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GEOTECHNICAL ENGINEERING STUDY
PROPOSED ADDITION TO SINGLE FAMILY RESIDENCE
LOT 41 BLUE ROCK SPRINGS SUBDIVISION
38 ROCK SPRINGS ROAD
BLUE RIVER, COLORADO

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SUMMARY

1. A representative of Kumar and Associates, Inc. observed two exploratory pits on the subject property. The subsoils consist of about 6 inches of topsoil overlying medium dense, well graded gravel (GW) with sand, cobbles and boulders, extending to the full depth of exploration of about 10 feet below the ground surface.

2. The medium dense, native, granular soils encountered are considered good for support of shallow foundations, floor slabs and concrete flatwork. The existing topsoil is not suitable for support of structures or improvements and will require removal from beneath, foundations, floor slabs and exterior flatwork.

3. Groundwater was not encountered to the explored depth of 10 feet below the existing ground surface. Groundwater depths may vary seasonally and frozen ground can create a perched condition, especially during spring thaw conditions.

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for a proposed addition to a single family residence to be located at 38 Rock Springs Road, Blue River, Colorado. The project site 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 agreement for geotechnical engineering services to Lee Sky, Proposal No. P6-19-133, dated May 13, 2019.

A field exploration program consisting of exploratory pits and a site reconnaissance was conducted to obtain information on the surface and subsurface conditions. Samples of the subsoils obtained during the field exploration were tested in the laboratory to determine their classification 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

The project consists of a building addition to the north side of an existing residence on the property. Review of preliminary plans indicate the proposed addition will be have a footprint of about 950 square-feet and will be a two-story, wood-framed, structure, with a slab-on-grade or structural floor over crawlspace. Grading for the addition is assumed to be relatively minor with cuts of approximately 4 to 5 feet below the adjacent ground surface. We assume relatively light foundation loadings, typical of the proposed type of construction.

If construction plans are different than those described above, we should be notified to re-evaluate the recommendations presented in this report.

SITE CONDITIONS

The project site is a residential lot located on the south side of Rock Springs Road. The lot is currently occupied with an approximate 840 square foot single-family residence with a loft. The surface of the lot is relatively flat with a slight slope down to the east. Vegetation consists of deciduous and conifer trees with grass and weeds on the site surface. The property is bordered by residential lots to the south, west and east, and Rock Springs Road to the north.

FIELD EXPLORATION

The field exploration for the project was conducted on June 6, 2019. Two exploratory pits were excavated in the area of the proposed addition at the locations shown on Figure 1, to evaluate

the subsurface conditions. The pits were excavated with a tracked excavator and logged by a representative of Kumar and Associates, Inc. Due to underground utility constraints, the exploratory pits were excavated within the proposed addition footprint. During construction, disturbed soils in exploratory pit locations should be re-excavated, moisture conditioned to near optimum moisture content and replaced as properly compacted structural fill per the recommendations in this report.

Samples of the subsoils were taken with disturbed sampling methods. Depths at which the samples were taken are shown on the Logs of Exploratory Pits, Figure 2. The samples were returned to our laboratory for review by the project manager and testing.

LABORATORY TESTING

Laboratory testing performed on samples obtained from the exploratory pits consisted of natural moisture content, percent passing the No. 200 sieve and gradation analysis. The results of a gradation analysis performed on the minus 5 inch fraction of the natural granular soils are shown on Figure 3. The laboratory test results are shown on the Logs of Exploratory Pits, Figure 2, and summarized in Table 1.

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 medium dense, well graded gravel with sand, cobbles and boulders, extending to the full depth of exploration of about 10 feet below the ground surface.

Groundwater: No groundwater was encountered in the pits at the time of excavation. The subsoils were generally slightly moist to moist. The depth to groundwater can vary based on seasonal and climatic factors.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Subsurface data indicate that medium dense, granular, GW soil will likely be the predominant soil type encountered beneath shallow foundation, floor slab and flatwork areas. The anticipated soils at the foundation level are considered good for shallow foundation support.

Existing fill, loose and disturbed soils, building remnants; including existing foundations and utilities, should be removed from foundation areas and footing excavations extended down to the undisturbed natural granular soils.

SITE GRADING

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

1. Where fill is to be placed, existing fill, building remnants, 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 to the minimum required density.
2. Permanent unretained cut and fill slopes should be graded at 2 horizontal to 1 vertical (2:1) 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	Structural Fill – 98%
Foundation Wall Backfill	± 2% Optimum	Processed On-site or Structural Fill – 95%
Below Floor Slabs	± 2% Optimum	Structural Fill – 95%
Landscape Areas	± 2% Optimum	Processed On-site – 90%
Below Concrete Flatwork/Pavements	± 2% Optimum	Structural Fill – 95%
Utility Trenches	As they apply to the finished area	

Suitability of On-Site Soil

The on-site GW soils are suitable as backfill after processing to remove all plus 6-inch material and moisture treatment. The on-site topsoil is not suitable for reuse except in the upper 6 to 12 inches of backfill in landscape areas.

