SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED RESIDENCE
LOT 2, RIVERSHORE SUB
TOWN OF BLUE RIVER
SUMMIT COUNTY, COLORADO

JOB NO. 09-72

DATE:
OCTOBER 21, 2009

PREPARED FOR:

ALLEN-GUERRA DESIGN BUILD
P.O. BOX 7404
BRECKENRIDGE, COLORADO 80424

PREPARED BY:

WALTER O. SCHULTZ P.E.
P.O. BOX 1957
DILLON, CO 80435

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for a proposed residence to be located on Lot 2, Rivershore Sub, Summit County, Colorado. The project site is shown on Fig. 1. The purpose of the study was to develop recommendations for the foundation design. The study was conducted in accordance with the verbal agreement for geotechnical engineering services to Allen-Guerra Design Build dated October 19, 2009.

A field exploration program consisting of an exploratory pit was conducted to obtain information on subsurface conditions. Samples of the subsoils 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 building foundation. This report summarizes the data obtained during this study and presents my conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsoil conditions encountered.

PROPOSED CONSTRUCTION

The proposed residence will be a two to three story structure over a walkout basement. Grading for the structure is to be moderate with cut depths between about four to ten feet. I assume moderately heavy foundation loadings, typical of the proposed type of construction.

If buildings loadings, location or grading plans change significantly from those described above, I should be notified to reevaluate the recommendations contained in this report.

SITE CONDITIONS

The lot was vacant at the time of the study. The lot is irregular in shape with the southern boundary serpentine following Rivershore Drive and the northern boundary along Tract B private open space and Lot 1 Willow Springs Sub. The western boundary of the lot is Colorado Highway 9. Occupied Lot 4 borders on the east. The building site is located in the central area of the lot and is a medium sized knoll with sides sloping moderately to steeply downward from the building site. Vegetation consists of scattered pines. Several boulders were noted at the surface.

FIELD EXPLORATION

The field exploration for the project was conducted on October 20, 2009. One exploratory pit was excavated at the location shown on Fig. 1 to evaluate the subsurface conditions. The pit was dug with a rubber-tracked mini-backhoe. The pit was logged.

Samples of the subsoils were taken with disturbed sampling methods. Depths at which the samples were taken are shown on the Test Pit Log, Fig. 2. The samples were returned to the laboratory for review by the project engineer and testing of the natural coarse granular soils is shown.

SUBSURFACE CONDITIONS

Logs of the subsurface conditions encountered at the site are shown on Fig. 2. The subsoils consist of about four inches of topsoil overlying relatively dense sandy gravel containing cobbles and boulders.

Laboratory testing performed on samples obtained from the pit included gradation analysis, Proctor value and Atterberg limits. Results of the laboratory preformed on the samples of the natural coarse granular soils are shown.

No free water was encountered in the pit at the time of excavation and the subsoils were slightly moist to moist.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsoil conditions encountered in the exploratory pit and the nature of the proposed construction, I recommend the building be founded with spread footings bearing on the natural granular soils. The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed granular soils should be designed for an allowable soil bearing pressure of 4000 psf. Based on experience, I expect settlement 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 typically used in this area.
4) Continuous foundation walls should be reinforced top and bottom to span local anomalies (by assuming an unsupported length of at least 5 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 relatively dense natural granular soils or on properly compacted fill. If water seepage is encountered, the footing areas should be dewatered before concrete placement.

6) Any fill placed for foundation support should be granular and compacted to at least 100% ASTM D-698 Proctor density. Fill should be placed in maximum loose lifts of 8 inches at a moisture content of – 2 % to + 1% of optimum moisture content with a maximum depth of two feet.

7) A representative of the geotechnical engineer should observe all footing excavations prior to 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 lateral earth pressure computed on the basis of an equivalent fluid unit weight of 55 pcf for backfill consisting of the on-site soils. Cantilevered retaining structures which are separated from the building 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 35 pcf for backfill consisting of the on-site soils.

