NorthWest Colorado Consultants, Inc.
Geotechnical / Environmental Engineering • Materials Testing

April 20, 2009

Max Erb
P.O. Box 881390
Steamboat Springs, CO 80488

Job Number: 09-8309

Subject: Subsoil and Foundation Investigation, Proposed Erb Building, Lot 1, Filing 4, Copper Ridge Business Park, Steamboat Springs, Colorado.

Gentlemen:

This report presents the results of the Subsoil and Foundation Investigation for the proposed Erb Building to be constructed within Lot 1 in Filing 4 of the Copper Ridge Business Park in Steamboat Springs, Colorado. The approximate location of the project site is shown in Figure #1.

The scope of our work included obtaining data from cursory observations made at the site, the logging of two test holes, the sampling of the probable foundation soils and the laboratory testing of the samples obtained. This report presents recommendations for economically feasible and safe type foundations, as well as allowable soil pressures and other design and construction considerations that are advisable, but not necessarily routine to quality design and building practices.

Proposed Construction: The building plans were not available at the time of our investigation; however, we have assumed that the proposed building will consist of a one to two story wood or metal framed structure utilizing concrete slab-on-grade construction placed near or slightly above the existing ground surface.

For design purposes, we have assumed that the building loads will be light to moderate typical of this type of commercial construction. If loadings or conditions are significantly different from those above, we should be notified to reevaluate the recommendations in this report.

Site Conditions: The proposed building site is situated to the south of Copper Ridge Circle located in the Copper Ridge Business Park in Steamboat Springs, Colorado. The site was currently being used for storage of construction equipment and materials, and was covered by two to three feet of snow at the time of this investigation. It appears that some fill materials had been placed on the northern portion of the site.

The topography of the site is relatively flat due to the previous site grading, and the building site generally slopes very gently to gently down to the north on the order of 1 to 2 percent. It appeared that a maximum elevation difference of approximately 1 foot exists across the proposed building site.

Subsurface Conditions: To investigate the subsurface conditions at the site, two test holes were drilled on April 2, 2009 with an all-terrain mounted drill rig using 4-inch diameter continuous flight augers. The approximate test hole locations are shown in Figure #2.

The subsurface conditions encountered in the test holes were variable and generally consisted of a layer of natural topsoil and organics or fill materials overlying natural clays and claystone-shale bedrock to the maximum depth investigated, 25 feet. Graphic logs of the exploratory test holes are presented in Figure #3, and the associated Legend and Notes are presented in Figure #4.

A layer of fill materials were encountered at the ground surface in test hole 1 and was approximately 3 feet thick. The fill materials consisted of clay with occasional gravels that were moderately to highly plastic, medium stiff to stiff, moist and brown to gray in color. A layer of natural topsoil and organic materials was encountered at the ground surface in test hole 2 and was approximately 2 feet thick. Natural clays were encountered beneath the fill materials and natural topsoil materials in both test holes and extended to depths of 6 and 8 ½ feet beneath the existing ground surface. The natural clays were nil to slightly sandy with occasional gravels, moderately to highly plastic, stiff, slightly moist to moist and brown to gray in color. A sample of the natural clays classified as a CH soil in accordance with the Unified Soil Classification System. Claystone-shale bedrock materials were encountered beneath the clays in both test holes and extended to the maximum depth investigated in each of the test holes. The claystone-shale bedrock materials were slightly sandy, moderately to highly plastic, hard to very hard, slightly moist to moist and brown to gray in color. Samples of the claystone-shale bedrock materials classified as CL soils in accordance with the Unified Soil Classification System.

Swell-consolidation tests conducted on samples of the natural clays and claystone-shale bedrock materials indicate that the materials tested will exhibit a moderate to high swell potential when wetted under a constant load. The swell-consolidation test results are shown in Figures #5, #6 and #7 and all of the other laboratory test results are summarized in the attached Table 1.

Groundwater seepage was encountered in test hole 2 at a depth of 13 feet at the time of drilling. However, it should be noted that the groundwater conditions at the site can be expected to fluctuate with changes in precipitation and runoff.

Foundation Recommendations: Based on the subsurface conditions encountered in the test holes, the results of the field and laboratory investigations and our understanding of the proposed construction, we believe an economically feasible and safe type of foundation system is straight-shaft skin friction/end bearing piers drilled into the underlying claystone-shale bedrock. Foundation movement should be within tolerable limits if the following design and construction precautions are observed.

1) A minimum pier diameter of 12 inches, a minimum pier length of 20 feet and a minimum bedrock penetration of 6 feet are recommended.

2) The piers should be designed using an allowable skin friction value of 3,000 psf for the portion of the pier drilled into the claystone-shale bedrock. The upper 5 feet of the pier should be neglected in the skin-friction calculations. If a drill rig of sufficient size, type and operating condition is used, and the bottom of the piers can be cleaned out properly and approved by this office, then an allowable end bearing pressure of 30,000 psf can be used for the piers drilled into the undisturbed claystone-shale bedrock. A maximum pier length to diameter ratio of 25 should be used in the pier design.

3) The piers should be reinforced their full length with at least one #5 reinforcing rod for each 16 inches of pier perimeter.

4) The piers should be properly cleaned and dewatered prior to steel and concrete placement. Groundwater seepage should be anticipated in the piers. The use of casing and dewatering equipment may be required if groundwater seepage and/or caving soils are encountered. The concrete should not be placed in more than 3 inches of water unless the tremie or pump methods are used to place the concrete.

5) A 4-inch void should be provided beneath grade beams to prevent the swelling soils from exerting uplift forces on the grade beams and to concentrate pier loadings. A void should also be provided beneath necessary pier caps.

6) This office must be retained by the client to observe the pier drilling operations.

Alternate Foundation Recommendations: An alternative deep foundation system to the drilled piers is a helical screw pile foundation system. The helical screw pile foundation system should be designed by a qualified engineer, using industry standards and be installed by a licensed/certified installer. We strongly recommend that at least two test piles be advanced at the site so that the torque versus depth relationships can be established and the proper shaft and helix size and type can be determined. A representative of this office should observe the helical screw pile installations.

Floor Slabs: We have assumed that the proposed building will be constructed utilizing a concrete slab-on-grade floor system, placed near or above the existing ground surface. The on-site soils, with the exception of the topsoil and organic materials or existing fill materials, are suitable to support slab-on-grade construction. However, floor slabs present a very difficult problem where swelling materials are present near floor slab elevation because sufficient dead load cannot be imposed on them to resist the uplift pressure generated when the materials are wetted and expand. Based on the moisture-volume change characteristics of the natural clays encountered at this site, we recommend that structural floor systems over well-ventilated crawlspaces be used in the proposed building. If the client elects to construct concrete slab-on-grade floor systems, we recommend that the following special design and construction precautions be followed so that the amount of movement in the floor slabs can be reduced, if the natural clays become wetted and swell and/or consolidate.

