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# GEOTECHNICAL ENGINEERING STUDY
# HISTORIC CHAPEL BUILDING ADDITION
# 155 JEFFERSON STREET
# MONUMENT, COLORADO

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6/29/18

*Reviewed By:*

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Prepared for:

St. Peter Catholic Church
55 Jefferson Street
Monument, Colorado 80132

Attn: Mr. Rob Hickman

Project No. 18-2-172

June 29, 2018

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## SUMMARY


1. The subsurface conditions encountered in our borings generally consisted of nil to approximately 2 feet of silty sand fill, underlain by native well-graded sand with silt to approximate depths of 11 to 14 feet, followed by sandstone bedrock, which extended to the maximum 20 to 25-foot depths explored.

2. When water level measurements were made 7 days after drilling, groundwater was encountered at approximate depths of 11.9 feet in Boring 1 and 10.8 feet in Boring 2. Fluctuations in the water level may occur with time.

3. We recommend the proposed building addition be founded on spread footings bearing on the undisturbed native soils and/or properly compacted structural fill. Footings should be designed for an allowable bearing pressure of 2,000 psf, and with the other design and construction considerations presented in this report.


## PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study for the proposed Historic Chapel building addition, located at 155 Jefferson Street in Monument, Colorado. The project site is shown on Fig. 1. This study was conducted in accordance with the scope of work in our Proposal No. C18-209, dated June 1, 2018, to develop recommendations for foundations and floor slabs.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to the proposed construction are included in the report.

## PROPOSED CONSTRUCTION

We understand the proposed construction will consist of a two-story building addition that will have plan dimensions of approximately 80x55 feet. The new addition will take the place of an existing single-story addition located on the west side of the chapel building, which will be demolished. The building will either have a slab-on-grade floor, or a structurally supported floor above a crawlspace. Foundation loads are anticipated to be light to moderate, typical of the proposed construction type. Site grading is anticipated to be negligible, with construction occurring at the approximate existing grades. If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

SITE CONDITIONS

At the time of our study, a majority of the proposed addition footprint was occupied by the existing single-story addition. The building was surrounded by irrigated turf and/or landscape gravel, and the perimeter of the property was surrounded by picket fencing. The property was bordered by a parking lot to the south, an alley to the west, Jefferson Street to the east, and commercial development to the north. The ground surface within the property appeared relatively flat, with a gentle slope away from the building along each side.

FIELD EXPLORATION

The field exploration of subsurface conditions consisted of drilling two borings at the approximate location shown on Fig. 1. The borings were drilled on June 14, 2018. The boring logs and the corresponding legend and notes are included on Figs. 2 and 3, respectively.

The borings were drilled with 4-inch diameter continuous flight augers and were logged by a representative of Kumar & Associates, Inc. Samples of the overburden soils were taken with a 2-inch I.D. California sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. Penetration resistance values, when properly evaluated, provide an indication of the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the boring logs.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included index property tests such as in-situ moisture content and dry unit weight, grain size analysis, and Atterberg limits. Additional testing performed included swell-consolidation and concentration of water soluble sulfates. The testing was conducted in general accordance with recognized test procedures, primarily those of the American Society for Testing of Materials (ASTM). Results of the laboratory testing program are shown on Figs. 2, 4 and 5, and are summarized on Table I.

SUBSURFACE CONDITIONS

At the surface, a thin layer of topsoil was encountered in Boring 1, and a layer of landscape gravel was encountered in Boring 2. Below the gravel in Boring 2, man-placed fill consisting of silty sand (SM) was encountered to an approximate depth of 2 feet. The lateral or vertical extent of the fill beyond the boring locations is unknown.

Native well-graded sand with silt (SW-SM) was encountered in each of the borings, extending to approximate depths of 14 feet and 11 feet in Borings 1 and 2, respectively. The overburden soils were underlain by sandstone bedrock, which extended to the maximum 20 to 25-foot depths explored. The sand and sandstone were occasionally clayey, and the sandstone was noncemented. Sampler penetration blow counts indicate the overburden soils are loose to medium dense and the sandstone is hard to very hard. Swell-consolidation test results presented on Fig. 4 indicate the tested sample of clayey sandstone was nonexpansive after wetting the sample under a constant 1-ksf surcharge.

When water level measurements were made 7 days after drilling, groundwater was encountered at an approximate depth of 11.9 feet in Boring 1 and 10.8 feet in Boring 2. At the time of drilling, groundwater was encountered in Boring 1 at an approximate depth of 21 feet. Fluctuations in the water level may occur with time.

