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SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED RESIDENCES
MINOR'S BASE CAMP
1251 MAIN STREET
MINTURN, COLORADO

PROJECT NO. 19-7-505

SEPTEMBER 18, 2019

PREPARED FOR:

GILMAN 101 DEVELOPMENT, LLC
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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for the proposed residences to be located at Miner's Base Camp, 1251 Main Street, Minturn, 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 proposal for geotechnical engineering services to Gilman 101 Development, LLC dated August 12, 2019.

A field exploration program consisting of exploratory borings was conducted to obtain information on the 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 building 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 subsurface conditions encountered.

PROPOSED CONSTRUCTION

The proposed Miner's Base Camp development will consist of eight single family residences and twelve duplexes plus the Christiansan residence (Boring 4 area on Figure 1). We understand that the structures will be one to two stories with structural floors and crawlspaces. A one-way road will loop through the development, providing access to and from Main Street (Highway 24). Four detention ponds will be constructed as part of the site's drainage management system. Grading for the development is assumed to be relatively minor with cut depths between about 3 to 5 feet. We assume relatively light foundation loadings, typical of the proposed type of construction.

If building loadings, location or grading plans change significantly from those described above, we should be notified to re-evaluate the recommendations contained in this report.

SITE CONDITIONS

The site was previously developed with single and double wide trailer homes on the eastern portion and single-family residences on the southern, central, and western portions of the site. Several of the single-family residences had basement foundations. The residences were being demolished at the time of drilling. The terrain is generally flat with slopes gently sloping to the north. The ground surface is covered in concrete pavement, grass and weeds, and is bare in areas of demolition. Single-family residences are north, east, and west of the site. Main Street (US Highway 24) is north of the site. A heavily wooded slope is to the south of the site.

GEOLOGIC CONDITIONS

According to the Geologic Map of the Leadville 1° x 2° Quadrangle, Northwestern Colorado, dated 1978, by Tweto, Ogden, Moench, R.H., and Reed, J.C., the site is underlain by young glacial drift of the Bull Lake and younger period. The young glacial drift is described as unsorted boulder glacial deposits and associated sand and gravel deposits.

FIELD EXPLORATION

The field exploration for the project was conducted on September 10, 2019. Five exploratory borings were drilled at the locations shown on Figure 1 to evaluate the subsurface conditions. The borings were advanced with 4 inch diameter continuous flight augers powered by a truck-mounted CME-45B drill rig. The borings were logged by a representative of Kumar & Associates, Inc.

Samples of the subsoils were taken with a 1⅜ inch I.D. spoon sampler. The sampler was driven into the subsoils at various depths with blows from a 140 pound hammer falling 30 inches. This test is similar to the standard penetration test described by ASTM Method D-1586. The penetration resistance values are an indication of the relative density or consistency of the subsoils. Depths at which the samples were taken and the penetration resistance values are shown on the Logs of Exploratory Borings, Figure 2. The samples were returned to our laboratory for review by the project engineer and testing.

SUBSURFACE CONDITIONS

Graphic logs of the subsurface conditions encountered at the site are shown on Figure 2. The subsoils consist of about 1 to 5½ feet of loose to medium dense, silty sand and gravel fill overlying dense, slightly silty to silty sand and gravel with cobbles and possible boulders. Drilling in the coarse granular soils with auger equipment was difficult due to the cobbles and boulders and drilling refusal was encountered in the deposit. A concrete slab and topsoil were encountered at the ground surface in Borings 2 and 5, respectively.

Laboratory testing performed on samples obtained from the borings included natural moisture content and gradation analyses. Results of gradation analyses performed on small diameter drive samples (minus 1½ inch fraction) of the coarse granular subsoils are shown on Figures 4 through 6. The laboratory testing is summarized in Table 1.

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

FOUNDATION BEARING CONDITIONS

The undocumented sand and gravel fill is unsuitable for shallow foundation support in its current condition. The undocumented fill could settle causing damage to the residences. All existing foundations, slabs-on-grade, asphalt debris and undocumented fill should be removed from the proposed building footprint prior to construction. If structural floors are to be used, the removal of these items can be limited to footing areas. Building foundations can bear on either properly compacted structural fill or the natural dense sand and gravel.

DESIGN RECOMMENDATIONS

FOUNDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend the building be founded with spread footings bearing on the natural granular soils or properly compacted structural fill.

