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October 16, 2024

Jennisse Waters
MSU Planning, Design, & Construction
Montana State University, Plew Building
Bozeman, MT 59717

e-mail: jennisse.waters@montana.edu *(Sent via email only)*

Re: Geotechnical Design Memo
Foundation Options and Recommendations
MSU Roberts Hall – Bozeman, MT

Dear Ms. Waters:

This letter with attachments is provided as our **geotechnical design memo** for the *Room 101 Classroom Renovations project at Roberts Hall*, located on the Montana State University campus in Bozeman, MT. More specifically, this memo presents **foundation options and recommendations** for the support of the new first floor area.

Our recommendations are based on our understanding of the project from our review of the structural design concept options and our knowledge of the soil conditions from our previous geotechnical work on the neighboring American Indian Hall project site (located a few hundred feet to the north). Since we have nearby soils information (that closely matches the soil conditions found throughout the south end of campus), no additional borings were conducted as part of our geotechnical involvement.

We are assuming that all new project improvements will occur within the existing shell of the building. All of our geotechnical recommendations are focused on the foundation support for the new first floor area, which will consist of a new concrete slab poured on an elevated metal deck. The new first floor will overlie part of the building's existing first floor as well as the underlying basement area. If additional geotechnical input is needed for other parts of the project, we can provide this in a follow-up letter.

In summary, the site's soil conditions consist of native silt/clay that extends down to a depth of 15 to 16 feet (below exterior site grades). Beginning at this depth is a 10-foot (+/-) thick layer of native sandy gravel. As we understand it, the new first floor will be supported on new footings and columns in the basement area. Within this memo, we provide two options for foundation support including:

- Option 1: Helical Pier Support (best/recommended option due to lower settlement potential).
- Option 2: Wider Footings for Lower Bearing Pressure (2nd option with higher settlement risk).

Attached to this memo are several items. These include two figures (Figure 1 and 2) that illustrate Options 1 and 2 for foundation support. Excerpts from our 2018 geotechnical report for the American Indian Hall project include two maps showing the borehole locations (and depths to native gravel and groundwater at each of the borings) as well as our borehole logs (for BH-1 through BH-4). Assuming that portions of the building's basement slab will be removed/replaced as part of the project, we have included a project sheet for Stego 15-mil vapor barrier, which we recommend for moisture protection under slabs. Please review the figures and logs in conjunction with the memo.

Please forward this letter to applicable Design Team and Construction Team members. Since we include recommendations for foundation earthwork and helical pier installation, please make sure this gets sent on to the Earthwork Contractor and the Pier Installation Contractor.

SITE LOCATION

Roberts Hall is located on the west side of S. 6th Avenue and lies on the southwest corner of the intersection with W. Garfield Street. As we understand it, Room 101, which is the site of the classroom renovation project, occupies the northeast corner of the building. American Indian Hall lies adjacent to and to the north of Roberts Hall (across the pedestrian mall).

EXISTING CONDITIONS

Below is a summary of existing conditions (based on a review of concept structural design drawings):

- Room 101 lies on the first floor and houses the existing lecture bowl within the building.
- The room is underlain by a basement level with an existing concrete slab.
- The depth of the basement is about 8.0 to 9.0 feet below exterior site grades.
- The existing floor of Room 101 stair steps downward (from high end to low end of the room).
- Due to the stair-stepped floor, clearance height between first floor and basement slab varies.
- On the high end of the ex. floor area, the basement clearance height ranges from 5.0 to 8.0 feet.
- On the low end of the ex. floor area, the basement clearance height ranges from 2.0 to 4.0 feet.
- The existing first floor is supported on concrete footings (below the slab) and columns/beams.

PROJECT UNDERSTANDING

Below is our understanding of the project (based on a review of concept structural design drawings):

- The project will include a new concrete floor slab (over a metal pan deck) in Room 101.
- The new floor will be level and will encompass the majority of the existing first floor area.
- There are two structural options for support of the new, elevated floor slab area.
- Option A includes new continuous strip footings, new steel columns, and new steel stud walls.
- Option B includes new spread/pad footings and new steel columns.

PREVIOUS GEOTECHNICAL WORK ON MSU CAMPUS

Over the last few years, AESI has provided geotechnical-related services (incl. investigation, report, recommendations, and construction inspection) on several of the new buildings in the south half of the MSU campus area. These have included the new American Indian Hall, the Montana Hall Re-Model, the Romney Hall Renovation, the new Student Wellness Center, and the new City of Bozeman Fire Station, which is located on MSU property to the east of the MSU Police Station. Throughout this large area of campus, we have generally found similar soil conditions. These have included a thick surface layer of silt/clay that overlies a thinner layer of sandy gravel, which then in turn overlies the older Tertiary-aged sediments (ie. consolidated layers of silt and sand).

Depending on location, the thickness of the silt/clay (or the depth to the top of the sandy gravel) ranges from 13 to 20 feet; while the thickness of the gravel layer ranges from 6 to 10 feet. On the American Indian Hall project site, located due north of Roberts Hall, the depth to top of the gravel layer was as 15 to 16 feet and the thickness of the gravel layer was about 10 feet.

Helical piers have been used on the Montana Hall Remodel (for the new elevator), on the Romney Hall Renovation (for new interior footings and structural retrofits inside the building), and for parts of the new Student Well Center project (including new footings within the existing building area). On each of these projects, the piers extended through the silt/clay and penetrated into native sandy gravel layer, which was the defined “target” bearing material for foundation support.

As part of the Romney Hall pre-design work, 50-kip and 100-kip test piers (working load capacity) were installed and load tested. At this site, the thickness of the gravel layer was about 6 to 8 feet thick. What was learned from the testing is that 50-kip piers performed well in compression; however, the 100-kip piers penetrated too far into the gravel layer and plunged/settled extensively when compression tested. During tension testing, both piers had relatively high “pull-out” displacements, which lowered/reduced the recommended allowable design loads (in tension) below the 50 and 100-kip working capacities of the piers. The reason for the poor performance in tension is due to the shallow penetration depth into the top of the native gravels.

SOIL AND GROUNDWATER CONDITIONS AT AMERICAN INDIAN HALL

The closest geotechnical explorations we have done to the Roberts Hall project site are the soil borings that were completed for the new American Indian Hall project. As part of our work, we drilled four boreholes (BH-1 through BH-4) throughout the building area, which lies a few hundred feet to the north of Roberts Hall. The borings were performed on August 7, 2018.

The soil conditions were uniform in all four boreholes and consisted of 15 to 16 feet of native silt/clay overlying about a 10-foot layer of native sandy gravel. The depth to groundwater ranged from 18 to 24 feet. Excerpts from our 2018 geotechnical report (for American Indian Hall) are attached. These include two site maps showing the boring locations (and gravel and groundwater depths) and the borehole logs.

GEOTECHNICAL CONCERNS

Roberts Hall has been in-place for a very long time; and hence the foundation soils under existing footings are stable and not undergoing any additional settlement (for the loads it currently experiences). Based on the structural design concept options (for the renovations project), which are presented and overlaid on the old as-built structural drawings, it appears that the building is supported on a shallow foundation system (ie. perimeter footings/basement walls and interior footings) that bears on the native silt/clay. Assuming a basement depth of 8.0 to 9.0 feet and depth to top of native sandy gravel of 15 to 16 feet, the basement slab area is underlain by about 6.0 to 8.0 feet of silt/clay. We suspect that the existing footings extend 1.0 to 2.0 feet below the slab, meaning that they likely bear on 4.0 to 7.0 feet of native silt/clay. Based on the structural drawings, it does not appear the building bears on native gravel.

The biggest geotechnical concern with this project is non-uniform deformation of the new elevated slab caused by differential settlement under the new interior footings compared to the existing perimeter footings of the old building. In short, we do not expect that the perimeter area of the new slab, which will be connect to the existing building walls, will undergo any deformation; whereas, there is a potential for settlement under new interior footings (especially if they bear directly on the silt/clay). If too much settlement were to occur, the new slab would be susceptible to some cracking with the added possibility of some vertical displacement (along the cracks). By far, the best way to minimize the potential for foundation settlement is to support all new footings on helical piers that extend down into the layer of sandy gravel. If site constraints do not allow for the use of helical piers, then a second option would be to bear all new footings on undisturbed silt/clay subgrade; but design the footings for a lower bearing pressure which will result in wider footings. The second option (ie. bearing new footings on silt/clay) has a higher settlement risk and should only be used as an “option of last resort”.

SITE CONSTRAINTS

As stated above, the best (and recommended) option is to support all new footings on helical piers. In order to do so, the building interior and basement foundation area will need to be accessible by a mini-excavator or skidsteer (either of which will be used for pier installation). Another site constraint is the very low clearance heights in the basement area (in between the bottom of the existing first floor and the top of existing basement slab) throughout much of the basement area. If the existing first floor is going to stay in-place (and not be removed) as part of this project, the piers will likely need to be installed (through holes in the first floor) with the excavator/skidsteer sitting on the existing first floor. It would be best to fully remove the existing first floor (as part of the project) so there is full height access to the entire basement area (for pier installation and interior footing construction).

