February 14, 2023

Mr. Josh Cochran
Dr. C's Family Dentistry
13514 East 32nd Avenue
Spokane Valley, Washington 99216

Attention: Mr. Josh Cochran

RE: Geotechnical Evaluation
Proposed Multi-Family Housing
5115 South Freya Street
Spokane, Washington99223
ALLWEST Project No. 222-275G

Mr. Cochran:

ALLWEST has completed the authorized geotechnical evaluation for the proposed multi-family housing project located at 5115 South Freya Street 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 on this project. If you have any questions or need additional information, please call.

Sincerely,

ALLWEST

Prepared by:

Brenda Borer
Engineering Operation Manager

Reviewed by:

Scott Fraser P.E.
Engineering Services Manager

GEOTECHNICAL EVALUATION
PROPOSED MULTI-FAMILY HOUSING
5115 SOUTH FREYA STREET
SPOKANE, WASHINGTON
ALLWEST PROJECT NO. 222-275G

February 14, 2023

Prepared for:
DR. C'S FAMILY DENTISTRY
13514 EAST 32ND AVENUE
SPOKANE VALLEY, WASHINGTON 99216

Prepared by:
ALLWEST
16617 EAST EUCLID, BLDG. A
SPOKANE VALLEY, WA 99216

TABLE OF CONTENTS
GEOTECHNICAL EVALUATION
PROPOSED MULTI-FAMILY HOUSING
5115 SOUTH FREYA STREET
SPOKANE, WASHINGTON

EXECUTIVE SUMMARY

ALLWEST has completed the authorized geotechnical evaluation for the Proposed Multi-Family Housing project located at 5115 South Freya Street 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. 222-275G dated October 13, 2022. 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 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 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:

- Native soils are suitable for re-use as structural fill. The topsoil is not suitable for re-use as structural fill.
- An allowable bearing pressure of 2,000 pounds per square foot (psf) can be used for shallow footings bearing on one foot of structural fill overlying properly prepared subgrade.
- A pavement section of 3-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 Spokane Regional Stormwater Manual (SRSM). Gravel galleries should be designed using design infiltration rates provided in Table 7. Type A and B drywells are not recommended for the disposal of stormwater. Low-profile drywells may be used for the disposal of stormwater and designed with a recommended outflow rate of 0.1 cubic feet per second.

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. Section *8.0 EVALUATION LIMITATIONS* should be read for an understanding of the report limitations.

GEOTECHNICAL EVALUATION
PROPOSED MULTI-FAMILY HOUSING
5115 SOUTH FREYA STREET
SPOKANE, WASHINGTON

1.0 PROJECT DOCUMENTS

ALLWEST reviewed the Schematic Site Plan #3, prepared by Mercier Architecture and Planning, dated August 16, 2022, to help develop our understanding of the planned development.

2.0 PROJECT DESCRIPTION

According to the plans cited above, a multi-family residential housing development consisting of six duplexes and six townhouses is proposed on an approximately 2.96-acre, partially developed site located at 5115 South Freya Street in Spokane, Washington. Specific design criteria were not available at the time this report was prepared. We anticipate the buildings will be constructed with light timber framing supported on conventional spread footings with concrete slab-on-grade floors. We assume wall loads will be on the order of 2 kips per lineal foot and column loads, if any, will be on the order of 25 kips or less.

Improvements will include utility infrastructure, asphalt pavement roads, and stormwater management facilities. Preliminary grading plans were not available at the time this proposal was prepared; however, we anticipate site grading to consist of less than three feet of cut and/or fill to provide for desired finished grades. We assume traffic loads on the local access roads will consist primarily of passenger car traffic with occasional delivery vehicles.

If the actual 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 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 seven test pits throughout the project site. Information obtained from the field evaluation, laboratory testing, and geotechnical analyses was utilized to develop the recommendations presented in this report.

4.0 SITE CONDITIONS

The project site consists of a partially developed parcel, approximately 2.96 acres in total size, located on the east side of the intersection of East 50th Avenue and South Freya Street. An existing church with an asphalt parking lot and driveway is located in the southwest quadrant of the site and is to remain. The balance of the site is undeveloped.

Topographically, the property is relatively flat. The ground coverage consists of mostly native grass and soil along the east side of the parcel. The northwest portion of the parcel is forested predominately with mature coniferous trees.

The site is bound by South Freya Street to the west, single-family residential developed parcels to the north, the Ashton Apartments complex to the south, and an undeveloped parcel to the east.

Subsurface Conditions

4.1.1 Published Geologic and Soil Information

The geologic conditions on the property are mapped on the "Preliminary Geologic Map of the Spokane SE 7.5-minute Quadrangle, Spokane County, Washington" prepared by R. Derkey, M. Hamilton, D. Stradling and E. Kiver, 1999. The project site is mapped as Wanapum basalt- 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-Seaboldt, disturbed complex. Seaboldt soil is described as somewhat poorly drained, ashy loess overlying glaciofluvial deposits overlying basalt residuum. The soil profile is described as ashy loam overlying extremely gravelly sandy loam overlying relatively shallow basalt bedrock. Urban land soils are often highly variable as they consist of human transported material.

4.1.2 Subsurface Exploration Program

We observed the excavation of seven test pits at the site on November 2, 2022, utilizing a CAT C305.5E excavator with a 24-inch toothed excavation bucket. The approximate locations of the test pits are shown on Figure A-2, Exploration Location Map 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. The subsurface profiles and detailed soil descriptions 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. The subsurface conditions may vary between exploration locations.

The near surface geologic profile appears to consist of topsoil overlying native sand soils overlying clay soils.

4.2 Groundwater Conditions

We did not encounter groundwater within our 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 LABORATORY TESTING

We performed laboratory testing to supplement field classifications and to assess some of the soil engineering properties and parameters. The laboratory testing included particle size distribution/gradation (ASTM D6913), liquid and plastic limits (ASTM D4318), moisture content (ASTM D2216), fines content (ASTM D1140), and organic content testing (ASTM D2974). The laboratory test results are included in Appendix C of this report, and some results are also summarized on the test pit logs in Appendix B.

6.0 RECOMMENDATIONS

The previous sections of this report presented our understanding of the proposed project and surface and subsurface site conditions. 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, 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.

6.1 Site Preparation

6.1.1 Clearing and Stripping:

The stripping depth for topsoil removal is estimated to be approximately ½ to 1½ feet. Clearing and stripping debris should be wasted off-site or used for topsoil within non-structural/landscape areas.

6.1.2 Test Pit Excavations:

Test pit locations were loosely backfilled with the excavated material following completion. Due to the nature of this backfill, it should be assumed that these locations consist of pockets of loose uncontrolled fill and/or disturbed native soils. To limit the potential for future settlement or subsurface disturbance, we recommend that test pit locations be over-excavated in their entirety below pavements and structures and backfilled with properly compacted native soils or structural fill. The approximate test pit locations are indicated on Figure A-2 of this report, and the final test pit depths are included on the test pit logs included in Appendix B of this report.

6.1.3 Subgrade Preparation:

ALLWEST defines the subgrade as the native soil exposed at the base of excavation prior to placement of fill or concrete. The subgrade requires an evaluation by the geotechnical engineer of record or staff under their supervision to confirm the site conditions are consistent with those observed during our geotechnical evaluation.

The subgrade should be moisture conditioned to within two percentage points of the optimum moisture content for compaction. The subgrade should then be compacted to a firm and unyielding condition.

In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, we recommend that 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 taken by the contractor to protect the subgrade soils.

6.1.4 Undocumented Fill:

Undocumented means that there is no documentation of the fill material quality, density, gradation, placement method, etc. and no CQC or CQA documentation is available. Test pits

excavated on the project site did not encounter undocumented fill. If undocumented fill is encountered during construction, it should be removed from within five feet of all structures.

6.1.5 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. 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 6 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-7 or equivalent. Alternatives to Tensar TX-7 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 woven geotextile filter fabric should be placed on the properly prepared subgrade. The geosynthetic reinforcement should be placed 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 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.
- We recommend a minimum of 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. 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.
- Fill placed directly over the geosynthetic reinforcement should be properly moisture conditioned prior to placement and should meet the following gradation:

Table 1: 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.

6.2 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 2H:1V 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.

If excavations depths exceed 7 feet, mechanical splitting or blasting of the bedrock may be required.

It is exceedingly difficult under variable circumstances 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 1.5H:1V (horizontal to vertical) temporary slope.

6.3 Materials

The native soils are suitable for use as structural fill. 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 fill materials are provided in Table 2.

Table 2. Fill Material Recommendations

Fill Type	Criteria
Structural Fill	Maximum size ≤ 3 inches Retained on ¾-inch sieve <30% Passing No. 200 Sieve ≤ 10% Non-plastic
Utility Trench Backfill	Maximum size ≤ 2 inches Passing No. 200 Sieve ≤ 15% Non-plastic
Top and Base Course	Washington Department of Transportation (WSDOT) Standard Specification 9-03.9(3)

6.4 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. Structural fill and utility trench backfill should be compacted to a minimum of 95 percent of the maximum dry density established by ASTM D1557 (modified Proctor).

