111 West 2nd Street, Suite 400
Casper, Wyoming 82601
Phone: (307) 672-8750
pilchengineeringllc.com

January 5, 2023

Ms. Tamara Ross
IMEG Consultants Corp.
1817 South Avenue West, Suite A
Missoula, Montana 59801

RE: Report of Geotechnical Evaluation
Curtis Street Subdivision
123 South Curtis Street
Missoula, Montana 59860

Ms. Ross:

At your request, Pilch Engineering, LLC (Pilch) has completed the authorized geotechnical evaluation for the proposed residential subdivision to be located at 123 South Curtis Street in Missoula, Montana. The following report outlines the purpose and scope of our services, details our evaluation procedures, summarizes our findings, and presents our engineering analysis and corresponding conclusions and recommendations to assist with design and construction of the proposed project.

Pilch appreciates the opportunity to present this report and provide these services to you. If you have questions or require additional information, please call us at (307) 672-8750.

Sincerely,

PILCH ENGINEERING, LLC

Prepared by:

Andrew Warren, P.E.
Principal & Senior Engineer

Reviewed by:

Tyler Vanderhoef
Principal

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

Report of Geotechnical Evaluation

Curtis Street Subdivision
123 South Curtis Street
Missoula, Montana

January 5, 2023

PRESENTED TO:

IMEG Consultants Corp.
Attention: Ms. Tamara Ross
1817 South Avenue West, Suite A
Missoula, Montana 59801

MONTANA
ANDREW WARREN
No. 59778PE
01/05/2024
LICENSED PROFESSIONAL ENGINEER

PRESENTED BY:

Pilch Engineering, LLC
111 West 2nd Street, Suite 400
Casper, Wyoming 82601
Phone: (307) 672-8750
pilchengineeringllc.com

EXECUTIVE SUMMARY

Pilch Engineering, LLC (Pilch) has completed the authorized geotechnical evaluation for the proposed residential subdivision at 123 South Curtis Street in Missoula, Montana. The general location of the project is shown on Figure A-1, Project Vicinity Map, in Appendix A of this report. This geotechnical evaluation was performed to assess the subsurface conditions at the project site relative to the proposed design and construction. The following report outlines the purpose and scope of our services; details our evaluation procedures; summarizes our findings; and presents our engineering analysis and corresponding conclusions and recommendations to assist with design and construction of the proposed project. A summary of the primary geotechnical considerations follows:

- The subsurface soil profile observed in the test pits generally consisted of a veneer of topsoil covering silty sand and sandy silt to depths on the order of 5.5 to 6 feet in test pits TP-01 and TP-02. Beneath the silty sand/sandy silt or beneath the topsoil in TP-03 and TP-04, gravel containing varying silt, sand, and cobble content was observed to the maximum depth explored, approximately 9.5 feet.

- Residences for the proposed subdivision can be supported on conventional spread footings bearing on a properly prepared subgrade. Where the natural subgrade consists of silty sand or sandy silt (generally on the west side of the site), footings may be supported on a minimum of 12 inches of granular structural fill extending to a properly prepared subgrade, placed and compacted as recommended herein. Footings supported on a zone of granular structural fill as recommended herein may be designed for an allowable bearing pressure of 2,000 pounds per square foot (psf), provided estimated settlements as outlined herein are acceptable.

  Where the natural subgrade consists of gravel (generally on the east side of the site), footings may be supported on a properly prepared subgrade consisting of natural gravel, prepared as described herein. Footings supported as previously described may be designed for an allowable bearing pressure of 3,000 pounds per square foot (psf), provided estimated settlements as outlined herein are acceptable.

- A pavement section consisting of 3 inches of asphalt over 8 inches of crushed base course is recommended for use for the proposed local asphalt street. If a geosynthetically reinforced pavement section is desired, it should consist of 3 inches of asphalt over 6 inches of base course, and a layer of Tensar NX750, TX7, BX1200, or Mirafi RS380i, or approved equivalent, placed at the subgrade and base course interface.

This geotechnical evaluation is based on preliminary plans and project information which were available to Pilch at the time of exploration and preparation of this report. The geotechnical engineer must be informed of future changes to the site layout, proposed structure locations and layout, and/or loading criteria which differ from the assumptions stated herein.

Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support for proposed structures. If Pilch is not retained to provide required construction monitoring services, we cannot be responsible for soil engineering related construction errors or omissions. This summary should be used in conjunction with the following report in its entirety for design purposes. It should be recognized that details were not included or fully developed in this summary, and the following report must be read in its entirety for a comprehensive understanding of the items contained herein. In addition, the *Limitations* section provides an understanding of the limitations of this report.

TABLE OF CONTENTS

APPENDICES

Appendix A
- Important Information About This Geotechnical Engineering Report (Published by Geoprofessional Business Association)
- Project Vicinity Map
- Exploration Locations Map

Appendix B
- General Notes
- Unified Soil Classification System
- Logs of Exploratory Test Pits

Appendix C
- Laboratory Testing

1.0 PURPOSE AND SCOPE OF SERVICES

This geotechnical evaluation was performed to assess the subsurface conditions at the project site with respect to the proposed design and construction. The general location of this project is shown on Figure A-1, Project Vicinity Map, in Appendix A of this report. Pilch conducted a field exploration program consisting of four exploratory test pits throughout the project site (see Figure A-2, Exploration Locations Map, Appendix A for approximate exploration locations) to obtain information on subsurface soil conditions at the proposed project site in Missoula, Montana. A series of laboratory tests were performed on representative samples collected from select locations and depths to determine the physical and engineering characteristics of the on-site soils as they relate to the proposed construction.

This report summarizes the field exploration and laboratory data and presents conclusions and recommendations to assist the project team in project planning, design, and construction of the proposed project. Services for this project were provided in general accordance with Pilch's proposal and scope of services dated November 6, 2023, and subsequent authorization-to-proceed.

2.0 PROJECT DESCRIPTION

The proposed project will consist of the design and construction of a new residential subdivision consisting of 10 individual lots spanning roughly 1.6 acres. An existing residence and accessory structures located on the east side of the parcel will be demolished as part of this project. A new asphalt paved access drive from South Curtis Street will be constructed on the north side of the new development, terminating in a cul-de-sac on the west end of the parcel.

Preliminary structural loads for the proposed structures were not available at the time this report was prepared. Based on the assumed construction consisting of one- to two-story homes constructed with slab-on-grade floors and wood or light-gauge metal framing, maximum column dead loads are anticipated to be on the order of 25 kips or less. Maximum continuous loads on the order of 2 kips per linear foot or less are anticipated.

Preliminary grading plans were not available at the time this report was prepared; however, cut and/or fill of less than 2 feet are anticipated to grade the current site topography to desired finished site contours and provide positive drainage away from the new structures. If the proposed design or loads vary from those stated, Pilch Engineering should be notified to review the recommendations herein.

3.0 EVALUATION PROCEDURES

Published soil and geologic information applicable to the project area were reviewed in conjunction with available project related reference documents to complete this geotechnical evaluation. The subsurface conditions were evaluated for this study by observing a series of exploratory test pits. Representative samples of the subsurface materials were tested to determine pertinent engineering properties and characteristics for the proposed construction.

Information obtained from the field explorations, laboratory testing, and subsequent geotechnical analyses were utilized to develop the conclusions and recommendations presented herein.

3.1 REFERENCE DOCUMENTS

Pilch was provided and reviewed the following reference documents and information to help develop an understanding of the proposed project:

1. Preliminary Layout, Gooden Curtis – Feasibility, Sheet 1 of 1, prepared by IMEG Consultants Corp., dated May, 2023

In addition to the provided sources, several publicly available information sources were used to assist with this study.

3.2 FIELD EXPLORATION PROGRAM

Pilch observed the excavation of four test pits at the project site on November 30, 2023. The exploratory test pits for this project were excavated using a track-mounted Sany SY50U excavator equipped with a soil excavation bucket. Approximate locations of the exploratory test pits are shown on Figure A-2, Exploration Locations Map, in Appendix A. Prior to mobilization, Montana 811 was contacted to request the location and clearance of public underground utilities. Review of the site was also performed to determine possible access limitations to proposed exploration locations prior to subsurface exploration.

Subsurface conditions observed in the exploratory test pits were visually described and classified in general accordance with ASTM D2488 and the subsurface profiles were logged by a Pilch geotechnical engineer. Disturbed samples representative of soil conditions from select locations were obtained from excavation spoils.

Detailed descriptions of the soil conditions observed in the explorations are presented on the test pit logs found in Appendix B of this report. The General Notes and Unified Soil Classification System (USCS) summary, both presented in Appendix B, should be referenced for an understanding of the descriptive soil terms used on the exploration logs and in this report.

3.3 LABORATORY TESTING

Representative samples obtained during the field exploration were selected and tested in general accordance with ASTM or other applicable testing procedures to supplement field classifications and to assess the pertinent soil engineering properties and characteristics for use in design of the proposed construction. The laboratory testing program conducted for this evaluation included the tests listed in the following table.

Table 3.1. *Laboratory Testing Program*

Test Performed:	Information Acquired:
Natural Water Content (ASTM D2216)	Water content representative of soil conditions at the time and location samples were collected
Particle-size Distribution (ASTM D6913)	Size and distribution of soil particles (i.e., gravel, sand, and silt/clay) of a particular sample
Atterberg Limits (ASTM D4318)	Effects of varying water content on the consistency of fine-grained soils present in a particular sample
Moisture-Density Relationship (ASTM D698)	Relationship between the laboratory maximum dry density and corresponding water content of a soil for a particular compaction effort
California Bearing Ratio (ASTM D1883)	The ability of a soil to support a particular pavement section subjected to known traffic loading
Chemical Analysis (ASTM D4972, G187, C1580)	The potential of a soil to corrode metal or concrete used in construction

4.0 SITE CONDITIONS

The project site is located on the west side of Curtis Street, on a rectangular shaped parcel. Residential development surrounds the subject parcel. An existing residence and accessory structures exist on the east side of the property. Ground cover throughout the property generally consists of grass and weeds, with trees lining the north edge and east side of the property. Existing site topography is relatively flat, with an approximate elevation difference on the order of 2 feet across the subject property.

4.1 GEOLOGIC OVERVIEW

Subsurface conditions at the site are mapped as Quaternary alluvium (Qal) on the "Geologic Map of the Montana Part of the Missoula West 30' x 60' Quadrangle", Montana Bureau of Mines and Geology, prepared by Lewis, R.S., 1998. Based on the mapping and previous experience at nearby project sites, subsurface conditions at the project site were anticipated to consist of gravel with varying silt and sand content, with possible discontinuous layers of sand or silt. Cobbles and boulders are common to this stratum. The information presented by the mapping was generally consistent with Pilch's observations in the explorations.

4.2 GEOLOGIC HAZARDS

Typical geologic hazards present in the general project site vicinity include liquefaction and slope instability. In review of the subsurface information to determine the potential for liquefaction triggered by strong ground motion, consideration was given to the age of the sediment, soil classification and stratigraphy, groundwater conditions, relative soil density, and depth to bedrock. Based on the preceding factors coupled with seismic considerations for the project area, the potential for seismically induced liquefaction of the soils at the project site is negligible.

