June 17, 2014

Re: Geotechnical Subsurface Exploration Report

Lot 3, Block 1 – The Ridge at Riverdale
13945 Riverdale Road
Brighton, Colorado
Soilogic Project # 14-1081

Soilogic, Inc. (Soilogic) personnel have completed the geotechnical subsurface exploration you requested for a proposed single-family residence to be constructed on Lot 3, Block 1 in the The Ridge at Riverdale residential development in Brighton, Colorado. The results of our subsurface exploration and pertinent geotechnical engineering recommendations are included with this report.

We anticipate the proposed residence will be a single to two-story wood-frame structure constructed over a full basement. Foundation loads for the structure are expected to be relatively light, with continuous wall loads less than 3 kips per lineal foot and individual column loads less than 75 kips. Small grade changes are anticipated to develop finish site grades in the residence area. Wastewater generated by the residence will be disposed of through an on-site wastewater treatment system (OWTS).

The purpose of our investigation was to describe the subsurface conditions encountered in the completed site borings and develop the test data necessary to provide recommendations concerning design and construction of the residence foundation and support of floor slabs and exterior flatwork. Results of a completed site percolation test are also included. The conclusions and recommendations outlined in this report are based on results of the completed field and laboratory testing and our experience with subsurface conditions in this area.

SITE DESCRIPTION

The proposed residence will be constructed on Lot 3, Block 1 in the The Ridge at Riverdale residential development, located at 13945 Riverdale Road in Brighton, Colorado. At the time of our site exploration, the proposed construction area had been recently graded, was generally devoid of vegetation and relatively level, with the maximum difference in ground surface elevation across the approximate building footprint estimated to be on the order of about 2 feet or less. Evidence of prior building construction was not observed in the proposed construction area by Soilogic personnel at the time of our site exploration.

EXPLORATION AND TESTING PROCEDURES

To develop site specific subsurface information, two (2) soil borings were extended to depths ranging from approximately 15 to 30 feet below present site grades within the approximate building envelope. The proposed building envelope location was conveyed to Soilogic by a representative of the client and the boring locations were established in the field by Soilogic personnel based on that information using a mechanical surveyor's wheel and estimating angles from identifiable site references. The boring locations should be considered accurate only to the degree implied by the methods used to make the field measurements. A diagram indicating the approximate boring locations is included with this report. Graphic logs of each of the auger borings are also included.

The test holes were advanced using 4-inch diameter continuous-flight auger, powered by a truck-mounted CME-55 drill rig. Samples of the subsurface materials were obtained at regular intervals using California barrel sampling procedures in general accordance with ASTM specification D-1586. Penetration resistance measurements were obtained by driving the standard sampling barrels into the substrata using a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the samplers a distance of 12 inches is recorded and helpful in estimating the consistency, relative density or hardness of the soils or bedrock encountered. In the California barrel sampling procedure, lesser disturbed samples are obtained in removable brass liners. Samples of the subsurface materials obtained in the field were sealed and returned to the laboratory for further evaluation, classification and testing.

The samples collected were tested in the laboratory to measure natural moisture content and dry density and visually and/or manually classified in accordance with the Unified Soil Classification System (USCS). The USCS group symbols are indicated on the attached boring logs. An outline of the USCS classification system is included with this report. Classification of bedrock was completed through visual and tactual observation of disturbed samples. Other bedrock types could be revealed through petrographic analysis.

As part of the laboratory testing, a calibrated hand penetrometer (CHP) was used to estimate the unconfined compressive strength of essentially cohesive specimens. The CHP also provides a more reliable estimate of soil consistency than tactual observation alone. Dry density, Atterberg limits, -200 wash and swell/consolidation tests were completed on selected samples to help establish specific soil characteristics. Atterberg limits tests are used to determine soil plasticity. The percent passing the #200 size sieve (-200 wash) test is used to determine the percentage of fine grained soils (clay and silt) in a sample. Swell/consolidation tests are performed to evaluate soil volume change potential with variation in moisture content. The results of the completed laboratory tests are outlined on the attached boring logs and swell/consolidation summary sheets.

SUBSURFACE CONDITIONS

The materials encountered in the completed site borings can be summarized as follows. Mottled gray/brown sandy lean clay with claystone was encountered at ground surface at the boring locations. This material was identified as existing fill which had been placed to develop finish site grade. The existing lean clay/claystone fill varied from stiff to very stiff in terms of consistency, exhibited high swell potential at current moisture and density conditions and extended to depths between about 4½ to 7½ feet below present site grades, where it was underlain by gray/brown/rust claystone bedrock with lenticular siltstone/sandstone interbeds. The bedrock varied from medium hard to very hard in terms of hardness and exhibited low to high swell potential at current moisture and density conditions. The site borings were terminated at depths ranging from approximately 15 to 30 feet below present site grades in the competent claystone bedrock.

The stratigraphy indicated on the included boring logs represents the approximate location of changes in soil and bedrock types. Actual changes may be more gradual than those indicated.

Groundwater was not encountered in either boring to the depths explored, approximately 15 to 30 feet below ground surface, when checked immediately after completion of drilling. When checked about 24 hours after drilling, the borings remained dry to the approximate depths explored. Groundwater levels will vary seasonally and over time based on weather conditions, site development, irrigation practices and other hydrologic conditions. Perched and/or trapped groundwater conditions may also be encountered at times throughout the year. Perched water is commonly encountered in soils overlying less permeable soil layers and/or bedrock. Trapped water is commonly encountered within more permeable zones of layered bedrock systems. The location and amount of perched and/or trapped water can also vary over time.

ANALYSIS AND RECOMMENDATIONS

General

The overburden lean clay/claystone fill and underlying claystone bedrock encountered at this site typically exhibited moderate high swell potential in laboratory testing at current moisture and density conditions. Heaving of site improvements placed directly on or immediately above the expansive existing fill and underlying claystone bedrock would be expected as the moisture content of those materials increases subsequent to construction. In order to reduce the potential for movement of the structure in the expansive soils/bedrock environment, we recommend the residence be supported by a drilled pier foundation system. This type of system extends the foundation elements through expansive materials which are subjected to wetting and swelling and can place them in materials not as likely to experience significant moisture changes and resulting volume change. At the same time, drilled piers better concentrate building dead-loads, aiding in the resistance of uplift forces caused by expansive materials. There will remain some risk associated with building in areas of expansive soils/bedrock. The risk of some movement and associated distress cannot be eliminated.

Swell-consolidation tests indicate that the lean clay/claystone existing fill and underlying claystone bedrock likely to influence slab-on-grade construction typically have moderate to high swell potential. For this site, we estimate total slab heave of 9 inches or more could be realized over time if deep wetting of the site occurs. Therefore, we recommend all floor slabs be constructed as structural floors supported independent of the subgrade materials. Recommendations concerning drilled pier foundation design criteria and structural floor systems are outlined below.

Drilled Pier Foundations

We recommend drilled pier foundations extend a minimum of 9 feet into competent bedrock with minimum shaft lengths of 27 feet and be designed using a maximum allowable end bearing pressure of 25 kips per square foot (ksf). An allowable skin friction value of 2,500 psf could be used for that portion of the pier extended into competent bedrock. Credit for skin friction should be neglected for the top 3 feet of bedrock penetration.

We recommend the drilled piers be designed to maintain a minimum dead-load pressure of 8 ksf based on the cross-sectional area of the piers. If the minimum recommended dead-load pressure cannot be achieved, increasing the minimum length and bedrock penetration requirements outlined above could be considered to compensate for the deficiency. An uplift skin friction resistance value of 1,675 psf could be used to calculate additional uplift resistance for the increase in pier length only.