FOUNDATION OPTIONS AND RECOMMENDATIONS

In our opinion, there are two options for the support of new footings. These include Option 1 (helical pier support down to native gravel) and Option 2 (wider footings designed to a lower bearing pressure that are supported on undisturbed silt/clay). Option 1 is the **best option due to its lower foundation**

settlement potential; <u>and is the recommended option</u>. <u>Option 2</u> is considered as the **"second option" and should only be considered if helical piers cannot be used**. See Figures 1 and 2 for illustrations of Options 1 and 2. Provided below are summaries of each option.

- <u>Option 1: Helical Pier Support</u>: Support all new footings on helical piers that extend down into the native sandy gravel at depths of 15 to 16 feet (below exterior site grades). We recommend using 25 to 50-kip design/working capacity piers. It will likely be more cost effective to use more, lower capacity piers (25 to 35-kip) as opposed to less, higher capacity piers (50-kip piers). We have been told (on past projects) that a higher quantity of lower cost piers is typically less expensive than a lower quantity of higher cost piers. Also, by using more piers, there is more redundancy (tighter pier spacing) built into the pier design/layout. The number of pier helices (1, 2, or 3) will depend on the pier capacity/pier design and recommended by the pier installer.

- <u>Option 2: Wider Footings for Lower Bearing Pressure</u>: Design all footings for a maximum soils bearing pressure of 1,500 pounds per square foot (psf) and support all footings on undisturbed silt/clay subgrade soils at footing grade. The lower bearing pressure will result in wider footings. The footing grade soils must be stiff and compacted to an unyielding condition. Depending on the site conditions, some depth of over-excavation and replacement (with 3"-minus granular structural fill) may be required to bear on undisturbed soils.

STRUCTURAL DESIGN PARAMETERS

Foundation Design

- <u>For Option 1</u>, all footings will be supported on helical piers that extend down into the "target" bearing sandy gravel. As a result, continuous strip footings will need to be designed as grade beams that span between the piers. For spread/pad footings, their thickness and reinforcement will depend on the pier layout and quantity.

- <u>For Option 2</u>, all footings will be supported on undisturbed, silt/clay subgrade soils. To lessen the foundation loading on the soils, we are recommending a lower bearing pressure which will result in wider footings. Another structural item that should be considered is designing the strip footings more as thicker/heavily-reinforced, grade beam footings. By doing so, the strip footing elements will be more rigid and carry/spread the column loads over longer distances (and better bridge any weaker areas in the silt/clay subgrade soils).

Seismic Design Factors

A main requirement of the Structural Engineer's seismic analysis will be a determination of the site class. Based on our on-site explorations and knowledge of the underlying geology, the site class for the project site will be **Site Class D** (as per criteria presented in the 2021 IBC). This site class designation is valid as long as our foundation recommendations are followed.

To obtain site-specific seismic loading and response spectrum parameters, a web-based application from the USGS Earthquake Hazards Program can be used. The link to their web page is as follows: https://earthquake.usgs.gov/hazards/designmaps/. Upon entering this page, there are links to three third-party interfaces that can be used to obtain the seismic information. The user needs to enter the design code reference document, site soil classification, risk category, site latitude, and site longitude.

Helical Pier Capacity (<u>Option 1</u>)

All helical piers for compression and tension must penetrate and torque up in the "target" bearing layer of native sandy gravel, which underlies the site beginning at depths of 15 to 16 feet (below exterior site grades). Due to the expected, 10-foot thickness of the layer of sandy gravel layer, we recommend using **25 to 50-kip piers (design/working capacity)**. Higher capacity piers are not recommended as they may penetrate too far into the gravel layer and be at risk of higher settlement potential due to plunging. During pier installation, piers are installed to ultimate capacity, which is 2x the design/working capacity. Compression piers will likely be vertical in orientation; while tension piers are typically installed with a batter. We recommend piers manufactured by AB Chance or approved equal. Helical pier spacing will be dictated by the foundation loads and shall be designed/laid out by the Structural Engineer.

<u>Note:</u> As stated previously, we recommend using more, lower capacity piers (25 to 35-kip) verses less, higher capacity piers (50-kip). Not only will this likely be a less expensive option and also limit the pier penetration depth into the relatively thin, gravel layer (due to lower required torque); but the use for more piers will provide for tighter pier spacing and more redundancy in the design.

Helical Pier Load Testing (<u>Option 1</u>)

As long as lower capacity piers are used, load testing should not be needed. If piers will be 50 kips, it probably should be specified on the Structural plans/specifications that a pier (or two) should be load tested at the on-set of construction. The intent is to verify that piers do not penetrate/extend too deep into the gravel and excessively settle when tested.

Helical Pier Lateral Resistance (<u>Option 1</u>)

Vertically installed helical piers are assumed to have no lateral resistance. On helical pier projects, the building's lateral resistance must be primarily developed by the backfilled foundation wall. In addition to the foundation wall, additional lateral resistance can be obtained by battering some of the piers at angles of 15 to 45 degrees. Based on the structural analysis, the pier design/layout will likely include a combination of vertical and battered piers.

Foundation Bearing Pressure (<u>Option 2</u>)

For silt/clay subgrade conditions at footing grade, the allowable bearing pressure for all new footings is **1,500 pounds per square foot (psf)**. Allowable bearing pressures from transient loading (due to wind or seismic forces) may be increased by 50 percent. We estimate that the above-referenced design bearing pressure will result in total foundation settlements of one inch or less, with only minor differential settlements (under new footings).

Note: If possible, some over-excavation/replacement under footings will reduce settlement potential. If the basement area is accessible by a mini-excavator, we recommend that all new footings bear on 12 to 24 inches of compacted granular structural fill (3”-minus sandy gravel) overlying native silt/clay.

Note: The biggest risk of differential settlement will occur between existing perimeter footings and new interior footings.

FOUNDATION EARTHWORK

Knowing that construction access within a basement area of an existing building can be very difficult, we have provided foundation options that will limit the amount of foundation earthwork (including footing excavation and granular structural fill). Provided below are our recommendations for each option:

Option 1: Helical Pier Support

- Excavate footings to footing grade.
- Compact subgrade.
- Install helical piers.
- Pour footings.

Option 2: Wider Footings for Lower Bearing Pressure

- Excavate footings to footing grade (and bear on undisturbed silt/clay subgrade soils).
- Compact subgrade to a stiff and unyielding condition.
- Some over-excavation/gravel replacement may be required to bear on undisturbed soils.
- Pour footings on compacted/competent/suitable footing grade surface.
- If possible, 12 to 24 inches of over-excavation/structural fill replacement is recommended.
- A thicker 24 inch section of granular structural fill (3”-minus sandy gravel) is the best (preferred).
- By doing so, more silt/clay is removed under footings, which will lessen settlement potential.

SUBSLAB MOISTURE PROTECTION

Most likely as part of this project, areas of the existing basement slab will be removed (for new footing excavation/construction) and will be replaced (once new footings are installed/backfilled). For sub-slab moisture protection, we recommend that slabs be supported on 6 inches of 1”-minus clean crushed rock and underlain by a heavy-duty, 15-mil vapor barrier. The barrier should be taped at all seams, along foundation walls, and at pipe penetrations. The product we recommend is a Stego 15-mil vapor barrier, which is available at MaCon Supply in Four Corners. A product sheet is attached.

CLOSING

In closing, using helical piers to support all new interior footings (Option 1) is the **best/recommended option** for a few reasons. These include reduced differential settlement potential between new interior footings and existing perimeter footings (ie. lower risk of slab cracking) as well as a minimized amount of foundation earthwork within the existing basement area. We are hoping that building and basement access can be obtained to allow for the installation of helical piers. If access is a limiting site constraint that prevents the use of helical piers, then Option 2 (ie. wider footings bearing on undisturbed silt/clay) will need to be considered. As stated throughout this memo, this is a much riskier option (with respect to differential settlement potential and slab cracking); and hence is not recommended. If there are no other options and Option 2 must be used, we are recommending supporting all new interior footings on 12 to 24 inches of granular structural fill (if possible). Also, additional slab jointing may be required to limit the visual appearance of unwanted slab cracking/displacement.

If you have any questions about this geotechnical design memo or need any additional information, please give me a call at 1-406-582-0221.

Sincerely,

Allied Engineering Services, Inc.

