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

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Gorman & Company
Nathaniel Stark, AIA
1060 Bannock Street, Suite 305Steamboat
Springs, Denver, CO 80204
nstark@gormanusa.com

Job Number: 23-12981

Subject: Subsoil and Foundation Investigation Review, Lot E, Downtown Riverview Subdivision, Steamboat Springs, Colorado.

Nate,

This report presents the results of the Subsoil and Foundation Investigation Review (SFIR) for the proposed multi-family residential building to be constructed within Lot E of the Downtown Riverview Subdivision in Steamboat Springs, Colorado. A previous Subsoil and Foundation Investigation (SFI) report for the "Riverwalk" property was prepared by NWCC, Inc. (NWCC) under our job number 06-7351 and dated July 21, 2008. A copy of the original SFI report is attached. This review has been completed in accordance with NWCC's recommendations outlined in the Limitations section of the previously prepared SFI report.

Proposed Construction: NWCC understands that the proposed building will most likely be four stories in height with the lower level used for parking. NWCC assumes the lower level of parking will be constructed using slab-on-grade floor systems placed near the existing ground surface.

For design purposes, NWCC has assumed that building loads will be moderate typical of this type of multi-story, multi-family residential construction. If loadings or conditions are significantly different from those above, NWCC should be notified to reevaluate recommendations in this report.

Subsurface Conditions: To evaluate the subsurface conditions within Lot E, eight test holes (TH-33, TH-38 to TH-44) were previously advanced on this lot in May 2008 for the original SFI report. The subsurface conditions were variable and generally consisted of a layer of existing fill materials overlying natural clays or sands and silts, overlying natural sands and gravels, which were underlain by claystone-sandstone bedrock.

A layer of existing fill materials was encountered at the ground surface in four of the test holes and these materials extended 3 to 8 feet below the existing ground surface (bgs). The existing fill materials were highly variable and consisted of intermixed silts, clays, sands and gravels that were low to moderately plastic, soft to medium dense, moist to wet and brown to dark brown in color.

A relatively thin layer of natural clays, ranging from 2 to 3 feet in thickness, was encountered in two of the test holes (TH-38 and TH-44) below the existing fill materials. The natural clays were slightly sandy to sandy with occasional gravels, moderately plastic, medium stiff to stiff, moist to very moist and brown in color.

A layer of sands and silts, approximately 6 feet in thickness, was encountered in one of the test holes (TH-33) below the existing fill materials. The sands and silts were interbedded, low to non-plastic, fine to medium grained, very soft to medium dense, moist to wet and brown to dark brown in color.

Natural sands and gravels were encountered at the ground surface in four of the test holes (TH-39 to TH-42) and below the fill materials, clays and sands and silts in the remaining test holes at depths ranging from 7 to 10 feet bgs. The sands and gravels extended to the maximum depths investigated in TH-33 and TH-43. TH-33 was drilled to a depth of 15 bgs and TH-43 was drilled to a depth of 12 feet bgs. The sands and gravels were silty to clayey, fine to coarse grained with cobbles and boulders, low to non-plastic, medium dense to dense, moist to wet and brown in color.

Claystone-sandstone bedrock was encountered below the sands and gravels in the other six holes at depths ranging from 4 to 9 feet bgs. The claystone-sandstone bedrock materials were sandy, low to moderately plastic, fine to medium grained, hard to very hard, moist to slightly moist and brown to light brown in color. Swell-consolidation testing conducted on the samples of the claystone-sandstone bedrock indicate the materials tested will exhibit a very low to low swell potential when wetted under a constant load.

Based on anticipated geologic site conditions, NWCC recommends a **Site Class C** designation be used in structural design calculations in accordance with Table 20.3-1 in Chapter 20 of ASCE 7-10.

Groundwater seepage was encountered in four of the test holes (TH-33, TH-38, TH-42 and TH-44) at the time of drilling and at depths ranging from 2 to 11 feet bgs. It should be noted that groundwater conditions at the site can be expected to fluctuate with changes in precipitation, runoff and the flows in the Yampa River and Spring Creek. In addition, numerous utility corridors and storm water control structures in the area can provide a preferential shallow groundwater flow path and affect natural flow conditions. The natural flow conditions should be in a southwesterly to westerly direction towards the Yampa River, which is situated immediately west/southwest of the property and flows in a southeast to northwest direction.

Previous Recommendations: Based on our review of the original SFI report (NWCC, 2008) and our experience with the other lots in the Downtown Riverview Subdivision, the design and construction of the foundations should use the recommendations outlined in the original report.

In addition, modifications to the recommendations for floor slabs, foundation and retaining walls, surface drainage, pavement sections and perimeter drainage systems will not be required at this time for the design and construction of the proposed structures.

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

Expansive bedrock materials and potentially expansive clays were encountered at this site. These soils and bedrock materials are stable at their natural moisture content but can shrink or swell significantly with changes in moisture. The behavior of expansive soils and bedrock materials is not fully understood. The swell or consolidation potential of any site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions which cannot always be predicted. Recommendations presented in this report and the previous SFI report are based on the current state of the art for foundations and floor slabs on expansive soils and bedrock materials. The owner must be made aware there is a risk in construction on these types of soil and bedrock materials. The performance of the structures will depend on following the recommendations and in proper maintenance after construction is complete. As water is the main cause for volume change in the soils and bedrock materials, 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 structures. Any distress noted in the structures should be brought to the attention of NWCC.

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, NWCC strongly recommends that our firm be contacted prior to finalizing the construction plans so that we can verify our recommendations are being properly incorporated into the construction plans. Man-made or natural changes in the conditions of a property can also occur over time.

In addition, changes in requirements due to state-of-the-art knowledge and/or legislation do 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 ensure that the information in this report is incorporated into the plans and/or specifications and construction of the project.

If you have any questions regarding this report or if NWCC may be of further service, please do not hesitate to contact us.

Sincerely,
NWCC, INC.

COLORADO LICENSED BRIAN D. LEN 25750 PROFESSIONAL ENGINEER
8/31/2023

Brian D. Len, P.E.
Principal Engineer

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

Subsoil and Foundation Investigation
Proposed Riverwalk Project
Steamboat Springs, Colorado

Prepared for:

Green Courte Partners, LLC
560 Oakwood Avenue, Suite 100
Lake Forest, Illinois 60045

Attn: Mr. Stephen Douglass

Job Number: 06-7351

July 30, 2008

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

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Conclusions

Based on the subsurface conditions encountered at the site, we recommend that the buildings to be constructed at the proposed Riverwalk Project be supported on a foundation system consisting of footings placed on the natural sands and gravels, claystone-sandstone-siltstone bedrock materials, or on properly compacted structural fill materials placed over the natural sands and gravels or bedrock materials. An alternative foundation system would be to found the buildings on helical/screw piles advanced into the underlying sands and gravels and/or claystone-sandstone-siltstone bedrock materials. Design parameters for the above foundation systems, as well as for the floor slabs, foundation walls, underdrain systems and pavement sections are outlined herein.

Purpose and Scope of Study

This report presents the results of a Subsoil and Foundation Investigation for the proposed Riverwalk Project located in downtown Steamboat Springs, Colorado. The approximate location of the project site is shown in Figure #1.

A field exploration program was conducted between April 29 to May 16, 2008 to obtain information on the subsurface conditions at the site. Material samples obtained during the subsurface investigation were tested in the laboratory to provide data on the classification and engineering characteristics of the on-site soils. The results of the field and laboratory investigations are presented herein.

This report has been prepared to summarize the data obtained and to present our conclusions and recommendations based on our understanding of the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed development are included.

Proposed Construction

It is our understanding that the proposed development will generally consist of multiple commercial/residential structures that will be constructed with a common below grade parking structure covering most of the site. The site will be developed with numerous buildings varying in height from 3 to 4 stories. Although building plans were not available at the time of this report, we have assumed that the building structures will generally be constructed using structural steel frames, or structural concrete columns, beams and slabs. The parking garage will be constructed with a concrete slab-on-grade floor system. It appears that the lower levels of the structures will be constructed from 10 to 20 feet below the existing ground surface at the site. We have also assumed that foundation loadings for these structures will be moderate to high typical of this type of commercial construction.

This report has been prepared specifically for Buildings H, C, D, and E. It is our understating that several other buildings will be constructed at the site. These future structures will require Supplemental Reports once the building plans have been completed and the finished floor elevations have been determined.

Site Conditions

The site is located along Yampa Avenue and between 3rd and 5th Streets in downtown Steamboat Springs. At the time of this investigation, the site was currently being used for storage of construction materials and parking areas. The site was previously occupied by a mobile home park. The mobile homes have been removed from the site in the last 2 years. The vegetation around the property generally consists of scattered grasses and weeds with occasional deciduous trees. The remainder of the site is paved with either asphalt or concrete.

The topography of the project site is variable and the majority of the site generally slopes gently to moderately down to the northwest on the order of 1 to 3 percent. However, steeper slopes are situated just west of the alley that runs along the eastern edge of the property. These areas generally slope moderately to steeply down to the northwest on the order of 10 to 15 percent.

The Yampa River is located directly west of the property and the river generally flows in a southeast to northwest direction along the property line. Soda Creek, which has been placed in a buried culvert pipe, is located in the southern end of the property and it appears that the pipe generally runs/flows in a northeast to southwest direction from the east side of Lincoln Avenue to the Yampa River.

Field Investigation

The field investigation for this project was conducted between April 29 and May 16, 2008. Forty-eight (48) test holes were advanced at the approximate locations shown in Figure #2 to assess the subsurface conditions. Locations of the test holes were in the proximity of staking done by Landmark Consultants, prior to this investigation.

The test holes were advanced through the overburden soils with 4-inch diameter continuous flight and 7-inch hollow stem augers, as well as with an air rotary hammer drill bit. The test holes were drilled with CME 55 drill rigs and were logged by a representative of NWCC, Inc.

Samples of the subsurface materials were taken with a California liner sampler and split spoon sampler, as well as obtained small disturbed samples from the auger cuttings. The samplers were driven into the various strata with blows from a 140-pound hammer falling 30 inches. This test is similar to the standard penetration test described by ASTM Method D-1586. Penetration resistance values, when properly evaluated, indicate the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the logs of the exploratory holes in Figures #3 through #8. The Legend and Notes associated with the logs are shown in Figure #9.

Laboratory Investigation

Samples obtained from the exploratory holes were examined and classified in the laboratory by the project engineer. Laboratory testing included standard property tests, such as natural moisture contents, density, grain size analyses, liquid and plastic limits, and swell-consolidation testing.

Results of the laboratory-testing program are shown in Figures #10 through #13, as well as summarized in Table 1. The laboratory testing was conducted in general accordance with applicable ASTM and/or AASHTO specifications.

Subsurface Conditions

The subsurface conditions encountered in the test holes were highly variable and generally consisted of a layer of topsoil and organic materials, asphalt pavement, concrete pavement, or man-made fill materials, overlying natural sands and silts, natural sands, clays, sands and gravels, and claystone-sandstone-siltstone bedrock to the maximum depth investigated, 30 feet.

A layer of natural topsoil and organic materials, asphalt pavement, concrete pavement or made fill materials was encountered at the ground surface in a majority of the test holes. These materials ranged from 6 inches to 8 feet in thickness. The man made fill materials consisted of silts, clays, sands and gravels that were low to moderately plastic, soft to medium dense, slightly moist to moist and brown in color.

Natural overburden soils consisting of natural sands and silts, sands, and clays were encountered beneath the topsoil and organics and fill materials, as well as at the ground surface in several of the test holes. The natural sands and silts were low to non-plastic, fine to medium grained, very soft to medium dense, moist to wet and brown to dark brown in color. Samples of the natural sands and silts classified as SM-ML to ML soils in accordance with the Unified Soil Classification System. The natural sands were silty to clayey, fine to coarse grained, low to non-plastic, loose to dense, moist to wet and brown in color. A sample of the natural sands classified as a SM soil in accordance with the Unified Soil Classification System. The natural clays were slightly sandy to sandy with occasional gravels, moderately plastic, medium stiff to stiff, moist to very moist and brown in color.

