Chinook GeoServices Inc.

July 10, 2007

Steve and Sara Mattheisen
10151 Southwest Lancaster Road
Portland, Oregon 97219

Subject: Allan Block Retaining Wall Design and Construction Recommendations
10151 Southwest Lancaster Road
Portland, Oregon
CGI Report No. 07-134-1

Dear Mr. and Mrs. Mattheisen:

As you requested, Chinook GeoServices, Inc. (CGI) has conducted engineering analysis for the proposed Allan Block walls on your property at 10151 Southwest Lancaster Road in Portland, Oregon. Our services were authorized by you on July 3, 2007 by you signing and returning our Professional Services Agreement. Enclosed are our design and construction recommendations for the mechanically stabilized earth (MSE) engineered retaining walls. We understand the design will be reviewed and permitted for construction by the City of Portland Bureau of Development Services.

Our understanding of the project is based on our discussions with you, review of the project Geotechnical Engineering Report by GeoPacific Engineering, Inc. dated September 5, 2006, a brief site visit, and review of rough cross sections provided by you. Figure 1 shows the site grading plan and approximate locations of the proposed walls. Figure 2 shows a front view of the proposed walls. Figure 3 shows a critical cross section of the proposed walls. The front view and cross sections were provided by you. Two Allan Block retaining walls are planned on the site between the proposed new home and the driveway for the existing home. The walls will be tiered and will reach a maximum height of about 8 feet per individual wall and a combined vertical height of about 12 feet. According to the information provided, the upper wall will be located behind the geogrid reinforced zone of the lower wall. Portions of the upper wall may be subject to a traffic surcharge. Grades above and below the proposed walls will be gently sloping.

According to the project Geotechnical Engineering Report and our observations on the site, undocumented fill is present in the area of the proposed retaining walls. However, based on the cross sections generated for the site, it appears that nearly all of the undocumented fill will be removed during site grading and excavation for geogrid reinforced zone. Therefore, we anticipate the proposed walls will retain predominantly native, very stiff to hard residual soil derived from in situ weathering of Columbia River Basalt.

1508 Broadway Street • Vancouver, Washington 98663 • Phone 360-695-8500 • Fax 360-695-8510

Allan Block Wall Design Parameters

The MSE Allan Block walls were designed in accordance with the National Concrete Masonry Association Design Method for Segmental Retaining Walls. Soil strength parameters used in design of the MSE retaining walls are in accordance with the soil descriptions in the project Geotechnical Engineering Report by GeoPacific Engineering, Inc. dated September 5, 2006. Design calculations for the critical wall geometry during static and seismic conditions are attached to this report.

According to the 2002 United States Geological Survey (USGS) Earthquake Hazards website http://eqint.cr.usgs.gov/eqmen/html/lookup-2002-interp-06.html, the Peak Ground Acceleration (PGA) predicted for the site is 0.411g. Design lateral earth pressures during seismic loading where determined using the pseudostatic Mononobe-Okabe method. For the design event, we took 2/3 of the MCE value, per the 2007 SOSSC. We then assumed a horizontal acceleration of 0.5 times the factored peak ground acceleration for design of the nonstructural engineered walls to account for the inherent conservatism of the pseudostatic design method. This results in the horizontal ground acceleration of 0.14g for use in design of MSE Allan Block walls.

Allan Block Wall Construction Recommendations

Retaining walls up to 6 feet in retained height should be embedded a minimum of 6 inches below finished grade. Retaining walls greater than 6 feet in retained height should be embedded a minimum of 12 inches below finished grade. Soil in front of the embedded block and subgrade soils should consist of undisturbed native soil or compacted engineered fill. As discussed above, some undocumented fill is present on the site, but should be almost completely removed during site grading. CGI should be contacted at the time of construction to review the subgrade soils prior to placement of the crushed rock leveling course. The wall should be founded on a crushed rock leveling pad a minimum of 6 inches thick.

The MSE Allan Block walls were designed using Allan Block Classic Blocks (8 inches high, 12 inches deep, and 18 inches long). The wall should be battered per the manufacturer's recommendations, which corresponds to a wall batter of 6 degrees.

A drain should be placed behind the toe of the wall as shown on the attached Allan Block Retaining Wall Construction Details, Figure 4 and Figure 5. The drain should consist of a 3-inch diameter perforated pipe embedded in a minimum of 1 square foot of drain rock, clean sand, or other approved free-draining material. The drainpipe and surrounding drain rock should be wrapped in a nonwoven filter fabric geotextile such as Mirafi 140N or equivalent. The wall drain should outlet to a storm water detention system or other approved outlet. Roof runoff from adjacent structures should not be discharged behind the wall.

