LIMITED GEOTECHNICAL EVALUATION

PROPOSED CHSEW NORTH FOOTHILLS
DEVELOPMENT
NE OF NORTH FOOTHILLS DRIVE AND NORTH
HAMILTON STREET
SPOKANE, WASHINGTON
ALLWEST PROJECT NO. 219-211G

OCTOBER 25, 2019

ALLWEST
Testing & Engineering

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Construction Materials Testing & Special Inspection
Geotechnical Engineering
Environmental Consulting
Non-Destructive Testing
Welder Certification

October 25, 2019

Ms. Mecca Rheingans
Catholic Housing Services of Eastern Washington
12 East 5th Avenue
Spokane, Washington 99202

RE: Limited Geotechnical Evaluation
CHSEW North Foothills Development
NE of North Foothills Drive and North Hamilton Street
Spokane, Washington
ALLWEST Project No. 219-211G

Ms. Rheingans,

ALLWEST Testing & Engineering, Inc. (ALLWEST) has completed the authorized Limited Geotechnical Evaluation for the proposed project at the above-referenced site in Spokane, Washington. The attached report presents the results of the field evaluation, laboratory testing, and our recommendations to assist the design and construction of the proposed project.

We appreciate the opportunity to work with you on this project. If you have any questions, or need additional information, please do not hesitate to call us at (509) 534-4411.

Sincerely,
ALLWEST Testing & Engineering, Inc.

Todd DeMico, P.E.
Project Engineer

Andy J. Eliason, P.E.
Spokane Area Manager

Attachment: Limited Geotechnical Evaluation Report

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LIMITED GEOTECHNICAL EVALUATION
PROPOSED CHSEW NORTH FOOTHILLS DEVELOPMENT
NE OF NORTH FOOTHILLS DRIVE AND NORTH HAMILTON STREET
SPOKANE, WASHINGTON

ALLWEST Testing & Engineering, Inc. (ALLWEST) has completed the authorized Limited Geotechnical Evaluation for the proposed apartment development to be located immediately northeast of the intersection of North Hamilton Street and North Foothills Drive in Spokane, Washington. The general location of the project is shown on the Site Location Map, Figure 1, in Appendix A of this report. The purpose of the limited evaluation was to assess the subsurface soil conditions at the subject property with respect to the proposed construction. This report presents the results of the field exploration and laboratory testing and presents our recommendations to assist the design and construction of the proposed development.

1.0 SCOPE OF SERVICES

To complete our services, we accomplished the following:

1) Reviewed the USDA Natural Resources Conservation Service and Washington Geological Survey geologic mapping information for the project site area. We also reviewed the following document prepared for the site:

   a) Conceptual Site Plan provided by Architecture All Forms.

2) Completed a site reconnaissance by walking the property and observing exposed surface conditions including pavement, vegetation, and drainage.

3) Performed a field evaluation by observing the drilling of five (5) borings within the proposed construction areas. We obtained samples of the soils encountered in the borings and retained them for laboratory testing. The soils were visually described and classified and the subsurface profiles were logged.

4) Performed laboratory tests on select soil samples to assess some of the soil engineering characteristics.

5) Reviewed the results of the field evaluation and laboratory testing with respect to the proposed construction.

6) Performed engineering analyses and prepared recommendations to assist project planning, design, and construction.

7) Prepared this report.

Our services were provided in general accordance with our proposal dated August 15, 2019.

2.0 PROJECT DESCRIPTION

We understand the proposed project will consist of constructing approximately four (4) apartment complexes and a community building northeast of the intersection of North Foothills Drive and North Hamilton Street in Spokane, Washington. The remainder of the site will primarily consist of pavement and egress as well as stormwater management facilities. Site drainage features were not shown on the preliminary plans; however, we assume drainage swales and/or infiltration ponds with drywells will be utilized for groundwater mitigation at the site. For our purposes, we have assumed wall loads will be on the order of 2 to 6 kips per lineal foot and column loads, if any, will be on the order of 100 kips or less. We have further assumed traffic loads in the parking and drive areas will consist of passenger car traffic with occasional delivery truck traffic.

3.0 EVALUATION PROCEDURES

To complete this limited evaluation, we reviewed soil and geologic literature for the project area. We also reviewed the document referenced in Section 1.0 of this report. We conducted a field evaluation of the property including a site reconnaissance to assist in planning the field evaluation and provide a general overview of the property. Information obtained from the field evaluation, review of the referenced documents, laboratory testing, and engineering analysis were utilized to develop recommendations for the geotechnical aspects of the project.

4.0 SITE CONDITIONS

At the time of our subsurface exploration, the site included a parking lot, an active segment of North Nevada Street, and multiple commercial facilities. In general, the site consists of relatively level developed land. We did not observe rock outcrops or standing water at the existing ground surface on the subject site during our site evaluation. The site is bounded by East North Foothills Drive to the south, North Hamilton Street to the north and west, and commercial facilities to the east.

4.1 General Soil Conditions

The USDA Natural Resources Conservation Service (NRCS) has mapped the soil on the property primarily as Urban land, gravelly substratum, 0 to 15 percent slopes (see Appendix A, Figure 2). Urban soils are difficult to generalize as they consist of highly variable human transported material. The soils encountered in the borings consisted predominately of silty sand overlying native poorly graded gravel (alluvium).

4.2 Hydrogeologic Conditions

The depth to groundwater is estimated to be approximately 50 feet or greater below the ground surface based on nearby water well logs provided by the State of Washington Department of Ecology. Site-specific groundwater reports were not identified for this project site. Groundwater was not observed in the borings. Based on the reference water well logs from the area and our subsurface findings, we do not anticipate groundwater will adversely affect the proposed construction.

5.0 SUBSURFACE CONDITIONS

Five (5) borings were drilled at the approximate locations shown on the Boring Location Map, Figure 3, in Appendix A of this report. The boring locations were field located based on features shown on the site plan provided. The borings were drilled with a truck mounted CME drill rig and operator under subcontract to ALLWEST.

The soil sampling in the borings was performed using standard penetration test procedures in accordance with ASTM D1586. With this method, a hollow-stem auger or casing is advanced to the desired test depth. A 140-pound hammer falling 30 inches was used to drive a split-barrel sampler a total of 18 inches below the tip of the hollow-stem auger. The blows required to advance the sampler are recorded for each 6-inch increment. The blows for the last foot of penetration are called the N-value and are an indication of the soil strength characteristics. The N-values are shown on the Log of Boring sheets in Appendix B. Penetration test samples were taken at 2.5-foot intervals for the top 10 feet and at 5-foot intervals thereafter. The borings were terminated between a depth of 30.9 feet and 31.5 feet.

An engineer from our firm continuously observed the borings, logged the surface and subsurface conditions in general accordance with ASTM D2487 and D2488, and obtained representative soil samples. All soil samples were stored in watertight containers. These samples were transported to our Spokane Valley laboratory for further visual examination and testing following drilling.

5.1 Subsurface Soil Conditions

Soils in the borings consisted predominately of silty sand alluvium overlying medium dense to very dense poorly graded gravel/well graded sand alluvium. Silty sand with pockets of poorly/well graded sand was encountered in Borings B-1 to B-4 and extended to a depth of approximately 7.5 feet. Boring B-5 encountered refusal on suspected boulders at a depth of approximately 4 feet. An offset boring to B-5 encountered refusal at a depth of 2 feet on suspected boulders. Borings extended to depths ranging between approximately 4 feet and 26.5 feet; all borings were terminated in alluvial soils.

Detailed descriptions of the soil observed in the borings are presented on the Boring Logs in Appendix B of this report. The descriptive soil terms used on the boring logs and in this report can be referenced by the Unified Soil Classification System (USCS). A copy of the USCS is included in Appendix B. The subsurface conditions may vary between exploration locations. Such changes in conditions would not be apparent until construction. **If the subsurface conditions do change from those observed in the borings, the construction timing, plans, and costs may change.**

5.2 Bedrock

Bedrock was not encountered in the borings.

5.3 Groundwater Conditions

Groundwater was not observed in the borings at the time of our exploration. Changes in precipitation, construction or other factors may impact the depth to groundwater on the property. Fluctuations in the groundwater level should be expected; however, we do not anticipate groundwater will adversely affect the proposed construction.

6.0 LABORATORY TESTING

Laboratory testing was performed to supplement field classifications and to assess some of the soil engineering parameters. The laboratory testing conducted included particle size distribution tests (ASTM D6913) on select soil samples. The laboratory test results are summarized in Appendix C. The laboratory testing was performed by ALLWEST.

7.0 SLOPE STABILITY ANALYSIS

A final grading plan for the site was not available at the time this report was prepared. In general, 2H:1V slopes taller than 5 feet in height, slopes of any height that are steeper than 2H:1V, or slopes near vehicular or structural loading should be evaluated for global stability. We recommend ALLWEST be provided with a final grading plan when available to evaluate potential global stability concerns.

8.0 CONCLUSIONS AND RECOMMENDATIONS

It is our opinion the site is suitable for the proposed construction provided the recommendations in this report are followed and the associated risks are acceptable to the owner. The following recommendations are presented to assist the planning and design of the proposed buildings, pavement, and stormwater management facilities. The recommendations are based on our understanding of the proposed construction, the conditions observed in the borings, laboratory test results, and engineering analysis. **If the scope of the construction changes, or if conditions are encountered during construction that are different than those described in this report, we should be notified so we can review our recommendations and provide revisions if necessary**.