Natural sands and gravels were encountered beneath the existing fill materials, natural sands and silts, clays and sands in all of the test holes and extended to the maximum depth investigated in 30 of the test holes. It should be noted that practical rig refusal using conventional augers was encountered in the cobbles and boulders in 11 of the test holes. An air rotary hammer drill was used to penetrate through the cobbles and boulders in several of the holes. The sands and gravels were silty to clayey, fine to coarse grained with cobbles and boulders, low to non-plastic, medium dense to dense, moist to wet and brown in color. Samples of the natural sands and gravels classified as SM-GM soils in accordance with the unified Soil Classification System.

Claystone-sandstone-siltstone bedrock materials were encountered in 18 of the test holes below the sands and gravels, and the bedrock materials extended to the maximum depth investigated in each of these test holes. The claystone-sandstone-siltstone bedrock materials were low to moderately plastic, fine to medium grained, hard to very hard, moist to very moist and brown to light brown in color. Samples of the claystone-sandstone-siltstone bedrock materials classified as CL, CL-ML, and CL-SC soils in accordance with the Unified Soil Classification system.

Swell-consolidation tests conducted on samples of the claystone-sandstone-siltstone bedrock materials indicate that the materials tested will exhibit a low to moderate swell potential when wetted under a constant load. The swell-consolidation test results are shown in Figures #10 through #13 and all of the other test results are summarized in the attached Table 1.

Free groundwater was encountered in all of the test holes at depths ranging from 2 ½ to 17 feet below the existing ground surface. It should be noted that groundwater conditions at the site can be expected to fluctuate with changes in precipitation, runoff and the flows in the Yampa River and Spring Creek.

Foundation Recommendations

Based on the soils 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 type of foundation system for the proposed buildings is spread footings or individual pads with grade beams founded on the undisturbed natural sands and gravels, claystone-sandstone-siltstone bedrock materials, or on properly compacted structural fill materials placed over the natural sands and gravels and/or claystone-sandstone-siltstone bedrock.

1) The footings placed on the undisturbed, natural sands and gravels or claystone-sandstone-siltstone bedrock may be designed using an allowable soil bearing pressure of 4,000 psf. The footing placed on properly compacted structural fill materials should be designed using an allowable soil bearing pressure of 3,000 psf. Due to the swell potential of the bedrock materials, we also recommend that the footings be designed for a minimum dead load pressure of at least 800 psf. A minimum dead load is not required for footings placed in the areas where there is at least 6 feet of natural sands and gravels or structural fill materials between the base of the footings and the bedrock materials.

2) The footings or pad sizes should be computed using the above soil pressures and placed on the natural undisturbed sands and gravels, claystone-sandstone-siltstone bedrock, or on properly compacted structural fill materials placed over the natural sands and gravels or claystone-sandstone-siltstone bedrock materials. Any topsoil and organic materials, existing fill materials, natural sands and silts, clays and sands encountered within the foundation excavations should be removed and the excavations extended to competent sands and gravels or bedrock materials prior concrete placement or structural fill placement. The footings may have to be narrow or interrupted to maintain the minimum dead load. The foundation design should be closely checked to assure that it distributes the loads per the allowable pressures given.

3) Any existing fill materials, topsoil and organic materials, loose and soft natural soils (silts, clays or sands) encountered within the foundation excavations should be removed and the excavations extended to competent natural sands and gravels or bedrock materials prior to structural fill or concrete placement. Any fill materials placed beneath the footings should be a non-expansive granular soil approved by the soil engineer. The fill materials placed under the footings should be uniformly placed and compacted in 6 to 8 inch loose lifts and compacted to at least 100% of the maximum standard Proctor density and within 2% of the optimum moisture content determined in accordance with ASTM D-698/AASHTO T-99. Free draining fill materials should be compacted to at least 80% of the maximum relative density determined in accordance with ASTM D-4253/4254. The structural fill materials should extend out from the edge of the footings on a 1(horizontal) to 1(vertical) or flatter slope. The on-site sands and gravels can be used for structural fill materials after the cobbles and boulders are removed.

4) The foundation walls should be designed and reinforced to span an unsupported distance of 10 feet or the length between pads, whichever is greater.

5) The footings or pads should be placed well enough below final backfill grades to protect them from frost heave. Forty-eight (48) inches is typical for this location considering normal snow cover and other winter factors.

6) Based on experience, we estimate the total settlement for footings and pads designed and constructed as discussed in this section will be approximately 1 inch. Additional bearing capacity values along with the associated settlements are presented in Figures #14 and 15.

7) We strongly recommend that the client retain our firm to observe the foundation excavations when they are near completion to identify the bearing soils and confirm the recommendations in this report, as well as test any structural fill materials placed beneath the foundations for compaction.

Alternate Foundation Recommendations

An alternative type of foundation system to the footings would be advance helical/screw piles into the underlying natural sands and gravels or bedrock materials. This type of foundation system may be feasible in areas where excessive amounts of overexcavation may be required to reach suitable bearing soils. We recommend that the helical/screw pile foundation system be designed by a qualified engineer, using industry standards and be installed by a licensed/certified installer. We strongly recommend that at least five test piles be advanced at the proposed building sites so that the torque versus depth relationships can be established and the proper shaft and helix size and type can be determined.

Floor Slab Recommendations

It is our understanding that the lower floor levels of the buildings will be constructed with concrete slab-on-grade floor systems. The natural sands and gravels, as well as the bedrock materials are capable of supporting slab-on-grade floor systems. However, floor slabs present a very difficult problem where expansive soils and bedrock materials are present near the 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 or when the soils consolidate under relatively light loads. Based on the moisture-volume change characteristics of the claystone-sandstone-siltstone bedrock materials encountered at this site, we believe slab-on-grade construction may be used, provided the risk of distress resulting from slab movement is recognized and special design precautions are followed.

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

1) The floor slabs must be separated from all bearing walls, columns and their foundation supports with a positive slip joint. We recommend the use of 1/2-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. A typical hung partition wall detail is shown in Figure #16.

3) A minimum 18-inch thick 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 perimeter of the slab or the low point of the excavation. We also recommend that all of the topsoil materials, any existing fill materials or foundation elements, the sands and silts or clays be removed from beneath the floor slabs.

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.

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) 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 loose lifts to at least 95% of the maximum standard Proctor density at or near the optimum moisture content, as determined by ASTM D-698/AASHTO T-99. Free draining fill materials should be compacted to at least 75% of the maximum relative density determined in accordance with ASTM D-4253/4254.

The above precautions and recommendations will not prevent floor slab movement in the event the bedrock materials 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 Recommendations

Because the proposed structures will be constructed with below grade areas and groundwater was encountered in all of the exploratory test holes, we recommend that the buildings and underground parking structures be designed with underdrain systems. The lower levels of the buildings should be protected by underdrain systems to help reduce the problems associated with the shallow groundwater, surface and subsurface drainage during high runoff periods. Groundwater or runoff can infiltrate the foundation at the foundation and floor slab levels. This water can be one of the primary causes of differential foundation and slab movement.

Structures constructed below the groundwater level should be protected by an underdrain system and be waterproofed and designed to resist hydrostatic uplift if daylighting of the drainage system cannot be accomplished. If a reliable drainage system cannot be implemented, the structure should be designed to resist hydrostatic uplift. The owner should be aware of the risk of damage to the structure should the underdrain system become inoperative during the life of the facility. The design of the structure should consider the consequences of hydrostatic uplift if the dewatering system fails. For example, the release of the uplift pressure could be achieved by blowout plugs placed in the parking level floor to equalize water pressure on both sides of the structure should the water level rise above the floor slab.

The underdrain systems should be located around the entire perimeter of the buildings and below the floor slabs. The underdrains should be located at least 1 to 2 feet below the lower floor level elevations. The underdrain systems should consist of a layer of free draining granular material beneath the floor slab connected to the perimeter and lateral drains. The lateral drains should be spaced on approximately 15 foot centers beneath the floor slabs. We recommend the use of perforated PVC pipe for the drain pipe which meets or exceeds ASTM D-2729 requirements to minimize the potential for crushing the pipe during backfill operations. The drain pipe should be covered by at least 12 inches of free draining gravel. The holes in the drain pipe should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of the water. The drainage system should be protected from contamination by a filter covering of Mirafi 140N subsurface drainage fabric or an equivalent product. The drain pipes should have a minimum slope of 1/8 inch per foot and should be daylighted at a positive outfall(s) protected from freezing, or be led to sumps 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 systems include cleanouts, be protected against intrusion by animals at the outfall(s) and be tested prior to backfilling. In addition, in areas where foundation voids are placed, we recommend that a barrier be constructed to keep water from infiltrating through the voided areas. The barrier should consist of a heavy PVC material (20mil) or similar liner material. A typical perimeter/underdrain detail is shown in Figure #17.

The design of the underdrain systems should be finalized after the excavations for the buildings have been completed and the flow rate of groundwater to be removed from the building can be estimated. The actual quantities of water which must be pumped from the sumps to dewater the lower level of the excavation should be determined at the time of construction by conducting pumping tests from the sumps.

Foundation Walls and Retaining Structure Recommendations

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 55 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 45 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 natural slope also increases the earth pressures on foundation walls and retaining structures.

The lateral resistance of retaining wall foundations placed on undisturbed natural soils at the site will be a combination of the sliding resistance of the footings on the foundation materials and the passive pressure against the sides of the footings. Sliding friction can be taken as 0.4 times the vertical dead load. Passive pressure against the sides of the footing can be calculated using an equivalent fluid pressure of 250 pcf. The fill placed against the sides of the footings to resist lateral loads should be compacted to at least 100% of the maximum standard Proctor density, near the optimum moisture content.

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 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 over compact 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 Recommendations

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 buildings have been completed:

1) The ground surface surrounding the buildings should be sloped (minimum of 1.0 inch per foot) to drain away from the building 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 buildings 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 foundations 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 buildings.

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

Pavement Section Recommendations

Based on the subsurface conditions encountered across the site and our experience with similar projects, we recommend that the portions of the site, which are subjected only to automobile traffic, such as the automobile parking areas, be paved with a composite section consisting of 3 inches of asphalt, 4 inches of base course gravels and a minimum of 6 inches of subbase (pit run) gravels. If a rigid concrete pavement section is opted for then we would recommend that the concrete pavement section for the automobile parking areas consist of a minimum of 5 inches of Portland cement concrete. However, if a snow-melt system is installed in these, we would recommend that the concrete section be a minimum of 6 inches in thickness.

We recommend that in any areas are subjected to both automobile and truck traffic, be paved with a composite section consisting of a minimum of 4 inches of asphalt, 4 inches of base course gravels and a minimum of 8 inches of subbase (pit run) gravels. If a rigid concrete pavement section is opted for then we would recommend that the concrete pavement section for the automobile parking areas consist of a minimum of 6 inches of Portland cement concrete. However, if a snow-melt system is installed in these, we would recommend that the concrete section be a minimum of 7 inches in thickness.

The areas subjected to concentrated truck traffic and turning movements, such as at the trash dumpster and around loading docks, should be paved with a minimum of 8 inches of Portland cement concrete. However, if a snow-melt system is installed in these, we would recommend that the concrete section be a minimum of 9 inches in thickness.

The asphalt pavement should consist of a hot bituminous plant mix meeting the job mix formula established by a qualified engineer, which also meets Colorado Department of Transportation (CDOT) specifications. The base course materials should consist of a well-graded aggregate base course material, which meets CDOT Class 6 or 5 grading and durability requirements.

The concrete pavement materials should have a modulus of third point loading of 650 psi. Normally, a concrete with a 28-day compressive strength of 4500 psi should develop this modulus of rupture value. Concrete should be air entrained with approximately 6% air and should have a minimum cement content of 6 sacks per cubic yard. Maximum allowable slump of the concrete should be 4 inches and expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. The concrete pavement should contain sawed or formed joints to 1/4 the depth of the slab at a maximum distance of 10 feet on center to control natural cracking.

