HP Geotech
HEPWORTH-PAWLAK GEOTECHNICAL

Hepworth-Pawlak Geotechnical, Inc.
P. O. Drawer 1887
Silverthorne, Colorado 80498
Phone: 970-468-1989

Fax: 970-468-5891
email: hpgeo4@hpgeotech.com

GEOTECHNICAL ENGINEERING STUDY
PROPOSED SINGLE-FAMILY RESIDENCE
103 UNCLE SAM LODE ROAD
LOT 62, WOODMOOR AT BRECKENRIDGE
BRECKENRIDGE, COLORADO

JOB NUMBER 415 172A

AUGUST 11, 2015

PREPARED FOR:

MARKLEY & ASSOCIATES, LLC
ATTN: JAKE MARKLEY
8125 BRIAR CLIFF DRIVE
CASTLE PINES, COLORADO 80108
(jakemarkley@gmail.com)

TABLE OF CONTENTS

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for a proposed residence to be located 0103 Uncle Sam Lode Road in Breckenridge, Colorado. The project site location is shown on Figure 1. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in accordance with our proposal for geotechnical engineering services to Markley & Associates, LLC dated June 11, 2015.

A field exploration program consisting of two exploratory test pits and a site reconnaissance was conducted to obtain information on the surface and subsurface conditions. Samples of the subsoils and bedrock obtained during the field exploration were tested in the laboratory to determine their classification, compressibility or swell and other engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths and allowable pressures for the proposed structure foundations. This report summarizes the data obtained during this study and presents our conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsoil conditions encountered.

PROPOSED CONSTRUCTION

Architectural details and grading plans for the residence were not available for our review prior to issuance of this report. We have assumed the proposed construction will consist of a two story wood-framed residence with a walkout basement and an attached garage. Grading for the structure is assumed to be relatively minor with cut depths between about 4 to 10 feet. We assume relatively light foundation loadings, typical of the proposed type of construction.

When building location, grading and loading information have been developed, we should be notified to re-evaluate the recommendations presented in this report.

SITE CONDITIONS

The site was vacant at the time of our field exploration. The ground surface slopes moderately down to the northwest from Uncle Sam Lode Road. Vegetation consists of grasses and sparse coniferous trees. No bedrock outcrops or surface water features were noted on the property. The site is bordered by Uncle Sam Lode Road to the south, wooded open space to the north and developed residential properties to the east and west.

FIELD EXPLORATION

The field exploration for the project was conducted on July 14, 2015. Two exploratory test pits were excavated at the locations shown on Figure 2 to evaluate the subsurface conditions. The test pits were excavated by with a rubber-tired backhoe. The test pits were logged by a representative of Hepworth-Pawlak Geotechnical, Inc.

Samples of the subsoils were taken with relatively disturbed sampling methods. Depths at which the samples were taken are shown on the Logs of Exploratory Pits, Figure 3. The samples were returned to our laboratory for review by the project engineer and testing.

SUBSURFACE CONDITIONS

SOIL TYPES ENCOUNTERED

Graphic logs of the subsurface conditions encountered at the site are shown on Figure 2. The subsoils consist of about 6 inches of topsoil overlying 3½ to 8½ feet of clayey, silty sand (SC-SM) with gravel and angular cobbles to the depth explored, 9 feet, in Pit 1. Beneath the SC-SM at 4 feet, slightly clayey, sandy gravel (GP-GC) was encountered in Pit 2 to the depth explored, 10 feet.

LABORATORY TESTING

Laboratory testing performed on samples obtained from the exploratory test pits consisted of natural moisture content, percent passing the #200 sieve, liquid and plastic limits and gradation analysis. The results of a gradation analysis performed on a large bulk sample (minus 2 inch fraction) of the natural coarse granular soils is shown on Figure 4. The laboratory test results are summarized on the Log of Exploratory Pits, Figure 3.

GROUNDWATER

No free water was encountered in the pits at the time of excavation. The subsoils were generally moist. The depth to free water can change based on seasonal and climatic factors.

ENGINEERING ANALYSIS

The anticipated soils at the foundation level are considered good for shallow foundation and floor slab support.