To determine the apparent risk of slope instability for the project site, existing and proposed topography, subsurface soil conditions, depth to groundwater, and the proposed construction were considered. Based on the anticipated limited site grading, and the existing topographical and geologic conditions surrounding the project site, slope instability risk at this project site is anticipated to be negligible.

4.3 SEISMICITY

Pilch anticipates the 2021 International Residential Code (IRC) will be used as the basis for design of the proposed residences as part of this project. Based on laboratory testing results, subsurface exploration information, and knowledge of the local geology, the natural soils at the site can be characterized as Site Class C for seismic design, in accordance with the previously referenced standard. The seismic parameters presented in the following table may be used for design of the proposed structure.

Table 4.1. *Seismic Design Parameters*

Parameter	Value	Description
Latitude	46.869841°	Project site geographic position
Longitude	-114.032907°	Project site geographic position
Seismic Site Class	C	Seismic Design Site Classification
Risk Category	II	Seismic design risk category
S_S	0.419	MCE_R ground motion (period = 0.2s)
S_1	0.140	MCE_R ground motion (period = 1.0s)
S_{DS}	0.363	Numeric seismic design value at 0.2s SA
S_{D1}	0.140	Numeric seismic design value at 1.0s SA
F_a	1.3	Site amplification factor at 0.2s
F_v	1.5	Site amplification factor at 1.0s
PGA	0.186	MCE_G peak ground acceleration
F_{PGA}	1.214	Site amplification factor at PGA
PGA_M	0.225	Site modified peak ground acceleration

5.0 SUBSURFACE CONDITIONS

General characterization of the subsurface profile observed follows, grouping soils with similar physical and engineering properties. The exploration logs should be referenced for more detailed descriptions of the soil types and their estimated depths. It should be noted that depths shown as boundaries between various strata on exploration logs are approximate. Transitions between soil types/layers may be gradual. In addition, subsurface conditions may vary between exploration locations from those observed at discrete exploration locations. Such changes in conditions would not be apparent until construction. If subsurface conditions significantly deviate from those observed in the explorations, construction timing, plans, and costs may change.

The subsurface soil profile observed in the test pits generally consisted of a veneer of topsoil covering silty sand and sandy silt to depths on the order of 5.5 to 6 feet in test pits TP-01 and TP-02. Beneath the silty sand/sandy silt or beneath the topsoil in TP-03 and TP-04, gravel containing varying silt, sand, and cobble content was observed to the maximum depth explored, approximately 9.5 feet.

5.1 TOPSOIL

Topsoil was observed from the surface to depths of approximately 3 inches throughout most of the site but was observed to depths up to approximately 1.2 feet on the west end of the site.

5.2 SAND & SILT

Silty sand and sandy silt were observed in test pits TP-01 and TP-02 from beneath the topsoil to depths on the order of 5.5 and 6 feet, respectively. The materials were interbedded and often indistinguishable due to their similar sand and silt content. The silty sand and sandy silt were observed to range in moisture from slightly moist to very moist depending on location and depth. The color varied from brown to tan, and the soil was generally medium plastic. Based on excavation difficulty, the silty sand/sandy silt generally had a loose/medium stiff relative consistency.

5.3 GRAVEL

Poorly graded gravel with silt, sand, and cobbles was observed in test pits TP-01 and TP-02 below a layer of sandy silt from a depth of approximately 5.5 to 6 feet, extending to the maximum depth explored (approximately 9.5 feet). The gravel was brown to multi-colored, moist, subrounded, and appeared medium dense based on excavation difficulty.

In test pits TP-03 and TP-04, brown, medium dense silty gravel with sand containing trace roots was observed beneath the topsoil horizon, extending to depths on the order of 1 to 1.5 feet. Beneath the silty gravel with sand, the silt content decreased, and the material visually classified as poorly graded gravel with sand and cobbles to the maximum depth explored (approximately 9.5 feet). The material was generally light brown to multi-colored, slightly moist, subrounded, and appeared medium dense. Some caving during excavation was observed, with test pit TP-03 terminated at approximately 9 feet due to caving.

5.4 GROUNDWATER

Groundwater was not observed in any of the four exploratory test pits at the time of the field exploration (November 2023). The test pits were backfilled immediately following excavation. Groundwater levels at the project site are expected to be dependent on seasonal precipitation, local irrigation practices, land use, and runoff conditions. As such, the groundwater level in the project vicinity is expected to fluctuate. Therefore, conditions may be different during construction. Based on publicly available well logs in the vicinity, the static groundwater depth is anticipated to exceed 20 feet in depth below existing site grades. A detailed study of site hydrogeologic conditions was beyond the scope of services for this study.

6.0 INFILTRATION TESTING

In-situ infiltration testing was performed at two test pit locations (TP-01 and TP-03) to assist in on-site stormwater management design. Infiltration testing was performed in accordance with the procedures outlined in Appendix 6-F of the current City of Missoula Public Works Standards and Specifications Manual.

At each testing location, the test pits were excavated to depths on the order of 9 to 9.5 below existing grades. Upon excavation to depth, solid 4-inch diameter PVC pipe was embedded into the natural soil in the borings as much as reasonable efforts allowed without damaging the pipe (generally 4 to 6 inches). Following seating of the pipe, the excavation surrounding the pipe was backfilled with excavation spoils.

Pilch returned to the site on December 6, 2023 to perform infiltration testing. Approximately 4 inches of pea gravel was placed in the PVC pipe to act as a splash guard. Water was then introduced into the pipe, commencing a one-hour saturation period.

After completion of the saturation period, an approximate 6-foot head of water was used to begin each trial, and the time for the water column to drop 24 inches was recorded. Per test method procedures, for locations requiring less than one hour for the water column to drop 24 inches (which occurred at both testing locations for this project), the average rate of the final four trials not varying by more than 10 percent for each test is reported as the infiltration rate. These data are presented in the following table.

Table 6.1. *Infiltration Testing Results*

Test Location	Depth of Test Below Ground Surface (in.)	Infiltration Rate (in/hr)	Soil Classification (USCS)
TP-01	105	6,425	Poorly graded gravel with silt, sand, and cobbles
TP-03	109	2,220	Poorly graded gravel with sand and cobbles

It is recommended that the civil engineer apply appropriate factors of safety to the measured values or select lower values based on previously observed and documented performance of drywells in the vicinity of the project.

7.0 LABORATORY TESTING RESULTS

Laboratory test results are presented in Appendix C and select results displayed on the exploration logs. Discussion of some of the laboratory testing results is presented in the following sections.

7.1 MOISTURE CONTENT

Results of natural water content testing of representative samples obtained at the time of exploration (November 2023) indicate most of the near surface subsurface materials are below the presumed optimum moisture content for compaction, depending upon location and material.

7.2 CLASSIFICATION

Gradation analyses in conjunction with Atterberg limits testing were performed on samples from test pits TP-01 (2 to 5 feet) and TP-02 (7 to 8 feet). The testing determined classifications of silty and silty sand with gravel, respectively. Atterberg limits testing of the samples determined the materials to be non-plastic. Graphical results of the laboratory testing are presented in Figures C-1 and C-2 in Appendix C.

7.3 MOISTURE-DENSITY RELATIONSHIP

Moisture-density relationship testing was performed on a bulk sample of representative material obtained from test pit TP-01 (2 to 5 feet) in accordance with ASTM D698 (standard Proctor). Through a series of controlled trials using a variety of moisture contents, a moisture-density curve was established for the subject soil. Results of the testing indicate a maximum dry density of approximately 111.2 pounds per cubic foot (pcf) at an optimum moisture content of 13.5 percent for the sample tested (Figure C-3, Appendix C).

7.4 CALIFORNIA BEARING RATIO

California Bearing Ratio (CBR) testing was performed in accordance with ASTM D1883 on a bulk sample of representative material obtained from boring TP-01 (2 to 5 feet). Testing determined a CBR value of 5.9 percent when compacted to 95 percent of the maximum dry density (Figure C-4, Appendix C). CBR strengths in this range are considered a poor to fair strength subgrade for supporting pavements under controlled placement conditions.

7.5 CHEMICAL ANALYSIS

7.5.1 pH and Resistivity

Factors which contribute to soil corrosion of buried metal structures include soil resistivity, pH, presence of water and oxygen, and soluble salts. Soil minimum resistivity and pH are typically regarded as the primary indicators of soil corrosion potential. In general, fine-grained soils (silt and clay) have lower resistivity and present a greater potential for corrosion. With an increase in soil moisture content, resistivity generally decreases, and corrosion potential generally increases. Soils with low pH and relatively high resistivity are also corrosive.

Generalized effects of soil resistivity and pH with respect to corrosion potential are summarized in the following table, based on information available from the National Association of Corrosion Engineers (NACE).

Table 7.1. *Soil Corrosivity Information*

Soil Resistivity (ohm-cm)	Soil Corrosivity
>20,000	Essentially Non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
<1,000	Extremely corrosive

Resistivity and pH testing was performed on a representative sample from test pit TP-01 (2 to 5 feet). Results of the testing determined a pH of 7.4 and minimum resistivity of 2,645 ohm-cm. Results of resistivity testing suggest the on-site silty sand/sandy silt has the potential to exhibit highly corrosive behavior to buried metal in contact with it. A licensed engineer experienced with corrosion should be consulted to determine appropriate protection measures. Where possible, it is recommended that non-corrosive materials be used in lieu of metal conduits, and ductile iron pipe (if used) be encased with polyethylene tubing.

7.5.2 Water-soluble Sulfate Content

The American Concrete Institute Standard 318 (ACI 318) presents durability requirements for concrete based on the exposure category and class of the structure, dependent on the ground and weather situation of the area. Sulfate attack (exposure category S) is one of the most important factors that influences the long-term durability of concrete structures when exposed to potentially corrosive environments such as soil or groundwater. The exposure class influences proportion of mixture, type of cement and cementitious materials, and percentage of chemical admixtures like air-entrainment admixture.

Durability requirements for concrete in contact with water or soil that contains sulfate ions which can solute in water are summarized in the following table, based on information available from

ACI 318. The degree of severity of concrete exposure to sulfate attack constitutes the four classes presented.

Table 7.2. *Concrete Durability Information*

Exposure Class	Water-Soluble Sulfate (SO_4^{2-}) in Soil (percent by mass)	Maximum Water/Cement Ratio	ASTM C150 Cement Type
S0	$SO_4^{2-} < 0.10$	N/A	No type restriction
S1	$0.10 \leq SO_4^{2-} < 0.20$	0.50	II
S2	$0.20 \leq SO_4^{2-} < 2.00$	0.45	V
S3	$SO_4^{2-} > 2.00$	0.45	V plus pozzolan or slag

Testing was performed on a representative sample from TP-01 (2 to 5 feet) to determine the concentration of water-soluble sulfates present. Results of the testing determined a water-soluble sulfate content of 905 mg/kg (0.09 percent). These testing results indicate a low exposure to sulfate attack in normal strength concrete exposed to these materials. Based on testing results, Exposure Category S0 (ACI 318) may be specified for concrete in direct contact with on-site soils.