We recommend that the pavement areas be prepared by sub-excavating and re-compacting the existing natural soils to provide uniform support for the pavements and help control differential settlement. We recommend the removal of all of the topsoil and organic materials from under the roadways and parking areas. We also recommend that the exposed subgrade materials be scarified to a depth of at least 6 inches and be moisture conditioned to near the optimum moisture content and then be compacted to at least 95% of the maximum modified Proctor density in accordance with ASTM D1557. After the subgrade soils have been properly moisture treated and recompacted, the subgrade should be proof rolled with a heavily loaded pneumatic tired vehicle and any areas which deform excessively under the wheel loads should be removed and replaced or stabilized prior to paving operations.

The collection and diversion of surface and subsurface drainage away from paved areas is extremely important to satisfactory performance of the pavements. Subsurface and surface drainage at the site may contribute to early pavement distress since this water is capable of entering the subgrade soils and base course materials beneath the pavement surface and causes them to lose strength.

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 structures. 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.

Swelling bedrock materials were encountered at this site. These materials are stable at their natural moisture content but can shrink or swell with changes in moisture and loading. The behavior of swelling soils and bedrock materials is not fully understood. The swell 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 soils and bedrock materials. The owner should be aware that there is a risk in construction on these types of materials. Performance of the structures 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 buildings. Any distress noted in the buildings 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. We strongly recommend that our firm be contacted prior to finalizing the construction plans so that we can verify that our recommendations are being properly incorporated into the building 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 structures. If there are any further questions concerning this report or if we may be of further service, please contact this office.

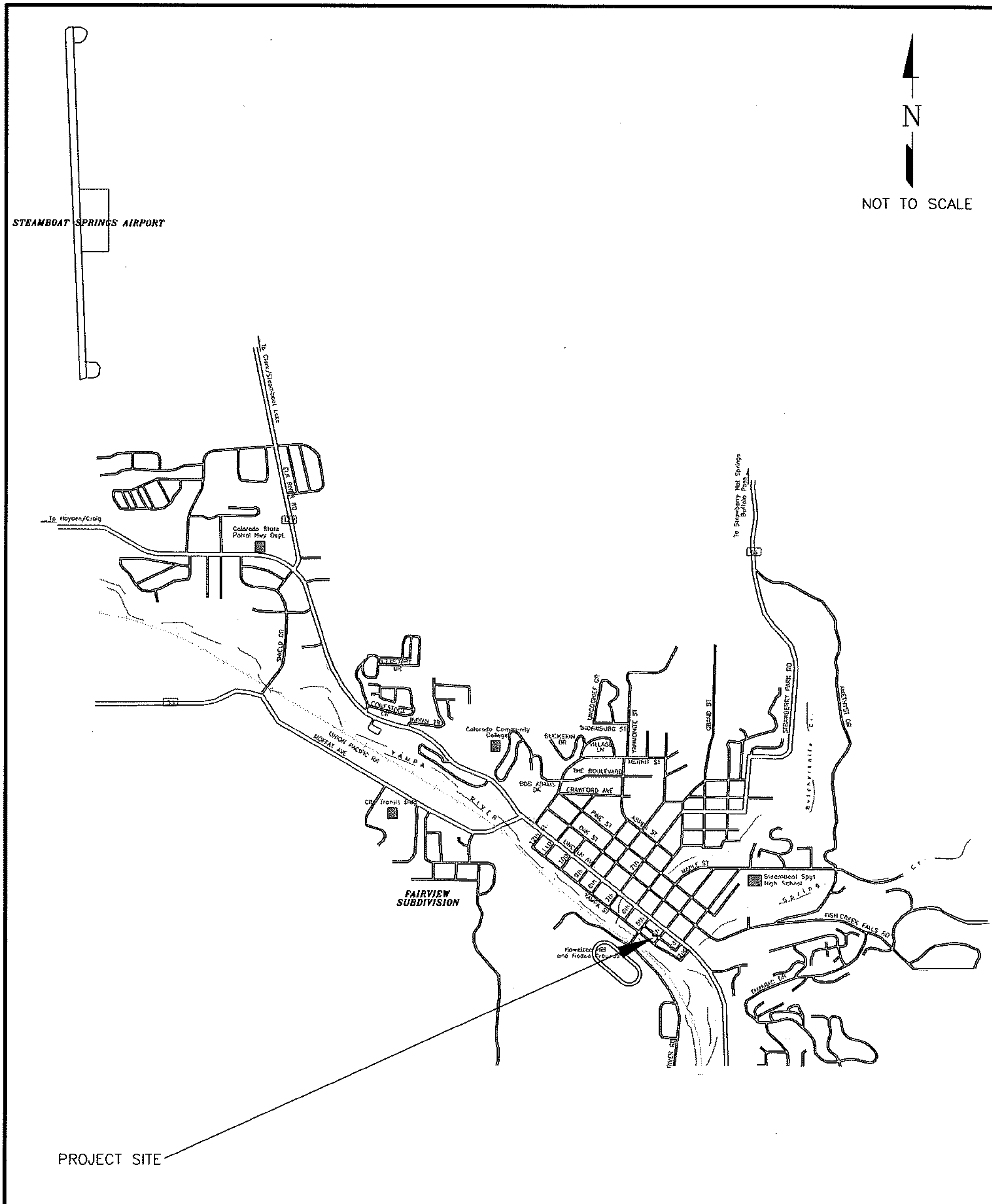
Sincerely,

NWCC, INC.

Josh P. Frappart, E.I.T.

Reviewed by Brian D. Len, P.E.

xc: Jim Cook
Ryan Spaulding – Landmark Consultants
Jim Kohler – Calcon
Cheryl Dornak – Davis Partnership



Title: VICINITY MAP	Date: 7/21/08
Job Name: Riverwalk Project	Job No. 06-7351
Location: Steamboat Springs, Colorado	Figure #1

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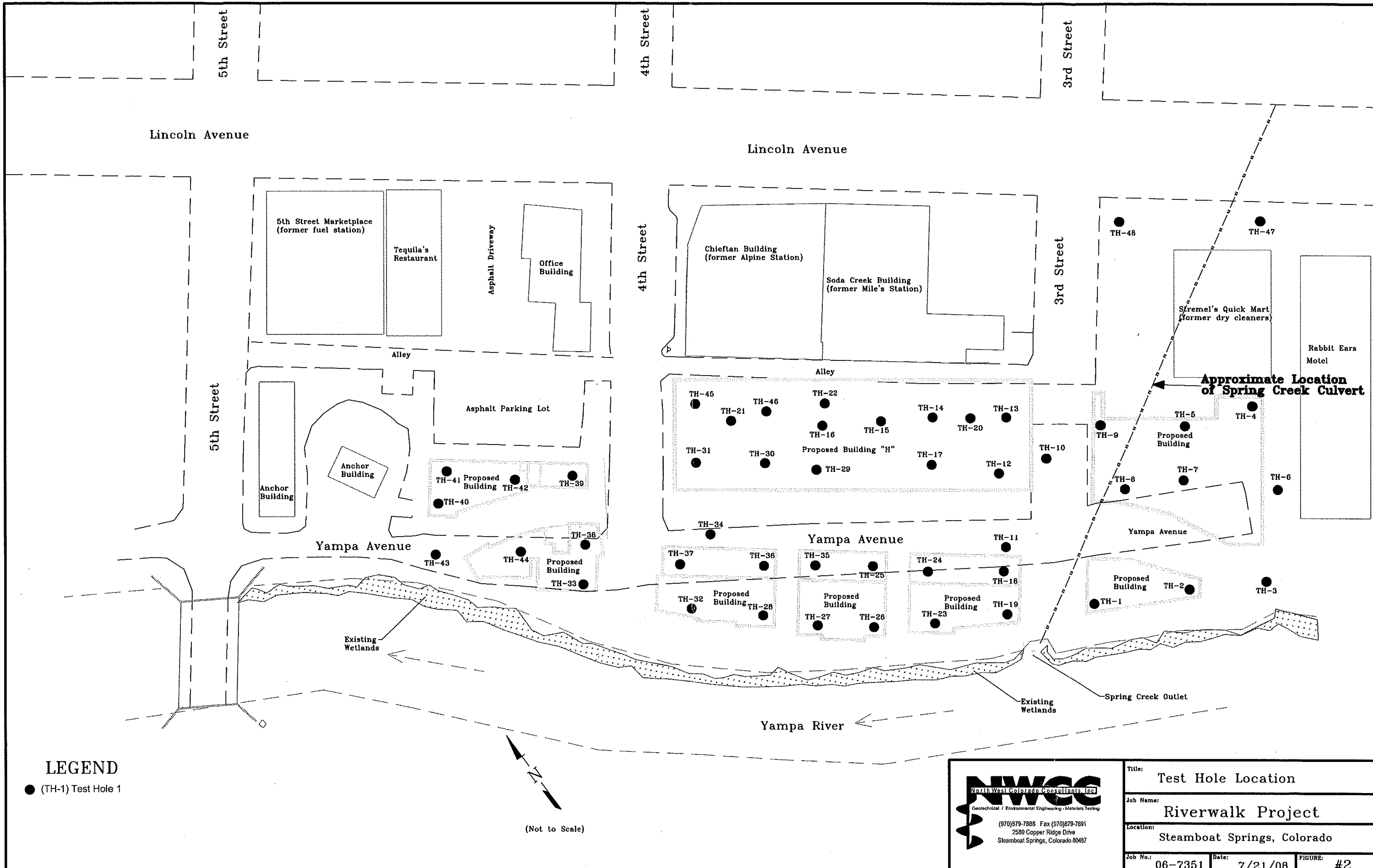

