RIMROCK
ENGINEERING, INC.

GEOTECHNICAL ENGINEERING REPORT

High Sierra Subdivision
18th Filing
Billings, Montana

July 28, 2021
Project No. G21105

Prepared for:

High Sierra II, Inc.
175 N 27th St, Suite #900
Billings, Montana 59101

Prepared by:

Rimrock Engineering, Inc.
5440 Holiday Avenue
Billings, Montana 59101

RIMROCK ENGINEERING, INC.

5440 Holiday Avenue · Billings, Montana 59101: · Phone: 406.294.8400 · www.rimrock.biz

July 28, 2021

Mr. Landy Leep
High Sierra II, Inc.
175 N 27th St, Suite #900
Billings, Montana 59101

Re: Geotechnical Engineering Report
High Sierra Subdivision
18th Filing
Billings, Montana

Dear Mr. Leep:

Rimrock Engineering, Inc. has completed the geotechnical engineering services for the referenced project. The attached report presents the results of our findings. Our work consisted of subsurface exploration, laboratory testing, engineering analyses, and preparation of this report.

We appreciate this opportunity to be of service to you and are prepared to provide construction materials testing services during the construction phase of the project. If you have any questions regarding this report or need additional information or services, please contact us.

Sincerely,
RIMROCK ENGINEERING, INC.

MONTANA
MATTHEW R. GEERING
No. 17038 PE
LICENSED PROFESSIONAL ENGINEER

Matt Geering, P.E.
Principal/Vice President

Wade Reynolds
Principal/President

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EXECUTIVE SUMMARY

Rimrock Engineering has completed the geotechnical engineering services for High Sierra Subdivision 18th Filing in Billings, Montana. Based on the results of our geotechnical investigation, the site can be developed for the proposed project consistent with the recommendations provided in this report. The following geotechnical conditions and considerations were identified:

- The subsurface profile consists of medium stiff to stiff, medium to high plasticity sandy lean clay and medium dense clayey sand soils overlying weathered, poorly indurated sandy shale bedrock with interbedded sandstone which extended to the maximum depths explored. The shale was encountered at depths ranging from about 1.5 to 9.5 feet. Groundwater was not encountered while drilling or for the short duration the borings were allowed to remain open.

- Medium and high plasticity lean clay soils and/or weathered shale bedrock was encountered at or near anticipated foundation and slab elevations. Based on field and laboratory testing, the clay soils are expected to be compressible. Although consolidation/swell tests did not indicate swell, index properties of the soils suggest expansive potential. Potential for swell can be quite significant for lightly loaded structures and therefore is of concern.

- Due to these concerns, if a shallow foundation system is desirable, we recommend the structure be supported on a zone of at least 1.5 feet of geotextile-reinforced structure fill over prepared subgrade. Performance of this system is directly related to the proper treatment and preparation of the native soils, placement and control of geotextiles and structural fill, and good positive drainage for the life of the structure.

- A higher level of assurance against movement related distress would be supporting the structures using deep foundations such as helical piers and a structural floor system on grade beams and void forms. In our opinion, a deep foundation system provides the highest level of assurance against movement related distress to the completed structures. The Owner should be made aware of and accept the risk of bearing on potentially compressible and/or expansive soils and the potential for movements.

It should be noted that specific project details were not fully developed or included in this section. The information provided in this executive summary should be used in conjunction with the entire report for design purposes.

GEOTECHNICAL ENGINEERING REPORT

High Sierra Subdivision
18th Filing
Billings, Montana

1.0 INTRODUCTION AND SCOPE

1.1 Project Description

The project consists of the High Sierra Subdivision 17th, 18th, 19th, and 20th Filings in Billings, Montana. The project will include residential lots, new streets, and associated utilities. Based on the preliminary plat, this phase of the subdivision will consist of 138 lots.

1.2 Purpose and Scope of Work

The purpose of this study is to evaluate the feasibility of the proposed development with respect to the observed subsurface conditions and to provide information, opinions, and geotechnical engineering recommendations relative to:

- General soil and groundwater conditions
- Site and subgrade preparation
- Recommended foundation type(s) and design parameters
- Estimated settlement of foundations
- Pavement thickness design
- Basement construction considerations
- Utility trench considerations
- Potential for site soils to adversely react with concrete
- General earthwork and site drainage

Our scope of services consisted of background review, site reconnaissance, field exploration, laboratory testing, engineering analyses, and preparation of this report.

2.0 INVESTIGATION

2.1 Field Exploration

The subsurface exploration for the 18th Filing consisted of drilling eight (8) borings on July 7, 2021 to approximately 15 feet below existing grades. The borings were drilled using our truck mounted drill rig equipped with solid flight augers. Groundwater levels were measured during drilling operations, if encountered. Upon completion of drilling and/or groundwater measurements, the borings were backfilled with drill cuttings and compacted with the equipment at hand.

Logs of the borings along with a Vicinity/Site Map are included in Appendix A. The borings were located in the field by Rimrock Engineering based on a site plan provided. Estimated ground surface elevations were set at 100 for purposes of this investigation. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

Rimrock Engineering personnel logged the soil conditions encountered in the borings. At selected intervals, samples of the subsurface materials were taken by driving split-spoon samplers, pushing Shelby tube samplers, and collecting auger cuttings. Penetration resistance measurements were obtained by driving the samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the relative density, or consistency, of the materials encountered. The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification.

2.2 Laboratory Testing

The purpose of the laboratory testing is to assess the physical and engineering properties of the soil samples collected in the field to be used in our geotechnical evaluations and analyses. Laboratory testing was performed on selected soil samples to assess the following:

- Visual classification (USCS)
- Moisture content
- Sieve analysis
- Atterberg limits
- Consolidation/swell
- Moisture/density relationship
- California Bearing Ratio (CBR)
- Water soluble sulfate, pH & resistivity

The soil descriptions presented on the boring logs are in accordance with the Unified Soil Classification System (USCS). Individual laboratory test results can be found in Appendix B at the end of this report.

3.0 SITE & SUBSURFACE CONDITIONS

3.1 Site Conditions

The project site consists of undeveloped property north of Ortega Street and Entrado Road in Billings, Montana. The site is vegetated mainly of natural grasses and weeds. Evidence of possible surface water was observed along shallow swales running through the property towards the east and north. A stormwater drainage appears to run through the property near Matador Avenue and runs north. The surrounding areas consist mainly of residential development and undeveloped property.

3.2 Subsurface Soil Conditions

The subsurface profile consists of medium stiff to stiff, medium to high plasticity sandy lean clay and medium dense clayey sand soils overlying weathered, poorly indurated sandy shale bedrock with interbedded sandstone which extended to the maximum depths explored. The shale was encountered at depths ranging from about 1.5 to 9.5 feet.

