# JOHNSON BARN
# 11810 MANASTASH ROAD
# KITTITAS COUNTY, WASHINGTON

*For:*

**BORARCHITECTURE, PLLC**
**1320 NORTH 16TH AVENUE, SUITE C**
**YAKIMA, WASHINGTON 98902**
**ATTN.: DAVE CARSON**

***Provided By:***


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*March 11, 2024*
*Project No: 24-016*

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**VIA EMAIL**

March 11, 2024

BORArchitecture, PLLC
1320 North 16th Avenue, Suite C
Yakima, Washington 98902
Attn.: Mr. Dave Carson

**RE: GEOTECHNICAL ENGINEERING STUDY; JOHNSON BARN; 11810 MANASTASH ROAD, KITTITAS COUNTY, WASHINGTON**

Dear Mr. Carson:

At your request, Baer Testing & Engineering, Inc. (BAER) conducted a Geotechnical Engineering study for the proposed barn-style residence at 11810 Manastash Road in Kittitas County, Washington. This report presents the results of the field explorations, laboratory testing, and engineering analyses.

This report presents recommendations for site grading, utility design and construction, and drainage. Recommendations for typical structure foundation design and construction, and seismic design for the various project features are also provided.

We appreciate the opportunity to be of service. If you have questions or comments, please contact our office.

Sincerely,

**BAER TESTING & ENGINEERING, INC.**

Gerry D. Bautista, Jr., P.E.
Geotechnical Engineer

Enclosures: Geotechnical Engineering Report

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## 1.0 INTRODUCTION

Baer Testing & Engineering, Inc. (BAER) is pleased to present the results of our geotechnical engineering study for the proposed barn-style residence at 11810 Manastash Road in Ellensburg, Kittitas County, Washington. This study provides a geologic hazardous area assessment, subsurface information to support site grading, drainage, utility design and construction, recommendations for foundation design and construction, and IBC seismic design criteria. Our scope of work included:

- observing 3 test pit excavations;
- collecting soil samples;
- conducting laboratory testing to determine soil properties;
- performing engineering analyses; and
- preparing this report.

## 2.0 PROJECT DESCRIPTION AND PROPOSED DEVELOPMENT

The approximately 28-acre parcel is located south of Manastash Road in the SW4 of NE4 of S16, T17N, R17E, WM in Kittitas County, Washington (**Figure 1 – Site Location**). The proposed site is in the northwestern 2-acres of the parcel. The mid-site coordinates are 46°57'53.9"N Latitude; 120°43'10.2"W Longitude.

The parcel is bordered on the north edge by Manastash Creek, with large trees present along the creek and covering much of the parcel's south half. The north third of the parcel consists mostly of pastures, with an existing residence and several outbuildings in the northwestern 2-acres. The proposed residence will be located south of the existing buildings. The *Kittitas County COMPAS Map* shows the southern two-thirds of the parcel contains slopes greater than 30 percent inclination. These steep slopes trigger the requirement by Kittitas County for a geologic hazard assessment (**Figure 2 – Geologic Hazards - Slopes**).

We understand the proposed construction consists of a split-level, barn-style residence with an approximately 70-foot by 80-foot footprint near the bottom of the steep slope (**Figure 3 – Site Layout**). We understand the structure will include a north-facing daylight basement and utilize shallow conventional foundations with a crawl space or slab-on-grade.

## 3.0 FIELD EXPLORATIONS

The exploration plan consisted of excavating three test pits designated TP-1 through TP-3 on **Figure 4 – Exploration Plan**. Belsaas & Smith (B&S) excavated the test pits on February 2, 2023, using a Takeuchi mini-excavator equipped with a 24-inch bucket.

Where possible, soil in-situ strength was estimated using a dynamic, mini-cone penetrometer (DCP) and our observations of the relative excavation difficulty. The mini cone uses a 15-pound slide hammer dropped 20 inches to drive a conical tip into the soil. The number of hammer blows required to drive the cone 1¾-inch increments is roughly equivalent to a SPT blow count. The blows per increment provide an indication of the relative soil density. The blow counts are recorded on the attached test pit logs. The mini-cone penetrometer test method is described in ASTM STP399.

