Kumar & Associates, Inc.®
Geotechnical and Materials Engineers
and Environmental Scientists

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SUBSOIL STUDY
FOR FOUNDATION DESIGN
PROPOSED BUILDING 10A AND 10B
LOT 6, BASE VILLAGE
WOOD ROAD
SNOWMASS VILLAGE, COLORADO

PROJECT NO. 22-7-416

AUGUST 18, 2022

PREPARED FOR:

SV BUILDING 10A DEVELOPMENT, LLC
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PURPOSE AND SCOPE OF STUDY

This report presents the results of a subsoil study for proposed Building 10A and 10B to be located on Lot 6, Base Village, Wood Road, Snowmass Village, 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 SV Building 10A Development, LLC dated June 6, 2022.

A field exploration program consisting of exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the subsoils and bedrock 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 foundation. 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

Development plans for the lot were in progress at the time of our study. In general, the proposed development will consist of a multi-level, mixed-use residential structure above underground parking and located as shown on Figure 1. Ground floors could be structural over crawlspace or slab-on-grade. Grading for the structure will be relatively extensive with assumed cut depths up to around 20 feet along the uphill, south side and around 5 to 10 feet on the downhill, north side. We assume moderate to relatively heavy foundation loadings for 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 project site was being utilized for construction staging and material storage at the time of our field exploration. The ground surface slope is somewhat irregular and generally down to the north and west at around 2 to 5% in the proposed building area then moderate down along the uphill, south side below Wood Road. The ground surface appears to have had cut and fill grading to create the relatively level central part of the lot. Vegetation along the perimeter of the lot generally consists of grass and weeds.

FIELD EXPLORATION

The field exploration for the project was conducted on July 11, 12 and 13, 2022. Eight 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.

Samples of the subsoils were taken with 1⅜ inch and 2-inch I.D. spoon samplers. The samplers were 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 and hardness of the bedrock. 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 encountered, below about 1 to 13 feet of various type fill soils, typically consist of very stiff, sandy clay with gravel or dense, silty clayey sandy gravel and cobbles with boulders. Claystone bedrock was encountered at depths between about 1½ and 18½ feet in the borings. Occasional very clayey layers were encountered in the gravel and cobble soils. The fill soils varied in type and density and contained some organics and debris. 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 at Boring 8. All the other borings were terminated in claystone bedrock.

Laboratory testing performed on samples obtained from the borings included natural moisture content and density, gradation analyses and plasticity index. Results of swell-consolidation testing performed on the clay soil and weathered claystone, presented on Figure 4, indicate relatively low compressibility and minor expansion potential when wetted under light load. Results of gradation analyses performed on small diameter drive samples (minus 1½-inch fraction) of the fill and natural coarse granular soils are shown on Figures 5 and 6. The laboratory test results are summarized in Table 1.

Free water was encountered in Borings 6 and 7 at the time of drilling at about 12½ and 10 feet below existing ground surface. The subsoils were generally moist and the bedrock was slightly moist.

FOUNDATION BEARING CONDITIONS

The dense, natural granular soils and bedrock encountered at the site are adequate for support of moderately loaded spread footings with low settlement potential. The existing fill soil types, depths and compaction are undocumented and based on our findings are unsuitable for building support due to high risk of excessive building movements. It appears most of the existing fill that is free of organics, debris and oversize rock can be processed and used as structural fill but should be further evaluated at the time of construction.

Relatively extensive excavations are assumed for below grade areas of the buildings. Groundwater was encountered in apparent deeper bedrock areas of Building 10A, Borings 6 and 7. Excavations in shallower cut areas and, possibly, Building 10A with shallow bedrock may be dry. Additional excavation depth could be needed to remove the existing fill or clay soils in the shallower cut, north part of the site. Replacement of the sub-excavated materials with compacted structural fill up to a maximum depth of about 5 feet below foundation bearing level can be used for building support. An IBC seismic Site Class C can be used in the building design for the dense soil and firm bedrock conditions encountered at the site.

