May 3, 2024

Kiemle Hagood
601 West Main Avenue, Suite 400
Spokane, Washington 99201

Attention: Shannon Meager

RE: Geotechnical Evaluation
Bethany Presbyterian Church Housing
2607 South Ray Street, Spokane County Parcel Number 35273.0618
Spokane, Washington

ALLWEST Project Number: 224-068G

Ms. Meager,

ALLWEST has completed the authorized geotechnical evaluation for the proposed Bethany Presbyterian Church Housing project to be located at 2607 South Ray Street, Spokane County Parcel Number 35273.0618 in Spokane, Washington. The attached report includes characterization of the soil and geologic conditions on site, the results of our field evaluation, and our geotechnical recommendations to assist with design and construction of the proposed project.

We appreciate the opportunity to provide services to you for this project. If you have any questions or need additional information, please call.

Sincerely,

ALLWEST

Prepared by:

Brenda Borer
Project Manager

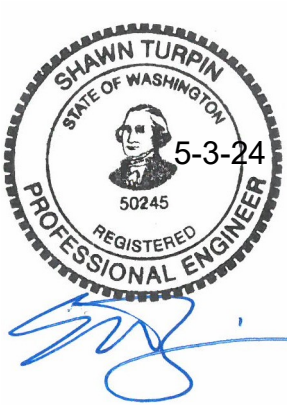
Reviewed by:

Shawn Turpin, P.E.
Senior Geotechnical Engineer

GEOTECHNICAL EVALUATION
BETHANY PRESBYTERIAN CHURCH HOUSING
2607 SOUTH RAY STREET, SPOKANE COUNTY PARCEL NUMBER 35273.0618
SPOKANE, WASHINGTON

224-068G

MAY 3, 2024



Prepared For:

KIEMLE HAGOOD
601 WEST MAIN AVENUE, SUITE 400
SPOKANE, WASHINGTON 99201

Prepared By:

ALLWEST

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EXECUTIVE SUMMARY

ALLWEST has completed the authorized geotechnical evaluation for the Bethany Presbyterian Church Housing project located at 2607 South Ray Street, Spokane County Parcel Number 35273.0618 in Spokane, Washington. The purpose of this evaluation was to assess the subsurface conditions on the project site with respect to the planned development. Our services were provided in accordance with our proposal no. 224-068G dated March 12, 2024. This report details the results of the field evaluation and laboratory testing and presents our geotechnical recommendations to assist the design and construction of the planned development.

The project site is suitable for the proposed construction provided the recommendations in this report are followed and the associated risks are acceptable to the owner. Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. If we are not retained to provide the required construction observation and materials testing services, we cannot be responsible for soil engineering related construction errors or omissions.

The following geotechnical considerations were identified:

- Approximately 2½ to 8 feet of undocumented fill was observed in the test pits excavated on the west and south parts the site. The undocumented fill should be removed its full depth below structural elements. The undocumented fill observed in the test pits may be reused as structural fill.
- The proposed building may be supported on conventional spread footings bearing on structural fill underlain by a properly prepared subgrade. Footings may be designed for an allowable bearing pressure of 2,500 pounds per square foot (psf).
- A flexible pavement section of 2½-inches asphaltic concrete over a minimum of 6-inches crushed aggregate base is recommended.
- Swales should be sized using equations 6-1B and 6-1D of the Spokane Regional Stormwater Manual (SRSM). Drywells should be designed using the recommended outflow rates provided in Table 14. Recommended Gravel Gallery Infiltration Rates. Gravel galleries should be designed using design infiltration rates provided in Table 14.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. 9.0 EVALUATION LIMITATIONS should be read for an understanding of the report limitations.

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APPENDICES

- Appendix A – Vicinity Map, Exploration Location Map, Over-Excavation Detail
- Appendix B – Test Pit Logs, Soil Classification Legend
- Appendix C – Laboratory Test Results, Infiltration Test Results

1.0 PROJECT DOCUMENTS

ALLWEST reviewed the following document to inform our understanding of the proposed project.

- Site Concept Plan, date 5/22/2023, prepared by ZBA Architecture.

2.0 PROJECT DESCRIPTION

According to preliminary information provided by Kiemle Hagood, we understand the proposed Bethany Presbyterian Church Housing project will consist of construction of two multi-story apartment buildings, an approximate 5,800-square-foot church and housing services building, and associated infrastructure on an approximately 1½-acre parcel located at the northeast corner of South Ray Street and East 27th Avenue in Spokane, Washington.

We assume the buildings will be constructed of light-weight timber framing supported on conventional spread footing foundations with slab-on-grade floors. Specific structural loading design criteria were not available at the time this report was prepared. We assume wall loads will be 6 kips or less per lineal foot and column loads, if any, will be on the order of 100 kips or less.

Development will include asphalt pavement parking, utility infrastructure, and on-site stormwater management facilities. We assume traffic loads will consist primarily of passenger car traffic with occasional delivery vehicles. We anticipate site grading will consist of cuts and fills up to four feet to obtain the desired finished grades.

If the proposed design or loads vary from those stated, we should be notified to review our recommendations and provide additional or revised information, as necessary.

3.0 SITE CONDITIONS

The project site is a 1.43-acre parcel located at the northeast corner of South Ray Street and East 27th Avenue. The property is bordered by East 26th Avenue to the north, residential development to the east, East 27th Avenue to the south, and South Ray Street to the west.

The site is currently developed with a vacant church building with a full depth basement, asphalt parking, and stormwater management infrastructure. The existing stormwater infrastructure consists of two drywells located in the south part of the parking lot. Both appear to be single-depth drywells. At the time of our site visit, the west drywell had less than 1 inch of water and minor silt and debris in the bottom. The east drywell was dry and contained approximately 1½ feet of silt and debris in the bottom.

The project site is cut into a northwest facing slope. Topographically, most of the property is relatively flat. However, the east perimeter consists of an approximate 15-foot high, approximate 2:1 (horizontal:vertical) cut slope with two-tier boulder facing. The tiers are approximately 4 feet high with an approximate 8-foot terrace between them. The terrace is vegetated with relatively small deciduous and coniferous trees and junipers. The upper slope is vegetated with grass.

The northeast property line from the East 26th Avenue entrance to the northeast corner slopes down to the south at an approximate average slope of 5:1 (horizontal:vertical) and the south property line from the East 27th Avenue entrance to the southeast corner slopes down to the north at an average 4:1 slope. The north and south property line slopes are primarily vegetated with junipers, grass, and a few small trees.

No visible signs of slope movement such as stress cracks, scarps, or slough areas were observed at the surface of the slopes. No soil migration or movement of the boulders was observed.

The ground coverage across much of the project site consists of asphalt paved parking with some landscaped areas around the existing building and the perimeter of the site. The asphalt has extensive linear and alligator cracking. There are a few mature trees and shrubs near the northeast corner, the southeast corner, and at the south entrance to the site.

4.0 EVALUATION PROCEDURES

To complete this evaluation, we reviewed soil and geologic literature for the project site and surrounding area. We evaluated the subsurface conditions at the site by excavating eight test pits throughout the project site. Select soil samples were collected from the test pit excavations and returned to our Spokane laboratory for testing to assist evaluation of the properties and engineering characteristics of the on-site soils. Information obtained from the field evaluation, laboratory testing, and geotechnical analyses was utilized to develop the recommendations presented in this report.

4.1 PUBLISHED GEOLOGIC AND SOIL INFORMATION

The geologic conditions in the vicinity of the subject property are mapped as Pleistocene epoch glacial flood deposits, predominately sand, (Qfs), and Middle Miocene Wanapum Basalt, Priest Rapids Member (Mvwp) on the “Preliminary Geologic Map of the Spokane NE 7.5-Minute Quadrangle, Spokane County, Washington” prepared by R. E. Derkey, M. M. Hamilton and D. F. Stradling, 1999. The flood deposit is described as a medium-bedded to massive deposit of sand with trace gravel, cobbles, and boulders and localized lenses and beds of gravel. The Wanapum Basalt formation is described as dark gray to black, fine-grained, and dense.

The USDA Natural Resources Conservation Service (NRCS) has mapped the soils on and around the property as Urban land-Marble, disturbed complex, 3 to 8 percent slopes on the west side of the site and Urban land-Seaboldt, disturbed complex, 8 to 15 percent slopes is mapped on the east side of the property. Marble, disturbed is described as well-drained sandy glaciofluvial deposits. The soil profile is described as loamy sand overlying sand. Seaboldt, disturbed soil is described as well drained loess mixed with minor amounts of volcanic ash, overlying sandy and gravelly glaciofluvial deposits overlying basalt residuum. The soil profile is described as ashy loam grading to extremely gravelly sandy loam overlying basalt bedrock at two to three feet below ground surface. Urban land soils are often highly variable as they consist of human transported material.

4.2 SUBSURFACE EXPLORATION PROGRAM

We observed the excavation of eight test pits at the site on April 11, 2024, utilizing a CAT 305.5E with a 24-inch toothed excavation bucket. The approximate locations of the test pits are shown on Figure A-2, Exploration Location Plan in Appendix A.

The subsurface profiles and soil conditions observed in the test pits were visually described and classified in general accordance with ASTM D 2488. Detailed descriptions of the soil observed within the test pits are presented on individual test pit logs in Appendix B of this report. The descriptive soil terms used on the test pit logs, and in this report, can be referenced by the Unified Soil Classification System (USCS). A summary of the USCS is included in Appendix B.

Subsurface conditions may vary between exploration locations; such changes in subsurface conditions may not be apparent until construction.

4.2.1 Subsurface Conditions

The near surface geologic profile generally appears to consist of topsoil overlying undocumented fill overlying natural sand soils. Undocumented fill consisted of sand with varying amounts of silt and debris.

4.2.2 Groundwater Conditions

We did not observe groundwater within our test pit explorations. We did not observe surface water on the property during our evaluation. Changes in precipitation, irrigation, construction, or other factors may impact depth to groundwater and the surface water flow on the property and therefore, conditions may be different during construction.

5.0 INFILTRATION TESTING

A single-ring falling head infiltration test was performed adjacent to test pit TP-07 at a depth of approximately two feet. The test was performed by pushing a 12-inch diameter steel casing approximately 8-inches into undisturbed soil. The soil in the casing was saturated for one hour prior to conducting the infiltration test. An infiltration rate of 0.24 inches per hour was measured.

