ROCKY MOUNTAIN GROUP

Job No. 159927

September 28, 2017

Wayne Connell
PO Box 2434
Parker, CO 80134

Re: Subsurface Soil Investigation
37300 Stillwater St
Elizabeth, Colorado

Dear Wayne Connell:

RMG - Rocky Mountain Group drilled two test borings at the above-referenced address on August 30, 2017. The layout of the site and the approximate location of our explorations are provided in Figure 1, Aerial Site Map. Our findings, conclusions and recommendations are provided in this report.

This report presents geotechnical engineering recommendations for design and construction of residential foundations. The following is excluded from the scope of this report including but not limited to geologic, natural and environmental hazards such as landslides, unstable slopes, seismicity, snow avalanches, water flooding, corrosive soils, erosion, radon, wild fire protection, hazardous waste and natural resources.

Site Description and Proposed Construction

The site was vacant at the time of our subsurface exploration. The existing vegetation consists of native grasses and weeds. It is our understanding that a new single family residential structure with an attached garage is planned for the proposed construction.

Subsurface Materials

From the surface in the test borings, sandy clay soil was encountered to approximately 6 feet below the existing ground surface (bgs). In Boring B-1, the surficial sandy clay was underlain by interbedded sandy silt and silty sand that extended to approximately 14 feet bgs and was underlain by silty sandstone that extended to the maximum depth explored of approximately 20 feet bgs. In Boring B-2, the surficial sandy clay was underlain by interbedded sandy silt and silty sand that extended to approximately 18.5 feet bgs and was underlain by silty sandstone that extended to the maximum depth explored of approximately 30 feet bgs.

Groundwater was not encountered in the test borings at the time of drilling. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

Additional descriptions and the interpreted distribution (approximate depths) of the subsurface materials are presented in the Test Boring Logs. The soil/rock classifications shown on the logs are based upon the engineer's classification of samples. Lines shown on the logs represent the approximate boundary between subsurface materials, and the actual transition may be gradual and vary across the site. An Explanation of the Test Boring Logs, the Test Boring Logs, and a Summary of Laboratory Test Results are presented in Figures 2 through 4. Soil Classification Data are presented in Figure 5. Swell/Consolidation Test Results are presented in Figures 6 and 7.

Foundation Recommendations

A spread footing foundation supported on undisturbed native soils is suitable for the proposed residential structure. A maximum allowable bearing pressure of 2,400 psf with a minimum dead load requirement of 800 psf 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 36 inches below finished grade for frost protection. Footings and isolated pads should **not** be placed on frozen or saturated soil. Prior to placing concrete, all bearing surfaces must be cleared of loose material.

Open Excavation Observation

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 to be 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.

It is recommended that excavation equipment remain onsite until the open excavation observation has been completed. If unsuitable conditions are identified during the open excavation observation, i.e. pockets of loose/soft soils, high groundwater, potentially expansive or collapsible soils, etc., additional earthwork recommendations and/or testing and potentially alternative foundation recommendations may be required at an additional cost.

Interior Floor Slabs

Slab performance risk evaluation is an engineering judgement which is used as a predictor of the general magnitude of potential slab heave, and the risk of poor slab performance. The Slab

Performance Risk at this site is judged to be Low (between 0% and 2% swell with a 1,000 psf surcharge) based on the criteria in the following table.

Slab Performance Risk Category	Representative Percent Swell (500 psf Surcharge)	Representative Percent Swell (1,000 psf Surcharge)
Low	0 to < 3	0 to < 2
Moderate	3 to < 5	2 to < 4
High	5 to < 8	4 to < 6
Very High	>8	>6
Note: Based on Colorado Association of Geotechnical Engineers, Guidelines for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area, 1996).		

The Colorado Association of Geotechnical Engineers (CAGE) recommends structural floors where the slab performance risk is judged to be high or very high. However, the owner must understand that vertical slab movement on the order of one to two inches is considered possible for soils/bedrock of low expansion potential. In some cases, vertical movement may exceed this range. If movement and associated damage to floors and finishes cannot be tolerated, a structural floor system should be used.

Floor slabs should be separated from structural components to allow for vertical movement. Control and construction joints should be placed in accordance with the latest guidelines and standards published by the American Concrete Institute (ACI) and applicable local Building Code requirements.

Recommendations for exterior concrete slabs, such as patios, driveways, and sidewalks, are not included in this report.

Interior Partitions

Interior non-bearing partitions and attached furnishings (e.g., cabinets, shower stalls, etc.) on concrete slabs should be constructed with a void so that they do not transmit floor slab movement to the roof or overlying floor. A void of at least 2 inches is recommended beneath non-bearing partitions. Doors should be provided with at least a 1 inch gap at floor level. Voids and gaps may require reconstruction over the life of the structure to re-establish the void due to vertical slab movement.

Interior non-bearing partitions walls and other attached finishes do not require isolation from the structural floor system.

Lateral Earth Pressures

Foundation walls should be designed to resist lateral earth pressures. For moisture-conditioned on-site backfill materials, we recommend an equivalent fluid pressure of 50 pcf for "Active" conditions and 70 pcf for "At-Rest" conditions be used for design.