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 dense, natural granular soils, claystone bedrock or up to 5 feet of 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, bedrock or compacted structural fill should be designed for an allowable bearing pressure of 4,000 psf. A one-third increase in the allowable soil bearing pressure can be taken for eccentrically loaded footings with the resultant force in the middle third of the footing section. Mat/structural slab foundations proposed below stair towers can be designed for a subgrade modulus of 150 tsf. Based on experience, we expect settlement of footings and mat/slab designed and constructed as discussed in this section will be around ½ to 1½ inches.
2) The footings should have a minimum width of 18 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 12 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) Existing fill, topsoil, clay soil layers and loose disturbed soils should be removed and the footing bearing level extended down to the relatively dense natural granular soils or bedrock. The exposed soils in footing areas should then be moisture adjusted to near optimum and compacted. Water seepage should be collected from outside of footing areas and pumped as needed to keep bearing soils dry before concrete placement. Structural fill should consist of granular soils compacted to at least 100% of standard Proctor density at near optimum moisture content and extend beyond the footing edges a distance at least equal to one-half the depth of fill below the footing. The depth of structural fill below footings should not exceed about 5 feet.

6) 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 up to about 15 feet 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 predominantly granular soils. Walls that are taller than 15 feet should be designed for a lateral earth pressure of 25H in psf where H is the retained wall height in feet. Cantilevered retaining structures which are separate from the structures 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 predominantly 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. Backfilling walls with an imported, relatively well graded granular soil such as road base and compaction to at least 98% of standard Proctor density can be used to reduce the settlement risk.

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 granular soils, exclusive of topsoil or bedrock, are suitable to support lightly loaded slab-on-grade construction. Existing fill and clayey soils could possess variable settlement/heave potential and should be further evaluated as slab support at the time of 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 and should be connected to the perimeter foundation drain such as with interior subdrains. 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 maximum standard Proctor density at a moisture content near optimum. Required fill can consist of the on-site granular soils devoid of vegetation, topsoil and oversized rock.

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 E1643.

UNDERDRAIN SYSTEM

Groundwater was encountered during our exploration and it has been our experience in the Snowmass Base Village area that the water level can rise and 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 rigid PVC slotted drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining granular material. Wall drainage mat and interior subdrains should also be provided to collect and dispose of the groundwater seepage. The drain lines should be placed at each level of excavation and at least 1 foot below lowest adjacent finish grade and sloped at a minimum ½% 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 and extend up to at least the line of seepage in the cut face.

SITE GRADING

There is a risk of construction-induced slope instability at the site due to the relatively extensive proposed excavation depths and potential for shallow groundwater. Construction-induced slope instability in shallow cut areas appears low provided cut and fill depths are limited and the cut slopes are laid back to a stable grade. We assume shallow cut and fill depths will not exceed about 8 to 12 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 existing fill, vegetation and topsoil and compacting to at least 95% of the maximum standard Proctor density.

Permanent unretained cut and fill slopes should be graded at 2½ 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 construction 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 6 inches in the first 10 feet in unpaved areas and a minimum slope of 2½ inches in the first 10 feet in paved areas. Free-draining wall backfill should be covered with filter fabric and capped with at least 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.

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.

COLORADO REGISTERED
STEVEN L. PAWLAK
15222
8/23/22
PROFESSIONAL ENGINEER

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Cc: East-West Partners – Travis Lindahl (tlindahl@ewpartners.com)

22–7–416	Kumar & Associates	BUILDING 10A AND 10B	LOCATION OF EXPLORATORY BORINGS	Fig. 1