Considerable processing will likely be necessary to reduce the on-site soil to fragments of minus 6-inches. Processing may include screening, rock raking and crushing. All on-site soil should be processed, moisture-conditioned and placed at the minimum required compaction.

Structural Fill

Structural fill used for support of the proposed addition should consist of the on-site processed soils or a relatively well-graded imported granular material with a liquid limit of 35 or less, a plasticity index of 10 or less, 5 to 25 percent material passing the No. 200 sieve, 60 percent or more passing the No. 4 sieve and no rocks larger than 6 inches. CDOT Class 1 structural backfill is acceptable as structural fill. Structural fill should be properly placed and compacted to reduce the risk of settlement and distress. 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 evaluate the suitability of 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 GW soil will likely classify as “Type C” in accordance with OSHA regulations. The regulations allow slopes of 1½ horizontal to 1 vertical (1½:1) for dry 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 pits and the nature of the proposed construction, we recommend the structure be founded with spread footings bearing on the undisturbed GW soil.

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

1) Footings placed on the undisturbed natural granular 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 GW soil. 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) The topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively undisturbed soils or replaced with properly compacted structural fill.
6) The exposed soils in footing areas should then be adjusted to near optimum moisture content 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) Voids in the footing area subgrade created by boulder removal should be backfilled with properly compacted structural fill, lean mix “flow-fill” concrete or structural concrete.
8) Structural fill used for support of the foundation should meet the requirements listed in the SITE GRADING section of this report.
9) 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 50 pounds per cubic foot (pcf) for backfill consisting of the on-site processed soils or suitable granular import. 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 40 pcf for backfill consisting of the processed on-site soils or suitable granular import. 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 0.45. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 460 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 suitable 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 limit 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. 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. 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 on-site granular 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 at least 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 A material. The vapor retarder should be installed in accordance with the manufacturers' recommendations and ASTM 1643.

UNDERDRAIN SYSTEM AND DAMP-PROOFING

Although groundwater was not encountered during our exploration, it has been our experience in mountainous areas that groundwater levels can rise and 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 12-inches 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 1-inch. The drain gravel backfill should be at least 1½ feet deep and protected by filter fabric. A typical drain detail is shown on Figure 4.

For exterior below grade foundation walls, we recommend, as a minimum, damp-proofing consist of bituminous material, 3 lbs per square yard, extending from the top of the footing to above ground level. A wall drain system consisting of a geocomposite, MiraDrain 6000, or equivalent, should be placed adjacent to below grade construction walls, with 100 percent coverage on the foundation wall facing the uphill slope and a minimum of 50 percent coverage for the adjacent foundation walls. The wall drain system should connect into the underdrain and extend to within 1 to 2 feet of the ground surface.

SURFACE DRAINAGE

The following drainage precautions should be observed during construction and maintained at all times after the addition 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 5 feet from foundation walls. The upper 2 feet of foundation wall backfill should consist of low permeability cover soil.