8.1 Site Preparation

General

In addition to the fill encountered in select borings drilled within the property, we anticipate significant fill and construction debris will be encountered during site grading and construction due to site redevelopment. All pavement and buildings (including foundations) should be removed in entirety below proposed structures and pavement. If the Contractor prefers to leave the existing fill material below existing roadways in place for use below proposed asphalt areas, this material should be proof rolled to evaluate its suitability at the time of construction. If soil infill is required at the site, following demolition and removal of existing structures and pavement structures, we recommend ALLWEST be on site to document material backfill and compaction. If ALLWEST is not present for site backfill, this material may need to be

over-excavated and removed at the time of construction of the new pavement/structures.

Building

Prior to conducting site grading, existing building foundations, pavement, vegetation, deleterious material, disturbed soil, and soil containing significant amounts of roots and organics, should be removed in entirety below foundations, slabs, pavement, and flatwork. In the event any material is considered unsuitable for foundation bearing material, it should be removed its entire depth below foundations, slabs, pavement, and flatwork and replaced with compacted structural fill. Over-excavation and replacement of unsuitable material should extend a minimum of five (5) feet horizontally beyond the building perimeters.

Prior to placing structural fill the exposed subgrade should be scarified to a minimum depth of eight (8) inches; then properly moisture conditioned and compacted to at least 95 percent of the modified Proctor maximum dry density as established by ASTM D1557. Compaction of the subgrade may be reduced to proof rolling at the discretion of the geotechnical engineer based on conditions at the time of construction. If the subgrade is observed to significantly deflect, it should be over-excavated to firm, non-yielding soil and replaced with properly compacted fill or stabilized as recommended in the Subgrade Stabilization section of this report.

Pavement Areas

Subsequent to removal of existing foundations, pavement, topsoil and any undocumented fill, the exposed subgrade should be scarified to an approximate depth of eight (8) inches; properly moisture conditioned and compacted to at least 95 percent of the modified Proctor maximum dry density as established by ASTM D1557. Compaction of the subgrade may be reduced to proof rolling at the discretion of the geotechnical engineer based on conditions. If the subgrade is observed to deflect, it should be over-excavated to firm, non-yielding soil and replaced with compacted fill or stabilized as recommended in the Subgrade Stabilization section (Section 8.2) of this report.

Utilities

Support soil for underground utilities will likely consist of silty sand or poorly graded gravel. It is our opinion the on-site sand or gravel should generally provide adequate support for utilities so long as they are properly bedded per the applicable standard. Additionally, we recommend any particles larger than 4 inches be removed from the utility bearing grade in order to prevent the development of point loads. If undocumented fill or loose soil is encountered in utility excavations below the utility bearing surface, we recommend these soils be removed from below utilities and replaced with compacted structural fill in properly sized lifts. It is further our opinion the native on-site sand or gravel may be used as backfill for utilities outside of the pipe bedding zone provided that particles larger than 4 inches are removed.

8.2 Subgrade Stabilization

If the subgrade is observed to deflect significantly during grading, it should be stabilized prior to placing fill. The subgrade may be stabilized using either fractured, angular cobble or with geosynthetics in conjunction with imported structural fill. The required thickness of crushed cobble or structural fill (used in conjunction with geosynthetic reinforcement) will depend on the construction traffic loads which are unknown at the time of this report. Therefore, a certain degree of trial and error may be needed to verify the recommended stabilization section thicknesses.

If fractured, angular cobble is selected to stabilize the subgrade, it should have a maximum particle size of 8 inches and should be relatively free of sand, silt, and clay. The first layer of cobble should be placed in an 18 inch thick loose lift and trafficked with tracked-construction and vibratory drum compaction equipment until it is observed to densify. If vibratory compaction destabilizes the subgrade, it should be discontinued. If the cobble is placed in a confined excavation, it should be mechanically densified from outside the excavation with vibratory compaction equipment.

If geosynthetic reinforcement is selected, it should consist of Tensar TX-160 or equivalent. Alternatives to Tensar TX-160 should be approved by the geotechnical engineer prior to use on site. The following recommendations are provided for subgrade stabilization using geosynthetic reinforcement.

- Geosynthetic reinforcement materials should be placed on a properly prepared subgrade with a smooth surface. Loose and disturbed soil should be removed prior to placement of geosynthetic reinforcement materials.

- A non-woven geotextile filter fabric should be placed on the properly prepared subgrade. The geosynthetic reinforcement should be placed six (6) inches above the filter fabric. The filter fabric and geosynthetic reinforcement should be unrolled in the primary direction of fill placement and should be over-lapped at least three (3) feet. The geosynthetic materials should be pulled taut to remove slack and pinned in place. If the material does not remain taut during fill placement, its effectiveness will be reduced.

- Construction equipment should not be operated directly on the geosynthetic materials. Fill should be placed from outside the excavation to create a pad on which equipment may be operated. We recommend a minimum of twelve (12) inches of structural fill be placed over the geosynthetic reinforcement before operating construction equipment on the fill. Low pressure, track-mounted equipment should be used to place fill over the geosynthetic reinforcement.

- Fill placed directly over the geosynthetic reinforcement should be properly moisture conditioned prior to placement and should meet the following gradation.

Sieve Size	Percent Passing
1 ½ inch	100
¾ inch	50 - 100
#4	25 - 50
#40	10 - 20
#100	5 - 15
#200	≤ 10

- The fill material should be properly compacted. Care should be taken with the use of vibratory compaction equipment. Vibration should be discontinued if it reduces the subgrade stability.

A representative of ALLWEST should be on site during subgrade stabilization activities to verify our recommendations are followed and to provide additional recommendations as appropriate.

8.3 Excavation

Excavation of the on-site soil can be conducted with typical excavation equipment. We recommend excavations greater than four (4) feet deep be sloped no steeper than 1.5H:1V (horizontal to vertical). Alternatively, deeper excavations may be shored or braced in accordance with OSHA specifications and local codes. Regarding trench wall support, the site soil is considered Type C soil according to Occupational Safety and Health Administration (OSHA) guidelines. The Contractor is responsible to provide appropriate trench wall support and/or sloping.

The Contractor shall limit excavations near roadways or existing structures. Sloping or excavating in front of roadways and structures, may create slope instabilities. If the Contractor needs to excavate near these features, ALLWEST should be given an opportunity to review the proposed excavation prior to construction.

Dewatering

We do not anticipate excavations for the proposed construction will encounter groundwater at this site to the depths anticipated for the proposed construction. In the event groundwater is encountered, we recommend excavations be continuously dewatered as determined by the Contractor's means and methods.

8.4 Structural Fill, Placement, and Compaction

Structural fill is defined as soil placed or moved on a site that will support any structural element including buildings, slabs, or pavement. Structural fill typically includes the footprint area and five (5) feet beyond for structures. Non-structural fill is soil placed beyond the structural fill area. Structural fill should be free of organic matter, frozen soil, and deleterious debris. Prior to placing structural fill, topsoil, organic material, uncontrolled fill and debris should be removed. The ground surface should be relatively level. Structural fill should be placed on subgrades prepared as directed in the Site Preparation section (Section 8.1) of this report. In wet weather or spring conditions, using silty or fine-grained soil for fill may delay construction and increase costs.

It is our opinion the native alluvial sand and gravel soils and are suitable for reuse as structural fill provided they can be kept at or near optimum moisture content for compaction and particles larger than eight (8) inches in diameter are separated. We recognize some of the granular soils may contain higher percentages of fine grained soils that can be difficult to properly compact. If these granular soils are found to be over-optimum moisture at the time of construction, it may be necessary to blend these soils with more permeable, coarse gravel or sand to stabilize the soils.

We recommend structural fill consist of granular material meeting the particle size requirements of the Washington State Department of Transportation Standard Specifications section 9-03.14(2) for Select Borrow as shown below in the following table. ALLWEST can review alternate structural fill submittals if requested prior to construction.

Sieve Size	Percent Passing
6-inch	99-100
3-inch	75-100
No. 40	50 max.
No. 200	10.0 max.

Structural fill should be placed in lift thicknesses which are appropriate for the compaction equipment used. Typically, six (6) to eight (8) inch loose lifts are appropriate for typical rubber tire and steel drum compaction equipment. Lift thicknesses should be reduced to four (4) inches for hand operated compaction equipment. Structural fill should be moisture conditioned to within two (2) percentage points of the optimum moisture content prior to placement to facilitate compaction. We recommend structural fill be compacted to a minimum of 95 percent of the modified Proctor maximum dry density up to subgrade elevation in building, parking, drive, and slab areas. The compaction efforts should result in the soil being compacted to a firm, dense, and unyielding condition (to the point where no further compression is observed. We recommend ALLWEST be retained to observe the placement and compaction to assess if sufficient compaction has been achieved.

The following recommendations are provided for placement of fill materials which cannot be tested due to the percentage of oversize particles (+3/4" diameter) being more than allowed by ASTM specifications.