Block infill and backfill should consist of ¾-inch minus crushed rock, or other granular material approved by the wall engineer. Wall backfill should be compacted to a minimum of 90 percent of Modified Proctor (ASTM 1557). Heavy equipment should not be used within 2 feet of the back of the Allan Block units. Compaction adjacent to the facing should be achieved with a plate compactor or other relatively lightweight equipment.

Geogrids should consist of Miragrid 3XT, Stratagrid 200, or approved equivalent, with a minimum ultimate tensile strength of 3,000 pounds per foot. Geogrids should be placed in accordance with the attached Wall Construction Details. The first geogrid should be placed between the second and third block and subsequent geogrids should be placed every three blocks vertically. Geogrids must be rolled out perpendicular to the wall face for correct grid orientation. The grids should be stretched taut before placement of the overlying wall backfill. Geogrid length depends on the location of the grid and height of the wall. Minimum required geogrid length is shown in Table 1. Geogrid length is measured from the face of the wall.

Table 1. Minimum Geogrid Length

	Allan Block Wall (5 degree backslope)		
Wall Height	**4 feet (6-8 blocks)**	**6 feet (9-11 blocks)**	**8 feet (12-13 blocks)**
Geogrid #4	-	-	7 ft
Geogrid #3	-	5 ft	6 ft
Geogrid #2	4 ft	4 ft	6 ft
Geogrid #1 (bottom grid)	3 ft	4 ft	6 ft

Our retaining wall stability analyses indicate the blocks located above the top geogrid will topple during a significant seismic event. This phenomenon applies to most segmental unit retaining walls in the Portland region given the design seismic loading. Some repair to the Allan Block walls should be expected following a significant earthquake. If it is desired to prevent toppling of the top blocks for safety reasons, the blocks overlying and above the top geogrid should be epoxied to the underlying blocks.

Conclusions

Our retaining wall stability analyses indicate the wall will have adequate factors of safety against bearing capacity failure, sliding, overturning, internal, and facing failure with the above noted exception during significant seismic loading, provided the wall is constructed in accordance with our recommendations and the recommendations of the wall manufacturer. CGI should observe wall construction including subgrade observations prior to placement of leveling pad, wall materials, retained soil conditions, backfill compaction, wall batter, block placement, drainage, geogrid placement, and finished grades.

Limitations

The engineering geologic and geotechnical engineering services performed for this project have been conducted with that level of care, skill, and judgment ordinarily exercised by members of the professional community currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

We will be available for further consultation and geotechnical observation of soil exposures and grading during the remaining design and construction phases of this project. If you have any questions regarding our recommendations, please call Ericka Koss at (360) 695-8500.

Sincerely,
Chinook GeoServices, Inc.