CONTINUING SERVICES

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

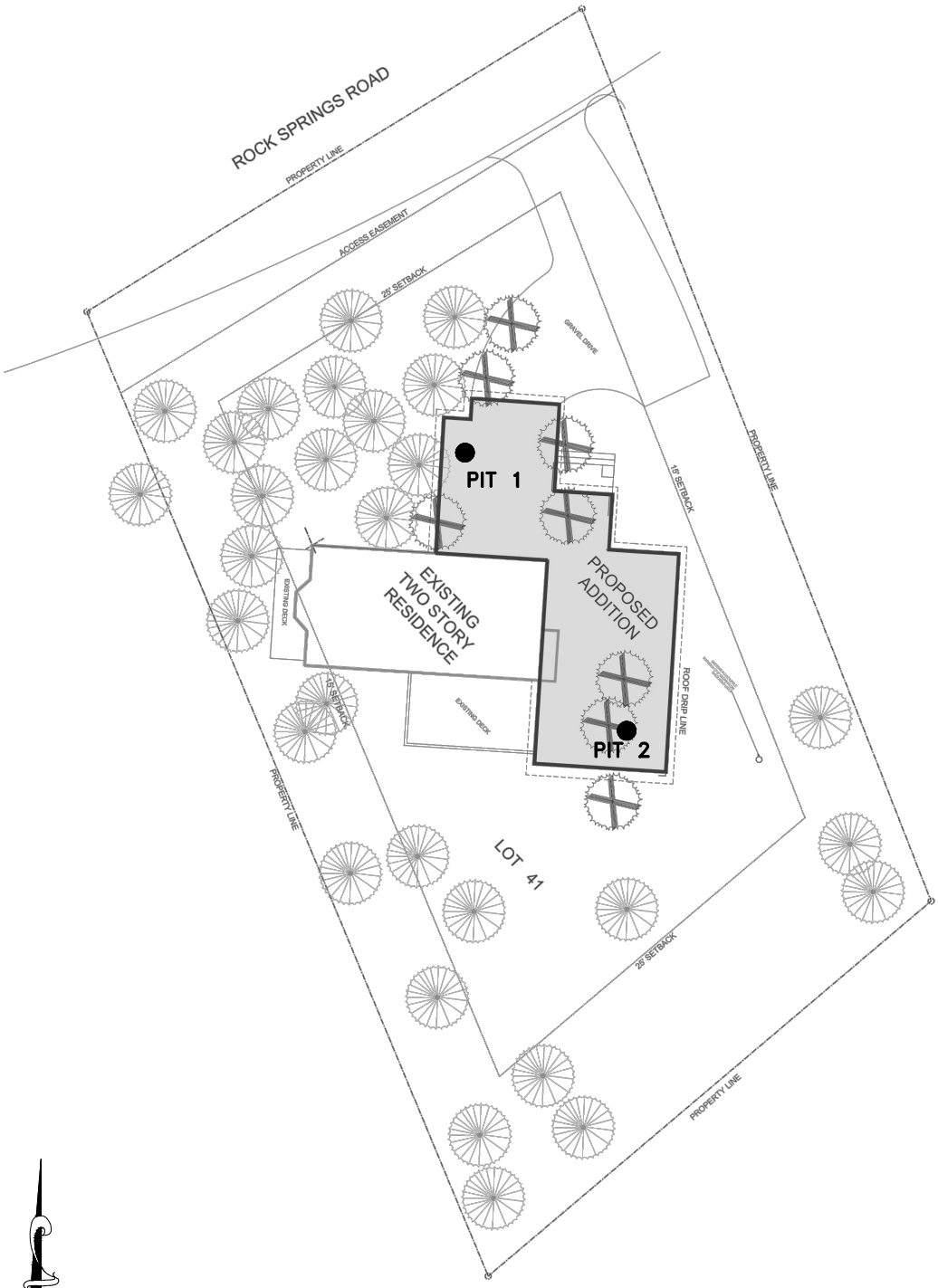
1) Consultation with design professionals during the design phases. This is important to ensure that the intentions of our recommendations are properly incorporated in the design, and that any changes in the design concept properly consider geotechnical aspects.
2) Observation and monitoring during construction. 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 observe the drain and dampproofing phases of the work, if constructed, to judge whether our recommendations have been properly implemented.

LIMITATIONS

This study has been conducted 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 pits at the locations indicated on Figure 1, the proposed type of construction and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing

in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. Our findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory pits and 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 re-evaluation of the recommendations may be made.

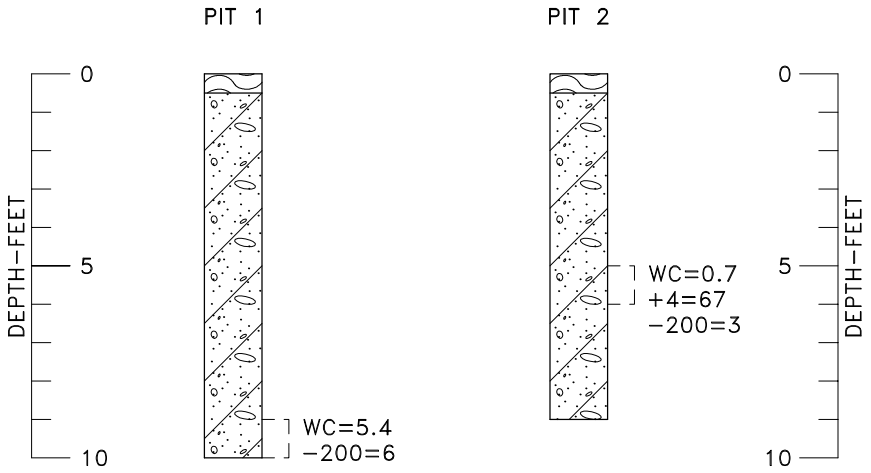
This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted. The recommendations contained in this report are contingent upon review of grading and excavation plans prepared by a civil engineer licensed in the State of Colorado. Review of grading plans may alter our recommendations. Significant design changes may require additional analysis or modifications to the recommendations presented herein.