Piers should be designed with a length/diameter ratio of 30 or less and full length steel reinforcement to help transmit any axial tension loads that may develop in the pier shaft. Uplift forces can be calculated using the formula {F_{up} (kips) = 68 x D} where D is pier diameter in feet. A minimum 10-inch continuous void space should be constructed beneath the foundation grade beams to concentrate dead-load on the piers and allow for some movement of the subgrade soils to occur without transmitting stresses to the overlying structure. Voids should be formed using approved methods to prevent soil and debris from entering the void space. Void form material should be collapsible enough such that sufficient loads cannot be transmitted through the void form to mobilize the grade beams.

Based on the materials encountered in the completed site borings, we expect the pier excavations could be completed using conventional augering techniques. Pier excavations would be expected to remain stable for short periods during construction such that we do not expect temporary casing of the drilled shafts would be required. Care will be needed to minimize the amount of sloughing/caving of the pier excavation side walls. Sloughed soils will need to be removed from the bottom of the pier excavations immediately prior to placement of reinforcing steel and pier concrete. Groundwater was not encountered in the borings when checked about 24 hours after completion of drilling, however, the bedrock in this area has been known to contain water bearing seams. If groundwater is encountered during caisson construction, dewatering of the excavations or placement of pier concrete with a tremmie may be required. A maximum three (3) inch water depth is acceptable at the bottom of pier excavations immediately prior to concrete placement.

Pier concrete should have a slump in the range of 5 to 7 inches and be placed in the pier excavations immediately after the completion of drilling, cleaning and placement of reinforcing steel. Care should be taken in forming the upper edges of the pier excavation to avoid "mushrooming" at the top of the drilled pier excavations. The mushroom shape would provide additional area for expansive soil uplift forces. Cylindrical cardboard forms or other approved means may be necessary to maintain a consistent upper shaft diameter.

We estimate long-term settlement of the drilled caisson foundations designed and constructed as outlined above and resulting from the assumed structural loads would be less than ¾ of an inch.

Living Area Floors

In order to help reduce the potential for movement of the residence floors, we recommend all interior living areas be constructed with structurally supported floors over a void space. Building codes should be followed for clear space requirements below structurally supported floors with crawl space areas and will depend, in part upon the type of materials used to construct the floor, as well as the expansion potential of the underlying soils/bedrock. Clear spaces for these types of floors normally range from 18 to 24 inches. A larger crawl space area has the advantage of allowing maintenance of grade beam void spaces and sub floor utilities. Where other floor support systems and materials are used, we recommend a minimum clear space/void of 12 inches be maintained between the underside of the structural floor system and the surface of the subgrade/exposed earth. It is prudent to maintain the minimum clear space/void below all plumbing lines. This can be accomplished by hanging plumbing on the underside of the structural floor, or by trenching below the lines.

We recommend the subgrades in the voided/crawl space areas be sloped to drain to a perimeter drain system in case of water infiltration into the crawl space/void areas. A vapor barrier should be employed in the voided/crawl space areas in order to help maintain in-situ subgrade moisture conditions and reduce the potential for migration of soil moisture into the sub floor area. A specialist with regard to mold prevention should be consulted during design of the voided/crawl space areas of the residence.

We recommend a perimeter drain system be installed around the voided/crawl space area to help reduce the potential for development of hydrostatic pressures behind the below-grade walls and water infiltration into the voided/crawl space area. A perimeter drain system should consist of a 4-inch diameter perforated drain pipe surrounded by a minimum of six (6) inches of free-draining gravel. A filter fabric should be considered around the free-draining gravel or perforated pipe to reduce the potential for an influx of fine-grained soils into the system. The drain pipe should be placed at approximate void space subgrade level around the interior perimeter of the structure, sloped at a minimum of ⅛-inch per foot to facilitate efficient water removal and should be designed to discharge to a sump pump and pit system.

Backfill placed adjacent to the foundation walls should consist of low-volume-change (LVC) potential and relatively impervious soils free from organic matter, debris and other objectionable materials. Because of the high plasticity and swell potential of the existing lean clay/claystone fill and underlying claystone bedrock, the on-site materials should not be used for wall backfill. Import materials should have low potential for volume change and be relatively impervious. Fill soils should be approved prior to use. Typically soils with a liquid limit less than 40 and plasticity index less than 18 could be used as LVC fill. Suitable import LVC backfill soils should be placed in loose lifts not to exceed 9 inches thick, adjusted to within ±2% of standard Proctor optimum moisture content and compacted to at least 95% of the materials standard Proctor maximum dry density.

Excessive lateral stresses can be imposed on the below-grade walls when using heavier mechanical compaction equipment. We recommend compaction of unbalanced foundation wall backfill be completed using light mechanical or hand compaction equipment.

Lateral Earth Pressures

For design of foundation walls subject to unilateral loading and where preventative measures have been taken to reduce the potential for development of hydrostatic loads on the walls, we recommend using an active equivalent fluid pressure value of 40 pounds per cubic foot. Some rotation of the below-grade walls must occur to develop the active earth pressure state. That rotation can result in cracking of the basement walls typically in between corners and other restrained points. The amount of deflection of the top of the wall can be estimated at 0.5% times the height of the wall. An equivalent fluid pressure value of 60 pounds per cubic foot could be used for restrained wall conditions.

Variables that affect lateral earth pressures include but are not limited to the nature of the backfill soil, backfill compaction and geometry, wetting of the backfill soils, surcharge loads and point loads developed in the backfill materials. The recommended equivalent fluid pressure values do not include a factor of safety or an allowance for hydrostatic loads. Excessive compaction of the wall backfill, surcharge loads placed adjacent to the below-grade walls or use of expansive soil backfill can add to the lateral earth pressures causing the equivalent fluid pressure values used in design to be exceeded.

Garage Floor Slab

We recommend the garage slab be constructed as a structurally supported slab over a void/crawl space. A Twin-T structural concrete deck could be considered and would significantly reduce the potential for post-construction movement of the garage floor.

As a much higher risk and lower cost alternative, it is our opinion overexcavation/backfill procedures could be considered to reduce the swell potential or the garage floor slab subgrade soils and resultant amount of anticipated heaving of the slab. Higher risk would include a much greater potential for total and differential movement of the floor slab and associated distress in the form of cracking and faulting of the slab. We estimate total and differential slab heave of 5 inches of more could result if deep wetting of the site occurs, even if heave mitigation is performed. If the owner fully understands and is willing to accept the increased risk associated with this type of heave mitigation procedure, it is our opinion overexcavation/backfill procedures could be considered. At a minimum, we recommend the subgrade soils beneath the garage floor slab be overexcavated to the maximum prudent depth possible (approximate basement voided/crawl space subgrade level) and replaced with approved LVC import fill. Due to the high plasticity and swell potential of the site lean clay/claystone fill and underlying claystone bedrock, these materials should not be used as overexcavation/backfill such that importing of suitable overexcavation/replacement soils should be anticipated. The reconditioned mat will provide a zone of material immediately beneath the garage floor slab which will have low potential for volume change subsequent to construction. The LVC mat and surcharge loads placed on the underlying soils by the reconditioned mat would reduce the potential for total and differential movement of the supported slab. The reconditioned zone would also assist in distributing movement in the event that some swelling of the materials underlying the reconditioned zone occurs.