CERTIFIED OREGON ERICKA J. KOSS E2016 ENGINEERING GEOLOGIST

Exp 11-30-07

REGISTERED PROFESSIONAL ENGINEER 16,590 OREGON JULY 20, 1993 MARCELLA M. BOYER

7/10/07

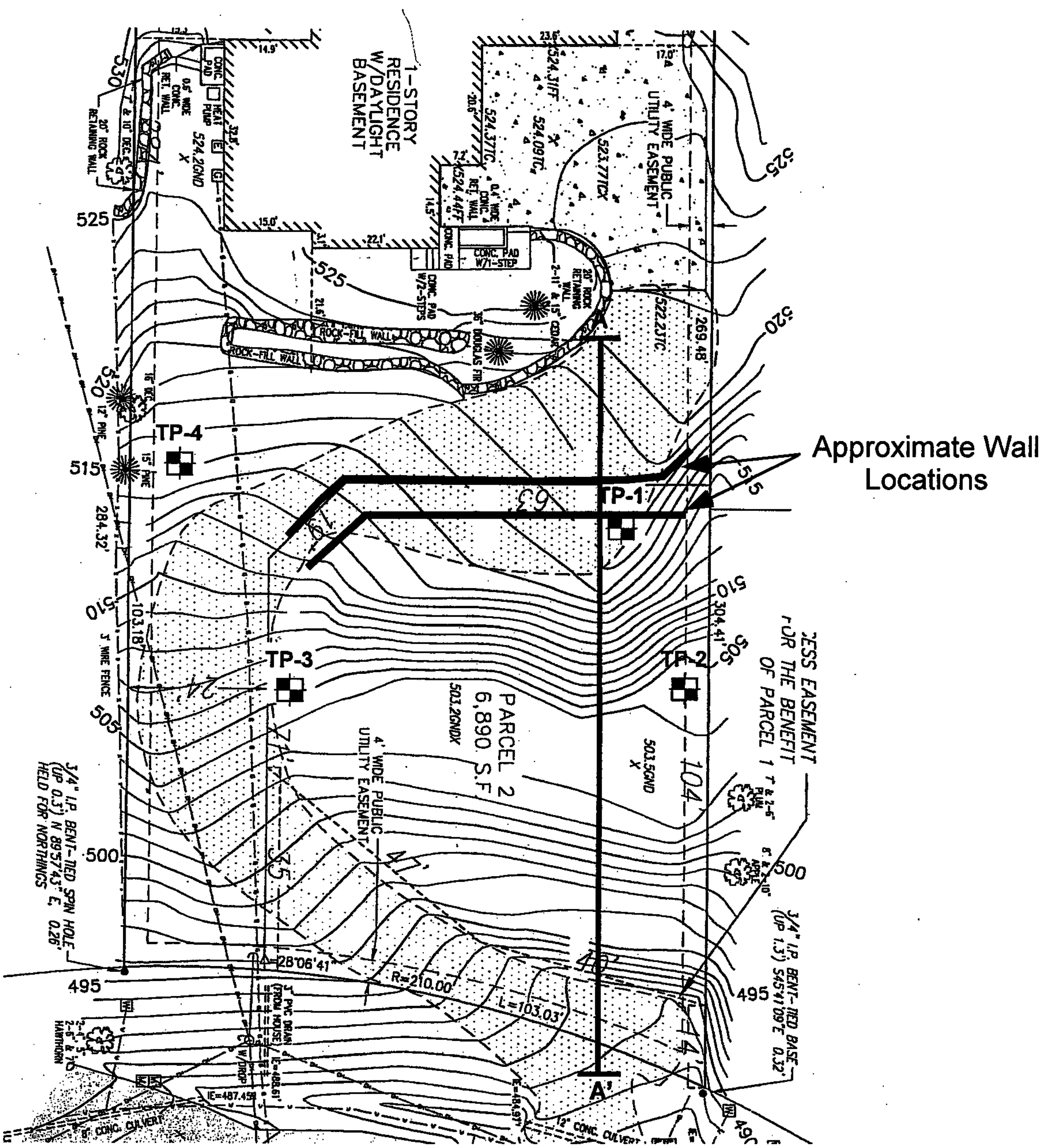
EXPIRES 12/31/07

Ericka J. Koss, R.G., C.E.G.
Project Engineering Geologist

Marcella M. Boyer, P.E., G.E.
Principal Geotechnical Engineer

Attachments: Figure 1: Site Plan and Approximate Wall Locations
Figure 2: Front View of Proposed Walls
Figure 3: Rough Cross Section of Proposed Walls
Figure 4: Allan Block Retaining Wall Construction Detail – 8 Feet
Figure 5: Allan Block Retaining Wall Construction Detail – 8 Feet
Retaining Wall Design Calculations – 8 Feet – Static
Retaining Wall Design Calculations – 8 Feet – Seismic