6.5 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. 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 is undertaken in wet periods of the year, it will be important to slope the ground surface to provide drainage away from construction. 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. Due to shallow limiting layers and bedrock, perched groundwater may be encountered during the wetter portion of the year or after rainfall events. Dewatering practices should be anticipated if earthwork is to be conducted during wetter periods.

6.6 Cold Weather Construction

Foundations should be embedded adequately to protect against frost action as recommended in section *6.7 Foundation Recommendations* of this report. We recommend removal of frost susceptible soils (soil with fines contents greater than 10 percent) within the frost-depth zone below concrete flatwork (sidewalks, patios, etc.) to reduce the potential detrimental effects of frost heave.

If site grading and construction are 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 additional earthwork or construction. Footings, floor slabs or 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.

6.7 Foundation Recommendations

The proposed buildings may be supported on conventional spread footings bearing on native silty sand or poorly-graded sand with silt if prepared 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:

- Shallow footings bearing on properly prepared native silty sand or poorly-graded sand with silt may be designed for an allowable bearing pressure of 2,000 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 native gravel of 0.40 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 or per local agency requirements, whichever is greater.
- 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.

6.8 Concrete Slabs-on-Grade

Concrete slabs-on-grade should be underlain by at least 6 inches of crushed top or 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).

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.

6.9 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 3*. For recommendations for site retaining wall design, refer to the section *6.10 Retaining Walls* of this report.

Table 3. Equivalent Fluid Pressures for Lateral Earth Pressures

Condition	Equivalent Fluid Pressure On-Site Soil AND Structural Fill (pcf)
At-rest	65
Active	45
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 12 pounds per cubic foot (pcf) and the passive pressure should be reduced by 12 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.

6.10 Retaining Walls

At the time this report was prepared we have 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.

6.11 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 C 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 4. Seismic Design Parameters

Latitude (degrees)	Longitude (degrees)	Spectral Accelerations		Site Coefficients	
		S_s	S_1	F_a	F_v
47.6275416	-117.222316	0.311g	0.1113g	1.551	2.378

6.12 Pavement

We understand new asphalt pavement will be constructed on the site for parking and drive areas. 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 5. Pavement Design Parameters

Criteria	Assumed Value
ESAL	100,000
Pavement Life	20 years
Subgrade California Bearing Ratio (CBR)	12%
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 5, we should be notified so we may re-evaluate our recommendations.

Table 6. Recommended Pavement Sections

Pavement Area	Flexible Pavement		Rigid Pavement	
	Asphalt (in.)	Base Course (in.)	Concrete (in.)	Base Course (in.)
Parking and Drive Lanes	3	6	-	-
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 specifying crushed aggregate base meeting the requirements of the WSDOT Standard Specification 9-03.9 for ¾-inch untreated base course. We recommend the asphalt concrete pavement meet the requirements of WSDOT Standard Specification 5-04 for plant mix asphalt concrete pavements. Portland cement concrete should have a minimum 28-day compressive strength of 4,000 psi. We recommend the crushed aggregate base be compacted to a minimum of 95 percent of the modified Proctor maximum dry density (ASTM D1557). 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. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the crushed aggregate base section.

The pavement sections provided in this report represent minimum recommended thicknesses. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to 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.

6.13 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.

6.13.1 Drywells

Due to the shallow limiting layers, we do not recommend the use of Type A or B drywells for the disposal of stormwater. Low-profile drywells may be used for disposal and may be designed with an outflow rate of 0.1 cubic feet per second (cfs). The recommended outflow rate has a factor of safety of 2 applied.

6.13.2 Gravel Galleries

ALLWEST performed a single ring infiltrometer test in the upper silty sand (SM) adjacent to test pit TP-5. The test locations are 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 7 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. 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 7. Recommended Gravel Gallery Infiltration Rates

Test Location	Actual Infiltration Rate (cfs/sf)	Soil Type	Design Infiltration Rate (cfs/sf)
INF-1	8.25×10^{-5}	SM	3.3×10^{-5}

Swales and ponds constructed in silty sand soils in the vicinity of the test locations 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.

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.

7.0 ADDITIONAL RECOMMENDED SERVICES

We recommend ALLWEST be retained to provide construction materials testing and observation to verify the 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.

8.0 EVALUATION LIMITATIONS

This report has been prepared to assist the planning and design for the Proposed Multi-Family Housing project located at 5115 South Freya Street 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.

The following appendices complete this report:

Appendix A – Site Vicinity Map, Exploration Location Map

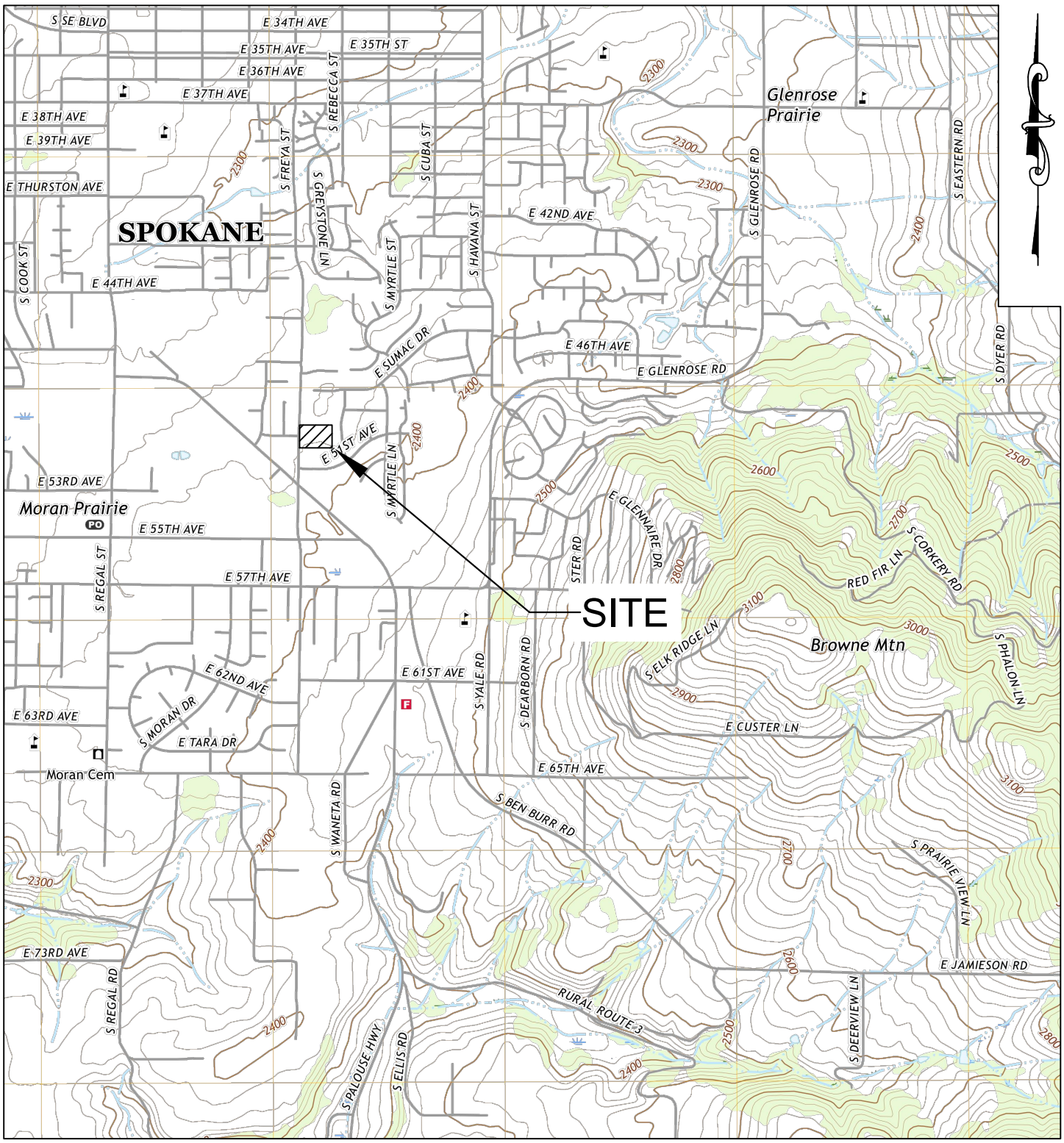
Appendix B – Test Pit Logs, Unified Soil Classification System