Lee S. Evans, PE
Geotechnical Engineer

MONTANA
LEE SCOTT
EVANS
14420PE
10/16/24
LICENSED
PROFESSIONAL ENGINEER

enc: Figure 1 – Foundation Support Option #1
Figure 2 – Foundation Support Option #2
Exhibit A – AIH Borehole Locations w/ Native Gravel Depth (Fig. 3 from AIH Geotech Report)
Exhibit B – AIH Borehole Locations w/ Groundwater Depth (Fig. 4 from AIH Geotech Report)
AIH Borehole Logs for BH-1 through BH-5 (From AIH Geotech Report)
Product Sheet for Stego 15-mil Vapor Barrier
Limitations of your Geotechnical Report

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MSU Roberts Hall

By: Lee Evans
AESI
10/11/24

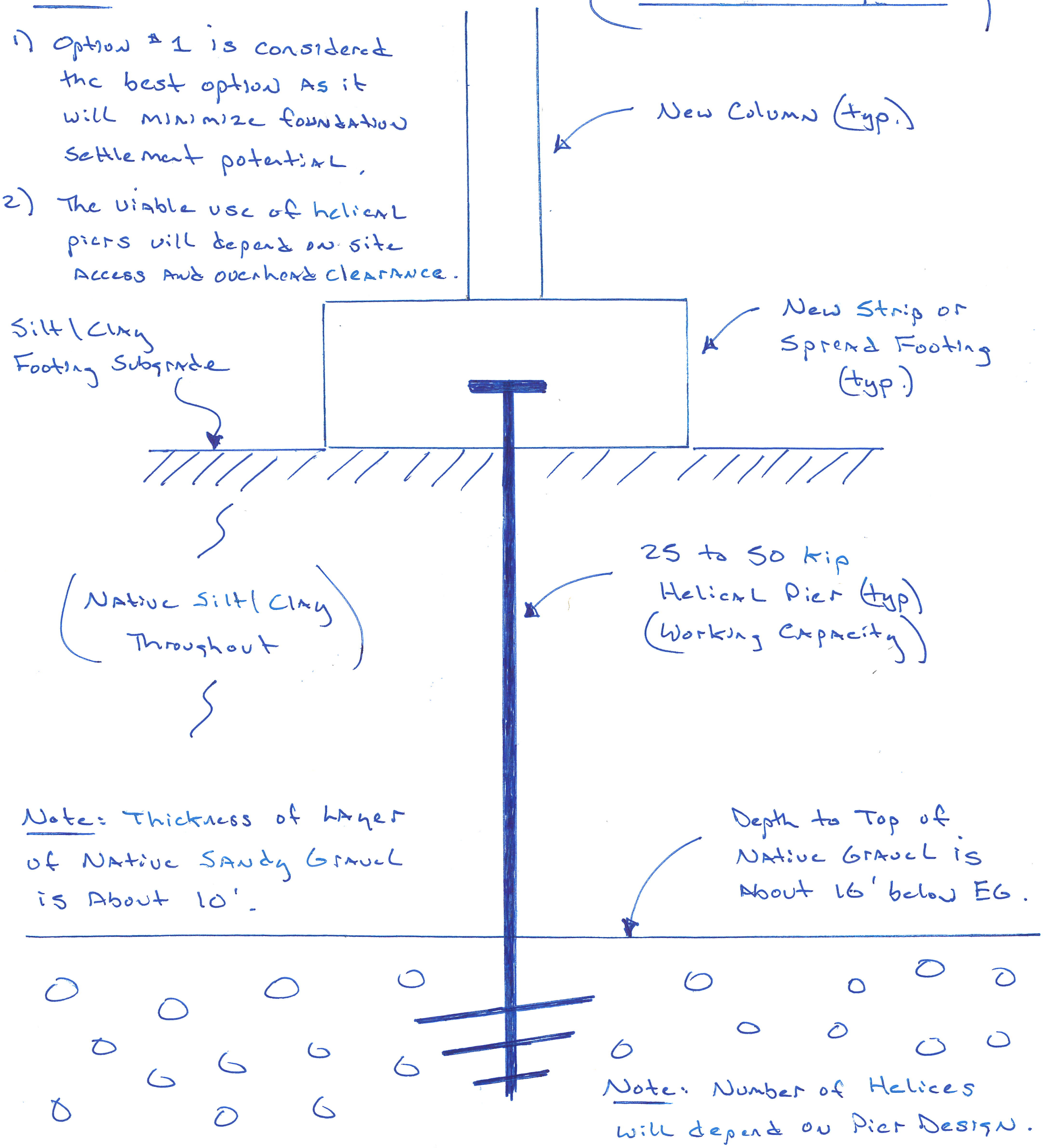
Figure 1 ~ Foundation Support Option #1

Support All New Footings on Helical Piers that extend and penetrate down into "target" Native sandy gravel.

(Recommended Option)

Notes:

1) Option #1 is considered the best option as it will minimize foundation settlement potential.
2) The viable use of helical piers will depend on site access and overhead clearance.



By: Lee Evans
AESI
10/11/24

MSU Roberts Hall

Figure 2 ~ Foundation Support Option #2

Support All New Footings on Undisturbed, Native Silt/Clay That is Stiff and Compacted at Footing Grade.

Notes:

1) Option #2 is considered a "second option".

2) This option has higher foundation settlement potential, especially with respect to differential settlement w/ existing building.

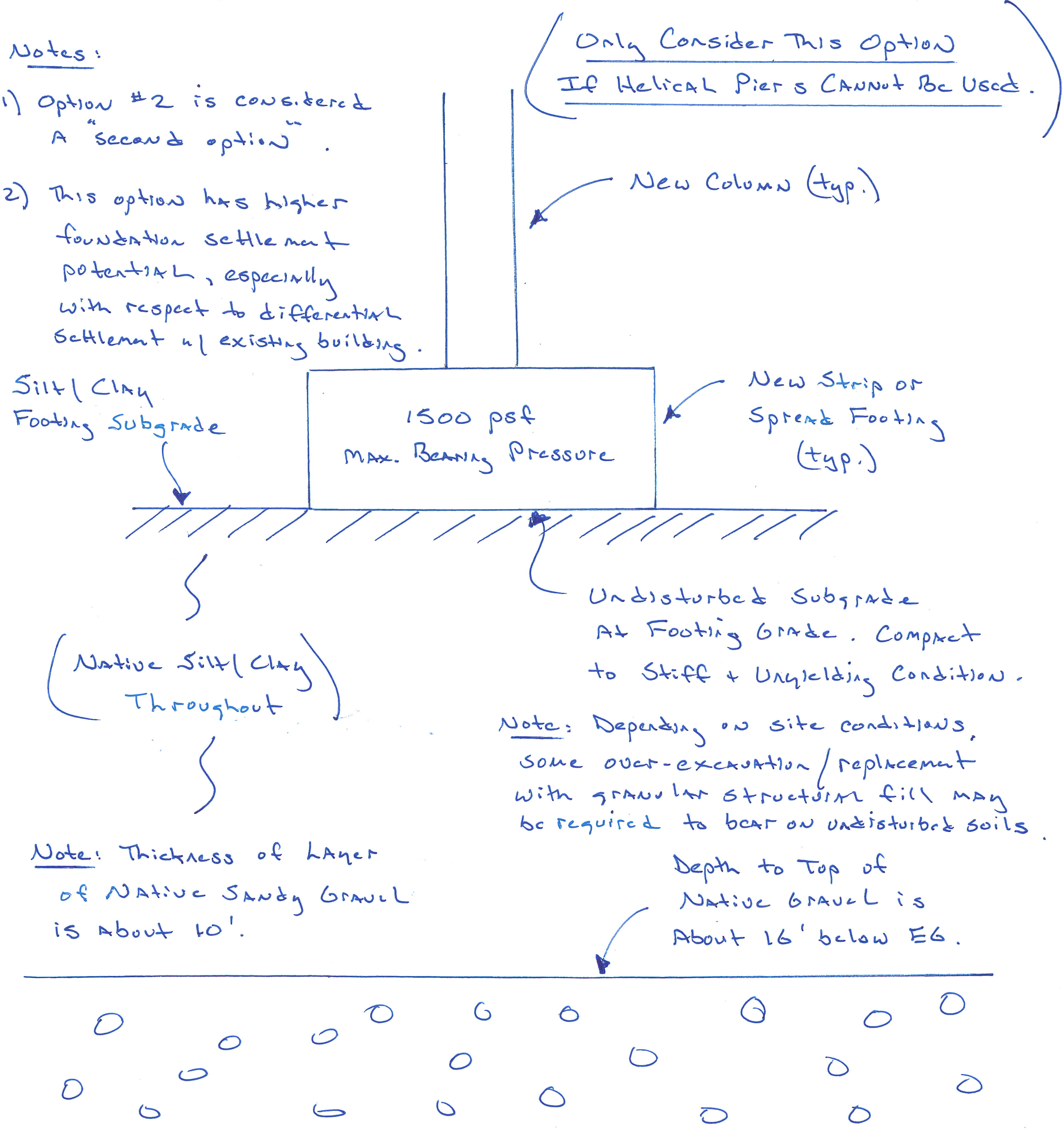
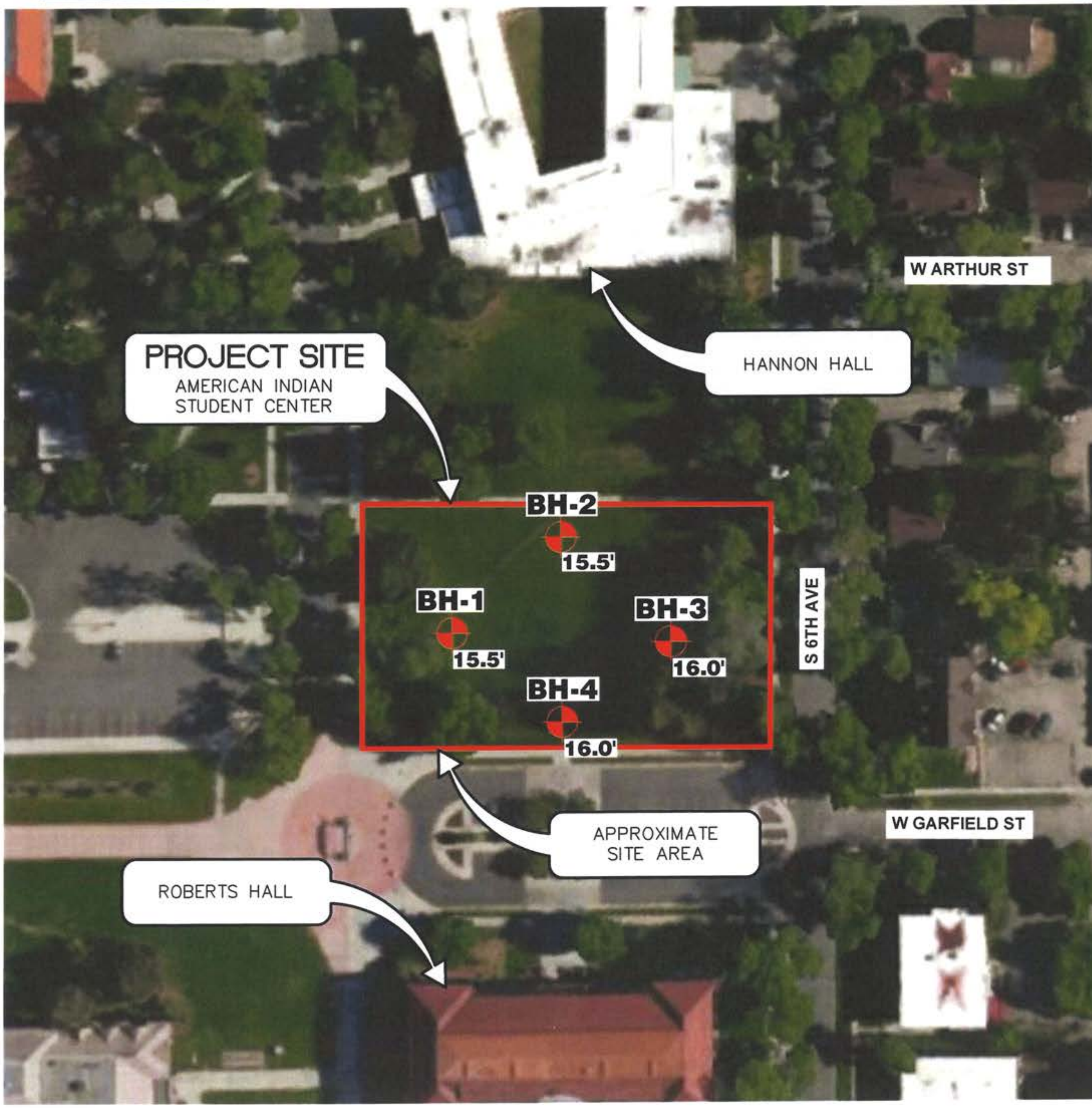
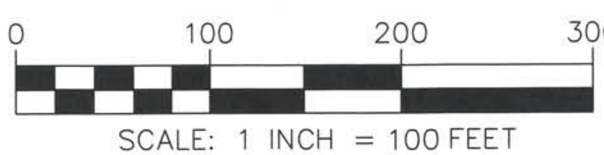


