GEOTECHNICAL AND GEOLOGIC HAZARD EVALUATION
PROPOSED STEAMBOAT AIRPARK SUBDIVISION-
PUBLIC INFRASTRUCTURE
LOT 1, WEST ACRES RANCH SUBDIVISION
GLORIA GOSSARD PARKWAY
STEAMBOAT SPRINGS, COLORADO

Prepared by

NWCC, Inc.
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Geotechnical / Environmental Engineering • Materials Testing

Geotech Report: This report shall be updated to analyze current proposal and evaluate cut and fill slopes with recommendations.

Prepared for

Overlook Park Properties, LLC
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NWCC Project NO. 21-12345

September 3, 2021

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Conclusions

NWCC believes that the construction of the proposed Public Infrastructure for the Steamboat Airpark Subdivision is feasible from a geotechnical standpoint provided the recommendations in this report are followed. A discussion of geologic and geotechnical considerations related to the proposed Public Infrastructure construction are outlined herein.

Purpose and Scope of Study

This report presents the results of a Geotechnical and Geologic Hazard Evaluation for the proposed Public Infrastructure to be constructed for the proposed Steamboat Airpark Subdivision located north of Gloria Gossard Parkway and within Lot 1 of the West Acres Ranch Subdivision in the City of Steamboat Springs, Routt County, Colorado.

NWCC previously completed a Preliminary Subsoil and Geologic Hazard Evaluation for the Overlook Park Subdivision and Gossard Parkway (formerly Victory Highway) under our job number 08-7985 in a report dated August 29, 2008. NWCC also completed a Slope Failure Observations and Recommendations for the slope failure in the southwest corner of Lot 5 of the West Acres Park Subdivision under our job number 09-8514 in a report dated March 12, 2010. NWCC also prepared a Slope Failure and Roadway Subgrade Observations and Recommendations report under our job number 10-8662 in a report dated July 28, 2010. This report addressed slope failures in the eastern portion of Gossard Parkway. NWCC also prepared a Geotechnical and Slope Failure Evaluation for the landslide near the end of the paved portion of Gossard Parkway under our job number 10-8662, in a report dated September 16, 2011. NWCC recently completed a draft report of a Preliminary Geologic Hazard Evaluation for the proposed Copper Ridge Village to be constructed within the proposed Lot 1 of the Steamboat Airpark Subdivision under our job number 21-12113, dated April 16, 2021.

This report has been prepared to summarize the data obtained and to present our conclusions and recommendations based on our current understanding of the proposed construction and development and the subsurface conditions encountered in this area during previous investigations. A discussion of geotechnical engineering considerations, local geology and site conditions related to construction of the public infrastructure construction are included.

Proposed Development

It is our understanding that the proposed Steamboat Airpark Subdivision will consist of subdividing Lot 1 of the West Acres Ranch Subdivision into two lots. Based on the plans provided by Four Points Surveying and Engineering (FPSE), it appears that a 10-foot wide sidewalk will be required along the north side of Gloria Gossard Parkway for the public infrastructure improvements. A retaining wall, approximately 700 feet in length, is required at the western end of the project where the proposed sidewalk encroaches into the base of the existing cut slope. A retaining wall,

approximately 50 feet in length, is required at the eastern end of the project, near Sta. 24+00. The proposed retaining walls will consist of stacked concrete blocks from Redi-Rock and will range in height from 1.5 to 7.5 feet above the finished ground surface.

Site Conditions

Lot 1 of the West Acres Ranch generally consists of approximately 134 acres of vacant undisturbed land located in Steamboat Springs, Colorado. The property is bordered to the west by Lot 2 of the West Acres Ranch and the Overlook Park Subdivision, currently under construction. The property is bordered on the north by the Steamboat Springs Airport and other undeveloped land, on the south by the Overlook Park Subdivision and West Acres Mobile Home Park and the east-southeast by the West Acres Park Subdivision.