Appendix C – Laboratory Test Results

2/14/2023

Appendix A

Vicinity Map
Exploration Location Map

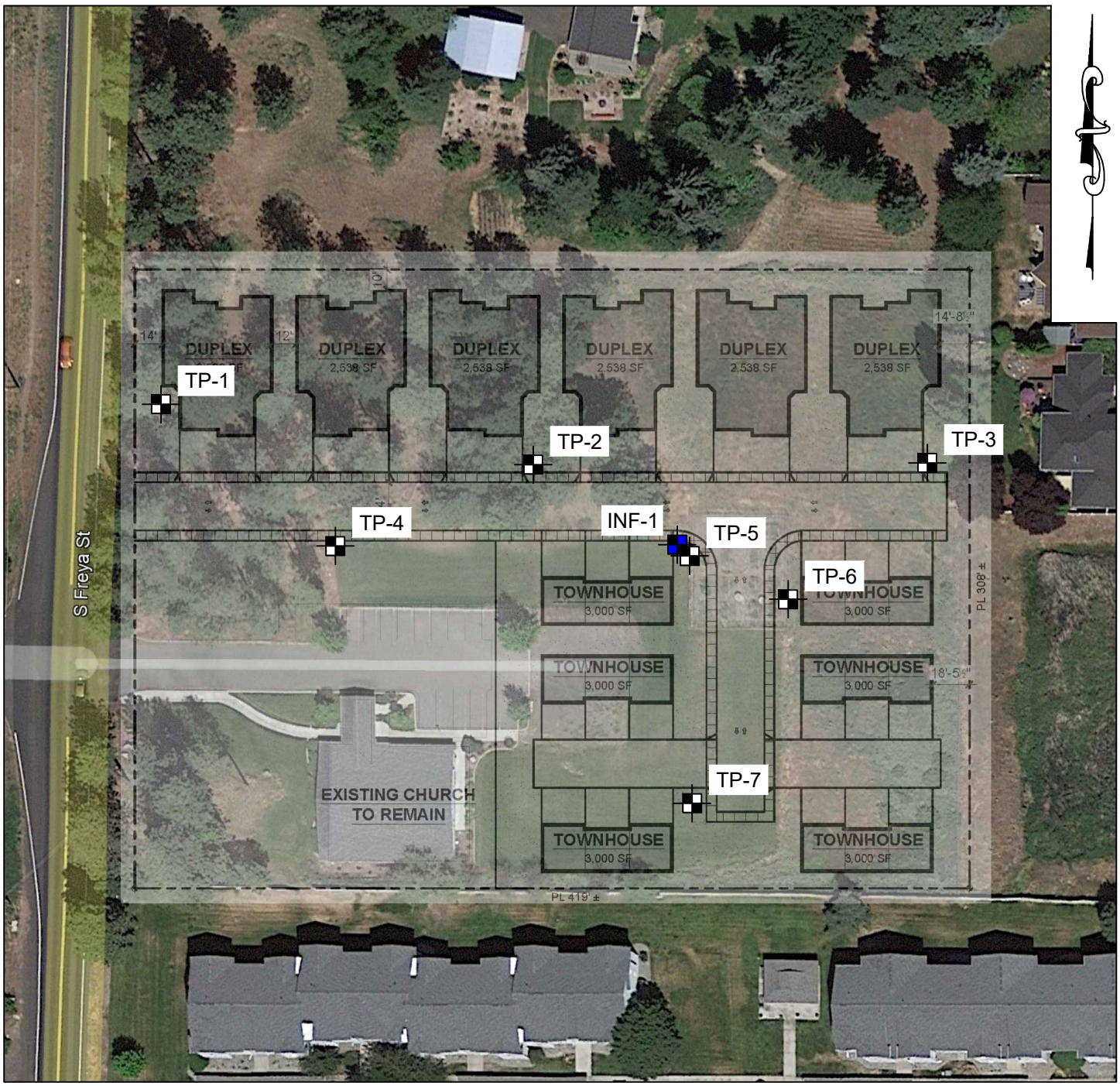


BASEMAP SOURCE: USGS TOPOGRAPHIC MAP, SPOKANE SE QUADRANGLE
WASHINGTON-SPOKANE COUNTY, 7.5-MINUTE SERIES, DATED 2020

ALLWEST
16617 E. Euclid Ave., Bldg A
Spokane Valley, Washington
(509) 534-4411
www.allwesttesting.com

FIGURE A-1: VICINITY MAP

PROJECT:	222-275G DR. C'S, MULTI-FAMILY HOUSING		
LOCATION:	5115 EAST FREYA STREET, SPOKANE, WA		
CLIENT:	DR. C'S FAMILY DENTISTRY		
DATE:	FEBRUARY 2023	SCALE:	1-IN = 2,000 FT



0 40 80 160

SCALE: 1" = 80'

LEGEND:

TP-# TEST PIT NUMBER AND APPROXIMATE LOCATION

INF-# INFILTRATION TEST NUMBER AND APPROXIMATE LOCATION

BASEMAP SOURCES: GOOGLE EARTH
SCHEMATIC SITE PLAN, DATED 8/16/2022 BY MERCIER ARCHITECTURE AND PLANNING

ALLWEST
16617 E. Euclid Ave., Bldg A
Spokane Valley, Washington
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FIGURE A-2: EXPLORATION LOCATION MAP

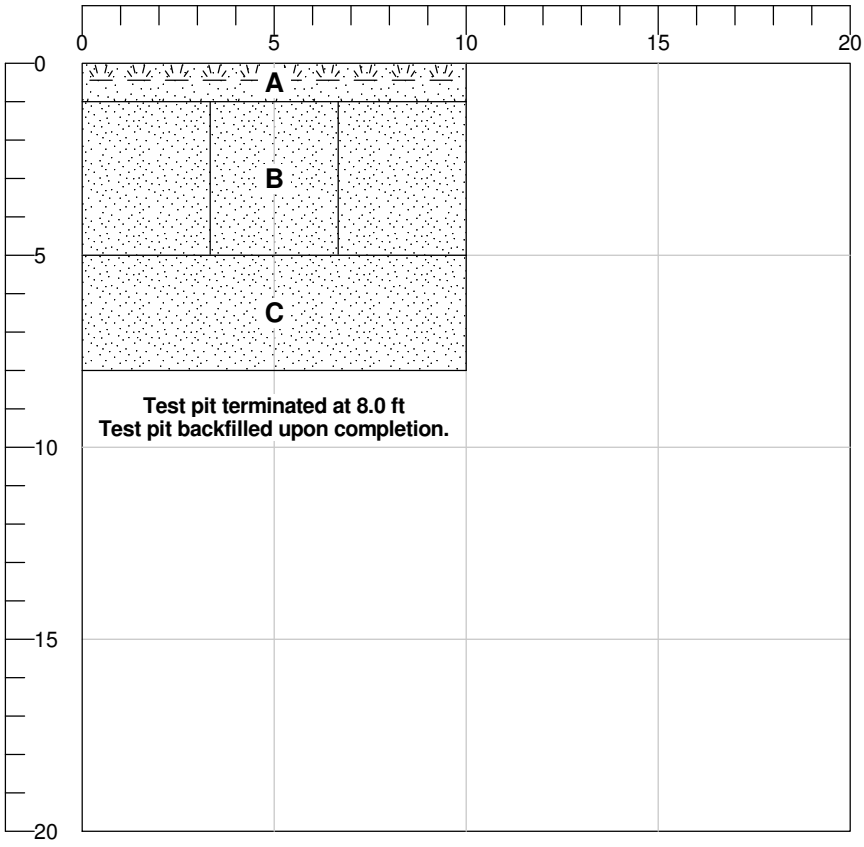
PROJECT:	222-275G DR. C'S, MULTI-FAMILY HOUSING		
LOCATION:	5115 EAST FREYA STREET, SPOKANE, WA		
CLIENT:	DR. C'S FAMILY DENTISTRY		
DATE:	FEBRUARY 2023	SCALE:	AS SHOWN

Appendix B

Test Pit Logs
Unified Soil Classification System

LOG OF TEST PIT — TP-01

Name: Dr. C's, Multifamily Housing
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Temp: 40's °F Weather Cloudy Date 11/2/2022
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service
Job: 222-275G
Datum: NA
Logged by: A. Gertsch
Operator: D. Schmidt



SAMPLES

NO.	DEPTH (ft)	MOISTURE (%)
S222-0819	5 - 8	2.0

TEST RESULTS

DEPTH	% GRAVEL	% SAND	% PASSING #200
5 - 8	0	97	3

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 1.0 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 1.0 - 5.0 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, medium dense, light brown, dry. (glaciofluvial deposit)

C 5.0 - 8.0 ft: (SP) Poorly-graded SAND, fine to medium-grained, stratified, medium dense, tri-colored: brown, black & white, dry. (glacioflufial deposit)

Lenses of SP-SC throughout matrix.