Exhibit A

(Borehole Logs Attached)



Note: Excerpt from 2018 American Indian Hall Geotechnical Report.



LEGEND

BH-1 15.5' — BOREHOLE LOCATION (APPROXIMATE) w/ DEPTH TO NATIVE SANDY GRAVEL

Note: Boreholes drilled on 8/7/2018.

Note: Gravel layer is approximately 10' thick and extends down to a depth of about 26'.

AMERICAN INDIAN STUDENT CENTER BH LOCATIONS w/ NATIVE GRAVEL DEPTH BOZEMAN, MONTANA	*Civil Engineering* *Geotechnical Engineering* *Land Surveying* 32 DISCOVERY DRIVE . BOZEMAN, MT 59718 PHONE (406) 582-0221 . FAX (406) 582-5770 www.alliedengineering.com	ALLIED ENGINEERING SERVICES, INC.	FIGURE 3 DRAWN BY: GDF DATE: 09/2018 PROJECT #:18-116 FIGURE 3.DWG

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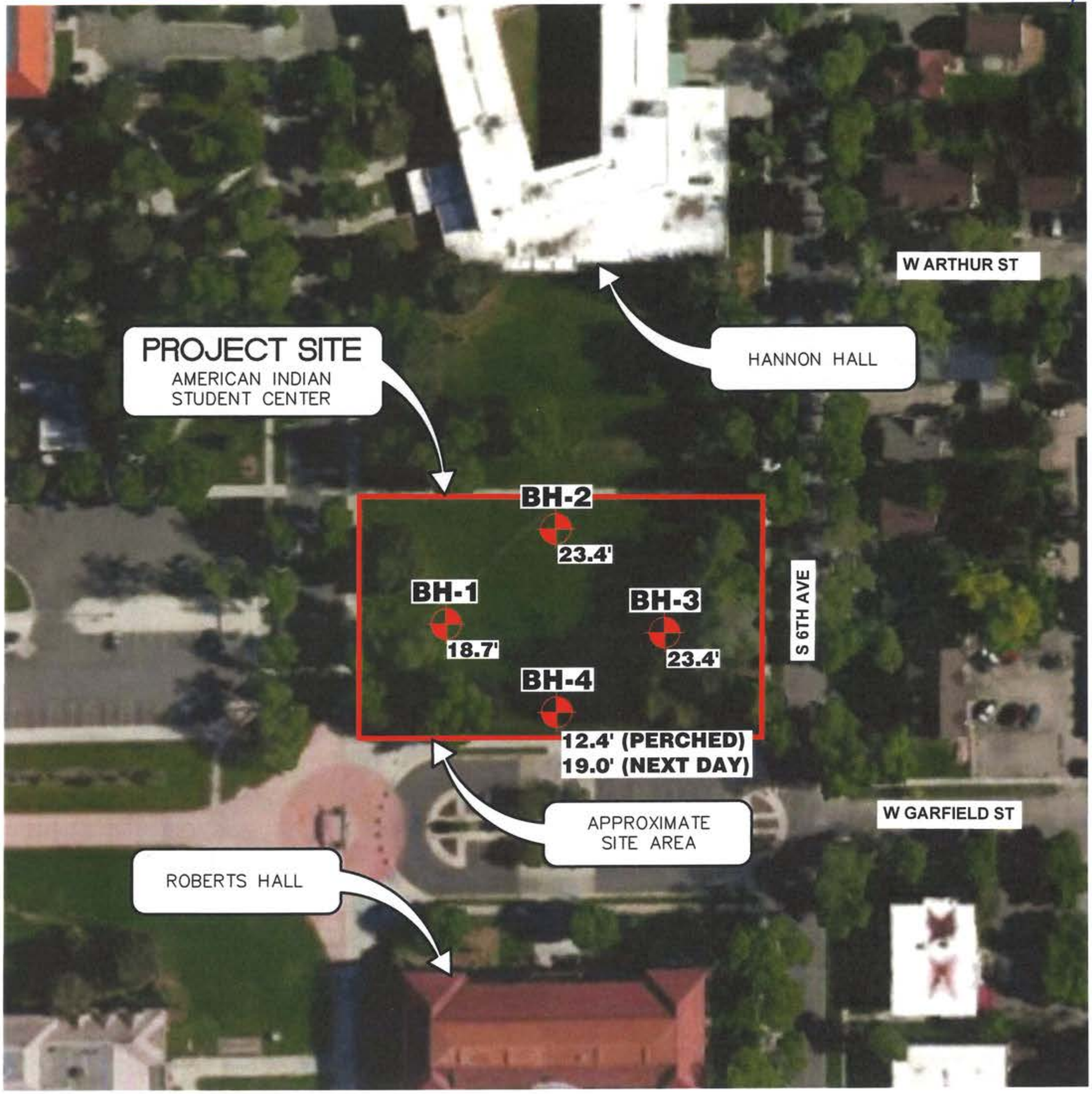
Exhibit B (Borehole Logs Attached)



Note: Excerpt from 2018 American Indian Hall Geotechnical Report.

Note: Groundwater depths will be a little shallower during the spring of the year.