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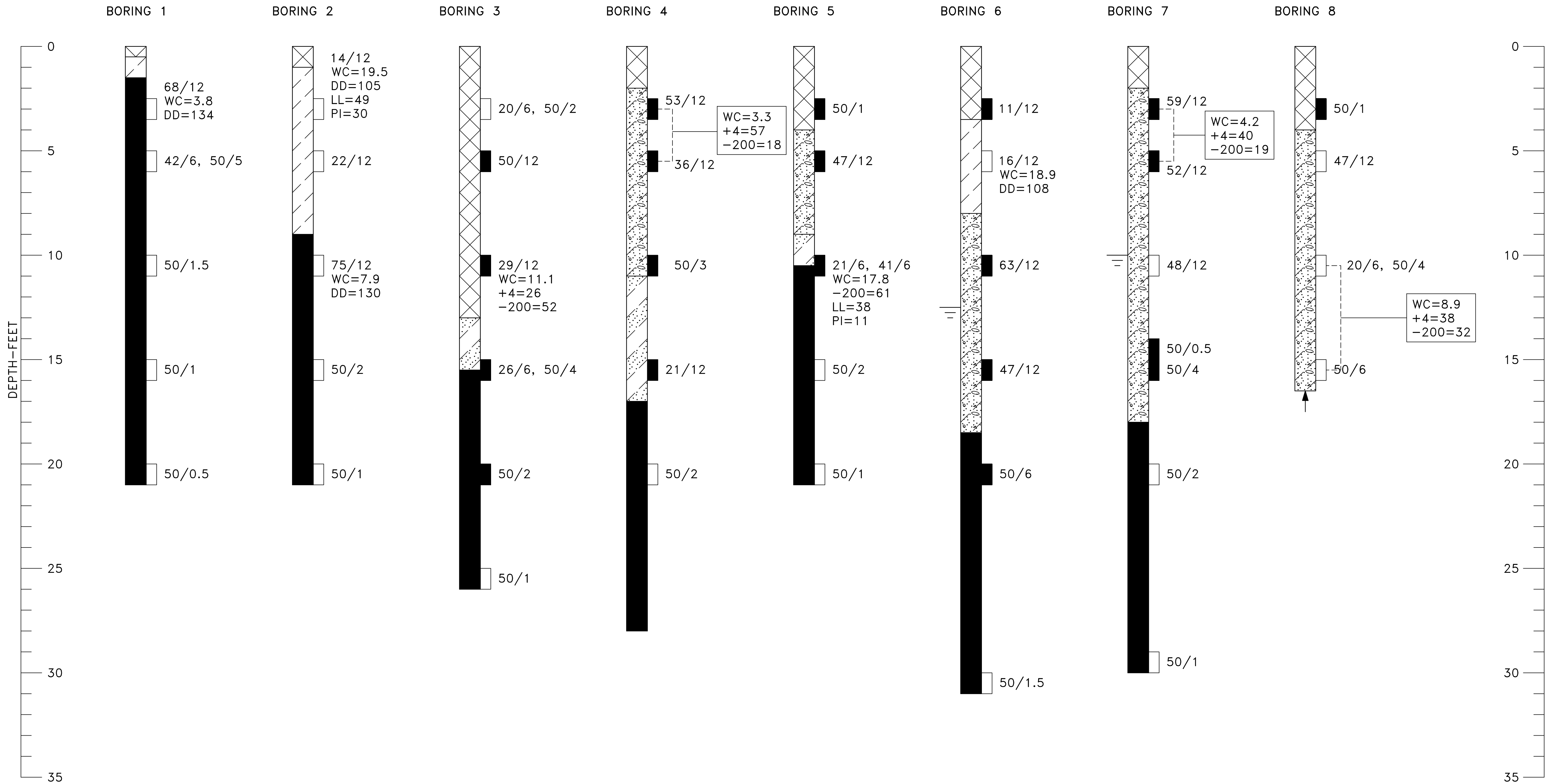

22-7-416	Kumar & Associates	BUILDING 10A AND 10B	LOGS OF EXPLORATORY BORINGS	Fig. 2

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LEGEND

FILL: MIXED SILTY, CLAYEY SAND AND GRAVEL WITH COBBLES, SOME ORGANICS AND DEBRIS, LOOSE TO MEDIUM DENSE, MOIST, MIXED GRAY.

CLAY (CL); SANDY, SCATTERED GRAVEL, VERY STIFF, MOIST, BROWN, MEDIUM PLASTICITY.

CLAY AND SHALE FRAGMENTS (CL-SC); SILTY, VERY STIFF/MEDIUM DENSE, MOIST, DARK GRAY.

GRAVEL AND COBBLES (GC); CLAYEY, SANDY, PROBABLE BOULDERS, DENSE, MOIST, DARK GRAY.

CLAYSTONE BEDROCK; VERY HARD, SLIGHTLY MOIST, DARK GRAY, MANCOS SHALE.

DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

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

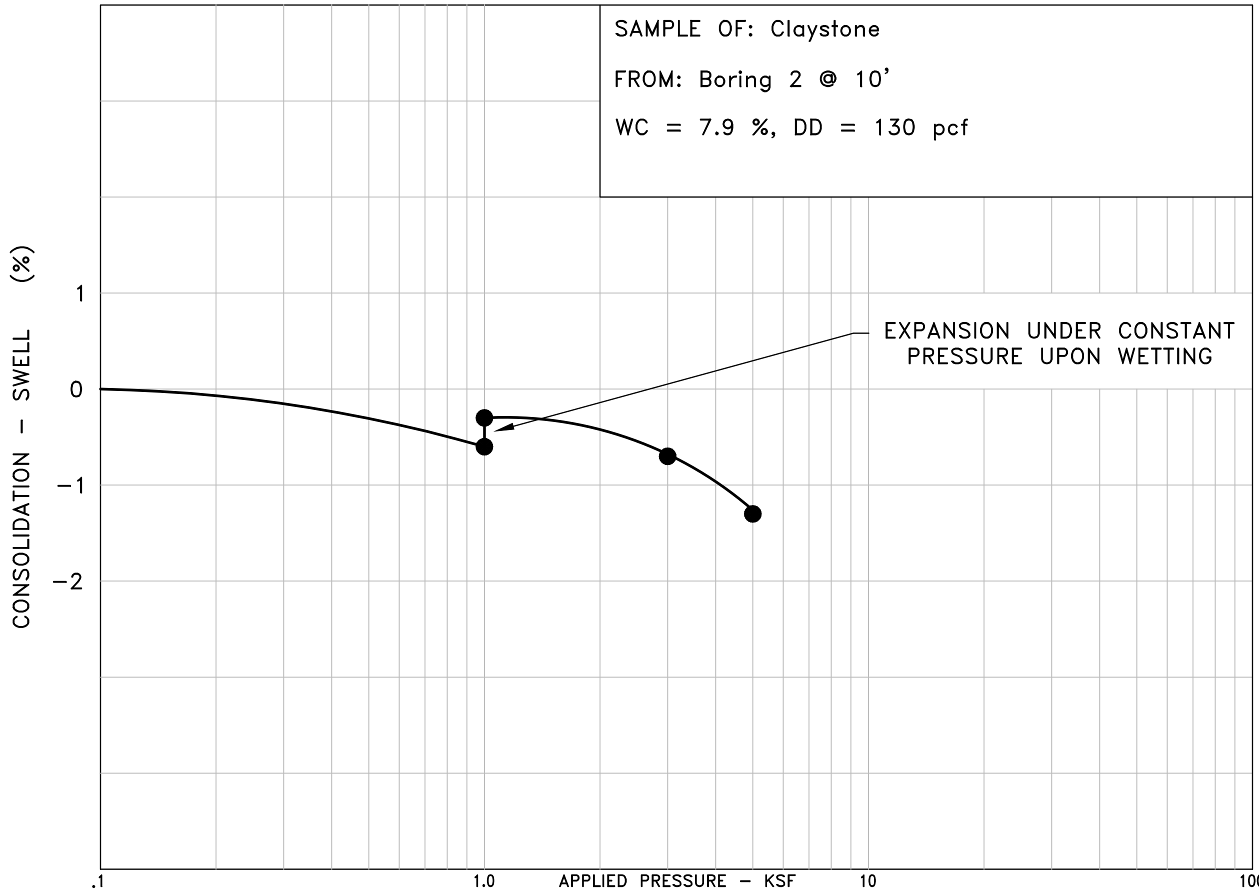
68/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 68 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

