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

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May/Riegler Properties
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Job Number: 24-13239

Subject: Preliminary Geotechnical Design and Construction Recommendations, Proposed Walton Creek Townhomes, 2075 Walton Creek Road, Steamboat Springs, Colorado.

Gaby,

This report presents the Preliminary Geotechnical Design and Construction Recommendations for the proposed Walton Creek Townhomes to be constructed at 2075 Walton Creek Road in Steamboat Springs, Colorado.

NWCC has prepared this report based on our cursory observations made at the site and our review of previously completed Subsoil and Foundation Investigation reports completed by our firm and in this part of Steamboat Springs.

This report presents preliminary foundation recommendations for economically feasible and safe type foundations for the proposed multi-family residence, as well as allowable soil pressures and other geotechnical design and construction considerations that are advisable, but not necessarily routine to quality design and building practices.

Proposed Construction: NWCC understands the existing residence will be demolished and two new multi-family townhome structures will be constructed on the property. We understand the buildings will consist of two stories of wood framing overlying lower basement and garage levels, which will be constructed with concrete slab-on-grade floor systems located near or up to 10 feet below the existing ground surface.

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

Subsurface Conditions: The subsurface conditions encountered at nearby sites were variable and generally consisted of a layer of natural topsoil and organic materials or existing fill materials overlying natural clays with interbedded sands and gravel lenses and layers.

The clays are typically very sandy to slightly sandy, low to moderately plastic, medium stiff to very stiff, moist to very moist and brown in color. The clays typically classify as CL soils in accordance with the Unified Soil Classification System.

Swell-consolidation tests conducted on samples of the natural clays obtained from the other sites indicate the materials tested exhibited low to moderate swell potential when wetted under a constant load.

Foundation Recommendations: Based on the assumed subsurface conditions and our assumptions regarding the proposed construction, NWCC believes an economically feasible and safe type of foundation system is straight-shaft skin friction/end bearing piers drilled into the natural clays and underlying bedrock materials, if encountered. Foundation movement should be within tolerable limits if the following design and construction precautions are observed.

1) A minimum pier diameter of 12 inches and a minimum pier length of 20 feet are recommended. A maximum pier length to diameter ratio of 25 is also recommended.

2) Piers should be designed using allowable skin friction value of 900 psf for the portion of pier drilled into the natural clays. The upper 5 feet of pier penetration should be neglected in skin-friction calculations. A drill rig of sufficient size, type and operating condition should be used so the bottom of the piers can be cleaned out properly and minimum length requirements can be met. If t of piers are properly cleaned and approved by an engineer from this office, then an allowable end bearing pressure of 3,000 psf may be used in the design of the piers.

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

4) Piers should be properly cleaned and dewatered prior to steel and concrete placement. If groundwater is encountered, casing and dewatering equipment may be required to reduce water infiltration and caving in the piers constructed at this site. 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 swelling soils from exerting uplift forces on grade beams and to concentrate pier loadings. A void should also be provided beneath the necessary pier caps.

6) NWCC strongly recommends at least one test hole or test pier be drilled at the building site prior to starting the pier drilling operations. Test holes/piers should be drilled to evaluate deeper subsoil/bedrock conditions and verify recommendations given above.

7) A representative of NWCC must observe the test hole and pier drilling operations.

Alternate Foundation Recommendations: If the owner is aware of the risks associated with placing shallow foundations on swelling soils and can tolerate and/or design for the differential movements that could result if the expansive clays swell, then the structures may be supported by spread footings founded on the natural clays. The design and construction details presented below should be observed if a shallow foundation system is opted for.

The precautions and recommendations itemized below will not prevent the movement of the foundations if the underlying clays become wetted and swell; however, they should reduce the amount of differential movement beneath the foundation system. Differential movements on the order of 1 to 2 inches are possible if the clays are subjected to wetting conditions. Additional movements are also likely with moisture changes associated with seasonal runoff and site landscape irrigation practices.

1) Footings placed on natural clays or sands and gravels encountered below any existing fill materials or topsoil and organic materials or should be designed using an allowable soil bearing pressure of 3,000 psf and a minimum dead load pressure of at least 1,000 psf.

2) Footings or pad sizes should be computed using the soil pressures and placed on the undisturbed natural clays and/or sands and gravels.

3) Any existing fill materials, topsoil and organic materials or any loose and soft natural soils encountered within the foundation excavations should be removed and excavations extended to competent natural soils prior to forming the footings.

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

5) 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.

6) Footings or pads should be placed well enough below final backfill grades to protect them from frost heave. Forty-eight (48) inches is recognized by Routt County as the minimum value for frost protection.

7) NWCC must observe foundation excavations when they are near completion to identify the bearing soils and confirm the recommendations in this report.

Floor Slabs: We understand the lower levels of the residences and garages will be constructed utilizing concrete slab-on-grade floor systems. The on-site soils, with the exception of the existing

fill materials and topsoil and organic materials, are capable of supporting 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 clays encountered at nearby sites, we recommend that structural floor systems over well-ventilated crawlspaces or void form be used in the proposed residences. 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 clays become wetted.