SCALE: 1 INCH = 100 FEET (0, 100, 200, 300)

N

LEGEND

BH-1 18.7' — BOREHOLE LOCATION (APPROXIMATE) w/ DEPTH TO GROUNDWATER DURING 8/7/18 EXPLORATIONS

Note: Boreholes drilled on 8/7/2018.

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AMERICAN INDIAN STUDENT CENTER BH LOCATIONS w/ GROUNDWATER DEPTH BOZEMAN, MONTANA	Civil Engineering Geotechnical Engineering Land Surveying 32 DISCOVERY DRIVE . BOZEMAN, MT 59718 PHONE (406) 582-0221 . FAX (406) 582-5770 www.alliedengineering.com	ALLIED ENGINEERING SERVICES, INC.	FIGURE 4 DRAWN BY: GDF DATE: 09/2018 PROJECT #:18-116 FIGURE 4.DWG

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Civil Engineering
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FIELD LOG OF BORING

PROJECT: **American Indian Student Center MSU Campus - Bozeman, MT** JOB #: **18-116** DATE: **8/7/18** BORING: **BH-1** PAGE: **1 of 1**

LOCATION: **West Side of Building Site (See Fig. 3 & 4 for Approx. Location)** ELEV: **N/A** TOTAL DEPTH: **35.5'** DEPTH TO GW: **18.7'**

DRILL TYPE: **Truck-Mounted B-61 Drill Rig** CASING/HAMMER/SAMPLER: **4.25" Hollow Stem Auger w/ 140 lb Hammer and 2" O.D. Standard Split Spoon Samplers**

DRILLER: **Steve Malkovich, O'Keefe Drilling (Butte, MT)** FIELD ENGINEER: **Erik Schnaderbeck, AESI**

Reviewed By: LSE, 8/30/18

DESCRIPTION OF MATERIALS

Important Note:
The beginning and ending depths of the individual soil layers are approximate.

{0.0' - 1.0'}: Topsoil
Medium stiff; black to dark brown; organic clayey SILT w/ small roots; moist.

{1.0' - 15.5'}: Silt/Clay
Soft to medium stiff to stiff; light brown/tan to brown; sandy SILT to sandy CLAY; moist to very moist.

Notes:
- Smooth and easy drill action entire depth.
- No apparent intermixed gravels (no grinding).
- Most of soil profile is soft to med. stiff.
- Stiffer at 12.0' and below.
- Some areas are soft w/ blow counts of 2 to 4.
- Some areas are med. stiff w/ blow counts of 4 to 8.
- Some areas are stiff w/ blow counts of 8 to 15.
- Most soils are generally very moist (>20%).
- No atterberg limit testing on BH-1 soils.
- Based on a little higher blow counts near the bottom, the lower silt/clay likely contains some scattered gravels (transitional zone).
- Unsuitable foundation bearing material.

{15.5' - 26.0'}: Sandy Gravel
Dense to very dense; brown; sandy GRAVEL w/ abundant gravels & cobbles; moist to wet.

Notes:
- Start of significant grinding at 15.5'. Slow drill.
- Pretty "clean" sandy gravel.
- No noticeable silt/clay seams in SSS samples.
- "Target" foundation bearing at 15.5' and below.

{26.0' - 35.5'}: Very Weathered Bedrock
Very stiff to hard; light brown/tan; sandy SILT to sandy CLAY w/ some sandy areas and occasional bedrock rock chips; moist to very moist.

Notes:
- Smooth drill action at 26.0'.
- Start of Tertiary bedrock strata (mostly soil).
- Suitable foundation bearing material.

Bottom of borehole @ 35.5'

Sample Data

Sample ID	N (Uncorr) Blows/1.0 Foot	Sampler Penetration	Moisture Content	Other Field or Sample Information
S1-A @ 0.0' (SSS)	10	18"	17.8%	Start Depth of Sampler: 0.0' End Depth of Sampler: 1.5' Blow Counts: 3 / 5 / 5
S1-B @ 2.0' (SSS)	13	18"	20.3%	Start Depth of Sampler: 2.0' End Depth of Sampler: 3.5' Blow Counts: 8 / 7 / 6
S1-C @ 4.0' (SSS)	6	18"	22.2%	Start Depth of Sampler: 4.0' End Depth of Sampler: 5.5' Blow Counts: 3 / 3 / 3
S1-D @ 7.0' (SSS)	6	18"	23.6%	Start Depth of Sampler: 7.0' End Depth of Sampler: 8.5' Blow Counts: 3 / 2 / 4
S1-E @ 9.0' (SSS)	3	18"	38.5%	Start Depth of Sampler: 9.0' End Depth of Sampler: 10.5' Blow Counts: 1 / 1 / 2
S1-F @ 12.0' (SSS)	16	18"	24.5%	Start Depth of Sampler: 12.0' End Depth of Sampler: 13.5' Blow Counts: 4 / 7 / 9
S1-G @ 14.0' (SSS)	28	18"	22.4%	Start Depth of Sampler: 14.0' End Depth of Sampler: 15.5' Blow Counts: 4 / 9 / 19
S1-H @ 17.0' (SSS)	50/5"	11"	Wet	Start Depth of Sampler: 17.0' End Depth of Sampler: 17.9' Blow Counts: 27 / 50 for 5"
S1-I @ 19.0' (SSS)	50/5"	5"	Wet	Start Depth of Sampler: 19.0' End Depth of Sampler: 19.4' Blow Counts: 50 for 5"
S1-J @ 22.0' (SSS*)	88	18"	Wet	Start Depth of Sampler: 22.0' End Depth of Sampler: 23.5' Blow Counts: 27 / 41 / 47
S1-K @ 24.0' (SSS)	39	18"	Wet	Start Depth of Sampler: 24.0' End Depth of Sampler: 25.5' Blow Counts: 18 / 21 / 18
S1-L @ 27.0' (SSS)	29	18"	32.7%	Start Depth of Sampler: 27.0' End Depth of Sampler: 28.5' Blow Counts: 7 / 12 / 17
S1-M @ 29.0' (SSS)	27	18"	32.4%	Start Depth of Sampler: 29.0' End Depth of Sampler: 30.5' Blow Counts: 21 / 11 / 16
S1-N @ 32.0' (SSS)	37	18"	35.4%	Start Depth of Sampler: 32.0' End Depth of Sampler: 33.5' Blow Counts: 9 / 16 / 21
S1-O @ 34.0' (SSS)	43	18"	29.4%	Start Depth of Sampler: 34.0' End Depth of Sampler: 35.5' Blow Counts: 10 / 14 / 29

Depth (ft) scale: 4, 8, 12, 16, 20, 24, ≈, 36

ALLIED ENGINEERING SERVICES, INC.

Civil Engineering
Geotechnical Engineering
Land Surveying

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FIELD LOG OF BORING

PROJECT: **American Indian Student Center MSU Campus - Bozeman, MT** JOB #: **18-116** DATE: **8/7/18** BORING: **BH-2** PAGE: **1 of 1**

LOCATION: **North Side of Building Site (See Fig. 3 & 4 for Approx. Location)** ELEV: **N/A** TOTAL DEPTH: **30.5'** DEPTH TO GW: **23.4'**

DRILL TYPE: **Truck-Mounted B-61 Drill Rig** CASING/HAMMER/SAMPLER: **4.25" Hollow Stem Auger w/ 140 lb Hammer and 2" O.D. Standard Split Spoon Samplers**

DRILLER: **Steve Malkovich, O'Keefe Drilling (Butte, MT)** FIELD ENGINEER: **Erik Schnaderbeck, AESI**

DESCRIPTION OF MATERIALS

Important Note:
The beginning and ending depths of the individual soil layers are approximate.

Reviewed By: LSE, 8/30/18

{0.0' - 1.0'}: Topsoil
Medium stiff; black to dark brown; organic clayey SILT w/ small roots; moist.

{1.0' - 15.5'}: Silt/Clay
Soft to medium stiff to stiff; light brown/tan to brown; sandy SILT to sandy CLAY; moist to very moist.

Notes:
- Smooth and easy drill action entire depth.
- No apparent intermixed gravels (no grinding).
- Upper half of soil profile is soft to med. stiff.
- Stiffer at 9.0' and below.
- Some areas are soft w/ blow counts of 2 to 4.
- Some areas are med. stiff w/ blow counts of 4 to 8.
- Some areas are stiff w/ blow counts of 8 to 15.
- Most soils are generally very moist (>20%).
- Conducted atterberg limit testing on BH-2 soils.
- Based on testing, the soil classifies as a sandy lean clay (CL), but is very close to being a sandy fat clay (CH).
- Based on a little higher blow counts near the bottom, the lower silt/clay likely contains some scattered gravels (transitional zone).
- Unsuitable foundation bearing material.

{15.5' - 26.0'}: Sandy Gravel
Dense to very dense; brown; sandy GRAVEL w/ abundant gravels & cobbles; moist to wet.

Notes:
- Start of significant grinding at 15.5'. Slow drill.
- Pretty "clean" sandy gravel.
- No noticeable silt/clay seams in SSS samples.
- "Target" foundation bearing at 15.5' and below.