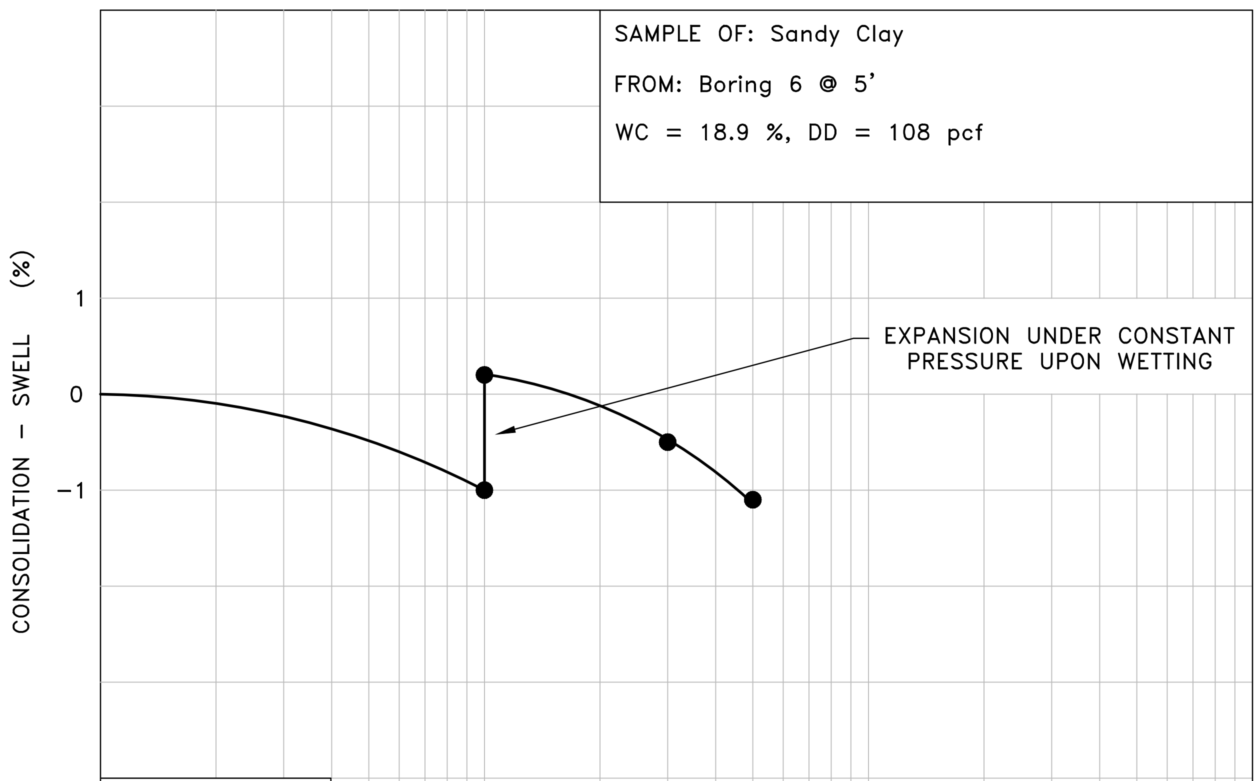
DEPTH TO WATER LEVEL ENCOUNTERED AT THE TIME OF DRILLING.

PRACTICAL AUGER REFUSAL

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON JULY 11, 12 AND 13, 2022 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 NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATIONS 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 LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318).