Figure 1. Site Plan and Approximate Wall Locations

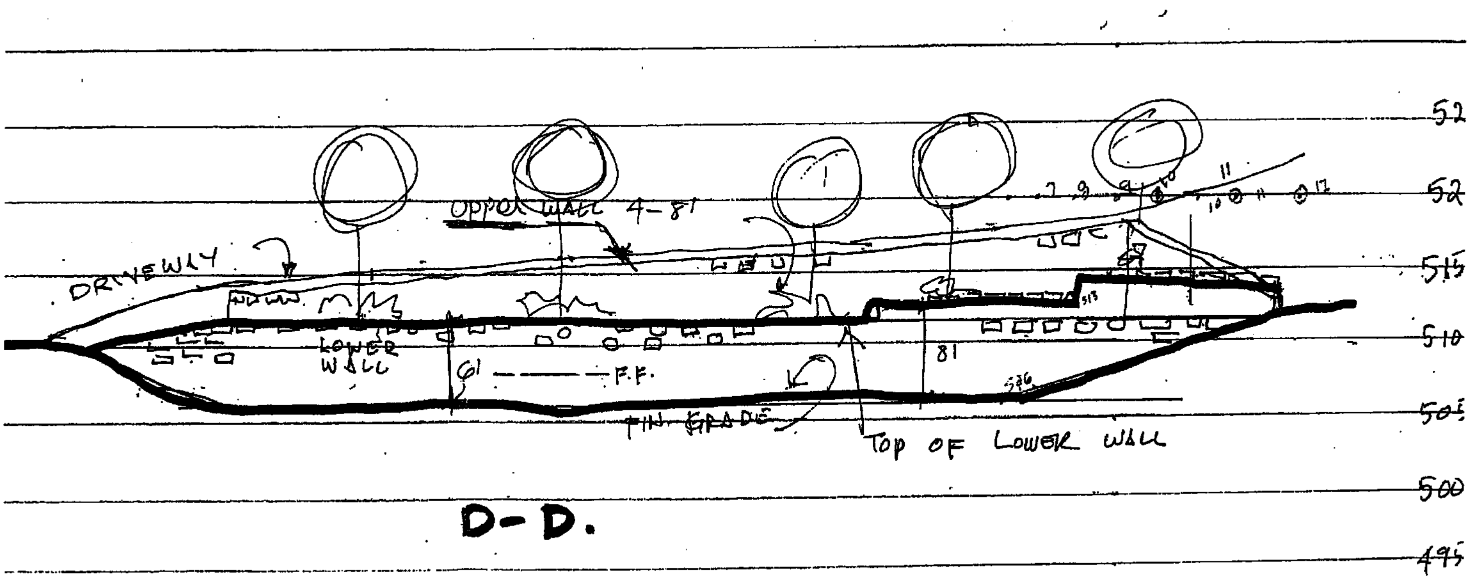


Source: GeoPacific Engineering, Inc.

Scale: 1" = 30 Feet

Chinook GeoServices Inc.	Mattheisen Residence Allan Block Retaining Wall 10151 Southwest Lancaster Road Portland, Oregon	Report No. 07-134-1 Date: July 10, 2007

Figure 2. Front View of Proposed Walls



Source: Client

Scale: NTS

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Allan Block Retaining Wall
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Date:
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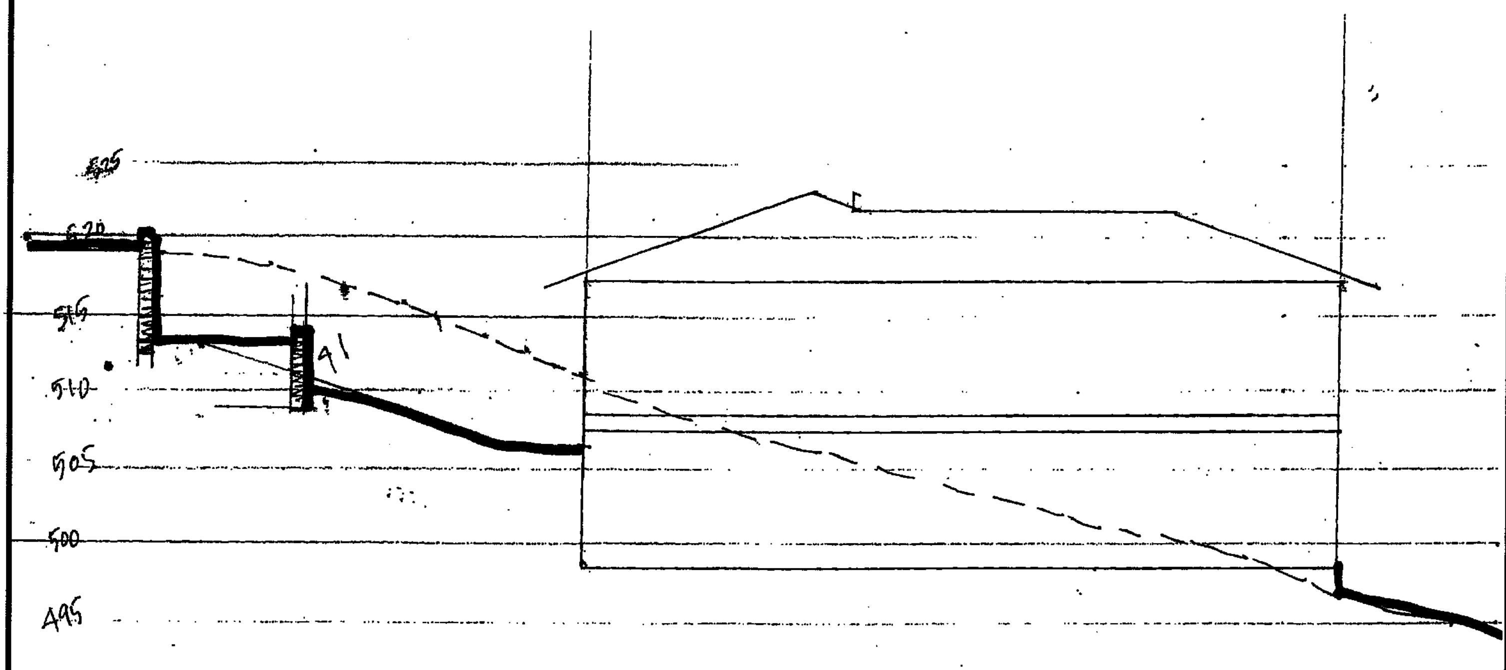
Figure 3. Rough Cross Section of Proposed Walls

