GEOTECH
CONSULTANTS, INC.

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June 5, 2023

JN 23150

Gregerson Custom Homes
21627 N.E. 133rd Street
Woodinville, Washington 98077

Attention: Chris Gregerson
*via email: chrisg@gregersoncustomhomes.com*

Subject: **Assessment of Recently-Constructed Modular Block Walls**
Cui Residence
8636 North Mercer Way
Mercer Island, Washington

Greetings:

This geotechnical report presents our observations and conclusions related to the terraced modular blocks walls recently constructed to the south of the existing Cui residence. The undersigned principal engineer visited the site on two different occasions to observe the as-constructed configuration of the walls, and to conduct explorations to assess the soil conditions behind and beneath the walls.

The terraced configuration generally consists of a lower and middle wall that each have a maximum exposed height of 4 feet. These modular block walls are separated by a distance of 3 to 4 feet. In front of the lower wall is a paver patio. Set back behind the middle wall is a short (2-foot) modular block wall, with a paver patio behind this short upper wall.

None of the modular walls was reinforced with geogrids. We assessed the soil conditions and found that the modular walls had been backfilled with a 6-inch width of pea gravel, behind which the backfill consisted of imported topsoil or the on-site silt soils. The soil placed behind the walls was loose. Explorations verified that the base of both the lower and middle walls had been placed on stiff native silt, which is the typical soil condition for the site vicinity. No groundwater seepage was observed in the test holes. However, the backfill soils had an elevated moisture content.

## ***CONCLUSIONS AND RECOMMENDATIONS***

### *GENERAL*

Based on the test holes, the lower and middle modular block walls were constructed on competent native soils. The ground surface around the walls does not slope steeply, and the walls themselves are laterally restrained by the foundations of the existing Cui residence.

Unfortunately, the soils that were used to backfill the modular walls have low compacted strengths and poor drainage characteristics. This, combined with the lack of geogrid reinforcement, makes the long-term stability of the walls questionable. The modular blocks are not sufficiently strong to resist the lateral soil loads that will result from silty, poorly-drained backfill soils.

We have discussed different alternatives for providing long-term stability for the modular block walls. Removal and replacement of the walls with properly engineered and constructed modular walls appears feasible and most appropriate. We have completed a design for such a system, which would involve the removal of the existing walls and poor backfill, followed by reconstruction using the existing modular blocks combined with imported granular backfill and geogrid reinforcement. These reinforced walls will support lateral loads from potential earthquakes, as well as the surcharge caused by both the middle and upper walls.

Attached to this letter is a typical detail for the lower and middle reinforced walls. The short, upper wall does not require geogrid reinforcement.

The existing soil that is removed to construct the new walls should be hauled away from the site.

Reconstruction of the walls, including the placement of the granular backfill and geogrids, should be observed by the geotechnical engineer of record.

We recommend including this report, in its entirety, in the project contract documents. This report should also be provided to any future property owners so they will be aware of our findings and recommendations.

## ***SEISMIC CONSIDERATIONS***

In accordance with the International Building Code (IBC), the site soil profile within 100 feet of the ground surface is best represented by Soil Profile D (Stiff Soil Profile). The site soils that will support the new construction are not susceptible to seismic liquefaction because of their granular nature, dense condition, and absence of near-surface groundwater. This liquefaction assessment is based on the Maximum Considered Earthquake (MCE), which has a return period of once in 2,475 years. According to the USGS, the factored MCE peak ground acceleration is 0.655g.

## ***LIMITATIONS***

The conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our site visit. If the subsurface conditions encountered during construction are significantly different from those anticipated, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unanticipated soil conditions are commonly encountered on construction sites. Such unexpected conditions frequently require making additional expenditures to attain a properly constructed project.

This report has been prepared for the exclusive use of Gregerson Custom Homes, and their representatives, for specific application to this project and site. Our recommendations and conclusions are based on the site materials observed and on previous experience with sites that have similar observed conditions. The conclusions and recommendations are professional opinions derived in accordance with current standards of practice within the limited scope of our services. No warranty is expressed or implied.