The following measures should be taken to reduce the damage to the floor slab, which could result from movement should the underslab clays be subjected to moisture changes.

1) The floor slabs should be separated from all bearing walls, columns and their foundation supports with a positive slip joint. We recommend the use of ½-inch thick cellotex or impregnated felt.

2) Interior non-bearing partition walls resting on the floor slabs should be provided with a slip joint, preferably at the bottom, so that in the event the floor slab moves, this movement is not transmitted to the upper structure. This detail is also important for wallboard and doorframes and is shown in Figure #8.

3) A minimum 6-inch gravel layer should be provided beneath all floor slabs to act as a capillary break and to help distribute pressures. Prior to placing the gravel, the excavation should be shaped so that if water does get under the slab, it will flow to the low point of the excavation. In addition, any topsoil and organic materials should be removed prior to placement of the underslab gravels or new structural fill materials.

4) The floor slabs should be provided with control joints placed a maximum of 12 feet on center in each direction to help control shrinkage cracking. The location of the joints should be carefully checked to assure that the natural, unavoidable cracking will be controlled. The depth of the control joints should be a minimum of ¼ the thickness of the slab.

5) The underslab soils should be kept as close as possible to their in-situ moisture content. Excessive wetting or drying of these soils prior to placement of the floor slab could result in differential movement after the slabs are constructed.

6) It has been our experience that the risk of floor slab movement can be reduced by removing at least 3 feet of the expansive materials and replacing them with a well compacted, non-expansive fill. If this is done or if fills are required to bring the underslab soils to the desired grade, the fill should consist of non-expansive, granular materials. The fill should be uniformly placed and compacted in 6 to 8 inch lifts to at least 95% of the maximum standard Proctor density at or near the optimum moisture content, as determined by ASTM D-698.

The above precautions and recommendations will not prevent floor slab movement in the event the fill materials or natural clays beneath the floor slabs undergo moisture changes. However, they should reduce the amount of damage if such movement occurs. The only way to eliminate the risk of all floor slab movement is to construct a structural floor over a well-vented crawl space.

Underdrain System: Any floor levels or crawl space areas constructed below the existing or finished ground surfaces and the foundations should be protected by an underdrain system to help reduce the problems associated with surface and subsurface drainage during high runoff periods. Localized perched water or runoff can infiltrate the lower levels of the structure at the foundation level. This water can be one of the primary causes of differential foundation and slab movement. Especially, when expansive soils are encountered. Excessive moisture in crawl space areas or lower level can also lead to rotting and mildewing

of wooden structural members and the formation of mold and mold spores. The formation of mold and mold spores could have detrimental effects on the air quality in these areas, which in turn can lead to potential adverse health effects.

The drains should be located around the entire perimeter of the lower levels and be placed and at least 12 inches below any floor slab or crawl space level and at least 6 inches below the foundation voids and bottom of the foundation walls. We recommend the use of perforated PVC pipe for the drainpipe, which meets or exceeds ASTM D-2729 requirements, to minimize the potential for crushing the pipe during backfill operations. The holes in the drainpipe should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of the water. The drainpipe should be surrounded with at least 12 inches of free draining gravel and should be protected from contamination by a filter covering of Mirafi 140N subsurface drainage fabric or an equivalent product. The drain should have a minimum slope of 1/8 inch per foot and should be day lighted at a positive outfall protected from freezing, or be led to a sump from which the water can be pumped. Caution should be taken when backfilling so as not to damage or disturb the installed underdrain. We recommend the drainage system include at least one cleanout, be protected against intrusion by animals at the outfall and be tested prior to backfilling. We also recommend that the client retain this firm to observe the underdrain system during construction to verify that it is being installed in accordance with our recommendations and observe a flow test prior to backfilling the system.

In addition, we recommend that an impervious barrier be constructed to keep water from infiltrating through the voided areas and/or under the foundation walls. The barrier should be constructed of an impervious material, which is approved by this office and placed below the perimeter drain and up against the sides of the foundation walls. A typical perimeter/underdrain detail is shown in Figure #9. The placement of the impervious membrane and properly compacted clays in the crawl space areas to a point at least 12 inches above the top of the foundation voids or bottom of the foundation walls will help reduce the moisture problems in these areas.

Foundation Walls and Retaining Structures: Foundation walls and retaining structures, which are laterally supported and can be expected to undergo only a moderate amount of deflection, may be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 45 pcf for imported, free draining granular backfill and 60 pcf for the on-site materials.

Cantilevered retaining structures on the site can be expected to deflect sufficiently to mobilize the full active earth pressure condition. Therefore, cantilevered structures may be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 35 pcf for imported, free draining granular backfill and 50 pcf for the on-site materials.

The foundation walls and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent buildings, traffic and construction materials. An upward sloping backfill and/or natural slope will also significantly increase the earth pressures on foundation walls and retaining structures and the structural engineer should carefully evaluate these additional lateral loads when designing the foundation and retaining walls.

We recommend imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. The imported granular materials should be placed to

within 2 to 3 feet of the ground surface. Imported granular soils should be free draining and have less than 7 percent passing the No. 200 sieve. The granular soils behind foundation and retaining walls should be sloped from the base of the wall at an angle of at least 45 degrees from the vertical. The upper 2 to 3 feet of fill should be a relatively impervious soil or pavement structure to prevent surface water infiltration into the backfill.

The wall backfill should be carefully placed in uniform lifts and compacted to at least 95 percent of the maximum standard Proctor density, near the optimum moisture content. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfill materials will occur even if the material is placed correctly.

Surface Drainage: Proper surface drainage at this site is of paramount importance for minimizing the infiltration of surface drainage into the wall backfill and bearing soils, which could result in increased wall pressures, differential foundation and slab movement. The following drainage precautions should be observed during construction and at all times after the structure has been completed:

1) The ground surface surrounding the structure should be sloped (minimum of 1.0 inch per foot) to drain away from the structure in all directions to a minimum of 10 feet. Ponding must be avoided. If necessary, raising the top of foundation walls to achieve a better surface grade is advisable.

2) Non-structural backfill placed around the structure should be compacted to at least 95% of the maximum standard Proctor density at or near the optimum moisture content in order to minimize future settlement of the fill. The backfill should be placed immediately after the braced foundation walls are able to structurally support the fill. Puddling or sluicing must be avoided.