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 or properly compacted structural fill should be designed for an allowable bearing pressure of 3,000 psf. Based on experience, we expect settlement of footings designed and constructed as discussed in this section will be about 1 inch or less. All undocumented fill

should be removed from the footing areas and to an extent outside of the footing area equal to the depth of fill. Structural fill should be placed and compacted to a minimum of 98% of the standard Proctor density.

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 42 inches below exterior grade is typically used in this area.

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.

5) 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.

6) All existing fill, topsoil and any loose or disturbed soils should be removed and the footing bearing level extended down to the relatively dense natural granular soils. The exposed soils in footing area should then be moistened and compacted. If water seepage is encountered, the footing areas should be dewatered before concrete placement.

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 a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 50 pcf for backfill consisting of the on-site granular soils. Cantilevered retaining structures which are separate from the residences 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 on-site granular soils. Backfill should not contain organics, debris or rock larger than about 6 inches.

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 the maximum standard Proctor density at a moisture content near optimum. Backfill placed in pavement and walkway areas should be compacted to at least 95% of the maximum standard Proctor density. 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.

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 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 granular material compacted to at least 95% of the maximum standard Proctor density at a moisture content near optimum.

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 undocumented fill underlying proposed slabs-on-grade should be removed and replaced with structural fill compacted to at least 95% of the standard Proctor density at a moisture content near optimum. Required fill can consist of the on-site granular soils devoid of vegetation, topsoil, deleterious material, and oversized rock.

UNDERDRAIN SYSTEM

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 system.

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 least 1 foot below lowest adjacent finish 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 1½ feet deep.

DETENTION POND

We attempted to run percolation testing in Boring 3 at a depth of 10 feet but was unable to maintain a head of water within the borehole. Based on the soils encountered and our experience, the detention ponds can be designed for an infiltration rate of approximately
1 minute per inch, however, the effects of siltation plugging should be considered. The bedrock is expected to be relatively deep in this area and groundwater level was not encountered to the boring depth of 10 feet.

SITE GRADING

The risk of construction-induced slope instability at the site appears low provided the building earthwork grading cut and fill depths are limited. We assume the cut depths will not exceed about 10 feet. Embankment fills should be compacted to at least 95% of the maximum standard Proctor density near optimum moisture content. Prior to fill placement, the subgrade should be carefully prepared by removing all debris, existing fill, vegetation and topsoil and compacting to at least 95% of the maximum standard Proctor density. The fill should be benched into slopes that exceed 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 residences 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 the maximum standard Proctor density in pavement and slab areas and to at least 90% of the maximum standard Proctor density in landscape areas.
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. Free-draining wall backfill should be covered with filter fabric and capped with about 2 feet of the on-site finer graded soils to reduce surface water infiltration.
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.

PAVEMENT SECTIONS

A pavement section is designed to distribute concentrated traffic loads to the subgrade. Pavement design procedures are based on strength properties of the subgrade and pavement materials assuming stable, uniform subgrade conditions.

Subgrade Materials: The granular soils encountered at the site are mainly low plasticity silty sand and gravel which are considered a good support for pavement materials. The soil classification tests indicate an Hveem 'R' value of around 25 for the onsite soils.

Pavement Section: Since anticipated traffic loading information was not available at the time of report preparation, an 18-kip equivalent daily load application (EDLA) of 10 was assumed for combined automobile and truck traffic on the roadways and 5 was assumed for automobile traffic only parking areas. This roadway loading is typical of a residential street and should be checked by the project civil engineer. A Regional Factor of 2.0 was calculated for this area of Eagle County based on the site terrain, drainage and climatic conditions.

Based on the assumed parameters, the pavement section in areas of combined automobile and truck traffic should consist of 8 inches of high quality base course and 3½ inches of asphalt surface.

As an alternative to asphalt pavement in areas where truck turning movements are concentrated, the pavement section can consist of 6 inches of portland cement concrete on 4 inches of high quality base course.

The section thicknesses assume structural coefficients of 0.14 for aggregate base course, 0.42 for asphalt surface and design strength of 4,500 psi for portland cement concrete. The material properties and compaction should be in accordance with the project specifications.