Please contact us if you have any questions regarding this report, or if we can be of further service.

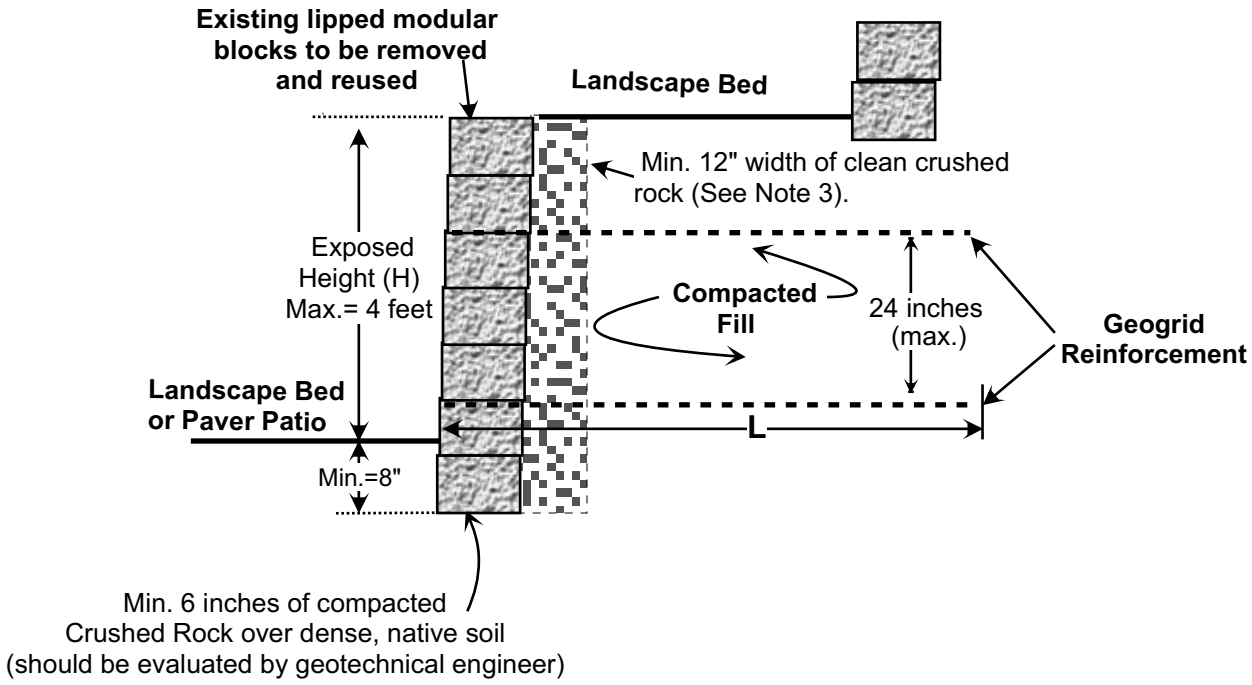
Respectfully submitted,

GEOTECH CONSULTANTS, INC.


6/5/2023
Marc R. McGinnis, P.E.
Principal

Attachments:
- Modular Block Wall Detail
- Wall Calculations

MRM:kg




**Notes:**

1. This design for a typical retaining wall condition, and is not intended to support surcharges, such as those from vehicles or structures.

2. Geogrid reinforcement shall be Stratagrid 150, Miragrid 3XT, or equivalent, with a maximum separation of 24 inches between geogrid layers. Based on a 3- to 4-foot exposed height, geogrid reinforcement shall extend behind the block facing a minimum distance of **L** = 6 feet. This geogrid length accounts for the need to excavate approximately 3 feet below existing grade to reach dense, stable soil suitable for bearing.

3. A minimum of 12 inches of washed crushed rock shall be placed between the facing blocks and the Compacted Fill. If a 4-inch diameter perforated drain pipe is buried at the wall base, the perforated drain should connect to a suitable discharge point.