- The structural fill should be placed in maximum 12 inch thick lifts with a minimum 10-ton vibratory compactor. The compactor should impart a minimum dynamic force of 30,000 pounds of impact per vibration with a minimum of 1,000 vibrations per minute. These recommendations are based on Washington State Department of Transportation Standard Specifications for placement of rock fill, WSDOT 2-03.3(14) A.
- A minimum of six (6), full coverage passes should be made for each six (6) inches of lift thickness.

- For fill materials not able to be tested by nuclear densometer due to the large amount of oversize particles, we recommend an ALLWEST representative observe the placement and compaction effort on a full-time basis.

8.5 Wet Weather Construction

We recommend earthwork for this site be scheduled for the drier seasons of the year. If construction is undertaken in wet periods of the year, it will be important to slope the ground surface to provide drainage away from construction areas. Additional earthwork may be needed to compact soils to recommended soil density levels if earthwork is performed during the wetter periods of the year.

8.6 Cold Weather Construction

The near surface soils encountered in the borings are considered to be frost susceptible. If site grading and construction are anticipated during cold weather, we recommend good winter construction practices be observed. Snow and ice should be removed from excavated and fill areas prior to additional earthwork or construction. Footings, floors slabs, or any structural portions of the construction should not be placed on frozen ground; nor should the supporting soils for buildings be permitted to freeze during or after construction. Frozen soils should not be used as backfill or fill.

8.7 Foundation Recommendations

It is our opinion the proposed buildings at the site may be supported on spread footings with on-grade floor slabs.

Spread Footing Foundation Design

- The proposed buildings may be supported on spread footings bearing on native silty sand or poorly/well graded gravel/sand compacted to at least 95 percent of modified Proctor maximum dry density and/or structural fill placed above the native silty sand or poorly/well graded gravel/sand compacted to at least 95 percent of the modified Proctor maximum dry density placed above the native soil.

- Spread footings may be designed for a net allowable bearing pressure of 3,000 pounds per square foot (psf) provided the footings bear on native silty sand or poorly/well graded gravel/sand or on structural fill placed above the native silty sand or poorly/well graded gravel/sand. The allowable bearing pressure value may be increased by one-third to account for transient loads such as wind and seismic.

- Footings should be embedded at least 24 inches below the lowest adjacent grade or to local jurisdiction required depth for frost protection. Interior footings may be placed immediately below the slab. Isolated or unheated foundations, such as for canopies, should be placed at least 36 inches below the exposed ground surface.

- If the previous recommendations are implemented, it is our opinion total settlement will be one (1) inch or less and differential settlement will be approximately ½ inch or less.

- A coefficient of friction of 0.45 may be used for sliding resistance between concrete footings and native soil/structural fill. For mass concrete placed on a vapor retarder, we recommend using a coefficient of friction against sliding of 0.35.

- The ground surface around foundations should be sloped away from the foundations at a minimum grade of five (5) percent in the first ten (10) feet. The slope may be reduced to two (2) percent if impermeable ground covering, such as pavement, is placed adjacent to the foundation.

- We recommend backfill placed adjacent to foundation walls be compacted to a minimum of 92 percent of the modified Proctor maximum dry density as established by ASTM D1557. Backfill should be placed in uniform lifts on both sides of the foundation walls to reduce displacement of the foundation walls.

8.8 Concrete On-Grade Slabs

We recommend placing a minimum of six (6) inches of crushed aggregate base immediately below slabs (i.e. 5/8" minus or equivalent). Aggregate base should be compacted as recommended in the Structural Fill, Placement, and Compaction section (Section 8.4) of this report.

We recommend consideration be given to including a moisture vapor retarder beneath concrete on-grade floor slabs to retard moisture migration through the slabs if moisture sensitive floor coverings are planned. We recommend the moisture retarder be installed per American Concrete Institute (ACI) recommendations and specifications. To reduce the potential for moisture migration through the slabs, it is important to include the moisture vapor retarder as well as direct surface and subsurface water away from the slabs. In addition, concrete should be given adequate time to cure prior to placing impermeable flooring.

8.9 Lateral Earth Pressures

At the time this report was prepared, it was unknown whether below grade walls such as basements are proposed for the project. If below grade walls are incorporated into the design, these walls may retain low to significant amounts of soil. Additionally, if walls are proposed near adjacent structures, parking lots or roadways, they may need to be designed to account for surcharge loading from these adjacent features. To prevent hydrostatic pressures from developing against the walls, we recommend using a free-draining granular material with less than five (5) percent passing a No. 200 sieve as backfill. The more permeable poorly graded gravel encountered on site could be used as free-draining backfill provided the fines content of the gravel is less than or equal to 5 percent.

The equivalent fluid pressure used to design potential walls will depend on the soil type used as backfill and whether the walls are designed to be flexible (allowed to move) or rigid (not allowed to move). We recommend using the following values for design.

Wall Type	Soil Type	Active Earth Pressure Coefficient (K_a)	At-Rest Earth Pressure Coefficient (K_o)	Equivalent Fluid Pressure (pcf)
Flexible	Native Sand/Gravel	0.30	---	40
Rigid	Native Sand/Gravel	---	0.47	65

For the native sand/gravel soils, we assumed a unit weight of 130 pcf and an angle of internal friction of 32 degrees for design.

For passive pressures, we recommend using the following values for design. Note that passive pressure should not be considered above the frost depth.

Soil Type	Passive Earth Pressure Coefficient, K_p	Equivalent Fluid Pressure (pcf)
Native Sand/Gravel	3.2	270

The equivalent fluid pressures are for horizontal backfill without surcharge loading. Sloped backfill above the wall or surcharge loading will increase the above-mentioned equivalent fluid pressures. These pressures also do not include any potential loading from adjacent structures or vehicular loading. If sloped backfill will be present behind walls or if proposed structures or pavements are to be located near these proposed walls, we should be contacted to provide additional recommendations for these equivalent fluid pressures. The active and at-rest pressures should be increased by an equivalent fluid weight of 10 pounds per cubic foot (pcf) and the passive pressure should be reduced by 10 pcf for seismic design. The dynamic component of the active pressure acts at a height of approximately 0.6 times the height of the wall.

The above values do not account for hydrostatic forces. Retaining and/or basement walls should be drained so the potential for hydrostatic forces affecting the walls is reduced. We recommend placing free-draining gravel and drain pipes behind walls to assist with drainage and reduce the potential for the buildup of hydrostatic pressures.

8.10 Seismicity

We anticipate the 2015 International Building Code (IBC) will be used as the basis for design of the proposed structures. Based on information provided in the IBC, the soil at the site can be characterized as Site Class D for seismic design. The following seismic parameters were calculated using 2015 National Earthquake Hazards Reduction Program (NEHRP) Provisions. Seismic design parameter values from the

2015 NEHRP Recommended Seismic Provisions have been adopted into the 2016 ASCE 7 Standard and the 2018 International Building Code.

Latitude: 47.6841569 °N Longitude: -117.39557144 °W

The following maximum earthquake spectral response accelerations should be used for design:

Short Period Response (S_S) – 0.308g
One Second Response (S_1) – 0.112g

The Site Class D site coefficients are:

F_a – 1.553 F_v – 2.377

8.11 Stormwater and Drainage

Specific stormwater management plans were not available at the time this report was prepared. We assume stormwater runoff will be directed to one or more grassed swale(s) with drywells around the proposed building development. Based on the results of the laboratory tests performed on samples collected from borings B-1, B-2, and B-4, permeability and outflow rates for the well graded sand to poorly graded gravel encountered at depth in the borings were estimated using the Spokane 200 Method from the Spokane Regional Stormwater Manual (SRSM). The estimated permeability and outflow rates are shown in the following table.

Recommended Drywell Design Outflow Rates

Boring No.	Depth (ft)	Percent Fines	Hydraulic Conductivity (cm/s)	Normalized Outflow Rate (cfs/ft)	Actual Drywell Outflow Rate (cfs)		Design Drywell Outflow Rate (cfs)	
					Type "A"	Type "B"	Type "A"	Type "B"
B-1	5.0 – 6.5	3.0	8.0×10^{-2}	0.180	1.08	--	0.30	--
B-2	5.0 – 6.5	6.9	1.8×10^{-2}	0.048	0.29	--	0.15	--
B-2	20.0 – 21.5	3.0	8.0×10^{-2}	0.180	--	1.8	--	1.0
B-4	12.0 – 15.0	6.0	2.2×10^{-2}	0.058	--	0.58	--	0.3

Our recommended drywell design outflow rates include a minimum safety factor between 1.3 and 2.0 as recommended by the SRSM. Maximum design outflow rates have been limited to 0.3 cfs and 1.0 cfs for single depth type "A" and double depth type "B" drywells, respectively, as recommended by the SRSM.

We recommend the site be graded such that storm run-off water is directed away from the building and pavement areas to a stormwater drainage system. We recommend landscape areas be sloped a minimum of six (6) inches within ten (10) feet of the building and slabs be sloped a minimum of two (2) percent. In addition, we recommend gutters and downspouts with long splash blocks or extensions. We do not recommend directing stormwater into a foundation drain pipe system.

8.12 Pavement

After removing the existing foundations, pavement, topsoil and any unsuitable undocumented fill, and preparing the subgrade, we anticipate the subgrade will consist of native silty sand/poorly graded gravel or structural fill placed above the native silty sand/poorly graded gravel. It is our opinion the native sand/gravel or structural fill will provide an adequate pavement section subgrade provided the subgrade is prepared as recommended in the Site Preparation section (Section 8.1) of this report. It is important the subgrade surface be shaped to provide for positive drainage to reduce the potential for water to pond in the subgrade.