The above lateral earth pressure applies to level, drained backfill conditions. Equivalent Fluid Pressures for sloping/undrained conditions should be determined on an individual basis.

Site Grading

The following sections present recommendations for earthwork during construction including site preparation, structural fill, and exterior backfill.

Site Preparation

Prior to construction, the ground surface in proposed structure and improvement areas should be stripped of existing vegetation, debris, topsoil, undocumented fill, soft, loose, or disturbed native soils and other deleterious material. This includes areas below foundation and floor slabs. Care should be taken to reduce drying of the subgrade soil below the foundation during construction. Site preparation procedures should be performed such that the potential for standing and ponding of water around the site is reduced. During wet weather earthen berms, swales, or other means should be used to direct water away from excavations. Water that accumulates in excavations should be pumped out or otherwise removed and these areas should be allowed to return to their "natural" moisture condition before resuming construction.

Structural Fill

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

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

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

To verify the condition of the compacted soils, density tests should be performed during placement. Early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction for the entire depth of fill.

Earthwork operations should be observed and compaction of structural fill materials should be tested by the project's geotechnical consultant. It is the **responsibility of the builder or contractor to schedule with this office** to conduct compaction tests, retrieve or accept delivery of a fill sample, or certify the fill material. Early testing is recommended to demonstrate that placement and compaction methods are achieving the required compaction for the entire depth of fill. Without a strict quality assurance program, the fill may not be of sufficient quality to achieved required performance.

Exterior Backfill

Backfill 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 90 percent of the maximum dry density as determined by the Standard Proctor test, ASTM D-698 on exterior sides of walls in landscaped areas. In areas where backfill supports pavement and concrete flatwork, the materials should be compacted to 95 percent of the maximum dry density.

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

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

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

Surface Grading and Drainage

Drainage is an important key to the successful performance of shallow foundations. The ground surface should be sloped away from structures with a minimum gradient of 10 percent for the first 10 feet. This is equivalent to 12 inches of fall across this 10-foot zone. If a 10-foot zone is not possible on the upslope side of the structure, then a well-defined swale should be created a minimum 5 feet from the foundation and sloped parallel with the wall with a minimum slope of 2 percent to intercept the surface water and transport it around and 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. It is imperative that homeowners maintain the surface grading and drainage recommended in this report to help prevent water from being directed toward and/or ponding near the foundations. Failure to maintain positive surface drainage away from the structure may result in localized differential vertical movement of foundations and slabs.

Landscaping should be selected to reduce irrigation requirements. Plants used close to foundation walls should be limited to those with low moisture requirements; and irrigated grass

should not be located within 5 feet of the foundation. To help control weed growth, geotextiles should be used below landscaped areas adjacent to foundations. Impervious plastic membranes are not recommended.

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

Perimeter Drain

A subsurface perimeter drain is recommended around portions of the structure which will have habitable or storage space located below the finished ground surface. This includes crawlspace areas but not the walkout trench, if applicable. A typical drain detail is presented in Figure 8.

A subsurface perimeter drain is designed to intercept some types of subsurface moisture and not others. Therefore, the drain could operate properly and not mitigate all moisture problems relating to foundation performance or moisture intrusion into the basement area. If the outlet for the drain daylights, the pipe should be protected with a screen to prevent rodent infestation.

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.

Foundation Configuration Remarks

The configuration of the foundation system is critical to its performance. The position of foundation windows, jogs, steps and the relative elevation of adjacent and opposite walls can affect foundation performance. The nature of residential foundation construction does not allow for control of these conditions by the Foundation Design Engineer. Improper placement of the above can result in differential and lateral foundation movement not anticipated by the Geotechnical Engineer. The Foundation Design Engineer should be contacted regarding the foundation configuration.

General Remarks

The recommendations provided in this report are based upon the subsurface conditions encountered in the test borings, anticipated foundation loads, and accepted engineering practices and principles in the area at the time of report preparation. No warranty is made or implied in this report that this firm has an all inclusive knowledge of every portion of the subsurface materials on or under the site. There is no evaluation detailed enough to reveal every subsurface condition. The nature and extent of variations across the site may not become evident until

construction commences or thereafter. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, our office should be notified. If additional mass site grading is performed at the site which results in elevations that vary significantly from existing grades (more than plus or minus 2 ft), our office should be informed about these changes. If needed and/or if desired, we will reexamine our analyses and make supplemental recommendations.

The recommendations are intended to reduce differential movement. However, it should be noted that geotechnical engineering recommendations are not an exact science. The recommendations presented in a geotechnical engineering report are not based only on the analytical and empirical tools but rely on engineering judgement as well. The fact that professional judgements must be used in making recommendations means that the conclusions and recommendations presented in a geotechnical engineering report should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. Furthermore, it must be recognized that the foundation will undergo some movement on all soil types. Concrete floor slabs will likely move vertically. The recommendations for isolating floor slabs from columns, walls, partitions or other structural components should be implemented to mitigate potential damage to the structure.

Subsequent owners should be provided a copy of this report. The recommendations are based on accepted local engineering practice and are intended for individuals familiar with local construction practices and standards. The owner is also encouraged to read *A Guide to Swelling Soils for Colorado Homebuyers and Homeowners, Special Publication No. 43*, available from the Colorado Geological Survey. Recommendations contained in the report are also applicable for prevention of settlement due to wetting of support soils.