4. Compacted fill shall be free-draining, imported, coarse-grained granular soil, such as Seattle Type 17. A sample of which shall be submitted to the Geotechnical Engineer for approval prior to its use. The on-site soil is unacceptable for use ias Compacted Fill n the geogrid-reinforced zone. The fill shall be compacted in a maximum of 10-inch lifts using a jumping jack..

5. Exposed slopes should be vegetated or hydroseeded following completion to reduce the potential for erosion.


6/5/2023

**GEOTECH**
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# GEOGRID-REINFORCED WALL

8636 North Mercer Way
Mercer Island, Washington

| *Job No:* | *Date:* | | *Plate:* |
|---|---|---|---|
| 23150 | June 2023 | | 1 |

| | | | | | |
|---|---|---|---|---|---|
| Client | Gregerson Custom Homes | | | | |
| Name | Cui Landscape Walls | | | Number | 23150 |
| Site | 8636 North Mercer Way | | | Designer | M McGinnis |
| Revision | 1 | Created | 6/4/2023 | Modified | 6/5/2023 |
| Standard | Rankine Theory Analysis | | | | |

Comments

Lower and Middle Walls Support Surcharge from Wall Above

Note †: Total Facing quantity is based on using full-sized units only on bottom course and an even mix of defined facing sizes, as identified elsewhere in this report, on remaining courses of each Section. The use of corners, tapered or cut units is not reflected in this quantity.

Note ‡: Infill values are calculated based on the average geogrid length in each Section. They do not account for anything beyond the reinforced zone (end of the geogrids). Actual infill values may be significantly higher.

Note Δ: Face drain values do not include the drainage stone within block. Drainage stone within block is calculated based on the percentage hollow core of the wall unit selected. If the percentage hollow core is not defined then the drainage stone within block will not be calculated.

Note ll: Cap area assumes double caps at steps as illustrated in wall elevation when half height caps are utilized. Other capping systems may may result in different quantities

Note: The Toe Slope input is only used to establish the basic embedment depth based on the Design Criteria settings and provide a graphical representation of the toe conditions for export. The Toe Slope input does not account for reduced bearing capacity due to the sloping toe condition or the geometrical considerations of bench construction on embedment and wall height. User must perform separate analysis for bearing and stability on slopes and properly interpret grading for bench construction effects on wall height.

## Quantities

| Wall | Facing | Wall/Cap Length [ft] | Facing Area [ft²] | Cap Area [ft²] | Total Wall Area [ft²] |
|---|---|---|---|---|---|
| Reinforced 54-In | BroadStone 8 in | 2 | 14 | 1 | 15 |
| | | **2** | **14** | **1** | **15** |

| Wall Unit | Reinforced 54-Inch Wall | Wall 1 |
|---|---|---|
| BroadStone 8 in | 11 | 0 |

| Wall | Leveling Pad [yd³] | Reinforced Fill [yd³] | Drainage Fill [yd³] | Core Fill [yd³] |
|---|---|---|---|---|
| Reinforced 54-Inch Wall | 0 | 2 | 0 | 0 |
| **Totals:** | **0** | **2** | **0** | **0** |

### Reinforcements

| Wall | SG150 [yd²] |
|---|---|
| Reinforced 54-Inch Wall | 2 |
| **Totals:** | **2** |


6/5/2023

NOTE: THESE CALCULATIONS, QUANTITIES, AND LAYOUTS ARE FOR PRELIMINARY DESIGN ONLY AND SHOULD NOT BE USED FOR CONSTRUCTION WITHOUT REVIEW BY A QUALIFIED ENGINEER