The sandy lean clay soils and clayey sand had Standard Penetration Test (SPT) N-values ranging from 6 to 20 blows per foot indicating the soils are medium stiff to stiff in consistency or loose to medium dense in relative density, compressible, and have low shear strength characteristics. The sedimentary bedrock is medium hard to hard and highly to moderately weathered at the contact and generally becoming more competent with depth. For a more detailed description of the subsurface conditions, please refer to the logs provided in Appendix A

3.3 Groundwater Conditions

The borings were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not encountered while drilling or for the short duration the borings were allowed to remain open. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater can be expected to fluctuate with varying seasonal, weather and irrigation conditions. Evaluation of the factors that affect groundwater fluctuations is beyond the scope of this report.

3.4 Laboratory Test Results

The site soils were tested for grain size distribution (sieve analysis) and Atterberg Limits. Atterberg limits are a basic measure of the critical water contents of a fine-grained soils. The clayey soils encountered in the borings generally ranged from medium to high plasticity. Results are summarized below:

Location	Depth (ft)	USCS	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Gravel (%)	Sand (%)	Clay/Silt (%)
B-27	4.5	SC	37	18	19	0.0	65.2	34.8
B-33	2.5	CL	27	18	9	0.0	49.2	50.8
B-33	4.0	CL	39	16	23	0.0	35.7	64.3

Samples of the site soils were tested for consolidation/swell potential. The samples were allowed to consolidate under a confining pressure of 1,000 pounds per square foot (psf). Once consolidation under the surcharge load was complete, the samples were inundated with water and allowed to swell/collapse. After movement from the addition of water ceased, incremental loads were then applied to further consolidate the samples.

Consolidation/swell test results indicate that the site soils exhibit moderate compressibility (See Consolidation Tests in Appendix B). Results are summarized below:

Location	Depth (ft)	Material	Dry Unit Weight (pcf)	Strain @ 2,000 psf (%)	Collapse(-)/Swell(+) (%)
B-27	4.5	SC	113	2.1	-0.2
B-33	4.0	CL	105	1.6	-0.2

A representative sample of the near surface soils was collected for Moisture-Density Relationship (M/D) and California Bearing Ratio (CBR) testing. The results are summarized in the following table:

Location	Depth, (ft)	Material	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	CBR
B-27 to B-34	1-3	CL	104.1	17.3	3.0

4.0 RECOMMENDATIONS

4.1 Geotechnical Concerns/Considerations

Medium and high plasticity lean clay soils and/or weathered shale bedrock was encountered at or near anticipated foundation and slab elevations. Based on field and laboratory testing, the clay soils are expected to be compressible. Although consolidation/swell tests did not indicate swell, index properties of the soils suggest expansive potential. Potential for swell can be quite significant for lightly loaded structures and therefore is of concern.

Due to these concerns, if a shallow foundation system is desirable, we recommend the structure be supported on a zone of at least 1.5 feet of geotextile-reinforced structure fill over prepared subgrade. Performance of this system is directly related to the proper treatment and preparation of the native soils, placement and control of geotextiles and structural fill, and good positive drainage for the life of the structure.

In addition to the structural fill system, if swell is of concern, treatment of the existing potentially expansive materials can be considered in order to reduce swell tendencies of the site materials. CST Concrete Stabilization Technologies, Inc. offers expansive soil remediation treatment. This option involves injecting a stabilizing agent called AGSS-ICS into the soil through small injection probes. This chemical reduces swell potential and minimizing shrinkage potential of expansive soils. This would provide an added level of protection against swell potential.

A higher level of assurance against movement related distress would be supporting the structures using deep foundations such as helical piers and a structural floor system on grade beams and void forms. In our opinion, a deep foundation system provides the highest level of assurance against movement related distress to the completed structures. The Owner should be made aware of and accept the risk of bearing on potentially compressible and/or expansive soils and the potential for movements.

Subsurface conditions may vary from one location to another and the structural characteristics may also vary from one structure to another. Contractors and/or home owners should consider performing site specific geotechnical investigations.

4.2 Earthwork

The following sections present recommendations for site and subgrade preparation and placement of fill materials on the project. Earthwork on the project should be observed and tested by Rimrock Engineering.

4.2.1 Site and Subgrade Preparation

Vegetation, topsoil, existing utilities (if present), and other unsuitable materials (e.g. debris, desiccated soil, frozen soil, etc.) should be removed from the proposed construction area. It is anticipated that general excavations for the proposed construction can be accomplished with conventional earthmoving equipment such as tractor mounted backhoes and tracked excavators.

If shallow foundations are desired, in order to limit consolidation and/or swell potential of the site subgrade soils, foundation preparation should allow for the placement of at least 1.5 feet of geotextile-reinforced structural fill. Excavation for structural fill placement should extend laterally beyond all edges of the foundation at least 8 inches per foot of over-excavation depth.

Prior to placing the geotextile and structural fill, the exposed subgrade soils should be tightened with a roller or similar equipment to provide a stable surface. Rimrock Engineering should observe the subgrade surface to ascertain integrity consistent with the design assumptions. Prior to the placement of structural fill, we recommend a separation/stabilization geotextile, such as Mirafi RS380i or approved alternate, be placed at the interface between the prepared subgrade and the structural fill zone to help stabilize the subgrade as well as keep the subgrade soils from intruding into the structural fill. A second layer of geotextile is recommended in the middle of the structural fill section for additional reinforcement.

The excavated site soils, cleaned of all organic/deleterious material, construction debris, and rock greater than 4 inches in nominal size (if encountered), may be stockpiled on-site and re-used as wall/trench backfill or for landscaping purposes. The processed, on-site clayey soils will provide some advantage as wall/trench backfill to limit potential for surface water infiltration.

Within the proposed areas to receive pavement, scarification, re-compaction and proof-rolling of the clay/silt subgrade soils is recommended. Subgrade soils beneath pavement areas should be scarified to a depth of at least 12 inches, moisture conditioned to within 3 percent of optimum and compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D698. The moisture content and compaction of subgrade soils should be maintained until pavement construction.

The prepared subgrade should be proof-rolled by a standard, tandem axle dump truck loaded to its capacity. The proof-rolling should be observed by our geotechnical engineer to identify areas of soft subgrade. Any areas that become unstable or “pump” under the loaded dump truck should be excavated to a depth to be determined by our geotechnical engineer and replaced with a dense graded gravel/sand mixture to stabilize the subgrade. Additionally, a geogrid or geotextile separation fabric may be required to stabilize soft subgrade soils, if encountered. Once the subgrade has been proof-rolled and approved by the geotechnical engineer, base course may be placed.

4.2.2 Material Requirements

It is anticipated that excavated materials will be used to the extent practical as engineered fill, wall/trench backfill, and/or lot fill. The material suitability should be evaluated by our geotechnical engineer prior to use. Moisture conditioning and processing of on-site soils will likely be required. Structural fill should meet the criteria outlined below:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 4 Sieve	30-75
No. 200 Sieve	15 (max)
Liquid Limit	25 (max)
Plasticity Index	6 (max)

4.2.3 Compaction Requirements

Fill materials should be placed and compacted in loose lift thicknesses of 8 inches or less when heavy, self-propelled compaction equipment is used. When hand-guided equipment such as jumping jack or plate compactor is used, loose lift thicknesses should be on the order of 4 to 6 inches.