1) Floor slabs must be separated from all bearing walls, columns and their foundation support with a positive slip joint. NWCC recommends the use of ½-inch thick cellotex or impregnated felt.

2) Interior non-bearing partition walls resting on the floor slabs must be provided with a slip joint, preferably at the bottom, so in the event the floor slab moves, this movement is not transmitted to the upper structure.

3) A minimum 6-inch gravel layer must be provided beneath all floor slabs to act as a capillary break and to help distribute pressures. Prior to placing the gravel, 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, all existing fill materials and any topsoil and organic materials should be removed prior to placement of the underslab gravels or new structural fill materials.

4) Floor slabs must be provided with control joints placed a maximum of 10 to 12 feet on center in each direction, depending on slab configurations, to help control shrinkage cracking. Locations of the joints should be carefully checked to assure that natural, unavoidable cracking will be controlled. Depth of the control joints should be a minimum of ¼ the thickness of the slab.

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

6) It has been NWCC's experience that the risk of floor slab movement can be reduced by removing at least 2 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 underslab areas to the desired grade, the fill should consist of non-expansive, granular materials. 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.

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

Underdrain System: Any floor levels or crawl space areas constructed below the existing or finished ground surfaces and the foundations should be protected by underdrain systems 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 levels. 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 levels can also lead to rotting and mildewing of wooden structural members and the formation of mold and mold spores. 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.

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 levels and at least 6 inches below the foundation voids and bottom of the foundation walls or footings. NWCC recommends the use of perforated PVC pipe for the drainpipe, which meets or exceeds ASTM D-3034/SDR 35 requirements, to minimize potential for pipe crushing during backfill operations. Holes in the drainpipe should be oriented down between 4 o'clock and 8 o'clock to promote rapid runoff of water. 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. Drains should have a minimum slope of 1/8 inch per foot and be daylighted at positive outfalls protected from freezing or be led to sumps from which water can be pumped. The use of interior laterals, multiple daylights or sumps may be required for the proposed structure. Caution should be taken when backfilling so as not to damage or disturb the installed underdrain. NWCC recommends the drainage system include a clean out every 100 feet, be protected against intrusion by animals at outfalls and be tested prior to backfilling. NWCC also recommends the client retain our firm to observe the underdrain systems during construction to verify that they are being installed in accordance with recommendations provided in this report and observe a flow test prior to backfilling the system.

In addition, NWCC recommends an impervious barrier be constructed to keep water from infiltrating through the voided areas and/or under the foundation walls. 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.

Placement of and impervious membrane and in /or properly compacted clays in crawl space areas to the top of the footings or at least 12 inches above the top of the foundation voids or bottom of the foundation walls should help reduce the moisture problems 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 on-site soils.

Cantilevered retaining structures at the site can be expected to deflect sufficiently to mobilize 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 on-site soils.

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 earth pressures on foundation walls and retaining structures and the structural engineer should carefully evaluate these additional lateral loads when designing foundation and retaining walls.

NWCC recommends imported granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. 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 5 percent passing the No. 200 sieve. Granular soils placed 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.

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

Surface Drainage: Proper surface drainage at this site is of paramount importance for minimizing infiltration of surface drainage into 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 structures have been completed:

1) Ground surface surrounding structures should be sloped (minimum of 1.0 inch per foot) to drain away from structures 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 structures 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. Backfill should be placed immediately after the braced foundation walls are able to structurally support the fill. Puddling or sluicing must be avoided.

3) Top 2 to 3 feet of soil placed within 10 feet of foundations should be impervious in nature to minimize infiltration of surface water into 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 foundation walls, 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 structures.

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

Limitations: The recommendations provided in this report are based on the soils encountered at nearby sites and our 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 soil profiles beneath those or adjacent to those observed. No warranties expressed or implied are given on the content of this report.

NWCC strongly recommends a Subsoil and Foundation Investigation be conducted for this site. NWCC recommends that at least one test hole or test pit be advanced at the site to verify the assumed subsurface conditions.

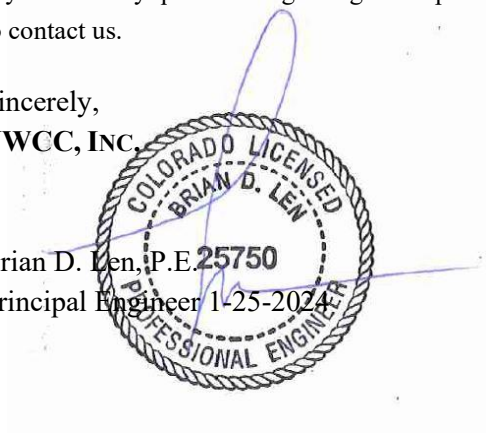
Swelling soils will most likely be encountered at this site. These soils are stable at their natural moisture content but can shrink or swell with changes in moisture. The behavior of swelling soils is not fully understood. The swell or consolidation potential of any particular site can change erratically both in lateral and vertical extent. Moisture changes also occur erratically, resulting in conditions which cannot always be predicted. Recommendations presented in this report are based on the current state of the art for foundations and floor slabs on swelling soils. As noted previously, the owner must be made aware there is a risk in construction on these types of soil. 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, 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 assumed subsurface conditions and on 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 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 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.



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