8.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

8.1 GENERAL

From a geotechnical perspective, it is the professional opinion of Pilch that the site is suitable for development and construction of the proposed project provided that the recommendations provided herein are followed. The opinions, conclusions, and recommendations presented herein are based on the field exploration, engineering analysis, physical and engineering properties of the materials observed in the subsurface explorations, the results of the laboratory testing program, and Pilch's understanding of the proposed project. These opinions, conclusions, and recommendations are subject to the limitations as presented in this report. If the construction scope changes, or if conditions are encountered during construction which are different than those described in this report, Pilch should be notified so the recommendations herein can be reviewed and revisions can be provided, if necessary. Additionally, Pilch should be given the opportunity to review plans and specifications to determine whether the recommendations presented in this report were properly incorporated as intended.

8.2 SITE GRADING

8.2.1 Clearing and Stripping

Prior to placement of fill, the site should be stripped of any undocumented fill, organics, debris, and other deleterious materials in the construction footprint. Where feasible, extend removal of organics and other debris or deleterious material a minimum of 5 feet beyond the structure footprints. Based on observations of subsurface conditions in the explorations and general site reconnaissance, the stripping (sub-excavation) depth for removal of topsoil within the structure and pavement envelopes is estimated to average approximately 3 inches throughout most of the site but was observed to depths up to approximately 1.2 feet on the west end of the site. In areas where existing trees will be removed, additional stripping depth will be required to remove the considerable root mass. In addition, the depth for complete removal of undocumented fill associated with the existing structures is estimated to be up to approximately 5 feet; however, deeper pockets may exist. Removed materials should be replaced with compacted granular structural fill to achieve design elevations, if required.

8.2.2 Excavation

Based on the preliminary plans provided by the project design team, cuts of less than 2 feet are anticipated to grade the current site topography to desired finished site contours. Based on conditions observed in the explorations, it is anticipated that excavation of the on-site soils can be achieved with typical heavy-duty excavation equipment.

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. In consideration of the gravel and sand present at the project site containing few fines content (silt/clay), caving and sloughing should be anticipated if cuts of significant depth are left unsupported or inadequately sloped. 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 temporary slope.

8.2.3 Subgrade Preparation

The subgrade is defined by Pilch as the exposed native soil 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 soils for structure and pavement envelopes underlying the west side of the project site generally consist of silty sand and sandy silt, transitioning to gravel with varying silt and sand content on the east side. Although not observed in the test pit explorations, undocumented fill is anticipated within and surrounding the footprint of the existing structures. Where present beneath foundations and slabs, or other structural features, undocumented fill should be removed its full depth due to the potential for post-construction densification which would result in settlement and potential damage to the supported structural element. Occasional debris or deleterious material may be present in the fill and should be anticipated.

The silty soils present near surface along the western portion of the project site are susceptible to pumping and rutting if subjected to significant and repeated traffic by rubber tire construction equipment. It is recommended tracked construction equipment be used to traffic the site and rubber tire equipment be limited to haul routes.

Prior to construction of footings, slabs, pavements, or placement of fill, the exposed subgrade soils should be scarified to a depth of approximately 8 inches, moisture conditioned to within 2 percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D698 (standard Proctor). Moisture conditioning of the subgrade surface may involve wetting or drying of the soil to help facilitate compaction. Please refer to the in-situ moisture content laboratory test results shown on the test pit logs for an estimation of existing soil-moisture conditions (at the time of exploration).

The subgrade should be sloped to promote runoff and reduce the potential for ponding of water on the subgrade surface. Proper grading of subgrade surfaces is critical to the long-term performance of supported structural elements. In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, the materials should 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 soils.

Weather conditions should be given careful attention during subgrade preparation to prevent excess moisture from collecting on or penetrating and possibly saturating the subgrade before and after compaction. It is recommended that the subgrade be temporarily sloped to provide drainage to a low area of the excavation and any excess water pumped from the excavation. Such collection and discharge must be in compliance with the Contractor's site-specific storm water pollution prevention plan (SWPPP). Should portions of the subgrade become saturated, those areas should be sufficiently excavated, replaced with moisture conditioned soil, and properly compacted.

8.2.3.1 Subgrade Stabilization

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

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, TX7, BX1200, or Mirafi Rs380i, or approved equivalent. 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.

- 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.

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

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

Table 8.1. *Structural Fill Recommendations for Use in Conjunction with Geosynthetic Reinforcement*

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 Pilch representative should be on site during subgrade stabilization activities to verify the recommendations presented herein are followed as intended and to provide additional recommendations as appropriate.

8.2.4 Materials

8.2.4.1 On-site Soils

The fine-grained silty sand/sandy silt present near surface throughout the west side of the project site are not suitable for re-use as structural fill beneath foundations or slabs, but may be used for backfilling of exterior foundation walls, trench backfill in utility trenches, and for general site grading fill, provided deleterious materials are removed and the material is placed in accordance with the recommendations outlined in the *Fill Placement and Compaction* section. In addition, on-site soils used for such purposes should be thoroughly mixed prior to placement to achieve a uniform texture.

Gravel of varying silt and sand content was observed beginning at various depth ranges throughout the property. If a significant volume of gravel is generated from excavation, it is suitable for re-use as structural fill beneath foundations and slabs, provided material greater than 3-inches in size (i.e., cobbles and boulders) and deleterious materials are removed, and the material is placed in accordance with the recommendations outlined in the *Fill Placement and Compaction* section. In addition, on-site soils used for such purposes should be thoroughly mixed prior to placement to achieve a uniform texture.

8.2.4.2 Import Soil

Import fill materials should be free of organics, debris, and other deleterious material and meet the recommendations in the following table. All import materials should be approved by the Geotechnical Engineer prior to delivery to the site.

Table 8.2. *Imported Fill Materials Recommendations*

Fill Type	Recommendations	
Import Granular Structural Fill[1]	***Sieve***	***Percent Passing***
	3-inch	100
	¾-inch	70 – 100
	No. 4	25 – 50
	No. 40	10 – 20
	No. 200	0 – 15
	Plasticity Index	Non-plastic
Crushed Base Course	***Sieve***	***Percent Passing***
Montana Public Works Standard	¾-inch	100
Specifications, 7th Edition, Section 02235	No. 4	40 – 70
	No. 10	25 – 55
	No. 200	2 – 10
	Liquid Limit	0% - 25%
	Plasticity Index	0% - 6%

Notes: [1] Soils with more than 30% retained on the ¾-inch sieve are considered 'oversized' and may require method-based compaction methods.

8.2.4.3 Fill Placement and Compaction

Fill should be placed in lift thicknesses appropriate for the compaction equipment used, but in no case should loose lift thicknesses exceed 8 inches. Typically, 6- to 8-inch thick loose lifts are appropriate for typical rubber tire and steel drum compaction equipment. Lift thicknesses should be reduced to a maximum of 4 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.

Additional care should be exercised during placement and compaction of fill adjacent to utilities such as manholes or storm drains. Inadequately compacted fill may densify and subside over time, potentially causing pavement deterioration issues such as potholes, fatigue cracks, and rutting. Additionally, water can pond in subsided regions, exacerbating such problems resulting in a shortened pavement life if left untreated.

Fill placed for on-site improvements and in structural areas should be compacted to a dense and unyielding condition and to the following minimum percentages in accordance with the associated standard.

Table 8.3. *Compaction Recommendations*

Area	Compaction (%)	Standard
Subgrade	95	ASTM D698
Beneath Foundations	98	ASTM D698
Foundation Wall Backfill	95	ASTM D698
Beneath Slabs-on-grade and Flatwork	98	ASTM D698
Utility Trench Backfill	98	ASTM D698
Site Grading	95	ASTM D698
Beneath Pavements	98	ASTM D698

For materials which are too coarse to establish a relevant moisture-density relationship curve (Proctor) and associated density test results with a nuclear densometer in accordance with ASTM methodology (greater than 30 percent retained on a ¾-inch sieve), a method-based compaction specification should be established in accordance with ASTM D698. The compaction method should be established by making repeated passes with appropriately sized compaction equipment over the subgrade with appropriate soil moisture conditioning until a dense and unyielding surface is achieved (a minimum of six, full-coverage passes is recommended). For areas where a large compactor cannot access, a walk-behind articulating trench roller or heavy plate compactor may be used if approved by the geotechnical engineer. Where appropriate, a moisture-density relationship (Proctor) test should be performed to assist in evaluating appropriate moisture and density conditions of the method-based compaction procedures. Success in executing proper compaction control is highly dependent upon the quality and experience of the contractor and inspector.

8.2.5 Wet Weather Earthwork

During periods of wet weather or when the subgrade becomes wet, Pilch recommends the following construction practices be observed.

- Earthwork should be planned to limit the disturbance area to as small as possible to minimize the potential for soil saturation. The contractor should take measures to protect the exposed subgrade and limit construction traffic. Where possible, construction equipment should not operate directly on wet subgrade. Low ground pressure equipment should be used in cases where wet subgrade must be trafficked.

- Site grades should be maintained to prevent ponding and capture runoff before it erodes or damages the subgrade. Earthen berms or other methods should be used to prevent runoff from draining into excavations. Additionally, all stockpiles should be covered or rolled with a smooth drum to shed water when not actively being worked or dried. All runoff should be collected and properly disposed of in compliance with the Contractor's site-specific storm water pollution prevention plan (SWPPP). Care should be taken to cover exposed surfaces with appropriate fill as soon as practical following exposure.

- The subgrade should be graded and rolled with a smooth drum roller to minimize the infiltration of water into the subgrade during wet weather and at the end of each shift if wet weather is forecasted.

- Following periods of wet weather, surficial soils should be allowed to dry to the greatest extent practical prior to handling or traversing with construction equipment. As necessary, wet soils should be scarified or tilled to promote drying during periods of dry weather.

8.2.6 Cold Weather Earthwork

Fill should not be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to properly thaw or be completely removed prior to placement of fill. In addition, concrete elements (i.e., foundations, slabs, etc.) should not be installed on frozen soil. All frozen soil should either be removed in its entirety beneath these elements or be completely thawed and recompacted. The amount of time between excavation and construction should be minimized to the extent practical to minimize frozen soils. The contractor should adhere to the recommendations presented by the American Concrete Institute (ACI) for placement and curing concrete in cold weather.

Use of blankets, soil cover, heating sources, or other methods may be required to prevent the subgrade or compacted fills from freezing. During the winter months when freezing temperatures are a factor, typical good construction practice is to cover compacted fills or subgrades with a 12-inch thick “blanket” of loose fill prior to the end of each day to help prevent compacted materials from freezing if otherwise exposed. Prior to resuming placement of fill the following day, the loose fill “blanket” must be removed in its entirety and allowed to completely thaw prior to incorporating that material into the fill.

8.3 FOUNDATIONS

Recommendations for conventional spread footing foundation systems are provided in the following section, based on the subsurface conditions observed and the stated assumptions.

8.3.1 Spread Footings

The following recommendations are provided for use in the design and construction of a conventional spread footing foundation system for residences as part of the proposed subdivision.