3) The top 2 to 3 feet of soil placed within 10 feet of the foundation should be impervious in nature to minimize infiltration of surface water into the wall backfill.

4) Roof downspouts and drains should discharge well beyond the limits of all backfill. Roof overhangs, which project two to three feet beyond the foundation, should be considered if gutters are not used.

5) Landscaping, which requires excessive watering and lawn sprinkler heads, should be located a minimum of 10 feet from the foundation walls of the structure.

6) Plastic membranes should not be used to cover the ground surface adjacent to foundation walls.

Limitations: The recommendations given in this report are based on the soils and bedrock materials encountered at this site, and our understanding of the proposed construction. We believe that this information gives a high degree of reliability for anticipating the behavior of the proposed structure; however, our recommendations are professional opinions and cannot control nature, nor can they assure the soils profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

Moderately to highly expansive soils and bedrock materials were encountered at this site and in the surrounding areas. These soils and bedrock materials are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of moisture sensitive soils/bedrock materials is not fully understood. The swell or consolidation potential of any particular site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions, which cannot always be predicted. The recommendations presented in this report are based on the current state of the art for foundations and floor slabs on swelling-consolidating soils/bedrock. The owner should be aware that there is a risk in construction on these types of soil/bedrock. Performance of the building will depend on following the recommendations and in proper maintenance after construction is complete. As water is the main cause for volume change in these soils, it is necessary that the changes in moisture content be kept to a minimum. This requires judicious irrigation and providing positive surface drainage away from the structure. Any distress noted in the structure should be brought to the attention of a professional engineer.

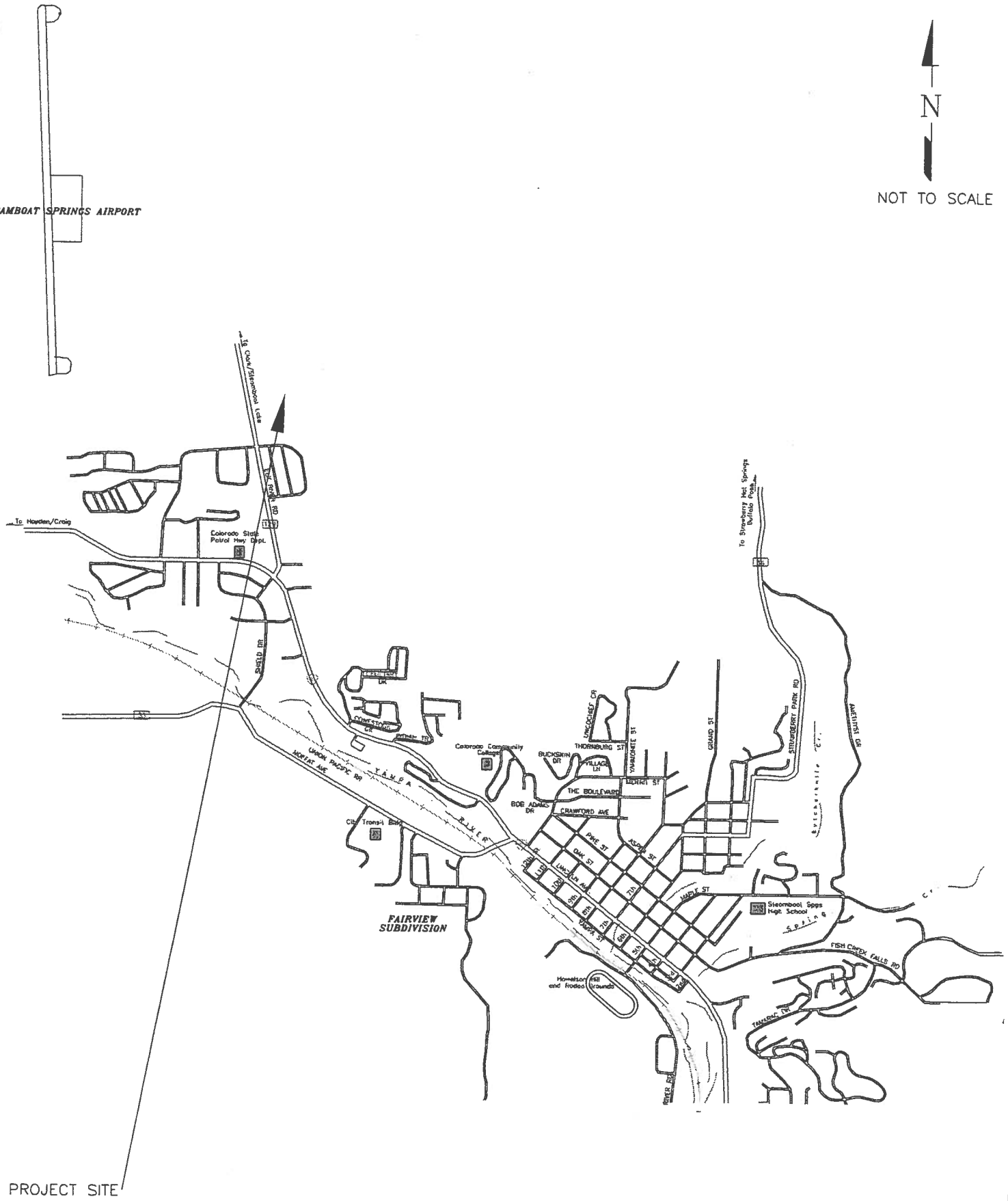
This report is based on the investigation at the described site and on the specific anticipated construction as stated herein. If either of these conditions is changed, the results would also most likely change. Therefore, we strongly recommend that our firm be contacted prior to finalizing the construction plans so that we can verify that our recommendations have been properly incorporated into the construction plans. Man-made or natural changes in the conditions of a property can also occur over a period of time. In addition, changes in requirements due to state of the art knowledge and/or legislation do from time to time occur. As a result, the findings of this report may become invalid due to these changes. Therefore, this report is subject to review and not considered valid after a period of 3 years or if conditions as stated above are altered. It is the responsibility of the owner or his representative to insure that the information in this report is incorporated into the plans and/or specifications and construction of the project. It is advisable that a contractor familiar with construction details typically used to dealing with the local subsoil and climatic conditions be retained to build the structure. If you have any questions regarding this report or if we may be of further service, please do not hesitate to contact us.

Sincerely,
NWCC, INC.