TIME	DEPTH TO W/L (FT)	NOTES

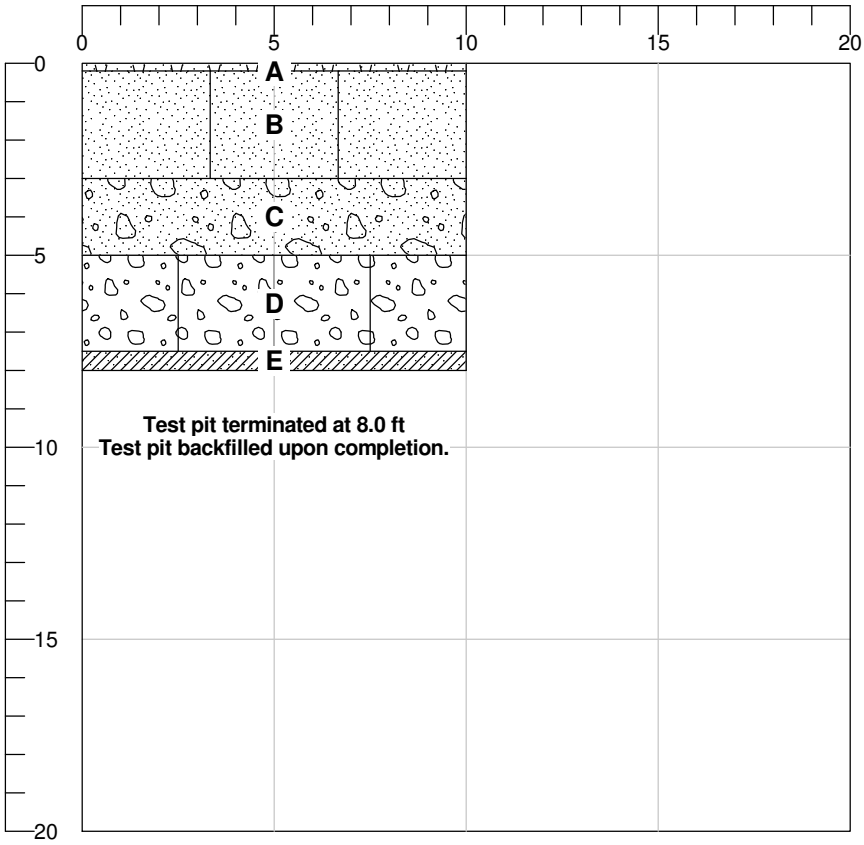
SPECIAL NOTES:

No groundwater observed during excavation.

LOG OF TEST PIT

TP-02

Name: Dr. C's, Multifamily Housing
Job: 222-275G
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Datum: NA
Temp: 40's °F Weather Cloudy
Date 11/2/2022
Logged by: A. Gertsch
Equipment: CAT 305.5E2
Contractor: Dave's Bobcat Service
Operator: D. Schmidt



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
S222-0820	5 - 7.5	47.0

TEST RESULTS			
DEPTH	% GRAVEL	% SAND	% PASSING #200
5 - 7.5	11	41	48

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 0.2 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 0.2 - 3.0 ft: (SM) Silty SAND, loosely stratified, fine to medium-grained, loosely stratified, medium dense, light brown, dry. (glaciofluvial deposit)

C 3.0 - 5.0 ft: (SP) Poorly-graded SAND with gravel, stratified, medium to coarse-grained, stratified, some cobbles, sub-round clasts, medium dense, tri-colored: brown, black & white, dry. (glacioflufial deposit)

Off-white silt stringer at 5.5 feet.

D 5.0 - 7.5 ft: (ML) Sandy SILT with gravel, low to medium plasticity, loosely stratified, medium dense, brown, dry. (glaciofluvial deposit)

E 7.5 - 8.0 ft: (CL) Sandy LEAN CLAY, stiff, dark gray to gray-blue, moist. (Wanapum basalt residuum)

TIME	DEPTH TO W/L (FT)	NOTES

SPECIAL NOTES:

Abundant duff on ground sruface.

Woody roots to 4 feet below ground surface.

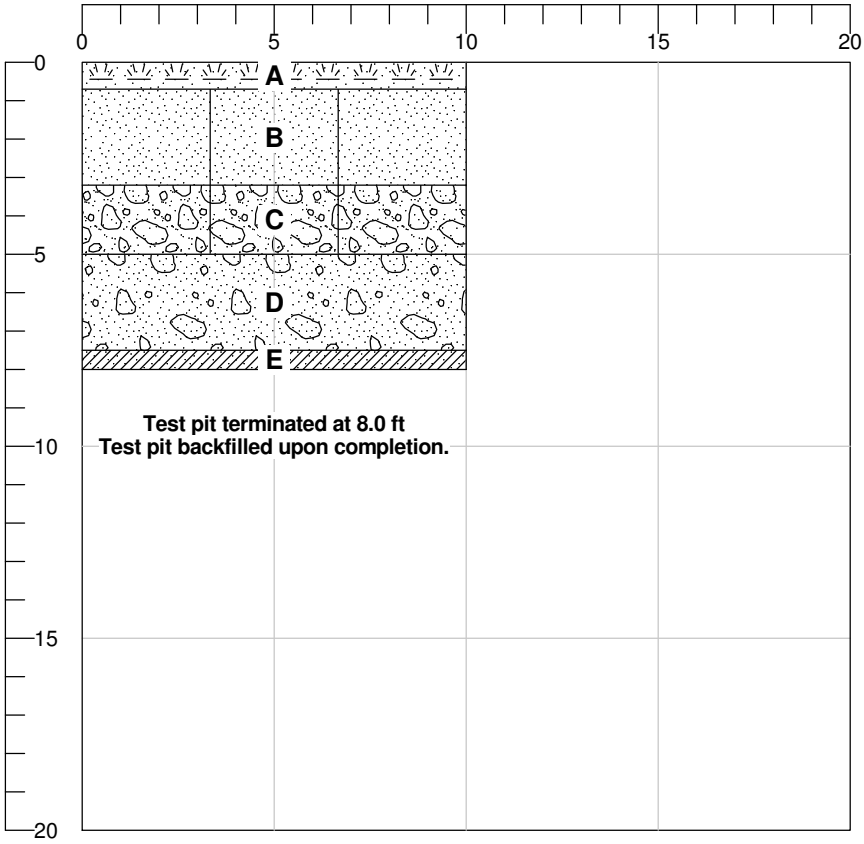
No groundwater observed during excavation.

Test pit terminated at at 8 feet - practical bucket refusal on basalt bedrock.

LOG OF TEST PIT — TP-03

Name: Dr. C's, Multifamily Housing
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Temp: 40's °F Weather Cloudy Date 11/2/2022
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service

Job: 222-275G
Datum: NA
Logged by: A. Gertsch
Operator: D. Schmidt



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

TEST RESULTS			
DEPTH	% GRAVEL	% SAND	% PASSING #200

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 0.7 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 0.7 - 3.2 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, medium dense, light brown, dry. (glaciofluvial deposit)

2 foot diameter boulder at 3 feet.

C 3.2 - 5.0 ft: (GP-GM) Poorly-graded GRAVEL with silt and sand, loosely stratified, some cobbles, trace boulders, sub-round clasts, medium dense, brown, dry. (glaciofluvial deposit)

D 5.0 - 7.5 ft: (SP) Poorly-graded SAND with gravel, medium to coarse-grained, stratified, some cobbles, sub-round clasts, medium dense, gray, dry. (glacioflufial deposit)

E 7.5 - 8.0 ft: (CL) Sandy LEAN CLAY, medium plasticity, stiff, dark gray to gray-blue, moist. (Wanapum basalt residuum)

TIME	DEPTH TO W/L (FT)	NOTES

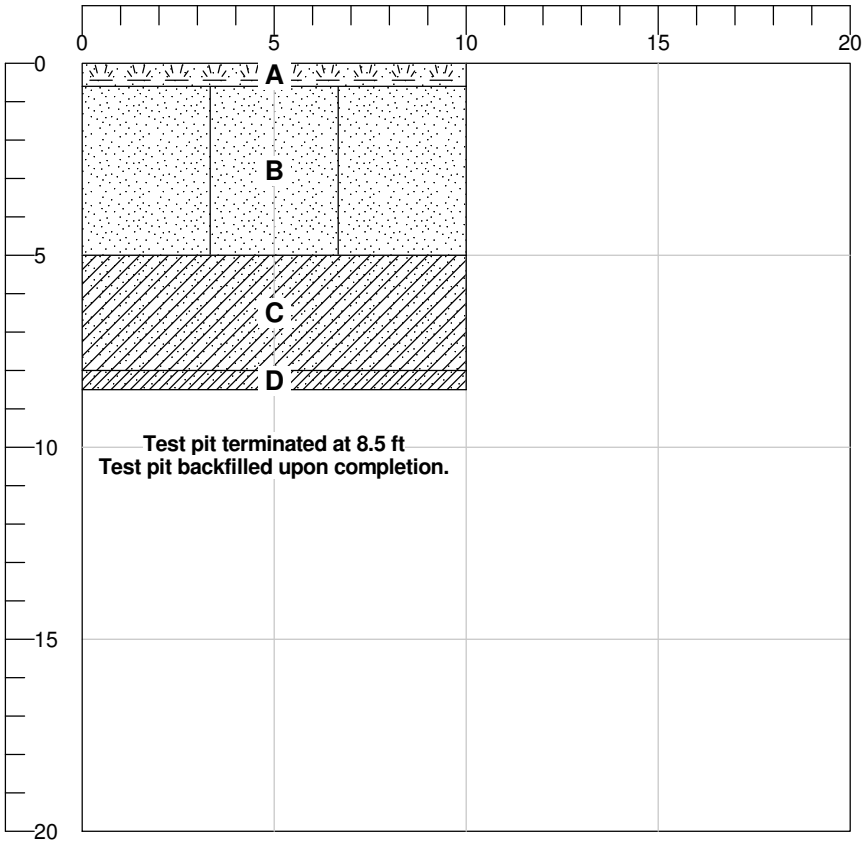
SPECIAL NOTES:

No groundwater observed during excavation.