Blow counts in gravel, cobbles, and boulders may lead to artificially elevated blow counts due to the CPT contacting oversized gravels. Elevated blow counts can lead to soil misclassification and over-estimating the soil properties. BAER's geologist counted the blows required to drive the rod into the ground for each 1¾-inch increment over a given depth. The recorded blow count data was evaluated using correlation charts to estimate the soil bearing capacity.

The subsurface conditions are known only at the test pit locations on the date explored and should be considered approximate. Actual subsurface conditions may vary between excavation locations. The test pit locations are presented in **Figure 4** and the test pit logs are presented in **Appendix A**. Our geologist classified the in-situ soil in the field and transported the soil samples to the laboratory for further examination and testing.

## 4.0 LABORATORY TESTING

BAER performed the following laboratory test on selected soil samples from our explorations.

- Particle Distribution (ASTM Designation: D 422 and ASTM Designation: D 1140) for material characterization and soil index properties.

Copies of the laboratory test reports are enclosed in **Appendix B**.

## 5.0 SUBSURFACE CONDITIONS

The following information summarizes the subsurface conditions encountered during the test pit explorations. Please refer to the enclosed logs (**Appendix A**) for more detailed information regarding subsurface conditions.

### 5.1 Regional Geologic Setting

The *Geologic Map of the Ellensburg Quadrangle, Washington*; Washington State Department of Natural Resources (Bentley et al., 1983), shows the site's near-surface geology is mapped as Qas – Alluvium, sidestream facies, and $Tgn_2$ – Grande Ronde Basalt, normal polarity. Qas consists of stream deposits of silt, sand, and mostly basalt gravel. $Tgn_2$ consists of Grande Ronde basalt flows, freshly gray to black, weathering red-brown to gray. In our opinion, the materials observed in the test pit excavations are consistent with this mapped geology (**Figure 5 – Near Surface Geology**).

### 5.2 Soils

Test pits typically encountered medium dense to dense, ***Poorly Graded Gravel with Silt and Sand (GP-GM)***. Test pits TP-1 and TP-2 encountered rounded gravels (alluvial), while TP-3 encountered more angular gravels (talus). The test pits extended 4.5 to 5.5 feet below the ground surface (bgs) before hitting refusal in the gravels.

### 5.3 Groundwater

Groundwater was encountered in test pits TP-1 and TP-2 at approximately 4 and 5.5 feet bgs, respectively. Groundwater levels in this area are influenced by the nearby Manastash Creek, located approximately 350 feet north, and spring/summer run-off.



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## 6.0 HAZARDOUS AREA EVALUATION

### 6.1 Slope Mitigation

Some site slopes are mapped as greater than 30 percent on the *Kittitas County COMPAS Map* (**Figure 2 – Geologic Hazards - Slopes**). To reduce the potential for slide planes developing between the native soils and structural fill in steep slopes (i.e., slopes greater than 5H:1V), we recommend constructing slopes in accordance with IBC 2018 Appendix J (**Figure 6 - IBC Benching Requirements**). In our opinion, if the development is constructed in accordance with the recommendations in this report, the slope failure potential at this site is low.

#### 6.1.1 Slope Protection

Occupational Safety and Health Administration (OSHA) Type C soil best describes the on-site gravel and silt. Type C soils may have maximum temporary construction slopes of 1.5H:1V. Permanent cut or fill slopes should be no steeper than 2H:1V and must be protected from both wind and water erosion. Erosion protection may consist of vegetative cover or a minimum 3 inches of coarse concrete aggregate conforming to the requirements of WSDOT Specification 9-03.1(4) c, "Concrete Aggregate AASHTO Grading No. 57."

### 6.2 Landslides

The near-surface geologic mapping of the area plots a large landslide area approximately 1,000 feet northwest of the site. Nearby available bedding data of the Grande Ronde basalt generally indicates dipping toward the south. The nearby mapped landslide is on a south-facing slope. Slope faces similar to the dip direction of a geologic unit will have an increased chance of slope failure along the bedding planes if the bedding plane is within a certain inclination range. The proposed structure is located on a north-facing slope and is not subject to the same conditions as the opposite-facing slope. Reviewing available LiDAR and satellite imagery of the nearby area, no visible head scarps or hummocky terrain are within the site.

