placement of the pavement section, the final subgrade should be scarified to a depth of 12 inches, adjusted to within 2 percent of the optimum moisture content and recompacted. The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle. Areas that deform under wheel loads should be removed and replaced. Subsequent base course layers should be compacted to at least 95 percent of the maximum Modified Proctor density (ASTM D1557).

Pavement Thickness

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

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

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

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

Pavement Materials

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

Surface Drainage

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

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 **Native Sun Construction Inc.** 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

ARCHITECTS
RMG
ENGINEERS
ROCKY MOUNTAIN GROUP

Southern Office
Colorado Springs,CO
80918
(719) 548-0600
Central Office:
Englewood, CO 80112
(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
(970) 330-1071

SITE VICINITY MAP

NATIVE SUN OFFICE BUILDING
15000 WOODCARVER ROAD
MONUMENT, COLORADO
NATIVE SUN CONSTRUCTION INC.

JOB No. 175840

FIG No. 1

DATE 4-17-2020

GPS COORDINATES OF TB-1: 39°02'58.3" N 104°51'20.9" W
(ACCURACY ± 15')

DENOTES APPROXIMATE LOCATION OF TEST BORINGS

ARCHITECTS RMG ENGINEERS

ROCKY MOUNTAIN GROUP

Southern Office
Colorado Springs,CO 80918
(719) 548-0600
Central Office:
Englewood, CO 80112
(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
(970) 330-1071

TEST BORING LOCATION PLAN

NATIVE SUN OFFICE BUILDING
15000 WOODCARVER ROAD
MONUMENT, COLORADO
NATIVE SUN CONSTRUCTION INC.

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FIG No. 2

DATE 4-17-2020

SOILS DESCRIPTION

SANDSTONE

SILTY SAND

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

SYMBOLS AND NOTES

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

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

FREE WATER TABLE

DEPTH AT WHICH BORING CAVED

BULK — DISTURBED BULK SAMPLE

AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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Colorado Springs: (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Spings, CO 80918
(719) 548-0600
SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

EXPLANATION OF TEST BORING LOGS

JOB No. 175840

FIGURE No. 3

DATE 4/17/20

TEST BORING: **1**
DATE DRILLED:
4/6/20
REMARKS:
GROUNDWATER @ 8.0 '
4/9/20

Description	DEPTH (FT)	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, light brown and brown to gray and olive with rust staining, medium dense, moist to wet	5	■	11	4.9
	10	■	14	15.7
	15	■	22	12.5
SANDSTONE, SILTY TO CLAYEY, gray, medium hard, moist to wet	20	■	38	17.5

TEST BORING: **2**
DATE DRILLED:
4/6/20
REMARKS:
GROUNDWATER @ 8.0 '
4/9/20

Description	DEPTH (FT)	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, light brown and brown to gray with rust staining, medium dense, moist to wet	5	■	17	5.3
	10	■	13	14.9
	15	■	23	17.6
SANDSTONE, CLAYEY, gray, hard, moist to wet	20	■	50/10"	13.0

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Colorado Springs: (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Spings, CO 80918
(719) 548-0600
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TEST BORING LOGS

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FIGURE No. 4

DATE 4/17/20

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load (psf)	% Swell/ Collapse	USCS Classification
1	4.0	4.9		NP	NP	6.4	6.9			SW-SM
1	9.0	15.7								
1	14.0	12.5								
1	19.0	17.5								
2	4.0	5.3								
2	9.0	14.9		NP	NP	6.4	8.2			SW-SM
2	14.0	17.6								
2	19.0	13.0								

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Colorado Springs: (Corporate Office)
2910 Austin Bluffs Parkway
Colorado Spings, CO 80918
(719) 548-0600
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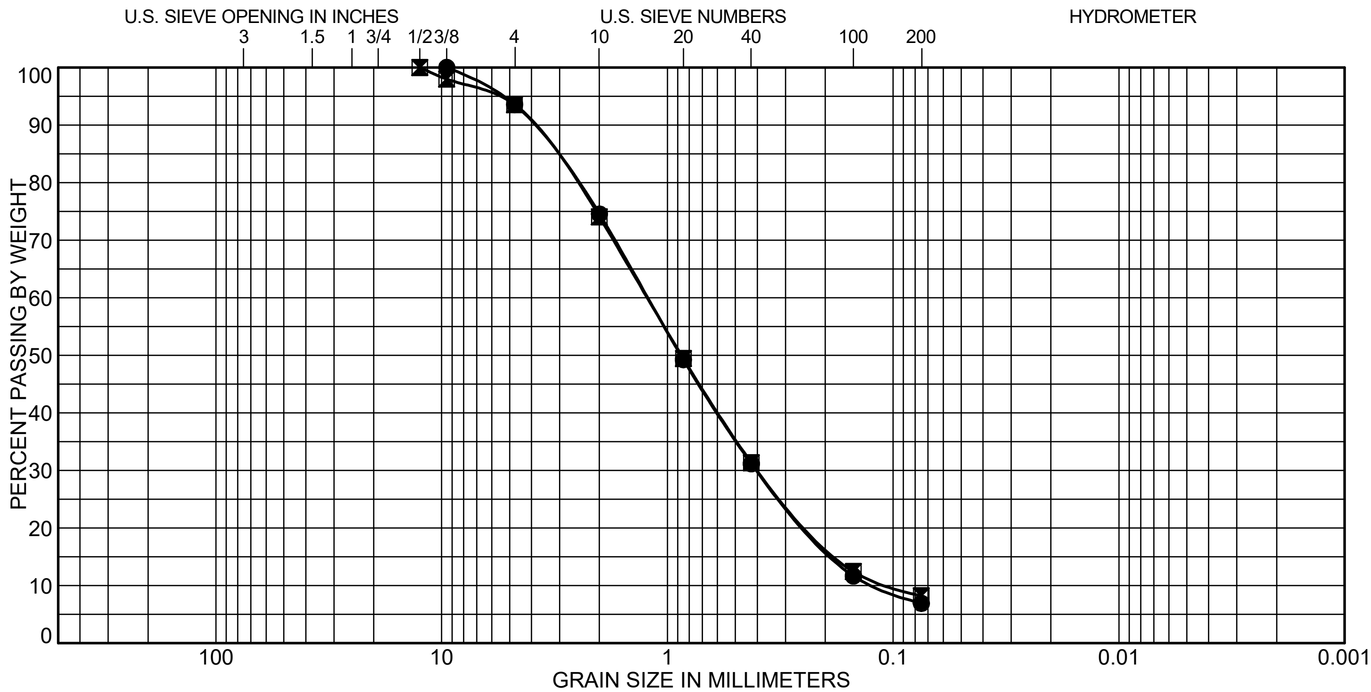
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 175840
FIGURE No. 5
PAGE 1 OF 1
DATE 4/17/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

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

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	**1**	**4.0**	**6.4**	**86.7**	**6.9**	
⧗	**2**	**9.0**	**6.4**	**85.4**	**8.2**	

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Colorado Spings, CO 80918
(719) 548-0600
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SOIL CLASSIFICATION DATA

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FIGURE No. 6

DATE 4/17/20