- Where the natural subgrade consists of silty sand or sandy silt (generally on the west side of the site), footings may be supported on a minimum of 12 inches of granular structural fill extending to a properly prepared subgrade, placed and compacted as recommended herein. Footings supported on a zone of granular structural fill as recommended herein may be designed for an allowable bearing pressure of 2,000 pounds per square foot (psf), provided estimated settlements as outlined herein are acceptable. The zone of engineered gravel fill beneath footings should extend 1 foot laterally beyond the outside edges of footings for each foot of depth of engineered gravel fill below the footings but should extend a minimum of 2 feet beyond the footing edges to provide a uniform layer of competent gravel upon which to support structural footing loads. The allowable bearing pressure may be increased by one-third to account for transient loads such as wind and seismic.

- Where the natural subgrade consists of gravel (generally on the east side of the site), footings may be supported on a properly prepared subgrade consisting of natural gravel, prepared as described herein. Footings supported as previously described may be designed for an allowable bearing pressure of 3,000 pounds per square foot (psf), provided estimated settlements as outlined herein are acceptable. The allowable bearing pressure may be increased by one-third to account for transient loads such as wind and seismic.

- Footings should be embedded a minimum of 42 inches below the lowest adjacent grade to provide protection against frost action.

- Unless specified by the project engineer or governing codes requiring an increased width, 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 properly compacted granular structural fill of 0.45 may be used for design.

- Foundation bearing surfaces should be free of loose soil and debris.

- Total settlement estimated for spread footing foundations designed and constructed as recommended herein will be 1-inch or less. Differential settlement is estimated to be 0.5-inch or less in a 30-foot span.

- A permanent foundation drainage system should be designed and constructed around the perimeter of the proposed structures. The drainage system should consist of a four-inch diameter, Schedule 40 PVC or high-density polyethylene (HDPE), perforated pipe surrounded on all sides by a minimum of 4 inches of free draining aggregate and encapsulated by non-woven filter fabric such as Mirafi 140N, or approved equivalent. The pipe should be located at the lowest elevation of the footing trench excavation such that gravity drainage may be achieved. Water collected in the drains should be discharged down-gradient of the structures. If the pipe cannot be daylighted and maintain positive drainage due to site gradient, it should be tied to an existing stormwater drainage feature, or a drywell should be considered.

- Portland cement type used should be selected by the project structural engineer so that the desired performance is achieved. Concrete in contact with the site soils does not require cement type restriction based on laboratory testing results of water-soluble sulfates.

- Backfill placed adjacent to foundation walls should be placed uniformly on both sides of the foundation walls to reduce displacement of the foundation walls.

- A Pilch geotechnical engineer or their designated representative should observe the subgrade below foundation excavations prior to the placement of any granular structural fill, concrete forms, and reinforcing steel to ensure the intent of the design criteria presented herein is met.

8.4 CONCRETE FLOOR SLABS

Satisfactory performance of slab-on-grade concrete construction is dependent upon relatively uniform support beneath the slab. The subgrade for concrete slabs-on-grade should be prepared as recommended in the *Subgrade Preparation* section of this report.

The following recommendations are provided for use in the design and construction of concrete slabs-on-grade.

- Where the natural subgrade consists of silty sand or sandy silt (generally on the west side of the site), floor slabs should be supported on a minimum of 12 inches of properly compacted engineered gravel fill. Where the natural subgrade consists of gravel (generally on the east side of the site), floor slabs should be supported on a minimum of 6 inches of properly compacted engineered gravel fill. A minimum of 4 inches of free-draining gravel should be placed between the slabs and the underlying granular structural fill, acting as a leveling course and capillary break. The layer of free-draining gravel may be included as part of the larger thickness of granular structural fill. Free-draining gravel should consist of minus ¾-inch aggregate with less than 60 percent passing the No. 4 sieve and less than 10 percent passing the No. 200 sieve.

- To reduce the effects of differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints, which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking.

- Utility lines which pass through the floor slab should be provided with a positive bond break so that they can move independently from the floor slab.

- Steel reinforcement for concrete floor slabs supported on compacted gravel as described herein should be designed using a modulus of subgrade reaction of 75 pounds per cubic inch (pci).

- A vapor retarder is recommended beneath the slab-on-grade floor if moisture sensitive floor coverings and/or adhesives are used. If a vapor retarder is used, 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 E1745 is recommended. Overlap lengths and the appropriate tape used to seal the laps should be in accordance with the vapor retarder manufacturer's recommendations. To help avoid puncturing the vapor retarder, a thin sand layer placed over the crushed gravel is recommended. 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.

8.5 EXTERIOR CONCRETE FLATWORK

The subgrade for exterior concrete flatwork should be prepared as recommended in the *Subgrade Preparation* section of this report. Following compaction, the pavement subgrade should be proof rolled with heavy rubber-tired construction equipment such as a loader with a full bucket or a loaded dump truck to identify any localized loose or soft areas. Any such areas should be mitigated as recommended in the *Subgrade Stabilization* section of this report.

A minimum of 6 inches of granular structural fill should be placed beneath concrete flatwork, placed and compacted as recommended in the *Fill Placement and Compaction* section of this report. Flatwork at door openings intended for egress or ingress into the buildings must be tied to the foundation or underlain by granular structural fill to reduce the magnitude of differential movement between the slab and structure.

8.6 RETAINING WALLS

Based on preliminary information provided to Pilch at the time this report was prepared, Pilch assumes that there will be no retaining walls constructed as part of this project (other than those functioning as below grade foundation walls). If retaining walls are to be implemented as part of this project, Pilch should be provided the opportunity to review the plans to determine if additional geotechnical evaluation is required. The development of wall specific lateral earth pressures may be necessary depending upon the location and height of the proposed retaining wall(s). Pilch's scope of services for this project did not include retaining wall design; however, these services can be provided for an additional fee, if requested.

8.7 LATERAL EARTH PRESSURES

Retaining walls will be subjected to horizontal loading due to lateral earth pressure and, in some cases, additional pressure due to loading from proposed or existing structures. The lateral earth pressure is a function of the natural and backfill soil types and acceptable wall movements, which affect soil strain and mobilize the shear strength of the soil.

Design for resisting lateral earth pressures should be computed based on the soil properties and lateral earth pressures provided in the following table. Resistance to overturning and sliding can be provided by passive earth pressure and sliding friction. Compacted fill placed against the side of the footing and building to resist lateral loads should meet the compaction and grading specifications in the *Fill Placement and Compaction* section. Appropriate factors of safety used in structural analysis for items such as overturning moments and sliding should be used for design.

Table 8.4. *Lateral Earth Pressures*

Material	Parameter	Earth Pressure Condition		
		At-rest	**Active**	**Passive**
On-site Silty Sand / Sandy Silt	Earth Pressure Coefficient	0.63	0.45	2.20
	Equivalent Fluid Density	65	45	160
Approved On-site and Imported Granular Structural Fill	Earth Pressure Coefficient	0.43	0.27	3.69
	Equivalent Fluid Density	55	35	330

Determination of whether the active or at-rest condition is appropriate for design depends on the flexibility of the walls. Walls that are free to rotate at least 0.002 radians (deflection at the top of the wall of at least 0.002H, where H is the unbalanced wall height) may be designed for the active condition. Walls that are not capable of sustaining such movement should be assumed rigid and designed for the at-rest condition. Reductions on the ultimate passive resistance should be incorporated into design to account for displacement compatibility with active earth pressures.

Seismic forces are additive to the provided lateral earth pressures and should be calculated based on 10H psf/foot, distributed as an inverse triangle for active conditions and as a uniform pressure for at-rest conditions. For passive conditions, seismic forces should be calculated based on a uniformly distributed reduction. In this case, "H" is equal to the exposed height of the wall (i.e., above ground permanent ground level in front of the wall). The seismic lateral earth pressure was determined based on a PGA value corresponding to one-half of two-thirds of the PGA_M.

The lateral earth pressures presented are for horizontal backfill and do not include the effects of hydrostatic forces or surcharges (i.e., traffic, footings), compaction, or truck-induced wall pressures. Any surcharge (live, including traffic, or dead load) located within a 1H:1V (horizontal:vertical) plane drawn upward from the base of the excavation should be added to the lateral earth pressures. The lateral contribution of a uniform surcharge load located immediately behind walls may be calculated by multiplying the surcharge by 0.33 for cantilevered walls under active conditions and 0.50 for restrained walls under at-rest conditions. Walls adjacent to areas subject to vehicular traffic should be designed for a vertical surcharge of 250 psf. Lateral load contributions from other surcharges located behind walls may be provided once the load configurations are known.

Walls should be properly drained or designed to resist hydrostatic pressures. Adequate drainage is essential to provide a free-drained backfill condition so that there is no hydrostatic buildup behind the wall. Walls should also be appropriately waterproofed to reduce the potential for staining.

8.8 STORMWATER AND DRAINAGE

The grading plan should include slopes such that storm water run-off is directed away from the building and pavement areas to a storm water management system. The ground surface adjacent to foundations should be sloped a minimum of five percent within 10 feet of the building. If the adjoining ground surface consists of hardscapes, it may be sloped a minimum of two percent in the first 10 feet. Water should not be allowed to infiltrate or pond adjacent to foundations.

Landscaping which requires watering is discouraged adjacent to structures due to the potential to introduce water into the subgrade soils by the irrigation system. Such introduction of water could result in greater settlement of foundations than those discussed herein.

8.9 PAVEMENTS

Based on the subsurface conditions observed in the borings, it is anticipated that the pavement subgrade for the proposed roadway will consist of silty sand and sandy silt on the west side of the subdivision transitioning to gravel with varying silt content on the east side. Laboratory testing of the silty sand material indicated a California Bearing Ratio (CBR) of 5.9 percent and was assumed for design of the entire roadway subgrade due to its limited length. Pilch can provide additional pavement section recommendations for areas underlain by gravel subgrades, if desired by the design team.

Roadway loading for the proposed residential street (characterized as a local asphalt street) for this project is estimated based on the assumption that traffic loading conditions totaling 50,000 equivalent single-axle loads (ESALs) or less will be required for the assumed pavement design life (20 years). If anticipated traffic loads differ significantly from the assumptions stated herein, Pilch should be notified so the recommendations can be reviewed and revisions can be provided, if necessary. A summary of the design parameters used for pavement section design is provided in the following table.

Table 8.5. *Pavement Section Design Parameters*

Criteria	Assumed Value
Subgrade California Bearing Ratio (CBR)	5.9%
ESAL	50,000 (local asphalt street)
Pavement Life	20 years
Reliability	85%
Initial Serviceability	4.2
Terminal Serviceability	2.0

The following recommendations are provided for use in the design and construction of the proposed pavements.

- The pavement subgrade should be prepared as recommended in the *Subgrade Preparation* section of this report prior to placing base course (or geosynthetic reinforcement). In areas where utilities such as manholes or storm drains are present, additional care should be exercised during placement and compaction of fill associated with them. Inadequately compacted fill may densify and subside over time, potentially causing pavement deterioration issues such as potholes, fatigue cracks, and rutting. Additionally, water can pond in subsided regions, exacerbating such problems resulting in a shortened pavement life if left untreated.

- Following compaction, the pavement subgrade should be proof rolled with heavy rubber-tired construction equipment such as a loader with a full bucket or a loaded dump truck to identify any localized loose or soft areas. Any such areas should be mitigated as recommended in the *Subgrade Stabilization* section of this report.