{26.0' - 30.5'}: Very Weathered Bedrock
Very stiff; light brown/tan; sandy SILT to sandy CLAY w/ some sandy areas and occasional bedrock rock chips; moist to very moist.

Notes:
- Smooth drill action at 26.0'.
- Start of Tertiary bedrock strata (mostly soil).
- Suitable foundation bearing material.

Bottom of borehole @ 30.5'

SAMPLE ID	N (UNCORR) BLOWS/1.0 FOOT	SAMPLER PENETRATION	MOISTURE CONTENT	OTHER FIELD OR SAMPLE INFORMATION
S2-A @ 0.0' (SSS)	8	18"	26.9%	Start Depth of Sampler: 0.0' End Depth of Sampler: 1.5' Blow Counts: 2 / 4 / 4
S2-B @ 2.0' (SSS)	4	18"	19.7%	Start Depth of Sampler: 2.0' End Depth of Sampler: 3.5' Blow Counts: 3 / 2 / 2
S2-C @ 4.0' (SSS)	2	18"	24.1%	Start Depth of Sampler: 4.0' End Depth of Sampler: 5.5' Blow Counts: 2 / 1 / 1
S2-D @ 7.0' (SSS)	6	18"	23.4%	Start Depth of Sampler: 7.0' End Depth of Sampler: 8.5' Blow Counts: 2 / 3 / 3
S2-E @ 9.0' (SSS)	15	18"	24.6%	Start Depth of Sampler: 9.0' End Depth of Sampler: 10.5' Blow Counts: 4 / 5 / 10
S2-F @ 12.0' (SSS)	24	18"	24.7%	Start Depth of Sampler: 12.0' End Depth of Sampler: 13.5' Blow Counts: 5 / 9 / 15
S2-G @ 14.0' (SSS)	29	18"	24.2%	Start Depth of Sampler: 14.0' End Depth of Sampler: 15.5' Blow Counts: 6 / 10 / 19
S2-H @ 17.0' (SSS)	50/4"	10"	4.4%	Start Depth of Sampler: 17.0' End Depth of Sampler: 17.8' Blow Counts: 35 / 50 for 4"
S2-I @ 19.0' (SSS)	50/2"	2"	Wet	Start Depth of Sampler: 19.0' End Depth of Sampler: 19.2' Blow Counts: 50 for 2"
S2-J @ 22.0' (SSS*)	74	18"	Wet	Start Depth of Sampler: 22.0' End Depth of Sampler: 23.5' Blow Counts: 35 / 39 / 35
S2-K @ 24.0' (SSS)	50/5"	11"	Wet	Start Depth of Sampler: 24.0' End Depth of Sampler: 24.9' Blow Counts: 40 / 50 for 5"
S2-L @ 27.0' (SSS)	23	18"	37.7%	Start Depth of Sampler: 27.0' End Depth of Sampler: 28.5' Blow Counts: 4 / 9 / 14
S2-M @ 29.0' (SSS)	26	18"	37.2%	Start Depth of Sampler: 29.0' End Depth of Sampler: 30.5' Blow Counts: 7 / 10 / 16

DEPTH (FT): 4, 8, 12, 16, 20, 24, 30

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FIELD LOG OF BORING

PROJECT: **American Indian Student Center MSU Campus - Bozeman, MT** JOB #: **18-116** DATE: **8/7/18** BORING: **BH-3** PAGE: **1 of 1**

LOCATION: **East Side of Building Site (See Fig. 3 & 4 for Approx. Location)** ELEV: **N/A** TOTAL DEPTH: **30.5'** DEPTH TO GW: **23.4'**

DRILL TYPE: **Truck-Mounted B-61 Drill Rig** CASING/HAMMER/SAMPLER: **4.25" Hollow Stem Auger w/ 140 lb Hammer and 2" O.D. Standard Split Spoon Samplers**

DRILLER: **Steve Malkovich, O'Keefe Drilling (Butte, MT)** FIELD ENGINEER: **Erik Schnaderbeck, AESI**

DESCRIPTION OF MATERIALS

Important Note: The beginning and ending depths of the individual soil layers are approximate.

OTHER FIELD OR SAMPLE INFORMATION — Reviewed By: LSE 8/30/18

{0.0' - 1.0'}: Topsoil
Medium stiff; black to dark brown; organic clayey SILT w/ small roots; moist.

{1.0' - 16.0'}: Silt/Clay
Soft to medium stiff to stiff; light brown/tan to brown; sandy SILT to sandy CLAY; moist to very moist.

Notes:
- Smooth and easy drill action entire depth.
- No apparent intermixed gravels (no grinding).
- Upper soils are soft to med. stiff.
- Stiffer at 7.0' and below.
- Some areas are soft w/ blow counts of 2 to 4.
- Some areas are med. stiff w/ blow counts of 4 to 8.
- Some areas are stiff w/ blow counts of 8 to 15.
- Most soils are generally very moist (>20%).
- Conducted atterberg limit testing on BH-3 soils.
- Based on testing, the soil classifies as a sandy lean clay (CL), but is very close to being a sandy fat clay (CH).
- Based on a little higher blow counts near the bottom, the lower silt/clay likely contains some scattered gravels (transitional zone).
- Unsuitable foundation bearing material.

{16.0' - 25.5'}: Sandy Gravel
Dense to very dense; brown; sandy GRAVEL w/ abundant gravels & cobbles; moist to wet.

Notes:
- Start of significant grinding at 16.0'. Slow drill.
- Pretty "clean" sandy gravel.
- No noticeable silt/clay seams in SSS samples.
- "Target" foundation bearing at 16.0' and below.

{25.5' - 30.5'}: Very Weathered Bedrock
Very stiff; light brown/tan; sandy SILT to sandy CLAY w/ some sandy areas and occasional bedrock rock chips; moist to very moist.

Notes:
- Smooth drill action at 25.5'.
- Start of Tertiary bedrock strata (mostly soil).
- Suitable foundation bearing material.

Bottom of borehole @ 30.5'

SAMPLE ID	N (UNCORR) BLOWS/1.0 FOOT	SAMPLER PENETRATION	MOISTURE CONTENT	OTHER FIELD OR SAMPLE INFORMATION
S3-A @ 0.0' (SSS)	8	18"	18.1%	Start Depth of Sampler: 0.0' End Depth of Sampler: 1.5' Blow Counts: 4 / 4 / 4
S3-B @ 2.0' (SSS)	5	18"	14.5%	Start Depth of Sampler: 2.0' End Depth of Sampler: 3.5' Blow Counts: 3 / 2 / 3
S3-C @ 4.0' (SSS)	6	18"	19.6%	Start Depth of Sampler: 4.0' End Depth of Sampler: 5.5' Blow Counts: 3 / 2 / 4
S3-D @ 7.0' (SSS)	15	18"	25.5%	Start Depth of Sampler: 7.0' End Depth of Sampler: 8.5' Blow Counts: 3 / 6 / 9
S3-E @ 9.0' (SSS)	11	18"	27.7%	Start Depth of Sampler: 9.0' End Depth of Sampler: 10.5' Blow Counts: 3 / 4 / 7
S3-F @ 12.0' (SSS)	42	18"	25.1%	Start Depth of Sampler: 12.0' End Depth of Sampler: 13.5' Blow Counts: 10 / 17 / 25
S3-G @ 14.0' (SSS)	19	18"	25.4%	Start Depth of Sampler: 14.0' End Depth of Sampler: 15.5' Blow Counts: 6 / 7 / 12
S3-H @ 17.0' (SSS)	50/5"	11"	6.8%	Start Depth of Sampler: 17.0' End Depth of Sampler: 17.9' Blow Counts: 22 / 50 for 5"
S3-I @ 19.0' (SSS)	50/4"	10"	6.8%	Start Depth of Sampler: 19.0' End Depth of Sampler: 19.8' Blow Counts: 17 / 50 for 4"
S3-J @ 22.0' (SSS*)	51	18"	Wet	Start Depth of Sampler: 22.0' End Depth of Sampler: 23.5' Blow Counts: 6 / 23 / 28
S3-K @ 24.0' (SSS)	43	18"	Wet	Start Depth of Sampler: 24.0' End Depth of Sampler: 25.5' Blow Counts: 23 / 24 / 19
S3-L @ 27.0' (SSS)	26	18"	37.3%	Start Depth of Sampler: 27.0' End Depth of Sampler: 28.5' Blow Counts: 8 / 10 / 16
S3-M @ 29.0' (SSS)	31	18"	37.0%	Start Depth of Sampler: 29.0' End Depth of Sampler: 30.5' Blow Counts: 7 / 12 / 19

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FIELD LOG OF BORING

PROJECT: **American Indian Student Center MSU Campus - Bozeman, MT** JOB #: **18-116** DATE: **8/7/18** BORING: **BH-4**

LOCATION: **South Side of Building Site (See Fig. 3 & 4 for Approx. Location)** ELEV: **N/A** TOTAL DEPTH: **30.5'** DEPTH TO GW: **12.4' (Perched Water Table) (19.0' Deep Next Day)**

DRILL TYPE: **Truck-Mounted B-61 Drill Rig** CASING/HAMMER/SAMPLER: **4.25" Hollow Stem Auger w/ 140 lb Hammer and 2" O.D. Standard Split Spoon Samplers**

DRILLER: **Steve Malkovich, O'Keefe Drilling (Butte, MT)** FIELD ENGINEER: **Erik Schnaderbeck, AESI**

DESCRIPTION OF MATERIALS

Important Note: The beginning and ending depths of the individual soil layers are approximate.