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 should be placed in uniform lifts and compacted to at least 90% of ASTM D-698 Proctor density (at a moisture content near optimum.) Backfill in pavement and walkway areas should be compacted to at least 95% of ASTM D-698 Proctor density. Care should be taken not to over compact 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.

I recommend on-site granular soils for backfilling foundation walls and retaining structures because their use results in lower lateral earth pressures. Subsurface drainage recommendations are discussed in more detail in the "Underdrain System" section of this report. Imported granular wall backfill should contain less than 10% passing the No. 200 sieve, be similar to the onsite granular soil and have a maximum size of 6 inches.

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 0.40. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 400 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 nonexpansive granular material compacted to at least 95% of ASTM D-698 Proctor density at a moisture content near optimum.

FLOOR SLABS

The natural on-site soils, exclusive of topsoil, are suitable to support lightly to moderately 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 may 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 fill materials for support of floor slabs should be compacted to at least 95% of ASTM D-698 Proctor density at a moisture content near optimum. Required fill can consist of the on-site soils devoid of vegetation, topsoil and oversized rock.

UNDERDRAIN SYSTEM

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

The drains should consist of drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining granular material. The drain should be placed at each level of excavation and at or below lowest adjacent footing grade and sloped at a minimum 1% to a suitable gravity outlet. Free-draining granular material 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 1 ½ feet deep. Geocomposite wall drain should extend to within 1 to 2 feet of finish grade and connect to the drain gravel or pipe.

SITE GRADING

The risk of construction-induced slope instability at the site appears low. I assume the cut depths for the basement level will not exceed, one level, about 8 to 10 feet. Fills should be limited to about 8 to 10 feet deep, especially at the downhill side of the residence where the slope steepens. Embankment fills should be compacted to at least 95% of ASTM D-698 Proctor density near optimum moisture content. Prior to fill placement, the subgrade should be carefully prepared by removing all vegetation and topsoil and compacting to 95% ASTM D-698 Proctor density. The fill should be benched into the portions of the hillside exceeding 20% grade.

Permanent unretained cut and fill slopes should be graded at 2 horizontal to 1 vertical 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.

SURFACE DRAINAGE

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

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

2) Exterior backfill should be adjusted to near optimum moisture and compacted to at least 95% of ASTM D-698 Proctor density in pavement and slab areas and to at least 90% of ASTM D-698 Proctor density in landscape areas.

2) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. I 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. Free- draining wall backfill should be capped with about 2 feet of the on-site soils to reduce surface water infiltration.

4) Roof downspouts and drains should discharge will beyond the limits of all backfill.

5) Landscaping which requires regular heavy irrigation should be located at least 10 feet from foundation walls.

6) Consideration should be given to use of xeriscape to reduce the potential for wetting of soils below the foundation caused by irrigation.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. I make no warranty either expressed of implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory pit excavated at the location indicated on Fig. 1, the proposed type of construction and my experience in the area. My findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory pit 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, I should be notified so that re-evaluation of the recommendations may be made.

This report has been prepared for the exclusive use by the client for design purposes. I am not responsible for technical interpretations by others of the information. As the project evolves, I should provide continued consultation and field services during construction to review and monitor the implementation of my 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. I recommend on-site observation of excavation and foundation bearing strata and testing of structural fill by a representative of the geotechnical engineer.

Sincerely,

WALTER O. SCHULTZ P.E.