These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

22-7-416	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULTS	Fig. 4

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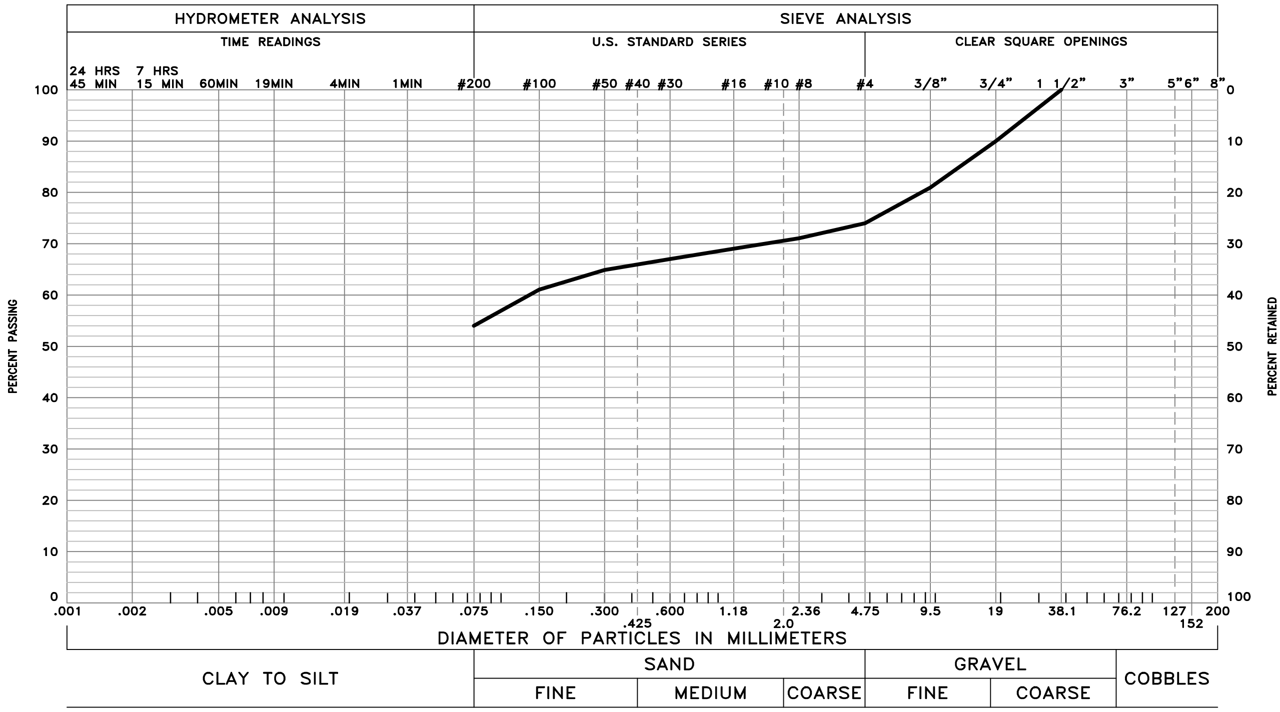
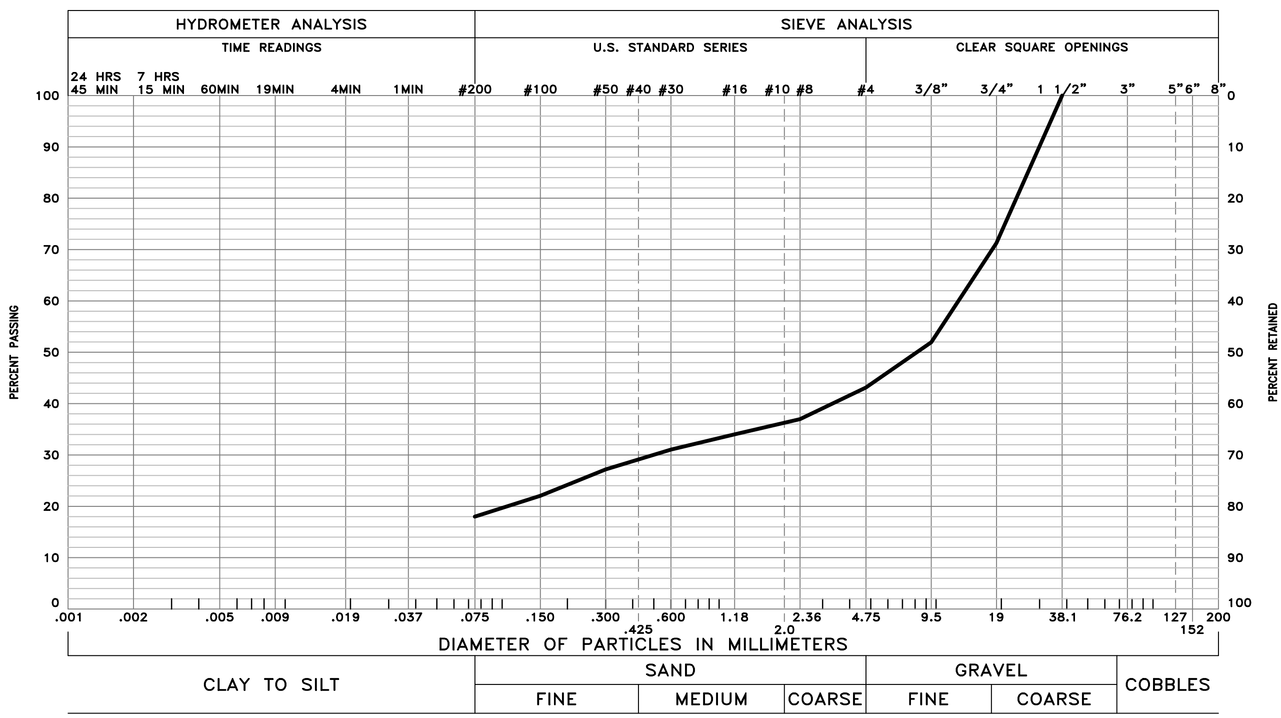