### 6.3 Talus Slopes

Talus slopes are naturally occurring slopes formed by rocks fallen from outcroppings above. Slopes closest to the outcropping are primarily composed of angular rocks, filling in with finer material as the slope extends horizontally. The proposed residence is located on a talus slope approximately 200 feet north of a basalt outcropping. The primary hazards for a structure built on a talus slope are rockfall and soil creep.

#### 6.3.1 Rockfall

Rockfalls from exposed outcroppings have a myriad of factors that can influence the speed and distribution the rock, and the condition of the slope. These factors may include drop height, rock size, and rock shape. Determining the probability or extent of rockfall hazards for this site is not within the scope of this report.

Potential mitigation methods for rockfall hazards could include extending the upslope concrete foundation stem walls above the ground level to provide a catchment to intercept falling rocks. If the catchment is constructed, periodic maintenance will be required to remove fallen rocks and soil. Catchment wall freeboard must be maintained to provide protection from additional rockfalls. The structural design of the upslope foundation wall would function as a combined foundation/retaining wall that extends above the adjacent final grade to provide catchment. BAER can provide preliminary catchment wall design parameters upon request.

#### 6.3.2 Soil Creep

Soil creep consists of a gradual downslope migration of loose soils, generally occurring during freeze/thaw cycles, and with increased moisture content. Trees immediately adjacent to the proposed building did not display notable signs of soil creep. However, the absence of deformed trees does not indicate the absence of this risk.

In our professional opinion, constructing the new residence on the subject property would neither increase nor decrease the instability risk at the subject property.

The property owners should be aware that the risk of slope movement includes damage to the property, including life-safety concerns. There would not be any practical way to mitigate against a large-scale failure. These regional conditions cannot be changed. However, we believe that the risk of such large-scale failures occurring on the subject property is low.

## 7.0 CONCLUSIONS AND RECOMMENDATIONS

### 7.1 General

The site is vegetated with large trees in the steeply sloped proposed building area. To mitigate the site slopes, all ordinary or structural fill placed on slopes must be constructed in accordance with IBC Appendix J requirements as shown in **Figure 6**. The proposed building location is on a talus slope, which has potential risks of rockfall and soil creep. These are outlined in Section 6.3.

### 7.2 Earthwork

Existing vegetation and any deleterious debris should be removed from the building pads or areas to receive fill. We anticipate approximately 12 to 24 inches of topsoil will need to be removed. However, deeper root balls may be encountered and require additional effort. Stripped soil materials may be stockpiled for use in future landscape areas but may not be used as structural fill.

#### 7.2.1 Test Pit Backfill

B&S used the excavator to backfill each test pit with excavated materials upon completion. The operator compacted the backfill using the excavator bucket. The test pits within building areas should be over-excavated and backfilled with compacted structural fill during site grading in accordance with Section "7.2.4 Placement and Compaction" below.

#### 7.2.2 Fill Subgrade Preparation

Areas to receive fill and the building pad area should be moisture conditioned to within 2 percent of optimum in the upper 12 inches and compacted to a minimum 92 percent of the maximum laboratory dry density as determined by the ASTM Designation: D 1557 – *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.* The subgrade may be proof rolled using a loaded water truck or dump truck to identify loose or unstable areas. The geotechnical engineer should observe the subgrade proof-rolling to assist in determining loose soils.

#### 7.2.3 Material Reuse

The native gravel soils may be used as general fill, backfill, and structural fill, once organics and rocks larger than 3 inches are removed. If off-site materials are required, we recommend using a well-graded, 2-inch minus, pit-run sand and gravel with less than 5 percent fines. All structural fill and backfill should be placed in accordance with Section "7.2.4 Placement and Compaction".

#### 7.2.4 Placement and Compaction

Fill and backfill should be moisture conditioned to within 2 percent of optimum, placed in maximum 8-inch loose lifts, and compacted to a minimum 95 percent of ASTM D 1557. Structural fill under footings should consist of 5/8-inch minus crushed surfacing top course (CSTC). Structural fill should be compacted to 95 percent of ASTM D 1557.