Overexcavation/backfill procedures will reduce, but not eliminate the potential for movement of the garage floor slab subsequent to construction. The risk of some movement cannot be eliminated and movement of lightly-loaded garage floor slabs should be expected. If the amount of movement estimated above and associated types of anticipated distress of the garage floor slab cannot be tolerated, a structural floor system should be employed.

Overexcavation/backfill materials should consist of approved LVC and relatively impervious soils free from organic matter, debris and other objectionable material. Because of the high plasticity and high to very high swell potential of the site lean clay/claystone fill and claystone bedrock, these materials should not be used as overexcavation/backfill. In addition, essentially granular structural fill soils should not be used as overexcavation/ backfill due to the ability of those materials to pond and transmit water.

After stripping and completing the overexcavation, suitable overexcavation/backfill soils should be placed in loose lifts not to exceed 9 inches thick, adjusted in moisture content and compacted to at least 95% of the materials standard Proctor maximum dry density. The moisture content of approved LVC import soils should be adjusted to be within ±2% of standard Proctor optimum moisture content at the time of compaction.

The garage floor slab could be supported directly on the overexcavation/backfill soils placed and compacted as outlined above. Care should be taken to maintain the proper moisture content in the subgrade soils prior to placement of floor slab concrete. In addition, prepared structural soils should not be left exposed for extended periods of time. In the event that the backfill soils are allowed to dry out or if rain, snowmelt or water from any other source is allowed to infiltrate the backfill soils, reworking of the subgrade soils or removal/replacement procedures may be required.

As a precaution, we recommend omitting garage partition walls supported above slabs-on-ground. If included in the design, partition walls should be constructed as floating walls to help reduce the potential for differential slab to foundation movement causing distress in upper sections of the building. A minimum 3-inch void space is recommended. Frequent monitoring of this void space should be completed to ensure that a sufficient space is maintained throughout the life of the structure. Special attention to framing, drywall installation, and trim carpentry should be taken to isolate those elements from the floor slabs allowing for some differential foundation to floor slab movement to occur without transmitting stresses to the overlying structures.

Inherent risks exist when building in areas of expansive soils/bedrock. The overexcavation/backfill procedures outlined above will reduce, but not eliminate the potential for movement of the garage floor slab subsequent to construction. The in-place materials below the moisture-conditioned zone can experience volume change with variation in moisture content, causing some floor slab movement.

Exterior Flatwork

Existing lean clay with bedrock fill with high swell potential will support sidewalks, driveways and other at-grade features on this site. The performance of sidewalks, driveways and other at-grade features on expansive soils is erratic and these features will likely heave and crack when the underlying soils increase in moisture content. Performance of these features may be unreasonable in some instances and may require frequent maintenance or replacement. If movement of these features cannot be accepted and/or must be reduced, swell/heave mitigation should be completed.

Heave mitigation would involve removal of at least 3 feet of the expansive lean clay/claystone fill and replacing these materials with approved LVC fill or recompacting the on-site existing fill with strict moisture and density control to reduce swell potential. In order to effectively reduce swell potential, the existing site lean clay/claystone fill would need to be properly processed and re-compacted at or above optimum moisture content as outlined for the scarified subgrade below. Import LVC soils should be moisture conditioned and compacted to the standards previously outlined. It should be recognized that even if these heave mitigation recommendations are followed some exterior flatwork/pavement distress in the form of cracking and faulting should be anticipated.

All existing topsoil and vegetation should be removed from exterior flatwork areas. After stripping and completing all cuts and prior to placement of any fill or flatwork concrete, we recommend the exposed subgrade soils be scarified to a depth of 9 inches, adjusted in moisture content and compacted to within 94% to 98% of the material's standard Proctor maximum dry density. The moisture content of the scarified soils should be adjusted to be within the range of 0% to +4% of standard Proctor optimum moisture content at the time of compaction.

Fill soils required to develop exterior flatwork subgrades should consist of approved LVC soils, free from organic matter, debris and other objectionable materials. Based on results of the completed laboratory testing, it is our opinion the site lean clay/claystone fill could be used as fill beneath exterior flatwork provided the proper moisture content is developed in those materials at the time of placement and compaction. Claystone bedrock should not be used as fill beneath exterior flatwork. We recommend the existing site lean clay/claystone fill or similar soils be placed in loose lifts not to exceed 9 inches thick, adjusted in moisture content and compacted as recommended for the scarified materials above. Exterior flatwork could be supported directly on the reconditioned existing fill soils or suitable fill soils placed and compacted as outlined above with the understanding that some movement of exterior flatwork will occur subsequent to construction.

Care should be taken to avoid disturbing exterior flatwork subgrades prior to placement of the overlying improvements. Subgrade soils expected to receive exterior flatwork concrete should be evaluated closely immediately prior to concrete placement. If areas of disturbed, wet and softened, or dry subgrade soils develop during construction, those materials should be removed and replaced or reworked in place prior to concrete placement.

Exterior flatwork will experience some heaving subsequent to construction as the subgrade soils increase in moisture content. Theoretically, total free field heave of exterior flatwork of 10 inches or more could be realized over time if deep wetting of the site occurs. The overexcavation/backfill procedures outlined above would reduce the amount of anticipated post-construction heaving of those improvements and tend to make movements more uniform. Care should be taken to ensure that when exterior flatwork moves, positive drainage will be maintained away from the residence.

Drainage

Positive drainage is imperative for long-term performance of the proposed residence and associated site improvements. We recommend positive drainage be developed away from the structure during construction and maintained throughout the life of the site improvements, with twelve (12) inches of fall in the first 10 feet away from the building. Shallower slopes could be considered in hardscape areas. In the event that some settlement of the backfill soils occurs adjacent to the residence, the original grade and associated positive drainage outlined above should be immediately restored.

Care should be taken in the planning of landscaping to avoid features which could result in the fluctuation of the moisture content of the foundation bearing and/or flatwork subgrade soils. We recommend watering systems be placed a minimum of 5 feet away from the perimeter of the site structure and be designed to discharge away from all site improvements. Gutter systems should be considered to help reduce the potential for water ponding adjacent to the structure with the gutter downspouts, roof drains or scuppers extended to discharge a minimum of 5 feet away from structural, flatwork and pavement elements. Water which is allowed to pond adjacent to the site improvements can result in unsatisfactory performance of those improvements over time.

Site Percolation Test

Three (3) six-inch diameter percolation test holes and one 9-foot deep profile boring were completed in the approximate area of the proposed wastewater absorption field. The materials encountered in the profile boring consisted of existing fill composed of sandy lean clay and bedrock fragments. The lean clay/claystone fill was stiff in consistency and extended to a depth of approximately 8 feet below ground surface, where it was underlain by gray/brown/rust claystone bedrock. The claystone extended to the bottom of boring at a depth of approximately 9 feet below ground surface. Groundwater was not encountered in the completed profile boring at the time of drilling, nor when checked 24 hours after drilling. A log of the profile test hole is included with this report as boring B-3.

An average percolation rate of 36.7 minutes per inch was established in the percolation test borings after presoaking for approximately 24 hours. Tri-County Health Department guidelines require a percolation rate in the range of 5 to 60 minutes per inch for use of a non-engineered conventional septic absorption field. The measured percolation rate meets that criterion. In addition, Tri-County guidelines require that neither groundwater nor bedrock be encountered within 4 feet of the bottom of the proposed absorption field. The test boring completed indicates the thickness of the near-surface site soils is sufficient to meet the bedrock separation criteria. Tri-County criteria concerning the proximity of septic system components to site features and amenities should be addressed at the time of system installation.