Prior to placing the aggregate base, we recommend subgrade areas be compacted to at least 95 percent of the modified Proctor maximum dry density (ASTM D1557). In addition, the subgrade area should be proof-rolled with a loaded dump truck. This measure would assist in detecting any localized soft areas. Any soft areas discovered during the proof-rolling operation should be excavated and replaced with a suitable structural fill material. We recommend the proof-rolling process be observed by a geotechnical engineer to make the final evaluation of the subgrade.

We recommend a pavement section consisting of a minimum of three (3) inches of hot mix asphalt pavement over seven (7) inches of crushed gravel top or base course for the parking and drive areas. The recommended pavement section assumes occasional delivery truck traffic with axle loads up to 10 tons on the pavement surface. Our pavement design section was calculated assuming an average daily traffic rate of 400 vehicles with a 2 percent truck factor. Should traffic volumes or axle loadings vary from these assumptions, ALLWEST should be given an opportunity to review our recommendations and provide additional recommendations, if necessary.

We recommend specifying crushed gravel top or base course meeting the requirements of the Washington Department of Transportation (WSDOT) Standard Specification 9-03.9(3) for crushed gravel top or base course. We recommend the structural fill (subbase, if used) consist of a relatively free-draining, coarse gravel or sand with less than 7 percent by weight passing a No. 200 sieve. We recommend the asphalt concrete pavement meet the requirements of WSDOT Standard Specification for Hot Mix Asphalt (HMA) Class ½ inch asphalt concrete pavements. We recommend the crushed gravel base be compacted to a minimum of 95 percent of its modified Proctor maximum dry density (ASTM D1557). We recommend the asphaltic concrete surface be compacted to a minimum of 92 percent of the Rice density. If a high percentage of truck traffic is expected, we should be notified so we can review our pavement recommendations and provide revisions if necessary.

9.0 ADDITIONAL RECOMMENDED SERVICES

We recommend ALLWEST Testing & Engineering, Inc. be retained to provide construction observation and materials testing to verify the soil and geologic conditions and the report recommendations are incorporated into the actual construction. In-place density testing should be performed by an experienced engineering technician at the time of construction to verify the recommended levels of compaction are achieved. If we are not retained to provide the recommended plan review and construction observation services, we cannot be responsible for soil engineering related construction errors or omissions.

10.0 EVALUATION LIMITATIONS

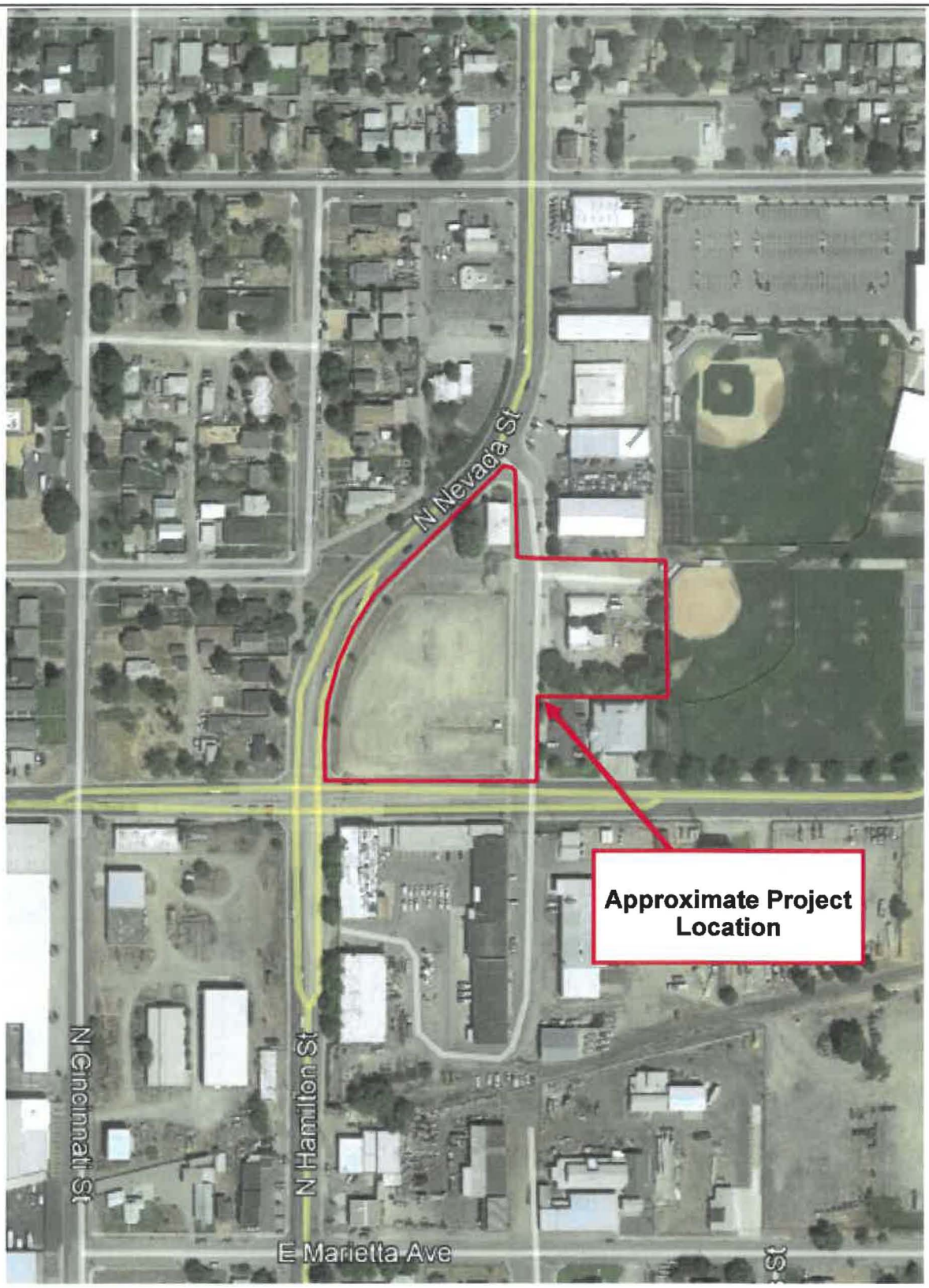
This report has been prepared to assist the planning and design of the proposed apartment development to be located northeast of North Foothills Drive and North Hamilton Avenue in Spokane, Washington. Our services consist of professional opinions and conclusions made in accordance with generally accepted geotechnical engineering principles and practices in our local area at the time this report was prepared. This acknowledgement is in lieu of all warranties either expressed or implied.

11.0 PROFESSIONAL ACKNOWLEDGEMENT

This report was prepared by me or under my direct supervision and I am a duly registered engineer under the laws of the State of Washington.

Andy J. Eliason, P.E.
Spokane Area Manager

APPENDIX A
SITE LOCATION MAP, NRCS SOILS MAP,
BORING LOCATION MAP



Google Earth

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

N
W E
S

ALLWEST Testing & Engineering

3005 N. Industrial Lane 5th Street, #S-21
Spokane Valley, Washington
www.allwesttesting.com

FIGURE A-1 - SITE LOCATION MAP

PROPOSED CHSEW NORTH FOOTHILLS DEVELOPMENT

NE OF NORTH FOOTHILLS DRIVE AND NORTH HAMILTON STREET

SPOKANE, WASHINGTON

Client Name: CHSEW

Project No.: 219-211G

Date: OCTOBER 2019

Anticipated Soil Types:
7105—Urban land, gravelly substratum, 0 to 15 percent slopes

United States Department of Agriculture (USDA)
National Resources Conservation Service (NRCS)
Web Soil Survey