RMG does not assure the existence of and/or the compliance with the above recommendations. This is the responsibility of the client referenced on the first page. RMG provided recommendations only and does not supervise, direct or control the implementation of the recommendations.

Senate Bill 13

This report may be partial fulfillment of Colorado Senate Bill 13 (1984), C.R.S. 6-6.5-101, *The Soil and Hazard Analysis of Residential Construction*, if the purchaser receives this report at least fourteen days prior to closing.

The purpose of Senate Bill 13 is to inform the purchaser of the presence of expansive soil or hazards on the site. Geologic and environmental hazards are outside the scope of services of this report. Expansive soil and bedrock may result in movement of foundation components and floor slabs. The recommendations presented in this report are intended to reduce, not eliminate, these movements.

The owner and builder should review and become familiar with Special Publications 43 issued by the Colorado Geologic Survey.

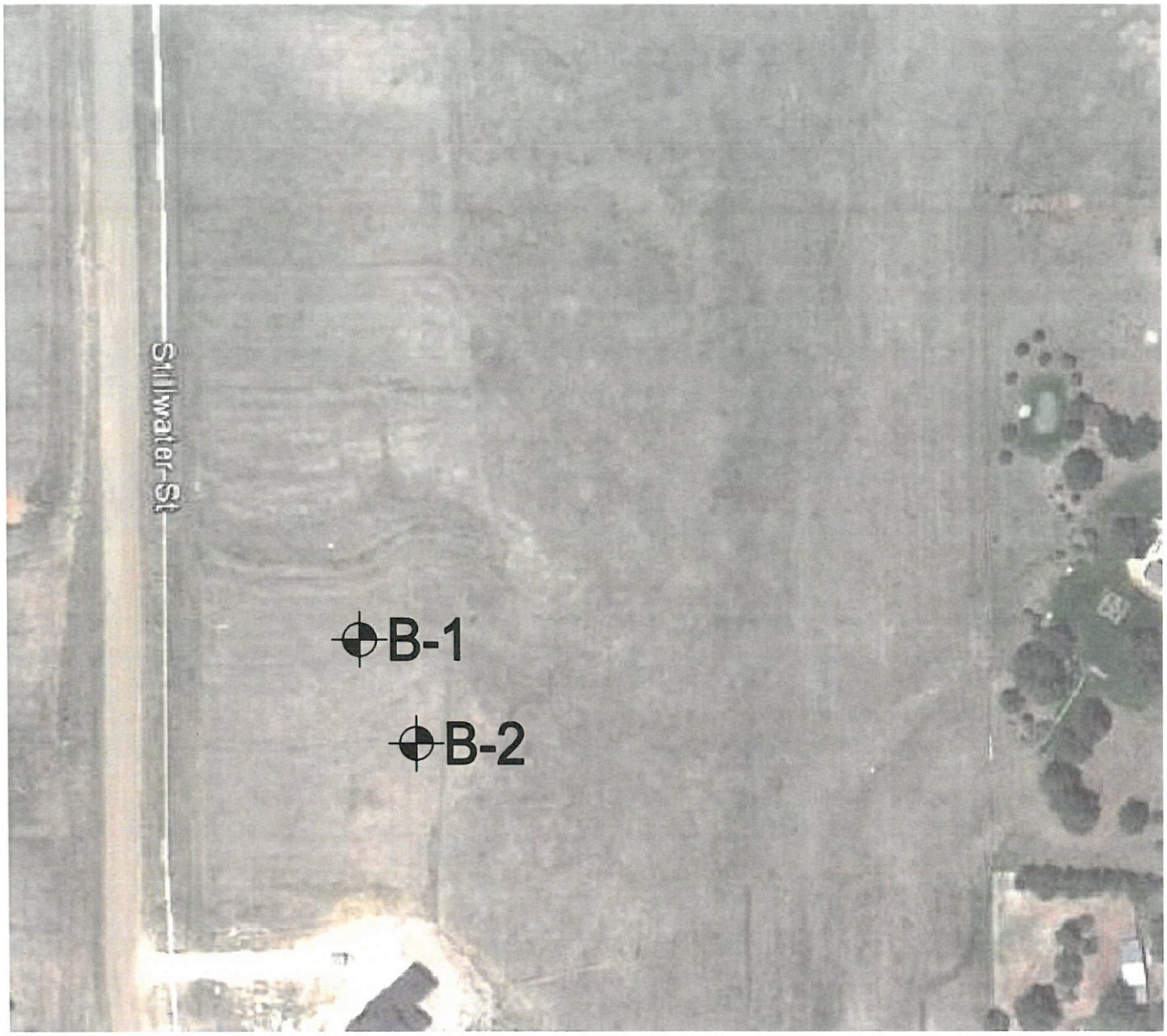
This report and the recommendations contained therein are only valid if all parts of Senate Bill 13 are satisfied.

Should you have questions, please do not hesitate to call.