Test pit terminated at at 8 feet - practical bucket refusal on basalt bedrock.

LOG OF TEST PIT — TP-04

Name: Dr. C's, Multifamily Housing
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Temp: 40's °F Weather Cloudy Date 11/2/2022
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service
Job: 222-275G
Datum: NA
Logged by: A. Gertsch
Operator: D. Schmidt



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

TEST RESULTS			
DEPTH	% GRAVEL	% SAND	% PASSING #200

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 0.6 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 0.6 - 5.0 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, medium dense, light brown, dry. (glaciofluvial deposit)

2-foot diameter boulder at 3 feet.

C 5.0 - 8.0 ft: (SC) Clayey SAND, fine to medium-grained, laminated, medium dense, off-white with heavy orange mottle, moist. (Latah Formation, glaciolucastrine)

D 8.0 - 8.5 ft: (CL) Sandy LEAN CLAY, medium plasticity, stiff, dark gray to gray-blue, moist. (Wanapum basalt residuum)

TIME	DEPTH TO W/L (FT)	NOTES

SPECIAL NOTES:

Abundant duff on ground surface.

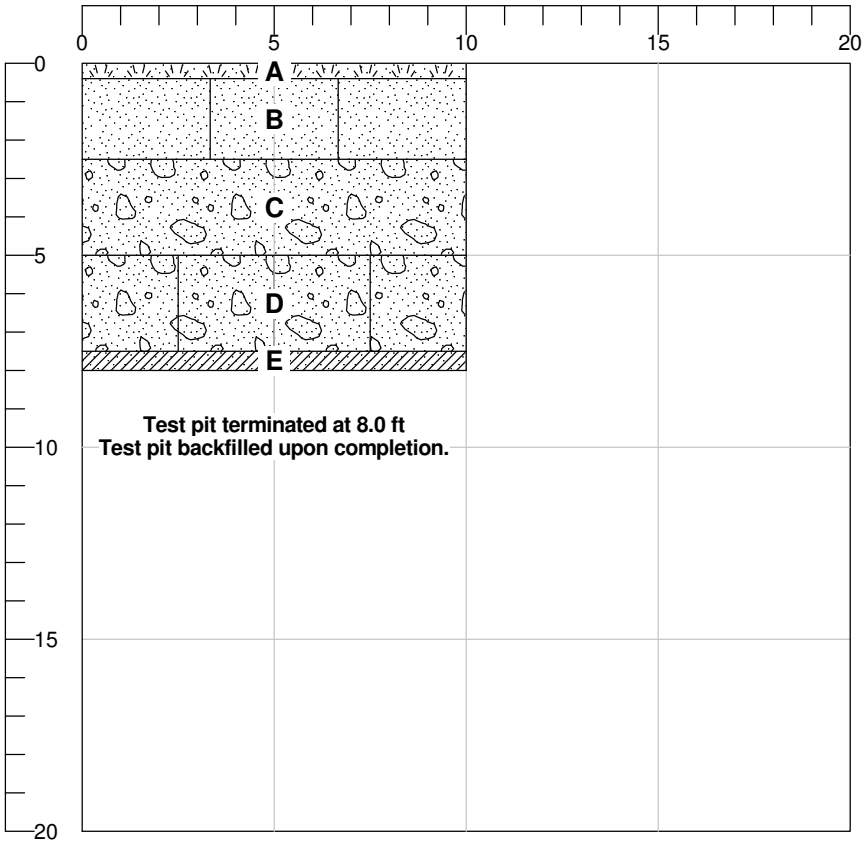
Abundant thin grass roots to 3 feet.

No groundwater observed during excavation.

Test pit terminated at at 8.5 feet - practical bucket refusal on basalt bedrock.

LOG OF TEST PIT TP-05 / INF-01

Name: Dr. C's, Multifamily Housing
Job: 222-275G
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Datum: NA
Temp: 40's °F Weather Cloudy Date 11/2/2022
Logged by: A. Gertsch
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service
Operator: D. Schmidt



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
S222-0818	0 - 1	20.0

TEST RESULTS			
DEPTH	% GRAVEL	% SAND	% PASSING #200
0 - 1	5	64	31

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 0.4 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 0.4 - 2.5 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, medium dense, light brown, dry. (glaciofluvial deposit)

Layer of granitic cobbles and boulders at 3 feet below ground surface.

C 2.5 - 5.0 ft: (SP-SM) Poorly-graded SAND with silt, medium to coarse-grained, stratified, some gravel, medium dense, gray, dry. (glaciofluvial deposit)

D 5.0 - 7.5 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, some gravel, medium dense, brown, moist. (glaciofluvial deposit)

E 7.5 - 8.0 ft: (CL) Sandy LEAN CLAY, medium plasticity, stiff, dark gray to gray-blue, moist. (Wanapum basalt residuum)

TIME	DEPTH TO W/L (FT)	NOTES

SPECIAL NOTES:

~1.5 foot diameter boulder at 3 feet below ground surface.

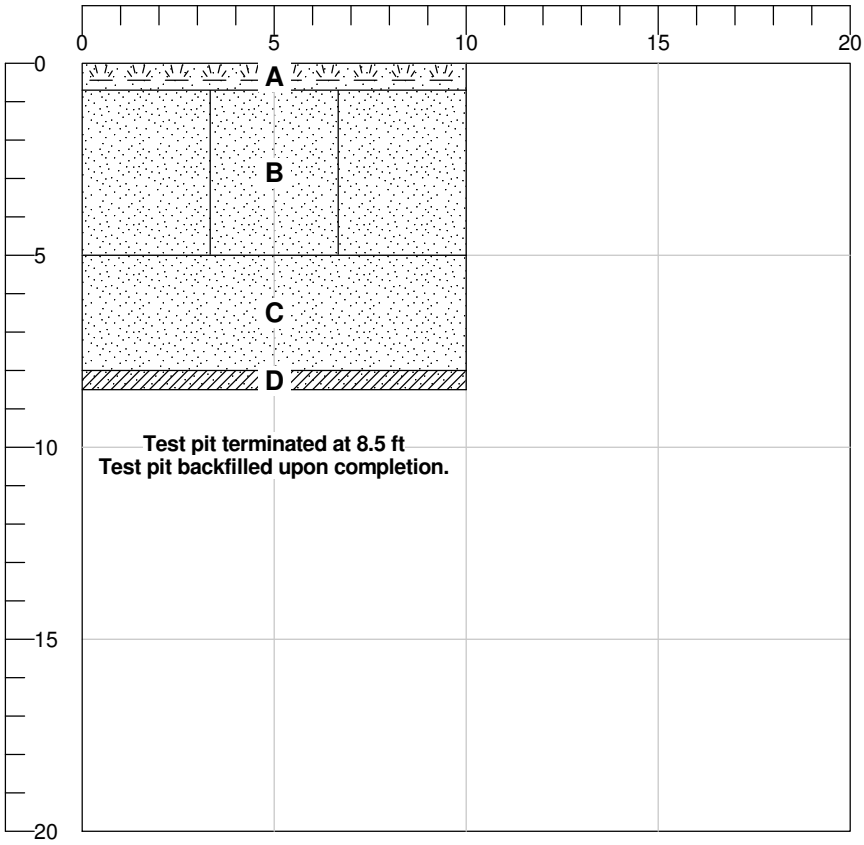
Some woody roots to 6 feet below ground surface.

No groundwater observed during excavation.

Test pit terminated at at 8 feet - practical bucket refusal on basalt bedrock.

LOG OF TEST PIT — TP-06

Name: Dr. C's, Multifamily Housing
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Temp: 40's °F Weather Cloudy Date 11/2/2022
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service
Job: 222-275G
Datum: NA
Logged by: A. Gertsch
Operator: D. Schmidt



SAMPLES

NO.	DEPTH (ft)	MOISTURE (%)
S222-0821	5 - 8	2.0

TEST RESULTS

DEPTH	% GRAVEL	% SAND	% PASSING #200
5 - 8	2	96	1.9

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 0.7 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 0.7 - 5.0 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, trace gravel, medium dense, light brown, dry. (glaciofluvial deposit)

Layer of granitic cobbles and boulders with orange stain at 3 feet below ground surface.

C 5.0 - 8.0 ft: (SP) Poorly-graded SAND, medium to coarse-grained, stratified, trace silt, gravel, and cobbles, medium dense, gray-brown, moist. (glaciofluvial deposit)

Matrix includes lenses of silty sand with sub-angular gravel and cobbles.