DESIGN RECOMMENDATIONS

SITE GRADING

The following recommendations should be followed for grading, site preparation, and fill compaction.

1. Where fill is to be placed, topsoil, loose or otherwise unsuitable material should be removed prior to placement of new fill. The exposed soils should then be scarified to a depth of 6 inches, moisture conditioned and compacted to the minimum requirements of the overlying fill. Soils should be compacted with appropriate equipment for the lift thickness placed. Lift thickness should be no more than 8 inches compacted at the recommended moisture content and greater than the minimum required density.
2. Permanent unretained cut and fill slopes should be graded at 3 horizontal to 1 vertical (3:1) or flatter and protected against erosion by revegetation or other

means. The risk of slope instability will be increased if seepage is encountered in cuts and flatter slopes may be necessary. If seepage is encountered in permanent cuts, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. This office should review site grading plans for the project prior to construction.

3. Slopes of 4:1 or steeper should be benched to provide a level surface for compaction.
4. All backfill should be processed so that it does not contain fragments larger than 6-inches in diameter and placed at the recommended moisture content.
5. The following compaction requirements should be used:

TYPE OF FILL PLACEMENT	MOISTURE CONTENT	SOIL TYPE - Compaction Percent (ASTM D698 – Standard Proctor)
Below Foundations	± 2% Optimum	Processed Onsite – 98%
Foundation Wall Backfill	± 2% Optimum	Processed Onsite – 95%
Below Floor Slabs	± 2% Optimum	Processed Onsite – 95%
Landscape Areas	± 2% Optimum	Processed Onsite – 90%
Below Concrete Flatwork/Pavements	± 2% Optimum	Processed Onsite – 95%
Utility Trenches	As they apply to the finished area	

Suitability of On-Site Soil

The onsite soil is suitable as fill under after processing to remove all plus 6-inch material and moisture treatment. The onsite topsoil is not suitable for reuse except in the upper 6 to 12 inches of backfill in landscape areas. Some considerable processing will be necessary to reduce some of the onsite soil to fragments of minus 6-inches. Processing may include screening and rock raking. All onsite soil should be processed, moisture-conditioned, and placed at the minimum required compaction.

Structural Fill

Structural fill used for support of the residence should consist of the on-site granular soils or a relatively well-graded imported granular material with no rock larger than about 6 inches in diameter. Structural fills should be placed in accordance with the recommendations presented in the SITE GRADING section of this report.

Import Fill

The Geotechnical engineer should approve any proposed import fill for its intended use.

Excavations

It is the responsibility of the Contractor to provide safe working conditions and to comply with the regulations in OSHA Standards, Excavations, 29CFS Part 1926. The onsite soil will likely classify will classify as "Type C" in accordance with OSHA regulations. The regulations allow slopes of $1^1/_2$ horizontal to 1 vertical ($1^1/_2$:1) for temporary excavations less than 20 feet deep.

The presence of water, seepage, fissuring, vibrations or surcharge loads will require temporary excavation to have flatter slopes. A Contractor's competent person should make decisions regarding cut slopes. A qualified Geotechnical engineer should observe any questionable slopes or conditions. Temporary shoring may be necessary.

FOUNDATIONS

Considering the subsoil conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the foundation be founded with spread footings bearing on the relatively undisturbed granular soils.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed natural onsite soils should be designed for an allowable soil bearing pressure of 2,500 pounds per square foot (psf). Based on

experience, we expect movement of footings designed and constructed as discussed in this section will be about 1 inch or less.

2) The footings should have a minimum width of 16 inches for continuous walls and 2 feet for isolated pads.
3) Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 40 inches below exterior grade is recommended for foundations bearing on the natural granular soils. Concrete should not be placed on frost, frozen soil, snow or ice.
4) Continuous foundation walls should be reinforced top and bottom to span local anomalies such as by assuming an unsupported length of at least 10 feet. Foundation walls acting as retaining structures should also be designed to resist lateral earth pressures as discussed in the "Foundation and Retaining Walls" section of this report.
5) All existing fill, topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively dense granular soils or replaced with properly compacted structural fill.
6) The exposed soils in footing area should then be moistened, if necessary, and compacted. If water seepage is encountered, the footing areas should be dewatered before concrete placement and we shall be contacted for further evaluation.
7) Structural fill used for support of the foundation should meet the requirements listed in the SITE GRADING section below.
8) A representative of the geotechnical engineer should observe all footing excavations prior to forming footings and concrete placement to evaluate bearing conditions.