The topography of the site is highly variable and generally consists of moderate to steeply sloping hillsides. Two drainages that generally flow in a north to south direction are located in the eastern portion of the property and the adjacent hillsides generally slope down towards the drainages. Two drainages that generally flow in an east to west direction are located in the western portion of the property and the adjacent hillsides generally slope down towards the drainages.

The vegetation across the site is variable and generally consists of grasses, weeds, deciduous brush, scrub oak and scattered aspen trees.

Field Investigations

NWCC has conducted several subsurface investigations along Gloria Gossard Parkway, within the Overlook Subdivision and at the Steamboat Springs Airport. A review of previous investigations in this area was completed to obtain general information on the anticipated subsurface conditions. NWCC has conducted several subsurface investigations along Gloria Gossard Parkway, within the Overlook Subdivision and at the Steamboat Springs Airport.

NWCC also completed site evaluations on July 19 and August 24, 2021 to observe the existing natural slopes and drainage conditions across the site.

Subsurface Conditions

The subsurface conditions encountered in previous subsurface investigations in this area are variable and generally consisted of a layer of topsoil and organic materials overlying natural clays and claystone-shale bedrock materials

The layer of topsoil and organic materials generally ranges from 6 to 24 inches in thickness, with the thicker amounts of topsoil being encountered in the drainage areas.

Natural clays are typically encountered below the topsoil and organic materials and range from 2 to 30 feet in thickness. The natural clays are typically slightly sandy to sandy with occasional bedrock fragments, moderately to highly plastic, medium stiff to hard, moist to very moist and brown to gray in color with calcareous stringers. Samples of the natural clays encountered in this area classified as CL, CL-CH, CH-CL, and CH soils in accordance with the Unified Soil Classification System (USCS).

Claystone-shale bedrock materials are encountered below the topsoil and organic materials or natural clays at depths ranging from 1 to 30 feet below the below the existing ground surface. The claystone-shale bedrock materials are slightly sandy to sandy, low to moderately plastic, weathered to hard, moist to slightly moist and gray to dark gray in color. Samples of the claystone-shale bedrock materials encountered in this area typically classified as CL soils in accordance with the USCS.

The natural clays and claystone-shale bedrock materials will typically exhibit a low to high swell potential when wetted under a constant load.

Groundwater levels are highly variable across the site. Seasonal groundwater seepage is typically encountered at the topsoil and clay or bedrock interface during spring snow melt and runoff. Groundwater seepage is also typically encountered in highly weathered or fractured zones of the claystone-shale bedrock during the spring and early summer months. It should be noted that the groundwater conditions can be expected to fluctuate with changes in precipitation and runoff conditions across the site.

Geologic Hazard and Slope Stability Evaluation

Slope Stability Evaluation: The stability of the natural and existing cut slopes have been considered in this evaluation. Aerial photographs and information from previous investigations were used for evaluation of the site geomorphology.

Small surface failures occurred during construction of the large cut slope in the southeast portion of the property. These surface failures were due to an excess amount of topsoil fill placed over the cut and the topsoil fill materials slumping where groundwater seepage was encountered. These surface failures were repaired by regrading and establishing vegetation. A small area was also repaired using a turf reinforcement mat.

A larger failure at the east end of this cut slope, near a utility trench, was repaired using a rock buttress. No evidence of further movement was observed in this area during our recent site observations.

We observed evidence of historic landslide activity in the form of small surface failures and hummocky topography in the western portion of the proposed Lot 1 of the Steamboat Airpark Subdivision. Two small surface failures were observed on the natural hillside along the western property line. The surface failures occurred in the upper 12 inches of topsoil materials and natural soils. The hummocky topography below the surface failures is the result of this landslide activity, in the form of

small-scale slumps and debris flows within the overburden soils. These features are now obscured by erosion and are mostly subtle and difficult to delineate.

A larger landslide is located in the southeast corner of the proposed Lot 2 of the Steamboat Airpark Subdivision, along the cut slope situated along the north side of Gloria Gossard Parkway. This landslide was repaired/stabilized using a rock buttress. Shallow head scarps, less than 5 feet in height, are located above the rock buttress. The head scarps were not repaired since the scarps were outside of the easement for Gloria Gossard Parkway. No evidence of further movement was observed in the head scarps or rock buttress during our recent site visit. Dense vegetation has obscured significant portions of the scarps.