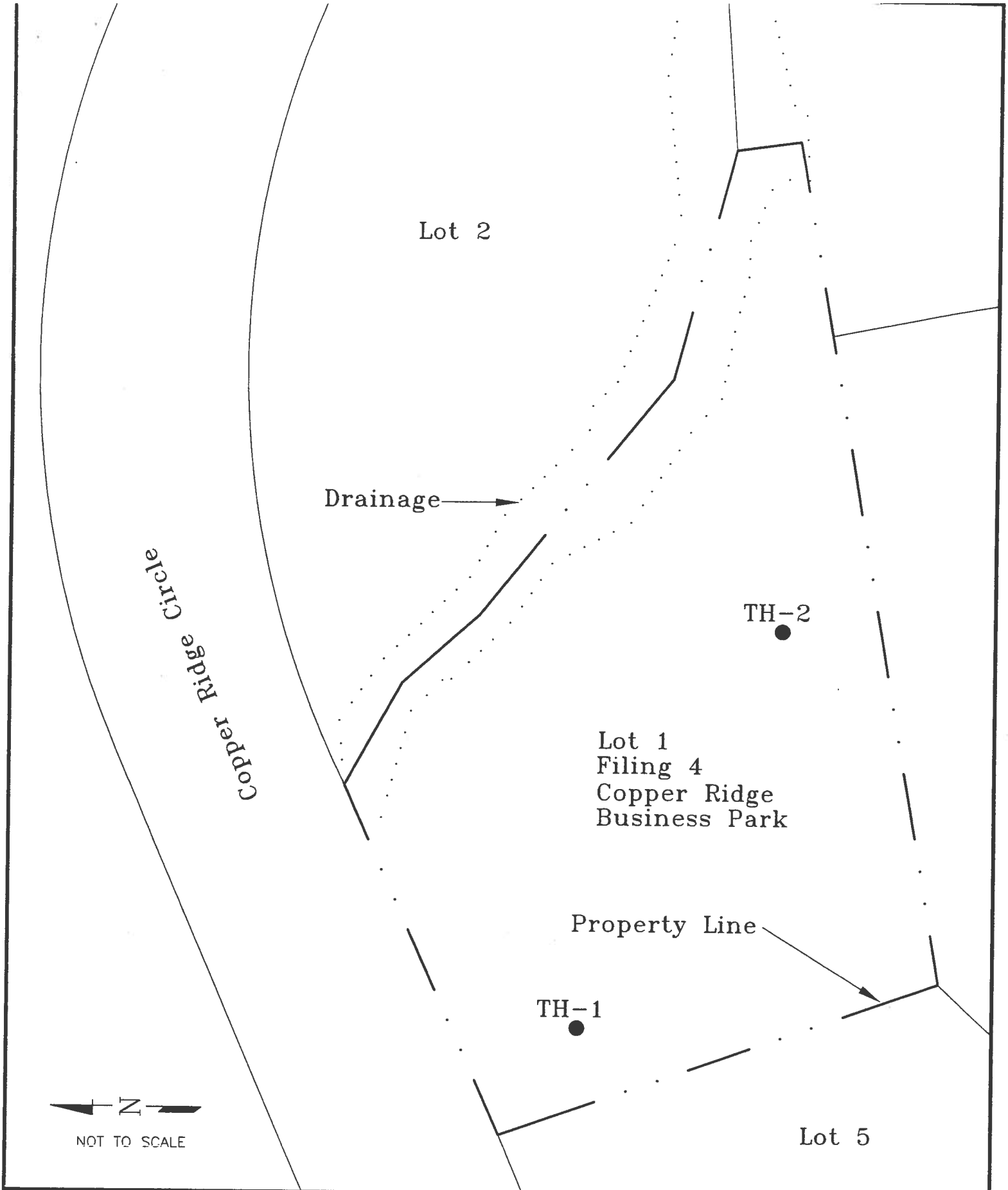
Josh P. Frappart, E.I.T.

Reviewed by Brian D. Len, P.E.

xc: Jim Stegmaier

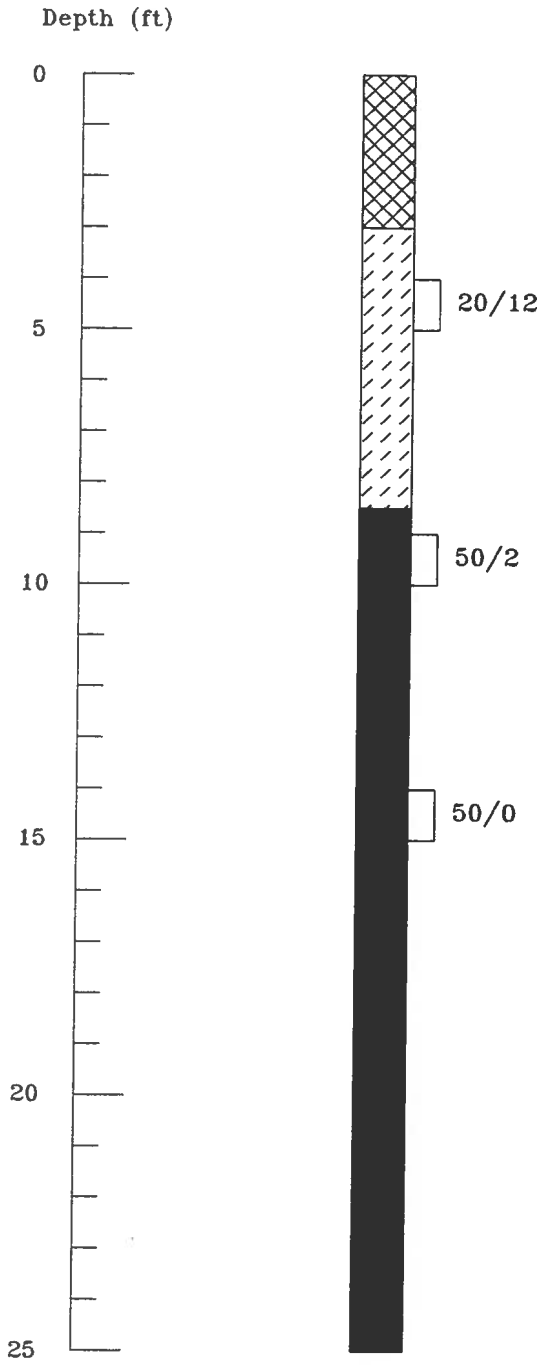


Title: VICINITY MAP	Date: 4/20/09	North West Colorado Consultants, Inc.
Job Name: Proposed Erb Building	Job No. 09-8309	Geotechnical / Environmental Engineering - Materials Testing
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO	Figure #1	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487