Cordially,

RMG – Rocky Mountain Group

Tony Munger, P.E.
Geotechnical Project Manager



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APPROXIMATE TEST BORING LOCATION

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(719) 548-0600
Central Office:
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(303) 688-9475
Northern Office:
Greeley / Evans, CO 80620
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AERIAL SITE MAP

37300 STILLWATER ST
ELIZABETH, COLORADO
WAYNE CONELL

JOB. No. 159927
FIG. No. 1
DATE: 09.28.2017

SOILS DESCRIPTION

SANDSTONE

SANDY CLAY

INTERBEDDED SANDY SILT AND SILTY SAND

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
14 INVERNESS DR. EAST, SUITE E-136
ENGLEWOOD, 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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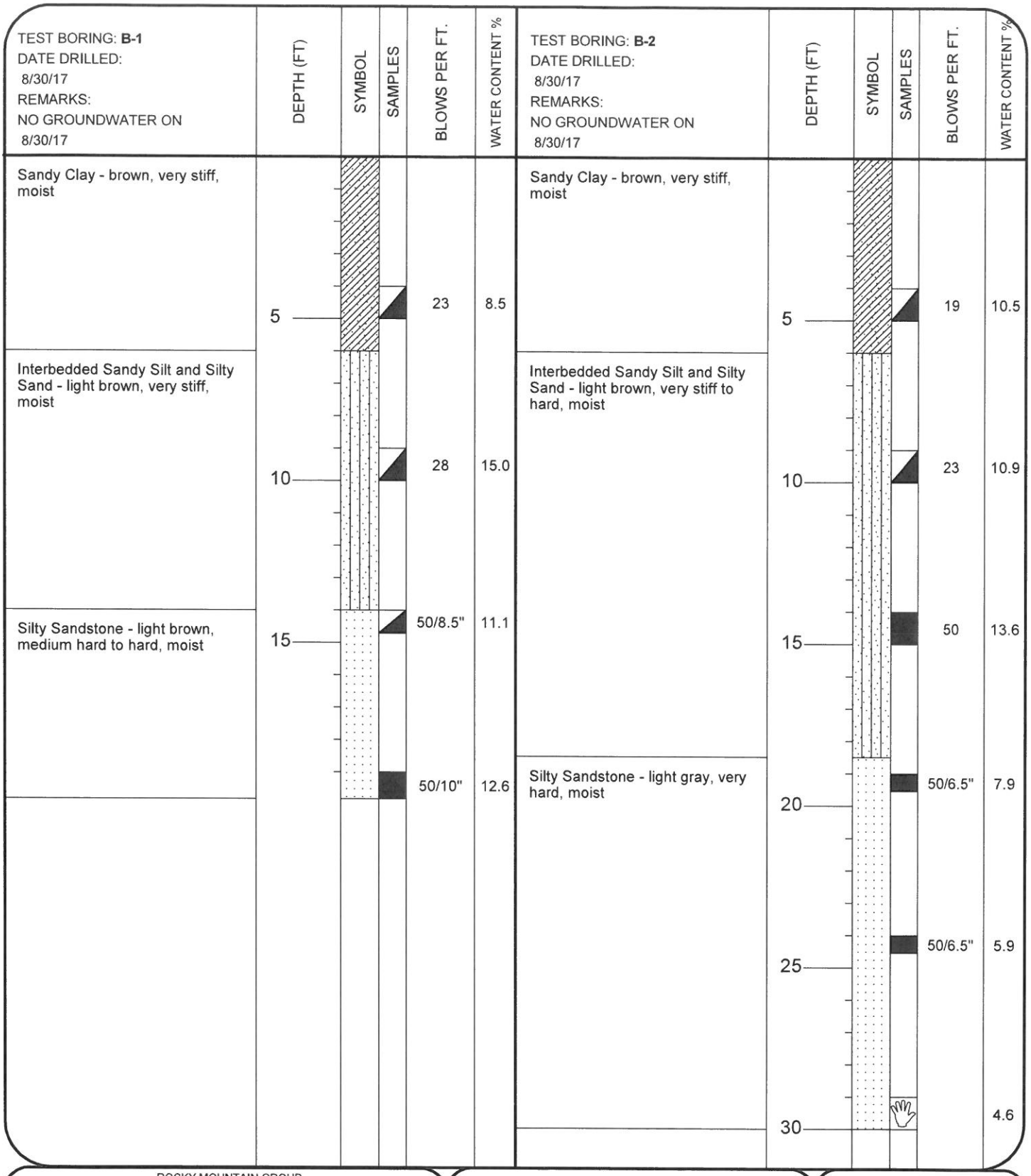
EXPLANATION OF TEST BORING LOGS

JOB No. 159927

FIGURE No. 2

DATE 9/28/17



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TEST BORING LOGS

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FIGURE No. 3

DATE 9/28/17

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
B-1	4.0	8.5	107.0						- 0.5	
B-1	9.0	15.0	113.0	43	15	0.0	69.2			ML
B-1	14.0	11.1	106.5						0.5	
B-1	19.0	12.6								
B-2	4.0	10.5	96.9	40	19	0.0	65.6			CL
B-2	9.0	10.9	107.4						0.8	
B-2	14.0	13.6		38	9	0.0	49.4			SM
B-2	19.0	7.9								
B-2	24.0	5.9								
B-2	29.0	4.6								