6.0 LABORATORY TESTING

We performed the following laboratory tests to supplement field classifications.

- particle size distribution/gradation (ASTM D6913)
- moisture content (ASTM D2216)

The laboratory test results are included in Appendix C of this report. Some results are also summarized on the test pit logs attached to this report in Appendix B.

6.1 MOISTURE CONTENT

The moisture content test results indicate the near surface soils are generally moist. If the moisture content of the near surface silty sand increases above the optimum moisture content it may be easily disturbed and pump or rut under construction traffic.

6.2 CLASSIFICATION

Particle size distribution/gradation test results indicate the upper 10 feet (approximate) of soils at the site consist of silty sand grading to poorly graded sand with silt or poorly graded sand. The silt content generally decreases with depth.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Our understanding of the proposed development and surface and subsurface site conditions were presented in the previous sections of this report. The following conclusions and recommendations are based on this understanding. If the proposed development changes or if unforeseen

conditions are encountered, we must be given the opportunity to review the latest information and, if necessary, update our recommendations. Additionally, prior to construction, we need to be given the opportunity to review the plans and specifications to determine whether the recommendations presented in this report were properly incorporated.

7.1 SITE PREPARATION

7.1.1 Clearing and Stripping

The stripping depth for topsoil removal is estimated to be approximately ½- to 1-foot. However, there are a few mature trees and bushes along the north, south, and east perimeters of the property. Test pit TP-08 was excavated in the vicinity of a large tree. Woody roots were observed in those test pits up to 3½ feet below the ground surface in those areas. Woody roots larger than 3 inches in diameter or an abundance of smaller woody roots are considered deleterious material and should be removed from beneath pavements and structures. Clearing and stripping debris should be wasted off-site or used for topsoil within non-structural/landscape areas.

7.1.2 Undocumented Fill

Undocumented means that there is no documentation of the fill material quality, density, gradation, placement method, etc. and no quality control or quality assurance documentation is available.

Undocumented fill was encountered in test pits TP-01, TP-04, TP-05, TP-06, TP-07, and TP-08. The undocumented fill extended to depths ranging from approximately 1 to 8 feet below the existing ground surface. Undocumented fill generally consisted of silty sand to poorly graded sand with silt and included minor amounts of debris. The undocumented fill soil depth observed at each excavation location is noted in the table below.

Table 1. Undocumented Fill

Test Pit No.	Undocumented Fill Depth (ft)
TP-01	0 - 3½
TP-04	0 - 8
TP-05	0 - 1
TP-06	0 - 1
TP-07	0 - 4
TP-08	0 - 2½

Undocumented fill should be removed the entire depth below structures, flatwork, and pavement. Removal of undocumented fill should extend at least five feet beyond the perimeters of structures, flatwork, and pavement where feasible. The undocumented fill may be reused as structural fill provided it is free of organics and deleterious material.

7.1.3 Test Pit Excavations

Test pit excavations were backfilled with the excavated material following completion. To reduce the potential for future settlement or subsurface disturbance, we recommend that test pit backfill be over-excavated in its entirety below flatwork, pavements and structures and backfilled in properly compacted lifts. The approximate test pit locations are indicated on Figure A-2 of this report, and the test pit depths are included on the test pit logs included in Appendix B of this report.

7.1.4 Subgrade Preparation

Building Areas

Undocumented fill should be removed the entire depth below the flatwork, pavement, and structures. Removal of undocumented fill should extend at least five feet laterally beyond the perimeters of flatwork, pavement, and structures, where feasible. The undocumented fill observed in the test pits may be reused as structural fill provided it is relatively free of organics, deleterious material, and material larger than 3 inches. Additionally, elements of the existing construction should be removed. The exposed subgrade at the base of the over-excavation should be scarified to a depth of approximately 8 inches, properly moisture conditioned, and compacted to at least 90 percent of the maximum dry density determined by ASTM D1557 (modified Proctor).

Pavement and Exterior Flatwork Areas

Full depth removal and replacement of undocumented fill is likely cost prohibitive in pavement areas. In these areas, partial over-excavation, and replacement of the undocumented fill in conjunction with geosynthetic reinforcement may be considered to support pavement and exterior flatwork. At a minimum, it is recommended the subgrade soils in these areas be over-excavated at least 2 feet below the finished subgrade elevation or existing elevation, whichever is greater, and replaced in properly compacted lifts prior to the placement of fill, concrete, or pavement. The exposed subgrade at the base of the over-excavation should be scarified to a depth of approximately 8 inches, properly moisture conditioned, and compacted to at least 90 percent of the maximum dry density determined by ASTM D1557 (modified Proctor).

Geosynthetic reinforcement, consisting of Tensar NX750, BX1200, Mirafi RS380i, or approved equivalent, should be placed between the finished subgrade surface and overlying base course. The owner should be aware there is potential for post-construction settlement of pavements and flatwork if the poorly compacted undocumented fill below the over-excavation and replacement zone is significantly wetted or if traffic loading conditions beyond those assumed herein are significantly exceeded.

In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, we recommend the materials be removed to a sufficient depth to develop stable subgrade soils that can be compacted to the minimum recommended levels. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the subgrade.

7.1.5 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 a minimum 24-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 NX750, BX 1200, or Mirafi Rs380i, or approved equivalent. Alternatives should be approved by the geotechnical engineer prior to use on site. Alternatives 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, such as Mirafi 140N or approved equivalent, should be placed on the properly prepared subgrade. The geosynthetic reinforcement should be placed directly on the filter fabric. Filter fabric is not required if Mirafi Rs380i is used. The filter fabric and geosynthetic reinforcement should be unrolled in the primary direction of fill placement and should be overlapped at least 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 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 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:

Table 2. Structural Fill over Geosynthetics

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.

7.2 WET WEATHER CONSTRUCTION

Due to generally wet conditions in this region during late fall, winter, and spring, we recommend construction (especially site grading) take place during the summer and early fall season. 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. We anticipate additional or mitigative earthwork may be needed to compact silty soils to recommended soil density levels if earthwork is performed during the wetter periods of the year. If construction occurs during or immediately

after excessive precipitation, it may be necessary to over-excavate and replace wet subgrade soil which might otherwise be suitable.

7.3 COLD WEATHER CONSTUCTION

Foundations should be embedded adequately to protect against frost action as recommended in section 7.7 FOUNDATION RECOMMENDATIONS of this report. We recommend removal of frost susceptible soils (soil with fines contents greater than 10 percent) within the upper two-foot frost-depth zone below concrete flatwork (sidewalks, patios, etc.) to reduce the potential for detrimental effects of frost heave.

If site grading and construction is anticipated during freezing weather, we recommend good winter construction practices be observed. Snow and ice should be removed from excavated and fill areas prior to performing earthwork or construction. Footings, floor slabs or structural portions of the construction should not be placed on frozen ground; the supporting soils for buildings should not be permitted to freeze during or after construction. Frozen soils should not be used as fill.

7.4 EXCAVATION

Based on the conditions observed within our explorations, we anticipate excavation of the on-site soil can be achieved with typical excavation equipment. We recommend all permanent cut or fill slopes constructed in native soils be designed at a 2:1 (horizontal:vertical) inclination or flatter.

It is extremely difficult to pre-establish a safe and “maintenance-free” temporary cut slope angle. Temporary excavation slope stability is a function of many factors, including:

- Presence and abundance of groundwater
- Type and density of the various soil strata
- Depth of cut
- Surcharge loading adjacent to the excavation
- Length of time the excavation remains open

It is the responsibility of the contractor to maintain safe temporary slope configurations. Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. Cuts should be adequately sloped, shored, or supported to prevent injury to personnel from local sloughing and spalling. All excavations should conform to applicable federal, state, and local regulations.

Regarding trench wall support, the site soil is considered Type C soil according to OSHA guidelines and therefore should not exceed a 1.5:1 (horizontal:vertical) temporary slope.

7.5 MATERIALS

The undocumented fill and native soils are suitable for use as structural fill, provided they are free of organics, debris, and material larger than 3 inches. The topsoil is not suitable for use as structural fill but may be re-used in non-structural landscape areas.

Import materials should consist of granular soil, free of organics, debris, and other deleterious material and meet the following criteria. Import materials should be approved by the Geotechnical

Engineer prior to delivery to the site. Our recommended requirements for structural fill and utility trench backfill materials are provided in 3.

Table 3. Structural Fill / Utility Trench Backfill Recommendations

Fill Type	Criteria
Structural Fill	Maximum size ≤ 3 inches Retained on ¾-inch sieve <30% Passing No. 4 sieve = 25 – 50% Passing No. 40 sieve = 10 – 20% Passing No. 200 Sieve ≤ 15% - non-plastic
Utility Trench Backfill	Maximum size ≤ 2 inches Passing No. 200 Sieve ≤ 15% - non-plastic
Top Course	Washington State Department of Transportation (WSDOT) 5/8-inch Top Course Standard Specification 9-03.9(3)

7.6 FILL PLACEMENT AND COMPACTION

Fill should be placed in lift thicknesses which are appropriate for the compaction equipment used. Typically, eight-inch loose lifts are appropriate for typical rubber tire and steel drum compaction equipment. Lift thicknesses should be reduced to four inches for hand operated compaction equipment. Fill should be moisture conditioned to within two percentage points of the optimum moisture content prior to placement to facilitate compaction. Fill materials should be compacted to the following maximum dry densities determined by ASTM D1557 (modified Proctor).

Table 4. Minimum Fill Compaction Percentages

Fill Area	Compaction %
Subgrade	90
Site Grading/Pavement	95
Foundations / Slabs / Wall	95
Utility Trench Backfill	95
Top and Base Course	95

7.7 FOUNDATION RECOMMENDATIONS

The proposed buildings may be supported on conventional spread footings bearing on a minimum of 1-foot of structural fill over a properly prepared subgrade as recommended in section 6.1 Site Preparation of this report. The following recommendations are provided for foundations based on the subsurface conditions observed and the stated assumptions:

- Spread footings bearing entirely on a minimum of 1-foot of structural fill over a properly prepared subgrade may be designed for an allowable bearing pressure of 2,500 pounds per square foot (psf). The allowable bearing pressure value may be increased by one-third to account for transient loads such as wind and seismic.
- Unless specified by project engineer or governing codes, continuous footings should be a minimum of 18 inches in width and column footings should be a minimum of 24 inches in width.