FOUNDATION AND RETAINING WALLS

Foundation walls and retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 55 pounds per cubic foot (pcf) for backfill consisting of the on-site processed soils or imported granular soils. Cantilevered retaining structures which are separate from the foundation and can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 45 pcf for backfill consisting of the processed on site soils and imported granular soils. The backfill should not contain rock larger than about 6 inches in diameter.

The lateral resistance of foundation or retaining wall footings will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.35. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 350 pcf. The coefficient of friction and passive pressure values recommended above assume ultimate soil strength. Suitable factors of safety should be included in the design to limit the strain which will occur at the ultimate strength, particularly in the case of passive resistance. Fill placed against the sides of the footings to resist lateral loads should be a granular material compacted to at least 95% of the maximum standard Proctor dry density at a moisture content near optimum.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or

retaining structure. An underdrain should be provided to prevent hydrostatic pressure buildup behind walls.

Backfill in patio, pavement, and walkway areas should be placed in uniform lifts and compacted to at least 95% of the maximum standard Proctor (ASTM D-698) dry density at a moisture content within 2% of optimum. Backfill in landscape areas should be compacted to at least 90% of the maximum standard Proctor dry density at a moisture content near optimum. Care should be taken not to overcompact the backfill or use large equipment near the wall, since this could cause excessive lateral pressure on the wall. Some settlement of deep foundation wall backfill should be expected, even if the material is placed correctly, and could result in distress to facilities constructed on the backfill.

FLOOR SLABS

The natural on-site soils, exclusive of topsoil, are suitable to support lightly loaded slab-on-grade construction. To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The requirements for joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. A minimum 4 inch layer of free-draining gravel should be placed beneath basement level slabs to facilitate drainage. This material should consist of minus 2 inch aggregate with at least 50% retained on the No. 4 sieve and less than 2% passing the No. 200 sieve. All backfill under floor slabs should be placed in accordance with the SITE GRADING section of this report.

We recommend vapor retarders conform to the minimum requirements of ASTM E1745 Class C material. Certain floor types are more sensitive to water vapor transmission than others. For floor slabs bearing on angular gravel or where flooring system sensitive to water vapor transmission are utilized, we recommend a vapor barrier be utilized

conforming to the minimum requirements of ASTM E1745 Class B material. The vapor retarder should be installed in accordance with the manufacturers' recommendations.

UNDERDRAIN SYSTEM AND DAMPPROOFING

Although free water was not encountered during our exploration, it has been our experience in mountainous areas that local perched groundwater can develop during times of heavy precipitation or seasonal runoff. Frozen ground during spring runoff can create a perched condition. We recommend below-grade construction, such as retaining walls, crawlspace and basement areas, be protected from wetting and hydrostatic pressure buildup by an underdrain and wall drain system.

The underdrain should consist of drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining gravel. The drain should be placed at each level of excavation and at least 1 foot below lowest adjacent finish grade and sloped at a minimum 1% to a suitable gravity outlet or sump and pump system. Free-draining gravel used in the underdrain system should contain less than 2% passing the No. 200 sieve, less than 50% passing the No. 4 sieve and have a maximum size of 2 inches. The drain gravel backfill should be at least 1½ feet deep and protected by filter fabric. A typical drain detail is shown on Figure 5.

For exterior below grade foundation walls, we recommend, as a minimum, dampproofing consist of bituminous material, 3 lbs per square yard, extending from the top of the footing to above ground level.

SURFACE DRAINAGE

The following drainage precautions should be observed during construction and maintained at all times after the residence has been completed:

1) Inundation of the foundation excavations and underslab areas should be avoided during construction.