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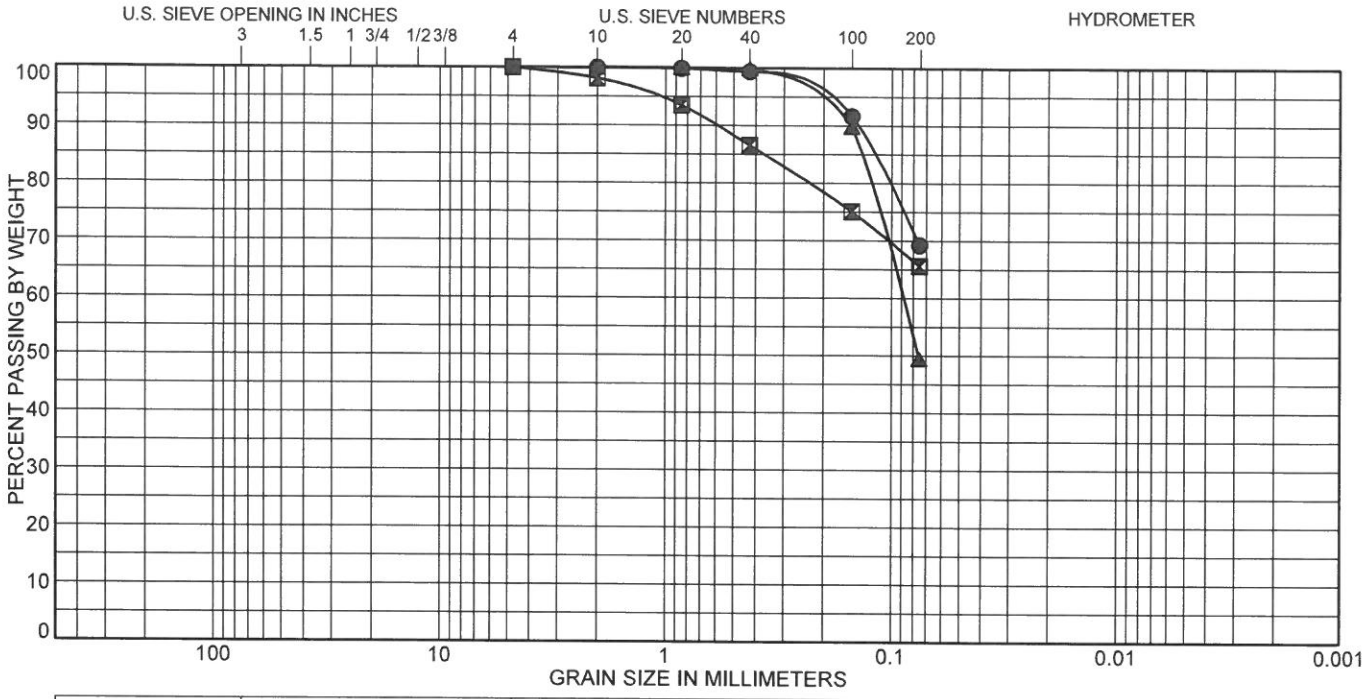
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 159927
FIGURE No. 4
PAGE 1 OF 1
DATE 9/28/17



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Test Boring	Depth (ft)	Classification	LL	PL	PI
●	B-1	9.0	SANDY SILT(ML)	43	28	15
⊠	B-2	4.0	SANDY LEAN CLAY(CL)	40	21	19
▲	B-2	14.0	SILTY SAND(SM)	38	29	9

	Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	B-1	9.0	0.0	30.8	69.2	
⊠	B-2	4.0	0.0	34.4	65.6	
▲	B-2	14.0	0.0	50.6	49.4	