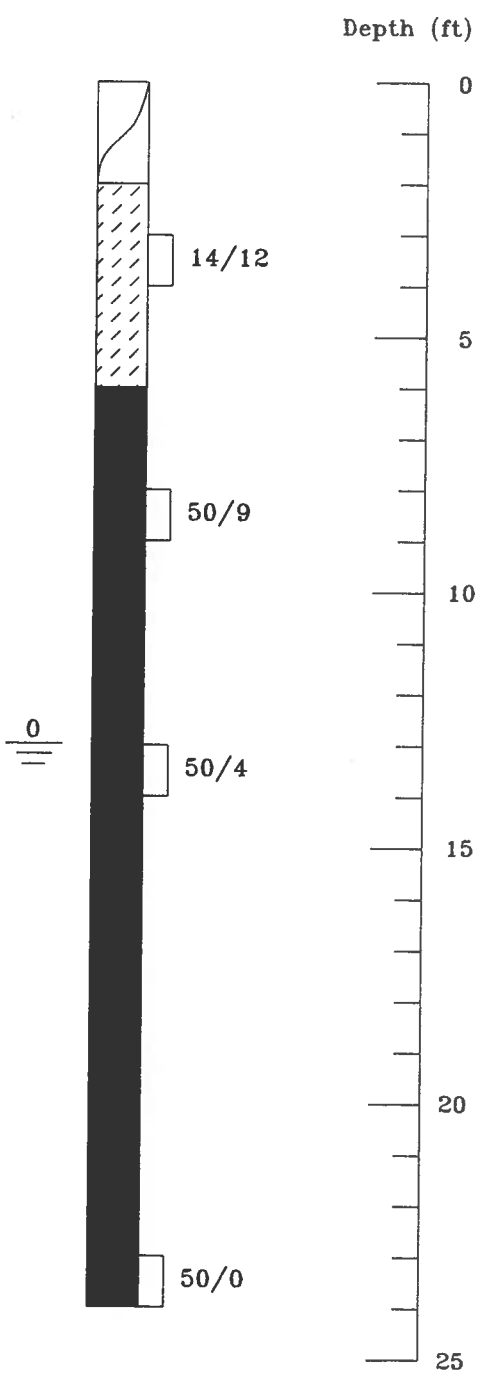


Title: SITE PLAN-LOCATION OF TEST HOLES	Date: 4/20/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Proposed Erb Building	Job No. 09-8309	(970)879-7688 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO	Figure #2	

Test Hole 1



Test Hole 2



Title: LOGS OF EXPLORATORY TEST HOLES		Date: 4/20/09
Job Name: Proposed Erb Building		Job No. 09-8309
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO		Figure #3

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2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487

LEGEND:

TOPSOIL AND ORGANICS:

FILL: Clays with occasional gravels, moderately to highly plastic, medium stiff to stiff, moist and brown to gray in color.

CLAYS: Nil to slightly sandy with occasional gravels, moderately to highly plastic, stiff, slightly moist to moist and brown to gray in color.

CLAYSTONE-SHALE BEDROCK: Slightly sandy, moderately to highly plastic, hard to very hard, slightly moist to moist and brown to gray in color.

Drive Sample, 2-inch I.D. California Liner Sampler.

20/12 Drive Sample Blow Count, indicates 20 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates depth at which groundwater was encountered at the time of drilling.

NOTES:

1) The test holes were drilled on April 2, 2009 with an all-terrain drill rig using 4-inch diameter continuous flight power augers.

2) Locations of the test holes were determined in the field by pacing from topographic features at the site.

3) Elevations of the test holes were not measured and logs are drawn to the depths investigated.

4) The lines between materials shown on the logs represent the approximate boundaries between material types and transitions may be gradual.

5) The water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels will probably occur with time.

Title: LEGEND AND NOTES	Date: 4/20/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
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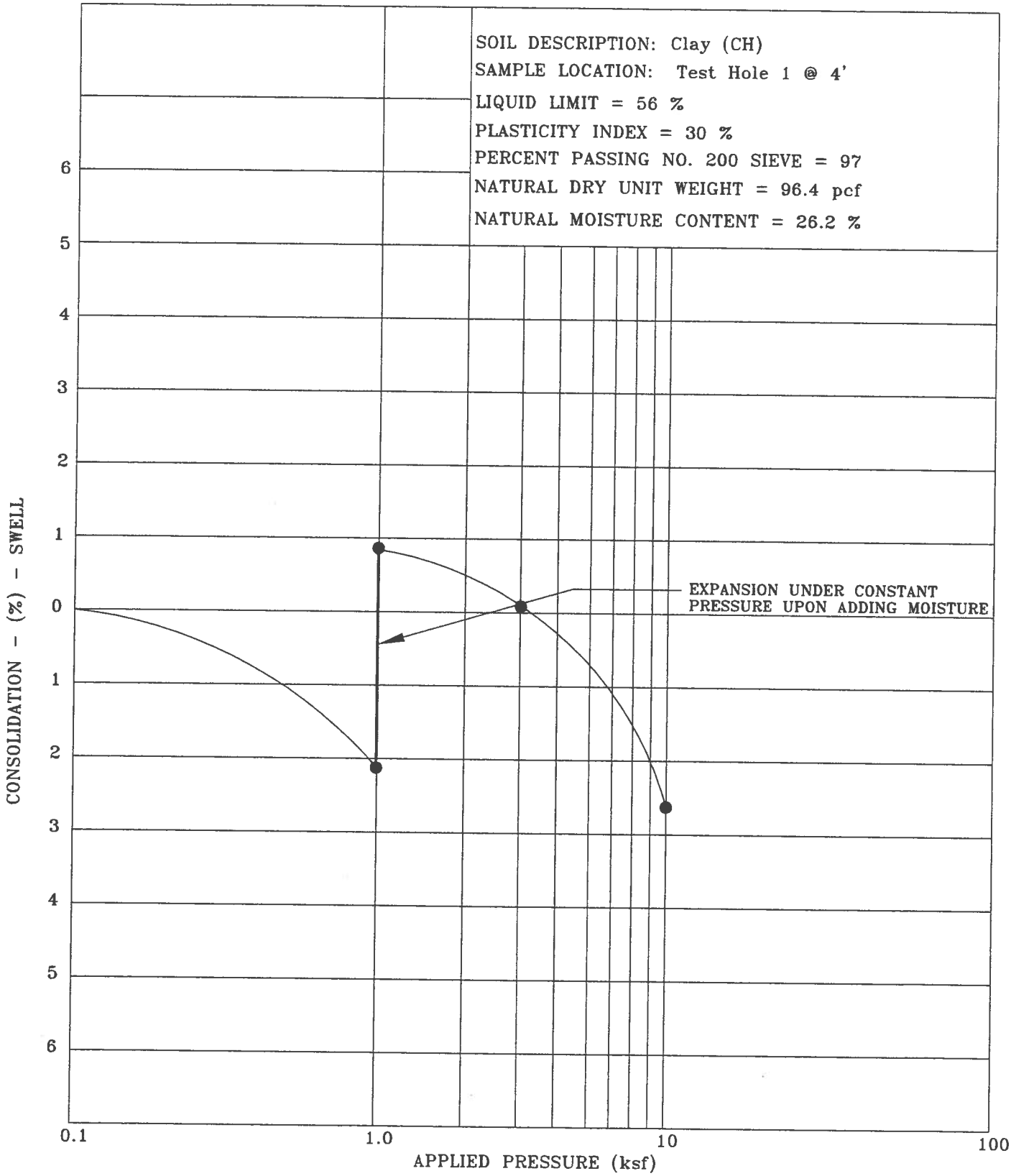
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO	Figure #4	