## FOUNDATION RECOMMENDATIONS

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

The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. Footings placed on the undisturbed native soils and/or properly compacted structural fill should be designed for an allowable bearing pressure of 2,000 psf.

2. Any existing fill encountered below the proposed foundation elevation should be removed and replaced with properly compacted nonexpansive structural fill. Additionally, areas of loose or soft material at the base of the excavation removed and replaced with a nonexpansive structural fill. New fill should extend down from the edges of the footings at a minimum 1 horizontal to 1 vertical projection.

3. The on-site soils, minus any deleterious materials, are suitable for reuse as structural fill. Import soils, if required, should consist of a minus 2-inch granular soil that contains a maximum 40 percent passing the No. 200 sieve, and a maximum plasticity index of 15.

4. Fill placed for support of foundations should be compacted to a minimum 98% of the standard Proctor maximum dry density (ASTM D 698), near the optimum moisture content.

5. We estimate total settlement for footings designed and constructed as discussed in this section will be approximately 1 inch or less. Differential settlements across the building addition are estimated to be less than ½ the total settlement. The settlement will be differential with respect to the existing building; plan details should provide for this potential differential movement.

6. Foundations should have a minimum width of 16 inches for continuous footings and 24 inches for isolated pads.

7. Exterior footings should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 30 inches below the exterior grade is typically used in this area.

8. The lateral resistance of a spread footing placed on undisturbed native soils and/or properly compacted structural fill material 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 may be calculated based on an allowable coefficient of friction of 0.35. Passive pressure against the sides of the footings may be calculated using an allowable equivalent fluid unit weight of 180 pcf.

9. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 10 feet.

10. Granular foundation soils should be densified with a smooth vibratory compactor prior to placement of concrete.

11. A representative of the geotechnical engineer should observe all footing excavations prior to fill or concrete placement.

FOUNDATION WALLS

Foundation walls which are laterally supported and can be expected to undergo only a moderate amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 55 pcf assuming the onsite granular soils are used for backfill, or 50 pcf for an imported Class I structural backfill. Cantilevered retaining structures which 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 45 pcf assuming the onsite granular soils are used for backfill, or 40 pcf for backfill consisting of imported Class I structural backfill.

Retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent buildings, 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 the wall.

The on-site soils, if used for backfill behind foundation walls, should consist of the silty sand to well-graded sand with silt type materials. Import granular soils should meet the requirements of a CDOT Class I structural backfill and contain less than 20% passing the No. 200 sieve. Proposed material should be approved by the geotechnical engineer prior to use.

The backfill behind walls should be sloped from the base of the wall at an angle of at least 45 degrees from the vertical. Wall backfill should be placed in uniform lifts and compacted to at least 95% of the standard Proctor maximum dry density (ASTM D698) at a moisture content near optimum. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls.

## SEISMIC DESIGN CRITERIA

The generalized subsurface profile was assumed to consist of generally granular overburden soils, underlain by sedimentary bedrock. The weighted average of the estimated shear wave velocities for this subsurface profile to a depth of 100 feet indicates an IBC design Site Class C. Based on the subsurface profile and site seismicity, liquefaction is not a design consideration.

## SLAB-ON-GRADE FLOOR SLABS

The native on-site soils, exclusive of topsoil, are suitable to support lightly to moderately loaded slab-on-grade construction. Any existing fill encountered below the proposed floor slab elevation should be removed and placed back, properly compacted. Structural fill placed for support of floor slabs should be a nonexpansive soil compacted to at least 95% of the standard Proctor maximum dry density (ASTM D 698), at moisture content near optimum. The specifications for structural fill and a discussion regarding the suitability for reuse of the on-site soils is presented under the "Foundation Recommendations" section of this report.

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 appropriate joint spacing is dependent on slab thickness, concrete aggregate size and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) or American Concrete Institute (ACI). The joint spacing and any requirements for slab reinforcement should be established by the designer based on experience and the intended slab use.

If moisture-sensitive floor coverings will be used, mitigation of moisture penetration into the slabs, such as by use of a vapor barrier, may be required. If an impervious vapor barrier membrane is used, special precautions will be required to reduce potential differential curing problems which could cause the slabs to warp. Section 302.1R of the ACI Manual of Concrete Practice addresses this topic.