Shale bedrock of the Mancos Formation was poorly exposed along the ridgelines and upper steep slope faces that surround the site, as well as in cuts for a rough road constructed to access the upper portion of the property. Where exposed, the bedrock displays near horizontal to slightly dipping bedding. The outcrops exposed in the steep slope faces form very steep slopes and are relatively stable. Small rafts of vegetation and overburden soil form small hummocks on the lower portions of these slopes.

The natural slopes and proposed cut slopes in the southwestern portion of Lot 1 of the West Acres Ranch Subdivision as part of a slope stability analysis completed for the Overlook Park Subdivision (NWCC, 2018). NWCC determined the calculated factor of safety for the proposed 3(H):1(V) cut slopes and natural slopes exceeded the minimum factor of safety of 1.5 under saturated conditions. The proposed and natural slopes also exceeded the minimum factor of safety of 1.0 under seismic loading.

Based on the topography, previous stability analysis, our experience with similar soil and bedrock conditions, we believe that there is generally a low risk of slope stability associated with the current development plan of the property. For much of the site, we believe that properly designed and constructed roadway cut and fill slopes should be safe from slope stability problems. Our analysis of the proposed retaining walls at the toe of the existing 3(H):1(V) cut slopes to allow construction of the proposed sidewalk will not affect the stability of the of the existing cut slopes and natural slopes. Based on our analysis, the stability of the existing cut slopes with the stacked concrete block retaining walls will have a local factor of safety for slope stability of 1.7 under saturated conditions. Recommendations for the design and construction of the proposed Redi-Rock stacked block retaining walls are provided later in this report.

Based on our review of the Routt County Geologic Hazard map, it appears that the steeper portions of the property located north of Gloria Gossard Parkway and in the adjacent properties to the west and north are mapped as Potentially Unstable Slopes (PUS). This implies a previously stable slope could become unstable due to disturbance from development related activities. We recognize this hazard classification as a general, all-encompassing grouping of slopes that do not exhibit signs

of instability at this time, but may have isolated steep topographical areas, or other isolated soil and/or groundwater conditions which may be conducive to small-scale slope failures. The proposed cut slopes in this area will be further evaluated in the subsurface investigation.

Swelling Soils and Bedrock: The potential hazards from swelling materials at the site and remedial measures have been briefly discussed above. Swell-consolidation tests conducted on samples collected in previous investigations in the area indicate a variable swell potential ranging from low to high exists across the site. A site-specific Subsoil and Foundation Investigation for the proposed development will be required to better evaluate the potential hazard from swelling soils and to provide recommendations to reduce the risk of construction at this site on swelling materials, since the swell potential of any particular site can change erratically both in lateral and vertical extent.

Geologic Setting and Seismic Activity: The project site is situated in the Southern Rocky Mountain Province and lies one to two miles west of the west flank of the Park Range. Portions of the Park Range are also referred to as the Gore Range in this area. The Park Range Uplift has been interpreted as a product of the Laramide orogeny which probably began in early Cretaceous time and reached its peak in Paleocene time. The Park Range uplift is anticlinal in nature with a core of igneous and metamorphic rocks flanked by sedimentary rocks of Cretaceous age in the project area.

Specifically, the near surface bedrock in the project site consists of the Cretaceous Mancos Shale Formation. The Mancos Shale Formation consists of a deep marine shale deposit up to 5,000 feet in thickness. The shale is typically low to moderately plastic, hard to very hard, fissile and dark gray to gray. The near surface claystone-shale beds of the Mancos Shale Formation are nearly horizontal in much of the project area.

Overlying the near surface bedrock, residual and colluvial clay soils are the products of chemical and mechanical erosion processes which continue. Some these residual and colluvial soils have experienced slumping, probably during a wetter climatic period than is currently being experienced.