2) Backfill in pavement and slab areas should be compacted to at least 95% of the maximum standard Proctor dry density at a moisture content within 2% of optimum. Exterior backfill placed in landscape areas should be compacted to at least 90% of the maximum standard Proctor dry density at a moisture content near optimum.
3) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 12 inches in the first 10 feet in unpaved areas and a minimum slope of 3 inches in the first 10 feet in paved areas.
4) Roof downspouts and drains should discharge well beyond the limits of all backfill.
5) Landscaping which requires regular heavy irrigation should be located at least 10 feet from foundation walls. The upper 2 feet of foundation wall backfill should consist of relatively impervious cover soil.

CONTINUING SERVICES

Two additional elements of geotechnical engineering service are important to the successful completion of this project.

1) Consultation with design professionals during the design phases. This is important to ensure that the intentions of our recommendations are properly incorporated in the design, and that any changes in the design concept properly consider geotechnical aspects.
2) Observation and monitoring during construction. A representative of the Geotechnical engineer from our firm should observe the foundation excavation, earthwork, and foundation phases of the work to determine that subsurface conditions are compatible with those used in the analysis and design and our recommendations have been properly implemented. Placement of backfill should be observed and tested to judge whether the proper placement conditions have been achieved. We recommend a representative of the Geotechnical Engineer

from our firm observe the drain and dampproofing phases of the work to verify if our recommendations have been properly implemented.

LIMITATIONS

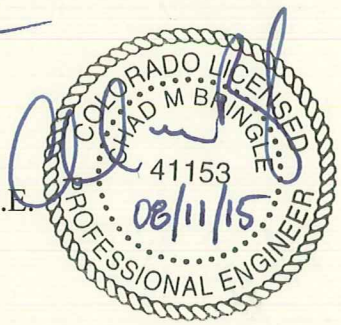
This report has been prepared in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory test pits, the proposed type of construction and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is performed. If conditions encountered during construction appear different from those described in this report, we should be notified so that revaluation of the recommendations may be made.

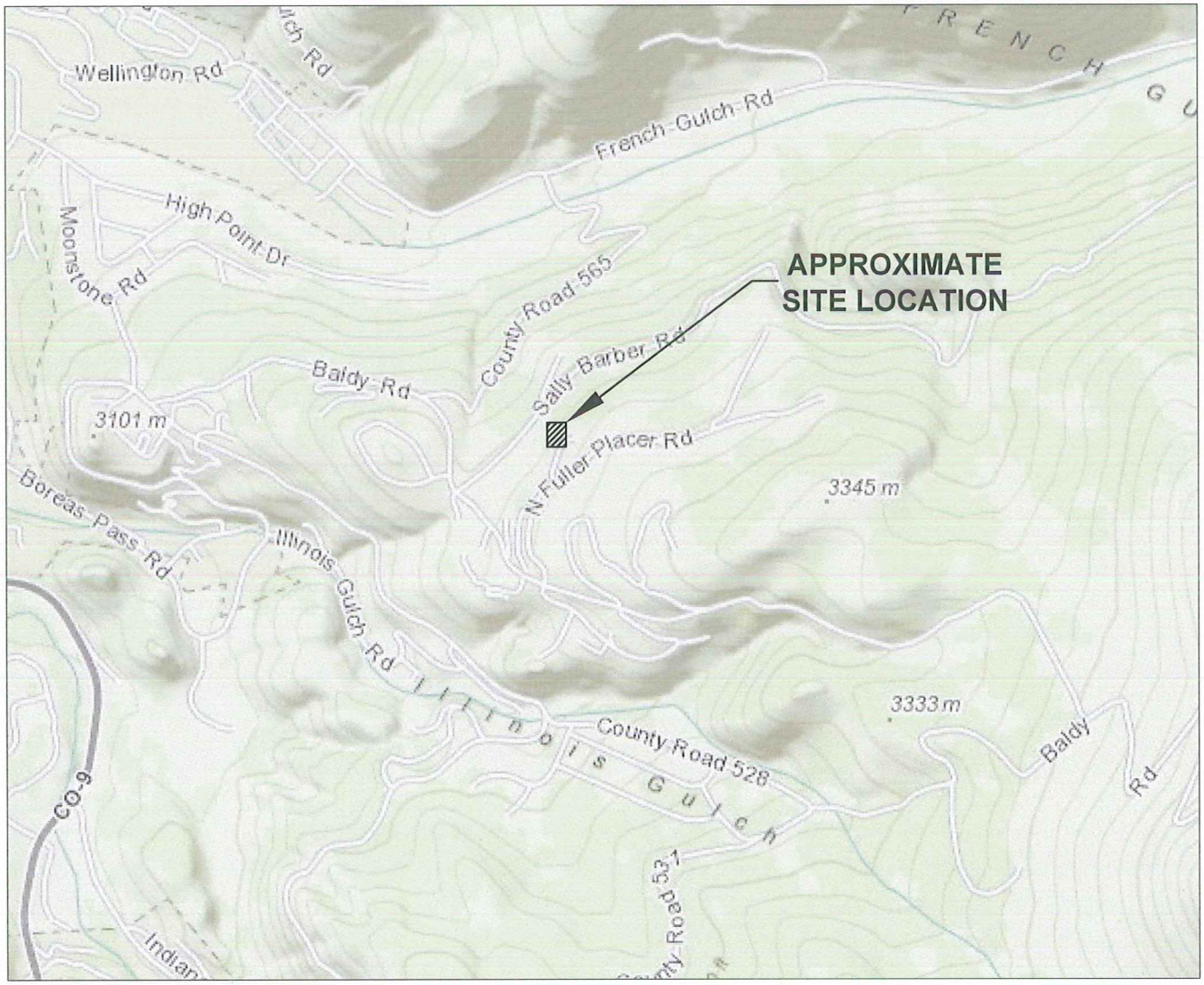
This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. Significant design changes may require additional analysis or modifications to the recommendations presented herein.