- An ultimate value for coefficient of friction between cast-in-place concrete and structural fill of 0.5 may be used for design.
- Foundation bearing surfaces should be free of loose soil and debris.
- Footings should be embedded at least 24 inches below finished exterior ground surface to help protect against frost action.
- We recommend backfill placed adjacent to foundation walls be placed uniformly on both sides of the foundation walls to reduce displacement of the foundation walls.
- If the previous recommendations are implemented, it is our opinion the total settlement will be less than one inch and differential settlement will be less than ½-inch in a 30-foot horizontal span.

7.8 CONCRETE SLABS-ON-GRADE

Concrete slabs-on-grade should be underlain by at least 6 inches of crushed base course. The crushed base course below the slabs should be compacted to at least 95 percent of the maximum dry density established by modified Proctor (ASTM D 1557). The slab subgrade should be prepared as previously recommended.

From a geotechnical perspective, a vapor retarder is not considered necessary beneath the slab-on-grade floor unless moisture sensitive floor coverings and/or adhesives are used. If a vapor retarder is used, we recommend using a 15-mil, puncture-resistant proprietary product such as Stego Wrap, or an approved equivalent that is classified as a Class A vapor retarder in accordance with ASTM E 1745. Overlap lengths and the appropriate tape used to seal the laps should be in accordance with the vapor retarder manufacturer's recommendations. To avoid puncturing of the vapor retarder, we recommend a thin sand layer be placed over the crushed gravel. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

7.9 LATERAL EARTH PRESSURES

Below-grade building walls should be designed to resist lateral earth pressures. Recommended equivalent fluid pressures for on-site soil and structural fill for calculation of lateral earth pressures are presented in Table 8. For recommendations for site retaining wall design, refer to the section 7.11 RETAINING WALLS of this report.

Table 5. Equivalent Fluid Pressures for Lateral Earth Pressures

Condition	Equivalent Fluid Pressure for On-Site Soil and Structural Fill (pcf)
At-rest	55
Active	35
Passive	250

The above values are for level backfill only and do not account for hydrostatic forces. Walls should be provided with adequate drainage so hydrostatic forces do not adversely affect the walls. We recommend placement of gravel behind walls and/or weep holes to assist with drainage and reduce the potential for the buildup of hydrostatic pressures. Walls that are braced in a manner that does not allow any rotational movement (rigid) (e.g., basement walls) should be designed using the given "at-rest" equivalent fluid pressure. 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.

7.10 PERMANENT SLOPES

We recommend all permanent cut or fill slopes constructed in native soils be designed at a 2:1 inclination or flatter. All permanent cut and fill slopes should be protected from erosion both temporarily and permanently. Prior to construction ALLWEST should be provided a copy of the final grading plan to determine whether the proposed site grading will affect the recommendations provided in this report.

7.11 RETAINING WALLS

At the time this report was prepared we had no knowledge of planned retaining walls for this project. If retaining walls are to be constructed as part of this project ALLWEST should be provided the opportunity to review the plans to determine if further geotechnical evaluation is required. We may need to develop wall specific lateral earth pressures depending on location and height of proposed retaining walls. Our scope of services did not include segmental block design, boulder faced slope design, or global stability analyses; we can provide these services for an additional fee, if requested.

7.12 SEISMICITY

We anticipate the 2018 International Building Code (IBC) will be used as the basis for design of the proposed structures. The soil at the site can be characterized as Site Class D for seismic design. The following seismic parameters were calculated using USGS U.S. Seismic Design Maps for use with the 2018 IBC. The latitude and longitude for the site were used to specify the location of the subject property.

Table 6. Seismic Design Parameters

Parameter	Value	Description
Latitude	47.630616	Project site geographic position
Longitude	-117.362829	Project site geographic position
Seismic Site Class	D	Seismic Design Site Classification
Risk Category	II	Seismic design risk category
S_S	0.307	MCER ground motion (period = 0.2s)
S_1	0.111	MCER ground motion (period = 1.0s)
S_{DS}	0.319	Numeric seismic design value at 0.2s
SD_1	0.176	Numeric seismic design value at 1.0s
F_a	1.554	Site amplification factor at 0.2s
F_v	2.377	Site amplification factor at 1.0s
PGA	0.138	MCEG peak ground acceleration
F_{PGA}	1.525	Site amplification factor at PGA
PGA_M	0.210	Site modified peak ground

7.13 PAVEMENT

We understand new asphalt pavement will be constructed on the site for parking and drive lanes. Prior to placing site grading fill or base course, the subgrade should be prepared as recommended in the Site Preparation section of this report. The following assumptions were used in developing our recommendations for the pavement section thickness.

Table 7. Pavement Design Parameters

Criteria	Assumed
ESALs	100,000
Pavement Life	20 years
Subgrade California Bearing	10%
Reliability	85%
Initial Serviceability	4.2
Terminal Serviceability	2.0

The following pavement sections are recommended based on stated ESALs and assumptions. If actual traffic loading varies from that stated in Table 10. Pavement Design Parameters, we should be notified so we may re-evaluate our recommendations.

Table 8. Recommended Flexible Pavement Section

Flexible Pavement		
Pavement Area	**Asphalt (in)**	**Top Course (in)**
Parking Lot	2½	7

Table 9. Recommended Rigid Pavement Section

Rigid Pavement		
Pavement Area	**Concrete**	**Top Course (in)**
Trash Dumpster	6	6

Steel reinforcement for rigid pavement should be designed by the structural engineer using a modulus of subgrade reaction of 200 pounds per cubic inch (pci).

We recommend crushed aggregate top course meeting the requirements of the WSDOT Standard Specification 9-03.9 for ⅝-inch crushed surfacing top course. We recommend the crushed aggregate be compacted to a minimum of 95 percent of the modified Proctor maximum dry density (ASTM D1557). We recommend the asphalt concrete pavement meet the requirements of WSDOT Standard Specification 5-04 for plant mix asphalt concrete pavements. We recommend the asphaltic concrete surface be compacted to minimum of 92 percent of the Rice density.

Pavements should be sloped to provide rapid drainage of surface water. Additionally, the pavement subgrade should be graded to provide positive drainage within the crushed aggregate base section. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration.

The pavement sections provided in this report represent minimum recommended thicknesses. Preventive maintenance should be planned and provided for with an on-going pavement management program. Preventive maintenance is intended to slow the rate of pavement deterioration and preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g., crack, and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

7.14 STORMWATER AND DRAINAGE

Final stormwater management plans were not available at the time this report was prepared. We anticipate stormwater runoff will be directed to one or more grassed swale(s) with drywells around the proposed building development. If the existing drywells are to remain in place and be utilized as part of the new stormwater management system, we recommend they be tested to verify the respective outflow rates.

We recommend the grading plan include slopes such that storm water run-off is directed away from buildings and pavement areas to a stormwater management system. We recommend the ground surface adjacent to foundations be sloped a minimum of five percent within ten feet of the building. If the adjoining ground surface consists of hardscapes, it may be sloped a minimum of two percent in the first ten feet. Water should not be allowed to infiltrate or pond adjacent to the foundations.

7.14.1 Drywells

Drywell outflow rates for the site were estimated in accordance with the Spokane 200 method as outlined within the Spokane Regional Stormwater Manual (SRSM). This method estimates drywell outflow rates based on the fines content of the soil (the percentage of soil particles passing a No. 200 sieve).

ALLWEST performed gradation testing on samples at depth from test pits at various locations across the site. The testing indicated a fines content of 3.4 to 8.9 percent for the native soils below 2 to 7½ feet, depending upon location. Recommended drywell outflow rates based on the soils encountered at the tested locations are provided in Table 10.

Table 10. Estimated Drywell Outflow Rates

TP ID	Sample Depth (ft)	USCS	Percent Fines (%)	Hydraulic Conductivity (cm/s)	Normalized Outflow Rate (cfs/f)	Factor of Safety	Actual Drywell Outflow Rate (cfs)		Estimated Design Drywell Outflow Rate (cfs)	
							Type A	Type B	Type A	Type B
TP-01	5-6	SP-SM	8.9	1.05E-02	3.09E-02	2.3	0.186	0.309	0.081	0.135
TP-02	4-5	SP-SM	7.2	1.56E-02	4.36E-02	2	0.262	0.436	0.131	0.218
TP-07	5-6	SP	3.4	6.41E-02	1.47E-01	1.3	0.880	1.466	0.3	1.0
TP-08	6-7	SP	3.8	5.20E-02	1.23E-01	1.3	0.735	1.225	0.3	0.942

Maximum design outflow rates are limited to 0.3 cfs for single depth type “A” and 1.0 cfs for double depth type “B” drywells - in accordance with the SRSM -7.5.2.

7.14.2 Gravel Galleries

ALLWEST performed a falling head single ring infiltrometer test at INF-1 in the upper silty sand (SM). The test location is shown on Figure A-2 attached to this report. Based on the in-situ test results, the anticipated additional stormwater produced by the site improvements may be treated with biofiltration swales and disposed of in infiltration galleries. See Table 14 for actual and recommended design infiltration rates. Recommended design rates are based on the onsite testing and include a factor of safety of 2.5 in the silty sand. Gravel galleries should be sized with a minimum of 2 feet of sidewall infiltration. All stormwater management features shall be designed in accordance with the SRSM.

Table 1. Recommended Gravel Gallery Infiltration Rates

Test Location	Actual Infiltration Rate (ft/s)	Soil Type	Design Infiltration Rate (ft/s)
INF-1	5.81E-06	SM	2.32E-06

Infiltration rates in undocumented fill will vary due to varying levels of compaction. ALLWEST recommends stormwater be disposed of in natural sands and gravels.

Swales and ponds constructed in silt soils should be sized using equation 6-1B and 6-1D in the SRSM based on the infiltration testing results. If swale bottoms are to be extended to depth where the poorly graded sand was encountered, then equations 6-1A and 6-1C should be used for sizing swales.

8.0 ADDITIONAL RECOMMENDED SERVICES

We recommend ALLWEST be retained to provide construction materials testing and observation to verify the site soil and geologic conditions and the report recommendations are incorporated into the actual construction. The design engineer of record should determine applicable testing and special inspection requirements in accordance with the governing code documents. If we are not retained to provide required construction observation and materials testing services, we cannot be responsible for soil engineering related construction errors or omissions.