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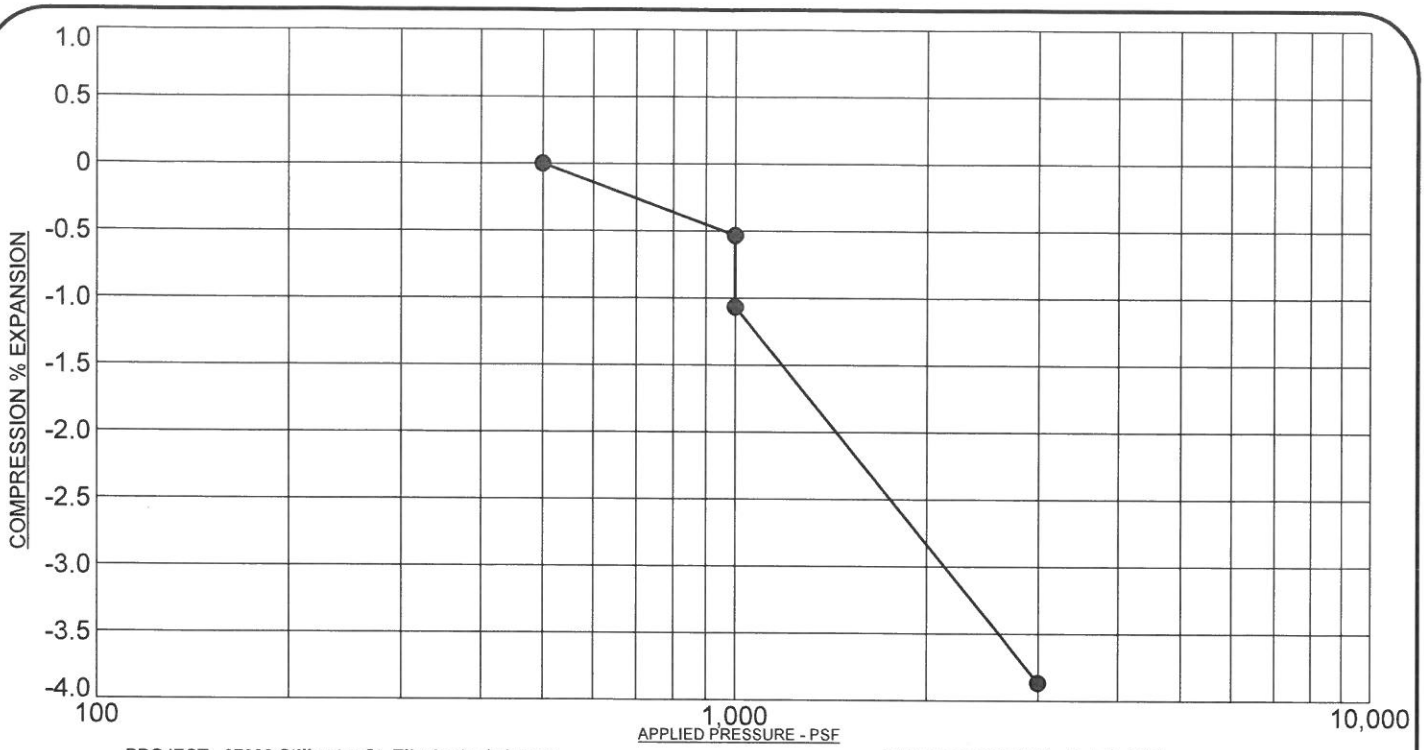
SOIL CLASSIFICATION DATA