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

N W E S

ALLWEST Testing & Engineering

3005 N. Industrial Park 5th Street, #S-21
Spokane Valley, Washington
www.allwesttesting.com

FIGURE A-2 - NRCS SOILS MAP

PROPOSED CHSEW NORTH FOOTHILLS DEVELOPMENT

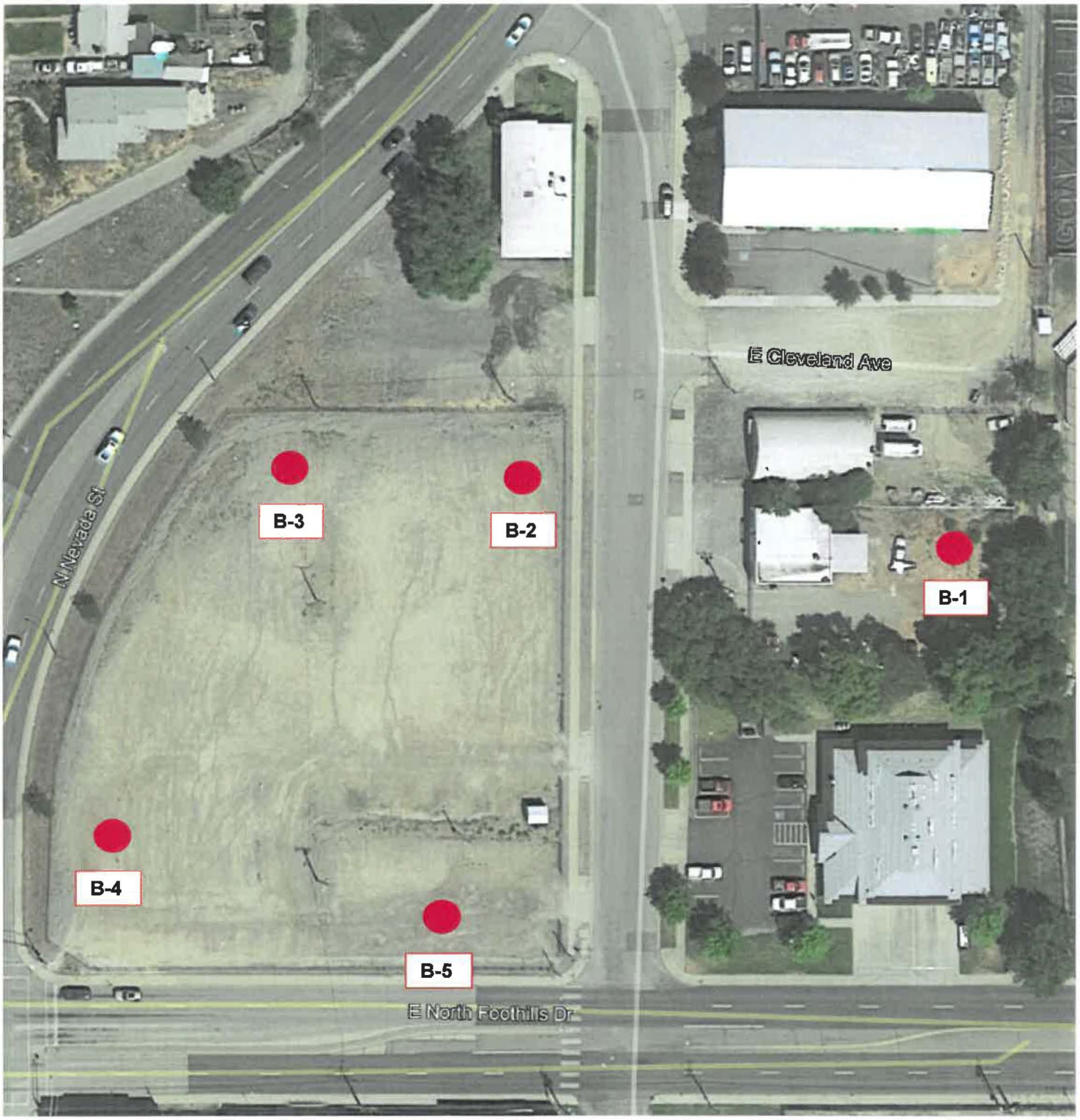
NE OF NORTH FOOTHILLS DRIVE AND NORTH HAMILTON STREET

SPOKANE, WASHINGTON

Client Name: CHSEW

Project No.: 219-211G

Date: OCTOBER 2019



Approximate Boring Location

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

N
W E
S

ALLWEST Testing & Engineering

3005 N. Industrial Lane 5th Street, #S-21
Spokane Valley, Washington
www.allwesttesting.com

FIGURE A-3 - BORING LOCATION MAP

PROPOSED CHSEW NORTH FOOTHILLS DEVELOPMENT

NE OF NORTH FOOTHILLS AND NORTH HAMILTON STREET

SPOKANE, WASHINGTON

Client Name: CHSEW

Project No.: 219-211G

Date: OCTOBER 2019

APPENDIX B
LOGS OF BORINGS,
UNITED SOIL CLASSIFICATION SYSTEM

LOG OF BORING

ALLWEST Testing & Engineering

PROJECT: **Chatholic Charities North Foothills Development** **Northeast of North Foothills Drive & North Hamilton** **Spokane, Washington 99203** **Project No. 219-211G**	BORING: **B-1** LOCATION: **See Attached Boring Map** DATE: **9/28/19** SCALE: **1" = 5'**

Depth	ASTM D2487 Symbol	Description of Materials	N	WL	Tests or Notes
0.5	SM	SILTY SAND, fine to medium grained, brown, moist. (Topsoil)			
2.5	GM	SILTY GRAVEL with SAND, fine to medium grained with gravel, dense, brown, moist. (Alluvium)	31		Soil classification testing performed on sample collected from a depth of 2.5 to 4.5 feet.
5.0	SW	WELL GRADED SAND with GRAVEL, fine to medium grained with gravel, medium dense, brown, moist. (Alluvium)	21		Soil classification testing performed on sample collected from a depth of 5.0 to 6.5 feet.
7.5	GP	POORLY-GRADED GRAVEL with SAND, medium to coarse grained, dense, gray, moist. (Alluvium)	36		
10.0	GP	POORLY-GRADED GRAVEL with SAND, medium to coarse grained, dense, gray, moist. (Alluvium)	40		
20.0	GP	POORLY-GRADED GRAVEL with SAND, medium to coarse grained, dense, gray, moist. (Alluvium)	34		
25.0		End of boring. Groundwater not encountered at time of drilling. Boring immediately backfilled upon completion.			

(See Report and Standard Plates for elevation and descriptive terminology.)

LOG OF BORING

ALLWEST Testing & Engineering

PROJECT:	BORING: B-2
Chatholic Charities North Foothills Development **Northeast of North Foothills Drive & North Hamilton** **Spokane, Washington 99203** **Project No. 219-211G**	LOCATION: **See Attached Boring Map**
	DATE: **9/28/19** SCALE: **1" = 5'**

Depth	ASTM D2487 Symbol	Description of Materials	N	WL	Tests or Notes
0.5					
2.5	SM	SILTY SAND, fine to medium grained, brown, moist. (Topsoil)			
5.0	SM	SILTY SAND, fine to medium grained with gravel, medium dense, brown, moist. (Alluvium)	29		
7.5	SW-SM	WELL GRADED SAND with SILT and GRAVEL, fine to medium grained with gravel, medium dense, brown, moist. (Alluvium)	24		Soil classification testing performed on sample collected from a depth of 5.0 to 6.5 feet.
10.0	GP	POORLY-GRADED GRAVEL with SAND, medium to coarse grained, medium dense, gray, moist. (Alluvium)	28		
20.0	GP	POORLY-GRADED GRAVEL with SAND, medium to coarse grained, dense, gray, moist. (Alluvium)	41		
25.0	SW	WELL GRADED SAND with GRAVEL, medium to coarse grained, dense, gray, moist. (Alluvium)	41		
		End of boring. Groundwater not encountered at time of drilling. Boring immediately backfilled upon completion.			

(See Report and Standard Plates for elevation and descriptive terminology.)

LOG OF BORING

ALLWEST Testing & Engineering

PROJECT:	BORING: B-3
Chatholic Charities North Foothills Development **Northeast of North Foothills Drive & North Hamilton** **Spokane, Washington 99203** **Project No. 219-211G**	LOCATION: **See Attached Boring Map**
	DATE: **9/28/19** SCALE: **1" = 5'**

Depth	ASTM D2487 Symbol	Description of Materials	N	WL	Tests or Notes
0.0	SM	SILTY SAND with GRAVEL, fine to coarse grained, compact, brown gray. (Alluvium)			Gravel content decreasing below approximately 2 feet.
5.0	GP	POORLY-GRADED GRAVEL with SAND, fine to coarse gravel, some medium to coarse sand, medium dense to very dense, gray. (Alluvium)	11		Soil classification testing performed on sample collected from a depth of 2.0 to 4.0 feet.
			23		
			17		Gravel and sand becoming coarser below approximately 10 feet.
			72		Blow counts may not be representative due to coarse gravel and cobbles below approximately 20 feet.
24.0	GP	POORLY-GRADED GRAVEL with cobbles and sand, coarse gravel and sand, very dense, gray. (Alluvium)	77		
26.5		End of boring. Groundwater not encountered at time of drilling. Borehole immediately backfilled upon completion.			

(See Report and Standard Plates for elevation and descriptive terminology.)

LOG OF BORING

ALLWEST Testing & Engineering

PROJECT:	BORING: B-4
Chatholic Charities North Foothills Development **Northeast of North Foothills Drive & North Hamilton** **Spokane, Washington 99203** **Project No. 219-211G**	LOCATION: **See Attached Boring Map**
	DATE: **9/28/19** SCALE: **1" = 5'**

Depth	ASTM D2487 Symbol	Description of Materials	N	WL	Tests or Notes
0.0	GM-SM	SILTY SAND with gravel to SILTY GRAVEL with sand, fine to coarse grained, dense, brown gray. (Alluvium)	36		
3.5	GP-GM	POORLY-GRADED GRAVEL with SILT and SAND, fine to coarse grained, medium dense, brown gray. (Alluvium)	28		
7.0	SM	SILTY SAND with GRAVEL, fine to coarse grained, very dense, gray. (Alluvium)	51		Occasional cobbles below approximately 10 feet. Blow counts may not be representative due to coarse gravel and cobbles below approximately 10 feet.
11.0	GP-GM	POORLY-GRADED GRAVEL with SILT and SAND, fine grained, fine to coarse sand, very dense, gray. (Alluvium)	62 67		Gravel and sand becoming coarser below approximately 12 feet. Soil classification testing performed on sample collected from a depth of 12.0 to 15.0 feet.
26.5		End of boring. Groundwater not encountered at time of drilling. Borehole immediately backfilled upon completion.			