## CRAWLSPACE CONSIDERATIONS

If a structural floor and crawlspace will be utilized, the design of the crawl space should consider drainage and moisture control. We recommend that crawl spaces be designed with positive surface drainage and an underdrain system so that free water introduced into these spaces can be removed. Additional discussion is provided in the "Underdrain System" section of the report. High humidity can develop in crawl spaces due to the transmission of water vapor through moist soils. Crawl space humidity should be controlled through ventilation and the use of a vapor barrier on the crawl space floor.

## UNDERDRAIN SYSTEM

We recommend the crawl space of the building be protected by a perimeter underdrain system. Although relatively shallow groundwater was not encountered, our experience indicates localized perched water conditions can develop after development, particularly in wetter seasons, and after precipitation events.

The underdrain system should consist of a perimeter drain (interior or exterior) that extends a minimum of 2 feet below the ground surface of the crawl space, with a minimum 4-inch diameter, perforated rigid pipe placed in the bottom of a trench and surrounded above the invert level with free-draining gravel. This free-draining gravel should be surrounded with filter fabric. If the drain is installed on the building interior, the gravel should extend up to the ground surface of the crawl space. If installed on the exterior, the gravel should extend to a minimum 1 foot above the drain pipe. Free-draining gravel used in the drain system should contain less than 5% passing the No. 200 sieve, less than 30% passing the No. 4 sieve and have a maximum size of 2 inches. The drain lines should be graded to a gravity outlet or sump at a minimum 1% slope.

If a slab-on-grade floor is used rather than a structural floor above a crawlspace, it is our opinion an underdrain system will not be necessary, provided the floor slab is higher than the adjacent exterior grades.

## WATER SOLUBLE SULFATES

The concentration of water soluble sulfates measured in samples obtained from the exploratory boring were less than approximately 0.02%. These concentrations of water soluble sulfates represent a Class 0 severity of exposure to sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class 0 to Class 3 severity of exposure as presented in ACI 201. Based on this information and our experience with the soil types encountered, we believe special sulfate resistant cement will not be required for concrete exposed to the on-site soils.

## SURFACE DRAINAGE

Providing proper surface drainage, both during construction and after the construction has been completed, is very important for acceptable performance of the building. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the foundation excavation and underslab areas should be avoided during construction.

2. Exterior backfill should be adjusted to a moisture content near optimum and compacted to at least 95% of the maximum standard Proctor density (ASTM D 698).

3. Care should be taken when compacting around the foundation walls to avoid damage to the structure.

4. 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. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce water infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in the paved areas. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

5. Ponding of water should not be allowed on backfill material or in within 10 feet of the foundation walls, whichever is greater.

6. Roof downspouts and drains should discharge well beyond the limits of all backfill.

7. Excessive landscape irrigation should be avoided within 10 feet of the foundation walls.

EXCAVATION CONSIDERATIONS

In our opinion, the overburden soils and upper bedrock encountered in the exploratory borings drilled for this study can be excavated with conventional heavy-duty construction equipment. Ripper teeth may be required for excavations that extend into bedrock. Excavations that extend beyond a depth of about 10 feet will approach the groundwater level and will likely require dewatering.

To avoid loss of support of the existing foundations, temporary excavations should not extend within a 1 horizontal to 1 vertical projection extending down from the edge of existing foundations, unless braced. Excavations that are required to extend within this zone should be properly shored or the existing foundations underpinned to prevent loss of support to existing foundations. Shoring or underpinning which allows the foundation supporting soils to yield will result in foundation movement and distress to the existing building.

All excavations should be in accordance with OSHA, state and local requirements. The contractor should follow appropriate safety precautions. In accordance with OSHA guidelines, the overburden soils should be considered a Type C material. Per OSHA criteria, unless excavations are shored, temporary unretained excavations in Type C materials should have slopes no steeper than 1½:1 (H:V). Flatter slopes will be required where ground-water seepage is encountered. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer. The contractor's on-site "competent person" should make decisions regarding necessary slope and shoring.

DESIGN AND SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary to accommodate possible changes in the proposed construction.