GENERAL COMMENTS

This report was prepared based upon the data obtained from the completed site exploration, laboratory testing, engineering analysis and any other information discussed. The completed borings provide an indication of subsurface conditions at the boring locations only.

Variations in subsurface conditions can occur in relatively short distanced away from the borings. This report does not reflect any variations which may occur across the site or away from the borings. If variations in the subsurface conditions anticipated become evident, the geotechnical engineer should be notified immediately 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 biological or environmental assessment of the site or identification or prevention of pollutants or hazardous materials or conditions. Other studies should be completed if concerns over the potential of such contamination or pollution exist.

The geotechnical engineer should be retained to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. The geotechnical engineer should also be retained to provide testing and observation services during construction to help determine that the design requirements are fulfilled.

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 the generally accepted standard of care for the profession. No warranties express or implied, are made. The conclusions and recommendations contained in this report should not be considered valid in the event that any changes in the nature, design or location of the project as outlined in this report are planned, unless those changes are reviewed and the conclusions of this report modified and verified in writing by the geotechnical engineer.

We appreciate the opportunity to be of service to you on this project. If we can be of further service to you in any way or if you have any questions concerning the enclosed information, please do not hesitate to contact us.

Very Truly Yours,
Soilogic, Inc.

COLORADO REGISTERED PROFESSIONAL ENGINEER
DARREL J. DICARLO
44271

Darrel DiCarlo, P.E.
Senior Project Engineer

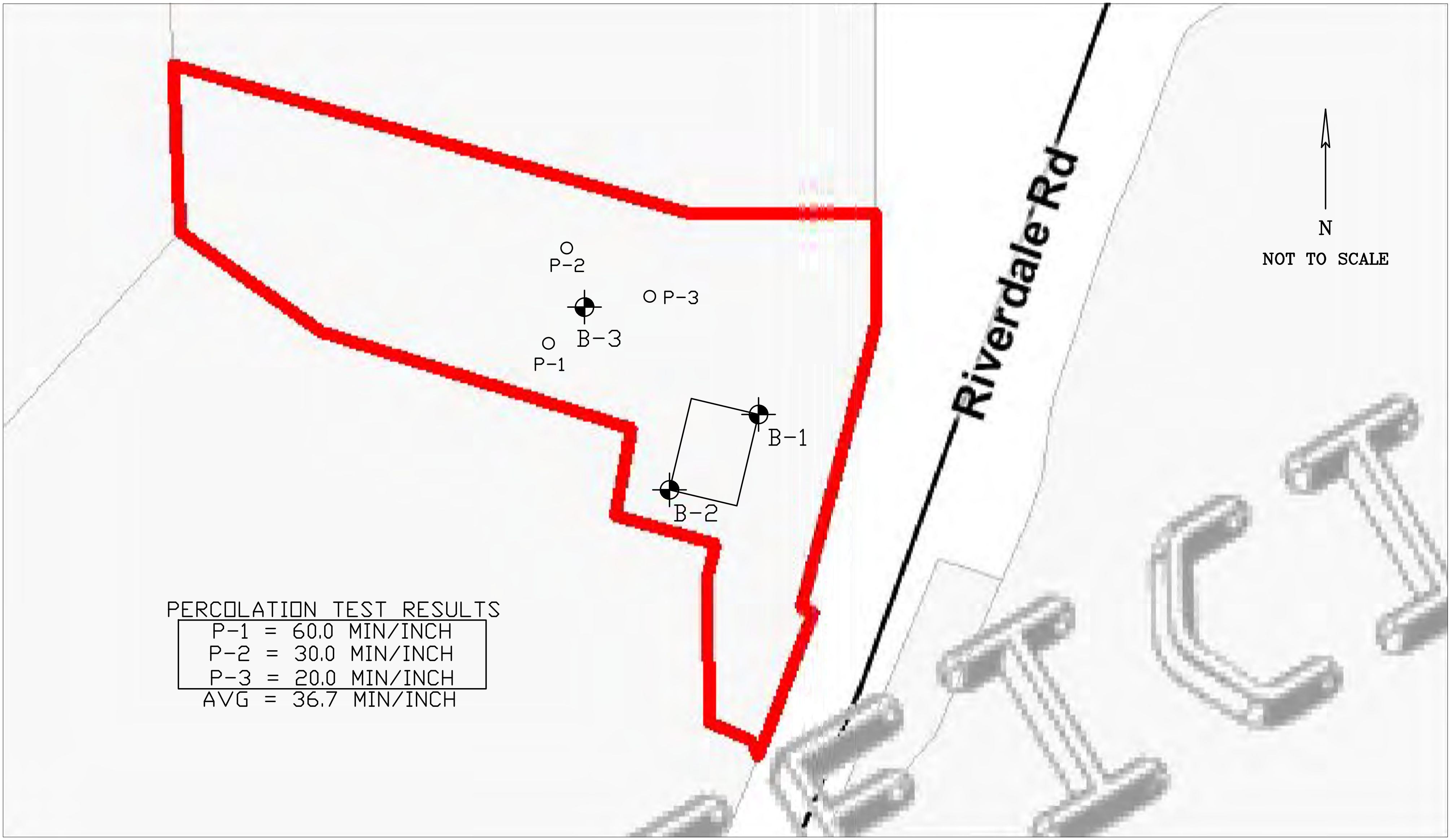
Reviewed by:

COLORADO REGISTERED PROFESSIONAL ENGINEER
WOLFRAM VON CARLOWITZ
36746

Wolf von Carlowitz, P.E.
Principal Engineer

JUNE 2014
PROJECT # 14-1081

BORING LOCATION DIAGRAM



LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE SUBDIVISION
13945 RIVERDALE ROAD, BRIGHTON, ADAMS COUNTY, COLORADO

LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

13945 RIVERDALE ROAD, BRIGHTON, COLORADO
Project # 14-1081
June 2014

SOILOGIC

LOG OF BORING B-1

Sheet	1/1	Drilling Rig:	CME 55	Water Depth Information	
Start Date	6/3/2014	Auger Type:	4" CFA	During Drilling	None
Finish Date	6/3/2014	Hammer Type:	Automatic	After Drilling	None
Surface Elev.	-	Field Personnel:	BMc	24 Hours After Drilling	None

USCS	SOIL DESCRIPTION	Depth (ft)	Sampler	"N"	MC (%)	DD (pcf)	Estimated q_u (psf)	% Swell @ 500 psf	Swell Pressure (psf)	Atterberg Limits LL	Atterberg Limits PI	% Passing # 200 Sieve (%)
CL	PROBABLE EXISTING FILL MATERIAL; SANDY LEAN CLAY with CLAYSTONE dark brown, brown, gray, rust stiff to very stiff	3	CS	14	11.9	-	-	-	-	-	-	-
		5	CS	20	12.8	106.6	9000+	8.0%	4200	-	-	-
	CLAYSTONE with lenticular SILTSTONE/SANDSTONE interbeds gray, brown, rust medium hard to very hard	10	CS	50/11"	14.3	120.4	9000+	5.8%	10000	-	-	-
		15	CS	50/5"	10.6	116.1	9000+	4.2% @ 1000	8000	-	-	-
		20	CS	50/7"	14.2	113.8	9000+	-	-	-	-	-
	BOTTOM OF BORING @ 30.0'	30	CS	50/6"	25.6	104.0	9000+	-	-	-	-	-

LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

13945 RIVERDALE ROAD, BRIGHTON, COLORADO
Project # 14-1081
June 2014

LOG OF BORING B-2

Sheet	1/1	Drilling Rig:	CME 55	Water Depth Information	
Start Date	6/3/2014	Auger Type:	4" CFA	During Drilling	None
Finish Date	6/3/2014	Hammer Type:	Automatic	After Drilling	None
Surface Elev.	-	Field Personnel:	BMc	24 Hours After Drilling	None

USCS	SOIL DESCRIPTION	Depth (ft)	Sampler	"N"	MC (%)	DD (pcf)	Estimated q_u (psf)	% Swell @ 500 psf	Swell Pressure (psf)	Atterberg Limits LL	Atterberg Limits PI	% Passing # 200 Sieve (%)
CL	PROBABLE EXISTING FILL MATERIAL; SANDY LEAN CLAY with CLAYSTONE dark brown, brown, gray, rust very stiff	0 - 4										
	CLAYSTONE with lenticular SILTSTONE/SANDSTONE interbeds gray, brown, rust hard to very hard	5	CS	50/8"	20.0	109.6	9000+	3.8%	5200	-	-	-
		10	CS	50/5"	11.2	107.6	9000+	0.5%	1100	-	-	-
		15	CS	50/3"	15.3	105.0	9000+	-	-	-	-	-
	BOTTOM OF BORING @ 15.0'	16 - 25										

LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

13945 RIVERDALE ROAD, BRIGHTON, COLORADO
Project # 14-1081
June 2014

LOG OF BORING B-3

SOILOGIC

Sheet	1/1	Drilling Rig:	CME 55	Water Depth Information	
Start Date	6/3/2014	Auger Type:	4" CFA	During Drilling	None
Finish Date	6/3/2014	Hammer Type:	Automatic	After Drilling	None
Surface Elev.	-	Field Personnel:	BMc	24 Hours After Drilling	None

USCS	SOIL DESCRIPTION	Depth (ft)	Sampler	"N"	MC (%)	DD (pcf)	Estimated q_u (psf)	% Swell @ 500 psf	Swell Pressure (psf)	Atterberg Limits LL	Atterberg Limits PI	% Passing # 200 Sieve (%)
CL	PROBABLE EXISTING FILL MATERIAL; SANDY LEAN CLAY with CLAYSTONE dark brown, brown, gray, rust medium stiff	- 1 - 2 - 3 - 4 -										
		5	SS	7	-	-	-	-	-	57	38	92.1%
		- 6 - 7 - 8										
	CLAYSTONE with SILTSTONE/SANDSTONE	- 9										
	BOTTOM OF BORING @ 9.0'	- **10** - 11 - 12 - 13 - 14 - **15** - 16 - 17 - 18 - 19 - **20** - 21 - 22 - 23 - 24 - **25**										

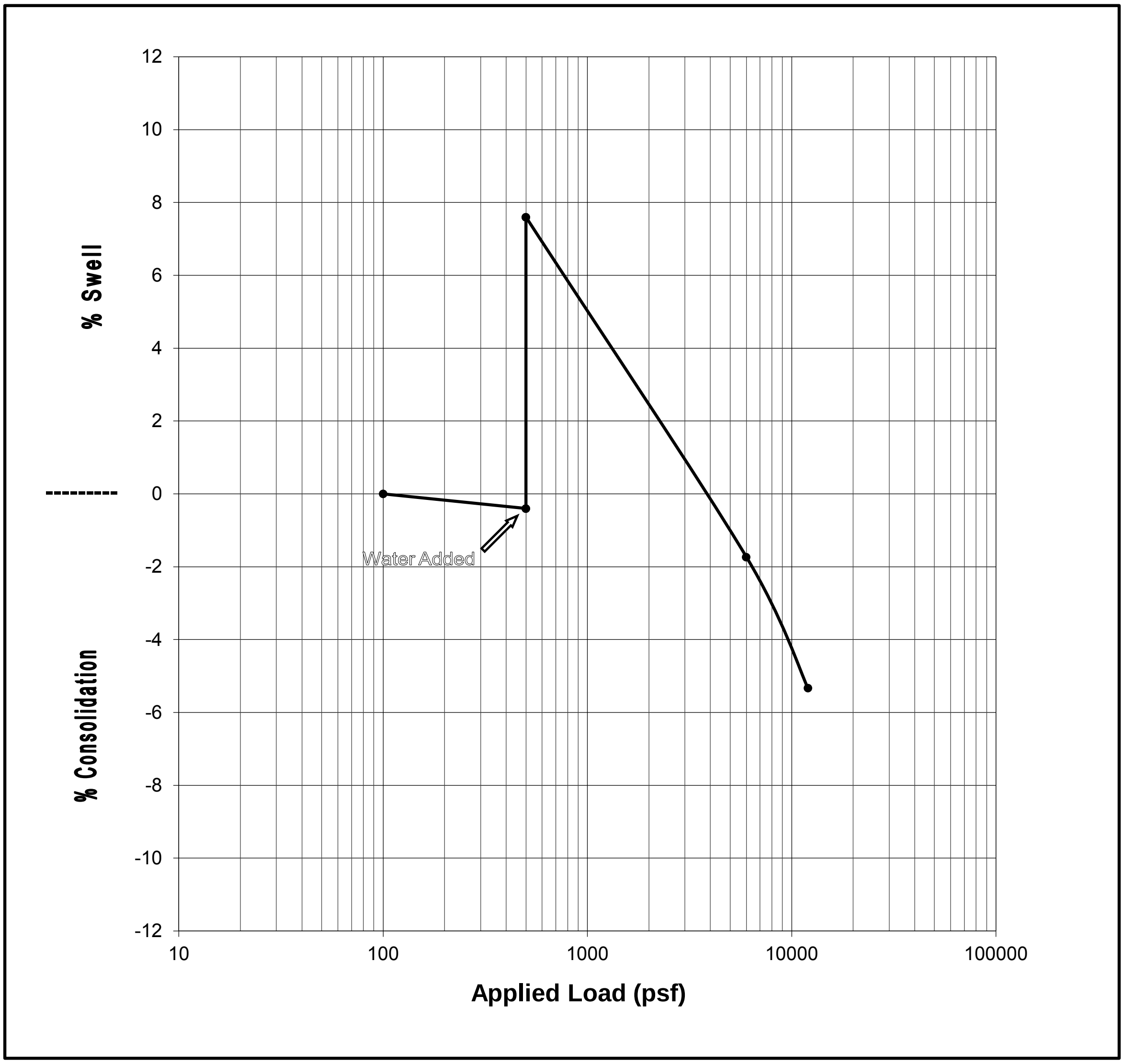
LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

BRIGHTON, COLORADO

Project # 14-1081

June 2014

SWELL/CONSOLIDATION TEST SUMMARY



Sample ID: B-1 @ 4'

Sample Description: Gray/Brown Sandy Lean Clay (CL) with Claystone

Initial Moisture	12.8%	Liquid Limit	-
Final Moisture	23.1%	Plasticity Index	-
% Swell @ 500 psf	8.0%	% Passing #200	-
Swell Pressure	4,200 psf	Dry Density	106.6 pcf