JOB No. 159927

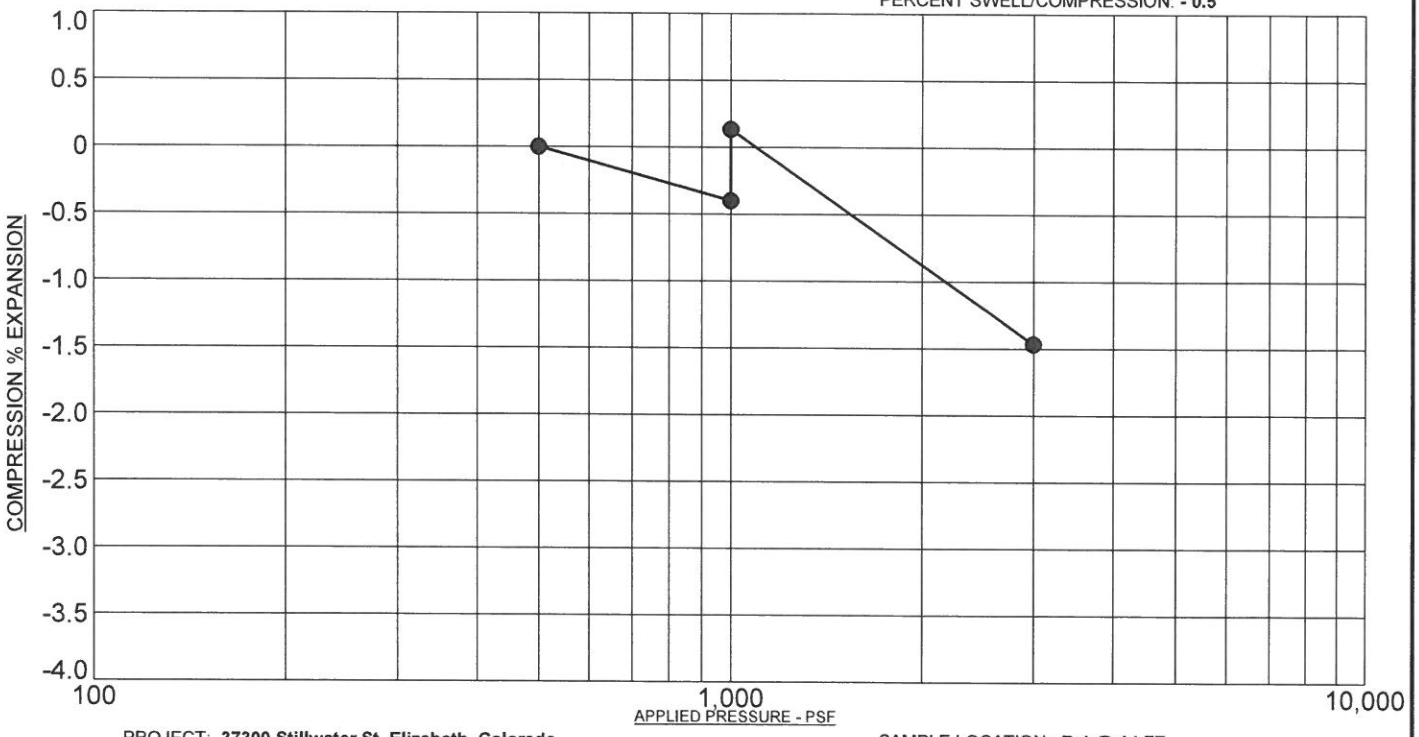
FIGURE No. 5

DATE 9/28/17



PROJECT: **37300 Stillwater St Elizabeth, Colorado**
SAMPLE DESCRIPTION: **Sandy Clay**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-1 @ 4 FT**
NATURAL DRY UNIT WEIGHT: **107.0 PCF**
NATURAL MOISTURE CONTENT: **8.5%**
PERCENT SWELL/COMPRESSION: **- 0.5**



PROJECT: **37300 Stillwater St Elizabeth, Colorado**
SAMPLE DESCRIPTION: **Sandstone**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-1 @ 14 FT**
NATURAL DRY UNIT WEIGHT: **106.5 PCF**
NATURAL MOISTURE CONTENT: **11.1%**
PERCENT SWELL/COMPRESSION: **0.5**

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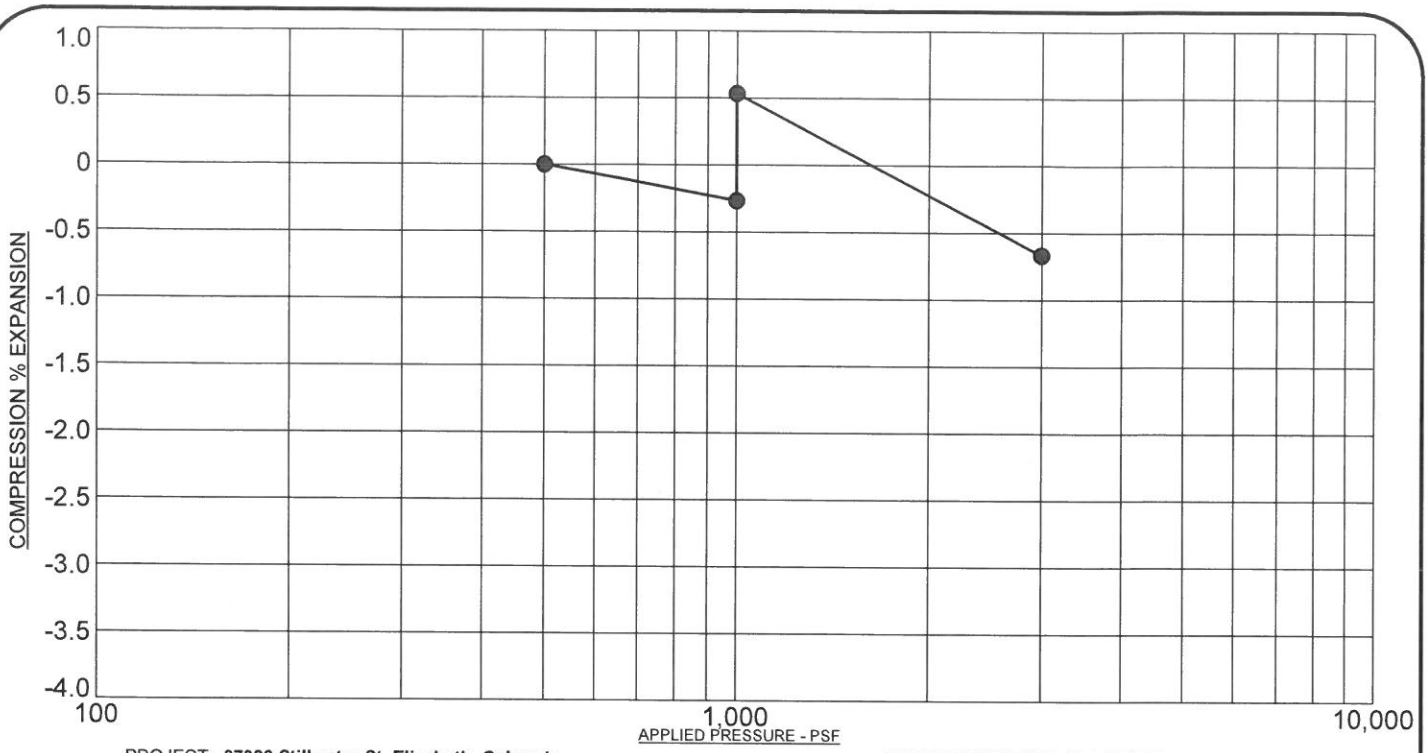
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 159927

FIGURE No. 6

DATE 9/28/17



PROJECT: **37300 Stillwater St Elizabeth, Colorado**
SAMPLE DESCRIPTION: **Interbedded Sandy Silt and Silty Sand**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 1,000 PSF

SAMPLE LOCATION: **B-2 @ 9 FT**
NATURAL DRY UNIT WEIGHT: **107.4 PCF**
NATURAL MOISTURE CONTENT: **10.9%**
PERCENT SWELL/COMPRESSION: **0.8**