- The following flexible (asphalt concrete) pavement section for the local asphalt street, or approved equivalent, are recommended for the proposed roadway as part of this project, based on the stated design parameters:

Table 8.6. *Flexible Pavement Section Recommendations for Local Asphalt Street*

	Thickness (in.)	
Material	**Unreinforced**	**Reinforced**
Asphalt Concrete Surfacing	3	3
Crushed Base Course	8	6
Geosynthetic Reinforcement	No	Yes
Total	**11**	**9**

- If a reinforced pavement section is selected for use, geosynthetic reinforcement consisting of Tensar NX750, TX7, BX1200, or Mirafi RS380i, or approved equivalent, should be placed at the subgrade/base course interface in accordance with the manufacturer's recommendations.

- Crushed base course should meet the recommendations presented in the *Materials* section of this report.

- Asphalt concrete surfacing should be compacted in accordance with current Montana Public Works Standard Specifications requirements.

- The recommended pavement sections assume paving will not be completed until grading operations and heavy equipment or truck traffic are complete for the project.

- Crack maintenance on pavements should be performed at a minimum of every three years, or when cracking is evident. Crack sealing will help reduce surface water infiltration into the underlying soils.

8.10 OWNER OPERATION AND MAINTENANCE RESPONSIBILITIES

Property owners must accept the responsibility for maintaining the site grading, drainage, monitoring utility connections, and have a defined schedule for verifying and making necessary repairs to maintain the overall as designed positive site grading to ensure long term performance of the foundations as defined herein. The property owner shall not make modifications to site grading that compromises the as-designed positive surface drainage. In addition, landscaping and irrigation must be designed, installed, and maintained so as to not impact the overall site grading and/or become a source of water to the site soils which could result in movement of the support structures, pavement, or slabs.

9.0 CONTINUING SERVICES

Successful completion of this project includes additional important geotechnical services which extend beyond this report. Consultation with Pilch's geotechnical engineer during the design phase of this project is an essential element to ensure the intent of the recommendations provided herein are incorporated into design decisions and appropriate project documents, and that any changes to the design concept consider geotechnical aspects.

Pilch should be retained to provide earthwork observation and monitoring during construction to ensure the subsurface conditions are consistent with those described in this study. The design engineer-of-record should determine applicable testing and special inspection requirements in accordance with applicable governing code documents.

10.0 LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices exercised by reputable members of its profession in the region where the services were provided at the time in which it was conducted. The conclusions and recommendations submitted in this report are based upon project information provided to Pilch and data obtained from the field explorations at the locations indicated. The nature and extent of subsurface variations across the site may not become evident until construction occurs. Pilch should be on site during construction to verify that actual subsurface conditions are consistent with those described herein.

This report has been prepared exclusively for the client. This report and the data included herein shall not be used by any third party without the express written consent of both the client and Pilch. Furthermore, Pilch is not responsible for technical interpretations by others. Pilch should provide continued consultation and field services during construction to review and monitor the implementation of the recommendations and verify that the recommendations have been appropriately interpreted. Significant project design changes may require additional analysis or modifications to the recommendations presented herein. Pilch recommends on-site observation of excavations and foundation bearing strata and testing of fill by a representative of the geotechnical engineer. This acknowledgement is in lieu of all warranties, express or implied.

APPENDIX A

- Important Information About This Geotechnical Engineering Report (Published by Geoprofessional Business Association)
- Project Vicinity Map
- Exploration Locations Map

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will <u>not</u> likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

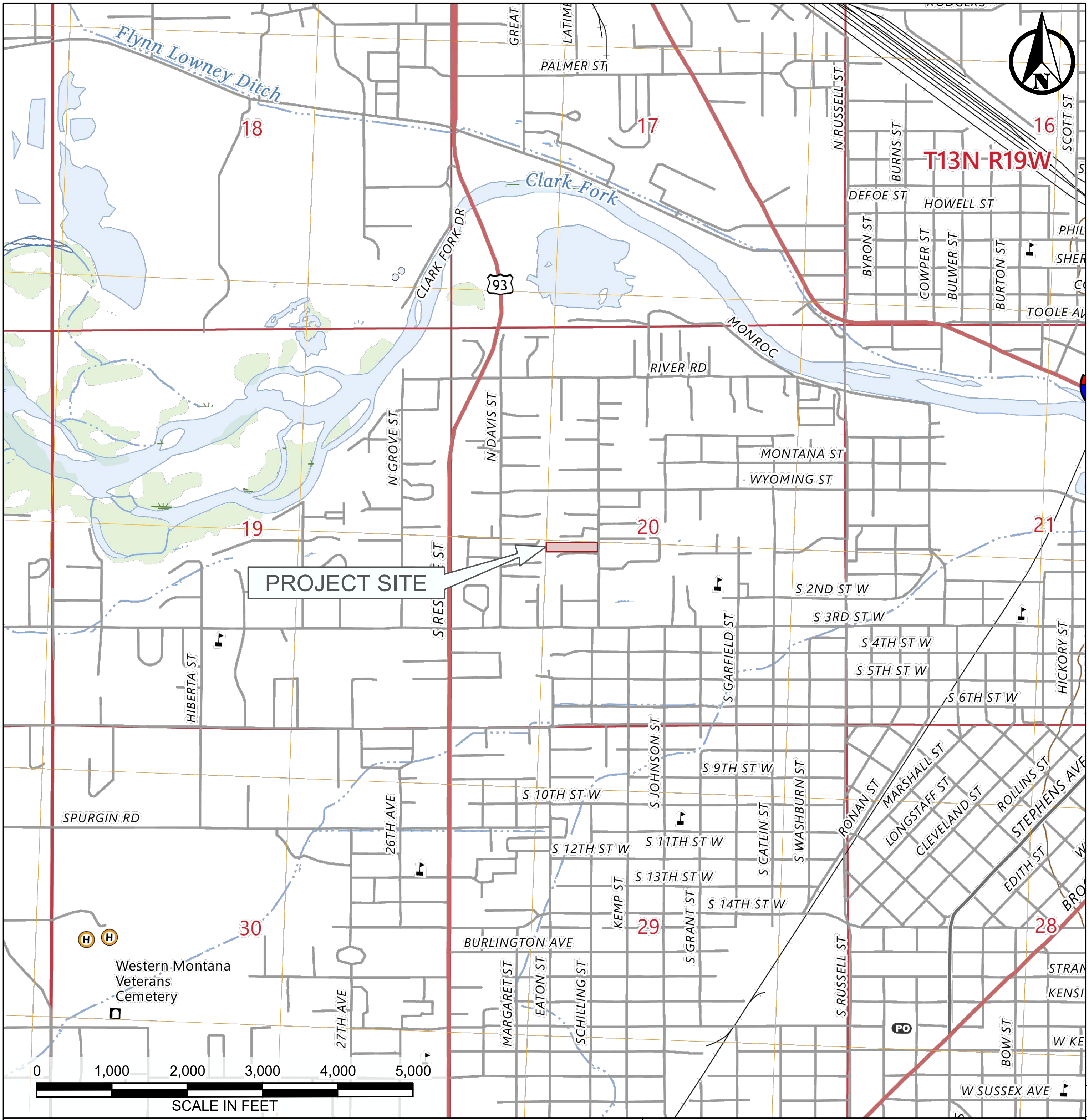
The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org



LEGEND

Approximate Project Boundary

REFERENCES

Basemap: Southwest Missoula and Northwest Missoula, Montana Quadrangles, United States Geological Survey, 2020

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

111 West 2nd Street, Suite 400
Casper, Wyoming 82601
Phone: (307) 672-8750
www.pilchengineeringllc.com

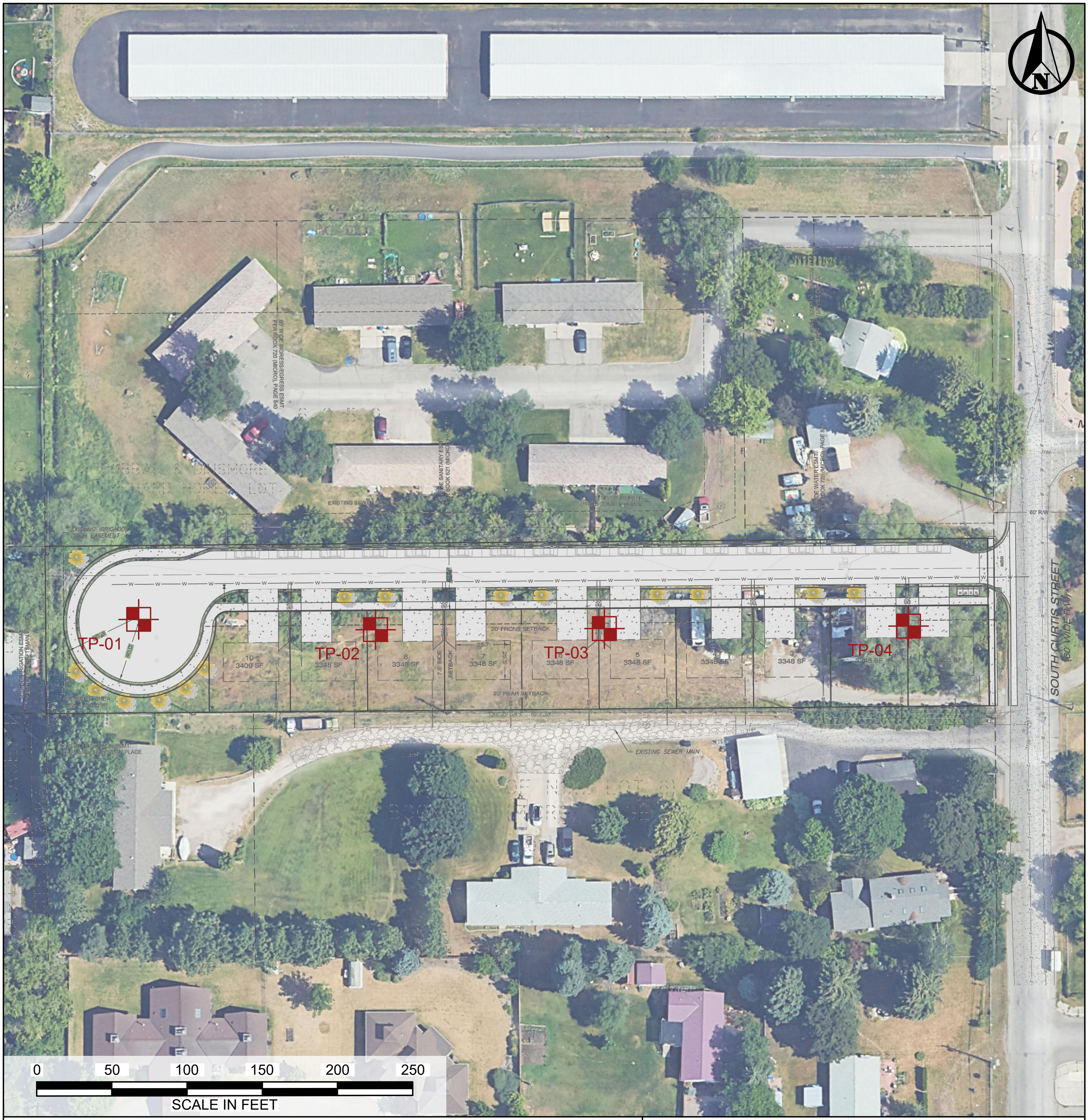
FIGURE A-1: PROJECT VICINITY MAP

PROJECT
Curtis Street Subdivision

LOCATION
Missoula, Montana

CLIENT
IMEG Consultants Corp.