D 8.0 - 8.5 ft: (CL) Sandy LEAN CLAY with gravel, medium plasticity, trace cobbles, stiff, dark gray to gray-blue, moist. (Wanapum basalt residuum)

TIME	DEPTH TO W/L (FT)	NOTES

SPECIAL NOTES:

Heavy orange stain on cobbles.

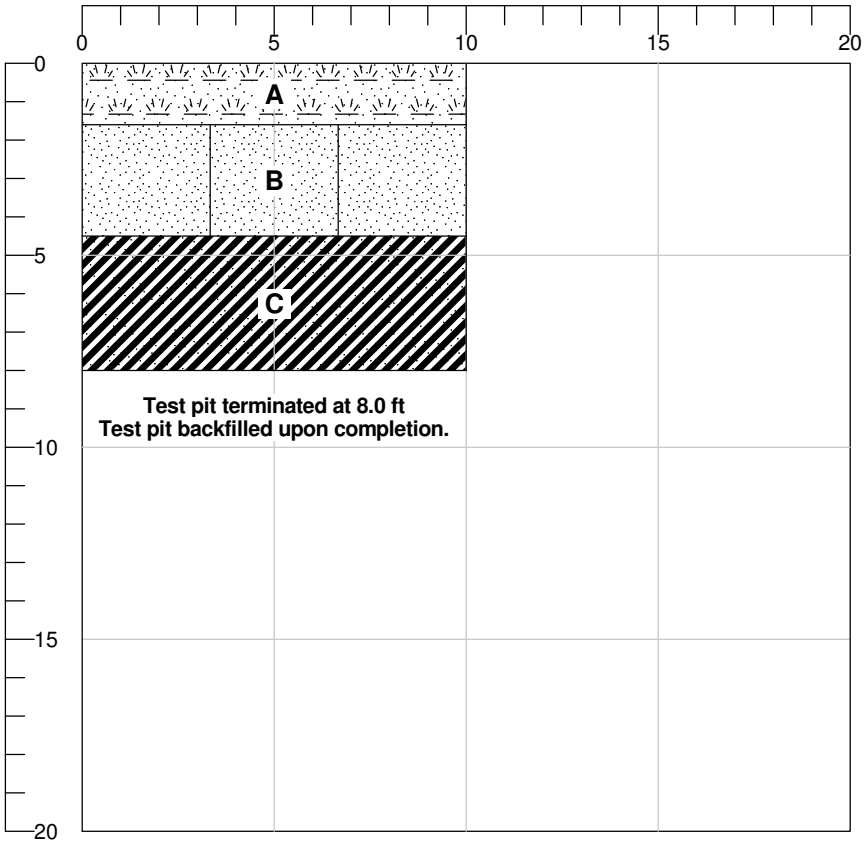
No groundwater observed during excavation.

Test pit terminated at at 8.5 feet - practical bucket refusal on basalt bedrock.

LOG OF TEST PIT — TP-07

Name: Dr. C's, Multifamily Housing
Location: See Exploration Location Map - Figure A-2 Elevation: not surveyed
Temp: 40's °F Weather Cloudy Date 11/2/2022
Equipment: CAT 305.5E2 Contractor: Dave's Bobcat Service

Job: 222-275G
Datum: NA
Logged by: A. Gertsch
Operator: D. Schmidt



SAMPLES		
NO.	DEPTH (ft)	ORGANIC CONTENT (%)
S222-0822	0 - 1.6	3.0
S222-0823	4.5 - 8	

TEST RESULTS			
DEPTH	% GRAVEL	% SAND	% PASSING #200
0 - 1.6	0	34	66
4.5 - 8			

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

A 0.0 - 1.6 ft: TOPSOIL; (SM) Silty SAND, organics, fine to medium-grained, dark brown, moist.

B 1.6 - 4.5 ft: (SM) Silty SAND, fine to medium-grained, loosely stratified, trace gravel, medium dense, light brown, moist. (glaciofluvial deposit)

Distrurbed to ~1 foot below ground surface.

C 4.5 - 8.0 ft: (CH) Sandy FAT CLAY, high plasticity, laminated, stiff, off-white with heavy orange mottle, moist. (Latah Formation, glaciolucastrine)

TIME	DEPTH TO W/L (FT)	NOTES

SPECIAL NOTES:

Debris includes asphalt.

Irrigation line at 1 foot below ground surface.

No groundwater observed during excavation.

Test pit terminated at at 8 feet - practical bucket refusal on basalt bedrock.

Unified Soil Classification System

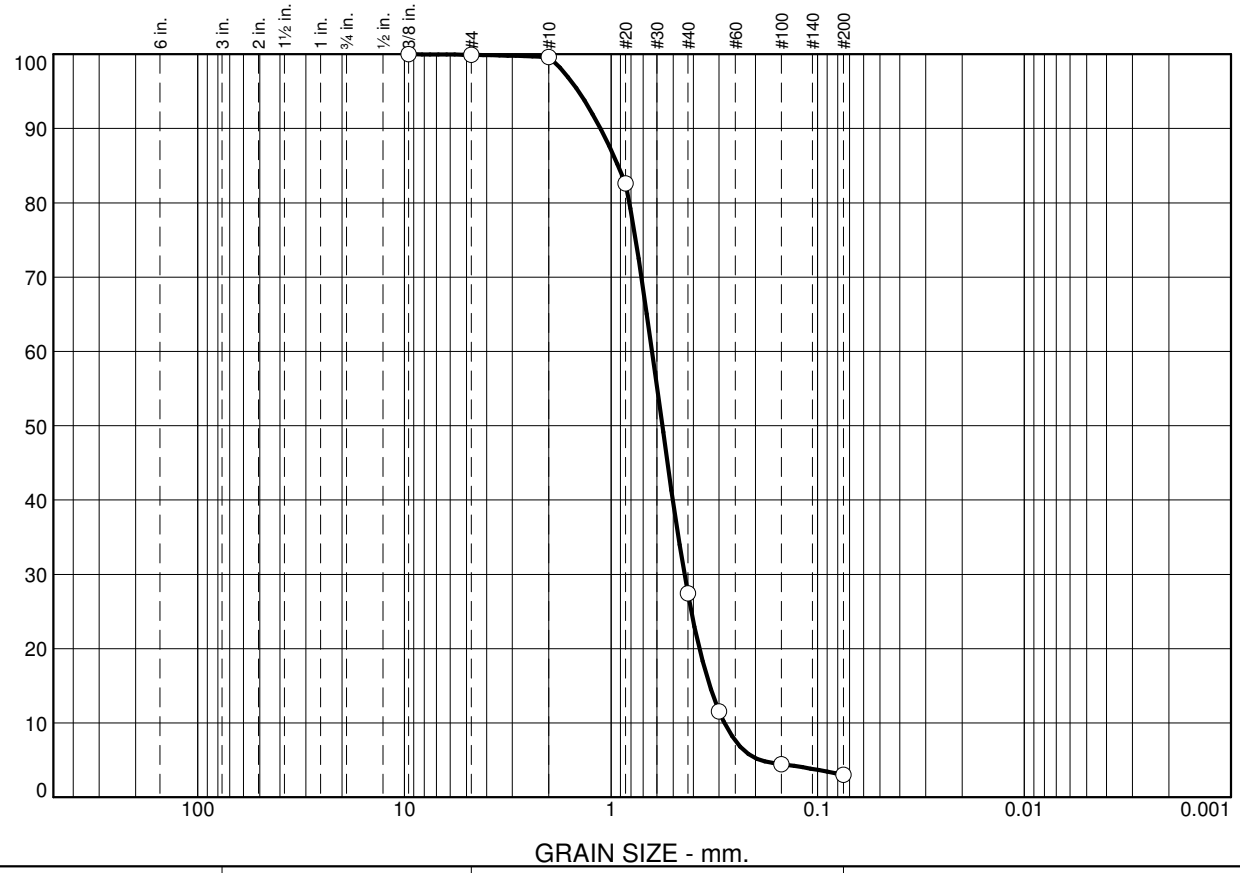
MAJOR DIVISIONS			SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS	GRAVELS	CLEAN GRAVELS	GW	Well-Graded Gravel, Gravel-Sand Mixtures.
			GP	Poorly-Graded Gravel, Gravel-Sand Mixtures.
		GRAVELS WITH FINES	GM	Silty Gravel, Gravel-Sand-Silt Mixtures.
			GC	Clayey Gravel, Gravel-Sand-Clay Mixtures.
	SANDS	CLEAN 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	0	0	0	73	24	3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#10	100		
#20	83		
#40	27		
#50	12		
#100	4		
#200	3.0		

* (no specification provided)

Material Description

Poorly graded sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 1.1245 D_{85}= 0.9237 D_{60}= 0.6333
D_{50}= 0.5648 D_{30}= 0.4411 D_{15}= 0.3329
D_{10}= 0.2826 C_u= 2.24 C_c= 1.09