5th Street
4th Street
3rd Street
Lincoln Avenue
Lincoln Avenue
5th Street Marketplace (former fuel station)
Tequila's Restaurant
Asphalt Driveway
Office Building
4th Street
Chieftan Building (former Alpine Station)
Soda Creek Building (former Mile's Station)
3rd Street
TH-48
TH-47
Stremel's Quick Mart (former dry cleaners)
Rabbit Ears Motel
Alley
Alley
5th Street
Asphalt Parking Lot
Anchor Building
Anchor Building
Approximate Location of Spring Creek Culvert
TH-45
TH-21
TH-46
TH-22
TH-16
TH-15
TH-14
TH-20
TH-13
TH-31
TH-30
Proposed Building "H"
TH-29
TH-17
TH-12
TH-10
TH-9
TH-5
TH-4
Proposed Building
TH-8
TH-7
TH-6
TH-41
Proposed Building
TH-42
TH-39
TH-40
TH-34
Yampa Avenue
Yampa Avenue
Yampa Avenue
TH-38
TH-43
TH-44
Proposed Building
TH-33
TH-37
TH-36
TH-35
TH-25
TH-24
TH-11
TH-18
TH-32
Proposed Building
TH-28
Proposed Building
TH-27
TH-26
Proposed Building
TH-23
TH-19
Proposed Building
TH-2
TH-1
TH-3
Existing Wetlands
Existing Wetlands
Spring Creek Outlet
Yampa River
N
(Not to Scale)
LEGEND
(TH-1) Test Hole 1
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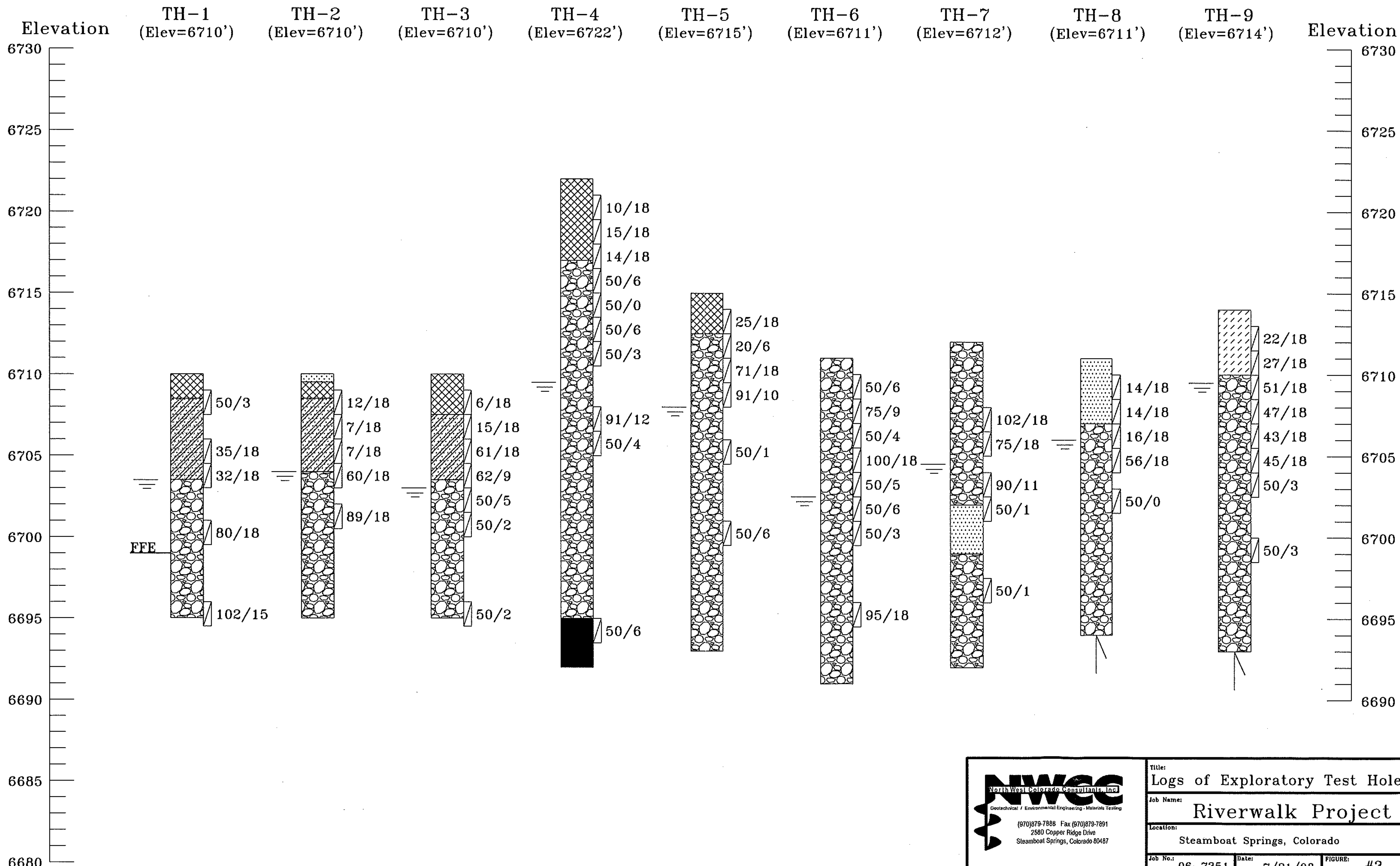
Steamboat Springs, Colorado 80487
Title: Test Hole Location
Job Name: Riverwalk Project
Location: Steamboat Springs, Colorado
Job No.: 06-7351
Date: 7/21/08
FIGURE: #2



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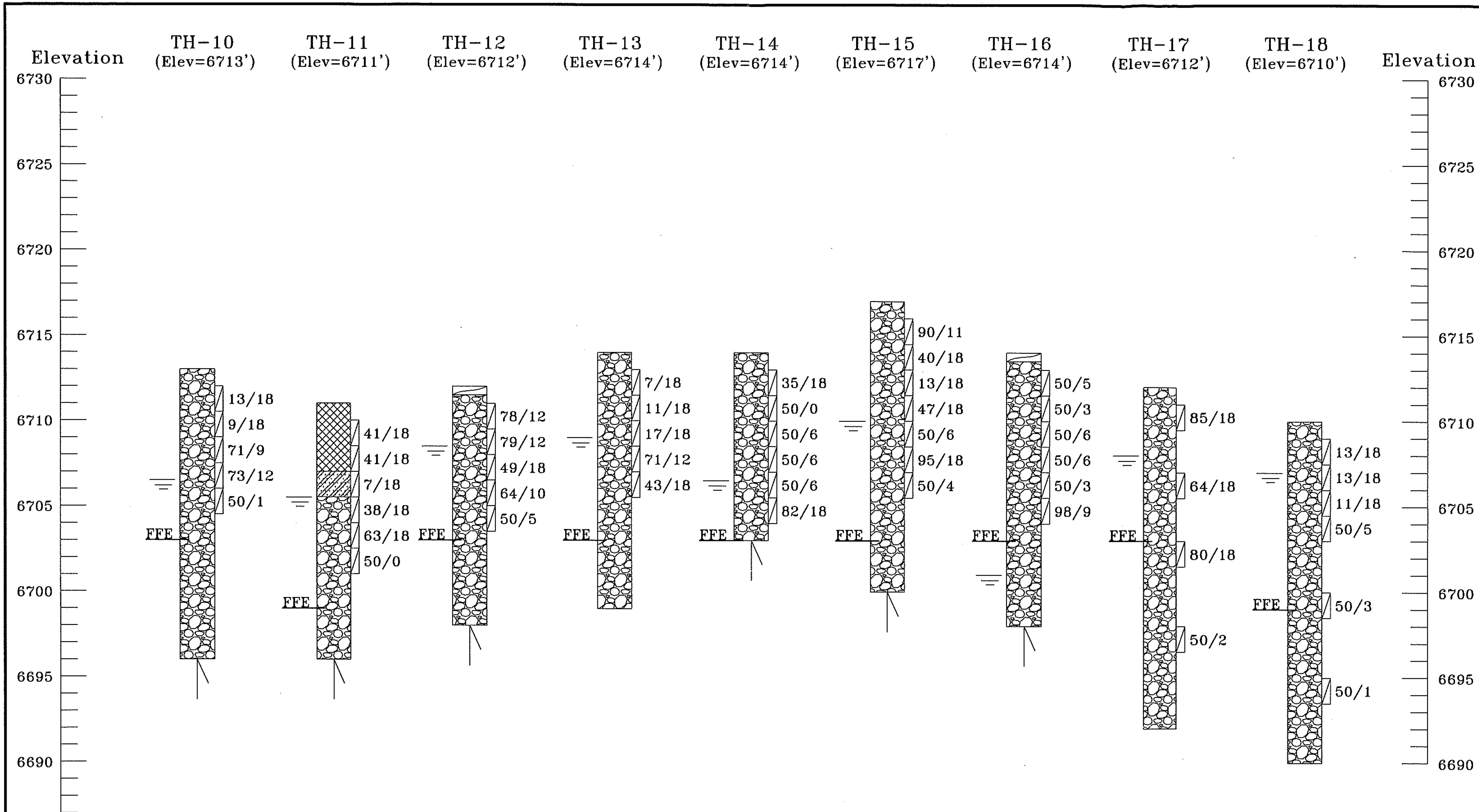
Title: Logs of Exploratory Test Holes	
Job Name: Riverwalk Project	
Location: Steamboat Springs, Colorado	
Job No.: 06-7351	Date: 7/21/08
FIGURE: #3	



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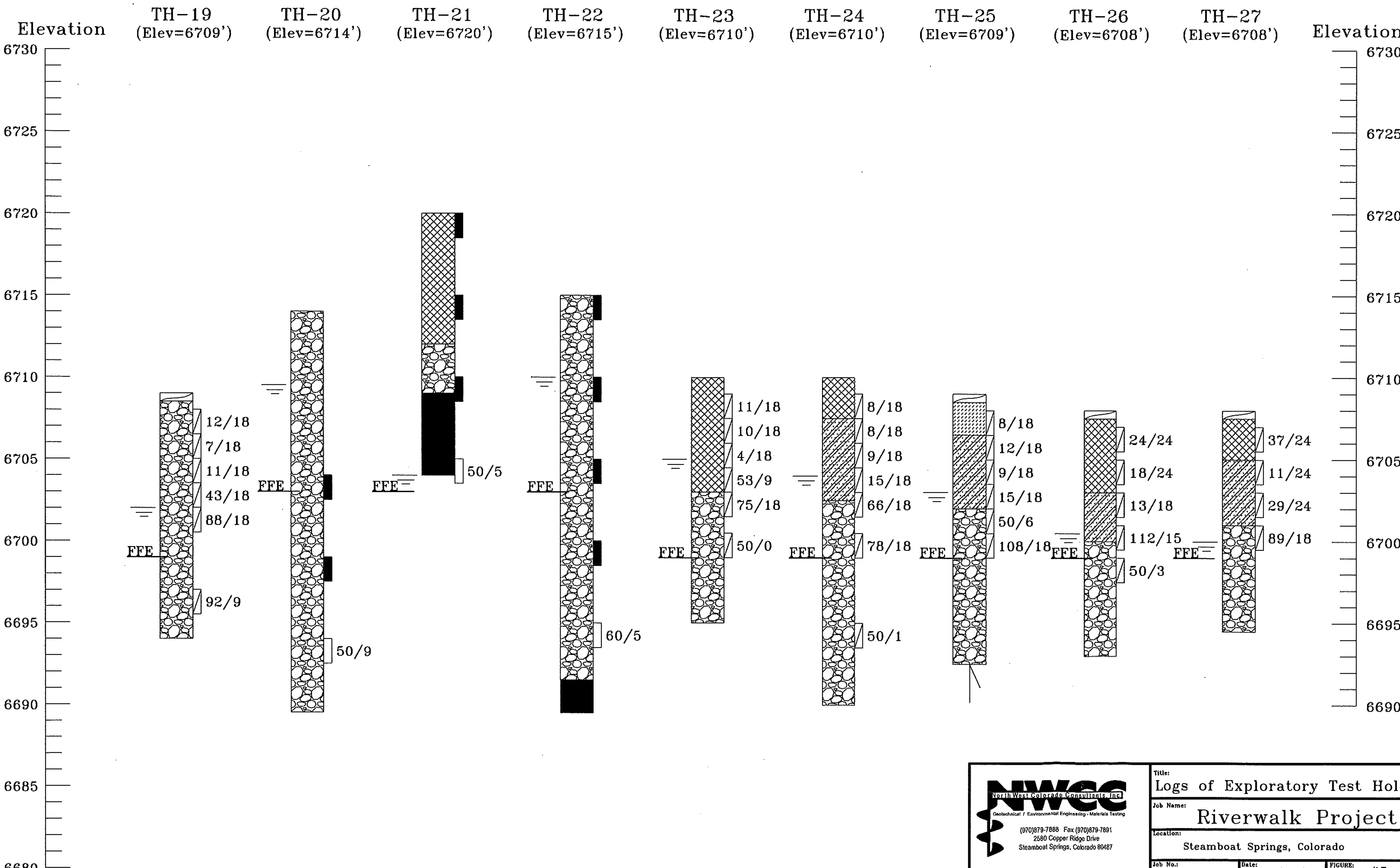
Title:	Logs of Exploratory Test Holes
Job Name:	Riverwalk Project
Location:	Steamboat Springs, Colorado
Job No.: 06-7351	Date: 7/21/08
FIGURE:	#4