DATE
December 2023



LEGEND

TP-XX — Approximate Exploratory Test Pit Location and Designation

REFERENCES

Basemap: Google Earth Imagery, July 2023

Site Map: IMEG Consultants Corp., May 2023

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

111 West 2nd Street, Suite 400
Casper, Wyoming 82601
Phone: (307) 672-8750
www.pilchengineeringllc.com

FIGURE A-2: EXPLORATION LOCATIONS MAP

PROJECT
Curtis Street Subdivision

LOCATION
Missoula, Montana

CLIENT
IMEG Consultants Corp.

DATE
December 2023

APPENDIX B

- General Notes
- Unified Soil Classification System
- Logs of Exploratory Test Pits

General Notes

Descriptive Terminology of Soil & Symbology

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

Descriptive Soil Classification

Soil classification, as noted on the soil exploration logs, is based on the Unified Soil Classification System. This procedure is used where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 “Classification of Soils for Engineering Purposes”. Where there is insufficient laboratory data for classification purposes, ASTM D2488 “Description and Identification of Soils (Visual-Manual Procedure)” is used to classify the soils. In some cases, variations to these methods are applied as a result of local practice or professional judgment.

Order of Soil Descriptors

1. Group Name
2. Other constituents
3. Consistency or Relative Density
4. Moisture Condition
5. Plasticity (fine-grained soils)
6. Particle size descriptor(s) (coarse-grained soils)
7. Angularity (coarse-grained soils)
8. Color
9. Other relevant notes or comments

Example: Sandy lean CLAY (CL): trace fine gravel, medium stiff, moist, medium plasticity, brown to tan (lenses of fine sand throughout).

Consistency (fine-grained soils)

Consistency	N Value (blows/foot)
Very Soft	< 2
Soft	2 – 4
Medium Stiff	5 – 8
Stiff	9 – 15
Very Stiff	16 – 30
Hard	> 30

Relative Density (coarse-grained soils)

Relative Density	N Value (blows/foot)
Very Loose	< 4
Loose	4 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

Moisture

Descriptor	Meaning
Dry	Absence of moisture, dusty, dry to the touch
Slightly Moist	None to some apparent moisture, dry appearance
Moist	Damp, but no visible water
Very Moist	Enough moisture to wet the hands
Wet	Saturated, visible free water

Other Constituents

Soil Type	Trace	With	Modifier	Lens(es)	Seam(s)
Fine-grained	< 5%	5% – 12%	> 12%	< 1/8”	1/8” – 1”
Coarse-grained	< 15%	15% – 30%	> 30%	< 1/8”	1/8” – 1”

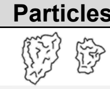
Soil Plasticity Descriptors

Descriptor	Plasticity Index (%)	Characteristics
Non-Plastic	0	A 1/8” thread cannot be rolled at any moisture content.
Low Plasticity	1 – 10	A thread can barely be rolled and the soil lump cannot be formed when drier than the plastic limit.
Medium Plasticity	11 – 20	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The soil lump crumbles when drier than the plastic limit.
High Plasticity	> 20	It takes considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. The soil lump can be formed without crumbling when drier than the plastic limit.

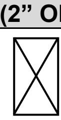
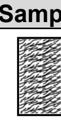
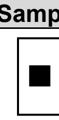
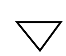
Grain Size

Component		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	¾” – 3”	¾” – 3”	Thumb-sized to fist-sized
	Fine	# 4 – ¾”	0.19” – ¾”	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		< #200	< 0.0029”	Flour-sized and smaller

Angularity of Coarse-Grained Particles

Descriptor	Meaning	Typical Particles
Angular	Particles have sharp corners and edges and relatively plane sides with unpolished surfaces	
Subangular	Particles are similar to angular but with slightly rounded edges and sides that are slightly curved	
Subrounded	Particles are similar to round but with some nearly plane sides and generally well-rounded corners and edges	
Rounded	Particles have smoothly curved sides and well-rounded corners and edges	

Exploration Log Symbology

Standard Split Spoon (2” OD)	Modified California (2½” OD)	Shelby Tube (3” OD)	Bulk Sample	Grab Sample	Water (Time of Drilling)	Water (After Drilling)
						

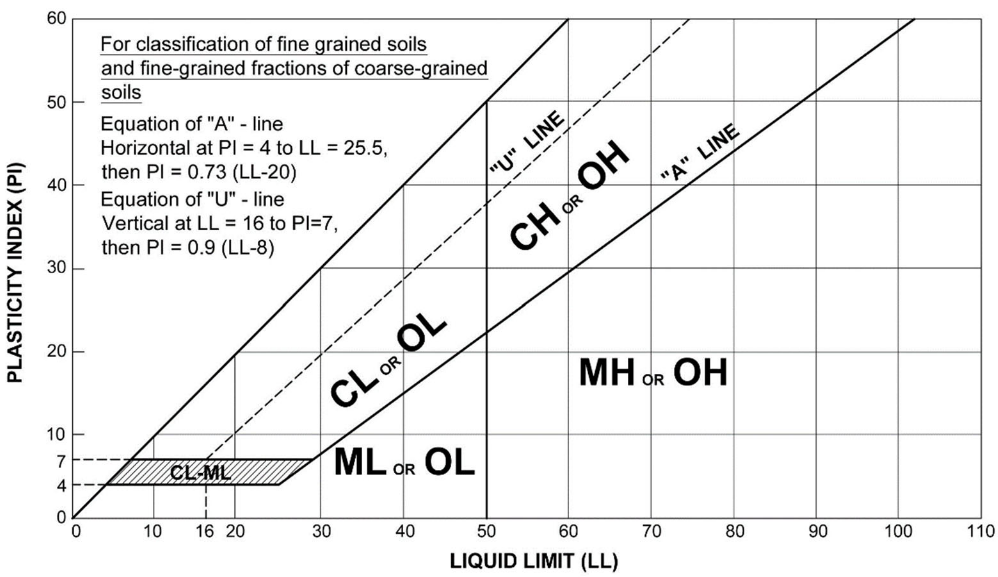
Unified Soil Classification System

Classification of Soils for Engineering Purposes
Based on ASTM D2487

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	**Group Name[B]**
Coarse-grained Soils More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** Less than 5% fines[C]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[D]	**GW**	Well-graded gravel[E]
			$C_u < 4$ and/or $1 > C_c > 3$[D]	**GP**	Poorly graded gravel[E]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	**GM**	Silty gravel[E,F,G]
			Fines classify as CL or CH	**GC**	Clayey gravel[E,F,G]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** Less than 5% fines[H]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[D]	**SW**	Well-graded sand[I]
			$C_u < 6$ and/or $1 > C_c > 3$[D]	**SP**	Poorly graded sand[I]
		Sands with Fines More than 12% fines[H]	Fines classify as ML or MH	**SM**	Silty sand[F,G,I]
			Fines classify as CL or CH	**SC**	Clayey sand[F,G,I]
Fine-grained Soils 50% or more passes the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	**Inorganic**	PI > 7 and plots on or above "A" line[J]	**CL**	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	**ML**	Silt[K,L,M]
		Organic	(Liquid limit – oven dried) / (Liquid limit – not dried) < 0.75	**OL**	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	**Inorganic**	PI plots on or above "A" line	**CH**	Fat clay[K,L,M]
			PI plots below "A" line	**MH**	Elastic silt[K,L,M]
		Organic	(Liquid limit – oven dried) / (Liquid limit – not dried) < 0.75	**OH**	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly Organic Soils		Primarily organic matter, dark in color, and organic odor		**PT**	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] $C_u = D_{60}/D_{10}$ $\quad Cc = (D_{30})^2 / (D_{10} \times D_{60})$
[E] If soil contains ≥15% sand, add "with sand" to group name.
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[G] If fines are organic, add "with organic fines" to group name.
[H] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[I] If soil contains ≥15 % gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to < 30 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



PILCH ENGINEERING
Consulting Engineering & Geology

Curtis Street Subdivision

123 South Curtis Street, Missoula, Montana 59801

TP-01

Contractor:	MFCII 406, LLC	Project No.:	-	Remarks: Refer to Figure A-2 for approximate location	
Operator:	Pat Malone	Date Started:	11/30/2023		
Logged by:	Andrew Warren, P.E.	Test Pit Depth:	9.5 feet		
Equipment:	Sany SY50U	Elevation:	~3160.8'		
Hammer Type:	N/A	Coordinates	Longitude: -114.03403	Latitude: 46.86983	
Drilling Method:	Test Pit	Water Level at Time of Drilling:	N/A	Delayed Water Level:	N/A
		Cave-In at Time of Drilling:	N/A	Delayed Water Observation Date:	-

Depth (ft)	Elevation (ft)	Graphic Log	Soil Description and Remarks	Sample Number	Bulk / Grab	Driven	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits (LL-PL-PI)	Moisture Content (%)
0–1.2	3160		TOPSOIL: moist, dark brown								
1.2–5.5	3155		Silty SAND (SM): loose, moist to very moist, fine grained, brown (trace roots throughout, interbedded with sandy silt)		X		0	55	45	NP	
5.5–9.5			Poorly Graded GRAVEL with silt and sand (GP-GM): medium dense, moist, fine to coarse grained, subrounded, brown (cobbles up to 12" nominal throughout, trace boulders, minor caving, imbricated)								

Test pit terminated at 9.5 feet.
No groundwater observed.
Installed 4" PVC to bottom of excavation.
Test pit loosely backfilled upon completion.

Curtis Street Subdivision

123 South Curtis Street, Missoula, Montana 59801

TP-02

Contractor:	MFCII 406, LLC	Project No.:	-	Remarks: Refer to Figure A-2 for approximate location
Operator:	Pat Malone	Date Started:	11/30/2023	
Logged by:	Andrew Warren, P.E.	Test Pit Depth:	9.5 feet	
Equipment:	Sany SY50U	Elevation:	~3158.9'	
Hammer Type:	N/A	Coordinates	Longitude: -114.03338	Latitude: 46.86981
Drilling Method:	Test Pit	Water Level at Time of Drilling: N/A; Cave-In at Time of Drilling: N/A		Delayed Water Level: N/A; Delayed Water Observation Date: -

Depth (ft)	Elevation (ft)	Graphic Log	Soil Description and Remarks	Samples: Sample Number	Samples: Bulk / Grab	Samples: Driven	Lab: Gravel (%)	Lab: Sand (%)	Lab: Fines (%)	Lab: Atterberg Limits (LL-PL-PI)	Lab: Moisture Content (%)
0–0.3			TOPSOIL: moist, dark brown								
0.3–6.0	3155		Silty SAND (SM): loose, slightly moist, fine grained, brown to tan (trace roots throughout, interbedded with sandy silt)		■						4
6.0–9.5	3150		Poorly Graded GRAVEL with silt and sand (GP-GM): medium dense, moist, fine to coarse grained, subrounded to rounded, light brown to multi-colored (cobbles up to 8" nominal throughout, discontinuous zones of poorly graded gravel with sand, minor caving, imbricated) Sample from 7' - 8' classified as silty SAND with gravel (SM)		■		28	54	18	NP	

Test pit terminated at 9.5 feet.
No groundwater observed.
Test pit loosely backfilled upon completion.