Sincerely,
HEPWORTH-PAWLAK GEOTECHNICAL, INC.

Jason A. Deem
Project Geologist

Chad M. Bringle, P.E.
Project Engineer





N

APPROXIMATE SCALE:
1 INCH = 2000 FEET

Adapted from Colorado State Land Board GIS

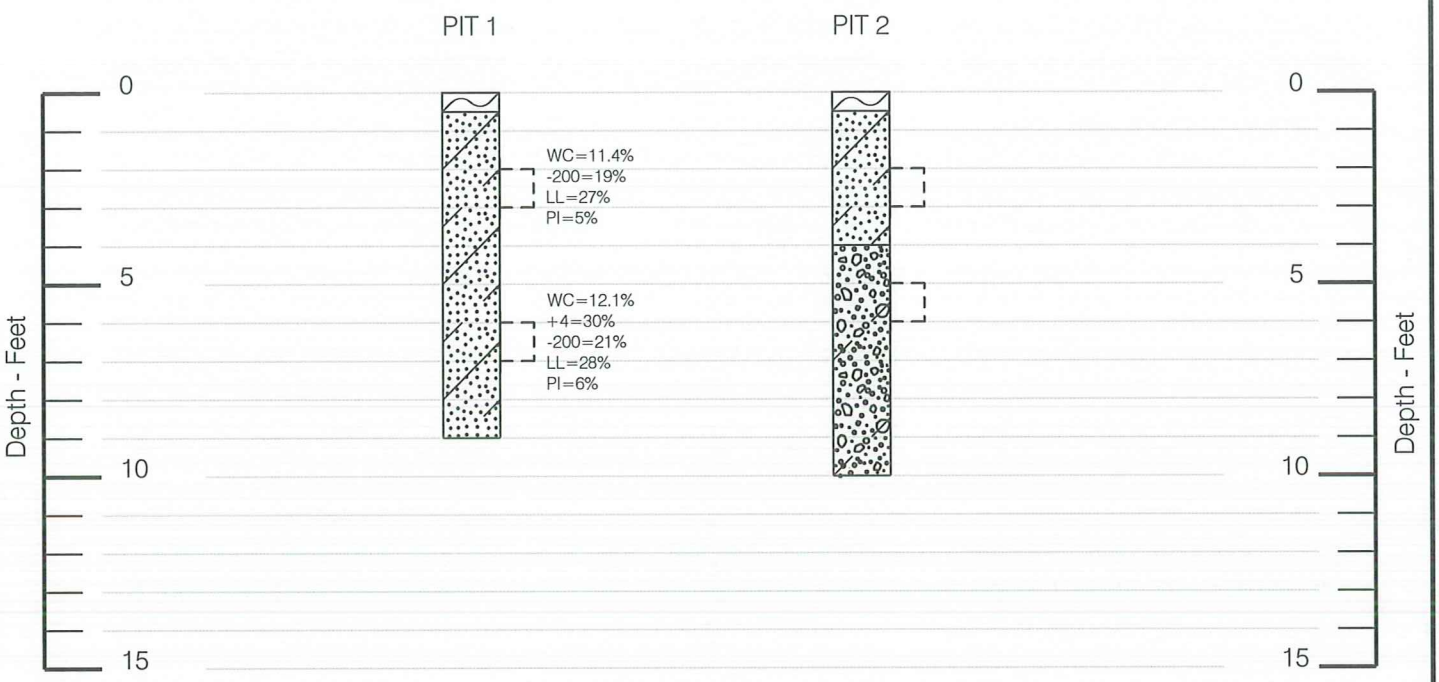
415 172A	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOT 62, WOODMOOR AT BRECKENRIDGE SITE LOCATION MAP	FIGURE 1