Seismic activity in the project area is considered to be low. According to the Uniform Building Code (1997) all of Colorado is located in Zone 1. This classification implies the following seismic risk: "minor damage; distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 second; corresponding to intensities V and VI on the Modified Mercalli Intensity Scale" (Algermissen, 1969). Based on the UBC definitions, levels of peak horizontal ground acceleration should not exceed 0.04g with a 90 percent probability level. Two earthquakes of significance have been recorded in Steamboat Springs since 1870. Both earthquakes, March 1895 and February, 1955, corresponded to Modified Mercalli Intensities of V (Kirkham and Rogers, 1981). Based on anticipated geologic conditions, NWCC recommends a **Soil Site Class B** designation be used for the site in accordance with Table 20.3-1 in Chapter 20 of ASCE 7.

Stacked Concrete Block Retaining Wall Recommendations

Based on the soil conditions anticipated at the site, our analysis and discussions with FPSE, NWCC has developed the following recommendations for the design and construction of the proposed stacked concrete block walls to be constructed for this project.

The proposed retaining walls can be constructed using a combination of 28, 41 and 60 inch blocks with a crushed stone backfill. It should be noted that this report does not address the elevation and layout of the blocks for the retaining wall. The elevation and wall layout will be completed by FPSE.

The design for the stacked block retaining wall for a maximum total height of 10.5 feet utilizing a 60-inch deep bottom block with five 41-inch middle block Redi-Rock wall units and one 28-inch top block with crushed stone backfill. The crushed stone must extend a minimum of 12 inches away from the back of the wall. Where the wall section steps up a 41-inch bottom block can be used and additional wall steps one of the 41-inch blocks can be removed at each step. Typical wall sections are provided in Figure #1.

Crushed stone should be used to backfill between the stacked block wall and the natural soils. The retained soils must be observed by NWCC prior to placement of the block walls to verify the soils being retained.

The retaining wall system outlined above will require a leveling pad, consisting of a layer of free draining gravels 12 inches in thickness placed at the base of the wall and keyed into the natural clays. The depth to suitable bearing soils must be evaluated at the time of excavation by NWCC. The free draining gravels placed for the leveling pad and wall backfill should be uniformly placed and compacted in 6 to 8-inch maximum loose lifts to at least 80% of the maximum relative density in accordance with ASTM D4353/4354. The retaining walls should be drained by the placement of a 4-inch diameter perforated PVC pipe surrounded with at least 12 inches of free draining gravel. The drain should be located behind the wall and at the base of the gravels. The drain should be uniformly graded to a daylighted outfall with at least a 1 percent slope.

A minimum bury depth of 18 inches for the bottom blocks of the retaining wall is recommended for walls 4.5 feet or greater in height. A minimum bury depth of 12 inches can be used for walls 4 feet or less in height or less where a 41-inch base block is used. Any backfill materials placed at the base of the wall should be uniformly placed and compacted in 6 to 12 inch loose lifts and be compacted to at least 95% of the maximum standard Proctor density and within 3 percent of the optimum moisture content determined in accordance with ASTM D698.

NWCC recommends a maximum slope configuration of 3 (horizontal) to 1 (vertical) above the proposed retaining walls that are greater than 4 feet above the finished ground surface. A maximum slope configuration of 2 (horizontal) to 1 (vertical) can be used above the proposed retaining walls that are 4 feet or less above the finished ground surface. However, slopes flatter than 2:1 are easier to re-vegetate and will have a higher FOS against slope failure.

Limitations

This report is based on previous investigations completed on at the subject and adjacent properties, and the assumed soil and bedrock conditions at the site. Based on our present knowledge, there are no subsurface or geological conditions, which

constitute a major hazard or would render the proposed sidewalk, retaining wall and roadway construction infeasible. However, additional subsurface investigations must be conducted to provide specific design criteria for the individual building foundations, slabs, retaining walls, lateral earth pressures, site grading, slope stabilization and other soil related construction activities for future development of the sites.

The owner must retain NWCC, Inc. to monitor the construction of the retaining walls and other development related site work to ensure compliance with the specifications and verify that the subsoil and groundwater conditions are similar to those assumed herein.