GRAVEL 26 % SAND 22 % SILT AND CLAY 52 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Sandy Clay with Shale Gravel (Fill) FROM: Boring 3 @ 10'



GRAVEL 57 % SAND 25 % SILT AND CLAY 18 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Sandy Gravel FROM: Boring 4 @ 2.5' and 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.

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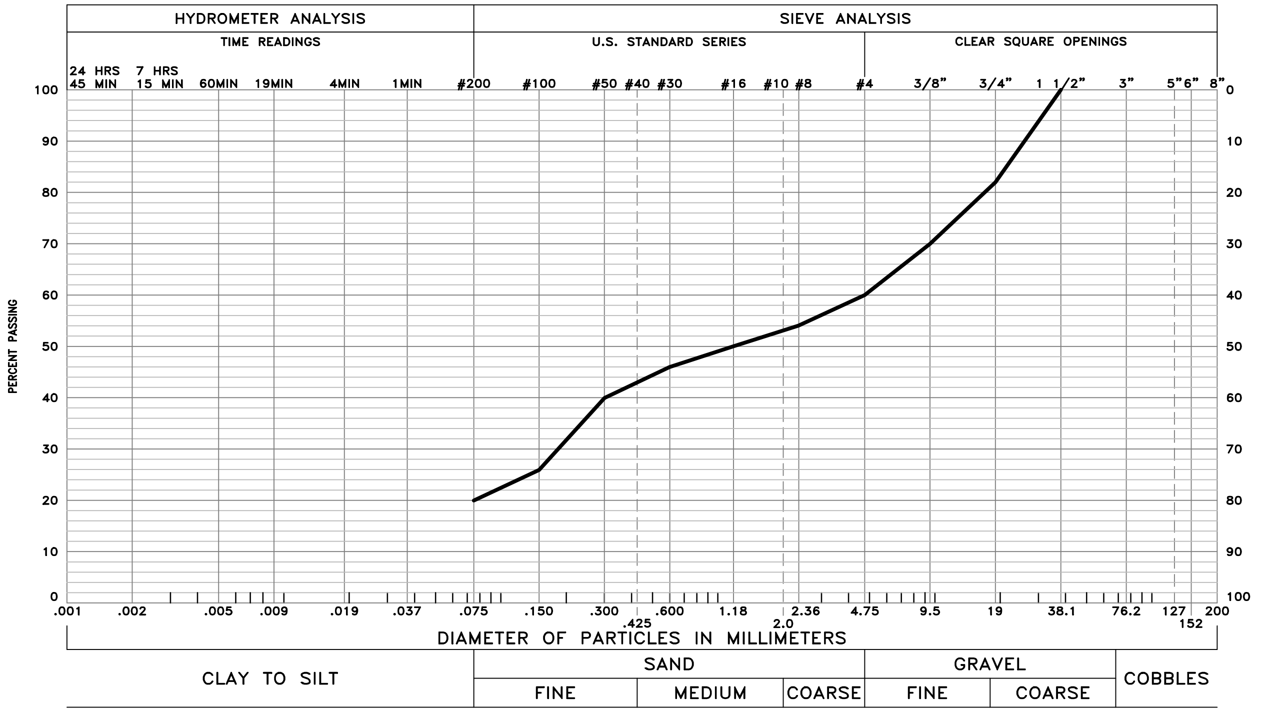
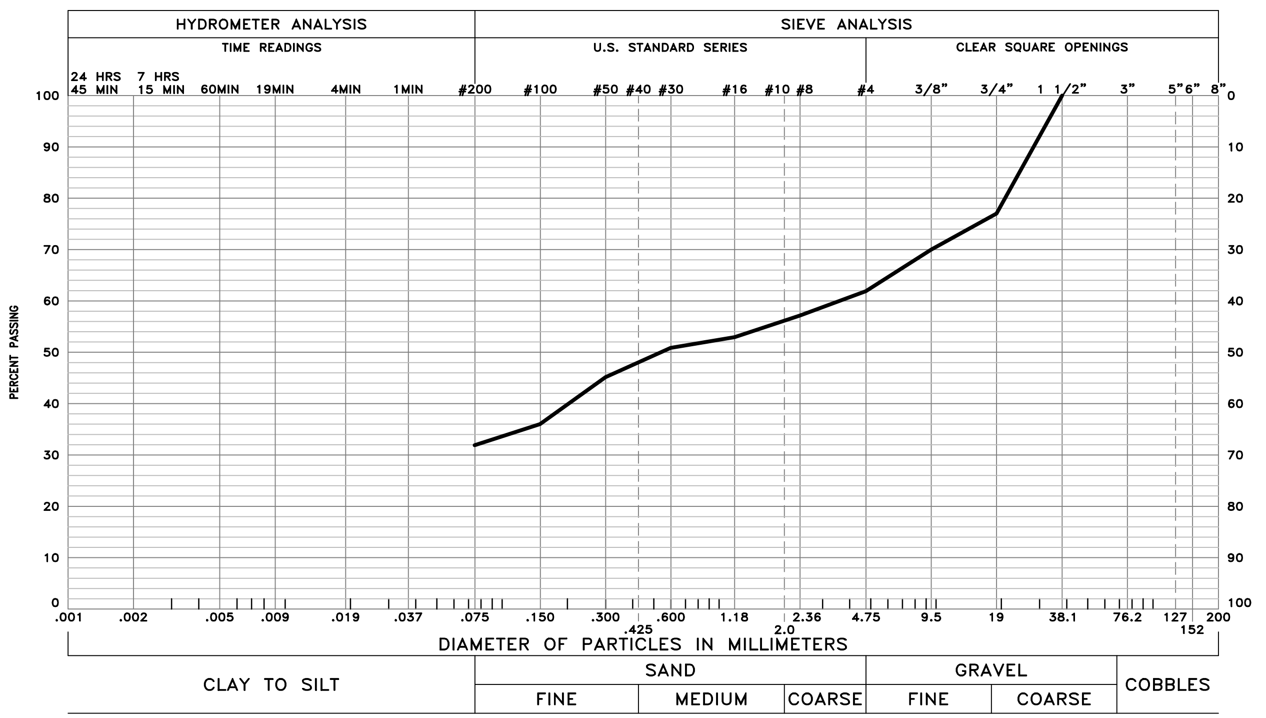
22-7-416	Kumar & Associates	GRADATION TEST RESULTS	Fig. 5



GRAVEL 40 % SAND 41 % SILT AND CLAY 19 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Sand and Gravel FROM: Boring 7 @ 2.5' and 5' Combined



GRAVEL 38 % SAND 30 % SILT AND CLAY 32 %

LIQUID LIMIT – PLASTICITY INDEX –

SAMPLE OF: Clayey Sandy Gravel FROM: Boring 8 @ 10' and 15' 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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22-7-416	Kumar & Associates	GRADATION TEST RESULTS	Fig. 6

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TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

Project No. 22-7-416

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	2½	3.8	134								Claystone
2	2½	19.5	105				49	30			Sandy Clay
	10	7.9	130								Claystone
3	10	11.1		26	22	52					Sandy Clay with Gravel (Fill)
4	2½ & 5 combined	3.3		57	25	18					Clayey Sandy Gravel
5	10	17.8				61	38	11			Sandy Clay with Shale Fragments
6	5	18.9	108								Sandy Clay
7	2½ & 5 combined	4.2		40	41	19					Clayey Sand and Gravel
8	10 & 15 combined	8.9		38	30	32					Clayey Sandy Gravel