15 0 15 30

APPROXIMATE SCALE–FEET

19–6–157	Kumar & Associates	LOCATION OF EXPLORATORY PITS	Fig. 1



LEGEND

TOPSOIL; SAND AND GRAVEL WITH ORGANICS, MOIST, BROWN.

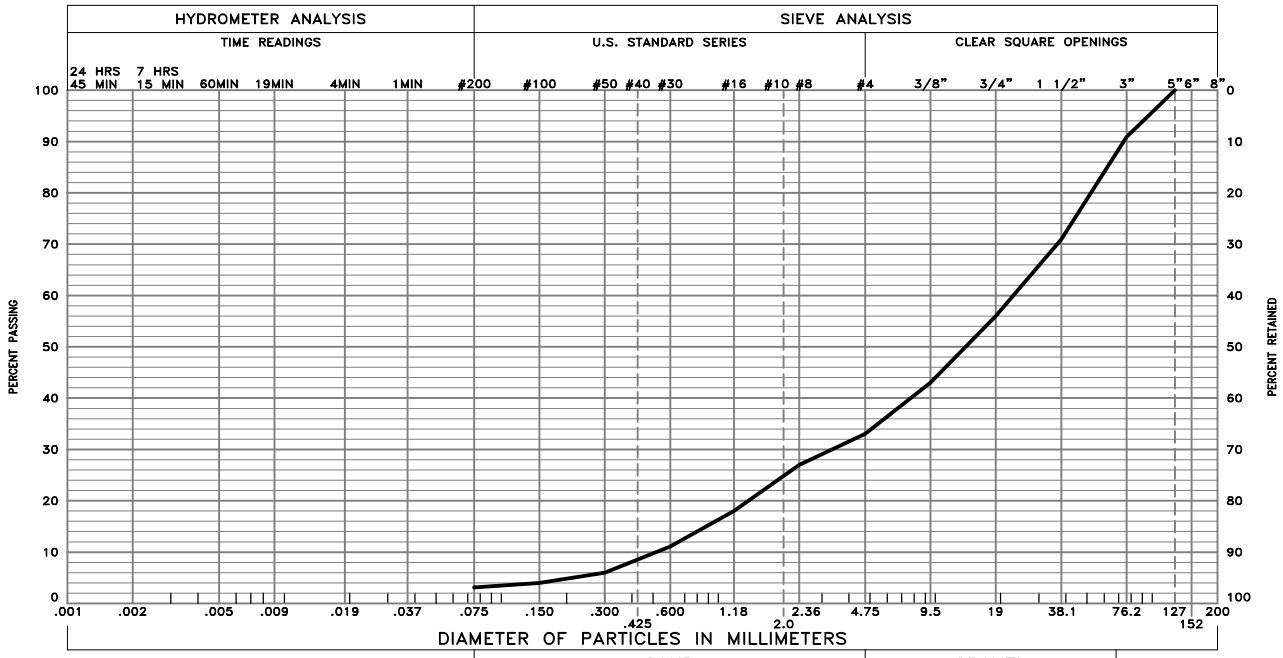
WELL GRADED GRAVEL (GW); WITH SAND, COBBLES, AND BOULDERS, MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, BROWN.

DISTURBED BULK SAMPLE.

NOTES

1. THE EXPLORATORY PITS WERE EXCAVATED ON JUNE 6, 2019 WITH A TRACKED EXCAVATOR.
2. THE LOCATIONS OF THE EXPLORATORY PITS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY PITS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY PITS ARE PLOTTED 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 THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE PITS AT THE TIME OF EXCAVATION. PITS WERE BACKFILLED SUBSEQUENT TO SAMPLING.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140).