Title: SWELL-CONSOLIDATION TEST RESULTS		Date: 4/20/09
Job Name: Proposed Erb Building		Job No. 09-8309
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO		Figure #5

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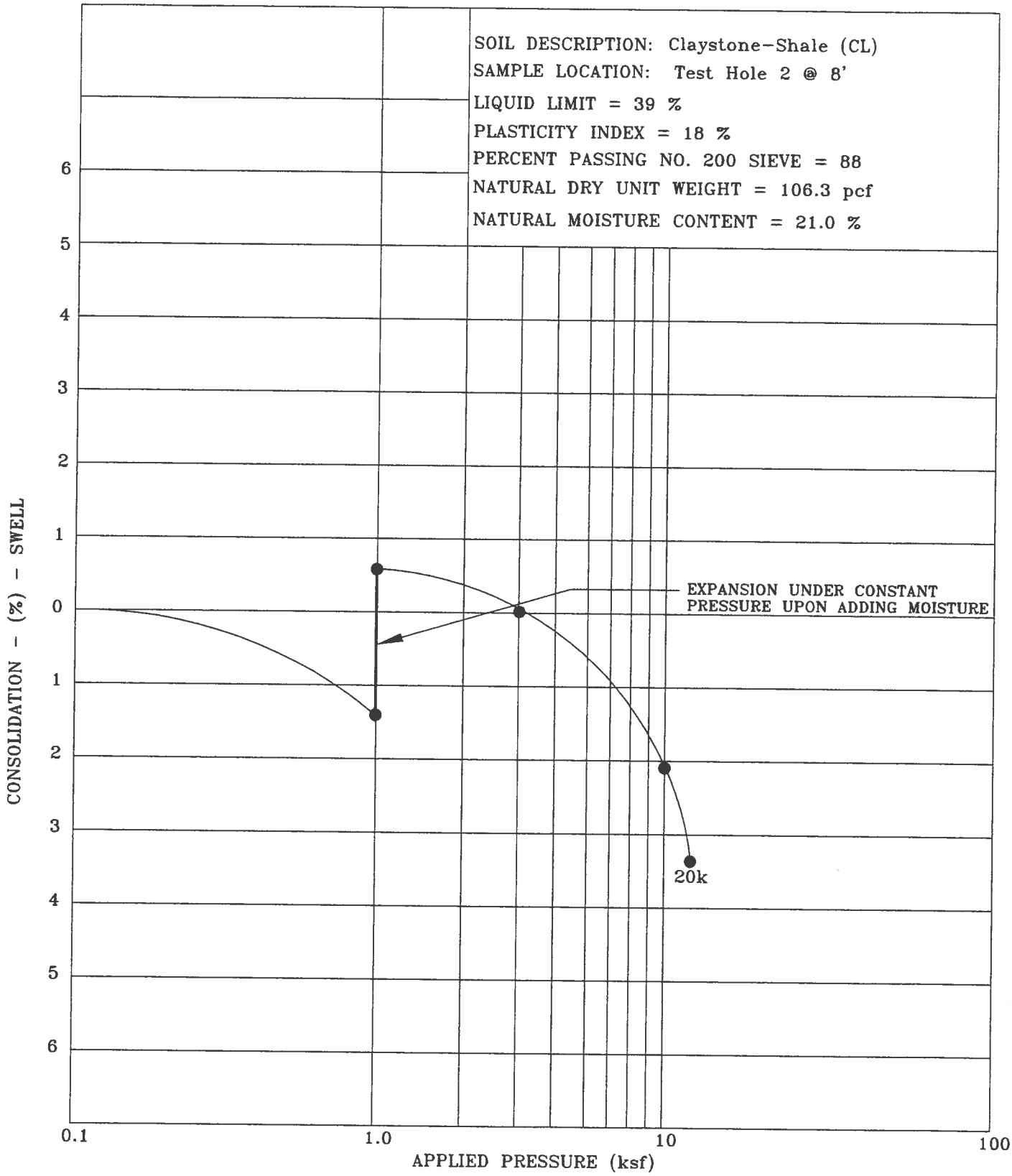
(970)879-7888 - Fax (970)879-7891
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487



Title: SWELL-CONSOLIDATION TEST RESULTS		Date: 4/20/09
Job Name: Proposed Erb Building		Job No. 09-8309
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO		Figure #6