The following table lists the compaction requirements for the different types of fill recommended in this report.

Item	Description
Compaction Requirement (ASTM D698)	**Structural Fill:** 98% **Subgrade Soils:** 95% **Aggregate Base (beneath slabs & pavements):** 95% **Wall/Trench Backfill:** 97% beneath pavements, 95% elsewhere **Drainage Aggregate:** Tamp to Stable Condition
Moisture Content (ASTM D698)	**Structural Fill:** ±3 % of optimum **Site Clayey Soils:** 0 to +3% of optimum

The Contractor shall provide and use sufficient equipment of a type and weight suitable for the conditions encountered in the field. The equipment shall be capable of obtaining the required compaction in all areas, including those that are inaccessible to ordinary rolling equipment.

4.2.4 Excavation and Trench Construction

Excavations into the on-site soils will likely encounter variably medium stiff to stiff clay and medium to hard shale bedrock. Sandstone may be encountered as well. The excavated materials will generally be suitable for use as trench backfill above the utility line bedding. It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The contractor is responsible for designing and constructing stable, temporary excavations and ultimately the safety of workers. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

If groundwater is encountered, it should be promptly removed using a dewatering technique designed by a dewatering consultant that lowers and keeps the groundwater surface at least 2 feet below the trench bottom throughout installation and backfilling operations.

If trenches are extended deeper than five feet or are allowed to dry out, the excavations may become unstable and should be evaluated to verify their stability prior to occupation by construction personnel. Shoring or sloping of any deep trench walls may be necessary to protect personnel and provide temporary stability.

As a safety measure, vehicles and stockpiles should be kept away from the excavation crest a distance at least equal to the slope height. The exposed slope face should be protected against the elements.

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the structures should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate beneath the structures. We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the structures. The plug material should consist of clay compacted at a water content at or above the optimum water content. The clay fill should be placed to completely surround the utility line above the bedding zone and be compacted in accordance with recommendations in this report. Trench plug material should conform to MPW specifications.

4.2.5 Site Drainage

Positive drainage should be provided during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction. All grades must provide effective drainage away from the structures during and after construction. Water permitted to pond next to the structures can result in greater soil movements than those discussed in this report. Estimated movements described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

In areas where sidewalks or paving do not immediately adjoin the structures, we recommend that protective slopes be provided with a minimum grade of approximately 10 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Downspouts, roof drains or scuppers should be extended and discharged beyond the backfill zone when the ground surface beneath such features is not protected by exterior slabs or paving. Landscaped irrigation adjacent to the foundation system should be minimized, eliminated, or strictly regulated.

4.2.6 Construction Considerations

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of light, rubber-tracked construction equipment would aid in reducing subgrade disturbance. Should unstable subgrade conditions develop, our geotechnical engineer should review conditions and provide recommendations for stabilization.

The site should be graded to prevent ponding of surface water on, or direction of runoff toward, the prepared subgrades or excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations, as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Rimrock Engineering should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during construction of the project.

4.3 Shallow Foundation System

If deep foundations are not desired, the proposed structure can be supported by a shallow spread footing foundation system or thickened edge monolithic slab bearing on a minimum of 1.5 feet of geotextile-reinforced structural fill. The spread footing foundation system constructed on structural fill as described above, may be designed for a maximum allowable bearing pressure of 2,000 pounds per square foot (psf). The design bearing pressure applies to dead load plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. A coefficient of friction value of 0.5 can be used for footings bearing on structural fill.

It should be noted that because the monolithic slab is not allowed to 'float' independent of the foundation, differential movement and cracking between the slab and the thickened edge foundation may occur. If used, the monolithic slab should be designed by a structural engineer to take this into account as well as the anticipated wall and point loads.

Rigid insulation panels should be placed along the exterior of the thickened edge for frost protection. These panels should extend outward approximately 4 feet and be sloped away from the structure to promote drainage of infiltration away from the structure.

Provided the structure is properly constructed, the total and differential movement resulting from the structural loads is estimated to be on the order of 1 inch and ¾ inch respectively. However, greater movements are possible given the site soil conditions. Foundation movement will depend upon the variation within the subsurface soil profile, structural loading conditions, embedment depth of footings, thickness of compacted fill, and quality of earthwork operations. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage is critical and should be provided in the final design, during construction and for the life of the project.

If conventional shallow spread footing and stem walls are used, exterior foundations should be embedded a minimum of 3.5 feet below lowest adjacent exterior finish grade for frost protection and confinement. Interior footings should be bottomed at least 18 inches below lowest adjacent finish grade for confinement. Wall foundation dimensions should satisfy the requirements listed in the latest edition of the International Building Code. Reinforcing steel requirements for foundations should be provided by the design engineer.

The base of all foundation excavations should be free of water and loose material prior to placing structural fill. Concrete should be placed soon after structural fill placement to reduce the potential for bearing surface disturbance. If the soil bearing levels become excessively dry, disturbed, saturated, or frozen, the affected material should be removed and replaced with suitable material prior to placing concrete. It is recommended that Rimrock Engineering be retained to observe and approve the foundation materials and their preparation for compliance with our recommendations and design assumptions.

4.4 Helical Pier Foundation System

Helical piers offer a deep foundation alternative for supporting the proposed structure. These consist of a steel helix welded to a solid steel shank. They are screwed through the soils using a hydraulic motor, usually attached to a mini excavator or skid-steer loader. Shank extensions are added, as needed, to reach the required bearing depth. Installation torque is monitored and has been shown to be a reliable method for estimating the individual pier capacity. This alternative avoids the potentially compressible/collapsible soil by extending loads to less compressible/collapsible bearing soils. Since helical piers do not require an open hole; no casing, drilling slurry, reinforcing steel or special concrete placement is typically required, nor is there any waste material requiring disposal.

For the conditions at this site, it is advisable to install helical piers to the maximum allowable installation torque to obtain the maximum capacity from each pier. Piers should extend into the underlying shale. We recommend design of the piers be performed by a licensed installer. Settlement of a helical pier foundation system should be about ½-inch, when designed in accordance with the recommended allowable capacities. At least one load test should be performed to verify the helical piers develop the design capacity without exceeding ½-inch vertical deflection. Foundation elements such as pier caps or footings should extend at least 3.5 feet below final grade to provide frost protection.

4.5 Concrete Slabs

To reduce the potential for movement related distress to concrete slabs where present, we recommend a minimum of 8 inches of geotextile-reinforced (Mirafi RS380i) structural fill be used for slab support. A leveling course, typically 4 to 6 inches of sand/gravel, should also be provided below the concrete slabs.