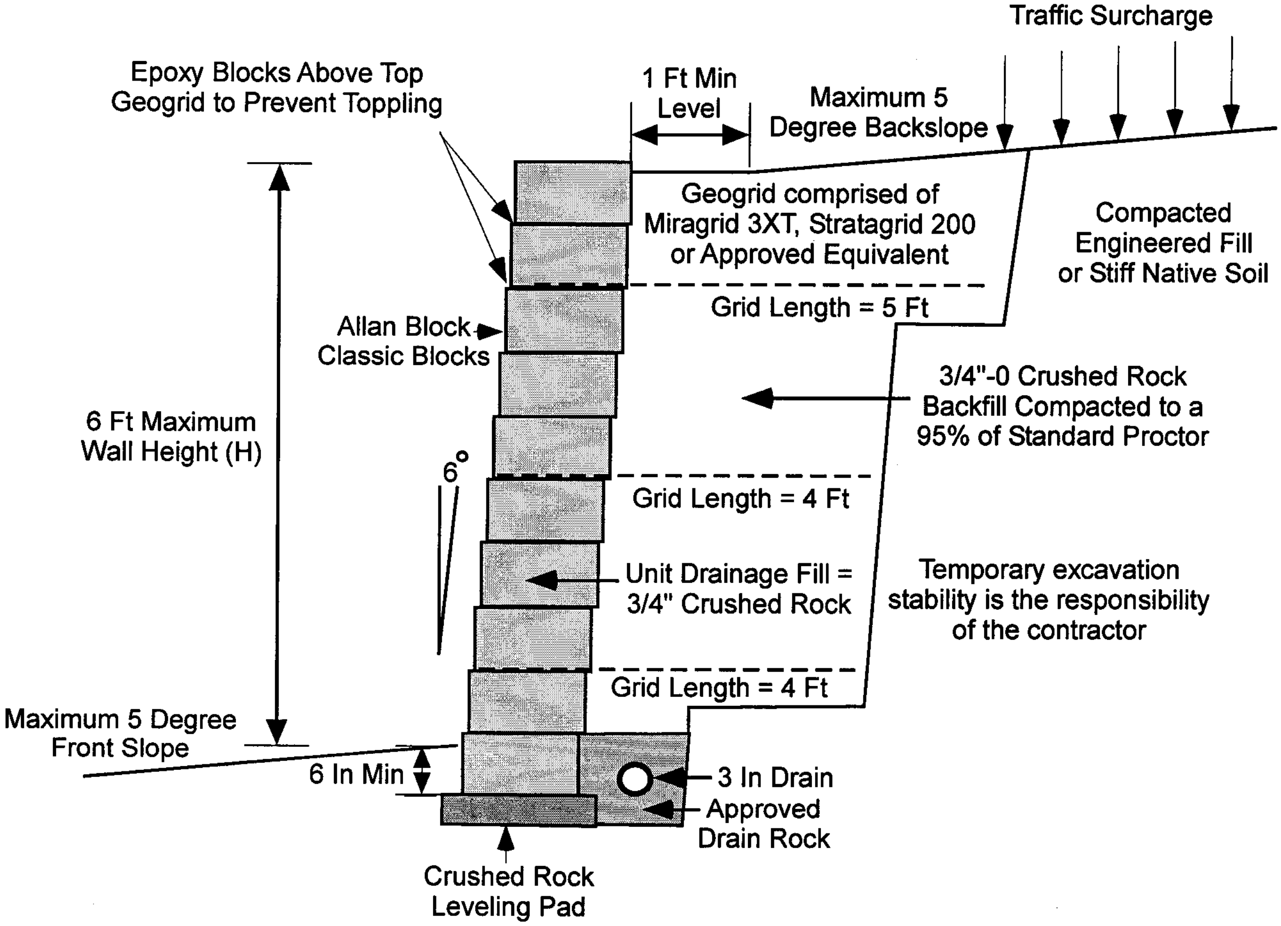


Source: Client

Scale: NTS

Chinook GeoServices Inc.	Mattheisen Residence Allan Block Retaining Wall 10151 Southwest Lancaster Road Portland, Oregon	**Report No.** **07-134-1** **Date:** **July 10, 2007**