Subgrade Preparation: Prior to placing the pavement section, the entire subgrade area should be stripped of vegetation and topsoil. Undocumented fill within 2 feet of finished grade should be removed. The exposed surface should be scarified to a depth of 8 inches, adjusted to a moisture content near optimum and compacted to at least 95% of the maximum standard Proctor density. The pavement subgrade should be proof rolled with a heavily loaded pneumatic-tired vehicle. Pavement design procedures assume a stable subgrade. Areas which deform excessively under heavy wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of pavement. Drainage design should provide for the removal of water from paved areas and prevent wetting of the subgrade soils. Uphill roadside ditches should have an invert level at least 1 foot below the road base.

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 borings drilled 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 borings 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. Significant design changes may require additional analysis or modifications to the recommendations presented herein. We recommend on-site observation of excavations and foundation bearing strata and testing of structural fill by a representative of the geotechnical engineer.

Respectfully Submitted,

Kumar & Associates, Inc.

Shane J. Robat, P.E.

Reviewed by:

COLORADO REGISTERED STEVEN L. PAWLAK 15222 PROFESSIONAL ENGINEER 9/19/19

Steven L. Pawlak, P.E.

SJR/kac

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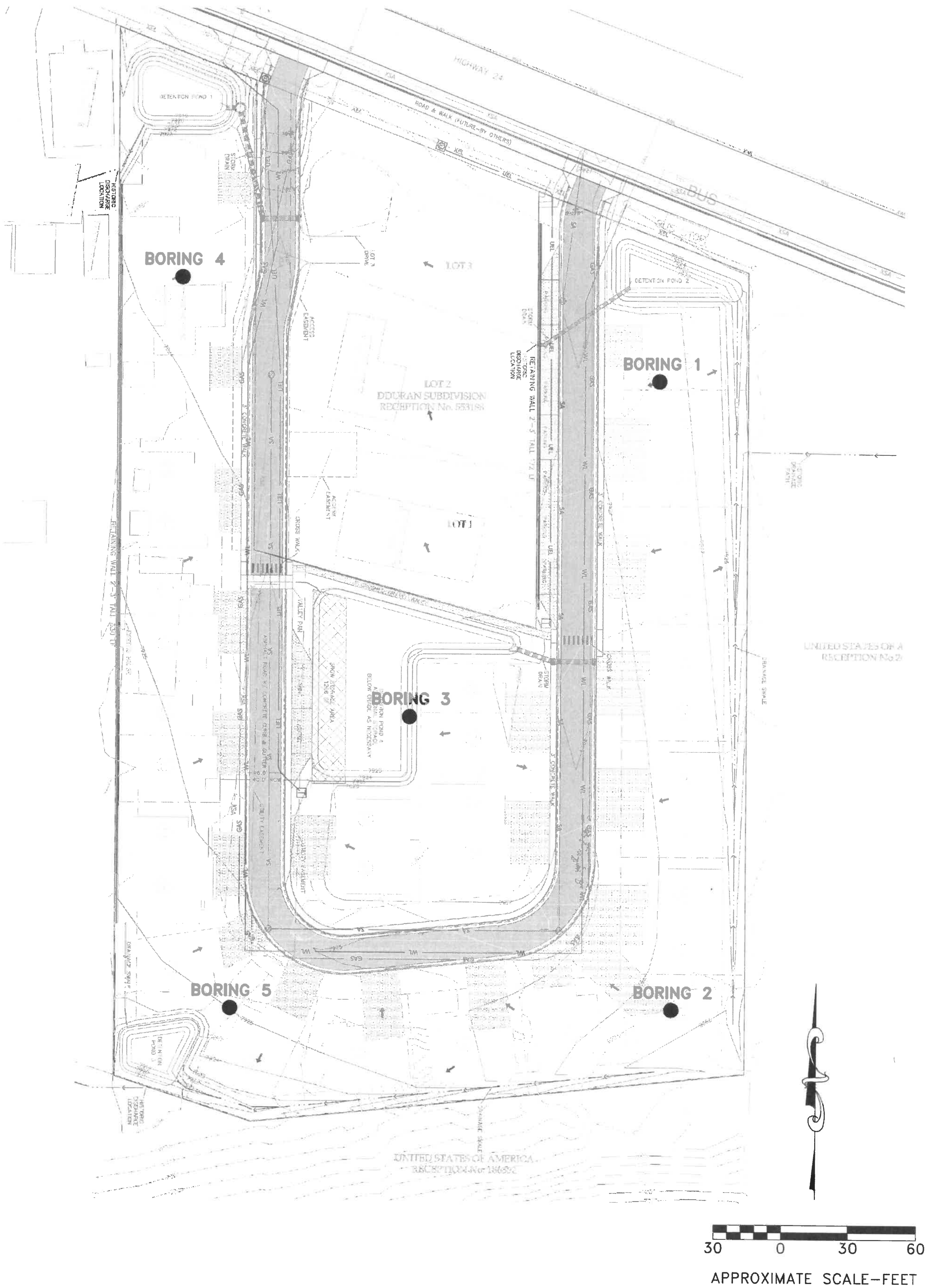