Additional floor slab design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement
- Contraction joints should be provided in slabs to control the location and extent of cracking
- Floor slabs should be structurally independent of any building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between slab and foundation
- The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions regarding the use and placement of a vapor retarder
- Floor slabs should not be constructed on frozen subgrade
- Other design and construction considerations, as outlined in Section 302.1R of the ACI Design Manual, are recommended

Exterior slabs-on-grade founded on the site soils may experience some movement due to the volume change of the near surface materials through moisture variation or freeze-thaw cycles. This movement may lead to loss of positive drainage away from the building and could present a tripping hazard where slab sections move independently. Potential movement could be reduced by:

- Performing regular joint-sealing maintenance
- Minimizing moisture variations in the subgrade
- Minimizing moisture introduction to slab surfaces
- Rebar reinforcement on relatively close centers
- Controlling moisture-density during placement
- Placing effective control joints on relatively close centers
- Using designs which allow vertical movement between the exterior features and adjoining structural elements

4.6 Basement and Crawlspace Construction

It should be noted that granular structural fill is a pervious material and the existing clay/shale subgrade is relatively impervious compared to granular materials. When placing structural fill in less pervious soils, there is potential for water to pond within the pervious materials. Therefore, in order to intercept potential water infiltration from impacting the foundation bearing stratum, an exterior perimeter drain should be considered due to the moisture-sensitive clay/shale subgrade materials.

The exterior drainage system should be constructed around the outer perimeter of the over-excavation, and sloped at a minimum 1/8 inch per foot to a suitable outlet, such as a sump and pump system or day-lighted to a suitable outlet.

The exterior drainage system should consist of a 4-inch perforated pipe (minimum), embedded in free-draining gravel. Gravel should extend a minimum of 3 inches beneath the bottom of the pipe, and at least 2 feet above the bottom of the foundation. The gravel should be wrapped with drainage fabric such as Mirafi 140N.To reduce the potential for surface water and/or groundwater infiltration (if present) into residential basements and crawlspaces, installation of a perimeter drainage system should be considered. The drainage system should be constructed around the exterior perimeter of the foundation, and sloped at a minimum 1/8 inch per foot to a suitable outlet such as a sump and pump system or day-lighted.

The exterior drainage system should consist of a 4-inch perforated pipe (minimum), embedded in free-draining gravel. Prior to placement of the drainage gravel, 20 mil (minimum) polyethylene sheeting should be placed to contain the flow of the system and be fixed to the footing. Gravel should extend a minimum of 3 inches beneath the bottom of the pipe, and at least 2 feet above the bottom of the foundation. The gravel should be wrapped with drainage fabric such as Mirafi 140N.

In our opinion, window well drains present a greater risk for introducing surface moisture into moisture-sensitive subgrade soils. Due to this, we recommend these be omitted unless they can be drained away from the structure such as sanitary sewer system. Positive drainage away from the structures along with properly installed rain gutters and downspouts are crucial for mitigating moisture infiltration and movement potential.

4.7 Lateral Earth Pressures

Basement walls will be subject to lateral earth pressure from the backfill. Basement walls are normally designed for the "at-rest" earth pressure condition, because the walls are restrained from rotating. Assuming the site clayey soils will be re-used as backfill material, a value of 80 pounds per square foot, per foot of depth, should be used for the at-rest lateral earth pressure against the basement walls. The lateral earth pressure does not include any factor of safety and is not applicable for submerged conditions or hydrostatic loading.

Compaction of each lift of backfill adjacent to the basement walls should be accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures which could result in wall damage.

4.8 Corrosion Protection

A soil sample was submitted for water soluble sulfate, pH and resistivity testing. The results are summarized in the following table:

Location	Depth (ft)	Material	Water Soluble Sulfate Content (%)	Resistivity (ohm/cm)	pH
B-28	4.5	CL	0.25	250	8.0

Water soluble sulfate values between 0.20 and 2.00 are considered to have severe attack potential on normal strength concrete. As a result, Type V Portland cement with a maximum water-cementitious materials ratio of 0.45 and a minimum compressive strength of 4,500 psi should be specified for all project concrete placed on and below grade. Foundation concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Resistivity values less than 1,000 are considered to be very strongly aggressive with regard to corrosion of buried metals. If corrosion of buried metal is critical, it should be protected using a non-corrosive backfill, wrapping, coating, sacrificial anodes, or a combination of these methods, as designed by a qualified corrosion engineer.

4.9 Pavements

Pavement section alternatives for this project were designed based on the procedures outlined in the 1993 Guideline for Design of Pavement Structures by the American Association of State Highway and Transportation Officials (AASHTO).

For purposes of this design analysis, a terminal serviceability index of 2.0, an inherent reliability of 85 percent, and a subgrade drainage coefficient of 0.9 were used. It is anticipated that pavement subgrade soils will consist of clay soils which are typically considered poor materials for pavement support. A California Bearing Ratio (CBR) value of 3.0 was used in the pavement design analysis. Please note that this CBR value and the pavement section alternatives provided assume that the site soils will be re-compacted and left in-place within the pavement areas. If this is not the case, Rimrock Engineering should be notified to provide additional pavement design recommendations based on the subgrade soils which will be present below the pavement sections.

Specific traffic data was not provided for this project. Therefore, we have assumed an equivalent 18-kip single axle load (ESAL) of 100,000 to represent the design traffic intensity for the proposed interior roads over a 20-year design period. Please notify us if any of the parameters used in the pavement design do not adequately define the anticipated conditions.

Select from the following pavement alternative, or an approved equivalent.

Pavement Alternative (inches)			
Traffic Area	**Asphalt Concrete**	**Base Course***	**Total**
Residential Streets	3	11	14

Base course thicknesses can typically be reduced by about 20 to 30 percent or more if a stabilization/separation geotextile such as Mirafi RS580i is used. Additional geotechnical input and design will be required if geosynthetics are to be used.

Asphalt concrete should be composed of a mixture of aggregate, filler and additives (if required), and approved bituminous material. The asphalt concrete should conform to approved mix designs which include volumetrics, Marshall properties, optimum asphalt cement content, job mix formula, and recommended mixing and placing temperatures. The asphalt concrete should be consistent with an approved mix design conforming to Montana Public Works (MPW). Mix designs should be submitted prior to construction to verify their adequacy. Aggregate used in the asphalt should meet MPW specifications for quality and gradation.

Asphalt material should be placed in maximum 3-inch lifts (compacted thickness) and should be compacted to the minimum standards outlined in the MPW specifications. Aggregate base course should consist of a blend of sand and gravel which meets MPW specifications for quality and gradation. Aggregate base course should be compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D 698.

Each pavement alternative should be evaluated with respect to current material availability and economic conditions. The pavement sections presented herein are based on design parameters selected by Rimrock Engineering based on experience with similar projects and soil conditions. Design parameters may vary with the specific project and material source. Variation of these parameters may change the thickness of the pavement sections presented. Rimrock Engineering is prepared to discuss the details of these parameters and their effects on pavement design and reevaluate pavement design as appropriate.

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. If heavy construction traffic is allowed on unfinished pavement sections or sections not designed for such traffic, premature rutting and/or failure may occur.

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance program, additional engineering input is recommended to determine the type and extent of preventive maintenance appropriate. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

5.0 ADDITIONAL SERVICES

5.1 Project Bid Documents

It has been our experience during the bidding process, that contractors often contact us to discuss the geotechnical aspects of the project. Informal contacts between Rimrock Engineering and an individual contractor could result in incorrect or incomplete information being provided to the contractor. Therefore, we recommend a pre-bid meeting be held to answer any questions about the report prior to submittal of bids. If this is not possible, questions or clarifications regarding this report should be directed to the project Owner or his designated representative. After consultation with Rimrock Engineering, the project Owner (or his representative) should provide clarifications or additional information to all contractors bidding the job.