COLORADO REGISTERED
WALTER O. SCHULTZ
19696
PROFESSIONAL ENGINEER

TEST PIT LOG

LOT 2, RIVERSHORE SUB, TOWN OF BLUE RIVER
SUMMIT COUNTY, COLORADO

PIT NO.1

0-4" TOPSOIL AND VEGETATION

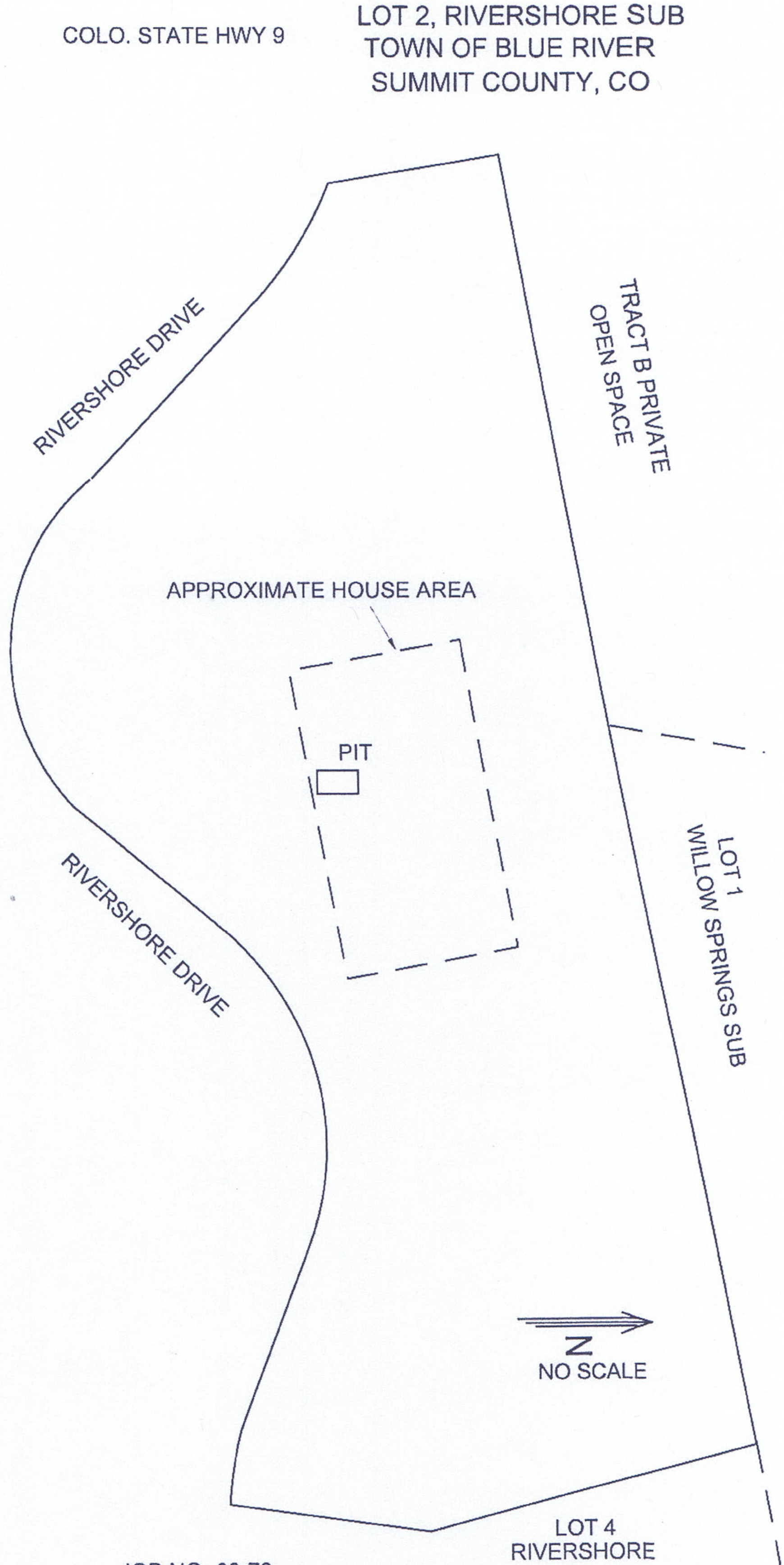
4"-8' SANDY GRAVEL W/ COBBLE & BOULDERS, DENSE, MOIST BROWN

NO FREE WATER ENCOUNTERED DURING EXCAVATION

COMPOSITE SAMPLES TAKEN

JOB NO: 09-72
FIGURE 2

TEST PIT LOCATION
LOT 2, RIVERSHORE SUB
TOWN OF BLUE RIVER
SUMMIT COUNTY, CO



JOB NO. 09-72

WALTER O. SCHULTZ P.E.