19-7-505	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS	Fig. 1

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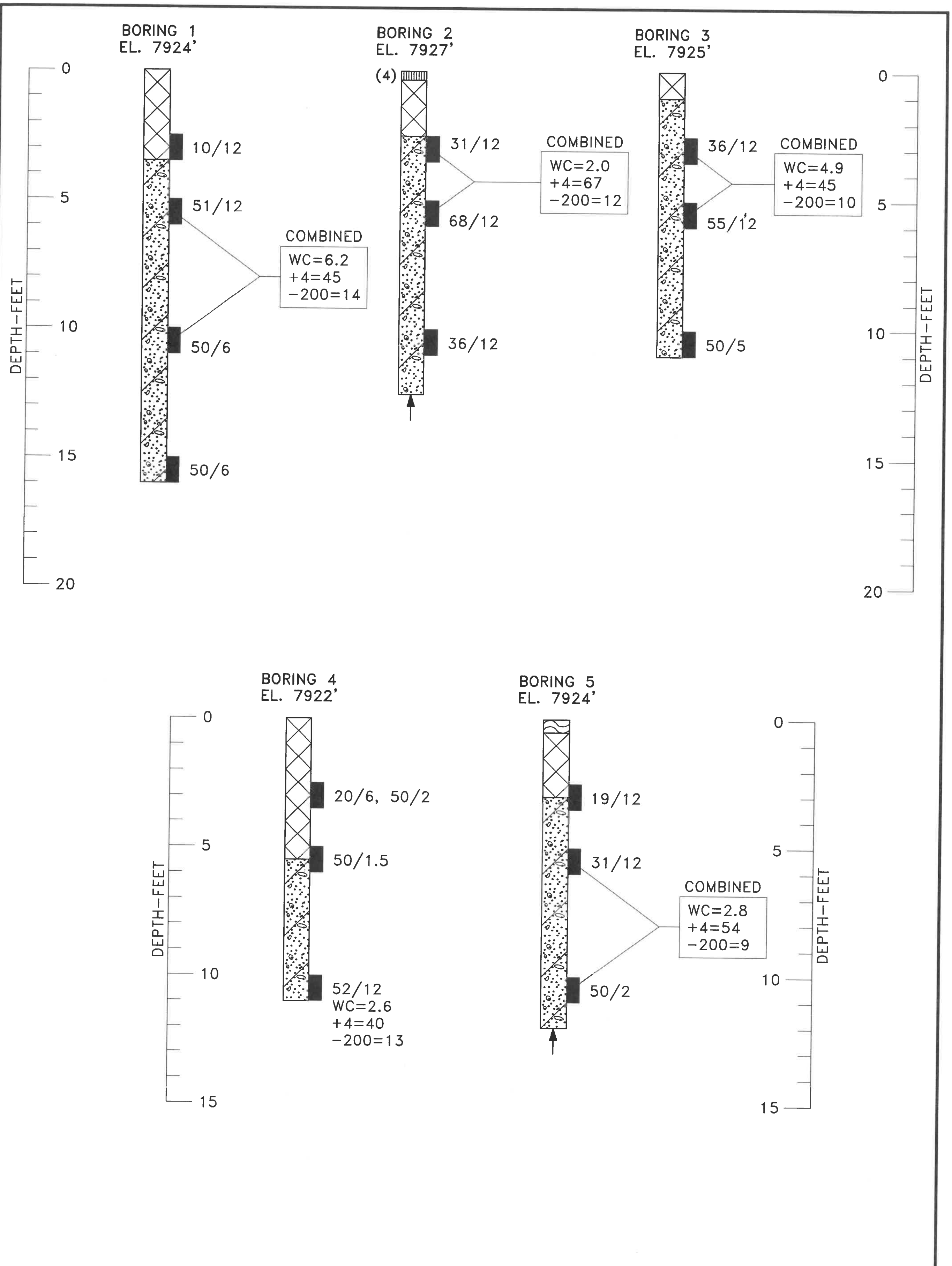


19−7−505	Kumar & Associates	LOGS OF EXPLORATORY BORINGS	Fig. 2

LEGEND

(4) CONCRETE, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

TOPSOIL; SILTY SAND WITH SCATTERED GRAVEL, ORGANICS, FIRM, SLIGHTLY MOIST, BROWN.