5.2 Construction Observation/Testing and Plan Review

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during construction to verify compliance with these recommendations. We recommend that project plans and specifications be reviewed by Rimrock Engineering to verify compatibility with our findings and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

The review of plans and specifications and the field observation and testing by Rimrock Engineering are an integral part of the conclusions and recommendations made in this report. If we are not retained for these services, the Client agrees to assume Rimrock Engineering's responsibility for any potential claims that may arise during construction.

6.0 LIMITATIONS

Recommendations contained in this report are based on our field explorations, laboratory tests, and our understanding of the proposed construction. The study was performed using a mutually agreed upon scope of work. It is our opinion that this study was a cost-effective method to evaluate the subject site and evaluate some of the potential geotechnical concerns. More detailed, focused, and/or thorough investigations can be conducted. Further studies will tend to increase the level of assurance; however, such efforts will result in increased costs. If the Client wishes to reduce the uncertainties beyond the level associated with this study, Rimrock Engineering should be contacted for additional consultation.

The soils data used in the preparation of this report were obtained from borings made for this investigation. It is possible that variations in soils exist between the points explored. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at this site which is different from those described in this report, our firm should be immediately notified so that we may make any necessary revisions to our recommendations. In addition, if the scope of the proposed project changes, our firm should be notified. This report has been prepared for design purposes for specific application to this project in accordance with the generally accepted standards of practice at the time the report was written. No warranty, express or implied, is made.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference," as that latter term is used relative to contracts or other matters of law.

This report may be used only by the Client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on- and off-site), or other factors including advances in man's understanding of applied science may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 36 months from its issue. Rimrock Engineering should be notified if the project is delayed by more than 24 months from the date of this report so that a review of site conditions can be made, and recommendations revised if appropriate.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk. Any party other than the Client who wishes to use this report shall notify Rimrock Engineering of such intended use. Based on the intended use of the report, Rimrock Engineering may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release Rimrock Engineering from any liability resulting from the use of this report by any unauthorized party.

APPENDIX A

Field Exploration

CONCEPT OF
HIGH SIERRA SUBDIVISION, 17TH, 18TH, 19TH & 20TH FILINGS
LOCATED IN A PORTION OF TRACT 1, CERTIFICATE OF SURVEY NO. 3776

PREPARED FOR : HIGH SIERRA II, INC.

PREPARED BY : SANDERSON STEWART

MAY, 2021

BILLINGS, MONTANA

NORTH

SCALE:1" = 200'

NOTES:

1. ZONING IS N3
2. ALL INTERNAL STREETS SHALL BE BUILT TO CITY OF BILLINGS STANDARDS 34' BACK TO BACK IN A 56' WIDE R.O.W.
3. 12" WATER MAIN WILL BE LOCATED IN ENTRADA ROAD AND MODERA AVE. ALL OTHER WATER MAINS WILL BE 8".
4. ALL SANITARY SEWER MAIN WILL BE 8" EXCEPT FOR SANITARY SEWER MAIN LOCATED IN LINDERO BLVD. WHICH WILL BE LARGER.
5. STORMWATER RUNOFF WILL BE DIRECTED TO AN EXISTING STORMWATER DETENTION FACILITY LOCATED NORTH OF THE SUBDIVISIONS. THE STORAGE FOR THE STORMWATER DETENTION FACILITY WILL BE EXPANDED TO ACCOUNT FOR THE ADDITIONAL RUNOFF. MAINS AND INLETS WILL BE PROVIDED AS NECESSARY.
6. PARKLAND HAS BEEN MET THROUGH PREVIOUS DEDICATION OF PARKLAND IN HIGH SIERRA SUBDIVISION, 14TH FILING. IF ADDITIONAL PARKLAND DEDICATION IS REQUIRED IT WILL BE MET THROUGH A CASH CONTRIBUTION.
7. A TRAFFIC IMPACT UPDATE LETTER WILL BE PROVIDED WITH PRELIMINARY PLAT SUBMITTAL EACH FILING.
8. IT IS ANTICIPATED THAT PRIVATE UTILITIES AND EASEMENTS WILL BE LOCATED ON THE FRONT LOT LINES. THIS WILL BE CONFIRMED WITH THE PRIVATE UTILITY COMPANIES.

17TH–20TH EXHIBIT.DWG 82061.137 05/20/21 BG

BORING NUMBER B-27

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
5.0			ST	100			113	14	37	18	19	35
7.5			SPT	100	15-50							
10.0												
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-28

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.	SPT	100	6-7-9 (16)			16				
7.5												
10.0												
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-29

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0			SPT	100	6-7-8 (15)			17				
7.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
10.0			SPT	100	12-13-15 (28)			15				
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-30

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.		**PROJECT NAME** High Sierra 17th-20th Filings	
PROJECT NUMBER G21105		**PROJECT LOCATION** Billings, MT	
DATE STARTED 7/7/21	**COMPLETED** 7/7/21	**GROUND ELEVATION** 100 ft	**HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.		**GROUND WATER LEVELS:**	
DRILLING METHOD Solid Stem Auger		**AT TIME OF DRILLING** ---	
LOGGED BY W.R.	**CHECKED BY** M.G.	**AT END OF DRILLING** ---	
NOTES		**AFTER DRILLING** ---	

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0			SPT	100	6-6-8 (14)			4				
7.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
10.0			SPT	100	12-14-15 (29)							
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-31

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0			SPT	100	3-3-4 (7)							
7.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
10.0												
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-32

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0			SPT	100	3-3-3 (6)							
7.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
10.0												
12.5												
15.0												

Bottom of borehole at 15.0 feet.

BORING NUMBER B-33

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.
PROJECT NAME High Sierra 17th-20th Filings
PROJECT NUMBER G21105
PROJECT LOCATION Billings, MT
DATE STARTED 7/7/21 **COMPLETED** 7/7/21
GROUND ELEVATION 100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR Rimrock Engineering, Inc.
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY W.R. **CHECKED BY** M.G.
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5			SPT	100	3-4-5 (9)			9	27	18	9	51
5.0			ST	100			105	17	39	16	23	64
			SPT	100	4-8-12 (20)			16				
7.5												
10.0		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.	SPT	100	9-11-14 (25)			17				
12.5												
15.0			SPT	100	50			16				

Bottom of borehole at 15.2 feet.

BORING NUMBER B-34

Rimrock Engineering, Inc.