N

APPROXIMATE SCALE
1 INCH = 40 FEET

Adapted from Summit County GIS

415 172A	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOT 62, WOODMOOR AT BRECKENRIDGE LOCATIONS OF EXPLORATORY PITS	FIGURE 2



LEGEND:

TOPSOIL; organic, clayey sand, moist, dark brown.

SAND (SC-SM); clayey, silty with gravel and angular cobbles, dense, moist, brown.

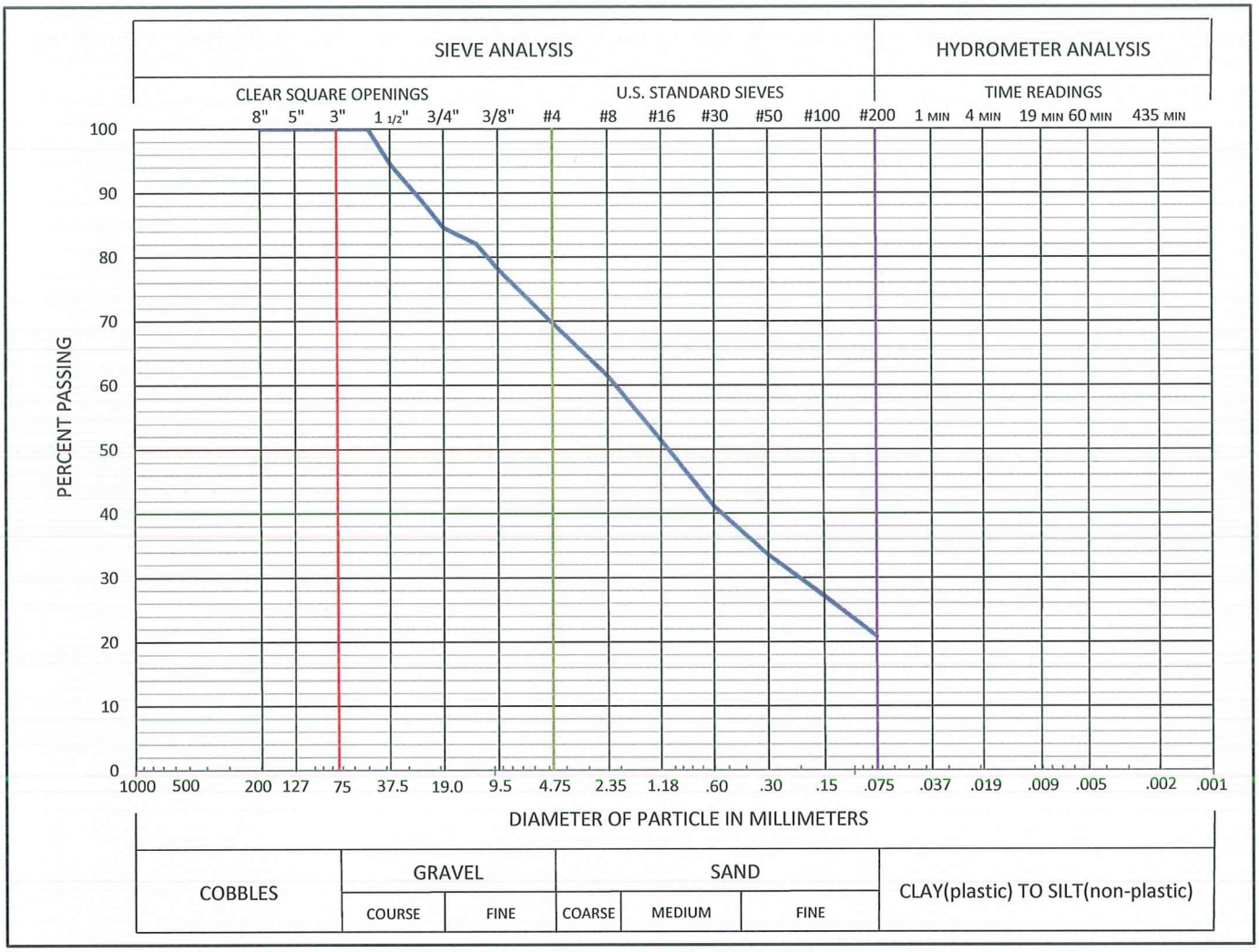
GRAVEL (GP-GC); sandy, slightly clayey with subangular cobbles and one boulder of 2 feet in diameter, dense, moist, brown.