We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

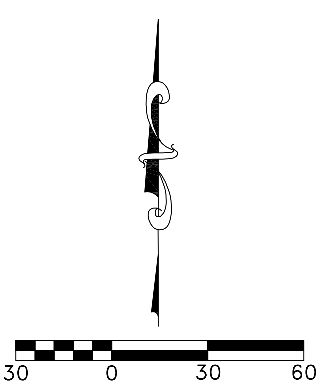
LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon data obtained from the exploratory borings at the approximate locations indicated on Fig. 1, and the proposed construction. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

The scope of services for this project does not include any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

DPC:bj


PROJECT ADDRESS: 155 JEFFERSON ST.
MONUMENT, CO




| | | | |
|---|---|---|---|
| 18–2–172 | Kumar & Associates | LOCATION OF EXPLORATORY BORINGS | Fig. 1 |

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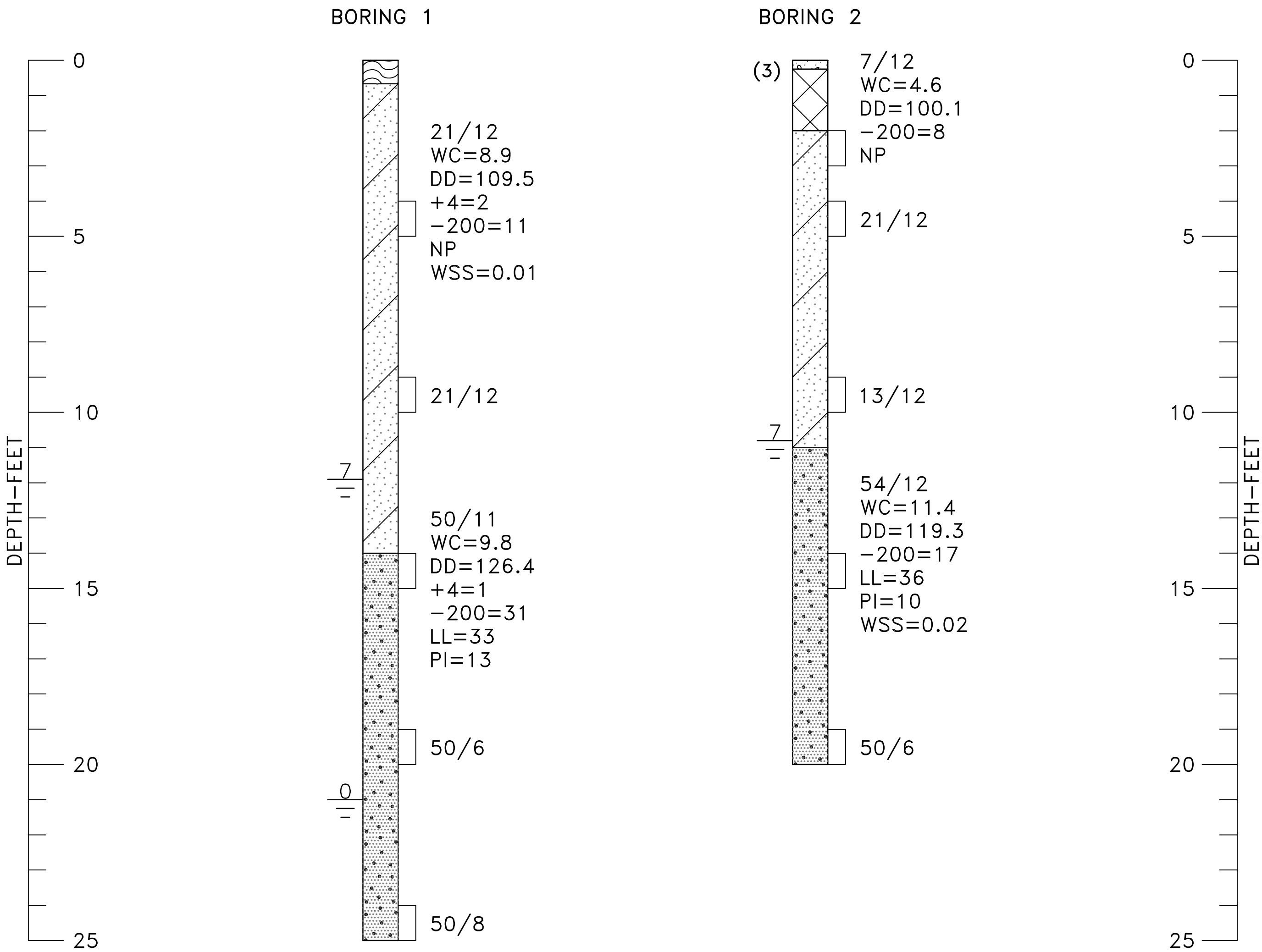



| 18-2-172 | Kumar & Associates | LOGS OF EXPLORATORY BORINGS | Fig. 2 |
|---|---|---|---|

## LEGEND

TOPSOIL.