PILCH ENGINEERING
Consulting Engineering & Geology

Curtis Street Subdivision

123 South Curtis Street, Missoula, Montana 59801

TP-03

Contractor:	MFCII 406, LLC	Project No.:	-	Remarks: Refer to Figure A-2 for approximate location	
Operator:	Pat Malone	Date Started:	11/30/2023		
Logged by:	Andrew Warren, P.E.	Test Pit Depth:	9 feet		
Equipment:	Sany SY50U	Elevation:	~3161.6'		
Hammer Type:	N/A	Coordinates	Longitude: -114.03278	Latitude: 46.86981	
Drilling Method:	Test Pit	Water Level at Time of Drilling:	N/A	Delayed Water Level:	N/A
		Cave-In at Time of Drilling:	N/A	Delayed Water Observation Date:	-

Depth (ft)	Elevation (ft)	Graphic Log	Soil Description and Remarks	Samples: Sample Number	Samples: Bulk / Grab	Samples: Driven	Lab: Gravel (%)	Lab: Sand (%)	Lab: Fines (%)	Lab: Atterberg Limits (LL-PL-PI)	Lab: Moisture Content (%)
			TOPSOIL: moist, dark brown — 0.3								
			Silty GRAVEL with sand (GM): medium dense, moist, fine to coarse grained, subrounded, brown (trace roots throughout) — 1.0								
	3160		Poorly Graded GRAVEL with sand (GP): medium dense, slightly moist, fine to coarse grained, subrounded, light brown to multi-colored (cobbles up to 10" nominal throughout, trace silt, some caving throughout, imbricated)								
					▌						1
5											
	3155										
			Increased moisture content below 7 feet								
			9.0								

Test pit terminated at 9 feet due to caving.
No groundwater observed.
Installed 4" PVC to bottom of excavation.
Test pit loosely backfilled upon completion.

Curtis Street Subdivision

TP-04

PILCH ENGINEERING
Consulting Engineering & Geology

123 South Curtis Street, Missoula, Montana 59801

Contractor: MFCII 406, LLC	Project No.: -		Remarks: Refer to Figure A-2 for approximate location	
Operator: Pat Malone	Date Started: 11/30/2023			
Logged by: Andrew Warren, P.E.	Test Pit Depth: 9.5 feet			
Equipment: Sany SY50U	Elevation: ~3164.5'			
Hammer Type: N/A	Coordinates	Longitude: -114.03197	Latitude: 46.86983	
Drilling Method: Test Pit	Water Level at Time of Drilling: N/A Cave-In at Time of Drilling: N/A		Delayed Water Level: N/A Delayed Water Observation Date: -	

Depth (ft)	Elevation (ft)	Graphic Log	Soil Description and Remarks	Samples: Sample Number	Samples: Sample Type	Lab: Gravel (%)	Lab: Sand (%)	Lab: Fines (%)	Lab: Atterberg Limits (LL-PL-PI)	Lab: Moisture Content (%)
			TOPSOIL: moist, dark brown — 0.3							
			Silty GRAVEL with sand (GM): medium dense, moist, fine to coarse grained, subrounded, brown (trace roots throughout) — 1.5							
			Poorly Graded GRAVEL with sand (GP): medium dense, slightly moist, fine to coarse grained, subrounded, light brown to multi-colored (cobbles up to 8" nominal throughout, trace silt, some caving throughout, imbricated)							
	3160									
5										
	3155		9.5							

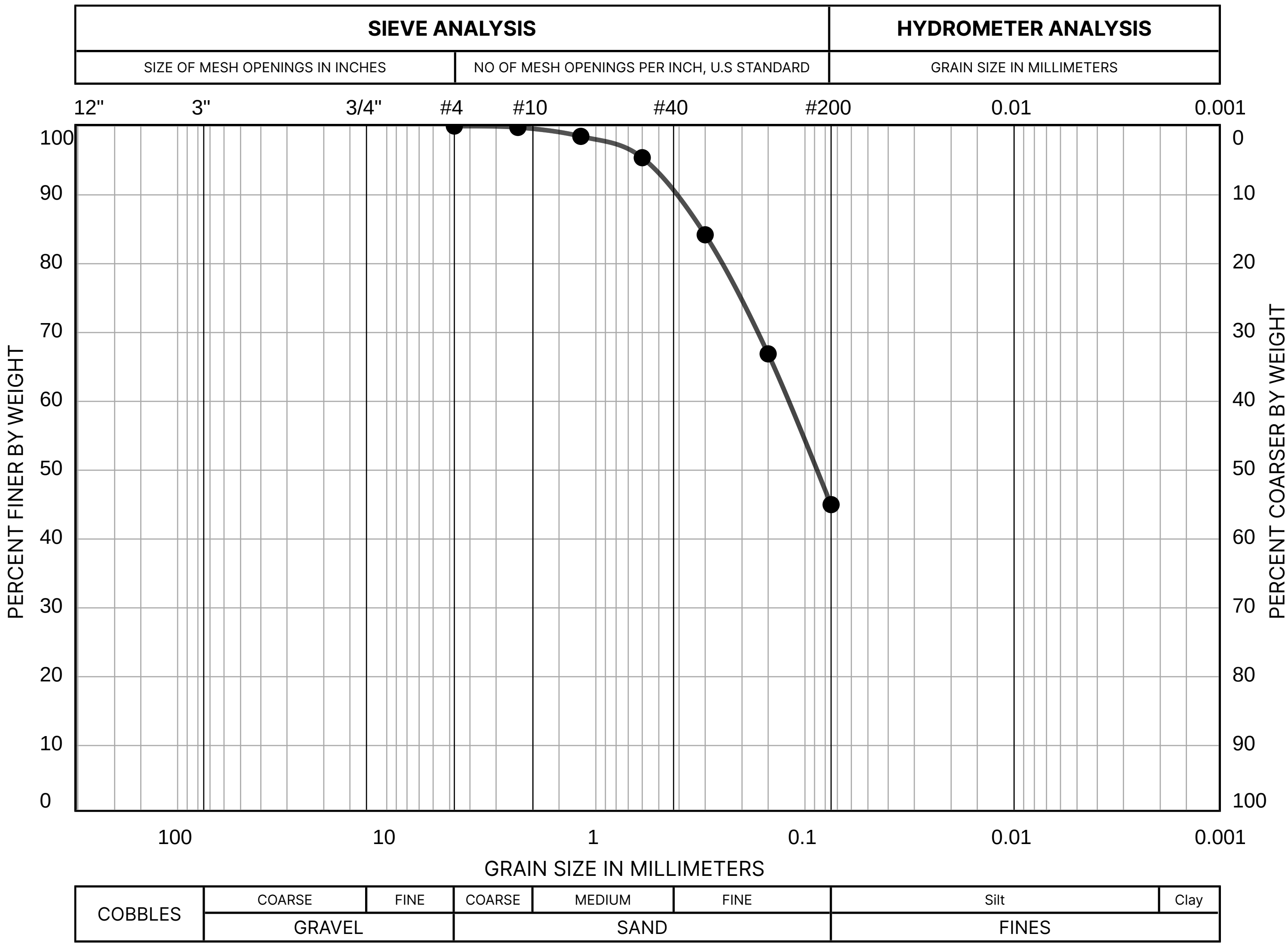
Test pit terminated at 9.5.
No groundwater observed.
Test pit loosely backfilled upon completion.

APPENDIX C

- Laboratory Testing

GRAIN SIZE DISTRIBUTION TEST RESULTS

TP-01, 2' - 5'



TEST RESULTS

SIEVE SIZE	% PASSING
#4	100
#8	100
#16	99
#30	95
#50	84
#100	67
#200	45

SPECIMEN DESCRIPTION

DESCRIPTION **Silty SAND**

USCS CLASS. **SM**

AASHTO CLASS. **A-4**

ATTERBERG LIMITS

LL	PL	PI
23	NP	NP

COEFFICIENTS

D10	D30	D60	D100	Cu	Cc
		0.13	4.75		

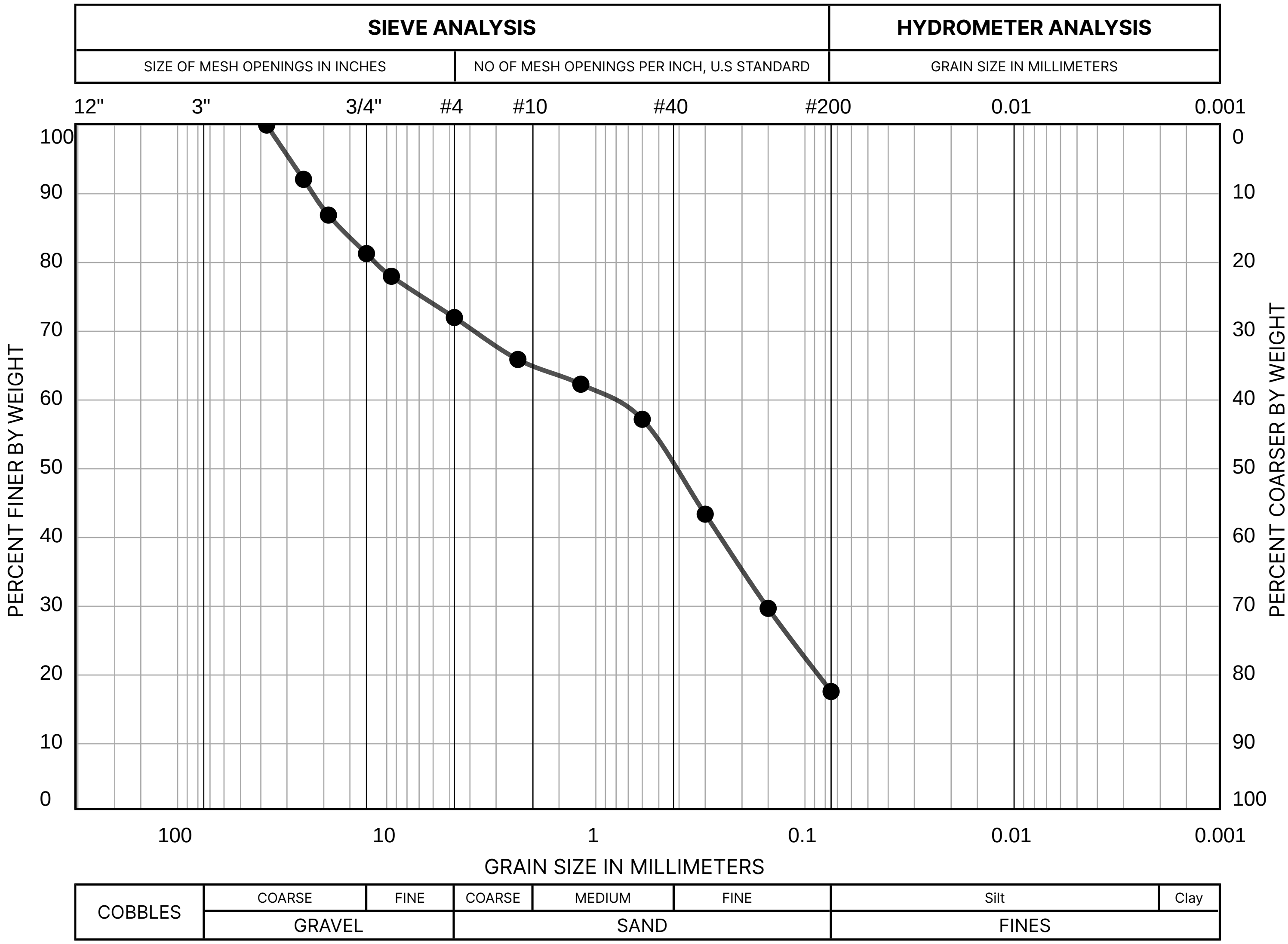
PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