9.0 EVALUATION LIMITATIONS

This report has been prepared to assist the planning and design of the Bethany Presbyterian Church Housing project located at 2607 South Ray Street, Spokane County Parcel Number 35273.0618 in Spokane, Washington. Reliance by any other party is prohibited without the written authorization of ALLWEST. Our services consist of professional opinions and conclusions made in accordance with generally accepted geotechnical engineering principles and practices in the local area at the time this report was prepared. This acknowledgement is in lieu of all warranties, express or implied.

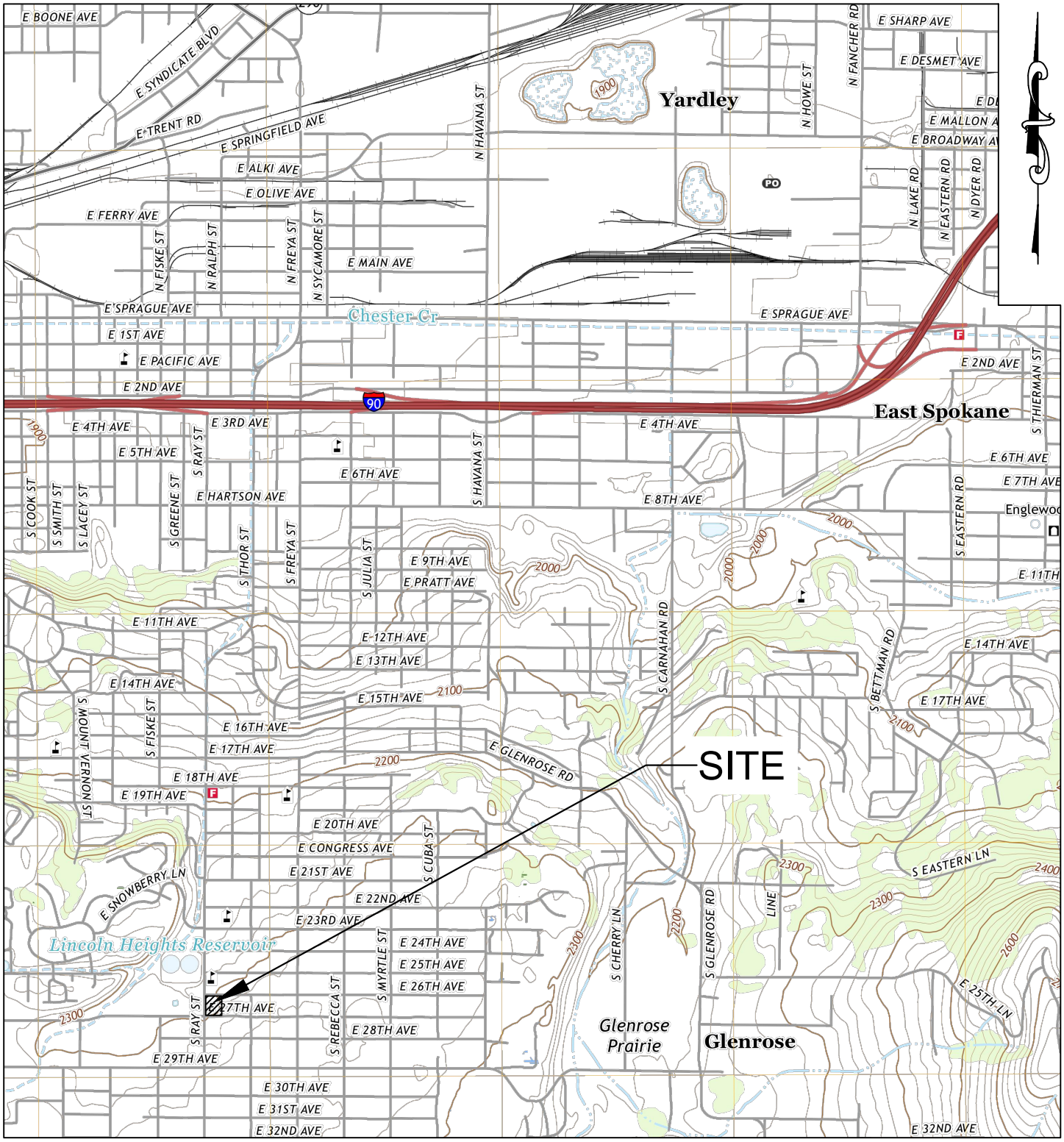
APPENDICES

The following appendices complete this report:

- Appendix A – Vicinity Map, Exploration Location Map, Over-Excavation Detail
- Appendix B – Test Pit Logs, Soil Classification Legend
- Appendix C – Laboratory Test Results, Infiltration Test Results

APPENDIX A

VICINITY MAP
EXPLORATION LOCATION MAP
OVER-EXCAVATION DETAIL



BASEMAP SOURCE: USGS TOPOGRAPHIC MAP, SPOKANE NE QUADRANGLE
WASHINGTON-SPOKANE COUNTY, 7.5-MINUTE SERIES, DATED 2020

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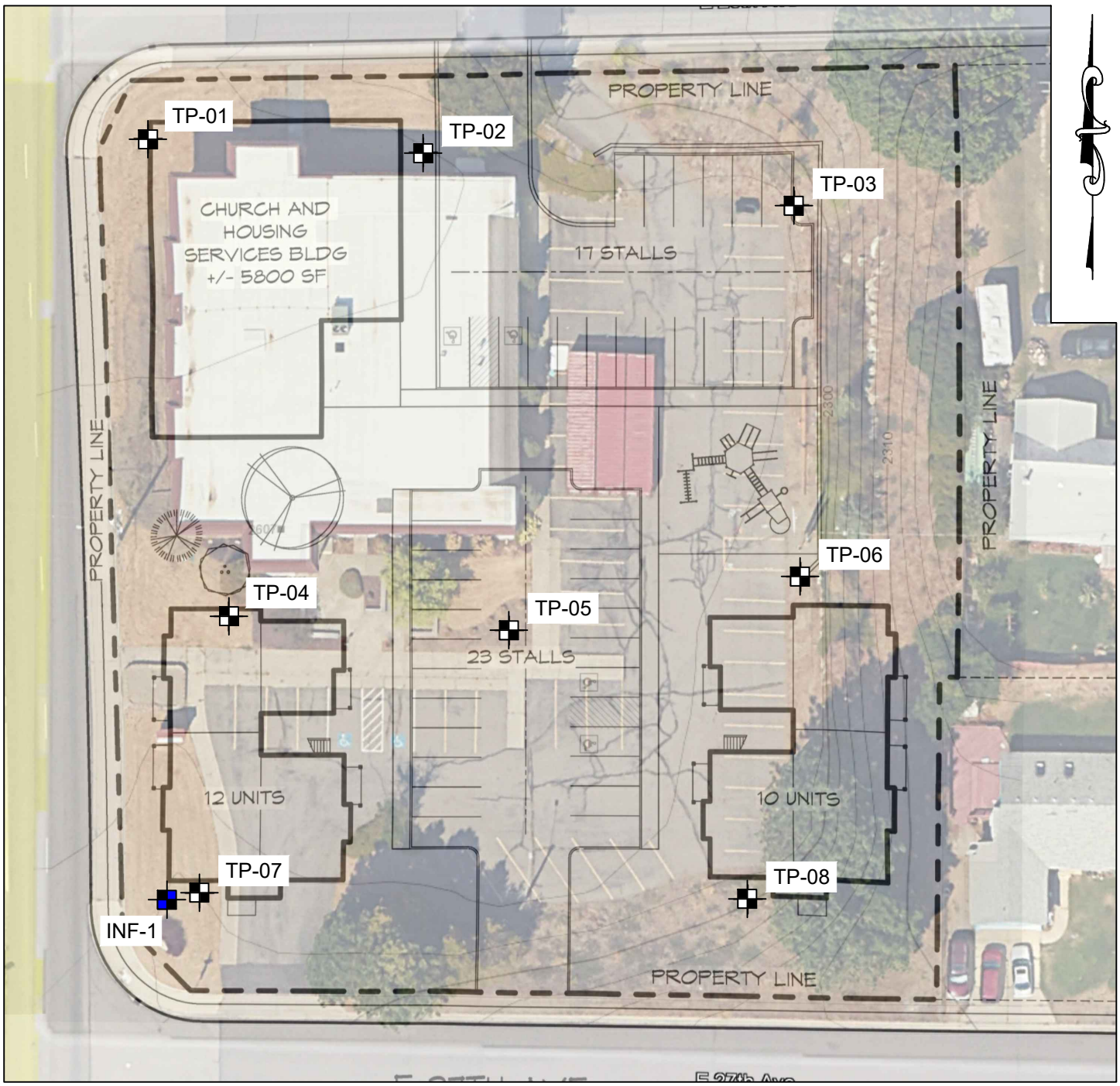
Spokane Valley, Washington
(509) 534-4411
www.allwesttesting.com

FIGURE A-1: VICINITY MAP

PROJECT:	224-068G BETHANY PRESBYTERIAN CHURCH HOUSING		
LOCATION:	2607 SOUTH RAY STREET		
CLIENT:	KIEMLE HAGOOD		
DATE:	MAY 2024	SCALE:	1-IN = 2,000 FT



BASEMAP SOURCES: GOOGLE EARTH IMAGERY DATE 7/15/2024
SITE CONCEPT PLAN, DATED 5/22/2023 BY ZBA ARCHITECTURE

0 20 40 80

SCALE: 1" = 40'

LEGEND:

TP-# TEST PIT NUMBER AND APPROXIMATE LOCATION

INF-# INFILTRATION TEST NUMBER AND APPROXIMATE LOCATION

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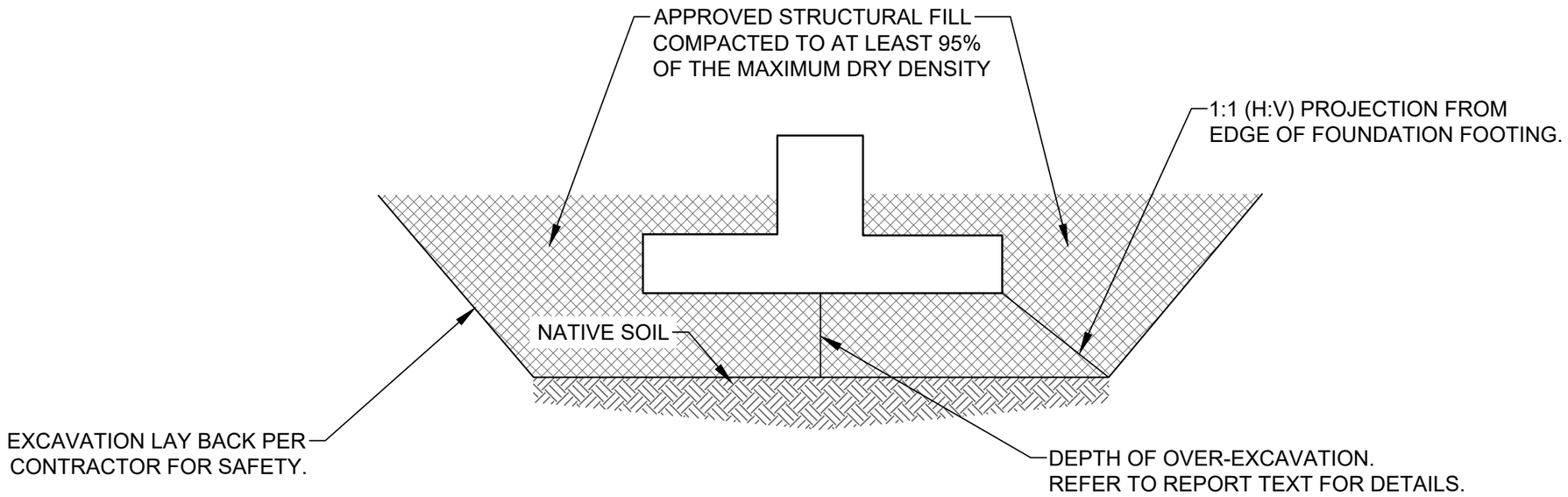
FIGURE A-2: EXPLORATION LOCATION MAP

PROJECT:	224-068G BETHANY PRESBYTERIAN CHURCH HOUSING		
LOCATION:	2607 SOUTH RAY STREET		
CLIENT:	KIEMLE HAGOOD		
DATE:	MAY 2024	SCALE:	AS SHOWN



NOT TO SCALE

NOTES:

1. SUBGRADE TO BE APPROVED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF ANY FILL
2. OVER-EXCAVATION OF UNSUITABLE MATERIAL TO EXTEND AT LEAST FIVE FEET BEYOND THE FOOTPRINT OF ALL STRUCTURAL ELEMENTS OF CONSTRUCTION
3. ALL STRUCTURAL FILL SHOULD BE COMPACTED TO AT LEAST 95% OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D1557 MODIFIED PROCTOR

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FIGURE A-4: OVER-EXCAVATION DETAIL

PROJECT:	224-068G BETHANY PRESBYTERIAN CHURCH HOUSING		
LOCATION:	2607 SOUTH RAY STREET		
CLIENT NAME:	KIEMLE HAGOOD		
DATE:	MAY 2024	SCALE:	NOT TO SCALE

APPENDIX B

TEST PIT LOGS
SOIL CLASSIFICATION LEGEND

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-01

Project No.:	224-068G	Date:	04/11/2024	Comments: Irrigation line at approximately 4 inches below ground surface. Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	7.5'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2296'	
Logged By:	B. Borer	Coordinates:	47.63092, -117.363	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: Lab Sample ID	Lab: Moisture Content (%)	Lab: % Gravel	Lab: % Sand	Lab: % Fines
	2296								
		TOPSOIL; silty SAND (SM); loose, moist, fine- to coarse-grained, dark brown — 0.4							
	2295	UNDOCUMENTED FILL; silty SAND (SM); some concrete debris, moderately compacted, moist, fine- to medium-grained, brown — 1.5							
		UNDOCUMENTED FILL; silty SAND (SM); moderately compacted, slightly moist, fine-grained, brown. Approximately 2 ft pocket (at 1½ to 3½ ft) of dark gray, medium- to coarse-grained sand on west side of test pit. — 3.5							
		Poorly graded SAND with silt (SP-SM); trace gravel, medium dense, slightly moist to moist, fine- to medium-grained, brown (outburst flood deposit)							
5				Grab	S224-0134	7	1	90	8.9
	2290								
		7.5							

Test pit terminated at 7½ feet due to severe caving.

Graphics Legend

SM

SM

SP-SM

Grab - Grab Sample

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-02

Project No.:	224-068G	Date:	04/11/2024	Comments: Irrigation line at approximately 1 ft below ground surface. Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	8'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2298'	
Logged By:	B. Borer	Coordinates:	47.63091, -117.36267	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
	2298	TOPSOIL; silty SAND (SM); some woody roots, loose, moist, fine- to coarse-grained, dark brown 0.5							
		Poorly graded SAND with silt (SP-SM); trace gravel, medium dense, moist, fine- to coarse-grained, stratified, brown (outburst flood deposit)							
	2295								
5				Grab	S224-0135	5	4	89	7.2
	2290	8.0							

Test pit terminated at 8 ft due to severe caving.

Graphics Legend

SM

SP-SM

Grab - Grab Sample

-

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-03

Project No.:	224-068G	Date:	04/11/2024	Comments: Four irrigation line at approximately 6 inches below ground surface. Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	10.5'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2300'	
Logged By:	B. Borer	Coordinates:	47.63087, -117.36224	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: % Gravel	Lab: % Sand	Lab: % Fines
	2300	TOPSOIL; silty SAND (SM); some woody roots, loose, moist, fine- to coarse-grained, dark brown					
		0.5					
		Poorly graded SAND (SP); trace gravel and cobbles, medium dense, moist, fine- to coarse-grained, brown (outburst flood deposit)					
5	2295						
				Grab			
10	2290						
		10.5					

Test pit terminated at 10½ ft.

Graphics Legend

SM

SP

Grab - Grab Sample

-

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-04

Project No.:	224-068G	Date:	04/11/2024	Comments: Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	10.5'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2299'	
Logged By:	B. Borer	Coordinates:	47.63054, -117.3629	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples	Lab				
				Sample Type	Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
	2299	TOPSOIL; silty SAND (SM); some woody roots, loose, moist, fine- to coarse-grained, dark brown							
		0.9							
		UNDOCUMENTED FILL; poorly graded SAND with silt (SP-SM); medium dense, moist, fine- to coarse-grained, brown							
				Grab	S224-0136	7	1	89	9.6
	2295								
5		Cobble size concrete chunk at 5 feet.							
		Trace brick fragments, concrete rubble, and a piece of furnace slag at 7 feet. Two large woody roots at 7½ feet.							
		8.0							
		Poorly graded SAND (SP); trace gravel and debris, medium dense, moist, fine- to coarse-grained, brown (outburst flood deposit)							
	2290								
10									
		10.5							
		Test pit terminated at 10½ feet.							

Graphics Legend

SM

SP

SP-SM

Grab - Grab Sample

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-05

Project No.:	224-068G	Date:	04/11/2024	Comments: Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	9'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2299'	
Logged By:	B. Borer	Coordinates:	47.63053, -117.36257	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: % Gravel	Lab: % Sand	Lab: % Fines
	2299	TOPSOIL; silty SAND (SM); minor woody roots, loose, moist, fine- to coarse-grained, dark brown					
		0.6					
		FILL (3/8-IN MINUS CSTC); poorly graded SAND with silt (SP-SM); poorly compacted, moist, fine- to coarse-grained, angular, light gray					
		1.0					
		Poorly graded SAND with silt (SP-SM); medium dense, moist, fine- to coarse-grained, brown (outburst flood deposit)		Grab			
		3.0					
	2295	Poorly graded SAND (SP); trace gravel and cobbles, medium dense, moist, fine- to coarse-grained, stratified, brown (outburst flood deposit)					
5							
	2290	9.0					

Test pit terminated at 9 feet due to caving.

Graphics Legend

SM

SP-SM

SP-SM

SP

Grab - Grab Sample

-

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-06

Project No.:	224-068G	Date:	04/11/2024	Comments: Irrigation line at approximately 5 inches below ground surface. Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	10'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2301'	
Logged By:	B. Borer	Coordinates:	47.63057, -117.36223	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: % Gravel	Lab: % Sand	Lab: % Fines
	2301						
	2300	TOPSOIL; silty SAND (SM); minor woody roots, loose, moist, fine- to coarse-grained, dark brown — 0.2					
		UNDOCUMENTED FILL; silty SAND (SM); poorly compacted, moist, fine- to medium-grained, brown — 1.0					
		Poorly graded SAND (SP); trace gravel, medium dense, slightly moist to moist, fine- to coarse-grained, stratified, brown (outburst flood deposit)					
		Pocket of gray coarse sand at 1 to 3 feet.		Grab			
5	2295						
10		10.0					
		Test pit terminated at 10 ft.					

Graphics Legend

SM

SP

SM

Grab - Grab Sample

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-07

Project No.:	224-068G	Date:	04/11/2024	Comments: Infiltration test performed at 2 ft below ground surface adjacent to test pit. Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	11'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2302'	
Logged By:	B. Borer	Coordinates:	47.63032, -117.36293	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
	2302	TOPSOIL; silty SAND (SM); loose, moist, dark brown — 0.3							
		UNDOCUMENTED FILL; well graded SAND with silt (SW-SM); moderately compacted, moist, fine- to medium-grained, brown							
	2300			Grab	S224-0137	8	0	90	9.6
		— 4.0							
		Poorly graded SAND (SP); medium dense, slightly moist, medium-grained (outburst flood deposit)							
5				Grab	S224-0138	5	0	97	3.4
	2295	— 7.0							
		Poorly graded SAND (SP); trace gravel, medium dense, slightly moist to moist, fine- to medium-grained, stratified, brown (outburst flood deposit)							
10		— 11.0							
		Test pit terminated at 11 feet.							

Graphics Legend

SM — SP

SW-SM — Grab - Grab Sample

Water Levels

▽ No groundwater encountered during excavation.