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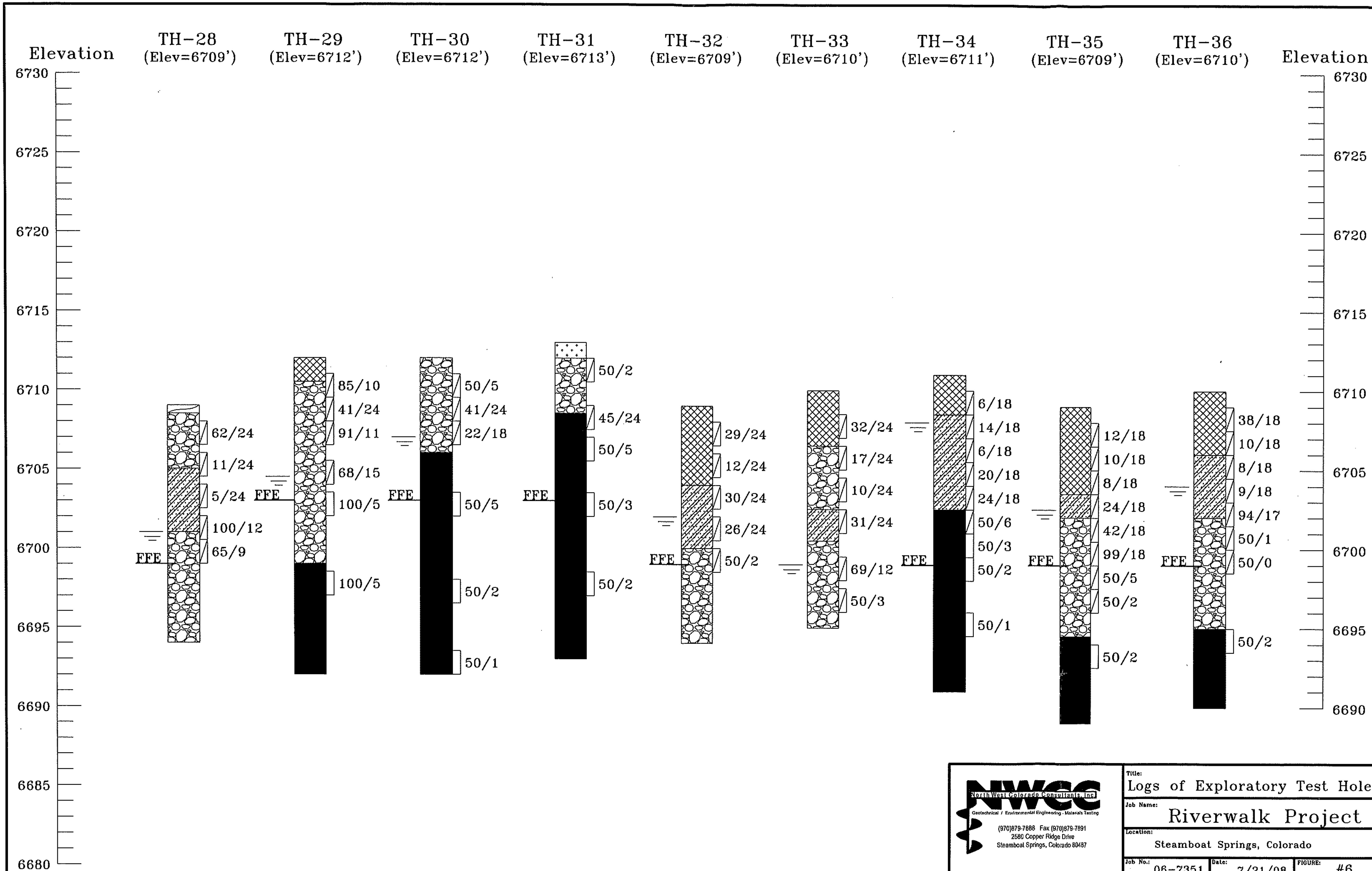
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487

Title:	Logs of Exploratory Test Holes
Job Name:	Riverwalk Project
Location:	Steamboat Springs, Colorado
Job No.: 06-7351	Date: 7/21/08
FIGURE:	#5


Elevation
TH-28 (Elev=6709')
TH-29 (Elev=6712')
TH-30 (Elev=6712')
TH-31 (Elev=6713')
TH-32 (Elev=6709')
TH-33 (Elev=6710')
TH-34 (Elev=6711')
TH-35 (Elev=6709')
TH-36 (Elev=6710')
Elevation
6730
6725
6720
6715
6710
6705
6700
6695
6690
6685
6680
62/24
11/24
5/24
100/12
65/9
FFE
85/10
41/24
91/11
68/15
100/5
100/5
FFE
50/5
41/24
22/18
50/5
50/2
50/1
FFE
50/2
45/24
50/5
50/3
50/2
FFE
29/24
12/24
30/24
26/24
50/2
FFE
32/24
17/24
10/24
31/24
69/12
50/3
6/18
14/18
6/18
20/18
24/18
50/6
50/3
50/2
50/1
FFE
12/18
10/18
8/18
24/18
42/18
99/18
50/5
50/2
50/2
FFE
38/18
10/18
8/18
9/18
94/17
50/1
50/0
50/2
FFE
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Geotechnical / Environmental Engineering - Materials Testing
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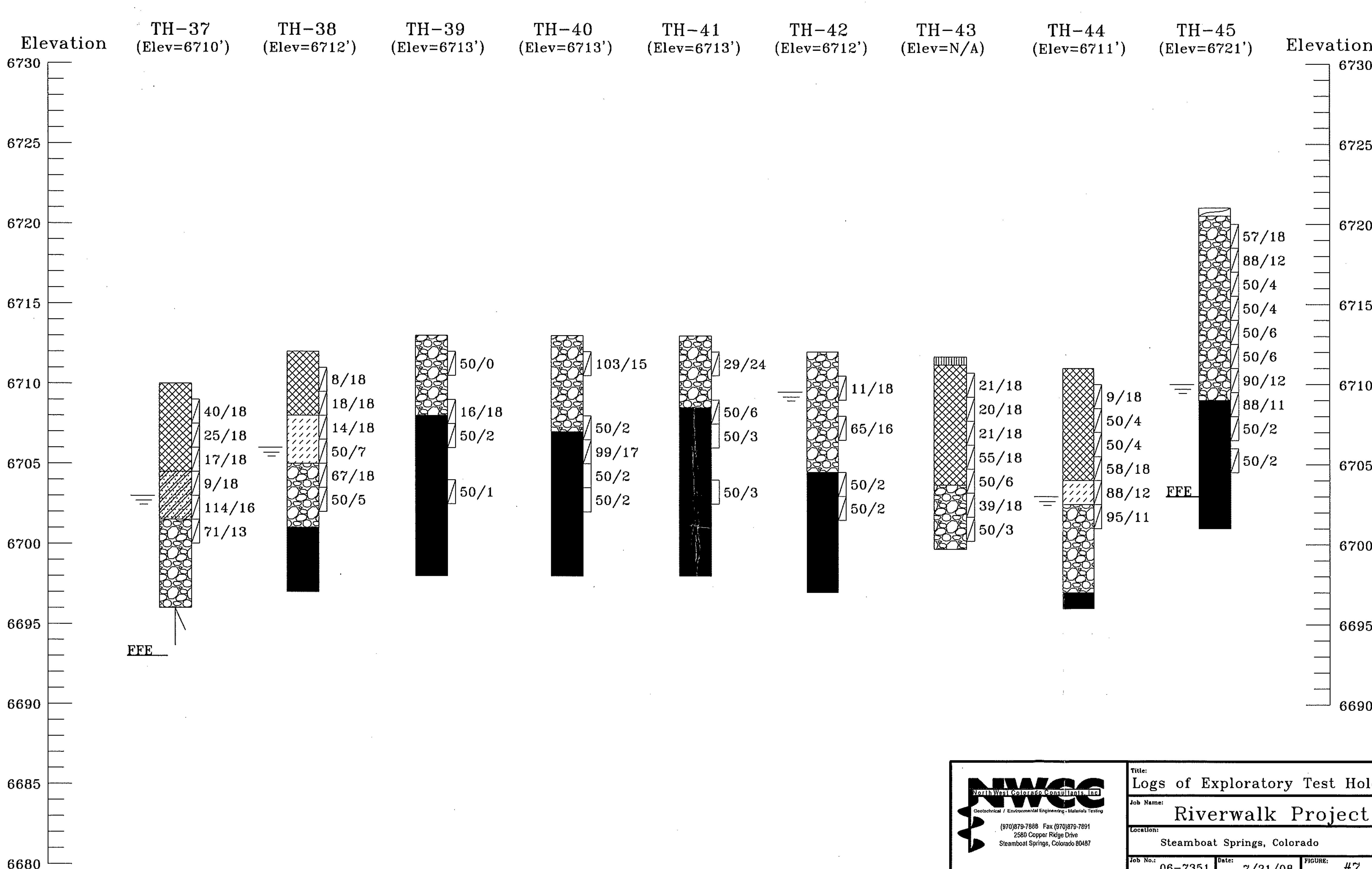
2580 Copper Ridge Drive
Steamboat Springs, Colorado 80487
Title:
Logs of Exploratory Test Holes
Job Name:
Riverwalk Project
Location:
Steamboat Springs, Colorado
Job No.: 06-7351
Date: 7/21/08
FIGURE: #6



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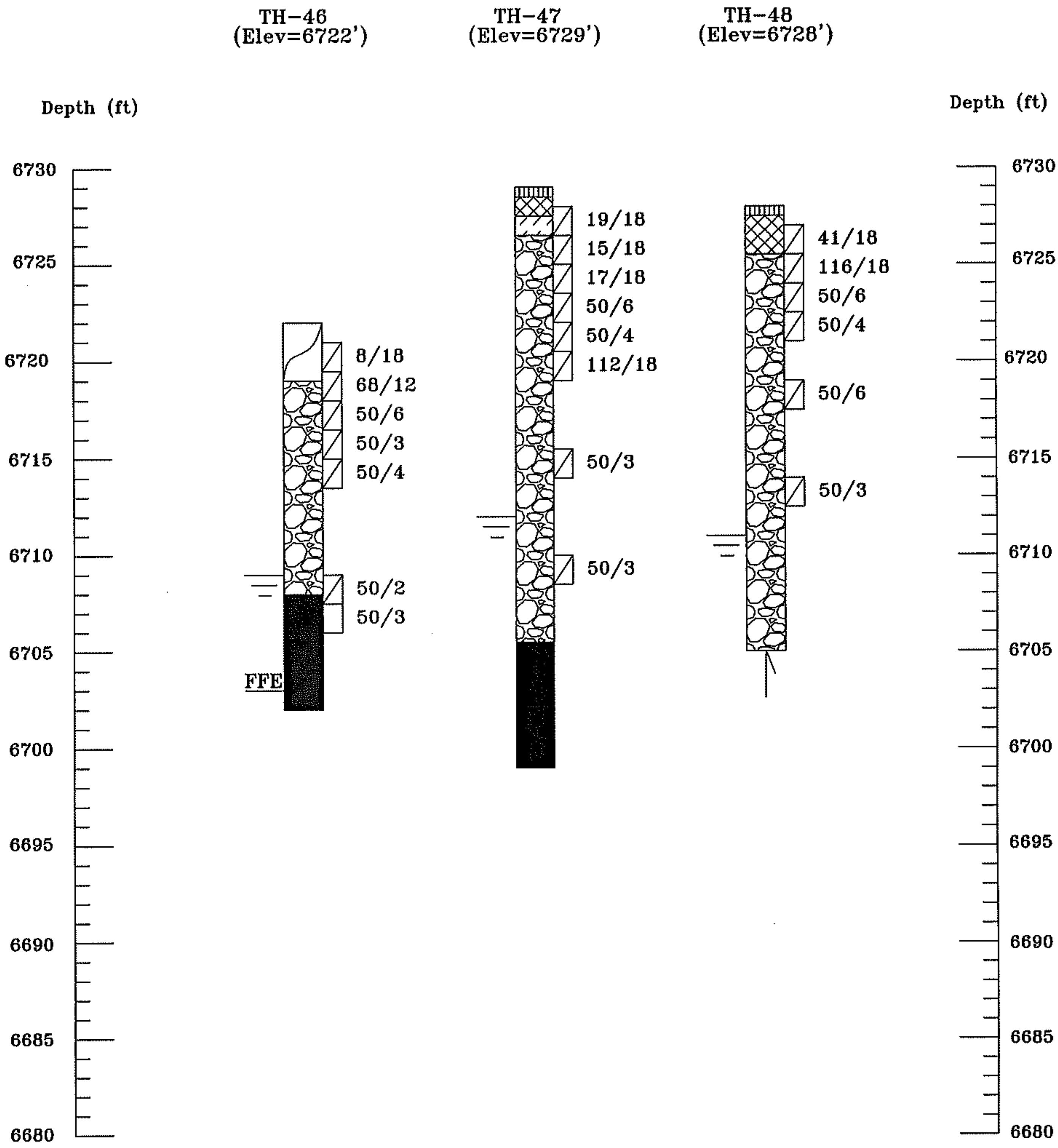
Title: Logs of Exploratory Test Holes	
Job Name: Riverwalk Project	
Location: Steamboat Springs, Colorado	
Job No.: 06-7351	Date: 7/21/08
FIGURE: #7	



Title: LOGS OF EXPLORATORY TEST HOLES	Date: 7/21/08
Job Name: Riverwalk Project	Job No. 06-7351
Location: Steamboat Springs, Colorado	Figure #8

North West Colorado Consultants, Inc.
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Steamboat Springs, Colorado 80487

LEGEND:

TOPSOIL AND ORGANICS:

ASPHALT PAVEMENT:

CONCRETE PAVEMENT:

FILL: Silts, clays, sands, and gravels, low to moderately plastic, soft to medium dense, slightly moist to moist and brown in color.