CLIENT	High Sierra II, Inc.	**PROJECT NAME**	High Sierra 17th-20th Filings
PROJECT NUMBER	G21105	**PROJECT LOCATION**	Billings, MT
DATE STARTED	7/7/21 **COMPLETED** 7/7/21	**GROUND ELEVATION**	100 ft **HOLE SIZE** 5 inches
DRILLING CONTRACTOR	Rimrock Engineering, Inc.	**GROUND WATER LEVELS:**	
DRILLING METHOD	Solid Stem Auger	**AT TIME OF DRILLING**	---
LOGGED BY	W.R. **CHECKED BY** M.G.	**AT END OF DRILLING**	---
NOTES		**AFTER DRILLING**	---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		TOPSOIL										
		(CL) SANDY LEAN CLAY Brown, stiff, medium plasticity, fine sand.										
2.5												
5.0			SPT	100	4-8-10 (18)			15				
7.5		SHALE Brownish gray, sandy, soft to moderately hard, highly weathered, more competent with depth, medium to high plasticity, interbedded sandstone.										
			AU	100				4				
10.0												
12.5												
15.0												

Bottom of borehole at 15.0 feet.

KEY TO SYMBOLS

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc.

PROJECT NUMBER G21105

PROJECT NAME High Sierra 17th-20th Filings

PROJECT LOCATION Billings, MT

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

CL: USCS Low Plasticity Clay

CLS: USCS Low Plasticity Sandy Clay

FILL: Fill (made ground)

SANDSTONE: Sandstone

SC: USCS Clayey Sand

SHALE: Shale

TOPSOIL: Topsoil

SAMPLER SYMBOLS

Auger Cuttings

Standard Penetration Test

Shelby Tube

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

▽ Water Level at Time Drilling, or as Shown

▼ Water Level at End of Drilling, or as Shown

▼ Water Level After 24 Hours, or as Shown

APPENDIX B

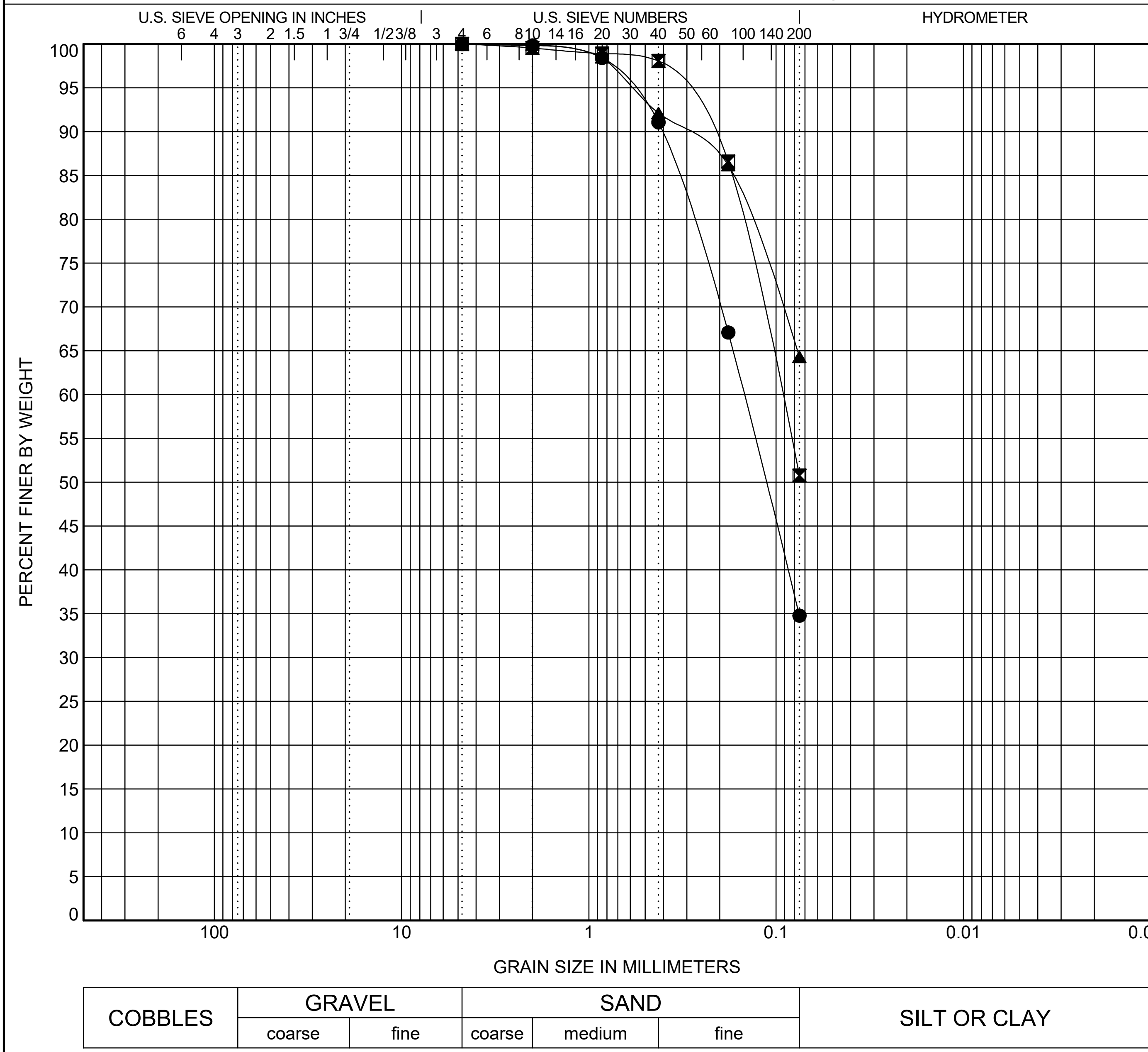
Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc. **PROJECT NAME** High Sierra 17th-20th Filings

PROJECT NUMBER G21105 **PROJECT LOCATION** Billings, MT



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-27**	**4.5**	**CLAYEY SAND(SC)**	**37**	**18**	**19**		
⊠	**B-33**	**2.5**	**SANDY LEAN CLAY(CL)**	**27**	**18**	**9**		
▲	**B-33**	**4.0**	**SANDY LEAN CLAY(CL)**	**39**	**16**	**23**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-27**	**4.5**	**4.75**	**0.149**			**0.0**	**65.2**	**34.8**	
⊠	**B-33**	**2.5**	**4.75**	**0.094**			**0.0**	**49.2**	**50.8**	
▲	**B-33**	**4.0**	**4.75**				**0.0**	**35.7**	**64.3**	