FILL; SILTY SAND AND GRAVEL, DEMOLITION DEBRIS, LOOSE TO MEDIUM DENSE, MOIST, DARK BROWN.

SAND AND GRAVEL (SM-GM); SLIGHTLY SILTY TO SILTY, COBBLES, POSSIBLE BOULDERS, MEDIUM DENSE TO DENSE, MOIST, BROWN. SUBANGULAR TO ROUNDED ROCK.

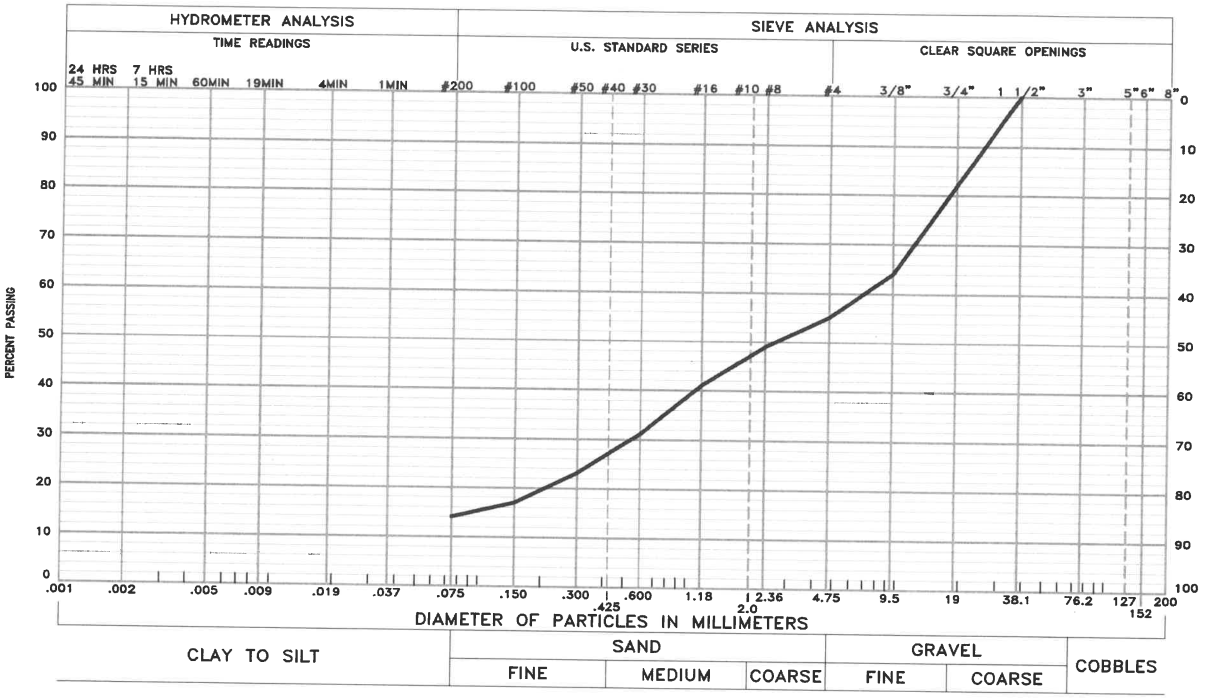
DRIVE SAMPLE, 1 3/8-INCH I.D. SPLIT SPOON STANDARD PENETRATION TEST.

10/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 10 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

PRACTICAL AUGER REFUSAL.