▼ -

Bethany Presbyterian Church Housing

2607 S Ray St, Spokane, WA 99223, USA

TP-08

Project No.:	224-068G	Date:	04/11/2024	Comments: Test pit backfilled upon completion.
Contractor:	Dave's Bobcat Service	Hole Depth:	11'	
Equipment:	CAT305.5E	V. Datum:	WGS84	
Operator:	D. Schmidt	Elevation:	~2304'	
Logged By:	B. Borer	Coordinates:	47.63032, -117.36229	

Depth (ft)	Elevation (ft)	Soil Description and Remarks	Graphic Log	Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
	2304	TOPSOIL; silty SAND (SM); abundant woody roots, loose, moist, fine- to coarse-grained, dark brown — 0.3						
		UNDOCUMENTED FILL; silty SAND (SM); poorly compacted, moist, fine- to medium-grained, brown						
		Abundant woody roots to 3½ feet. — 2.5						
		Poorly graded SAND with gravel (SP); medium dense, slightly moist to moist, fine- to coarse-grained, stratified, brown (outburst flood deposit)						
	2300							
5				S224-0139	6	16	80	3.8
	2295							
10								
		11.0						

Test pit terminated at 11 ft.

Graphics Legend

SM

SP

SM

Grab - Grab Sample

Water Levels

▽ No groundwater encountered during excavation.

▼ -

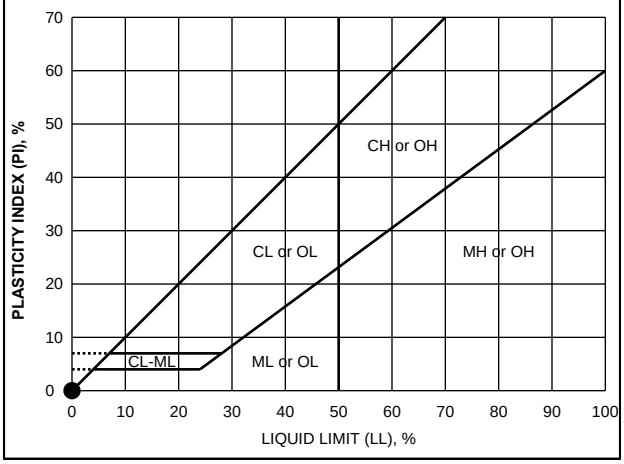
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			SECONDARY DIVISIONS		
			GROUP SYMBOL		GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly-graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly-graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly-graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction retained on No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly-graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly-graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly-graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic CLAY
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above 'A'-line)	organic CLAY
			OH (plots below 'A'-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

APPENDIX C

LABORATORY TEST RESULTS
INFILTRATION TEST RESULTS

Table C-1: Summary of Laboratory Test Results

			Gradation			
Test Pit #	**Depth (ft)**	**Moisture (%)**	**Gravel (%)**	**Sand (%)**	**Silt / Clay (%)**	**Sample Classification**
TP-01	5-6	7	1	90	8.9	Poorly graded sand with silt (SP-SM)
TP-02	4-5	5	4	89	7.2	Poorly graded sand with silt (SP-SM)
TP-04	3-4	7	1	89	9.6	Fill; poorly graded sand with silt (SP-SM)
TP-07	2-3	8	0	90	9.6	Well graded sand with silt (SW-SM)
TP-07	5-6	5	0	97	3.4	Poorly graded sand (SP)
TP-08	6-7	6	16	80	3.8	Poorly graded sand with gravel (SP)

ALLWEST

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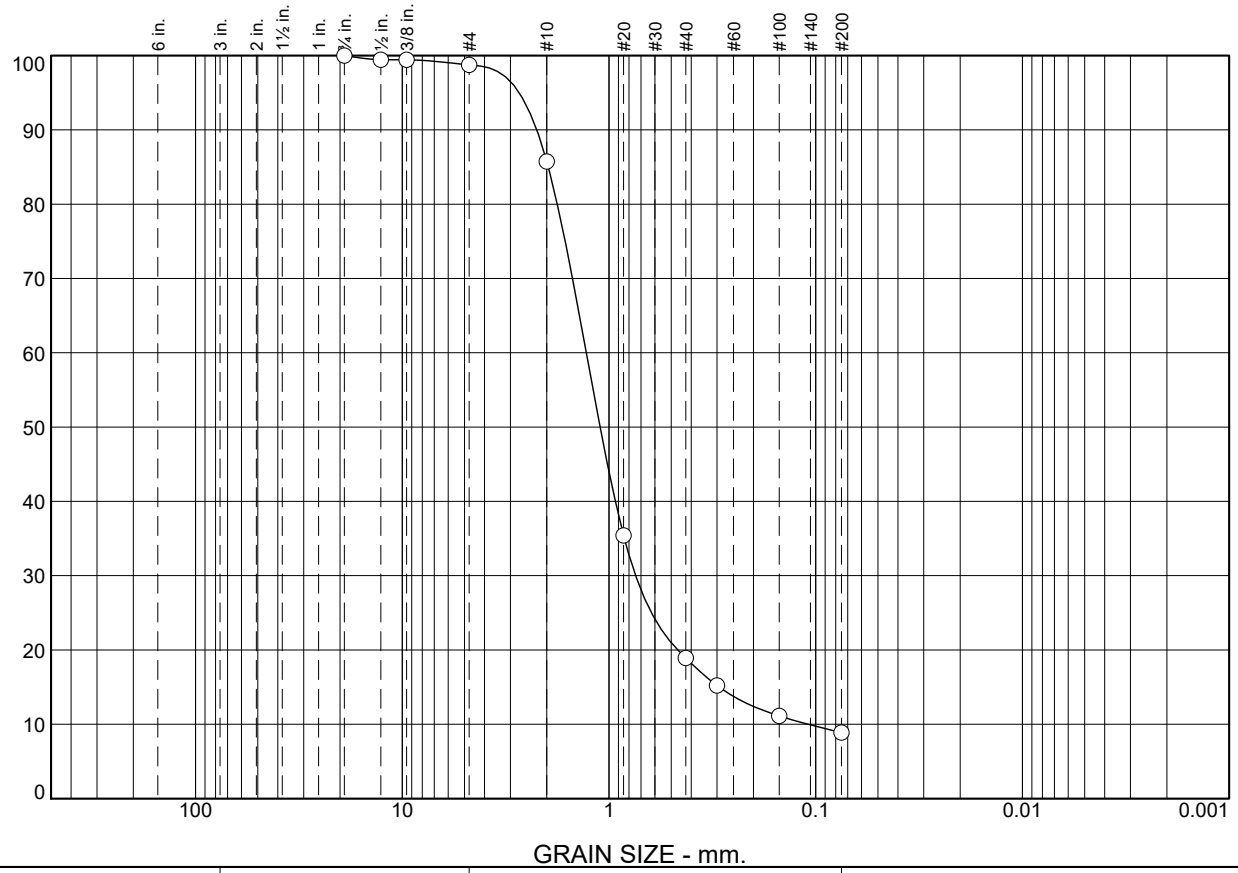
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	13	67	10	9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100		
1/2"	99		
3/8"	99		
#4	99		
#10	86		
#20	35		
#40	19		
#50	15		
#100	11		
#200	8.9		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 2.2353 D_{85}= 1.9673 D_{60}= 1.2873
D_{50}= 1.1033 D_{30}= 0.7427 D_{15}= 0.2930
D_{10}= 0.1087 C_u= 11.84 C_c= 3.94

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture content; 7%
B. Borer sampled 4/11/24

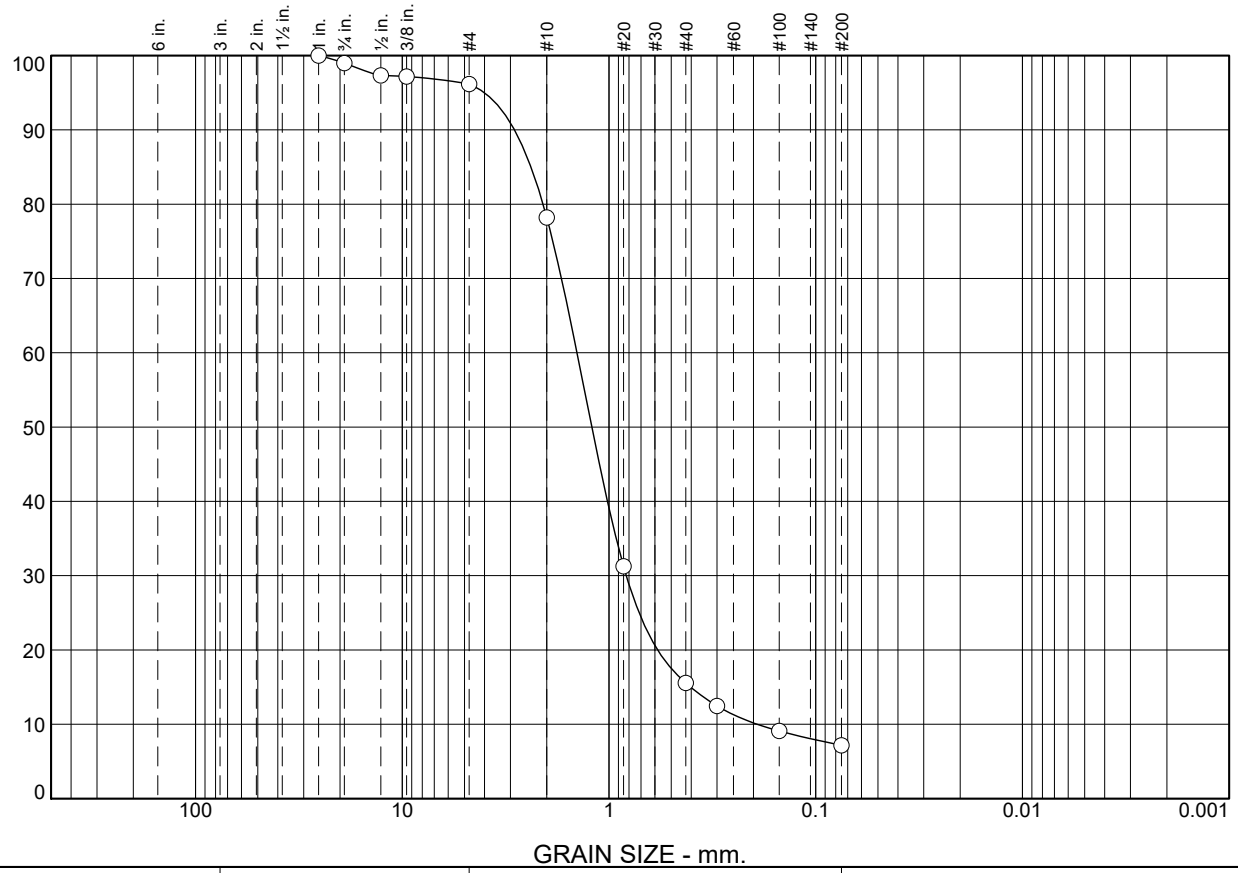
Location: TP-01
Sample Number: S224-0134 **Depth:** 5-6' **Date:** 4/18/24