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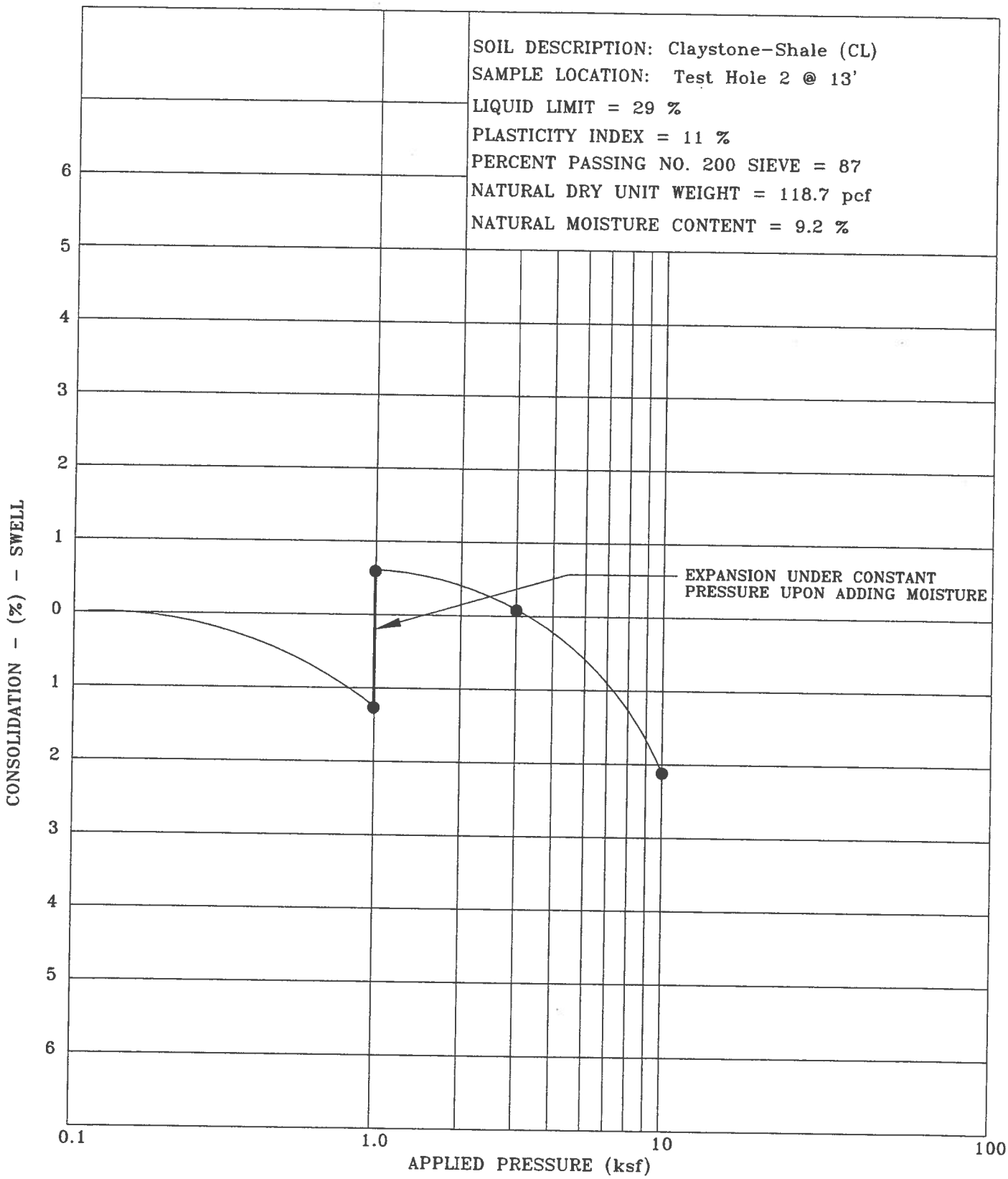
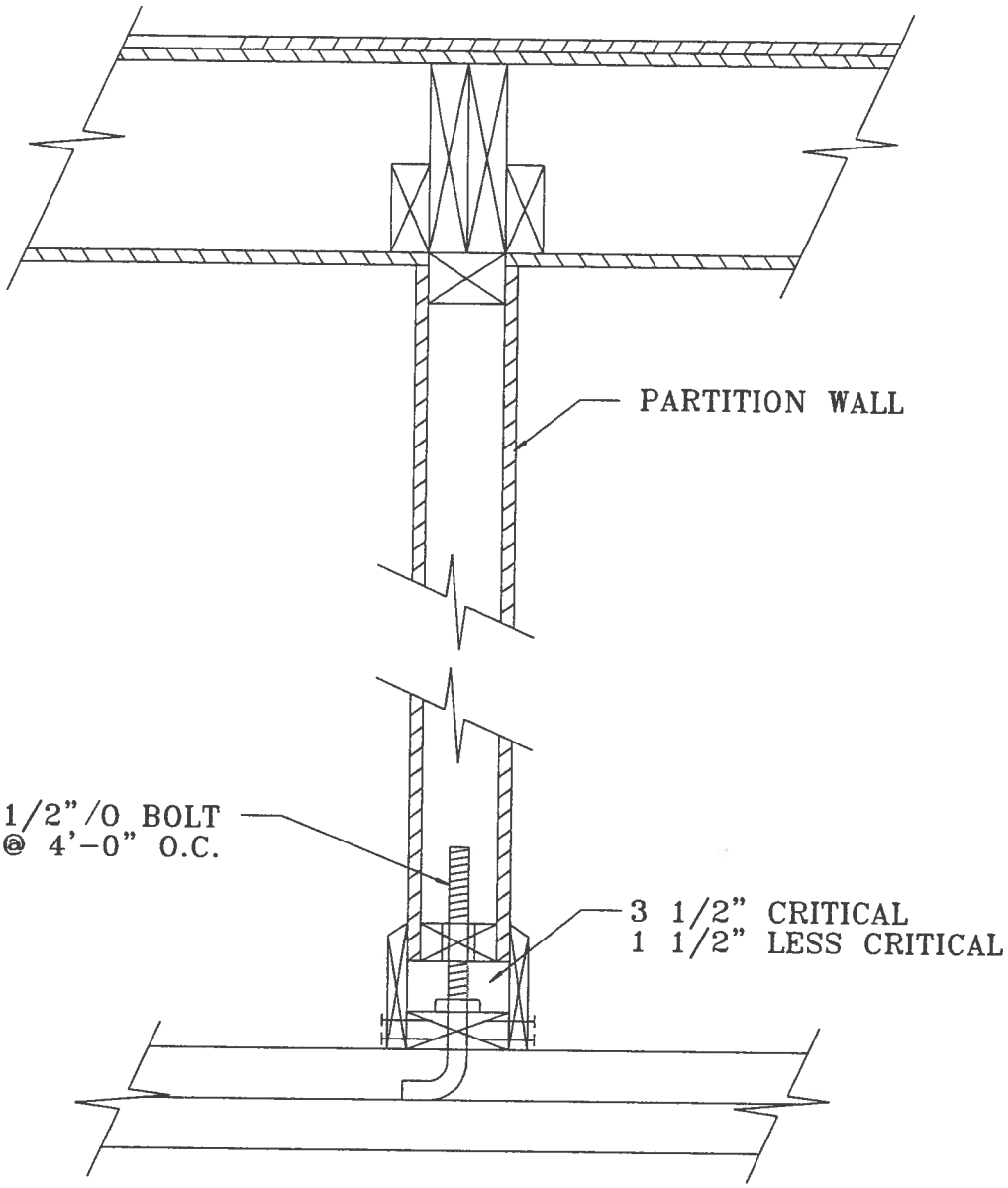
Steamboat Springs, Colorado 80487