(3) LANDSCAPE GRAVEL. THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF LOG.

FILL: SILTY SAND (SM), BROWN, MOIST.

WELL GRADED SAND WITH SILT (SW–SM), OCCASIONALLY CLAYEY, LOOSE TO MEDIUM DENSE, MOIST, GRAY.

SANDSTONE BEDROCK, CLAYEY, NONCEMENTED, HARD TO VERY HARD, MOIST TO WET, GRAY.

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

21/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 21 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

7 DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

## NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON JUNE 14, 2018 WITH A 4–INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.

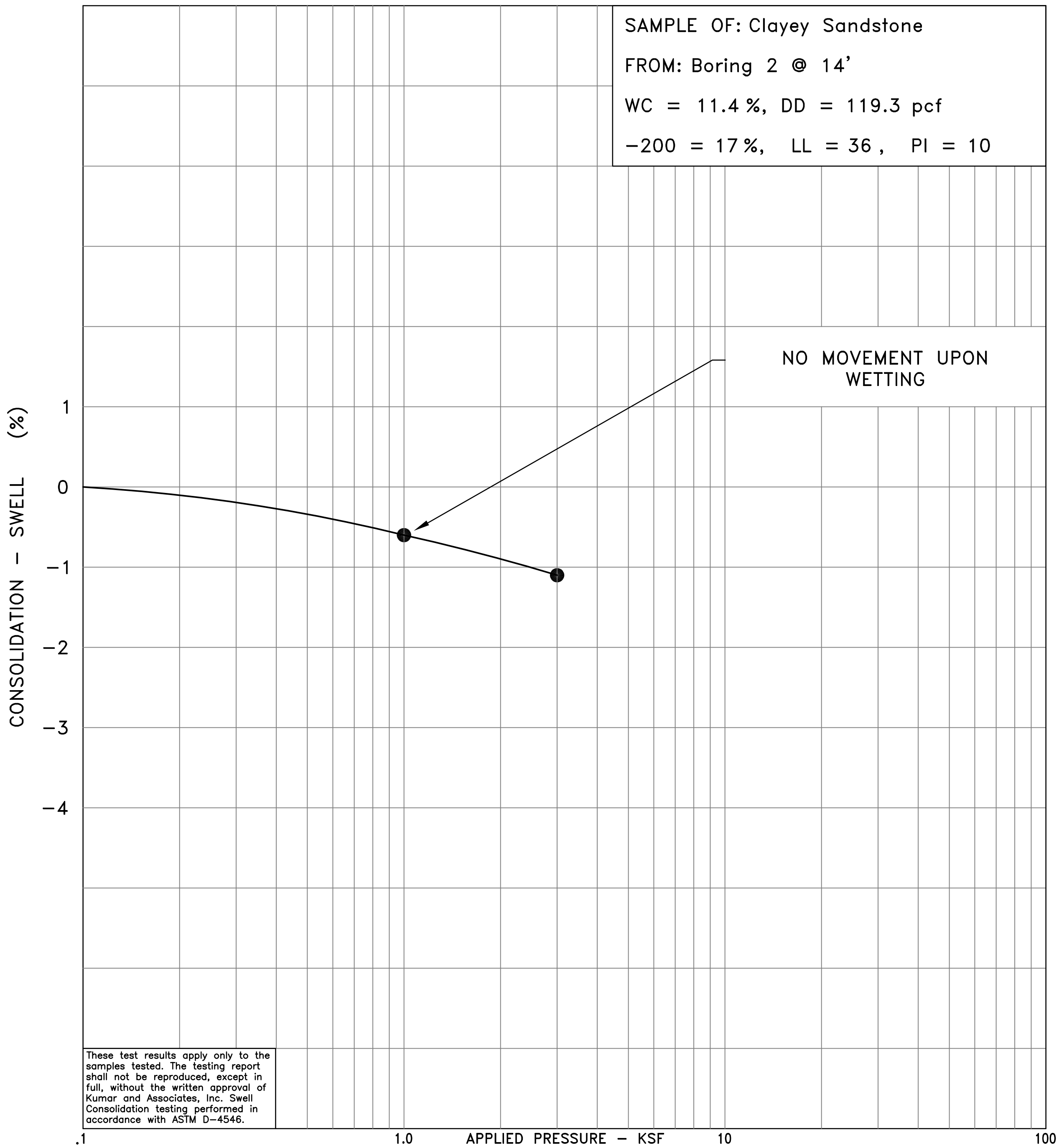
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED AND SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.

4. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

5. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.

6. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   DD = DRY DENSITY (pcf) (ASTM D 2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   –200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   LL = LIQUID LIMIT (ASTM D 4318);
   PI = PLASTICITY INDEX (ASTM D 4318);
   NP = NON–PLASTIC (ASTM D 4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP–L 2103).




| 18−2−172 | Kumar & Associates | SWELL−CONSOLIDATION TEST RESULTS | Fig. 4 |
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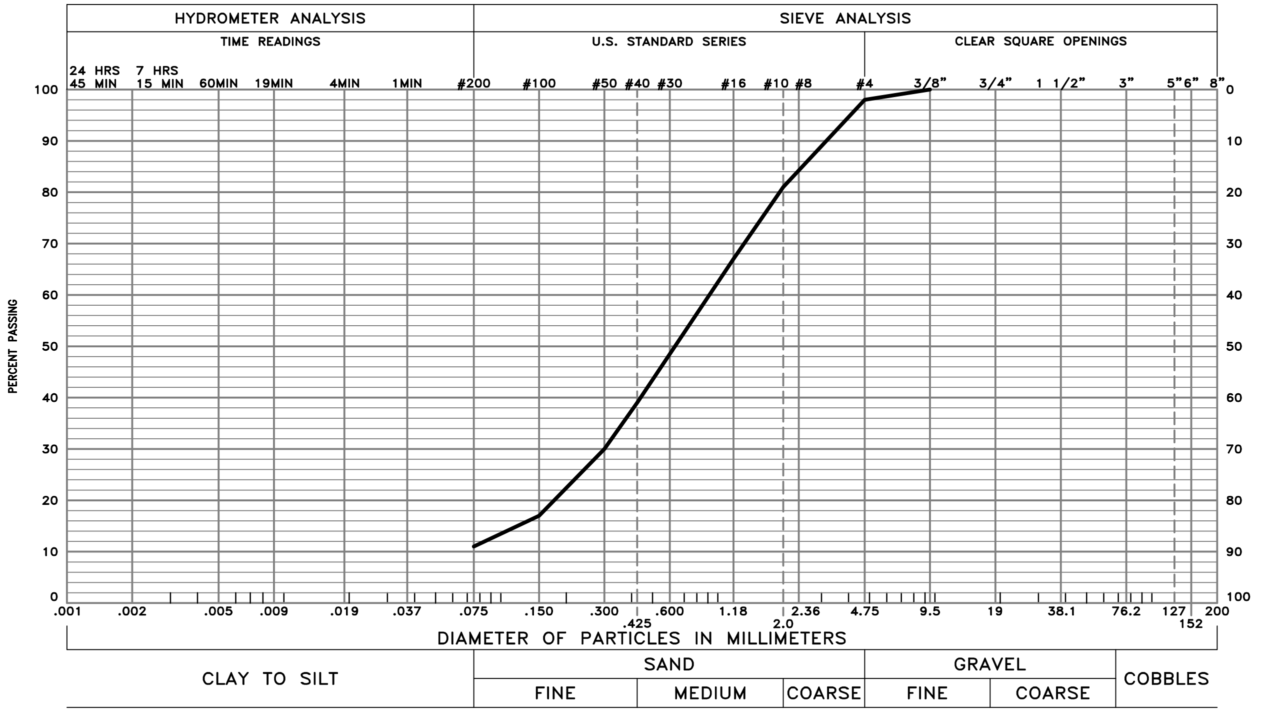
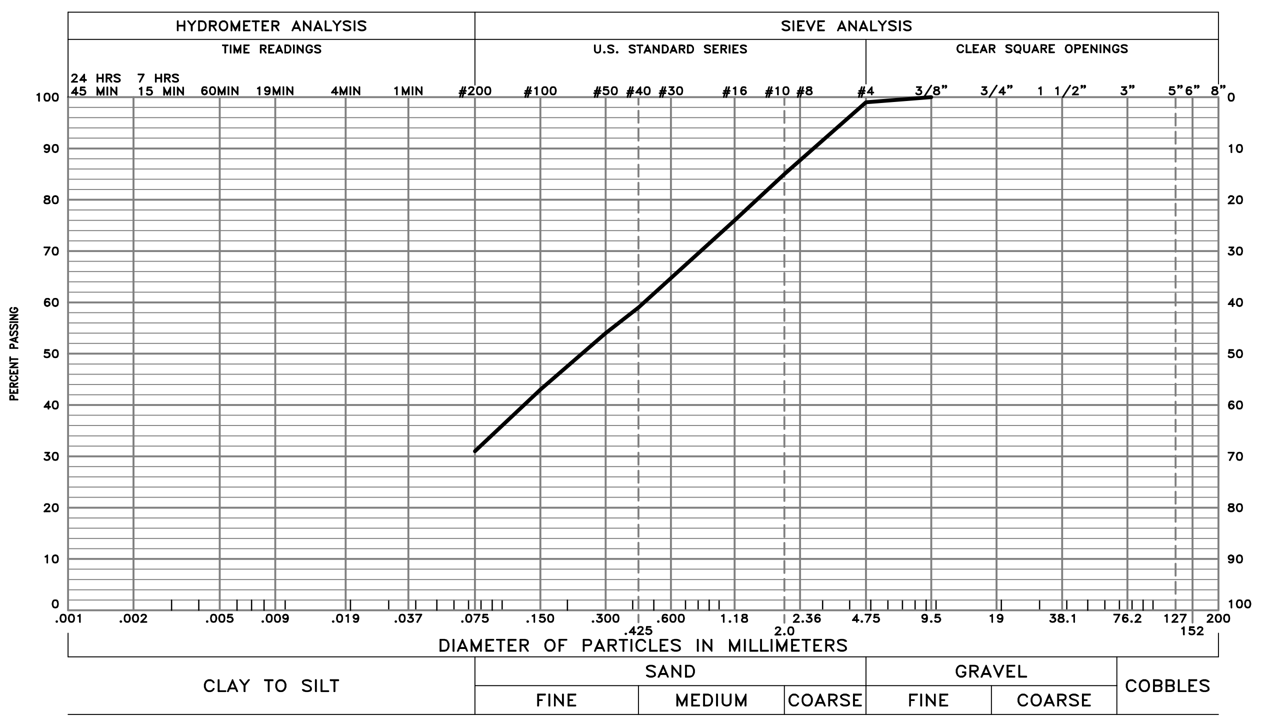