If you have any questions concerning this report, or if we may be of further service, please contact this office.

Sincerely,
NWCC, INC.,

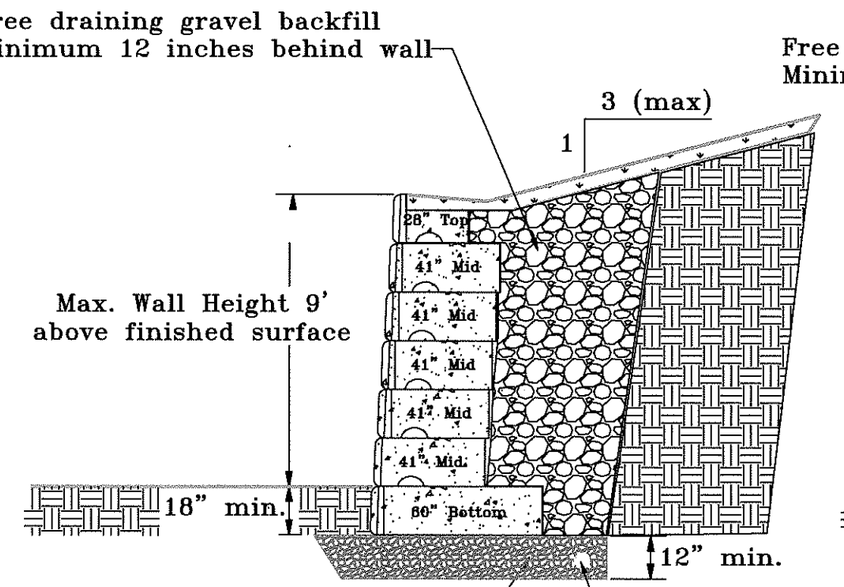
Timothy S. Travis, P.E.
Senior Project Engineer

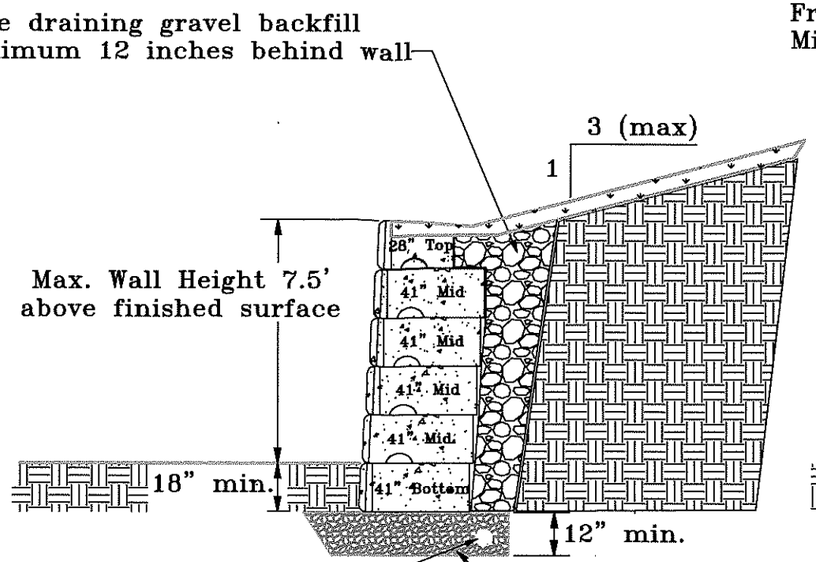
Reviewed by Brian D. Len, P.E.
Principal Engineer