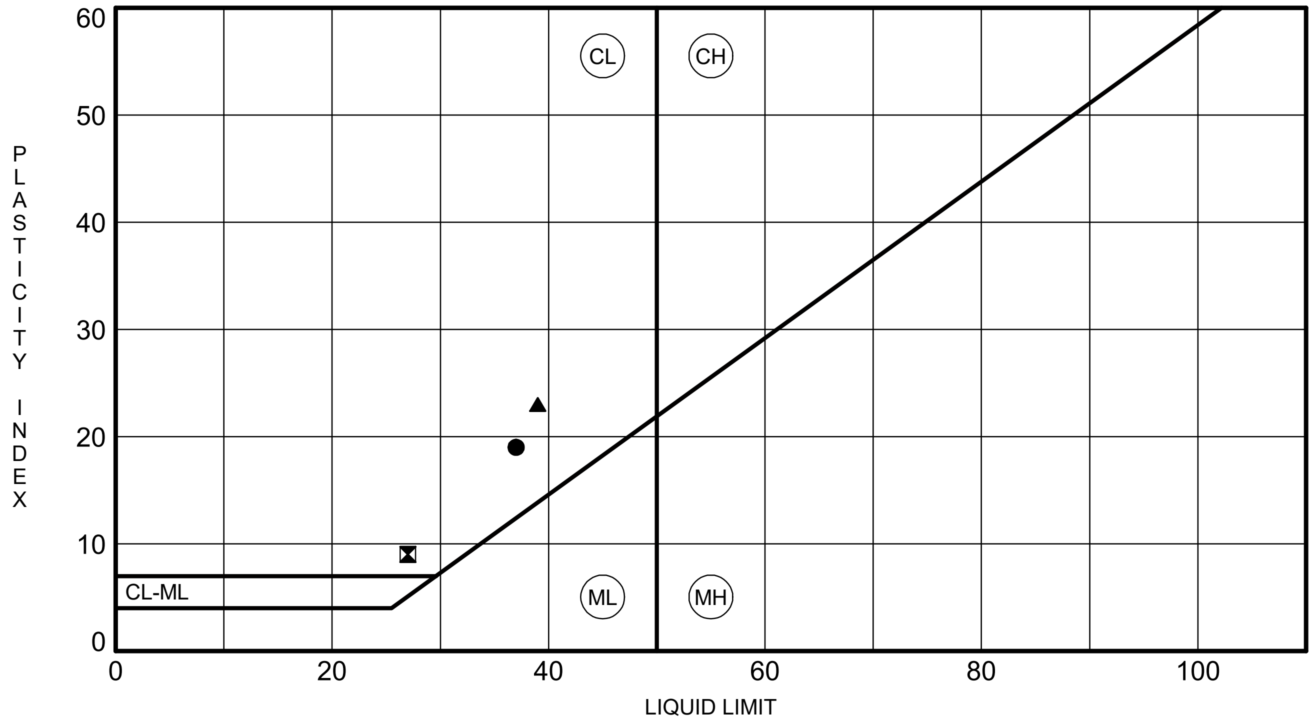
GRAIN SIZE - GINT STD US LAB.GDT - 7/28/21 15:02 - G:\PROJECTS\2021\G21105.GPJ

ATTERBERG LIMITS' RESULTS

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc. **PROJECT NAME** High Sierra 17th-20th Filings

PROJECT NUMBER G21105 **PROJECT LOCATION** Billings, MT



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-27**	**4.5**	**37**	**18**	**19**	**35**	**CLAYEY SAND(SC)**
⊠	**B-33**	**2.5**	**27**	**18**	**9**	**51**	**SANDY LEAN CLAY(CL)**
▲	**B-33**	**4.0**	**39**	**16**	**23**	**64**	**SANDY LEAN CLAY(CL)**

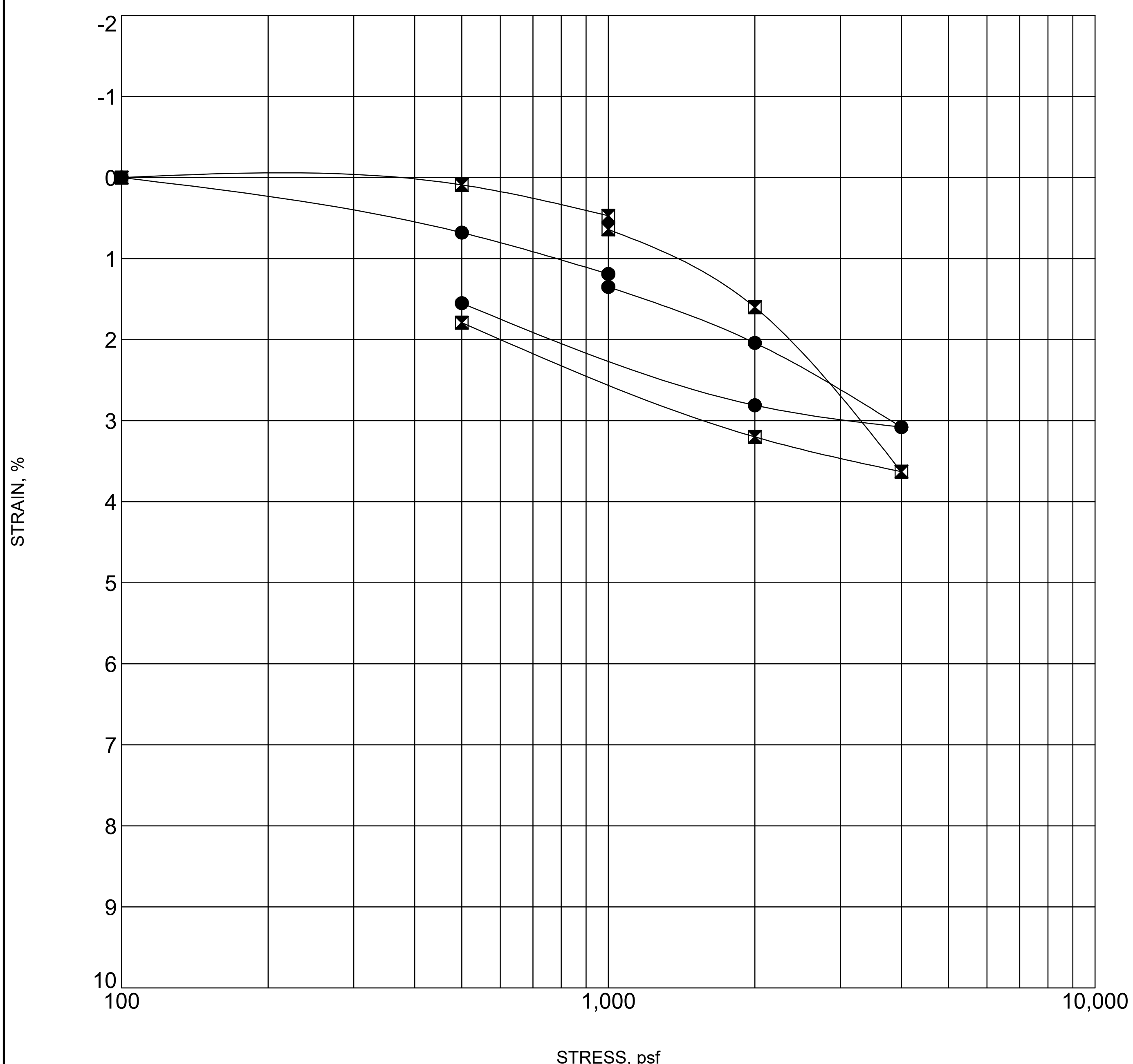
ATTERBERG LIMITS - GINT STD US LAB.GDT - 7/28/21 15:03 - G:\PROJECTS\2021\G21105.GPJ

CONSOLIDATION TEST

Rimrock Engineering, Inc.