09-72SITE

WALTER O. SCHULTZ P.E.
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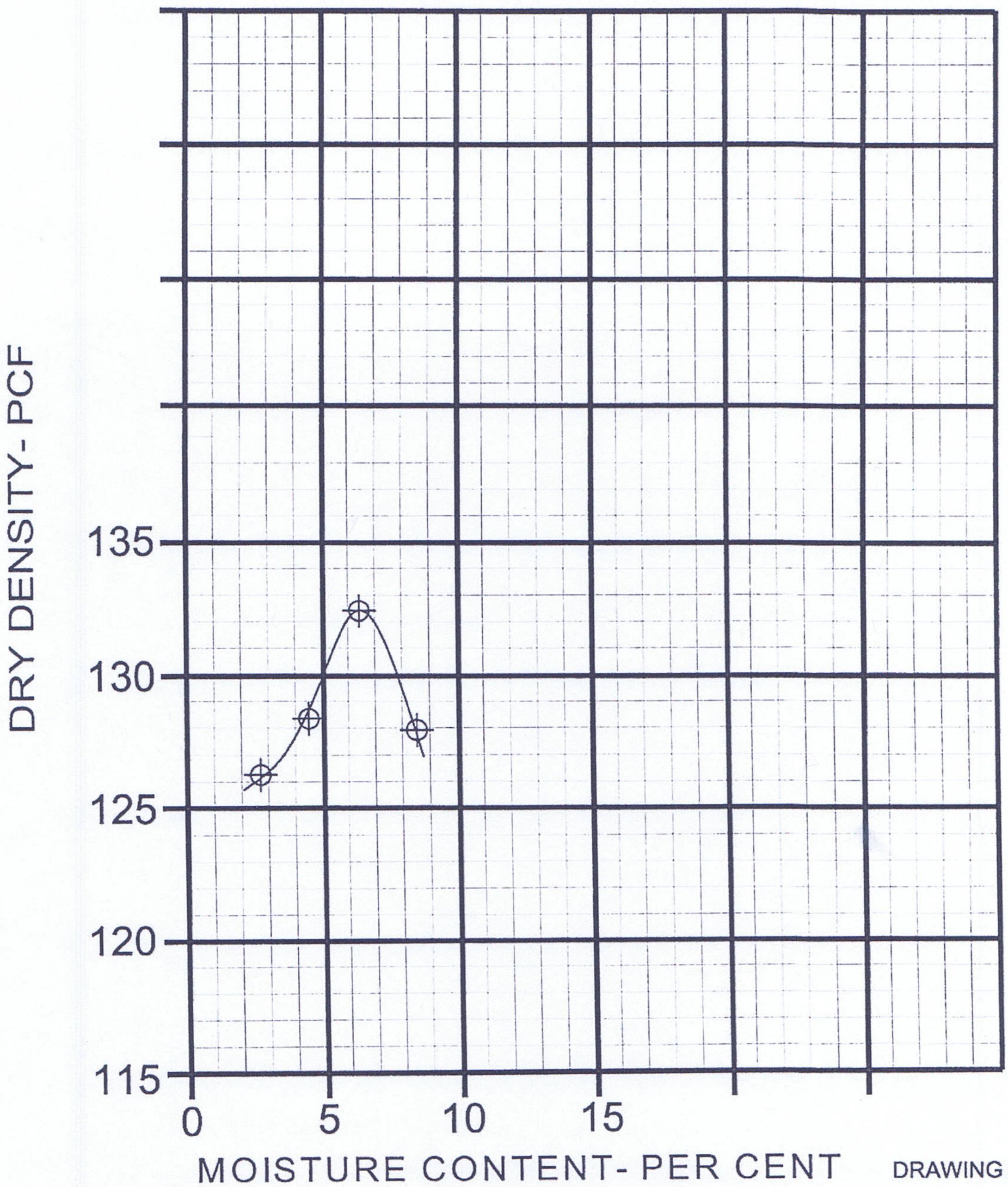
MOISTURE/DENSITY RELATIONSHIP