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-1

Tested By: B. Adona **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	1	3	18	62	9	7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	99		
1/2"	97		
3/8"	97		
#4	96		
#10	78		
#20	31		
#40	16		
#50	12		
#100	9		
#200	7.2		

* (no specification provided)

Soil Description

Well-graded sand with silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 2.8657 D_{85}= 2.3847 D_{60}= 1.4286
D_{50}= 1.2102 D_{30}= 0.8247 D_{15}= 0.4026
D_{10}= 0.1919 C_u= 7.44 C_c= 2.48

Classification

USCS= SW-SM AASHTO=

Remarks

Moisture content; 5%
B. Borer sampled 4/11/24

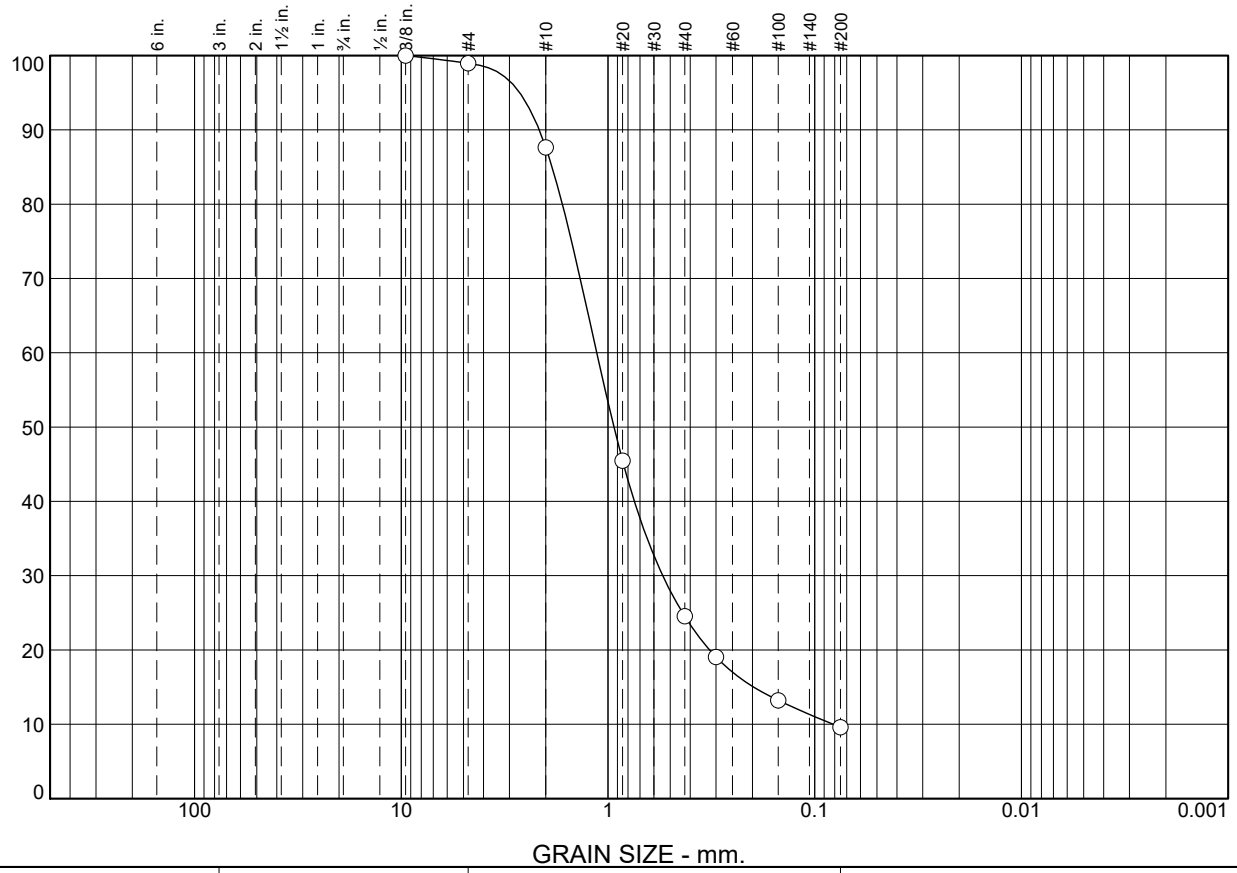
Location: TP-02
Sample Number: S224-0135 **Depth:** 4-5' **Date:** 4/18/24

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-2

Tested By: B. Adona **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	11	63	15	10	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	99		
#10	88		
#20	45		
#40	25		
#50	19		
#100	13		
#200	9.6		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 2.1504 D_{85}= 1.8646 D_{60}= 1.1331
D_{50}= 0.9354 D_{30}= 0.5435 D_{15}= 0.1973
D_{10}= 0.0814 C_u= 13.92 C_c= 3.20

Classification

USCS= SP-SM AASHTO=

Remarks

Moisture content; 7%
B. Borer sampled 4/11/24

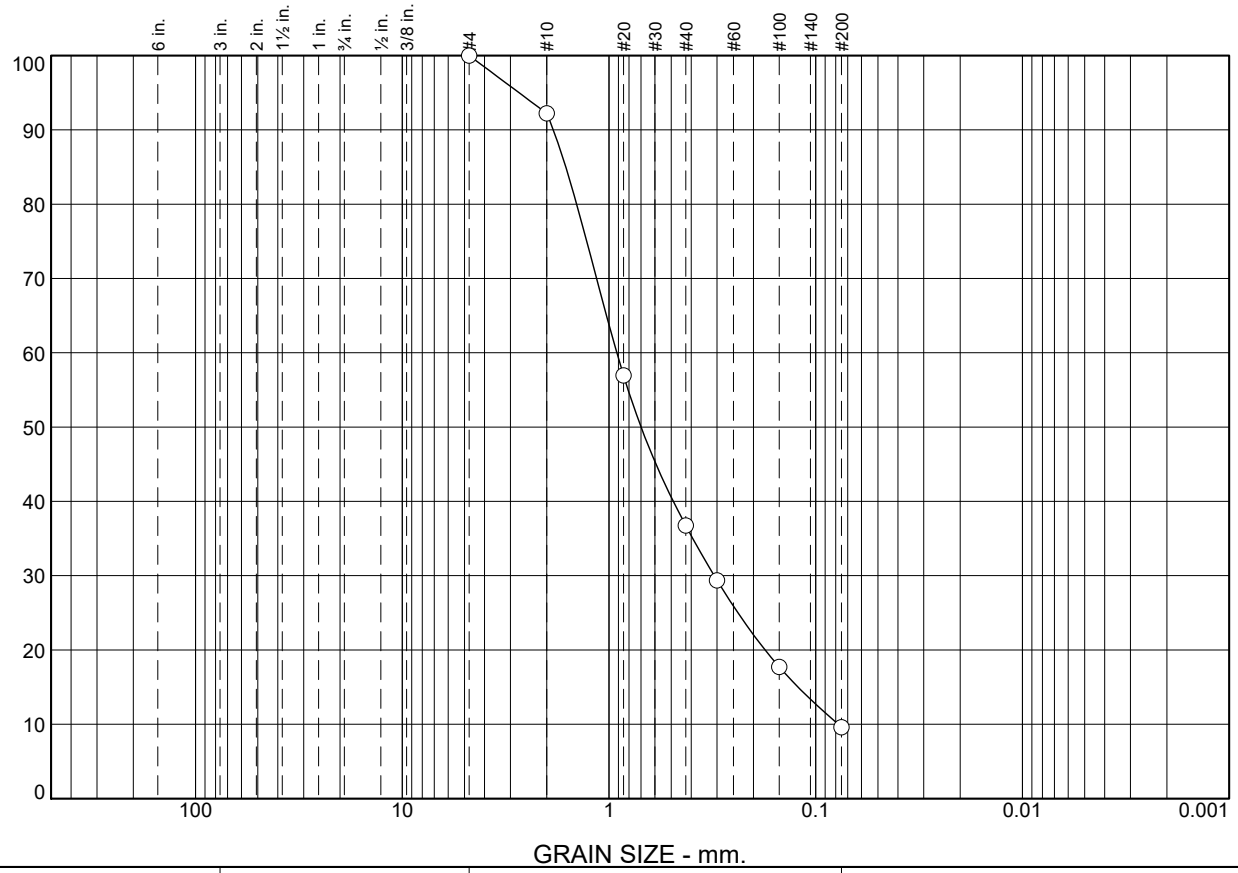
Location: TP-04
Sample Number: S224-0136 **Depth:** 3-4' **Date:** 4/18/24

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-3

Tested By: B. Adona **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	8	55	27	10	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	92		
#20	57		
#40	37		
#50	29		
#100	18		
#200	9.6		

* (no specification provided)

Soil Description

Well-graded sand with silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 1.8588 D_{85}= 1.6184 D_{60}= 0.9161
D_{50}= 0.6997 D_{30}= 0.3097 D_{15}= 0.1216
D_{10}= 0.0779 C_u= 11.77 C_c= 1.34