Classification

USCS= SP AASHTO=

Remarks

Moisture content: 2.2%
A. Gertsch sampled 11/2/22

Location: TP-1
Sample Number: S222-0819 **Depth:** 5'-8' **Date:** 11/7/22

ALLWEST

Client: Dr. C Family Dentistry
Project: Dr. C's - Freya

Project No: 222-275G

Tested By: A. Gertsch **Checked By:** S. Fraser

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	8	3	4	13	24	48	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	92		
1/2"	91		
3/8"	90		
#4	89		
#10	85		
#20	78		
#40	72		
#50	68		
#100	59		
#200	48		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 9.7961 D_{85}= 1.9685 D_{60}= 0.1613
D_{50}= 0.0868 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Moisture content: 47.0%
A. Gertsch sampled: 11/2/22

Location: TP-2
Sample Number: S222-0820 **Depth:** 5'-7.5' **Date:** 11/7/22

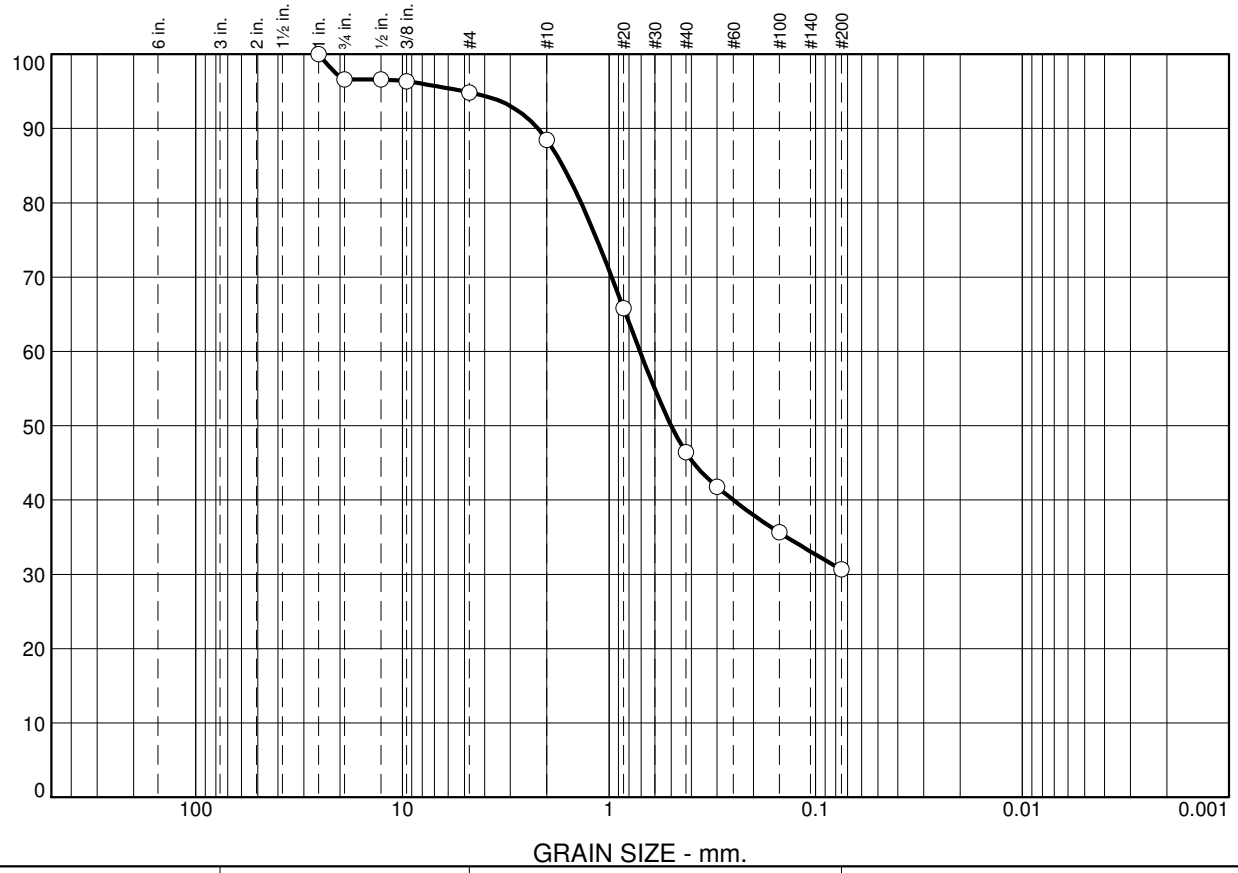
ALLWEST

Client: Dr. C Family Dentistry
Project: Dr. C's - Freya

Project No: 222-275G

Tested By: C. McDonald **Checked By:** S. Fraser

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	2	7	42	15	31	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	97		
1/2"	97		
3/8"	96		
#4	95		
#10	88		
#20	66		
#40	46		
#50	42		
#100	36		
#200	31		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 2.2128 D_{85}= 1.6745 D_{60}= 0.7085
D_{50}= 0.5004 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Moisture content: 20.4%
A. Gertsch sampled: 11/2/22

Location: TP-5 / INF-1
Sample Number: S222-0818 **Depth:** 1' **Date:** 11/7/22

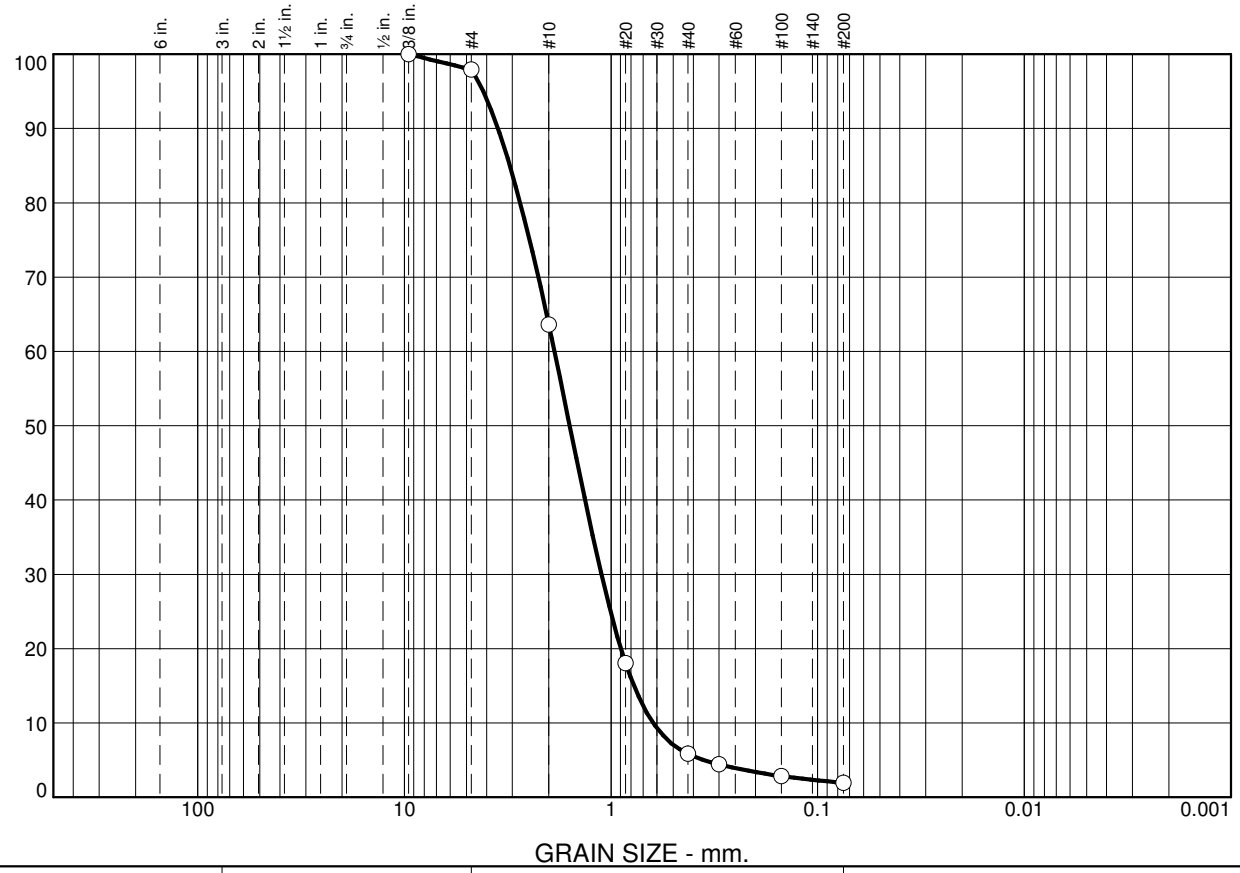
ALLWEST

Client: Dr. C Family Dentistry
Project: Dr. C's - Freya

Project No: 222-275G

Tested By: C. McDonald **Checked By:** S. Fraser

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	2	34	58	4	2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	98		
#10	64		
#20	18		
#40	6		
#50	4		
#100	3		
#200	1.9		

* (no specification provided)

Material Description

Poorly graded sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 3.5214 D_{85}= 3.0864 D_{60}= 1.8776
D_{50}= 1.5835 D_{30}= 1.1118 D_{15}= 0.7745
D_{10}= 0.6252 C_u= 3.00 C_c= 1.05