NOTES

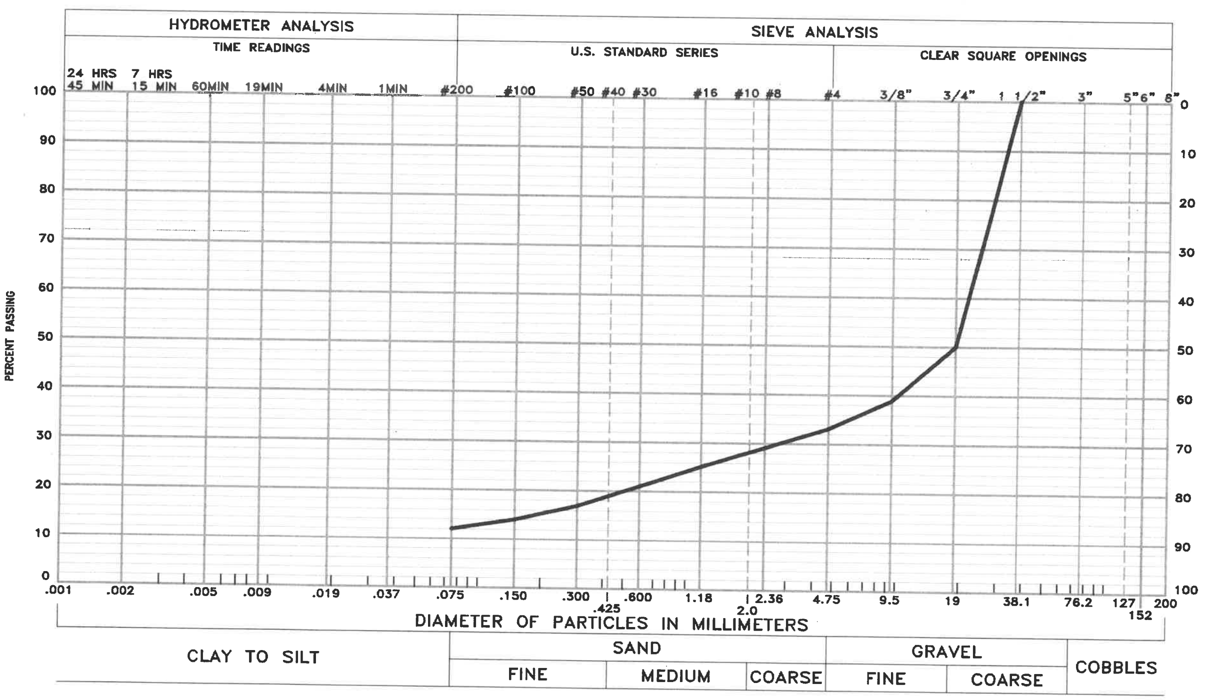
1. THE EXPLORATORY BORINGS WERE DRILLED ON SEPTEMBER 10, 2019 WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED BY INTERPOLATION BETWEEN CONTOURS ON THE SITE PLAN PROVIDED.
4. THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORINGS AT THE TIME OF DRILLING.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140).



GRAVEL 45 % SAND 41 % SILT AND CLAY 14 %

LIQUID LIMIT PLASTICITY INDEX

SAMPLE OF: Silty, Very Sandy Gravel FROM: Boring 1 @ 5' & 10' (Combined)



GRAVEL 67 % SAND 21 % SILT AND CLAY 12 %

LIQUID LIMIT PLASTICITY INDEX

SAMPLE OF: Slightly Silty, Sandy Gravel FROM: Boring 2 @ 2.5' & 5' (Combined)

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.