# Project: 23150 - Cui Landscape Walls

**Site: 8636 North Mercer Way**

**Date: 6/5/2023**

**Section Summary Report**

| | |
|---|---|
| Section | #1 at Station 1.00 |
| Report Date | June 05, 2023 |
| Designer | M McGinnis |
| Design Standard | Rankine Theory Analysis |
| Design | Static and Seismic |
| Unit of Measure | U.S./Imperial |
| Selected Facing Unit | |
| **Product Line:** | Keystone Lip/Lug Systems |
| **Name:** | BroadStone 8 in |
| Seismic As 0.44 | Default Deflection of 2.00 inch |

Soil Parameters

| Soil Zone | Phi Angle [degrees] | Cohesion [lb/ft²] | Unit Weight [lb/ft³] | Description |
|---|---|---|---|---|
| Reinforced | 32 | n/a | 135.00 | Imported Compacted Type 17 |
| Retained | 28 | 0.00 | 120.00 | On-site Silt |
| Foundation | 32 | 100.00 | 125.00 | Native Stiff Silt |
| Leveling Pad | 40 | n/a | n/a | |
| Drainage | n/a | n/a | 0.70 | |

Section Details

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Section Height | 5.00 | Back Slope | 0.00° | LL Surcharge | 0 | DL Surcharge | 0 |
| Design Height | 4.67 ft | Crest Offset | 0.00 ft | LL Offset | 0.00 ft | DL Offset | 0.00 ft |
| Embedment | 0.17 ft | Wall Batter | 1.80° | Toe Slope | 0.00° | Toe Offset | 0.00 ft |

Minimum Factors of Safety

| Reinforced External | | Value | Internal | | Value | Facing | | Value |
|---|---|---|---|---|---|---|---|---|
| FSsl | Base Sliding | 1.50 | FSsl | Internal Sliding | 1.50 | FScs | Connection Strength | 1.50 |
| FSbc | Bearing Capacity | 2.00 | FSpo | Pullout | 1.50 | FSsc | Facing Shear | 1.50 |
| FSct | Crest Toppling | 1.50 | FSto | Tensile Overstress | 1.50 | | | |
| FSot | Overturning | 2.00 | | | | | | |

Seismic

| Reinforced External | | Value | Internal | | Value | Facing | | Value |
|---|---|---|---|---|---|---|---|---|
| FSsl | Base Sliding | 1.10 | FSsl | Internal Sliding | 1.10 | FScs | Connection Strength | 1.10 |
| FSbc | Bearing Capacity | 1.50 | FSpo | Pullout | 1.10 | FSsc | Facing Shear | 1.10 |
| FSct | Crest Toppling | 1.10 | FSto | Tensile Overstress | 1.10 | | | |
| FSot | Overturning | 1.50 | | | | | | |

Reinforcements

**SG150 - StrataGrid 150** **Supplier: Strata Systems - Stratagrid, Fill Type:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Tult | 1,875.00 lb/ft | RFcr | 1.65 | RFd | 1.10 | LTDS | 939.14 lb/ft |
| RFid | 1.10 | Cds | 0.70 | Ci | 0.70 | | |

**Connection/Shear Properties**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| αcs1 | 1,140.00 lb/ft | IP-1 | 1,800.00 lb/ft | αcs2 | 1,457.39 lb/ft | IP-2 | 6,000.00 lb/ft |
| αcs max | 1,457.39 lb/ft | au | 520.00 lb/ft | λu | 37.00 lb/ft | Vu(max) | 2,781.00 lb/ft |

Analysis Results

*** Embedment is included in Bearing Capacity**

| External Static | FS | | | |
|---|---|---|---|---|
| Bearing Capacity | 15.53 | Bearing Pressure | 690.84 | lb/ft² |
| Overturning | 7.12 | Max Eccentricity | 0.23 | ft |
| Base Sliding | 3.36 | | | |
| Crest Toppling | 6.55 | | | |
| Internal Sliding | 6.08 | | | |

| External Seismic | FS | | | |
|---|---|---|---|---|
| Bearing Capacity | 11.75 | Bearing Pressure | 912.73 | lb/ft² |
| Overturning | 2.86 | Max Eccentricity | 0.66 | ft |
| Base Sliding | 1.74 | | | |
| Crest Toppling | 3.37 | | | |
| Internal Sliding | 2.88 | | | |