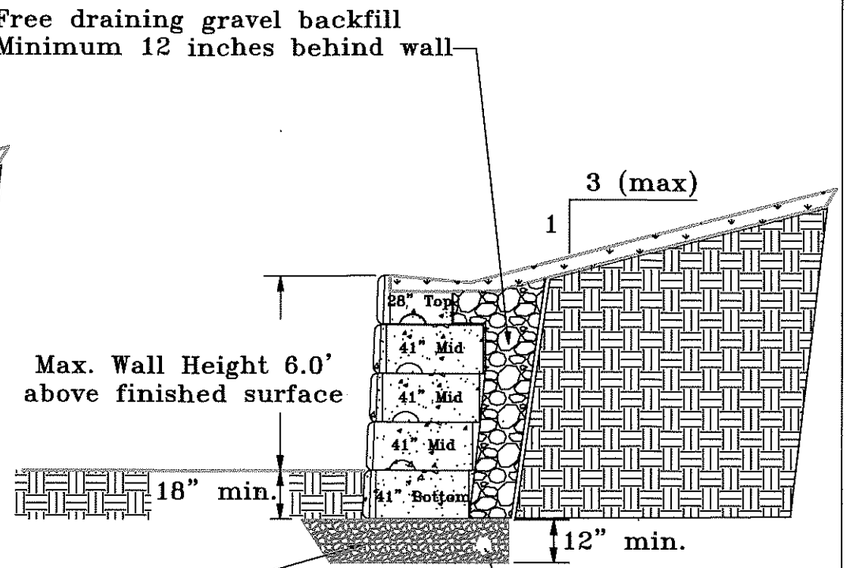
cc: Walter Magill - FPSE

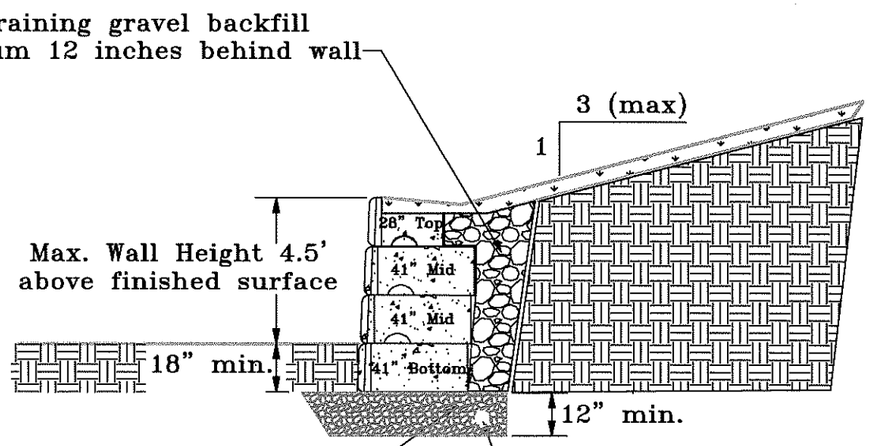
Unreinforced Wall Sections

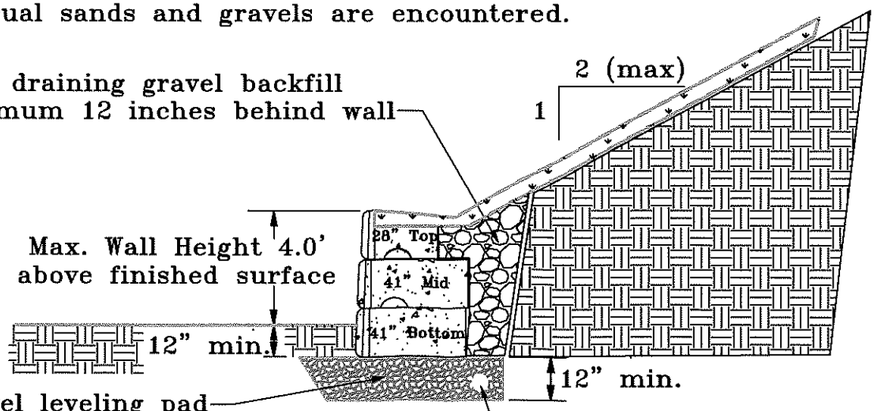
"NOT-TO-SCALE"











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Title: Unreinforced Wall Sections

Job Name: Steamboat Airpark Subdivision-Public Infrastructure

Location: West Acres Ranch Subdiv., Gloria Gossard Parkway, Steamboat Springs, Colorado

Job No.: 21-12345 | Date: 9/3/2021 | FIGURE: #1