SANDS AND SILTS: Low to non-plastic, fine to medium grained, very soft to medium dense, moist to wet and brown to dark brown in color.

SANDS: Silty to clayey, fine to coarse grained, low to non-plastic, loose to dense, moist to wet and brown in color.

CLAYS: Slightly sandy to sandy with occasional gravels, moderately plastic, medium stiff to stiff, moist to very moist and brown in color.

SANDS AND GRAVELS: Silty to clayey, fine to coarse grained with cobbles and boulders, low to non-plastic, medium dense to dense, moist to wet and brown.

CLAYSTONE-SANDSTONE-SILTSTONE BEDROCK: Low to moderately plastic, fine to medium grained, hard to very hard, moist to slightly moist and brown to light brown in color.

Drive Sample, Split Spoon Sampler.

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

Small Disturbed Sample

50/3 Drive Sample Blow Count, indicates 50 blows of a 140-pound hammer falling 30 inches were required to drive the sampler 3 inches.

FFE Indicates approximate finished floor elevation.

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

Indicates depth at which practical rig refusal was encountered in cobbles and boulders.

NOTES:

1) The test holes were drilled from April 29 to May 16, 2008 with CME 55 drill rigs using 4-inch diameter continuous flight and 7-inch hollow stem augers.

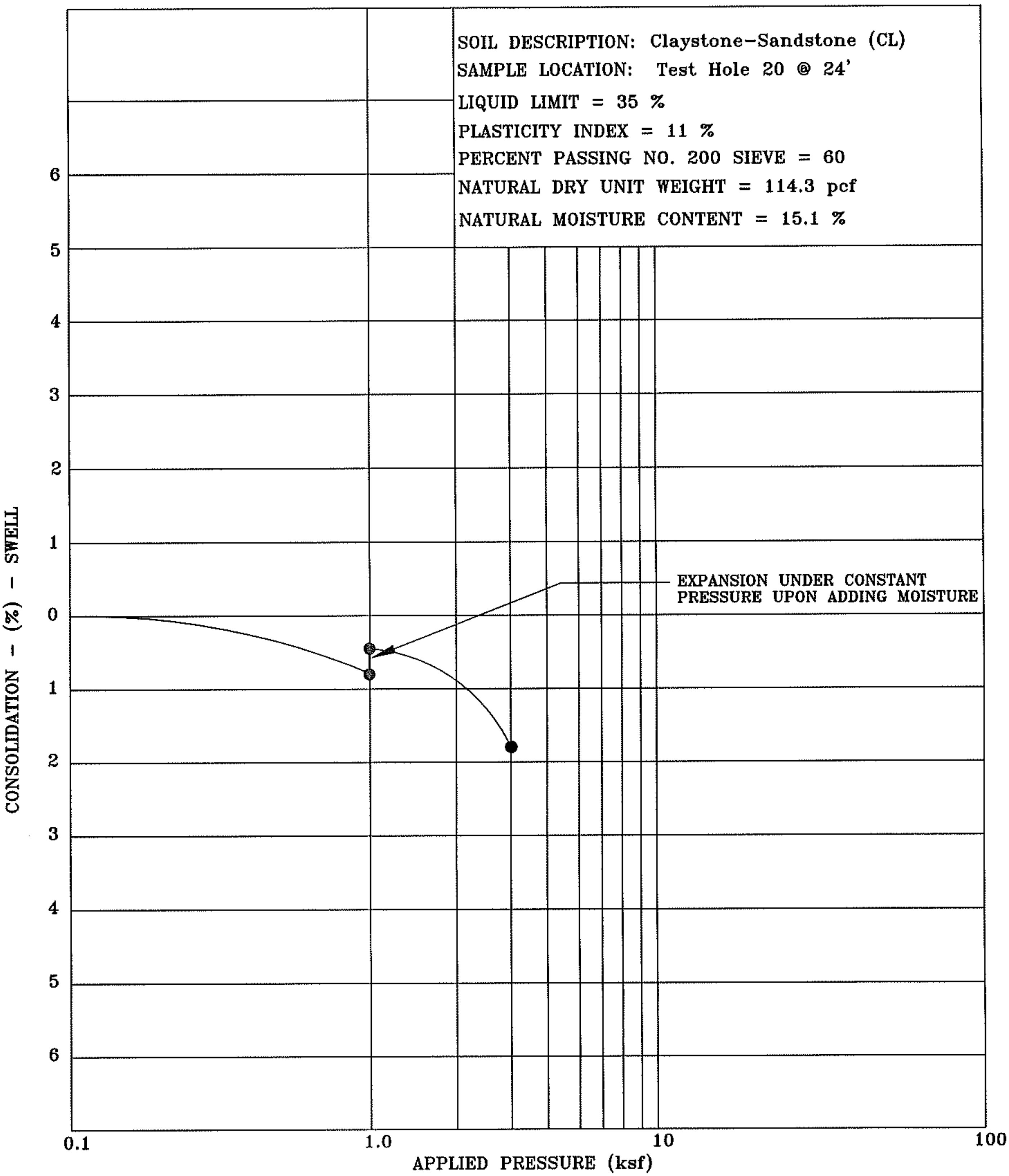
2) Locations of the test hole were in the proximity of staking done by Landmark Consultants, prior to this investigation.

3) Elevations of the test holes were measured by instrument survey.

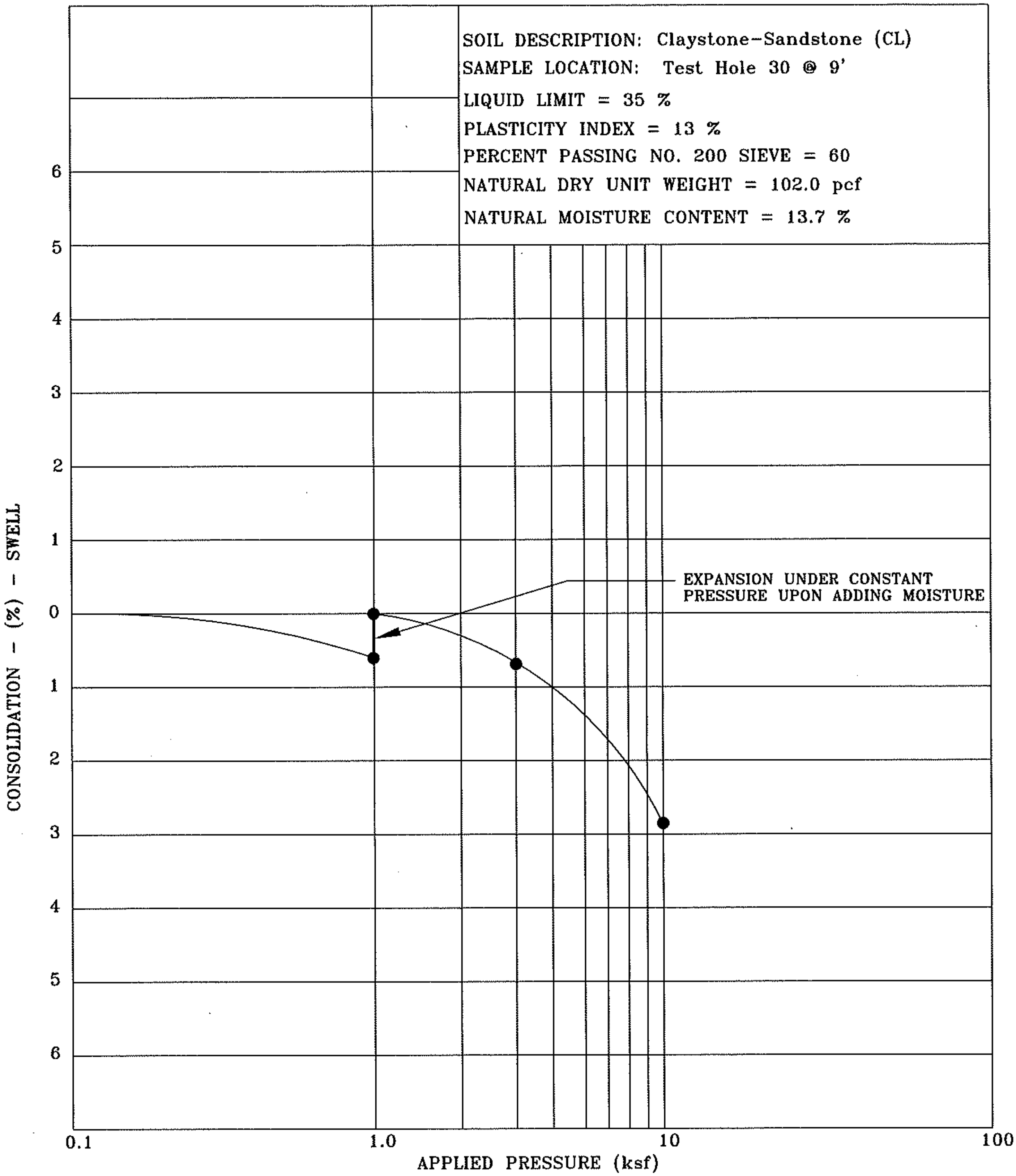
4) The lines between materials shown on the logs represent the approximate boundaries between material types and transitions may be gradual.

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.