#### 7.2.5 Utility Trenching

Utility trenching should be accomplished in accordance with American Public Works Association (APWA) Standard Specifications. Based on our explorations, we anticipate excavations may be accomplished using standard excavation equipment. Utility piping should be bedded as recommended in the APWA specifications. Utility trenches should be backfilled using structural fill compacted as specified in section "7.2.4 Placement and Compaction". Enough backfill should be placed over the utility before compacting with heavy compactors to prevent damage. On-site materials with gravels smaller than 3 inches may be used for utility trench backfill.

#### 7.2.6 Wet Weather Construction

The near- surface soils are typically fine-grained. The stability of the exposed soils may deteriorate due to changes in moisture content. If construction occurs during wet weather, we recommend:

- Fill materials consist of clean, granular soil with less than 5 percent fines passing the #200 sieve. Fines should be non-plastic.
- The ground surface in the construction area should be sloped to drain and sealed to reduce water infiltration and to prevent water ponding.
- Work areas and stockpiles should be covered with plastic. Geotextile silt fences, straw bales, straw wattles, and/or other measures should be used as needed to control soil erosion.

## 8.0 FOUNDATION DESIGN RECOMMENDATIONS

### 8.1 Footings

The proposed residential structure may be supported on conventional spread or continuous footings bearing on the native gravel soils. A horizontal bearing pad should be created for the footings on the talus slope, as shown in **Figure 6**. Exterior footings should be embedded a minimum 24 inches below adjacent grades for bearing considerations and frost protection.

A minimum 6 inches of CSTC should be placed below the foundations and compacted to 95 percent of ASTM D 1557. The geotechnical engineer should observe subgrade preparation prior to crushed rock placement and concrete placement.

We recommend constructing footings a minimum of 2 feet wide for spread footings and minimum 16 inches wide for continuous footings. Footings constructed with these recommendations can be designed with an allowable bearing pressure of 2,000 pounds per square foot (psf). The allowable bearing pressure may be increased by one-third for short-term transient loading conditions (i.e., seismic and/or wind loads).

We anticipate settlement will be the limiting factor for foundation design. Foundation settlement estimates are based on the soil profile and densities encountered at the site. Foundations designed as outlined above should experience less than ½-inch settlement. We anticipate differential settlement will be less than half of the total settlement between adjacent footings or across approximately 20 feet of continuous footings. Settlement should occur rapidly as loads are applied.

Lateral forces may be resisted using a combination of friction and passive earth pressure against the buried portions of the structure. For design, a 0.45 coefficient of friction may be assumed along the interface between the footing base and the compacted CSTC. Passive earth pressure from the native backfill may be calculated using an equivalent fluid weight of 320 psf per foot of embedment depth. The recommended coefficient of friction and passive earth pressure values do not include a safety factor.

### 8.2 Concrete Slabs-on-Grade

Exposed subgrade in areas to receive concrete slabs-on-grade should be moisture conditioned and compacted to a minimum 95 percent of ASTM D 1557. The geotechnical engineer should observe subgrade preparation prior to gravel placement.

After compacting the subgrade, we recommend placing a minimum 6-inch layer of 5/8-inch CSTC. The CSTC should be compacted to 95 percent of ASTM D 1557 or to a firm, unyielding condition.

### 8.3 Retaining Walls

Retaining wall foundations should be designed and constructed in accordance with the footing recommendations. All retaining walls should be designed with a minimum 12-inch-wide drainage zone directly behind the wall. The on-site soils with organics removed, may be used as backfill behind the drainage zone. The drainage zone should be separated from the backfill using a separation geotextile. Backfill should be placed in maximum 8-inch loose lifts and compacted to 95 percent of ASTM D 1557.

If retaining walls are constructed as recommended above, the values in the following table may be used for design.