{0.0' - 1.0'}: Topsoil
Medium stiff; black to dark brown; organic clayey SILT w/ small roots; moist.

{1.0' - 16.0'}: Silt/Clay
Soft to medium stiff to stiff; light brown/tan to brown; sandy SILT to sandy CLAY; moist to very moist.

Notes:
- Smooth and easy drill action entire depth.
- No apparent intermixed gravels (no grinding).
- Most of soil profile is soft to med. stiff.
- Only marginally stiffer at 12.0' and below.
- Some areas are soft w/ blow counts of 2 to 4.
- Some areas are med. stiff w/ blow counts of 4 to 8.
- Some areas are stiff w/ blow counts of 8 to 15.
- Most soils are generally very moist (>20%).
- Conducted atterberg limit testing on BH-4 soils.
- Based on testing, the soil classifies as a sandy fat clay (CH), but is very close to being a sandy lean clay (CL).
- Blow counts did not increase in lower silt/clay like in other boreholes. Possibly not as much scattered gravels in this transitional zone area. Biggest difference is likely higher groundwater.
- Unsuitable foundation bearing material.

(Perched) groundwater at 12.4'

{16.0' - 25.5'}: Sandy Gravel
Dense to very dense; brown; sandy GRAVEL w/ abundant gravels & cobbles; moist to wet.

Notes:
- Start of significant grinding at 16.0'. Slow drill.
- Pretty "clean" sandy gravel.
- No noticeable silt/clay seams in SSS samples.
- "Target" foundation bearing at 16.0' and below.

(Next Day) groundwater at 19.0'

{25.5' - 30.5'}: Very Weathered Bedrock
Very stiff to hard; light brown/tan; sandy SILT to sandy CLAY w/ some sandy areas and occasional bedrock rock chips; moist to very moist.

Notes:
- Smooth drill action at 25.5'.
- Start of Tertiary bedrock strata (mostly soil).
- Suitable foundation bearing material.

Bottom of borehole @ 30.5'

SAMPLE ID	N (UNCORR) BLOWS/1.0 FOOT	SAMPLER PENETRATION	MOISTURE CONTENT	OTHER FIELD OR SAMPLE INFORMATION
S4-A @ 0.0' (SSS)	6	18"	31.9%	Start Depth of Sampler: 0.0' End Depth of Sampler: 1.5' Blow Counts: 2 / 3 / 3
S4-B @ 2.0' (SSS)	3	18"	27.2%	Start Depth of Sampler: 2.0' End Depth of Sampler: 3.5' Blow Counts: 1 / 1 / 2
S4-C @ 4.0' (SSS)	4	18"	25.6%	Start Depth of Sampler: 4.0' End Depth of Sampler: 5.5' Blow Counts: 1 / 1 / 3
S4-D @ 7.0' (SSS)	3	18"	35.0%	Start Depth of Sampler: 7.0' End Depth of Sampler: 8.5' Blow Counts: 1 / 2 / 1
S4-E @ 9.0' (SSS)	6	18"	30.7%	Start Depth of Sampler: 9.0' End Depth of Sampler: 10.5' Blow Counts: 1 / 2 / 4
S4-F @ 12.0' (SSS)	13	18"	24.2%	Start Depth of Sampler: 12.0' End Depth of Sampler: 13.5' Blow Counts: 4 / 5 / 8
S4-G @ 14.0' (SSS)	13	18"	21.6%	Start Depth of Sampler: 14.0' End Depth of Sampler: 15.5' Blow Counts: 3 / 7 / 6
S4-H @ 17.0' (SSS)	57	18"	Wet	Start Depth of Sampler: 17.0' End Depth of Sampler: 18.5' Blow Counts: 20 / 26 / 31
S4-I @ 19.0' (SSS)	50/3"	9"	Wet	Start Depth of Sampler: 19.0' End Depth of Sampler: 19.8' Blow Counts: 36 / 50 for 3"
S4-J @ 22.0' (SSS*)	50/2"	8"	Wet	Start Depth of Sampler: 22.0' End Depth of Sampler: 22.7' Blow Counts: 44 / 50 for 2"
S4-K @ 24.0' (SSS)	55	18"	Wet	Start Depth of Sampler: 24.0' End Depth of Sampler: 25.5' Blow Counts: 17 / 31 / 24
S4-L @ 27.0' (SSS)	23	18"	35.6%	Start Depth of Sampler: 27.0' End Depth of Sampler: 28.5' Blow Counts: 5 / 9 / 14
S4-M @ 29.0' (SSS)	37	18"	37.3%	Start Depth of Sampler: 29.0' End Depth of Sampler: 30.5' Blow Counts: 9 / 16 / 21

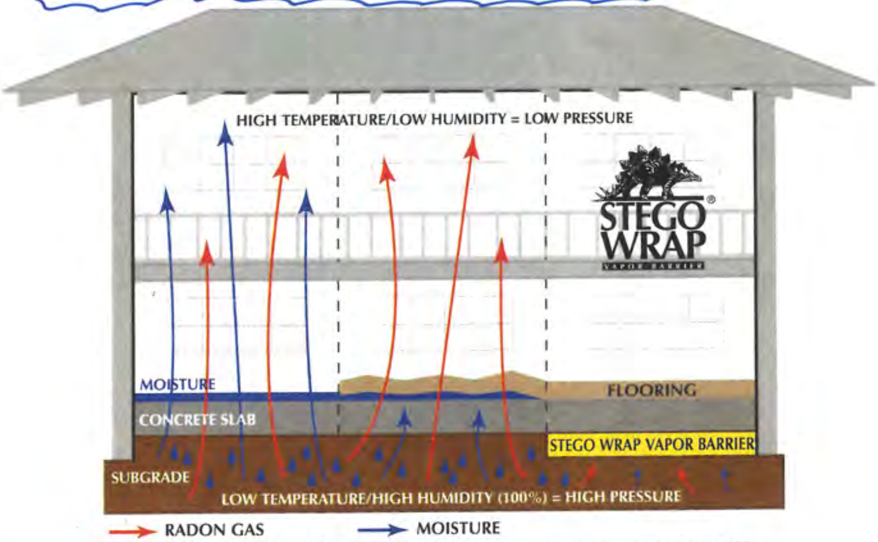
Reviewed By: LSE, 8/30/18

STEGO® INDUSTRIES, LLC

STEGO® VAPOR BARRIER

ASTM E 1745 Class A-B-C Compliant

Note: 15-mil Vapor Barrier



Regardless of the location of the water table, humidity below concrete slabs approximates 100%. Typical below slab vapor pressure is more than twice that of building interiors at room temperature, creating vapor drive from the substrate, up through the slab, and into the building.

STEGO® WRAP VAPOR BARRIER

represents a recent breakthrough in state-of-the-art plastic extrusion processes. By combining multi-layer extrusion technology with our proven trade secret blend of prime virgin resins and additives, we at Stego Industries have produced an ASTM E 1745 Class A polyolefin **VAPOR BARRIER**. Stego's emphasis has always been very low permeance (the most important quality according to industry experts). Our latest blend continues to provide next to zero permeance, while exceeding ASTM E 1745 Class A requirements for puncture resistance and tensile strength. All this comes with the same competitive pricing our customers have come to expect.

FEATURES & BENEFITS

Unsurpassed Permeance Characteristics

Life of the Building Protection

Exceptional Tear and Puncture Resistance

Easy, Reliable Installation

Competitively Priced

THE STEGO® ADVANTAGES

SUPERIOR DEFENSE Against Floor Failures:

Experts say "the need for a vapor barrier (as opposed to a vapor retarder) is becoming increasingly clear." Concrete Construction Magazine, August 2003, p.18.

Infiltration of moisture through concrete slabs is a major building defect liability. Stego Wrap Vapor Barrier has an extremely low water vapor transmission rate (WVTR)(0.006 grains/ft²/hour) preventing water vapor, soil gases (i.e. Radon), alkaline salts and soil sulfates from compromising the integrity of the building envelope and leading to serious problems with the concrete slab, floor coverings and indoor air quality. Stego Wrap Vapor Barrier is the best protection against these costly failures.