Classification

USCS= SP AASHTO=

Remarks

Moisture content: 1.8%
A. Gertsch sampled 11/2/22

Location: TP-6
Sample Number: S222-0821 **Depth:** 5'-8' **Date:** 11/7/22

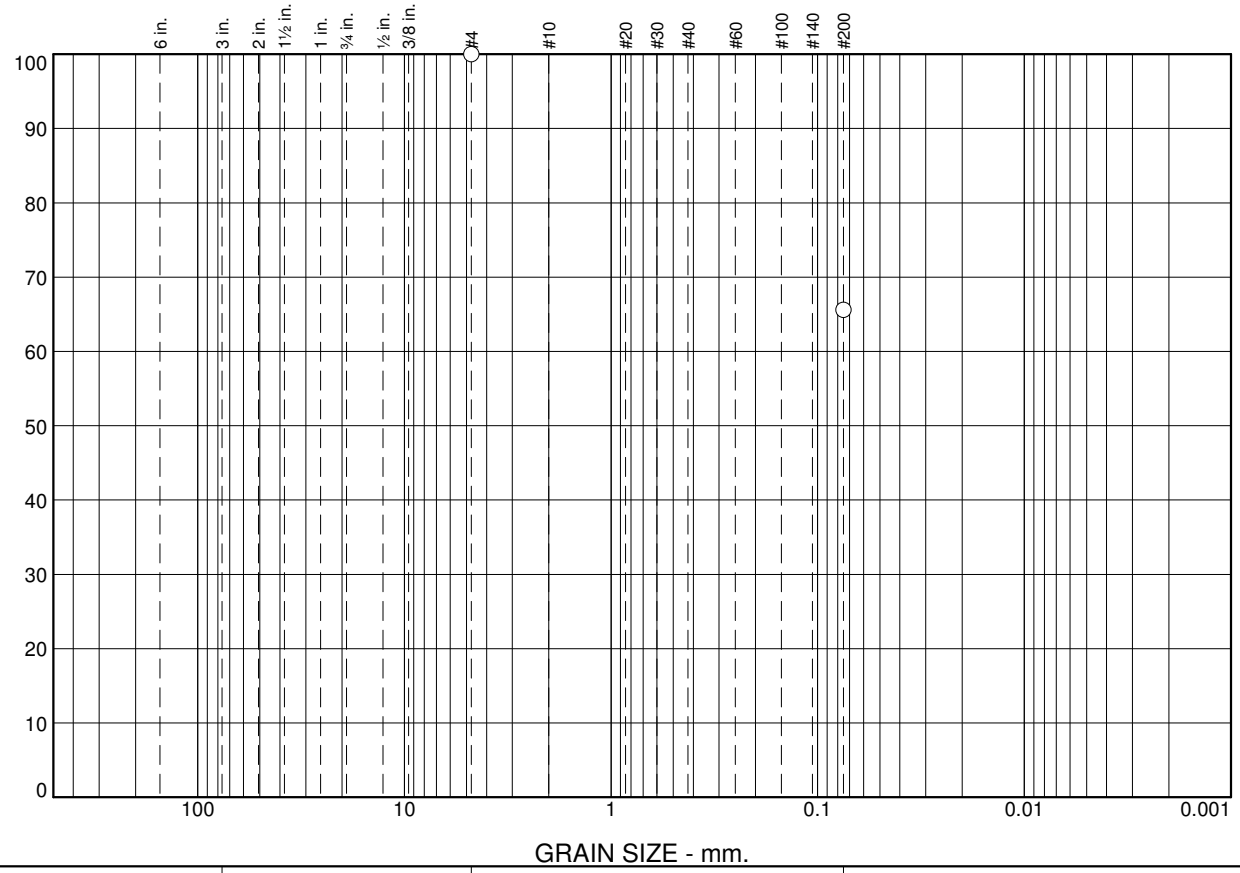
ALLWEST

Client: Dr. C Family Dentistry
Project: Dr. C's - Freya

Project No: 222-275G

Tested By: A. Gertsch **Checked By:** S. Fraser

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	7.2	12.8	14.4	65.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#200	65.6		

* (no specification provided)

Material Description

Sandy fat clay

Atterberg Limits

PL= 30 LL= 66 PI= 36

Coefficients

D_{90}= 1.4233 D_{85}= 0.7791 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-5(23)

Remarks

Moisture content: 30.9
A. Gertsch sampled: 11/2/22

Location: TP-7
Sample Number: S222-0823 **Depth:** 4.5'-8' **Date:** 11/7/22

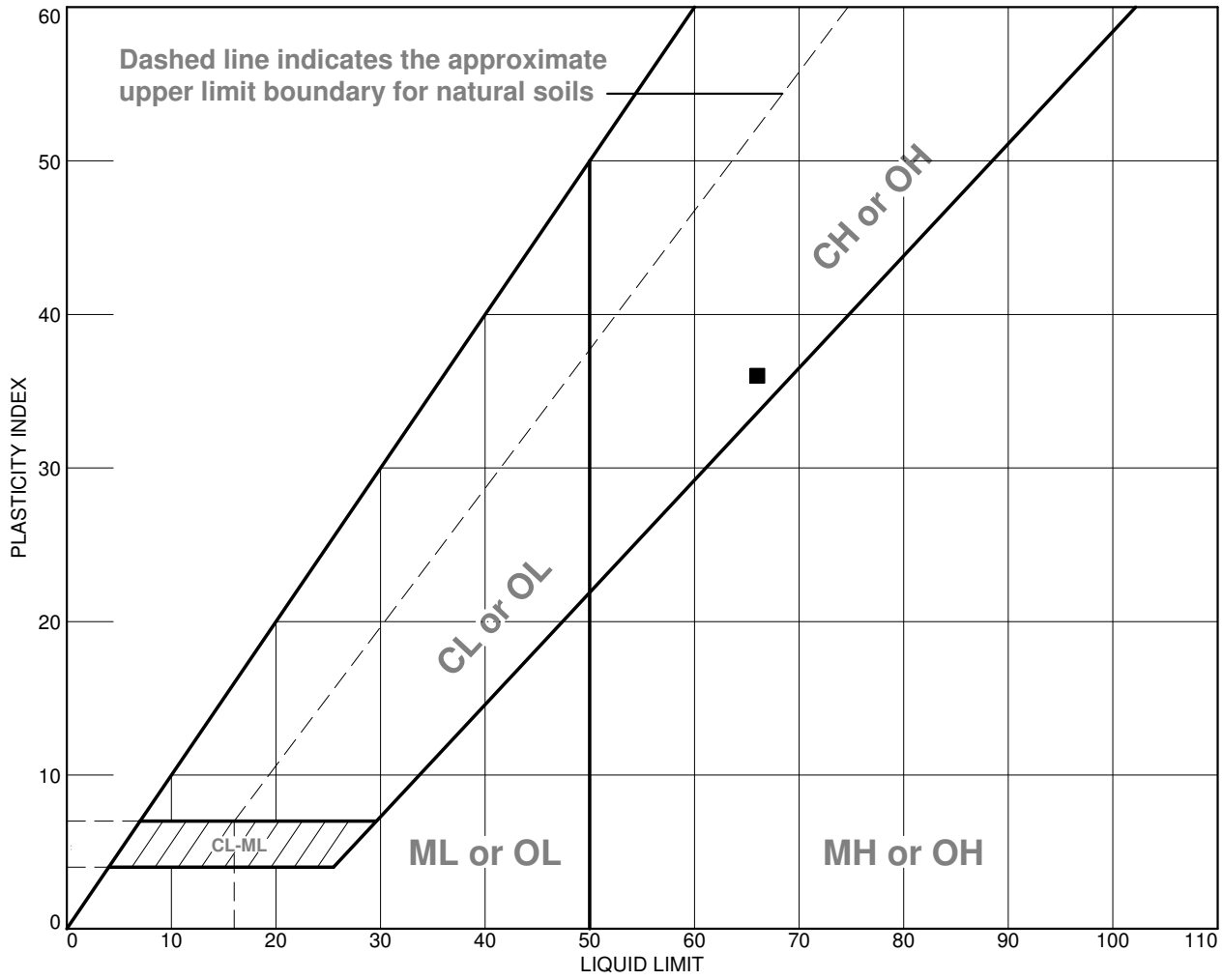
ALLWEST

Client: Dr. C Family Dentistry
Project: Dr. C's - Freya

Project No: 222-275G

Tested By: C. McDonald **Checked By:** S. Fraser

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty sand	NP	NP	NP	72	48	SM
■	Sandy fat clay	66	30	36	80.0	65.6	CH

Project No. 222-275G **Client:** Dr. C Family Dentistry

Project: Dr. C's - Freya

● **Location:** TP-2 **Depth:** 5'-7.5' **Sample Number:** S222-0820

■ **Location:** TP-7 **Depth:** 4.5'-8' **Sample Number:** S222-0823

Remarks:

■ A. Gertsch sampled 11/2/22

ALLWEST

Tested By: A. Gertsch **Checked By:** D. Schmitz