Disturbed bulk sample.

NOTES:

1. Exploratory pits were excavated on July 14, 2015 with a CAT 450F rubber-tired backhoe.
2. Locations of exploratory pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of exploratory pits were not measured and the logs are drawn to depth.
4. The exploratory pit locations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the exploratory pit logs represent the approximate boundaries between material types and transitions may be gradual.
6. No free water was encountered in the pits at the time of excavation. Fluctuation in water level may occur with time.
7. Laboratory Testing Results:
   WC = Water Content (%)
   DD = Dry Density (pcf)
   +4 = Percent retained on the No. 4 sieve
   -200 = Percent passing No. 200 sieve
   LL = Liquid Limit (%)
   PI = Plasticity Index (%)

415 172A	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOT 62, WOODMOOR AT BRECKENRIDGE LOGS OF EXPLORATORY PITS	FIGURE 3

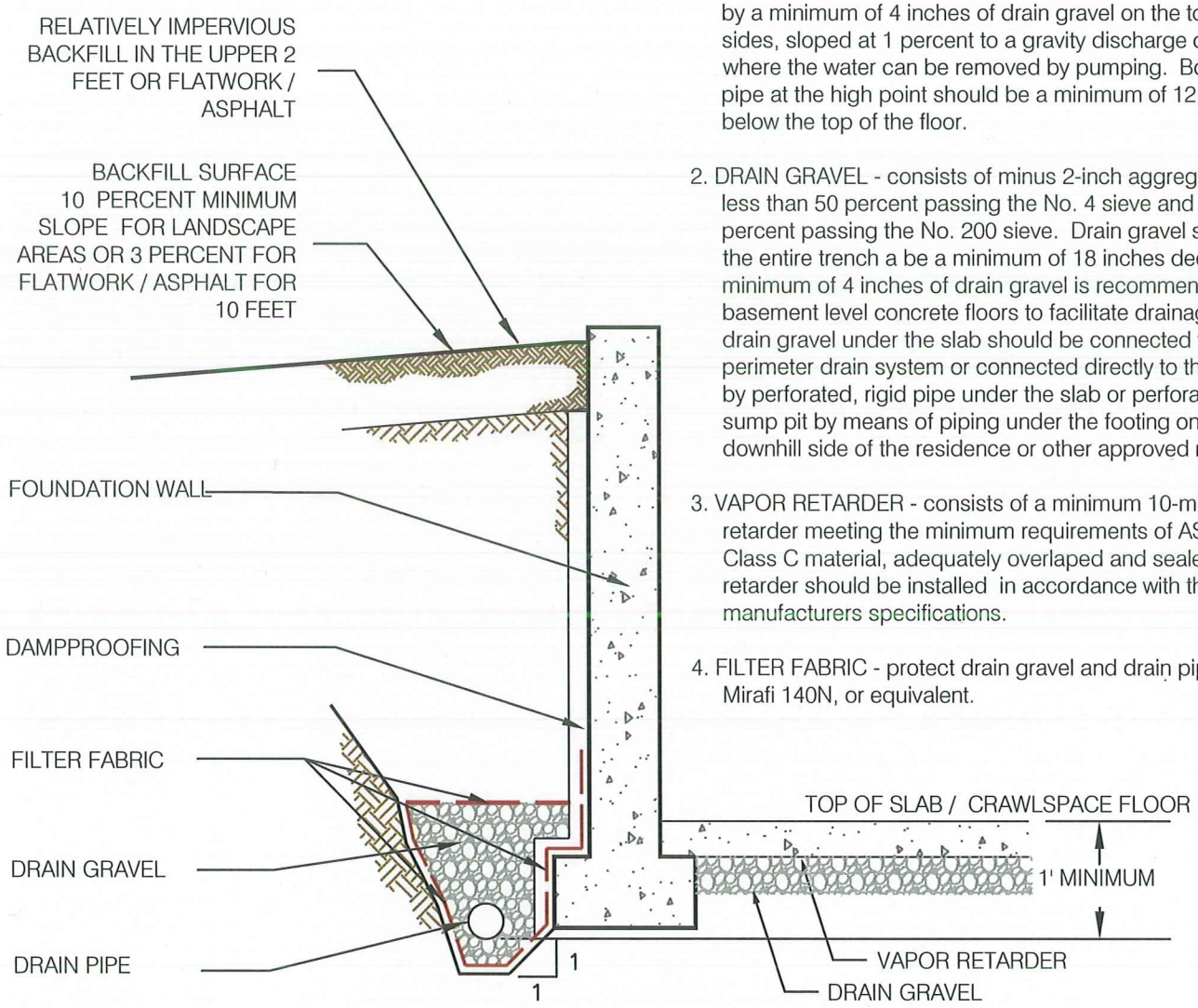


Grain Size (mm)	Sieve Size	% Passing
200	8"	100
127	5"	100
75	3"	100
50	2"	100
37.5	1 1/2"	94
25.0	1"	89
19.0	3/4"	85
12.5	1/2"	82
9.5	3/8"	78
4.75	#4	70
2.35	#8	61
1.18	#16	51
0.60	#30	41
0.30	#50	34
0.15	#100	27
0.075	#200	21

Particle Size Distribution	
Cobbles:	0%
Gravel:	30%
Sand:	49%
Silt & Clay:	21%

Classification: SAND (SM); silty, gravelly
Location: Pit 1
Depth: 6 to 7 Feet
Moisture Content: 12.1%
Liquid Limit: 28
Plasticity Index: 6