Title: SWELL-CONSOLIDATION TEST RESULTS		Date: 4/20/09	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering - Materials Testing
Job Name: Proposed Erb Building		Job No. 09-8309	(970)879-7888 - Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO		Figure #7	



Title: HUNG PARTITION WALL DETAIL	Date: 4/20/09	
Job Name: Proposed Erb Building	Job No. 09-8309	
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO	Figure #8	

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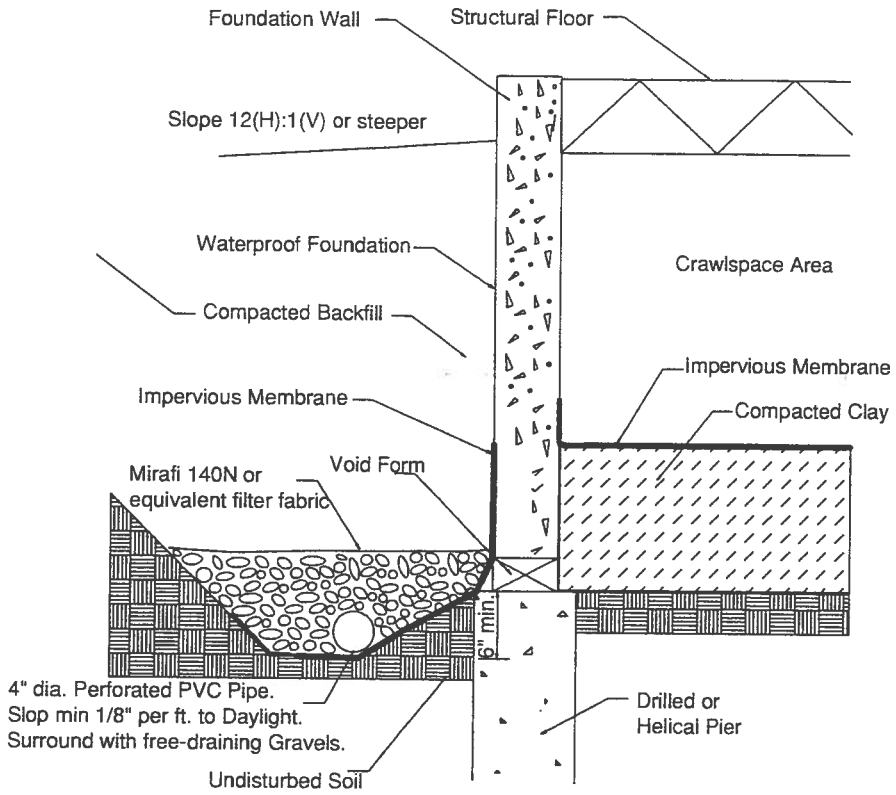
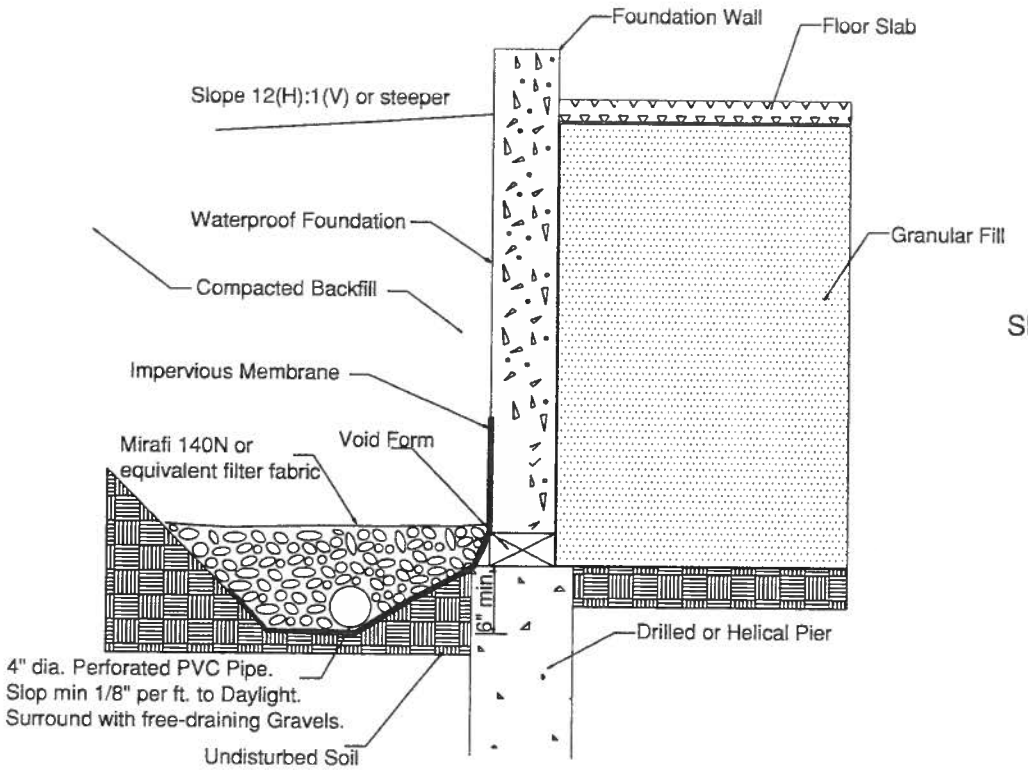


Crawlspace Area



Slab-on-Grade

Title: PERIMETER/UNDERDRAIN DETAIL		Date: 4/20/09
Job Name: Proposed Erb Building		Job No. 09-8309
Location: Lot 1, Fil. 4, Copper Ridge Business Park, Steamboat Springs, CO		Figure #9

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Geotechnical / Environmental Engineering - Materials Testing
(970)879-7888 · Fax (970)879-7891
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487

NWCC, Inc.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	ATTERBERG LIMITS		GRADATION		PERCENT PASSING No. 200 SIEVE	UNCONFINED COMPRESSIVE STRENGTH (psf)	SOIL or BEDROCK DESCRIPTION	UNIFIED SOIL CLASS.
TEST HOLE	DEPTH (feet)			LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAVEL (%)	SAND (%)				
1	4	26.2	96.4	56	30	0	3	97		Clay	CH
1	9	11.8	109.9	39	35	9	25	66		Claystone-Shale	CL
2	8	21.0	106.3	39	18	0	12	88		Claystone-Shale	CL
2	13	9.2	118.7	29	11	0	13	87		Claystone-Shale	CL

JOB NUMBER: 09-8309