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| Internal Static Layer | Elevation | Rein | Length | Load | Tensile Resist. | Tensile FS | Pullout Resist. | Pullout FS | Conn. Resist. | Conn. FS |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.17 | SG150 | 6.00 | 109 | 939 | 8.65 | 513 | 4.73 | 1,168 | 10.76 |
| 1 | 1.17 | SG150 | 4.00 | 326 | 939 | 2.88 | 907 | 2.78 | 1,211 | 3.72 |

| Internal Seismic Layer | Elevation | Rein | Length | Load | Tensile Resist. | Tensile FS | Pullout Resist. | Pullout FS | Conn. Resist. | Conn. FS |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.17 | SG150 | 6.00 | 458 | 1,550 | 3.38 | 513 | 1.12 | 1,168 | 2.55 |
| 1 | 1.17 | SG150 | 4.00 | 573 | 1,550 | 2.71 | 907 | 1.58 | 1,211 | 2.11 |

# Project: 23150 - Cui Landscape Walls

**Site: 8636 North Mercer Way**

**Date: 6/5/2023**

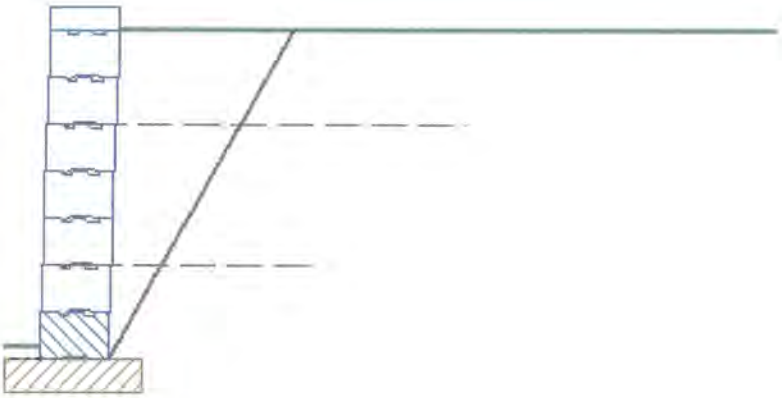
**Wall: Reinforced 54-Inch Wall**

# Project Summary

Note: The Toe Slope input is only used to establish the basic embedment depth based on the Design Criteria settings and provide a graphical representation of the toe conditions for export. The Toe Slope input does not account for reduced bearing capacity due to the sloping toe condition or the geometrical considerations of bench construction on embedment and wall height. User must perform separate analysis for bearing and stability on slopes and properly interpret grading for bench construction effects on wall height.

## Tallest Section

Section Height 5.00 ft



# Project Design Inputs

## Selected Reinforcement Types

### Reinforcements

**SG150 - StrataGrid 150** **Supplier: Strata Systems - Stratagrid, Fill Type:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Tult | 1,875.00 lb/ft | RFcr | 1.65 | RFd | 1.10 | LTDS | 939.14 lb/ft |
| RFid | 1.10 | Cds | 0.70 | Ci | 0.70 | | |

**Connection/Shear Properties**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| αcs1 | 1,140.00 lb/ft | IP-1 | 1,800.00 lb/ft | αcs2 | 1,457.39 lb/ft | IP-2 | 6,000.00 lb/ft |
| αcs max | 1,457.39 lb/ft | au | 520.00 lb/ft | λu | 37.00 lb/ft | Vu(max) | 2,781.00 lb/ft |

## Selected Soil Types

| Soil Zone | Phi Angle [degrees] | Cohesion [lb/ft²] | Unit Weight [lb/ft³] | Description |
|---|---|---|---|---|
| Reinforced | 32 | n/a | 135.00 | Imported Compacted Type 17 |
| Retained | 28 | 0.00 | 120.00 | On-site Silt |
| Foundation | 32 | 100.00 | 125.00 | Native Stiff Silt |
| Leveling Pad | 40 | n/a | n/a | |
| Drainage | n/a | n/a | 0.70 | |