**Table 8.3-1 Retaining Wall Design**

| Design Parameter | Value, pcf/ft. depth |
|---|---|
| Active Earth Pressure (unrestrained walls) | 35 |
| At-rest Earth Pressure (restrained walls) | 55 |

### 8.4 Seismic Design

Structures should be designed in accordance with the 2018 International Building Code (IBC). The Site Class is based on the average conditions present within 100 feet of the ground surface. The Site Classification is based on shear wave velocity. To establish a higher site class, additional explorations are required, including deep borings and geophysical measurements. Design values determined for the center coordinates of the site using the United States Geological Survey (USGS) *Earthquake Ground Motion Parameters* utility (ATC Hazards by Location Tool – ASCE 7-16) are summarized in Table 8.4-1 below.

**Table 8.4-1 Recommended Earthquake Ground Motion Parameters (2018 IBC)**

| Parameter | Value |
|---|---|
| Location (Latitude, Longitude), degrees | 47.964972, -120.719500 |
| Mapped Spectral Acceleration Values (MCE, Site Class D): | |
| Short Period, $S_s$ | 0.545 |
| 1.0 Sec. Period, $S_1$ | 0.218 |
| Soil Factors for Site Class D: | |
| $F_a$ | 1.364 |
| $F_v$ | N/A* |
| $S_{DS}$ | 0.496 |
| $S_{D1}$ | N/A* |
| * NOTE: N/A – No values found. A ground motion analysis is not required, pursuant to the requirements of Section 11.4-8 of ASCE 7-16. | |

### 8.4.1 Liquefaction

Soil liquefaction occurs when saturated soil deposits temporarily lose strength and behave as a liquid in response to earthquake shaking. Liquefaction typically occurs in loose, granular soils located in the upper 50 feet and below the water table. The groundwater depth is approximately 4.5 to 5.5 feet bgs for the lower two pits, and the underlying soils are dense. In our opinion, liquefaction potential at this site is low.

### 8.4.2 Fault Rupture Potential

Based on our review of available geologic literature, a partially hidden, west-east oriented thrust fault, is located approximately 2,000 feet (0.4 miles) south of the site. A strike-slip fault is also located approximately 3,500 feet (0.7 miles) southwest of the site, oriented northwest-southeast. We are not aware of any major movement along these faults in the last 10,000 years. In addition, we did not observe any noticeable evidence of surface rupture or recent faulting during our field observation. Therefore, we conclude the fault rupture potential is low at this site.

### 8.4.3 Slope Stability

As described in Section 6, a mapped landslide is located approximately 1,000 feet northwest of the site. The slide developed under different conditions those present at the project site. We did not observe any noticeable signs of slope instability during our site visit. In our opinion, if development is completed in accordance with the recommendations in this report, the potential for slope failure resulting from a seismic event impacting the proposed project site is low.

## 9.0 ADDITIONAL SERVICES

BAER is available to provide further geotechnical consultation during the project design phase. We should review the final design and specifications to verify earthwork and foundation recommendations have been properly interpreted and incorporated into the project design and construction specifications. We are also available to provide geotechnical engineering and special inspection services during construction. Observation during construction provides the geotechnical engineer the opportunity to assist in making engineering decisions if variations in subsurface conditions become apparent. If BAER is not retained to provide construction phase services, we cannot be responsible for soil related construction errors or omissions.

Construction observation and special inspection services are not part of this geotechnical engineering study scope of work. We will be pleased to provide a separate proposal for the construction phase services, if desired.

## 10.0 UNCERTAINTIES AND LIMITATIONS

This report was prepared for the exclusive use of BOR Architecture, PLLC, and the design team for the proposed barn-style residence at 11810 Manastash Road, in Ellensburg, Kittitas County, Washington. This report presents data from observations and field testing and is based on subsurface conditions at the specific locations and depths indicated. No other representation is made. This report should be made available to potential contractors for information on factual data only. Conclusions and interpretations presented in this report should not be construed as a guarantee or warranty of the subsurface conditions. If changes are made to the project components or layout, additional geotechnical data and analyses may be necessary.

Within the limitations of scope, schedule, and budget, BAER attempted to execute these services in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our services did not include environmental screening of soil samples retrieved from the explorations completed for this project. Further, we did not complete environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic materials in the soil, rock, surface water, or air in the project area.

We appreciate the opportunity to be of service. If you have questions or comments, please contact our office.

Sincerely,
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