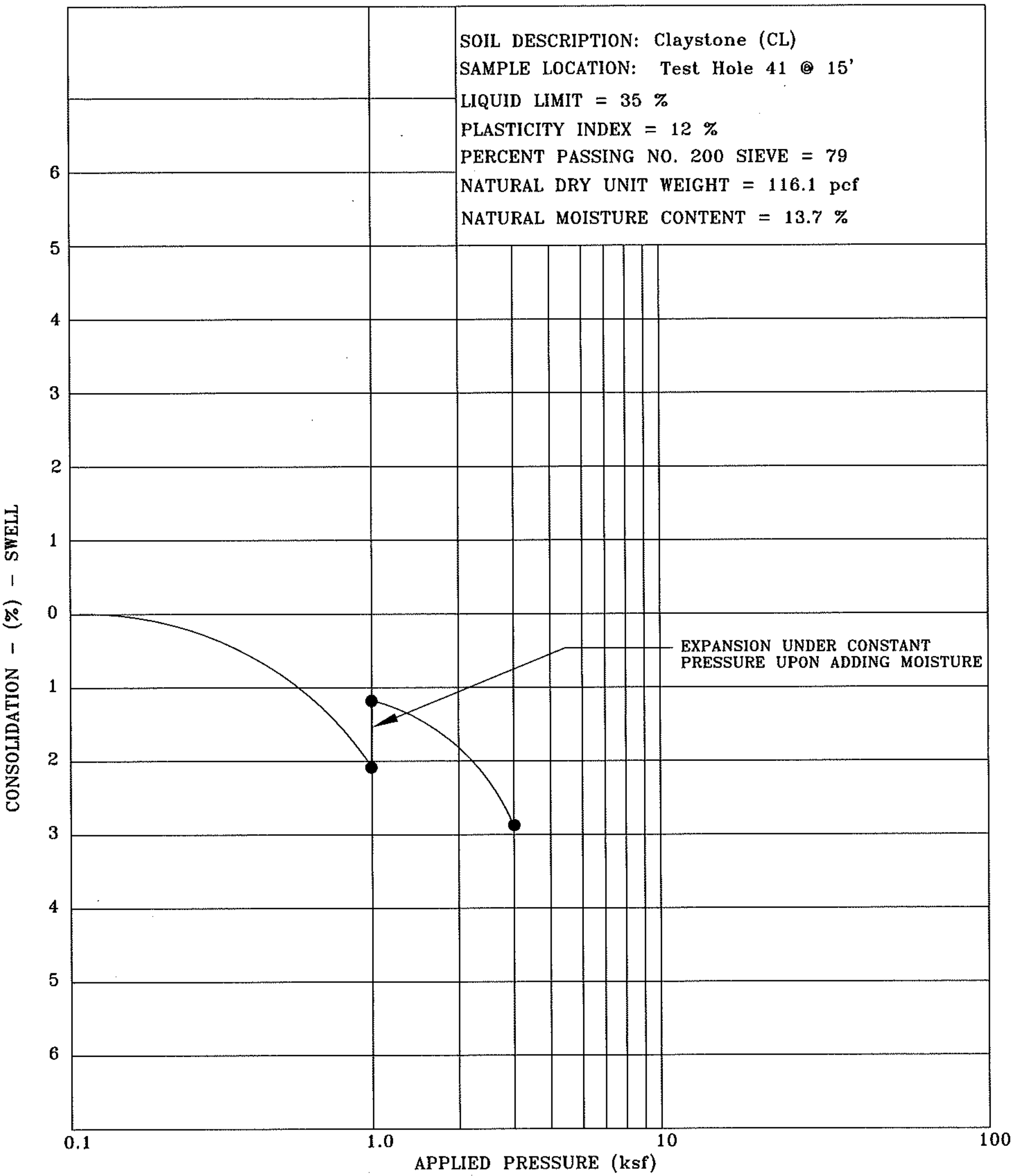
Title: LEGEND AND NOTES	Date: 7/21/08	North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing
Job Name: Riverwalk Project	Job No. 06-7351	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Location: Steamboat Springs, Colorado	Figure #9	



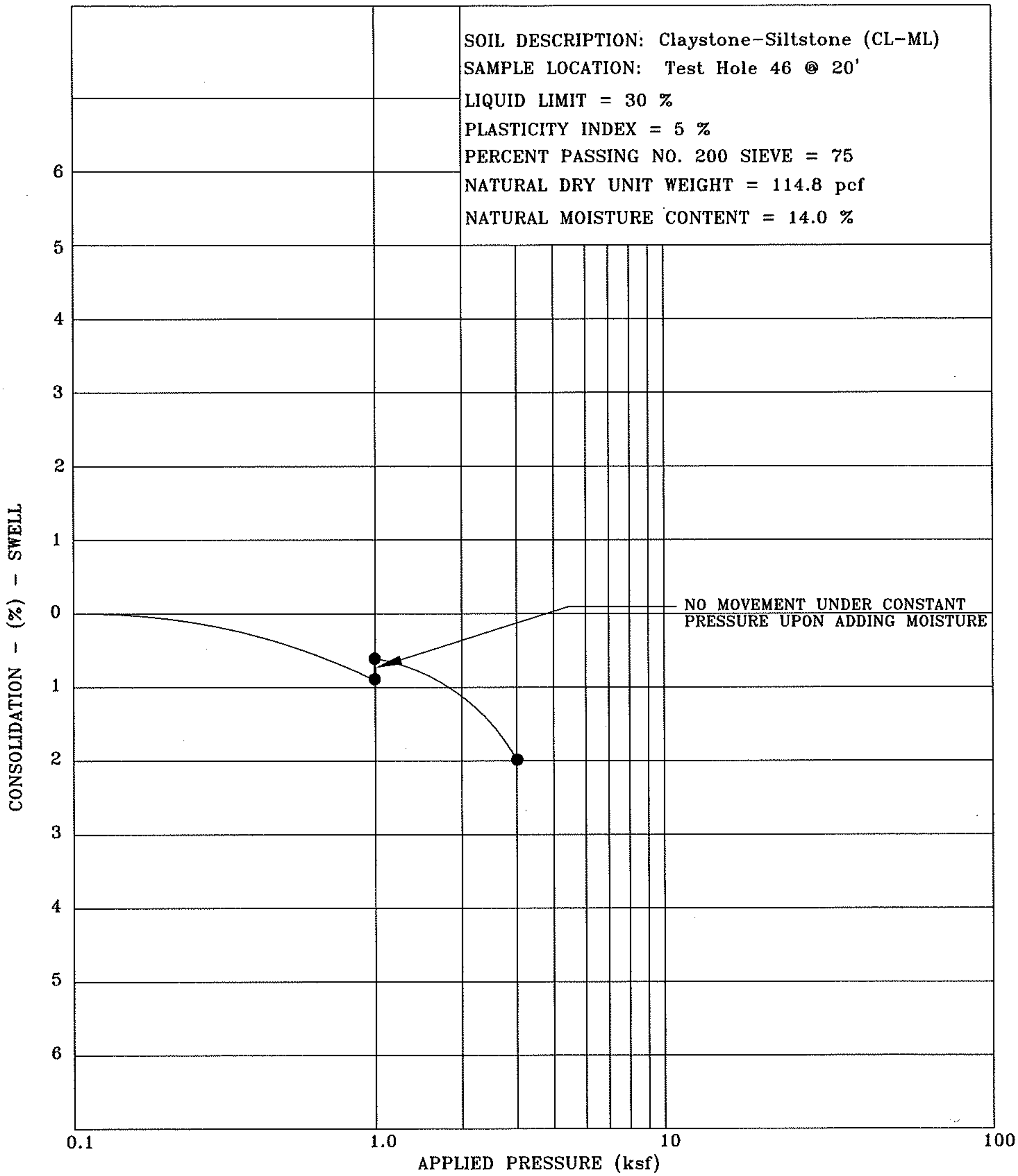
Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 7/21/08	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Riverwalk Project	Job No. 06-7351	
Location: Steamboat Springs, Colorado	Figure #10	



Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 7/21/08	NWCC North West Colorado Consultants, Inc.
Job Name: Riverwalk Project	Job No. 06-7351	Geotechnical / Environmental Engineering · Materials Testing
Location: Steamboat Springs, Colorado	Figure #11	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487



Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 7/21/08	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Riverwalk Project	Job No. 06-7351	
Location: Steamboat Springs, Colorado	Figure #12	



Title: SWELL-CONSOLIDATION TEST RESULTS	Date: 7/21/08
Job Name: Riverwalk Project	Job No. 06-7351
Location: Steamboat Springs, Colorado	Figure #13

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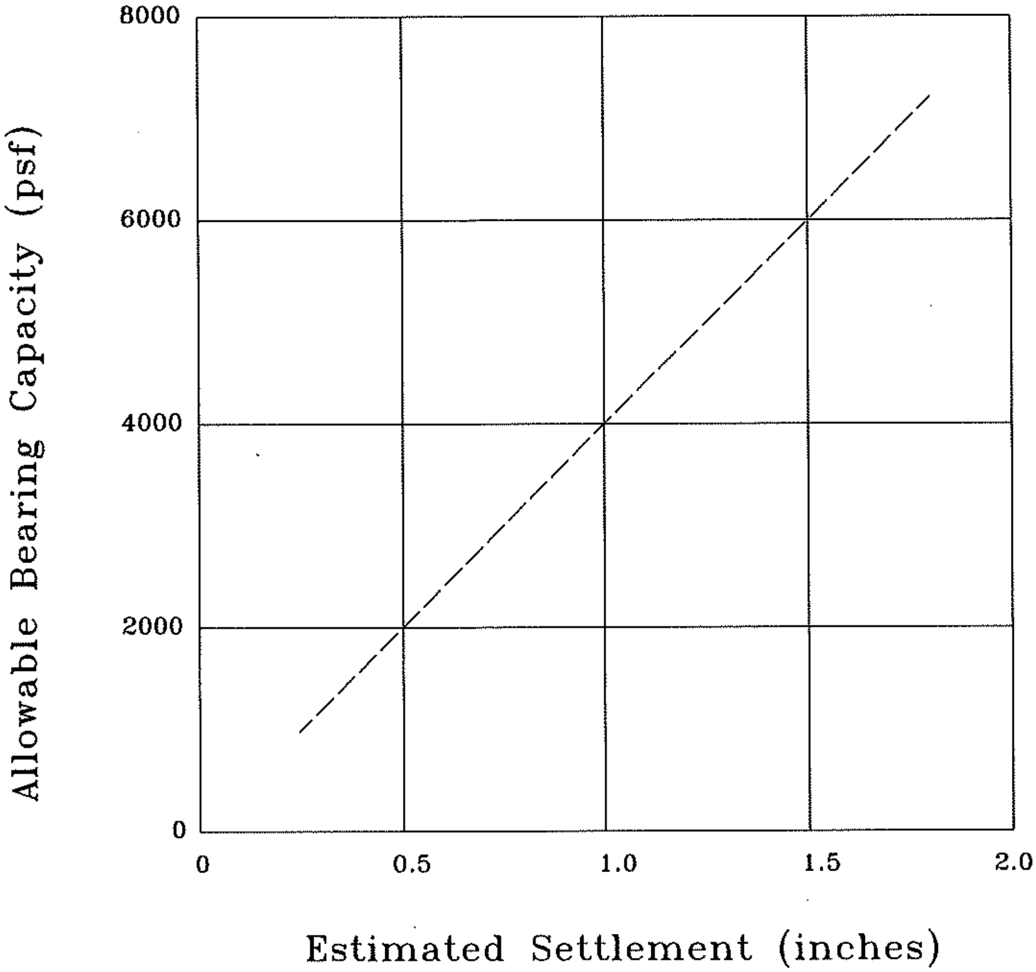
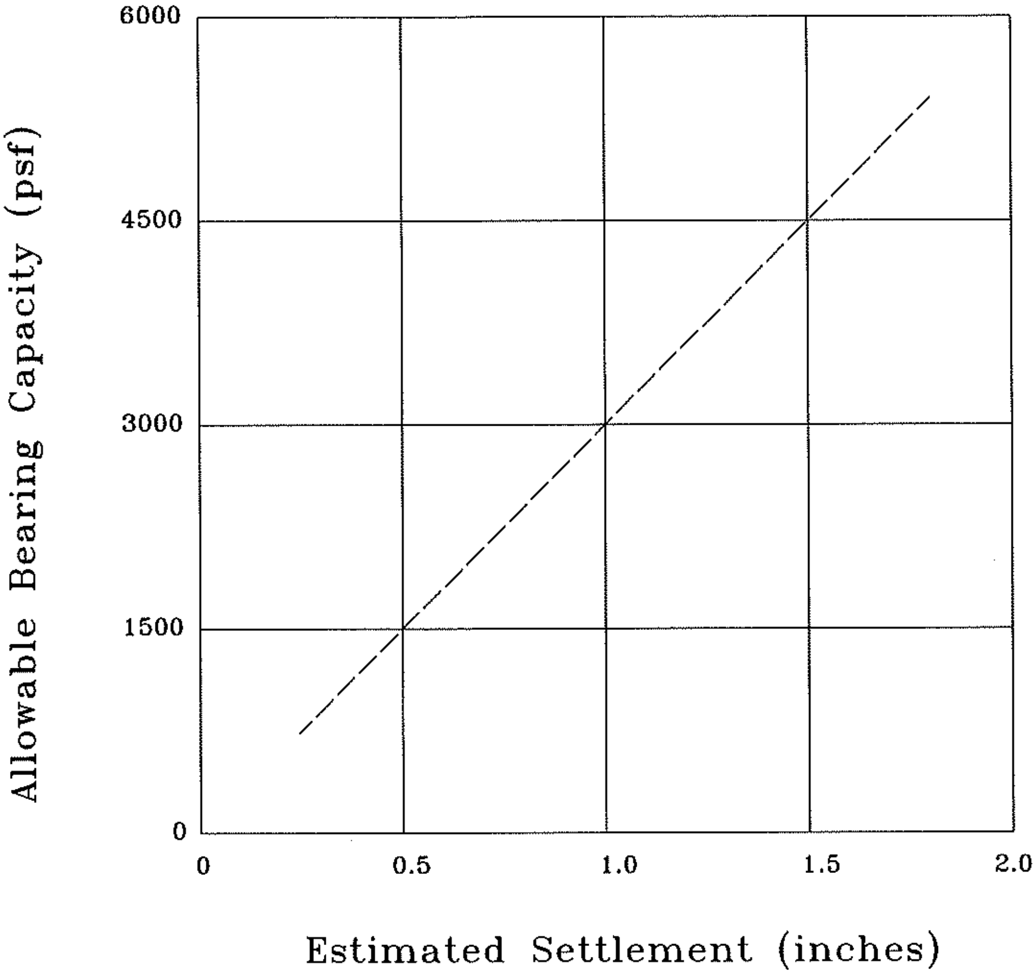
Steamboat Springs, Colorado 80487