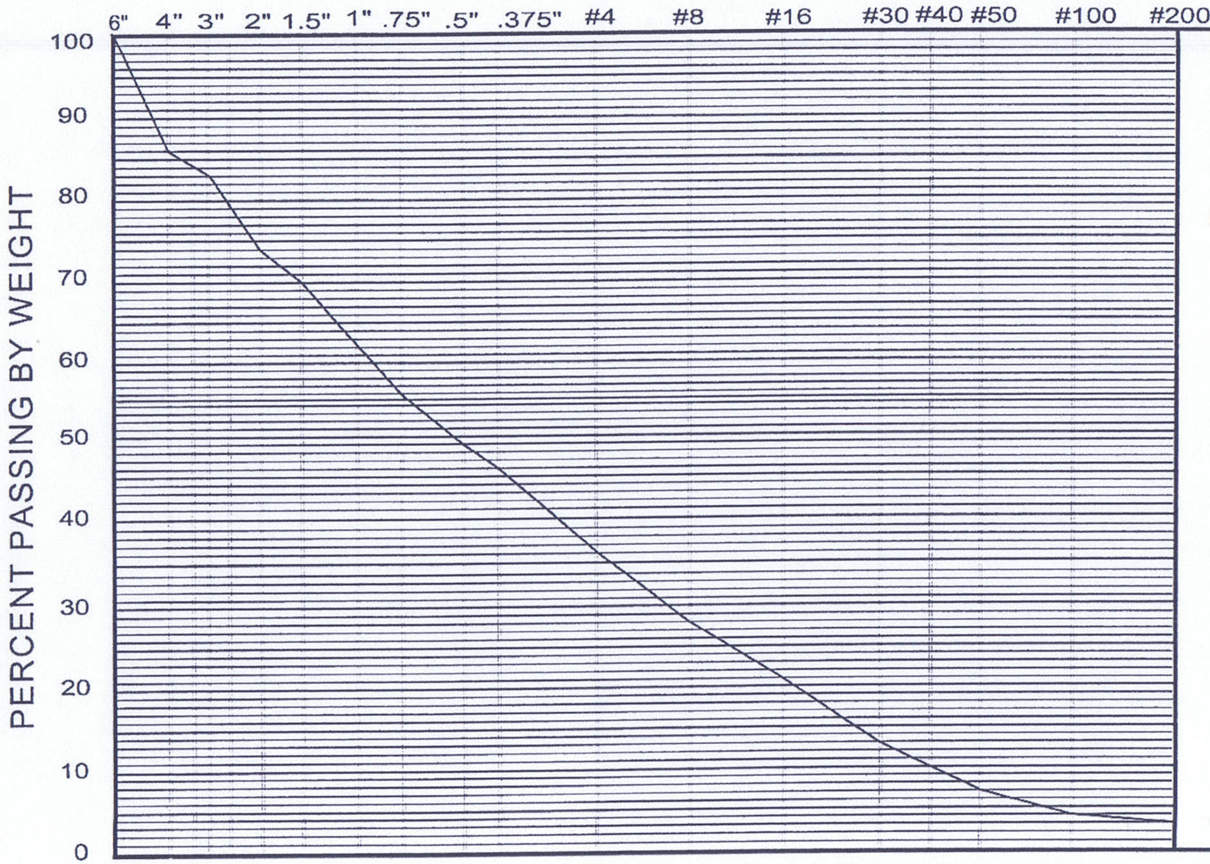


DRAWING NO. 09-72P

PIT NO.	SAMPLE NO.	DATE	DEPTH FEET	MAXIMUM DRY DENSITY	OPTIMUM MOISTURE	PROCTOR METHOD
1	1	10/20/09	COMPOSITE	132.4 PCF	6.4 %	ASTM D- 698D