(See Report and Standard Plates for elevation and descriptive terminology.)

LOG OF BORING

ALLWEST Testing & Engineering

PROJECT:	BORING: B-5
Chatholic Charities North Foothills Development **Northeast of North Foothills Drive & North Hamilton** **Spokane, Washington 99203** **Project No. 219-211G**	LOCATION: **See Attached Boring Map**
	DATE: **9/28/19** SCALE: **1" = 5'**

Depth	ASTM D2487 Symbol	Description of Materials	N	WL	Tests or Notes
0.0					
0.1	FILL	CRUSHED AGGREGATE SURFACING - less than 1 inch.			Possible boulders below approximately 2 feet.
	GP-GM	(Uncontrolled Fill)			
4.0		POORLY-GRADED GRAVEL with SILT and SAND, and COBBLES, fine to coarse grained, dense, brown gray. (Alluvium)			
		Borehole terminated at refusal on suspected boulders.			
		Groundwater not encountered at time of drilling.			
		Borehole immediately backfilled upon completion.			

(See Report and Standard Plates for elevation and descriptive terminology.)

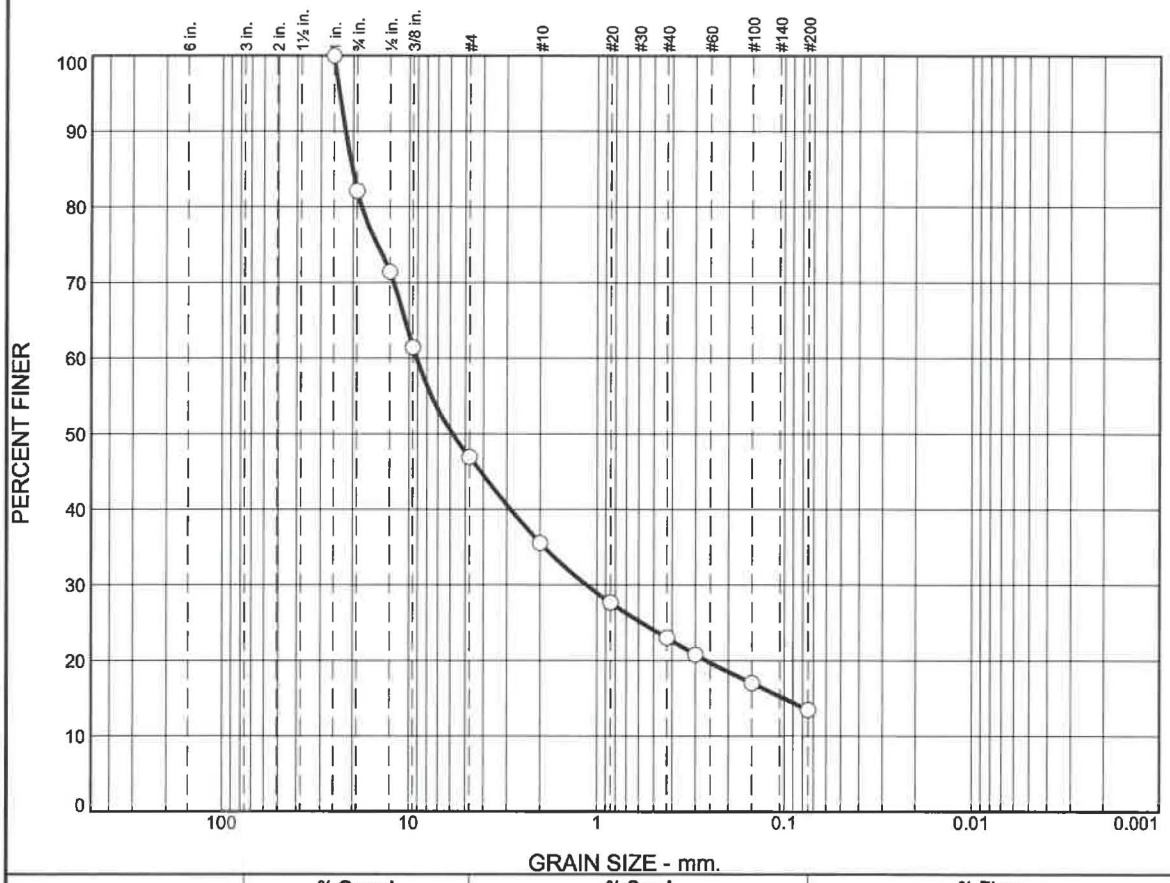
Unified Soil Classification System

MAJOR DIVISIONS			SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS	GRAVELS	CLEAN GRAVELS	GW	Well-Graded Gravel, Gravel-Sand Mixtures.
			GP	Poorly-Graded Gravel, Gravel-Sand Mixtures.
		GRAVELS WITH FINES	GM	Silty Gravel, Gravel-Sand-Silt Mixtures.
			GC	Clayey Gravel, Gravel-Sand-Clay Mixtures.
	SANDS	CLEAN SANDS	SW	Well-Graded Sand, Gravelly Sand.
			SP	Poorly-Graded Sand, Gravelly Sand.
		SANDS WITH FINES	SM	Silty Sand, Sand-Silt Mixtures.
			SC	Clayey Sand, Sand-Clay Mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50%		ML	Inorganic Silt, Silty or Clayey Fine Sand.
			CL	Inorganic Clay of Low to Medium Plasticity, Sandy or Silty Clay.
			OL	Organic Silt and Clay of Low Plasticity.
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	Inorganic Silt, Elastic Silt, Micaceous Silt, Fine Sand or Silt.
			CH	Inorganic Clay of High Plasticity, Fat Clay.
			OH	Organic Clay of Medium to High Plasticity.
Highly Organic Soils			PT	Peat, Muck and Other Highly Organic Soils.

ALLWEST

APPENDIX C
LABORATORY TEST RESULTS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	18	35	11	13	10	13	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	82		
1/2"	71		
3/8"	61		
#4	47		
#10	36		
#20	28		
#40	23		
#50	21		
#100	17		
#200	13		

* (no specification provided)

Soil Description

Silty Gravel with Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 21.9549 D_{85}= 20.1828 D_{60}= 9.1125
D_{50}= 5.8369 D_{30}= 1.1397 D_{15}= 0.1006
D_{10}= C_u= C_c=

Classification

USCS= GM AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

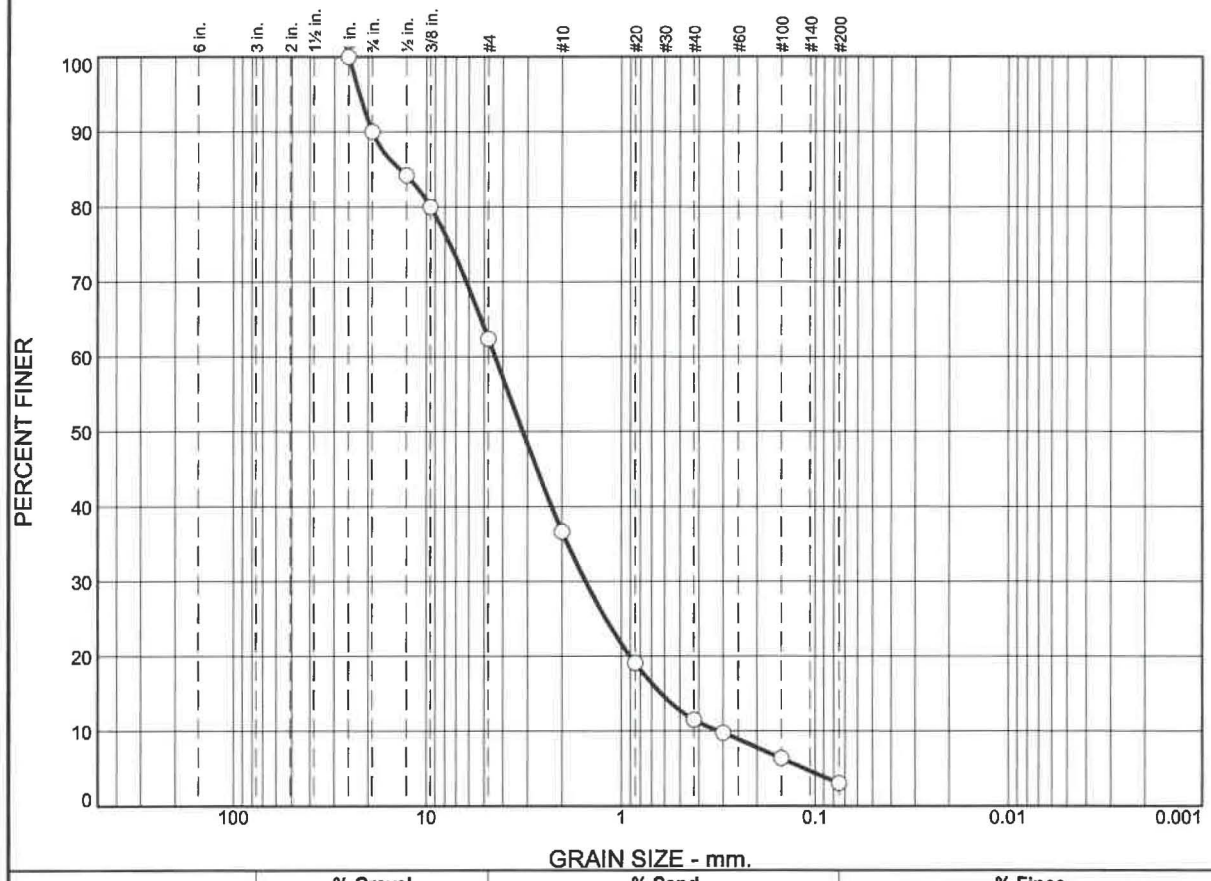
Location: B-1
Sample Number: S219-0410 **Depth:** 2.5 - 4.5 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:** DH