PROJECT Curtis Street Subdivision
CLIENT IMEG Consultants Corp.
LOCATION Missoula, MT

PROJECT NO.
FIGURE NO. C-1

GRAIN SIZE DISTRIBUTION TEST RESULTS

TP-02, 7' - 8'



TEST RESULTS

SIEVE SIZE	% PASSING
1.5”	100
1”	92
3/4”	87
1/2”	81
3/8”	78
#4	72
#8	66
#16	62
#30	57
#50	43
#100	30
#200	18

SPECIMEN DESCRIPTION

DESCRIPTION **Silty SAND with Gravel**

USCS CLASS. **SM**

AASHTO CLASS. **A-2-4**

ATTERBERG LIMITS

LL	PL	PI
NP	NP	NP

COEFFICIENTS

D10	D30	D60	D100	Cu	Cc
	0.15	0.92	37.5		

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

PROJECT Curtis Street Subdivision
CLIENT IMEG Consultants Corp.
LOCATION Missoula, MT

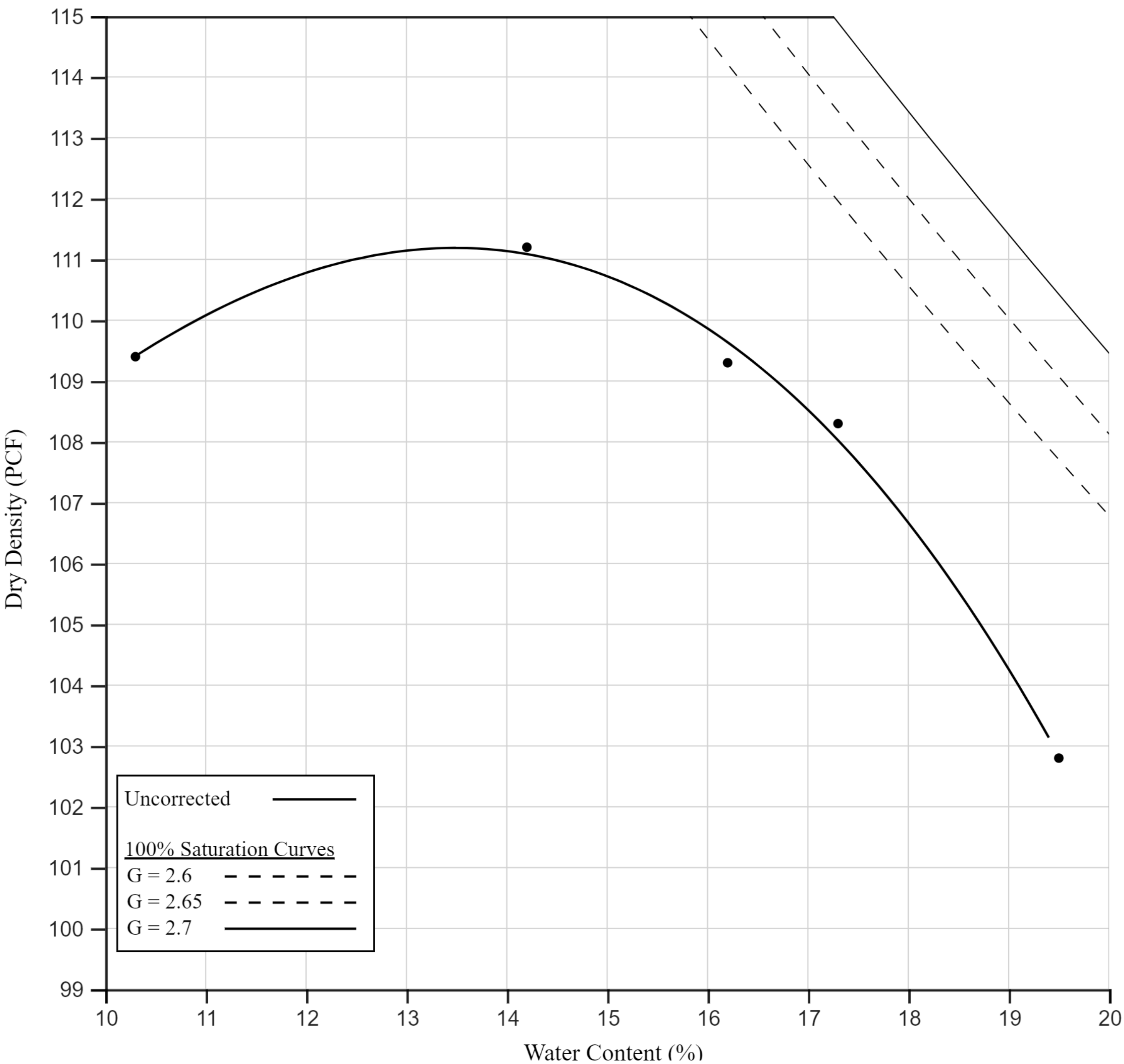
PROJECT NO.
FIGURE NO. C-2

MOISTURE-DENSITY RELATIONSHIP

Curtis Street Subdivision
Missoula, MT

TP-01, 2' - 5' | **FIGURE NO. C-3**

Test Method: ASTM D0698 (Standard)-A
(4.75mm Sieve, 4" Mold Diameter)

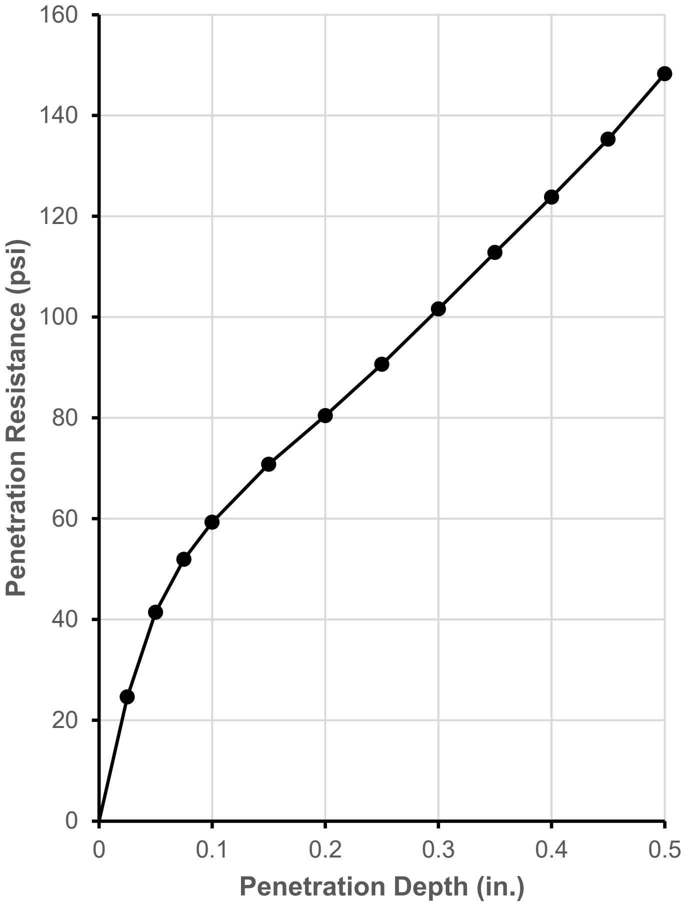


SAMPLE INFORMATION	
Sample Identification:	2' - 5'
Date Sample Obtained:	11/30/2023
Sample Depth/Elevation:	2.0'/3158.8'
Sample USCS Description Before Test Preparation:	Silty SAND with Gravel

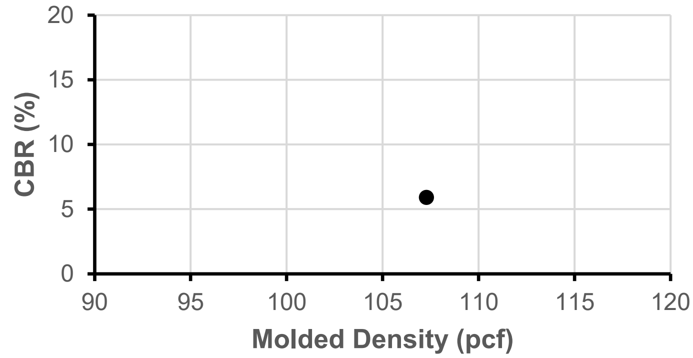
TEST RESULTS	Uncorrected for Oversize Material	Corrected for Oversize Material
Natural Water Content:	-	
Maximum Dry Density:	111.2PCF	
Optimum Moisture Content:	13.5%	

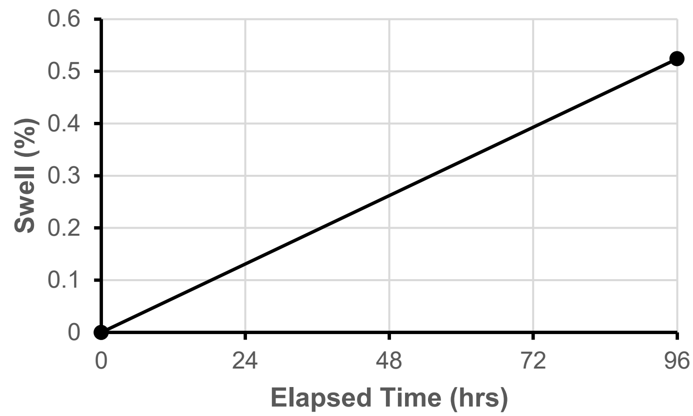
Remarks:
Moist Preparation Method

BEARING RATIO TEST REPORT
ASTM D1883-21



CBR at 95% Max. Density = 5.9%
for 0.10 in. Penetration





Trial	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	107.3	96.5	12.4	106.7	96.0	18.0	5.9	5.4	0.00	10	0.52
2 ▲											
3 ■											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Silty SAND	SM	111.2	13.5	23	NP

Sample Information	
Sample No.:	-
Location:	TP-01
Depth:	2' - 5'

Test Description / Remarks:
Proctor per ASTM D698
A. Warren sampled 11/30/2023

PILCH ENGINEERING
CONSULTING ENGINEERING & GEOLOGY

PROJECT	Curtis Street Subdivision	**PROJECT NO.**	-
CLIENT	IMEG Consultants Corp.	**DATE**	12/14/2023
LOCATION	Missoula, MT	**FIGURE NO.**	C-4