SOIL TYPE	PROJECT NO. 09-72
SANDY GRAVEL	LOT 2, RIVERSHORE TOWN OF BLUE RIVER SUMMIT COUNTY, CO

PARTICLE SIZE ANALYSIS CHART
U. S. STANDARD SIEVE SIZE



SAMPLE LOCATION: PIT NO.1 COMPOSITE

DATE OF SAMPLING: 10/20/09

PROJECT

LOT 2, RIVERSHORE
TOWN OF BLUE RIVER
SUMMIT COUNTY, CO

JOB NO. 09-72

LIQUID LIMIT NP   PLASTIC LIMIT NP   PLASTICITY INDEX NP

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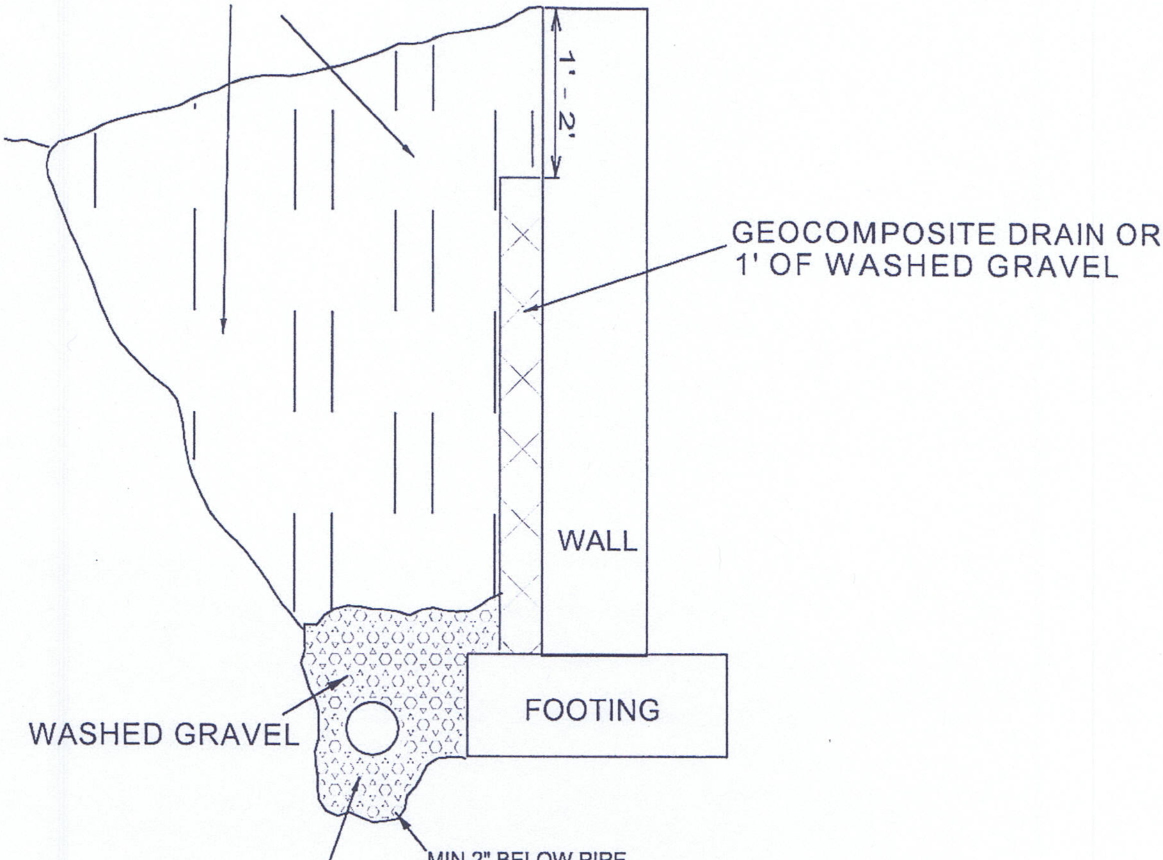
GRAVEL	SAND	SILT & CLAY
64 %	33 %	3 %

09-72G

CLASSIFICATION — SANDY GRAVEL



PIPE TO BE TYPICAL 4" DIAMETER
PERFORATED RIGID OR FLEXIBLE
WRAPPED IN FILTER FABRIC

PIPE MAY BE AT OR BELOW BOTTOM OF FOOTING

WALLDRAIN

TYPICAL DRAIN SYSTEM CROSS SECTION

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