Classification

USCS= SW-SM AASHTO=

Remarks

Moisture content; 8%
B. Borer sampled 4/11/24

Location: TP-07
Sample Number: S224-0137 **Depth:** 2-3' **Date:** 4/18/24

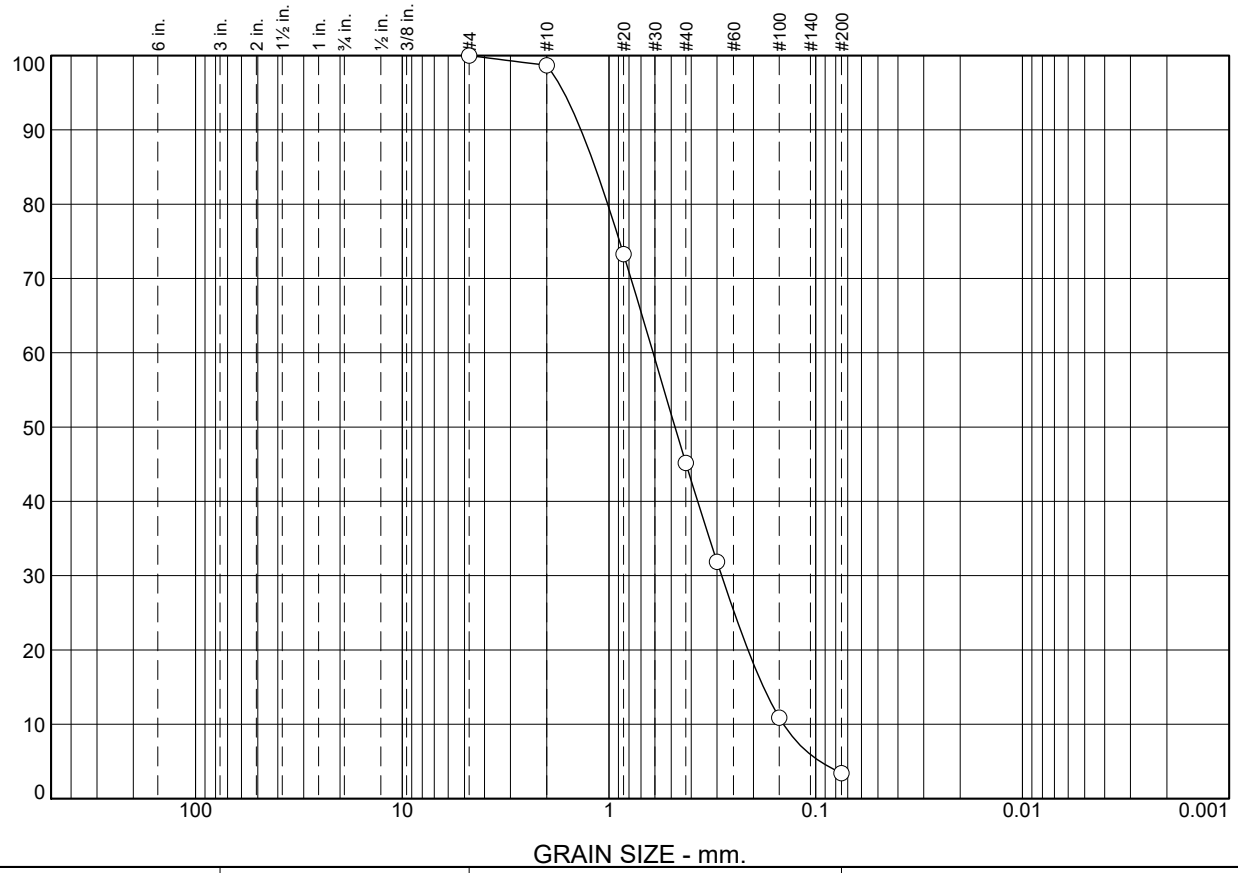
ALLWEST

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-4

Tested By: B. Adona **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	54	42	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	99		
#20	73		
#40	45		
#50	32		
#100	11		
#200	3.4		

* (no specification provided)

Soil Description

Poorly graded sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 1.3667 D_{85}= 1.1680 D_{60}= 0.6119
D_{50}= 0.4793 D_{30}= 0.2850 D_{15}= 0.1789
D_{10}= 0.1433 C_u= 4.27 C_c= 0.93

Classification

USCS= SP AASHTO=

Remarks

Moisture content; 5%
B. Borer sampled 4/11/24

Location: TP-07
Sample Number: S224-0138 **Depth:** 5-6' **Date:** 4/18/24

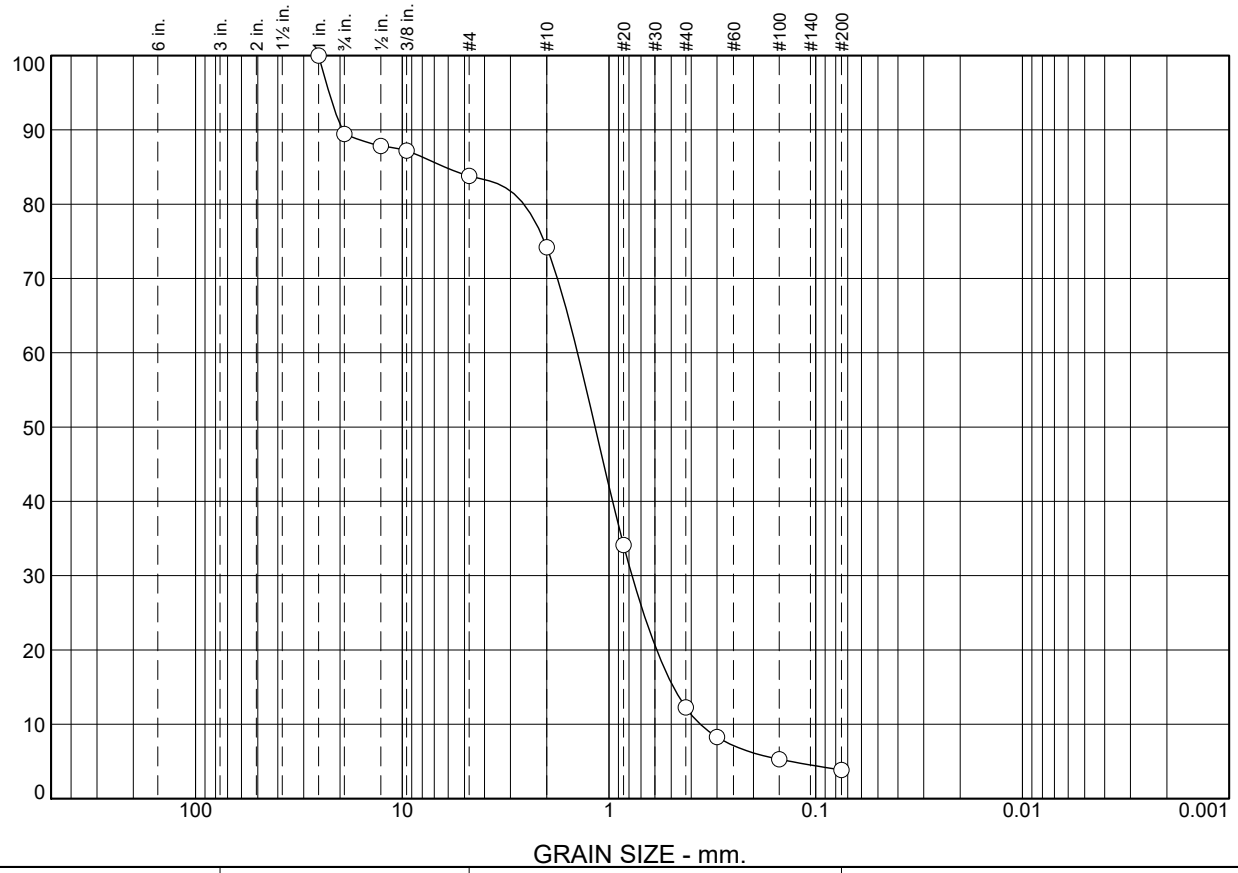
ALLWEST

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-5

Tested By: B. Adona **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	11	5	10	62	8	4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	89		
1/2"	88		
3/8"	87		
#4	84		
#10	74		
#20	34		
#40	12		
#50	8		
#100	5		
#200	3.8		

* (no specification provided)

Soil Description

Poorly graded sand with gravel

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 19.4955 D_{85}= 6.2411 D_{60}= 1.4199
D_{50}= 1.1668 D_{30}= 0.7737 D_{15}= 0.4876
D_{10}= 0.3617 C_u= 3.93 C_c= 1.17

Classification

USCS= SP AASHTO=

Remarks

Moisture content; 6%
B. Borer sampled 4/11/24

Location: TP-08
Sample Number: S224-0139 **Depth:** 6-7' **Date:** 4/18/24

ALLWEST

Client: Kiemle & Hagood Company
Project: Bethany Presbyterian Church

Project No: 224-068G **Figure No.** C-6

Tested By: B. Adona **Checked By:** D. Schmitz

FALLING HEAD INFILTRATION TEST
INF-1

Bethany Presbyterian Church Housing
Project No. 224-168G

Date: 4/11/2024

Test ID: INF-1
Location: See Exploration Location Map - Figure 2
Elevation: ~2 ft below existing ground surface
Soil Description: Silty sand (SM)

Ring Dimensions

Diameter, D, (in):	12	**Length, L, (in):**	24
Area, A, (in^2):	113.1	**Volume, a, (in^3):**	2714.3
		Embedment (in):	1

Notes:
Constant rate test attempted: flow rate too slow to measure with flow meter, switched to falling head test after 60 mins. Falling head test performed without anomolies.

Permeability Test Data

Start Time: 9:00 AM

Stage	Time (min)	Depth to Water (in)	Δ (cf)	Flow Rate (cfs)	I (ft/s) (Q/A)
Pre-soak	0	24.00	---	---	---
	60	0.40	0.00	5.45E-06	6.94E-06
Begin Test	70	0.45	0.00	5.45E-06	6.94E-06
	80	0.49	0.00	4.36E-06	5.56E-06
	90	0.53	0.00	4.36E-06	5.56E-06
	100	0.57	0.00	4.36E-06	5.56E-06
	110	0.61	0.00	4.36E-06	5.56E-06
	120	0.65	0.00	4.36E-06	5.56E-06
	125	0.67	0.00	4.36E-06	5.56E-06
	130	0.69	0.00	4.36E-06	5.56E-06
	135	0.71	0.00	4.36E-06	5.56E-06
End Test	140	0.73	0.00	4.36E-06	5.56E-06

Average Infiltration Rate (in/hr):	**0.24**
Average Infiltration Rate "I" (ft/s) :	**5.81E-06**
Design Infiltration Rate (in/hr):	**0.10**
Design Infiltration Rate "I" (ft/s):	**2.32E-06**

Recommended Factor of Safety:
2.5