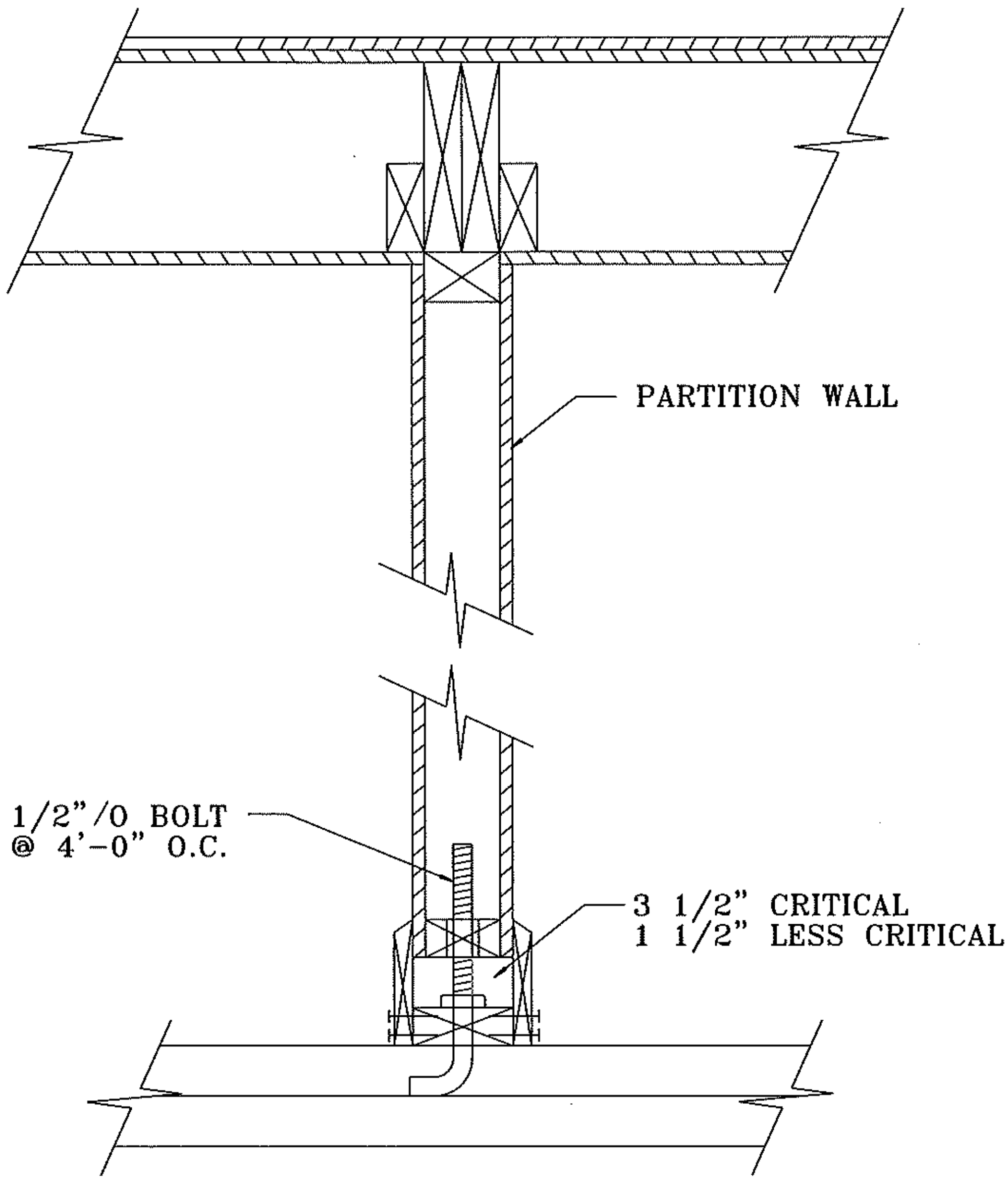
Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART–NATURAL SANDS AND GRAVELS AND BEDROCK MATERIALS	Date: 7/21/08	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing (970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Riverwalk Project	Job No. 06-7351	
Location: Steamboat Springs, Colorado	Figure #14	

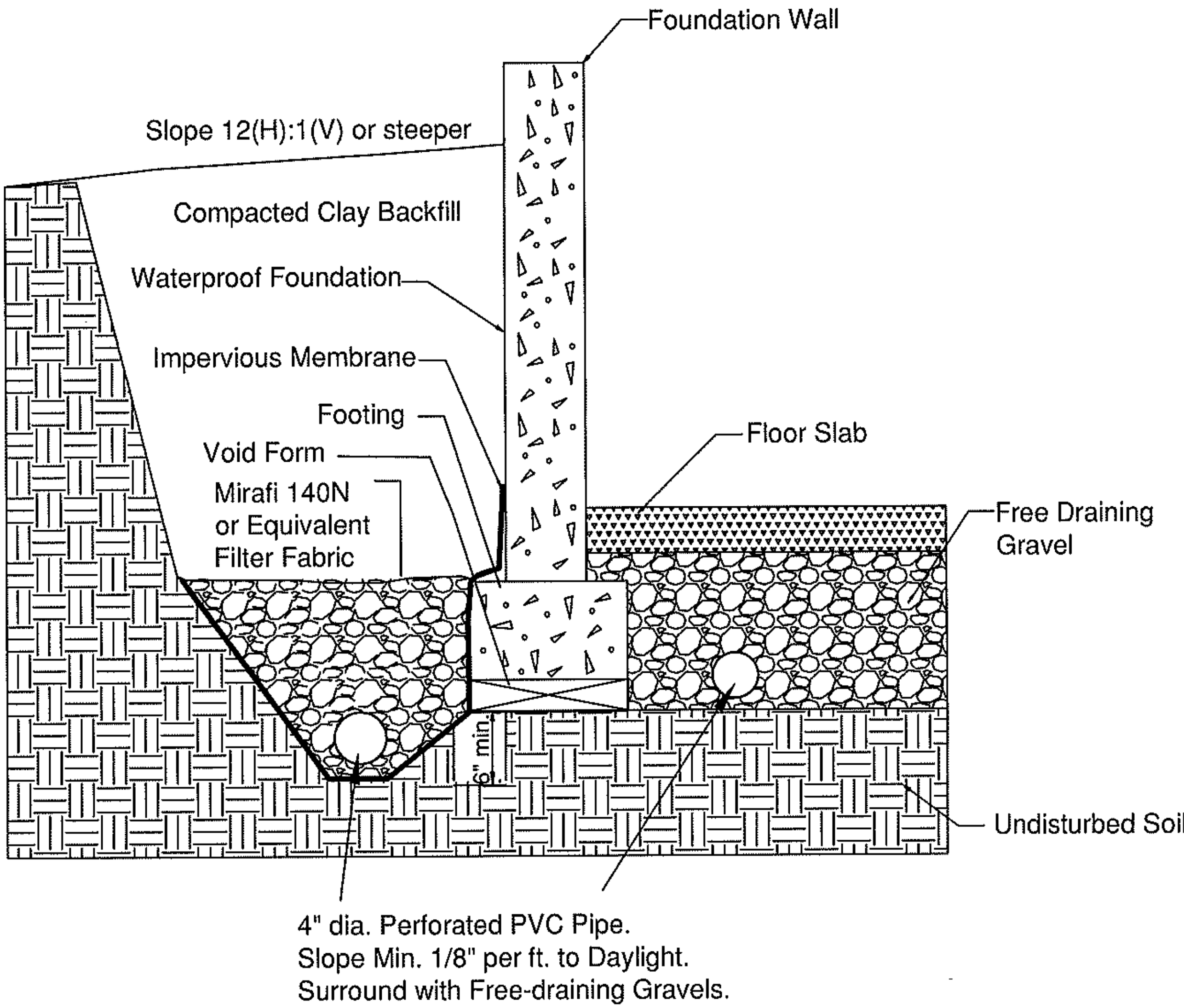


Note: These values are based on footing widths of 1 to 4 feet. If the footing width is to be greater than 4 feet in width, then we should be notified to re-evaluate these recommendations.

Title: BEARING CAPACITY CHART–FILL MATERIALS	Date: 7/21/08	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering · Materials Testing (970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487
Job Name: Riverwalk Project	Job No. 06-7351	
Location: Steamboat Springs, Colorado	Figure #15	



Title: HUNG PARTITION WALL DETAIL	Date: 7/21/08	NWCC North West Colorado Consultants, Inc.
Job Name: Riverwalk Project	Job No. 06-7351	Geotechnical / Environmental Engineering · Materials Testing
Location: Steamboat Springs, Colorado	Figure #16	(970)879-7888 · Fax (970)879-7891 2580 Copper Ridge Drive Steamboat Springs, Colorado 80487



Title: PERIMETER/UNDERDRAIN DETAIL	Date: 7/21/08	NWCC North West Colorado Consultants, Inc. Geotechnical / Environmental Engineering • Materials Testing (970)879-7888 • Fax (970)879-7891 2580 Copper Ridge Drive • P.O. Box 775226 Steamboat Springs, Colorado 80477
Job Name: Riverwalk Project	Job No. 06-7351	
Location: Steamboat Springs, Colorado	Figure #17	

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	4-5 1/2	27.8		30	4	3	51	46		Sand and Silt	SM-ML
3	4-5 1/2	28.2		NP	NP	0	53	47		Sand and Silt	SM-ML
4	27-30	14.7		32	11	0	41	59		Claystone-Sandstone	CL
16	7-8 1/2	5.1		NP	NP	46	39	15		Silty Sands and Gravels	SM-GM
20	24	15.1	114.3	35	11	0	40	60		Claystone-Sandstone	CL
25	2 1/2-4	29.9		26	2	1	41	58		Very Sandy Silt	ML
30	9	13.7	102.0	35	13	0	40	60		Claystone-Sandstone	CL
36	5 1/2-7	38.2		NP	NP	0	66	34		Silty Sand	SM
41	15	13.7	116.1	35	12	0	21	79		Claystone	CL
43	4-5	9.5		28	4	44	35	21		Silty Sands and Gravels	SM-GM
46	20	14.0	114.8	30	5	0	25	75		Claystone-Siltstone	CL-ML

JOB NUMBER: 06-7351