MOLD PREVENTION:

Mold needs three things to survive: moisture, sustained temperature (between 50° and 122° F), and a food source (dust, drywall, etc.). In any given building environment, contractors can only control one of these variables: moisture. Mold spores are present in 100% of building interiors. If moisture is allowed into your building environment, mold can and will grow. Toxic molds like Stachybotyrus can be fatal for nearly 5% of people (Institute of Medicine 1993), and cause a variety of serious health problems in others. Several recent well-publicized cases involving toxic mold have resulted in multimillion-dollar insurance settlements. Many of the nation's leading Insurance companies have severely limited or removed coverage for mold claims fearing that these claims will bankrupt their companies. Now more than ever, it is critically important that extra attention be paid to preventing the intrusion of moisture vapor from your below-slab environment. Stego Wrap Vapor Barrier offers the level of protection that many architects are now seeking and is considered to be inexpensive insurance against these costly failures.

LONGEVITY AND STRENGTH:

Stego Wrap Vapor Barrier is NOT made with recycled materials and will not disintegrate. Prime, virgin resins are the key. Molecules within Stego Wrap "interlock" to provide strength, durability and unprecedented resistance to moisture vapor and radon gas. Stego Wrap's puncture resistance is legendary. Stego Wrap will not tear, crack, flake, snag or puncture, even when 18,000 lb. laser-screed machines are driving directly across the barrier. (See the reverse side for Stego Wrap Vapor Barrier's specifications)

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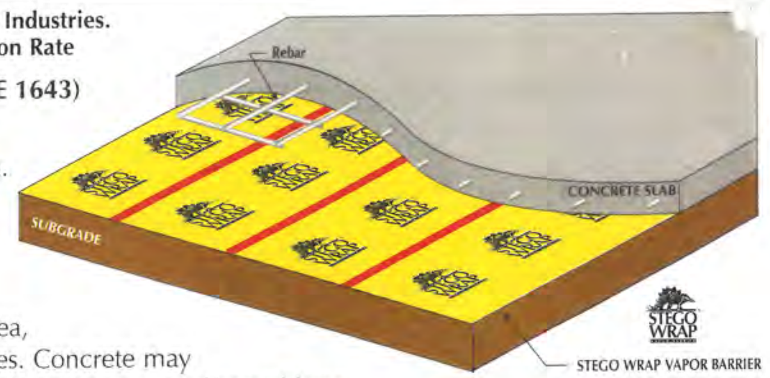
STEGO® WRAP VAPOR BARRIER SPECIFICATIONS

PROPERTIES	TEST METHOD	ASTM E 1745 Class A Requirements	TEST RESULT	EXPLANATION
Permeance	ASTM E 96	0.3 perms	0.012 perms * 0.006 WVTR	Very Impermeable to Water Vapor
Puncture Resistance	ASTM D 1709	2200 grams	Method A 2700 grams Method B 2445 grams	Resistant to puncturing from construction abuse
Tensile Strength	ASTM D 882	45.6 lbf./in.	76.6 lbf./in.	Will not tear easily
Chemical Resistance	ASTM E 154		Unaffected	Acids, alkali and fungi in soil or trace chemicals will not affect membrane
Methane Transmission Rate	ASTM D 1434		**149.6 GTR 2.12×10^{-6} perms	Greatly impedes the transmission of methane gas
Petroleum Resistance	ASTM E 154		0.013 perms	Little or no effect on permeance
Life Expectancy	ASTM E 154		Indefinite	Will not deteriorate/decompose below concrete slabs when buried
Thickness			15 mils	Stronger, tougher and less permeable than much thicker membranes
Roll Dimensions			14 ft. X 140 ft.	1,960 ft^2/roll - allows for a minimum of seams
Roll Weight			140 lbs.	Easy to unroll and install

All testing from "production" runs at labs independent of Stego Industries.
*** WVTR water vapor transmission rate **GTR = Gas Transmission Rate**



INSTALLATION INSTRUCTIONS: (Based on ASTM E 1643)

Unroll Stego Wrap over the area where the slab is to be poured. Stego Wrap should completely cover the pour area. Overlap seams 6 inches and tape using Stego Tape. All penetrations and blockouts should be sealed using a combination of Stego Wrap, Stego Tape and/or Stego Mastic. If the Stego Wrap is damaged, cut a rectangular piece from the Stego Wrap roll, place over the damaged area, and tape around all edges. Concrete may be poured directly on the barrier or a sand/gravel base can be used.

STEGO® TAPE:

STEGO WRAP POLYETHYLENE TAPE (4" x 180'/roll) is specially designed to seal seams and penetrations on Stego Wrap installations. The rubber-based, pressure-sensitive adhesive provides permanent bonding and quick-stick properties. The area to be bonded should be free of dust, dirt and moisture. If properly installed Stego Tape will provide years of continuous protection.

WARRANTY: STEGO INDUSTRIES, LLC believes, to the best of its knowledge, that specifications and recommendations herein are accurate and reliable. However, since site conditions and installations are not within our control, STEGO INDUSTRIES, LLC does not guarantee results from use of the information provided and disclaims all liability from any loss or damage. NO WARRANTY EXPRESS OR IMPLIED IS GIVEN AS TO THE MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR OTHERWISE WITH RESPECT TO THE PRODUCTS REFERRED TO.

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LIMITATIONS OF YOUR GEOTECHNICAL REPORT

GEOTECHNICAL REPORTS ARE PROJECT AND CLIENT SPECIFIC

Geotechnical investigations, analyses, and recommendations are project and client specific. Each project and each client have individual criterion for risk, purpose, and cost of evaluation that are considered in the development of scope of geotechnical investigations, analyses and recommendations. For example, slight changes to building types or use may alter the applicability of a particular foundation type, as can a particular client's aversion or acceptance of risk. Also, additional risk is often created by scope-of-service limitations imposed by the client and a report prepared for a particular client (say a construction contractor) may not be applicable or adequate for another client (say an architect, owner, or developer for example), and vice-versa. No one should apply a geotechnical report for any purpose other than that originally contemplated without first conferring with the consulting geotechnical engineer. Geotechnical reports should be made available to contractors and professionals for information on factual data only and not as a warranty of subsurface conditions, such as those interpreted in the exploration logs and discussed in the report.

GEOTECHNICAL CONDITIONS CAN CHANGE

Geotechnical conditions may be affected as a result of natural processes or human activity. Geotechnical reports are based on conditions that existed at the time of subsurface exploration. Construction operations such as cuts, fills, or drains in the vicinity of the site and natural events such as floods, earthquakes, or groundwater fluctuations may affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report.

GEOTECHNICAL ENGINEERING IS NOT AN EXACT SCIENCE

The site exploration and sampling process interprets subsurface conditions using drill action, soil sampling, resistance to excavation, and other subjective observations at discrete points on the surface and in the subsurface. The data is then interpreted by the engineer, who applies professional judgment to render an opinion about over-all subsurface conditions. Actual conditions in areas not sampled or observed may differ from those predicted in your report. Retaining your consultant to advise you during the design process, review plans and specifications, and then to observe subsurface construction operations can minimize the risks associated with the uncertainties associated with such interpretations. The conclusions described in your geotechnical report are preliminary because they must be based on the assumption that conditions revealed through selective exploration and sampling are indicative of actual conditions throughout a site. A more complete view of subsurface conditions is often revealed during earthwork; therefore, you should retain your consultant to observe earthwork to confirm conditions and/or to provide revised recommendations if necessary. Allied Engineering cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

EXPLORATIONS LOGS SHOULD NOT BE SEPARATED FROM THE REPORT

Final explorations logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final exploration logs and data are customarily included in geotechnical reports. These final logs should not be redrawn for inclusion in Architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of exploration log misinterpretation, contractors should be given ready access to the complete geotechnical report and should be advised of its limitations and purpose. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with Allied Engineering and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes.

OWNERSHIP OF RISK AND STANDARD OF CARE

Because geotechnical engineering is much less exact than other design disciplines, there is more risk associated with geotechnical parameters than with most other design issues. Given the hidden and variable character of natural soils and geologic hazards, this risk is impossible to eliminate with any amount of study and exploration. Appropriate geotechnical exploration, analysis, and recommendations can identify and lesson these risks. However, assuming an appropriate geotechnical evaluation, the remaining risk of unknown soil conditions and other geo-hazards typically belongs to the owner of a project unless specifically transferred to another party such as a contractor, insurance company, or engineer. *The geotechnical engineer's duty is to provide professional services in accordance with their stated scope and consistent with the standard of practice at the present time and in the subject geographic area. It is not to provide insurance against geo-hazards or unanticipated soil conditions.*

The conclusions and recommendations expressed in this report are opinions based our professional judgment and the project parameters as relayed by the client. The conclusions and recommendations assume that site conditions are not substantially different than those exposed by the explorations. If during construction, subsurface conditions different from those encountered in the explorations are observed or appear to be present, Allied Engineering should be advised at once such that we may review those conditions and reconsider our recommendations where necessary.

RETENTION OF SOIL SAMPLES

Allied Engineering will typically retain soil samples for one month after issuing the geotechnical report. If you would like to hold the samples for a longer period of time, you should make specific arrangements to have the samples held longer or arrange to take charge of the samples yourself.