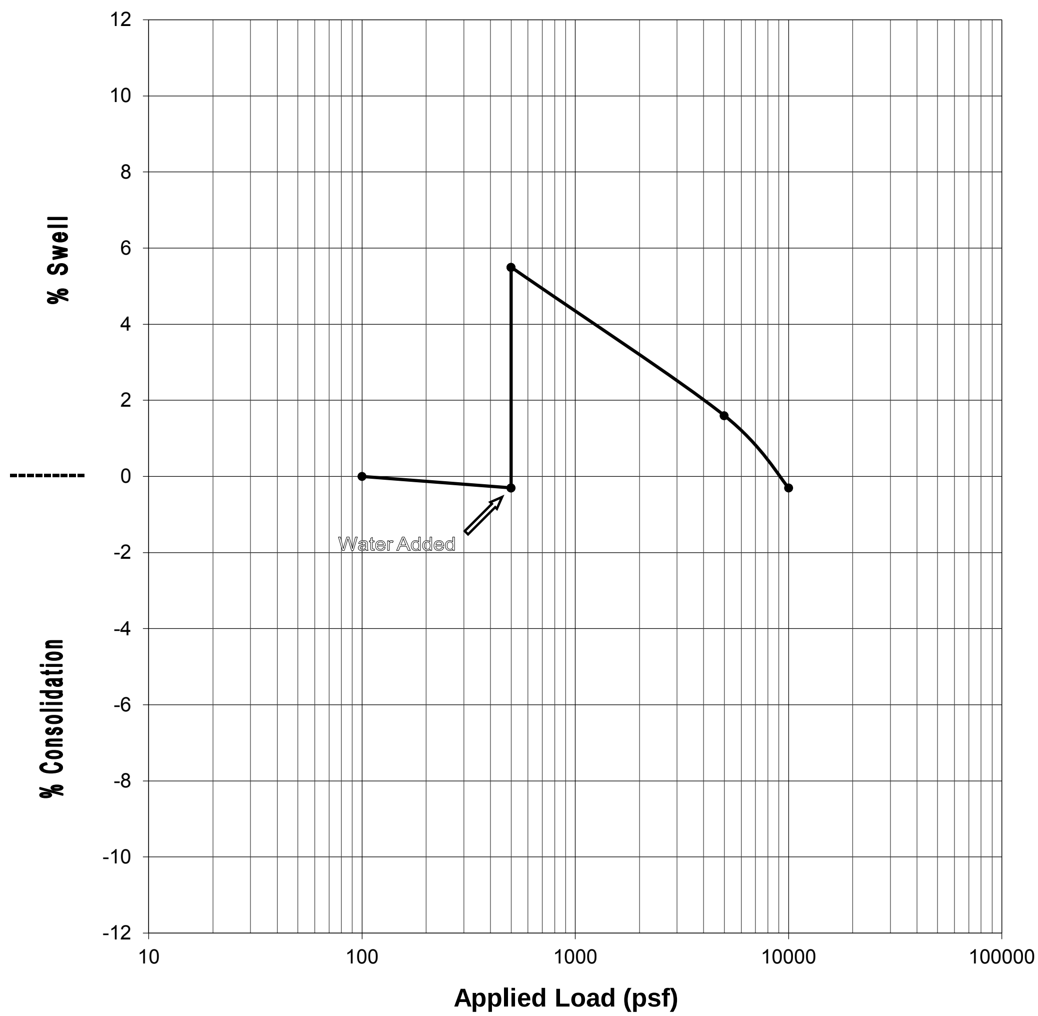
LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

BRIGHTON, COLORADO

Project # 14-1081

June 2014

SWELL/CONSOLIDATION TEST SUMMARY



Sample ID: B-1 @ 9'

Sample Description: Gray/Brown Claystone

Initial Moisture	14.3%	Liquid Limit	-
Final Moisture	19.6%	Plasticity Index	-
% Swell @ 500 psf	5.8%	% Passing #200	-
Swell Pressure	10,000 psf	Dry Density	120.4 pcf

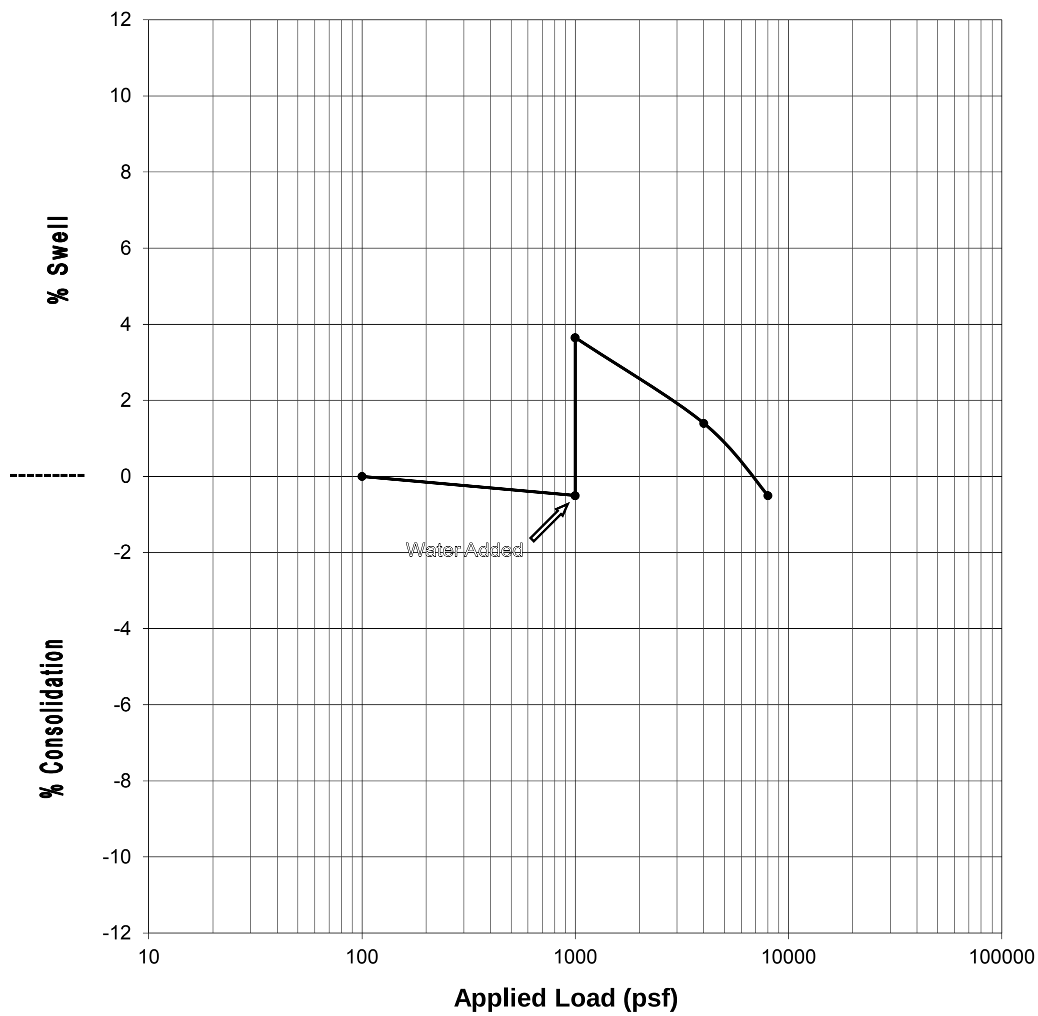
LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

BRIGHTON, COLORADO

Project # 14-1081

June 2014

SWELL/CONSOLIDATION TEST SUMMARY



Sample ID: B-1 @ 14'

Sample Description: Gray/Brown Claystone with Siltstone/Sandstone

Initial Moisture	10.6%	Liquid Limit	-
Final Moisture	24.0%	Plasticity Index	-
% Swell @ 1,000 psf	4.2%	% Passing #200	-
Swell Pressure	8,000 psf	Dry Density	116.1 pcf