19-7-505	Kumar & Associates	GRADATION TEST RESULTS	Fig. 4

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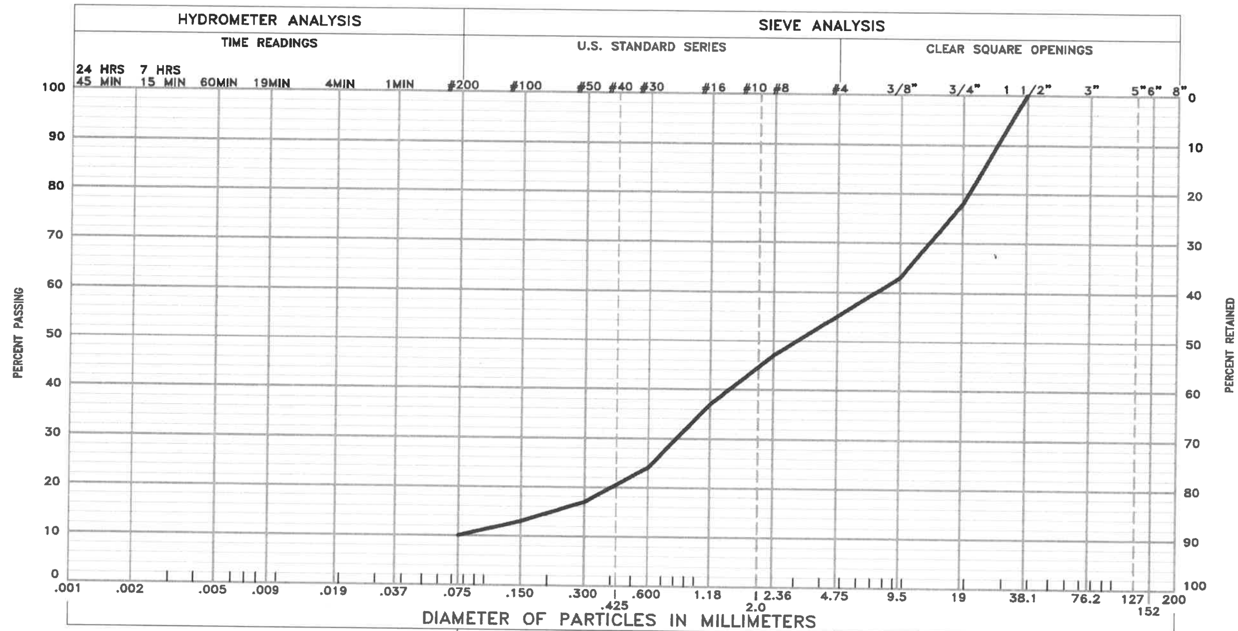
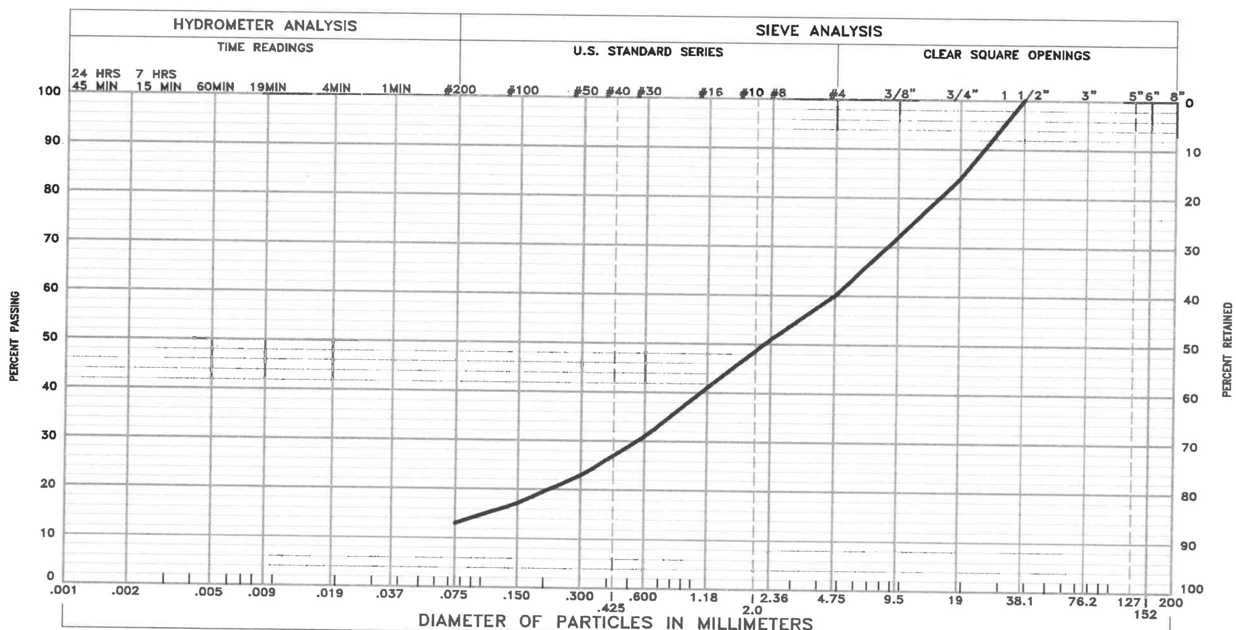


CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

GRAVEL 45 % SAND 45 % SILT AND CLAY 10 %

LIQUID LIMIT PLASTICITY INDEX

SAMPLE OF: Slightly Silty Sand and Gravel FROM: Boring 3 @ 2.5' & 5' (Combined)



CLAY TO SILT	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	

GRAVEL 40 % SAND 47 % SILT AND CLAY 13 %

LIQUID LIMIT PLASTICITY INDEX

SAMPLE OF: Silty Sand with Gravel FROM: Boring 4 @ 10'

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.