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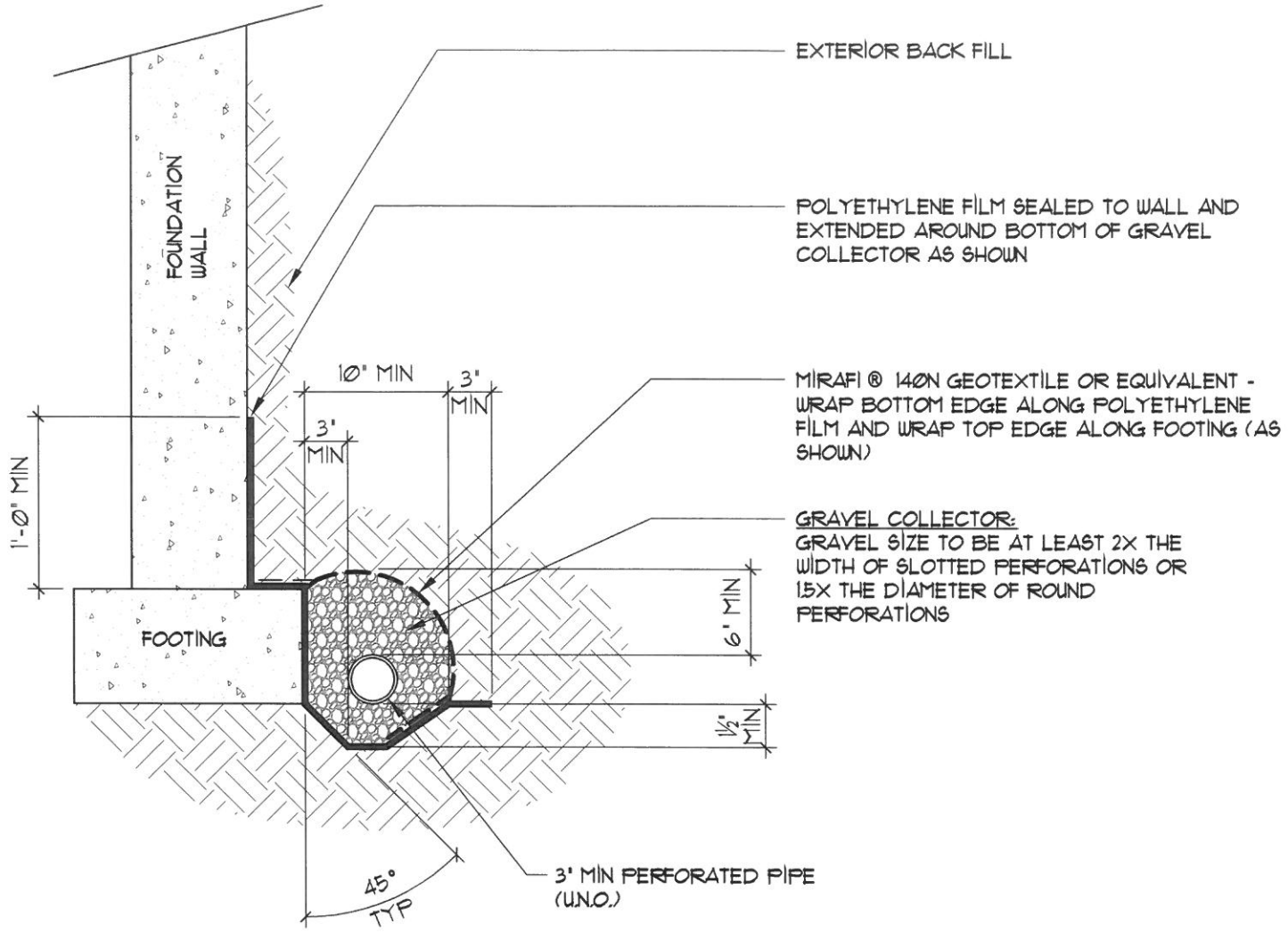
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 159927

FIGURE No. 7

DATE 9/28/17



GENERAL NOTES:

1. BOTTOM OF DRAIN PIPE SHALL BE AT OR BELOW BOTTOM OF FOOTING AT ALL LOCATIONS
2. ALL DRAIN PIPE SHALL BE PERFORATED PLASTIC, WITH THE EXCEPTION OF THE DISCHARGE PORTION WHICH SHALL BE SOLID, NON-PERFORATED PIPE.
3. DRAIN PIPE SHALL HAVE POSITIVE FALL THROUGHOUT.
4. DRAIN PIPE SHALL BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. IF A GRAVITY OUTFALL CANNOT BE ACHIEVED, THEN A SUMP PIT AND PUMP SHALL BE USED.
5. ALL DRAIN COMPONENTS SHALL BE RATED/APPROVED BY THE MANUFACTURER FOR THE INSTALLED DEPTH AND APPLICATION
6. DRAIN SYSTEM, INCLUDING THE OUTFALL OF THE DRAIN, SHALL BE OBSERVED BY QUALIFIED PERSONNEL PRIOR TO BACKFILLING TO VERIFY INSTALLATION.

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PERIMETER DRAIN

FIG No. 8