GRAVEL 2 % SAND 87 % SILT AND CLAY 11 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Well Graded Sand with Silt (SW-SM) FROM: Boring 1 @ 4'



GRAVEL 1 % SAND 68 % SILT AND CLAY 31 %

LIQUID LIMIT 33 PLASTICITY INDEX 13

SAMPLE OF: Clayey Sandstone FROM: Boring 1 @ 14'

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 D422, ASTM C136 and/or ASTM D1140.

# Kumar and Associates, Inc.

# TABLE I

# SUMMARY OF LABORATORY TEST RESULTS

Project No.: 18-2-172
Project Name : St. Peter Catholic Church, Chapel Building Addition
Date Sampled: 6/14/2018
Date Received: 6/14/2018

| SAMPLE LOCATION | | DATE TESTED | NATURAL MOISTURE CONTENT (%) | NATURAL DRY DENSITY (pcf) | GRADATION | | PERCENT PASSING NO. 200 SIEVE | ATTERBERG LIMITS | | WATER SOLUBLE SULFATES (%) | SOIL OR BEDROCK TYPE (Unified Soil Classification) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BORING | DEPTH (ft) | | | | GRAVEL (%) | SAND (%) | | LIQUID LIMIT | PLASTICITY INDEX | | |
| 1 | 4 | 6/20/18 | 8.9 | 109.5 | 2 | 87 | 11 | | NP | 0.01 | Well Graded Sand with Silt (SW-SM) |
| 1 | 14 | 6/20/18 | 9.8 | 126.4 | 1 | 68 | 31 | 33 | 13 | | Clayey Sandstone |
| | | | | | | | | | | | |
| 2 | 2 | 6/20/18 | 4.6 | 100.1 | | | 8 | | NP | | Well Graded Sand with Silt (SW-SM) |
| 2 | 14 | 6/20/18 | 11.4 | 119.3 | | | 17 | 36 | 10 | 0.02 | Clayey Sandstone |