Figure 5. Allan Block Retaining Wall Construction Detail
6 Feet Maximum Retained Height



Note: Geogrid length varies depending on wall height and backslope. See attached report for other wall configurations.

Geotechnical Engineer should observe subgrade prior to rock placement, wall batter, wall materials, leveling pad compaction, geogrid placement, drainage, backfill compaction, and finished grades.

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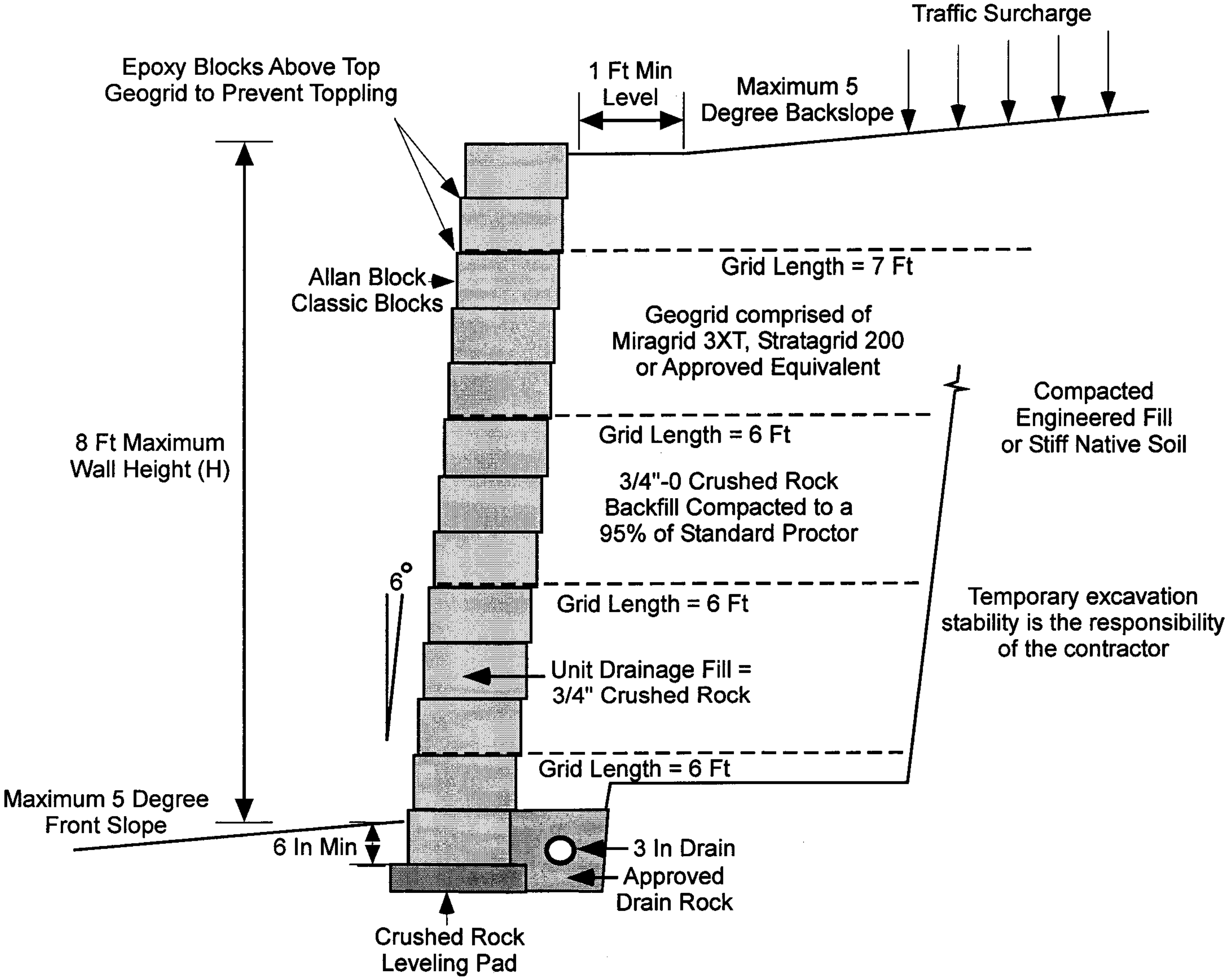
Figure 4. Allan Block Retaining Wall Construction Detail
8 Feet Maximum Retained Height



Note: Geogrid length varies depending on wall height and backslope. See attached report for other wall configurations.