415 172A	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOT 62, WOODMOOR AT BRECKENRIDGE, B1 GRADATION TEST RESULTS	FIGURE 4



1. DRAIN PIPE - consists of 4-inch perforated PVC, surrounded by a minimum of 4 inches of drain gravel on the top and sides, sloped at 1 percent to a gravity discharge or sump pit where the water can be removed by pumping. Bottom of pipe at the high point should be a minimum of 12 inches below the top of the floor.

2. DRAIN GRAVEL - consists of minus 2-inch aggregate with less than 50 percent passing the No. 4 sieve and less than 2 percent passing the No. 200 sieve. Drain gravel should fill the entire trench a be a minimum of 18 inches deep. A minimum of 4 inches of drain gravel is recommended under basement level concrete floors to facilitate drainage. The drain gravel under the slab should be connected to the perimeter drain system or connected directly to the sump pit by perforated, rigid pipe under the slab or perforation in the sump pit by means of piping under the footing on the downhill side of the residence or other approved method.

3. VAPOR RETARDER - consists of a minimum 10-mil vapor retarder meeting the minimum requirements of ASTM E1745 Class C material, adequately overlaped and sealed. Vapor retarder should be installed in accordance with the manufacturers specifications.

4. FILTER FABRIC - protect drain gravel and drain pipe with Mirafi 140N, or equivalent.

NOT TO SCALE

415 172A	HP Geotech HEPWORTH-PAWLAK GEOTECHNICAL	LOT 62, WOODMOOR AT BRECKENRIDGE, B1 TYPICAL DRAIN DETAIL	FIGURE 5