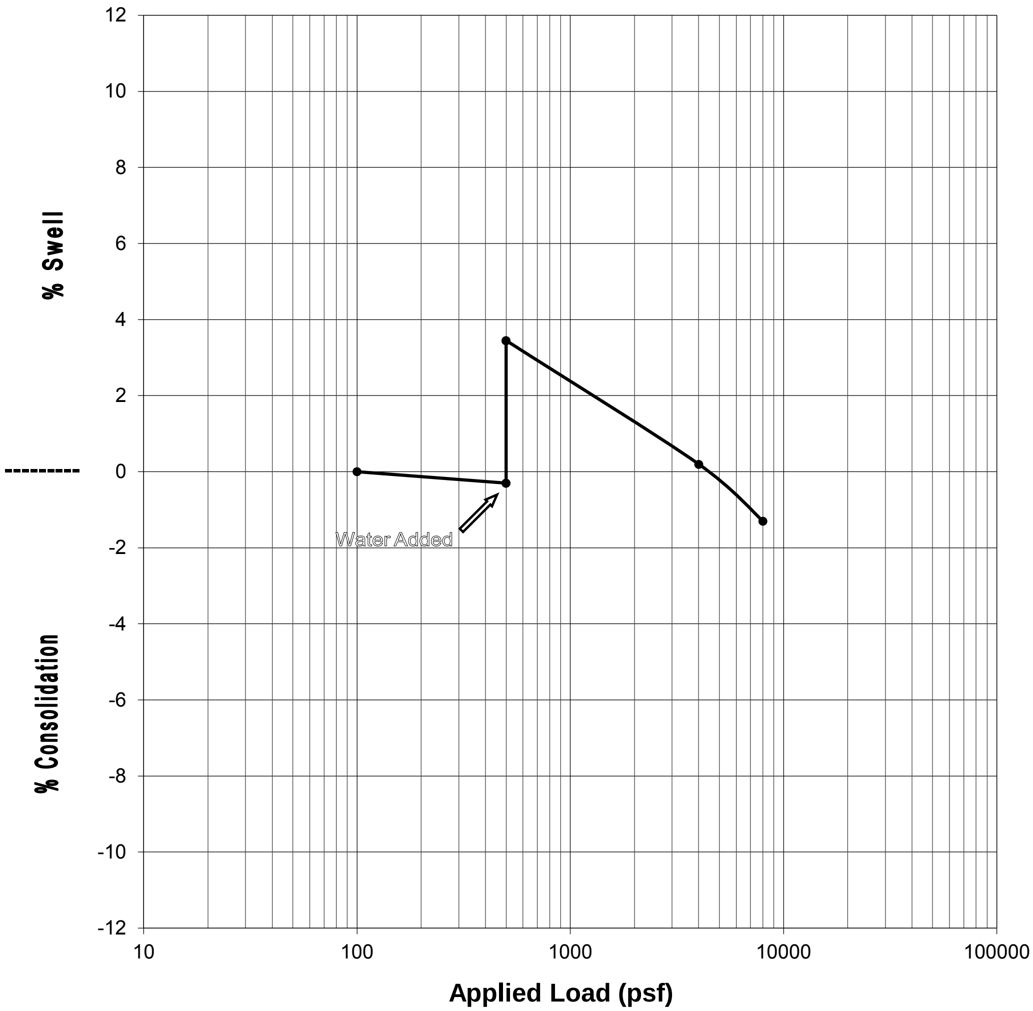
LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

BRIGHTON, COLORADO

Project # 14-1081

June 2014

SWELL/CONSOLIDATION TEST SUMMARY



Sample ID: B-2 @ 4'

Sample Description: Gray/Brown Claystone

Initial Moisture	20.0%	Liquid Limit	-
Final Moisture	21.4%	Plasticity Index	-
% Swell @ 500 psf	3.8%	% Passing #200	-
Swell Pressure	5,200 psf	Dry Density	109.6 pcf

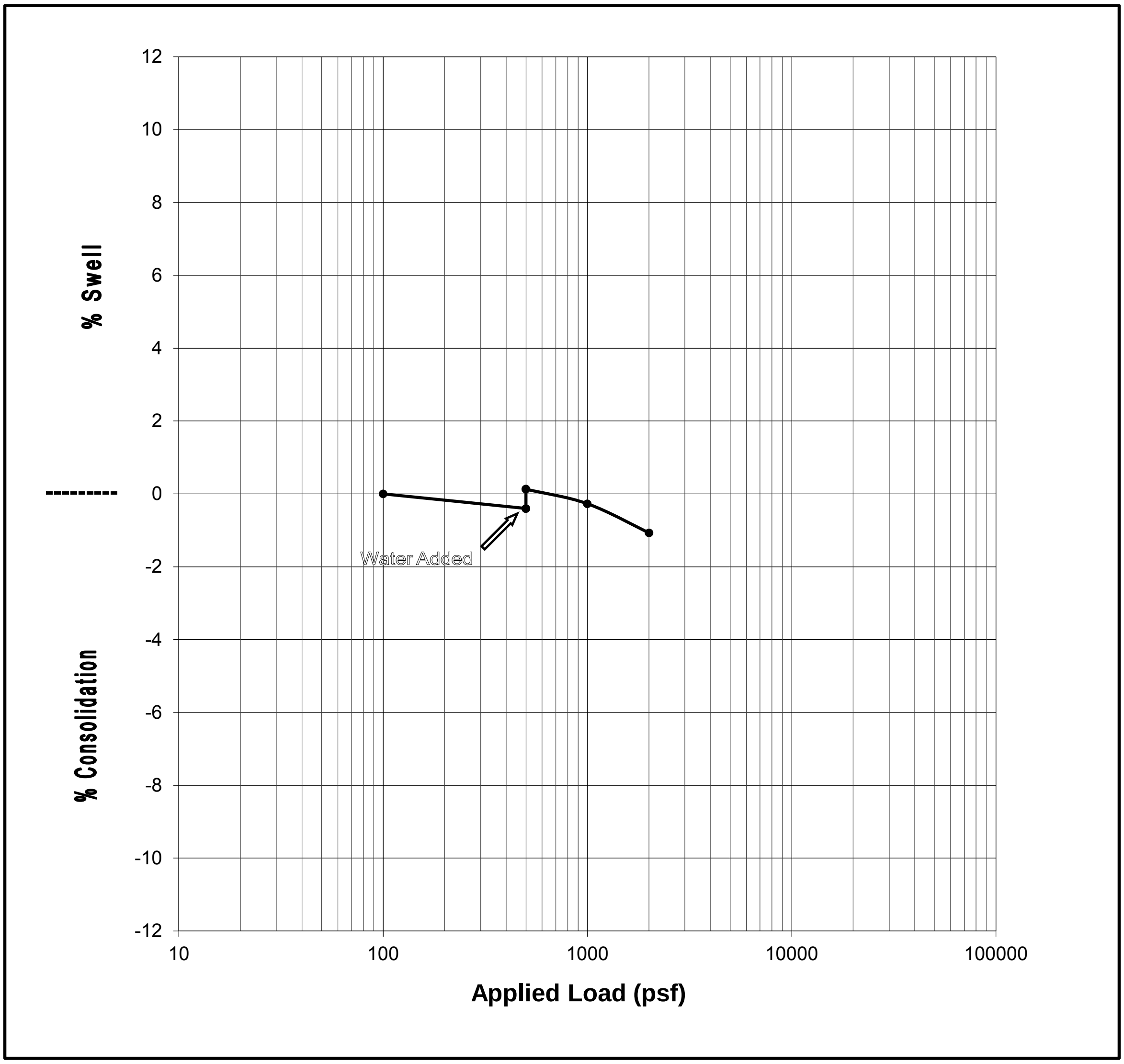
LOT 3, BLOCK 1 - THE RIDGE AT RIVERDALE

BRIGHTON, COLORADO

Project # 14-1081

June 2014

SWELL/CONSOLIDATION TEST SUMMARY



Sample ID: B-2 @ 9'