## Soil Glossary

| | |
|---|---|
| **CH:** | Inorganic clays, high plasticity |
| **CL:** | Inorganic clays, low to medium plasticity, gravelly, sandy, silty, lean clays |
| **GC:** | Clayey gravels, poorly graded gravel-sand-clay mixtures |
| **GM:** | Silty gravels, poorly graded gravel-sand-silt mixtures |
| **GP:** | 1/2"-3/4" clean crushed stone or crushed gravel |
| **GW:** | Well-graded gravels, gravel-sand. Little or no fines. |
| **MH:** | Inorganic clayey silts, elastic silts |
| **ML:** | Inorganic silts, very fine sands, silty or clayey, slight plasticty |
| **SC:** | Clayey sands, poorly graded sand-clay mixtures |
| **SM:** | Silty sands, poorly graded sand-silt mixtures |
| **SP:** | Poorly-graded sands, gravelly sands. Little or no fines. |
| **SW:** | Well-graded sands, gravelly sands. Little or no fines. |

# Analysis Summary

## Lowest Values - Reinforced

### Static Analysis

| Test | Description | Section | Layer/ Course | Minimum Requirement | Result | Status |
|---|---|---|---|---|---|---|
| FSsl | Base Sliding | 1 | | 1.50 | 3.36 | Pass |
| FSbc | Bearing Capacity | 1 | | 2.00 | 15.53 | Pass |
| FSct | Crest Toppling | 1 | 5 | 1.50 | 6.55 | Pass |
| FSot | Overturning | 1 | | 2.00 | 7.12 | Pass |
| FSsl | Internal Sliding | 1 | 1 | 1.50 | 6.08 | Pass |
| FSpo | Pullout | 1 | 1 | 1.50 | 2.78 | Pass |
| FSto | Tensile Overstress | 1 | 1 | 1.50 | 2.88 | Pass |
| FScs | Connection Strength | 1 | 1 | 1.50 | 3.72 | Pass |
| Rs | Max. Reinforcement Separation | 1 | | 0.0000 | 2.0000 | Pass |
| RsBottom | Max. multiple of Hu at bottom | 1 | | 0.0000 | 2.0000 | Pass |
| RsTop | Max. multiple of Hu at top | 1 | | 0.0000 | 2.0000 | Pass |
| La | Min. Anchorage Length | 1 | | 1.0000 | 2.3028 | Pass |
| L/H Ratio | Min. L/H Ratio | 1 | | 0.7000 | 0.8571 | Pass |
| L | Min. Reinforcement Length | 1 | | 4.0000 | 4.0000 | Pass |

### Seismic Analysis

| Test | Description | Section | Layer/ Course | Minimum Requirement | Result | Status |
|---|---|---|---|---|---|---|
| FSsl | Base Sliding | 1 | | 1.10 | 1.74 | Pass |
| FSbc | Bearing Capacity | 1 | | 1.50 | 11.75 | Pass |
| FSct | Crest Toppling | 1 | 5 | 1.10 | 3.37 | Pass |
| FSot | Overturning | 1 | | 1.50 | 2.86 | Pass |
| FSsl | Internal Sliding | 1 | 1 | 1.10 | 2.88 | Pass |
| FSpo | Pullout | 1 | 2 | 1.10 | 1.12 | Pass |
| FSto | Tensile Overstress | 1 | 1 | 1.10 | 2.71 | Pass |
| FScs | Connection Strength | 1 | 1 | 1.10 | 2.11 | Pass |

## Below Standard Values

| Test | Description | Section | Layer/ Course | Minimum Requirement | Result |
|---|---|---|---|---|---|
| Hemb | Minimum Embedment % | 1 | | 10.0000 | 3.2000 |
| MinHemb | Minimum Embedment | 1 | | 12.0000 | 1.8031 |