CLIENT High Sierra II, Inc. **PROJECT NAME** High Sierra 17th-20th Filings

PROJECT NUMBER G21105 **PROJECT LOCATION** Billings, MT



	BOREHOLE	DEPTH	Classification	γ_d	MC%
●	**B-27**	**4.5**	**CLAYEY SAND(SC)**	**113**	**14**
⧗	**B-33**	**4.0**	**SANDY LEAN CLAY(CL)**	**105**	**17**

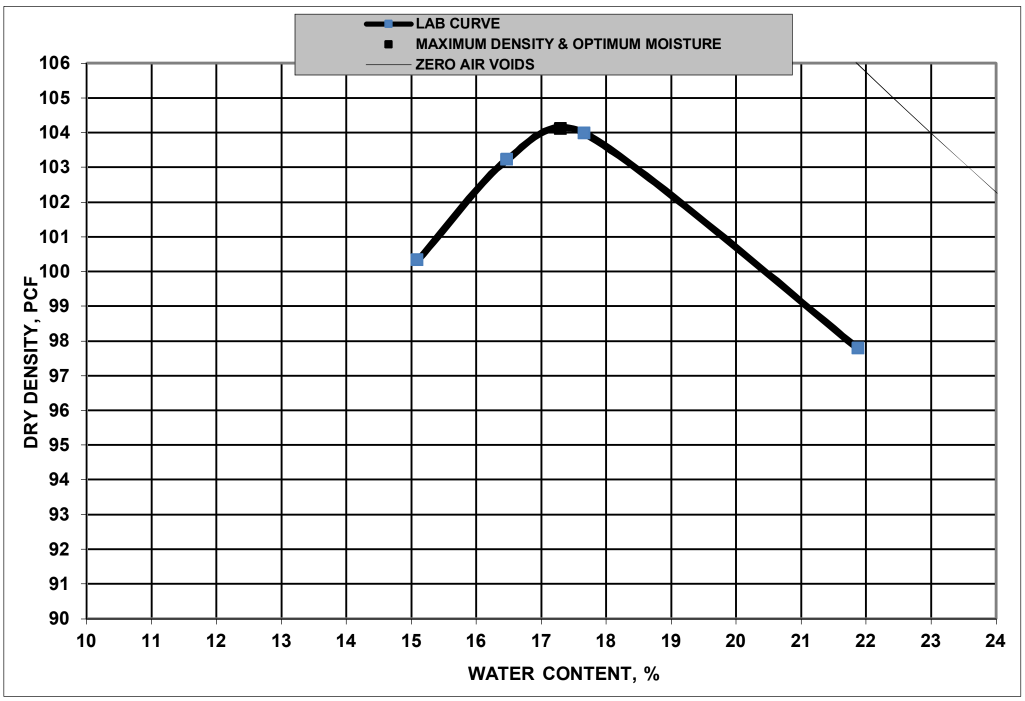
CONSOL STRAIN - GINT STD US LAB.GDT - 7/28/21 15:03 - G:\PROJECTS\2021\G21105.GPJ

RIMROCK ENGINEERING, INC.

PHYSICAL PROPERTIES OF SOIL/AGGREGATE

Client Name:	High Sierra II, Inc.	**Project No:**	G21105
		Date of Report:	7/28/2021
Project Name:	High Sierra 17th & 18th Filing	**Sample Location:**	B-1 to 13, B-27 to 34
Project Location:	Billings, Montana	**Sample Depth:**	1'-3'
Sampled By:	Rimrock Engineering, Inc.	**Classification:**	Sandy Lean Clay(CL)
Submitted By:	Rimrock Engineering, Inc.	**Date Sampled:**	7/6/2021

MOISTURE-DENSITY RELATIONSHIP



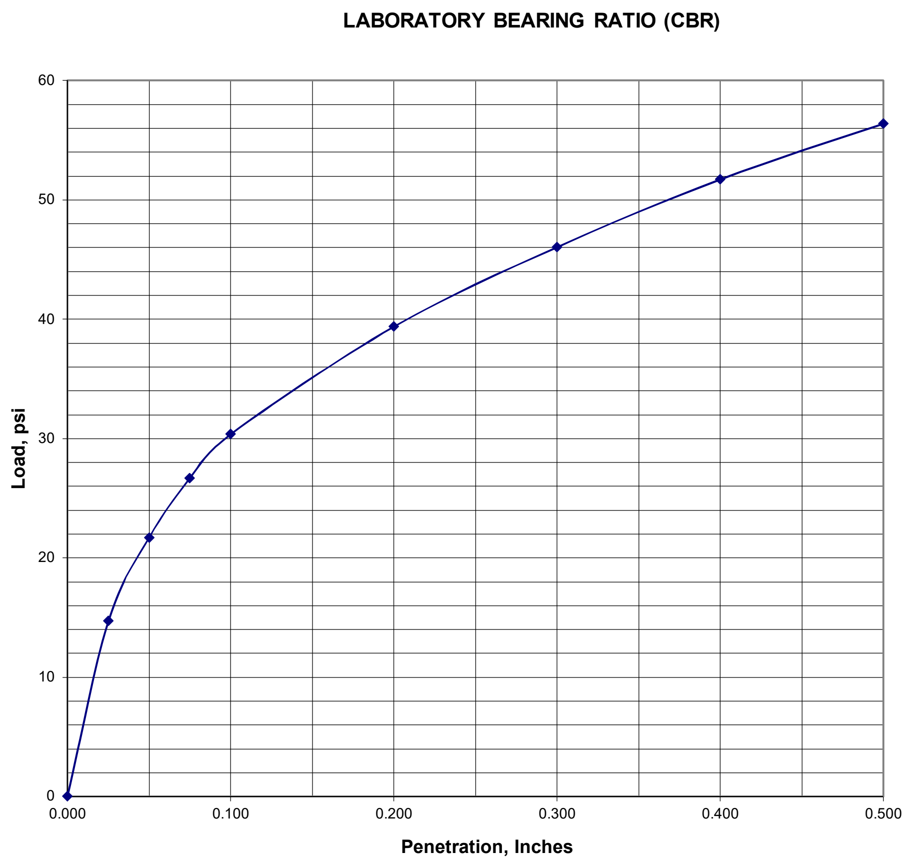
Maximum Density, PCF:	104.1
Optimum Moisture, %:	17.3
Test Method:	ASTM D698
Visual Classification:	Sandy Lean Clay(CL)

RIMROCK ENGINEERING, INC.

PHYSICAL PROPERTIES OF SOIL/AGGREGATE

Client Name:	High Sierra II, Inc.	**Project No:**	G21105
		Date of Report:	7/28/2021
Project Name:	High Sierra 17th & 18th Filing	**Sample Location:**	B-1 to 13, B-27 to 34
Project Location:	Billings, Montana	**Sample Depth:**	1'-3'
Sampled By:	Rimrock Engineering, Inc.	**Classification:**	Sandy Lean Clay(CL)
Submitted By:	Rimrock Engineering, Inc.	**Date Sampled:**	7/6/2021

CALIFORNIA BEARING RATIO



% CBR @ 0.1" 3