Geotechnical Engineer should observe subgrade prior to rock placement, wall batter, wall materials, leveling pad compaction, geogrid placement, drainage, backfill compaction, and finished grades.

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Licensed to: **Marcella Mae Boyer**
1508 Broadway Street
WAVancouver WA 98663

License Number: **0510935**

Project Identification:

Project Name: **Mattheisen Residence Allan Block Wall**
Section:
Data Sheet: **Allan Block Class Blocks**

Owner: **Steve and Sara Mattheisen**
Client:

Prepared by: **Ericka J. Koss**
Date: **7/9/07**
Time:

Data file: **p:\2007 projects\07-134 (mattheisen residence)\07-134 mattheisen residence allan block_8 ft static**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio **0.00**

Wall Geometry:

Design Wall Height (ft)	**8.67**
Embedment Wall Height (ft)	**1.0**
Exposed Design Wall Height (ft)	**7.67**
Minimum Levelling Pad Thickness (ft)	0.5
Number of Segmental Wall Units	**13**
Hinge Height (ft)	**8.67**
Wall Inclination (degrees)	**6.0**

Slopes:

Front Slope (degrees)	**5.0**
Back Slope (degrees)	**5.0**
Infinite Back Slope	

Uniformly Distributed Surcharges:

Live Load Surcharge (psf)	**250**
Dead Load Surcharge	**none**

Soil Data:	*Soil Description:*	*Cohesion (psf)*	*Friction Angle (degrees)*	*Unit Weight (pcf)*
Reinforced Soil	**crushed rock**	N/A	**38.0**	**130.0**
Retained Soil	**native residual soil**	N/A	**32.0**	**110.0**
Levelling Pad Soil	**crushed rock**	N/A	**38.0**	**130.0**
Foundation Soil	**native residual soil**	**100.0**	**32.0**	**110.0**

Segmental Unit Name: **Allan Block Classic**

Segmental Unit Data:

Cap Height (in)	**none**
Unit Height (Hu)(in)	**8.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**0.841**
Weight (infilled) (lbs)	**130.0**
Unit Weight (infilled) (pcf)	**130.0**
Center of Gravity (in)	**6.0**

Segmental Unit Interface Shear Data:

Properties	*Ultimate Strength Criteria*	*Service State Criteria*
Minimum (lbs/ft)	**1018.0**	**995.0**
Friction Angle (degrees)	**61.0**	**48.0**
Maximum (lbs/ft)	**5800.0**	**3900.0**

Geosynthetic Reinforcement Types and Number:

Type	*Number*	*Name*
1	**4**	**Miragrid 3XT**

Geosynthetics Properties:

Strength and Polymer Type:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength (lbs/ft)	**3000.0**	**N/A**	**N/A**
Polymer Type	**polyester**	**N/A**	**N/A**

Reduction Factors:	*Type 1*	*Type 2*	*Type 3*
Creep	**1.67**	**N/A**	**N/A**
Durability	**1.10**	**N/A**	**N/A**
Installation Damage	**1.10**	**N/A**	**N/A**
Overall Factor of Safety	**1.50**	**N/A**	**N/A**

Allowable Strength:	*Type 1*	*Type 2*	*Type 3*
Ta (lbs/ft)	**989.76**	**N/A**	**N/A**

Coefficient of Interaction:	*Type 1*	*Type 2*	*Type 3*
Ci	**0.9**	**N/A**	**N/A**

Coefficient of Direct Sliding:	*Type 1*	*Type 2*	*Type 3*
Cds	**0.9**	**N/A**	**N/A**

Connection Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	**1420.0**	**N/A**	**N/A**
Friction Angle (degrees)	**11.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**1837.0**	**N/A**	**N/A**
Service State Criterion:			
Minimum (lbs/ft)	**919.0**	**N/A**	**N/A**
Friction Angle (degrees)	**7.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**1162.0**	**N/A**	**N/A**