19-6-157	Kumar & Associates	LOGS OF EXPLORATORY PITS	Fig. 2

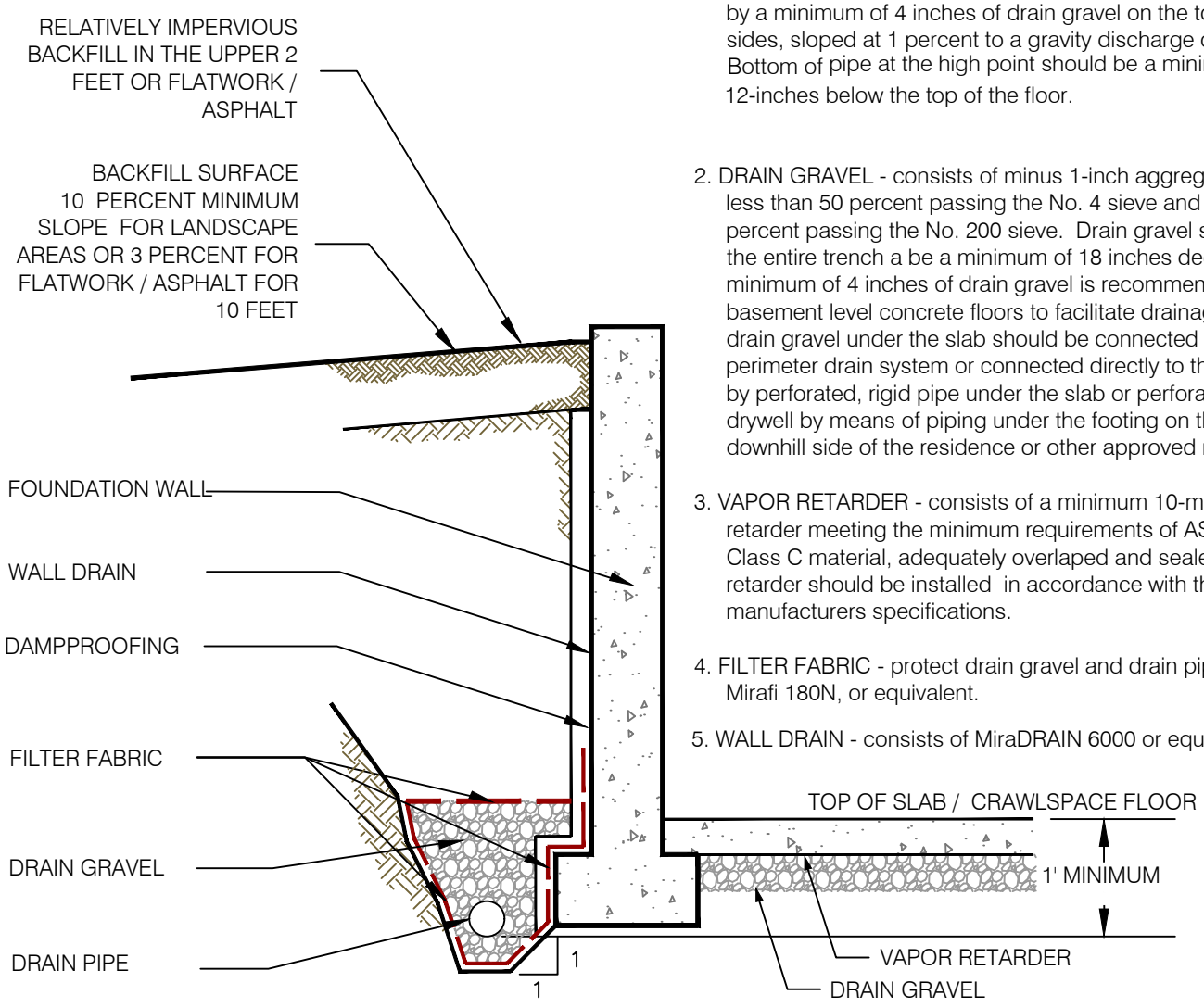


GRAVEL 67 % SAND 30 % SILT AND CLAY 3 %

SAMPLE OF: Well Graded Gravel with Sand FROM: Pit 2 @ 5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

19-6-157	Kumar & Associates	GRADATION TEST RESULTS	Fig. 3



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 drywell. 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 1-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 drywell by perforated, rigid pipe under the slab or perforation in the drywell 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 180N, or equivalent.

5. WALL DRAIN - consists of MiraDRAIN 6000 or equivalent.

NOT TO SCALE

19-6-157	Kumar & Associates	TYPICAL DRAIN DETAIL	FIG. 4

Kumar & Associates

JOB NO: 19-6-157
JOB NAME: PROPOSED ADDITION, 38 ROCK SPRINGS ROAD TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT	NATURAL DRY UNIT WEIGHT	GRADATION			ATTERBERG LIMITS		SWELL-COMPRESSION		HVEEM STABILOMETER	WATER SOLUBLE SULFATES	pH	SOIL OR BEDROCK DESCRIPTION
PIT (#)	DEPTH (feet)	(%)	(pcf)	GRAVEL (%)	SAND (%)	SILT & CLAY (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SWELL (%)	SUR-CHARGE (psf)	(R-VALUE)	(%)	()	
1	9	5.4				6								WELL GRADED GRAVEL WITH SAND
2	5	0.7		67	30	3								WELL GRADED GRAVEL WITH SAND