Sample Description: Olive-Brown/Rust Siltstone/Sandstone with Claystone

Initial Moisture	11.2%	Liquid Limit	-
Final Moisture	20.9%	Plasticity Index	-
% Swell @ 500 psf	0.5%	% Passing #200	-
Swell Pressure	1,100 psf	Dry Density	107.6 pcf

TRI-COUNTY HEALTH DEPARTMENT

PERCOLATION TEST AND SOILS DATA FORM

Property Address: 13945 Riverdale Road

Legal Description: Lot 3, Block 1 – The Ridge at Riverdale Subdivision

Property Owner:

Name: ______

Address: ______

Phone: ______

Note:

- ***Percolation Test Form, Site Plan and Grain Size Distribution Curve of the Sample must be submitted with this form.***
- ***For all lots < 5 acres the site plan must include the entire lot. Test locations must be accurately tied to lot corners or other permanent markers.***

Saturation and Swelling

Date and time presoak water added:
__________June 3, 2014 @ 2:00 PM___

Amount of presoak added (gallons):
________~3 gallons/hole___

Date and time percolation test is started:
______________June 4, 2014 @ 4:00 PM___

Did water remain in hole after the overnight swelling period:

Hole 1 ☐Yes X No   Hole 4 ☐Yes ☐No

Hole 2 ☐Yes X No   Hole 5 ☐Yes ☐No

Hole 3 ☐Yes X No   Hole 6 ☐Yes ☐No

Percolation Rate Measure:

Hole 1 __60 mpi___   Hole 4 ___________

Hole 2 __30 mpi___   Hole 5 ___________

Hole 3 __20 mpi___   Hole 6 ___________

Average __36.7 mpi_____

Groundwater

Groundwater Encountered: ☐Yes X No

If yes, at what depth: ___________ feet

Estimated depth to maximum seasonal water table if not encountered in profile: _____>9'__

Is area believed to be subject to seasonal fluctuations which could result in a seasonal water table within 8' of surface?

☐Yes X No

Slope determination in absorption area: ___<2 % to the _NE________ (direction)

Bedrock

Bedrock Encountered: X Yes ☐No

If yes, bedrock encountered at ____8______ feet.

Type of bedrock (if present):

☐Sandstone X Claystone ☐Siltstone

☐Other: ________________________________

If present is bedrock fractured or weathered:

☐Yes X No

Profile Hole Information (Continued)

Soils must be classified using Unified System ASTM D2487

Profile Hole Log

0

1

2

3 Existing Fill Material:

Sandy Lean Clay (CL)

4 with Claystone

dark brown/brown/gray/rust

5 stiff

6

7

8

Claystone Bedrock @ 8’

9 gray/brown/rust

Bottom of Boring 9’

10

Blow Counts at Depth of Bed: 7

Atterberg Limits:

PL: 19

LL: 57

PI: 38

Certification

I certify that the above information is correct and complete to the best of my knowledge and that all tests were performed in accordance with the provisions of Tri-County Health Department Regulation I-02 by myself or under my supervision.

Original Signature

June 17, 2014

Date

Soilogic Inc.

Company Name

3050 67th Avenue, Suite 200, Greeley, CO 80634

Address

970.535.6144

Phone

COLORADO REGISTERED
WOLFRAM VON CARLOWITZ
36746
PROFESSIONAL ENGINEER

Original Seal

TRI-COUNTY HEALTH DEPARTMENT

PERCOLATION TEST RESULT FORM

Hole No.	Hole Depth (in.)	Length of interval (min.)	Water Depth @ Start of Interval (in.)	Water Depth @ End of Interval (in.)	Drop in Level (in.)	Percolation Rate @ Final Interval (min./in.)
1	43	30	19.375	19.875	.5	
			19.875	20.375	.5	
			20.375	20.875	.5	
			20.875	21.375	.5	60
2	39	30	18.5	19.625	1.125	
			19.625	20.625	1	
			20.625	21.625	1	
			21.625	22.625	1	30
3	37.5	30	18.625	20.25	1.625	
			20.25	21.75	1.5	
			21.75	23.25	1.5	
			23.25	24.75	1.5	20

Note:

1) Field Notes shall be recorded on this form or in this format; typed copies of field records may be submitted on this form.

1) A four hour test must be conducted unless (a) water remains in the hole after the presoak in which case one 30 min. interval is sufficient, (b) the first 6" of water seeps away in <30 minutes in which case a one-hour test of 6-10 minute time intervals may be used, (c) the test is being conducted in sand (SW or SP) in which case a one-hour test of 6-10 minute time intervals may be used,(d) three successive water level drops do not vary by more than 1/16 inch in which case a two-hour test may be conducted, (e) test is in Dawson Sands, in which case the test must be run a minimum of four hours until the last three successive water level drops vary by less than 1/16 inch.

UNIFIED SOIL CLASSIFICATION SYSTEM

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

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] 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.

[D] 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] $Cu = D_{60}/D_{10} \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

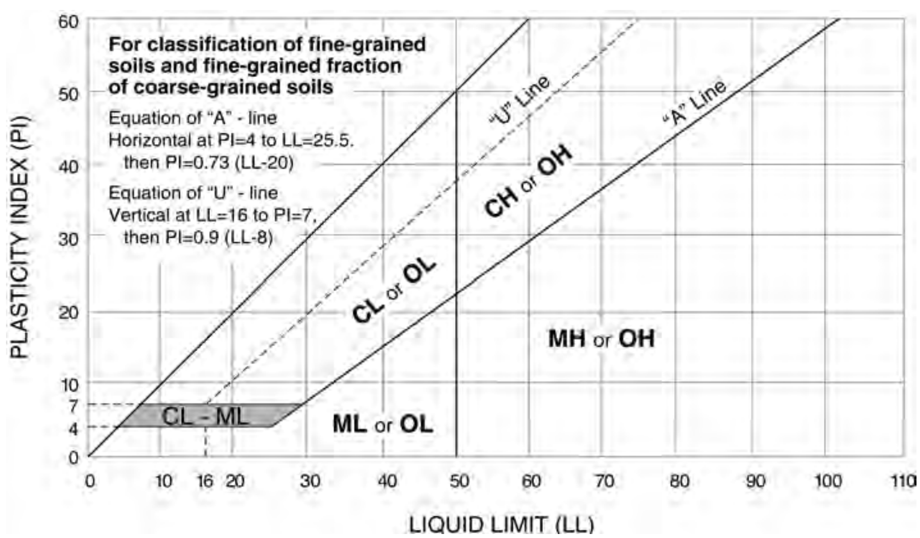
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1⅜" 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
CS:	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

(CB) Blows/Ft.	(SS) Blows/Ft.	Consistency
< 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

(CB) Blows/Ft.	(SS) Blows/Ft.	Relative Density
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

(CB) Blows/Ft.	(SS) Blows/Ft.	Consistency
< 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

Descriptive Terms of Other Constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
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

Descriptive Terms of Other Constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1-10
Medium	11-30
High	30+