19-7-505	Kumar & Associates	GRADATION TEST RESULTS	Fig. 5

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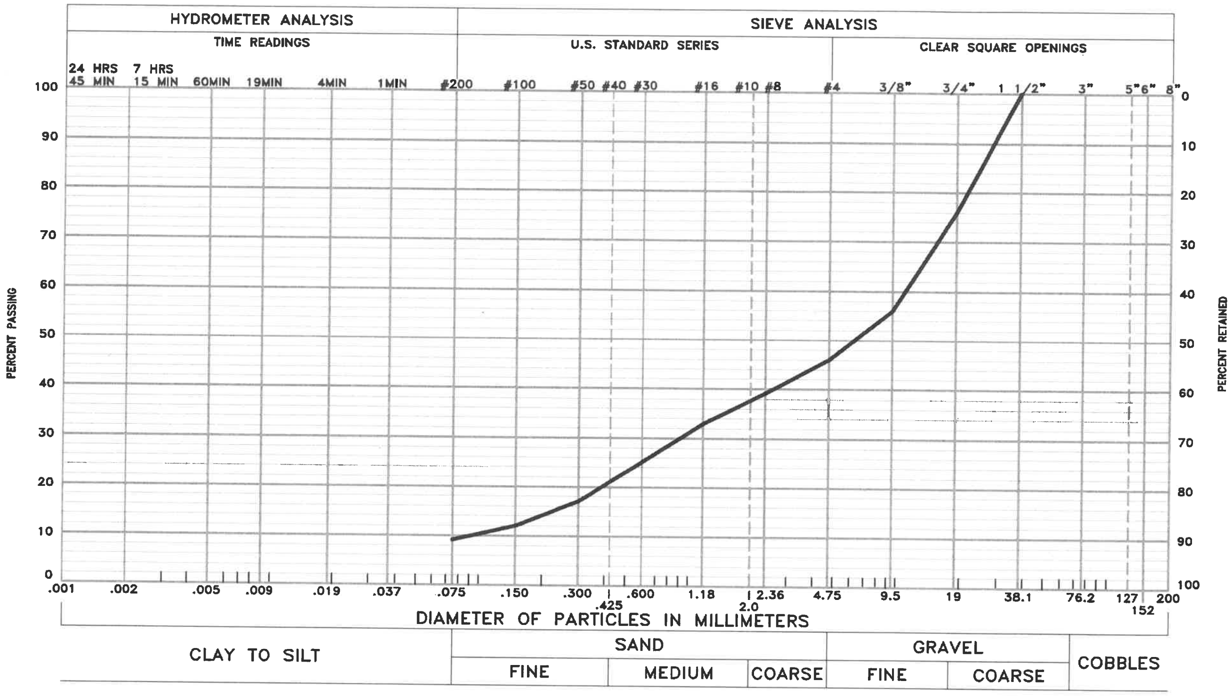

GRAVEL 54 % SAND 37 % SILT AND CLAY 9 %

LIQUID LIMIT PLASTICITY INDEX

SAMPLE OF: Slightly Silty, Sandy Gravel FROM: Boring 5 @ 5' & 10' (Combined)

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.

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19-7-505	Kumar & Associates	GRADATION TEST RESULTS	Fig. 6

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TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Project No. 19-7-505

SAMPLE LOCATION		NATURAL MOISTURE CONTENT	NATURAL DRY DENSITY	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH		SOIL TYPE
BORING	DEPTH (ft)	(%)	(pcf)	GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTIC INDEX (%)	(psf)		
1	5 & 10 Combined	6.2		45	41	14					Silty, Very Sandy Gravel
2	2½ & 5 Combined	2.0		67	21	12					Slightly Silty, Sandy Gravel
3	2½ & 5 Combined	4.9		45	45	10					Slightly Silty Sand and Gravel
4	10	2.6		40	47	13					Silty Sand with Gravel
5	5 & 10 Combined	2.8		54	37	9					Slightly Silty, Sandy Gravel