Tested By: W. Neville **Checked By:** C. Warrick

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	10	28	25	25	9	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	90		
1/2"	84		
3/8"	80		
#4	62		
#10	37		
#20	19		
#40	12		
#50	10		
#100	6		
#200	3.0		

* (no specification provided)

Soil Description

Well Graded Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 19.0305 D_{85}= 13.7004 D_{60}= 4.3901
D_{50}= 3.1724 D_{30}= 1.5239 D_{15}= 0.6255
D_{10}= 0.3159 C_u= 13.90 C_c= 1.67

Classification

USCS= SW AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

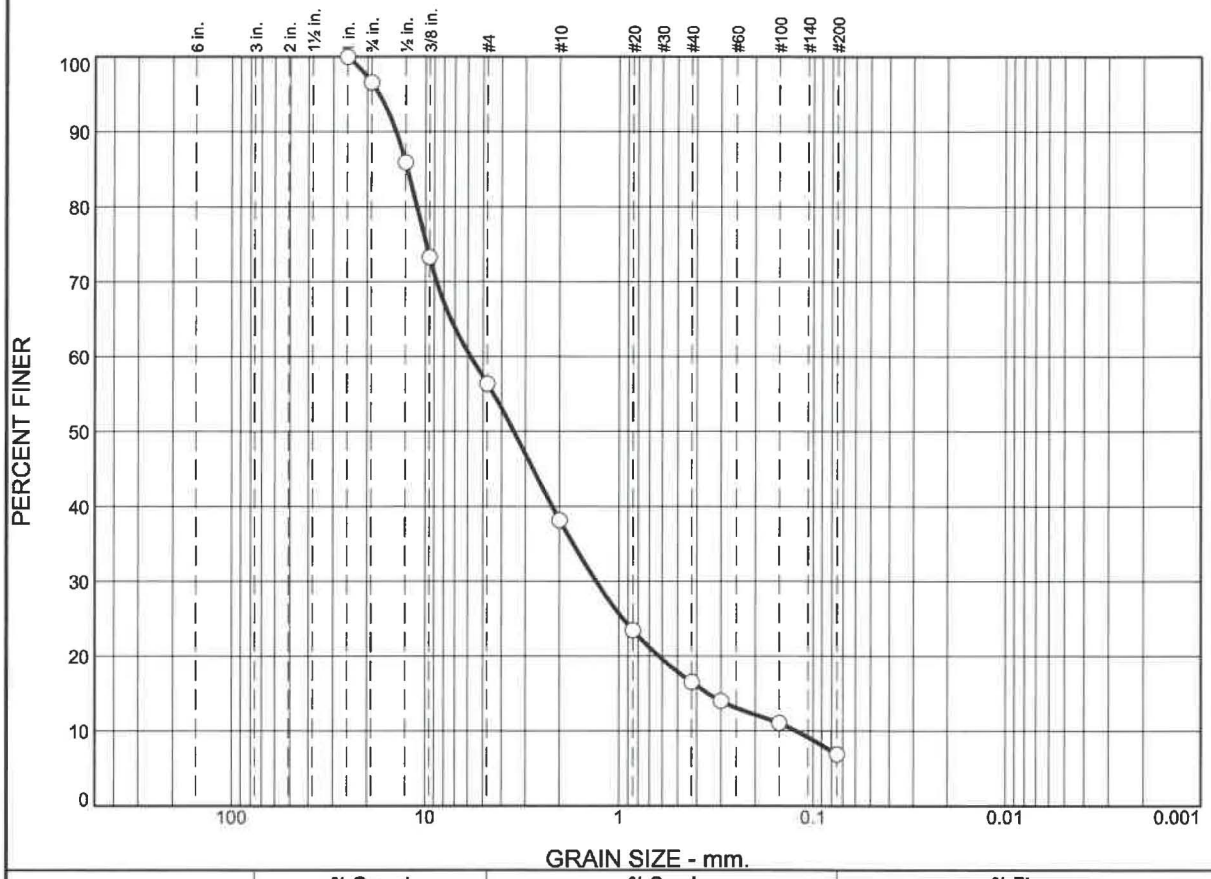
Location: B-1
Sample Number: S219-0414 **Depth:** 5.0 - 6.5 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:** TLO

Tested By: W. Neville **Checked By:** C. Warrick

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	41	18	21	10	7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	97		
1/2"	86		
3/8"	73		
#4	56		
#10	38		
#20	23		
#40	17		
#50	14		
#100	11		
#200	6.9		

* (no specification provided)

Soil Description

Well Graded Sand with Silt and Gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 14.2492 D_{85}= 12.4177 D_{60}= 5.8091
D_{50}= 3.4554 D_{30}= 1.3063 D_{15}= 0.3487
D_{10}= 0.1219 C_u= 47.66 C_c= 2.41

Classification

USCS= SW-SM AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

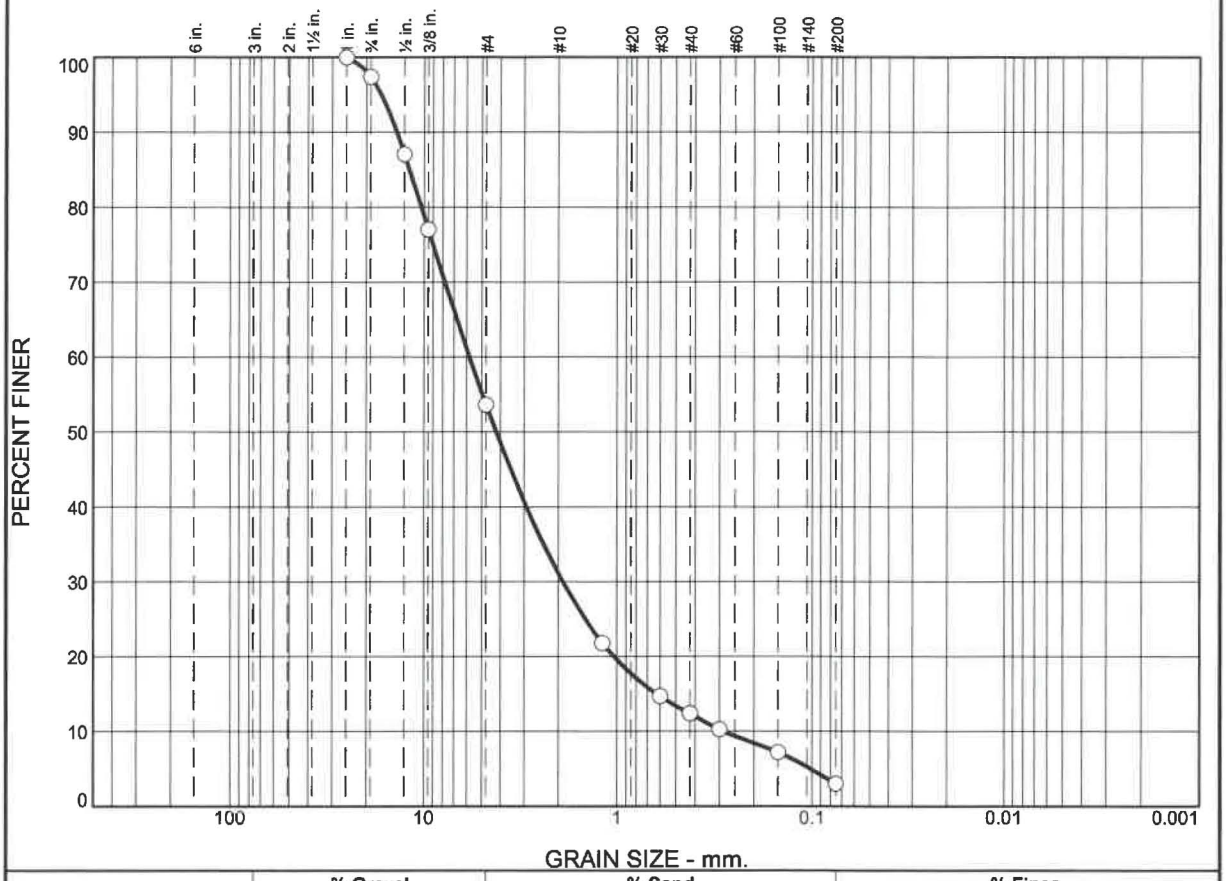
Location: B-2
Sample Number: S219-0411 **Depth:** 5.0 - 6.5 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:**

Tested By: W. Neville **Checked By:** C. Warrick

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	43	23	19	9	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	97		
1/2"	87		
3/8"	77		
#4	54		
#16	22		
#30	15		
#40	12		
#50	10		
#100	7		
#200	3.0		

* (no specification provided)

Soil Description

Well Graded Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 13.9232 D_{85}= 11.9355 D_{60}= 5.8015
D_{50}= 4.2069 D_{30}= 1.8918 D_{15}= 0.6252
D_{10}= 0.2857 C_u= 20.31 C_c= 2.16

Classification

USCS= SW AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

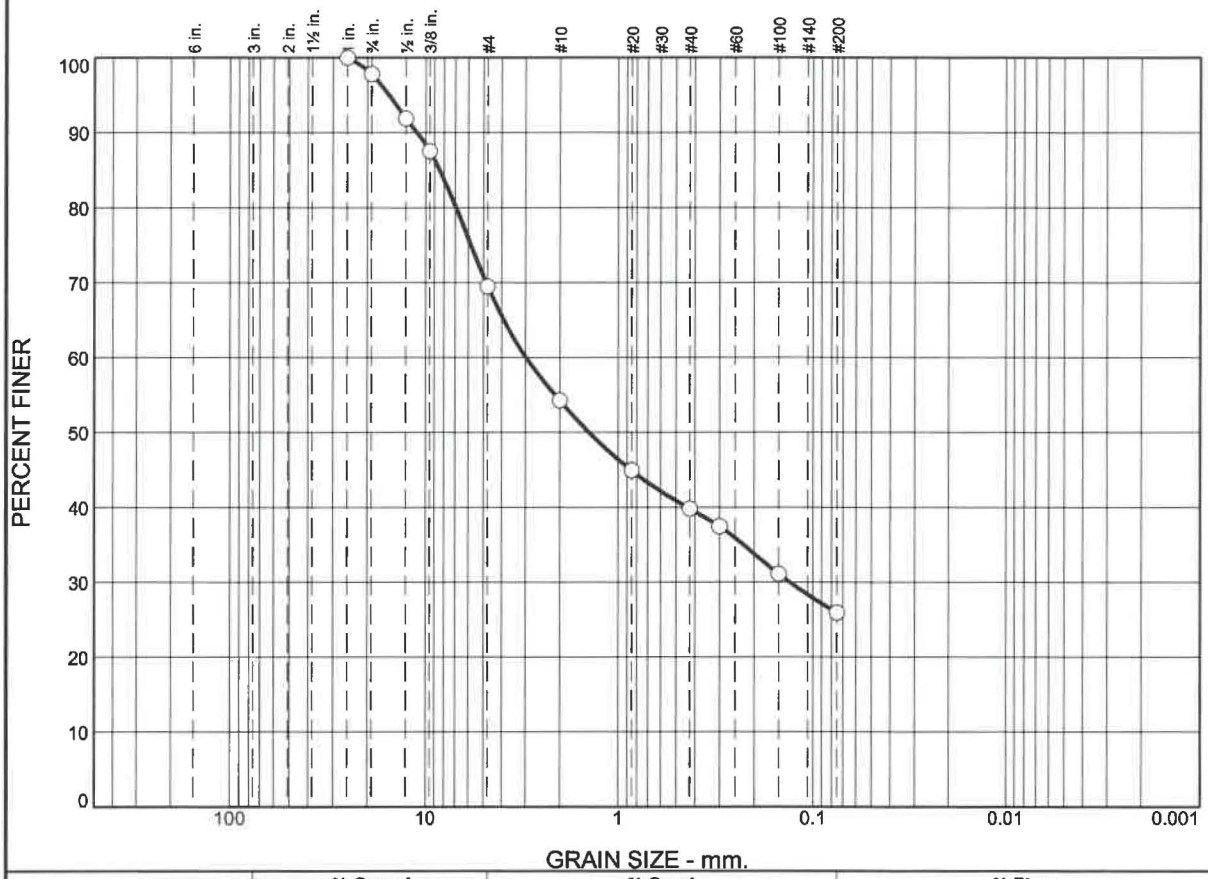
Location: B-2
Sample Number: S219-0412 **Depth:** 20.0 -21.5 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:** TH

Tested By: W. Neville **Checked By:** C. Warrick

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	29	15	14	14	26	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	98		
1/2"	92		
3/8"	88		
#4	69		
#10	54		
#20	45		
#40	40		
#50	37		
#100	31		
#200	26		

* (no specification provided)

Soil Description

Silty Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 11.1062 D_{85}= 8.4369 D_{60}= 2.9845
D_{50}= 1.4067 D_{30}= 0.1317 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

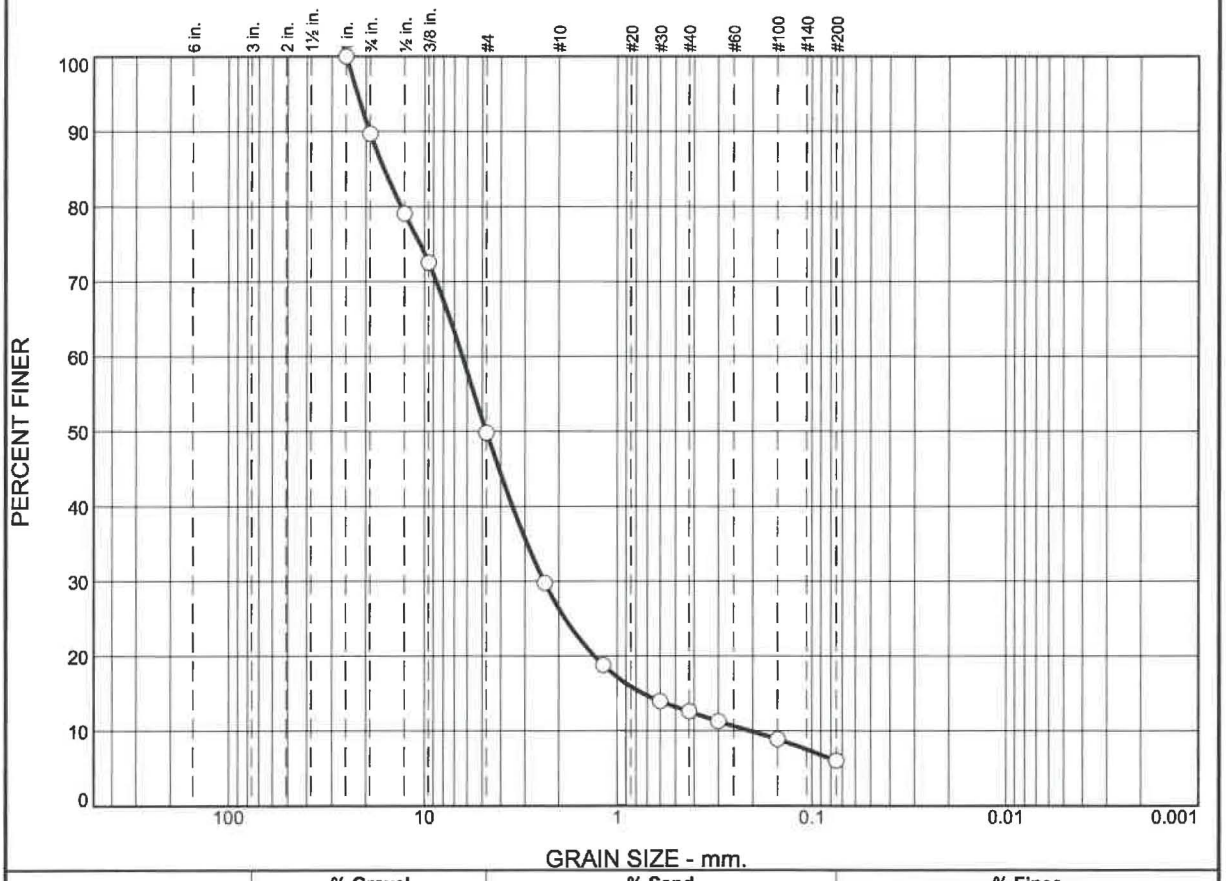
Location: B-3
Sample Number: S219-0413 **Depth:** 2.0 - 4.0 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:** TDB

Tested By: W. Neville **Checked By:** C. Warrick

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	10	40	24	13	7	6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	90		
1/2"	79		
3/8"	73		
#4	50		
#8	30		
#16	19		
#30	14		
#40	13		
#50	11		
#100	9		
#200	6.0		

* (no specification provided)

Soil Description

Poorly Graded Gravel with Silt and Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 19.2086 D_{85}= 16.2189 D_{60}= 6.3635
D_{50}= 4.7716 D_{30}= 2.3856 D_{15}= 0.7314
D_{10}= 0.2057 C_u= 30.94 C_c= 4.35

Classification

USCS= GP-GM AASHTO=

Remarks

Sampled by A. Eliason 10/2/19

Location: B-4
Sample Number: S219-0415 **Depth:** 12.0 - 15.0 Feet **Date:** 10/25/19

ALLWEST TESTING & ENGINEERING, INC.
Spokane, WA

Client: Catholic Housing Charaties of E. Washington and N. Idaho
Project: Gonzaga Haven
Project No: 219-211G **Reviewed By:**

Tested By: W. Neville **Checked By:** C. Warrick