Geosynthetic-Segmental Retaining Wall Unit Interface Shear Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	**1018.0**	**N/A**	**N/A**
Friction Angle (degrees)	**61.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**5800.0**	**N/A**	**N/A**
Service State Criterion:			
Minimum (lbs/ft)	**995.0**	**N/A**	**N/A**
Friction Angle (degrees)	**48.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**3900.0**	**N/A**	**N/A**

Coefficients of Earth Pressure and Failure Plane Orientations:

Reinforced Soil (Ka)	**0.186**
Reinforced Soil (Ka horizontal component)	**0.176**
Orientation of failure plane from horizontal (degrees)	**57.76**
Retained Soil (Ka)	**0.247**
Retained Soil (Ka horizontal component)	**0.222**
Orientation of failure plane from horizontal (degrees)	**52.69**

Results of External Stability Analyses:

	Calculated	*Design Criteria*
FOS Sliding	**3.23**	**1.5 OK**
FOS Overturning	**4.43**	**1.5 OK**
FOS Bearing Capacity	**9.82**	**2.0 OK**
Base Reinforcement Length (L) (ft)	**6.0**	**5.2 OK**
Base Eccentricity (e)(ft)	**0.32**	N/A
Base Eccentricity Ratio (e/L-2e)	**0.06**	N/A
Base Reinforcement Ratio (L/H)	**0.69**	**0.6 OK**

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses:	*Calculated Values:*
Total Horizontal Force (lbs/ft)	**1523.0**
Total Vertical Force (lbs/ft)	**6905.5**
Sliding Resistance (lbs/ft)	**4915.0**
Driving Moment (lbs-ft/ft)	**5397.0**
Resisting Moment (lbs-ft/ft)	**23894.1**
Bearing Capacity (psf)	**15001.0**
Maximum Bearing Pressure (psf)	**1527.8**

Results of Internal Stability Analyses:

SRW Unit #	*Geosyn Type*	*Elev (ft)*	*Length (ft)*	*Anchor Length (ft)* **> 1.0**	*FOS Over-stress* **> 1.0**	*FOS Pullout* **> 1.5**	*FOS Sliding* **> 1.5**	*Layer Spacing (ft)* **< 4.0**
12	**1**	**7.33**	**7.0**	**2.15**	**6.01**	**4.19**	**14.82**	**OK**
9	**1**	**5.33**	**6.0**	**2.2**	**4.12**	**6.11**	**8.89**	**OK**
6	**1**	**3.33**	**6.0**	**3.25**	**2.99**	**10.01**	**6.58**	**OK**
3	**1**	**1.33**	**6.0**	**4.3**	**1.97**	**11.77**	**5.28**	**OK**

Note: calculated values MEET ALL design criteria

Detailed Results of Internal Stability Analyses:

SRW Unit #	*Geosyn Type*	*Elev (ft)*	*Allowable Strength (lbs/ft)*	*Tensile Load (lbs/ft)*	*Pullout Capacity (lbs/ft)*	*Sliding Force (lbs/ft)*	*Sliding Capacity (lbs/ft)*
12	**1**	**7.33**	**989.8**	**164.7**	**689.7**	**137.8**	**2042.4**
9	**1**	**5.33**	**989.8**	**240.1**	**1466.0**	**385.1**	**3425.6**
6	**1**	**3.33**	**989.8**	**331.5**	**3316.9**	**730.3**	**4808.7**
3	**1**	**1.33**	**989.8**	**502.2**	**5911.7**	**1173.3**	**6191.9**

Results of Facing Stability Analyses:

SRW Unit #	Heel Elev (ft)	Geosynthetic Type	FOS Over-turning > 1.5	FOS Shear (peak) > 1.5	Shear (deformation) < 0.02 x Hu	FOS Connection (peak) > 1.5	Connection (deformation) < 0.75 in
13	8.0	none	3.98	34.18	OK	-	-
12	7.33	1	1.93	16.87	OK	8.83	OK
11	6.67	none	6.83	-	-	-	-
10	6.0	none	6.7	48.8	OK	-	-
9	5.33	1	5.86	16.57	OK	6.26	OK
8	4.67	none	6.13	-	-	-	-
7	4.0	none	5.84	43.2	OK	-	-
6	3.33	1	5.37	14.7	OK	4.69	OK
5	2.67	none	5.29	-	-	-	-
4	2.0	none	5.04	40.25	OK	-	-
3	1.33	1	4.73	13.69	OK	3.2	OK
2	0.67	none	4.6	-	-	-	-
1	0.0	none	4.41	-	-	-	-

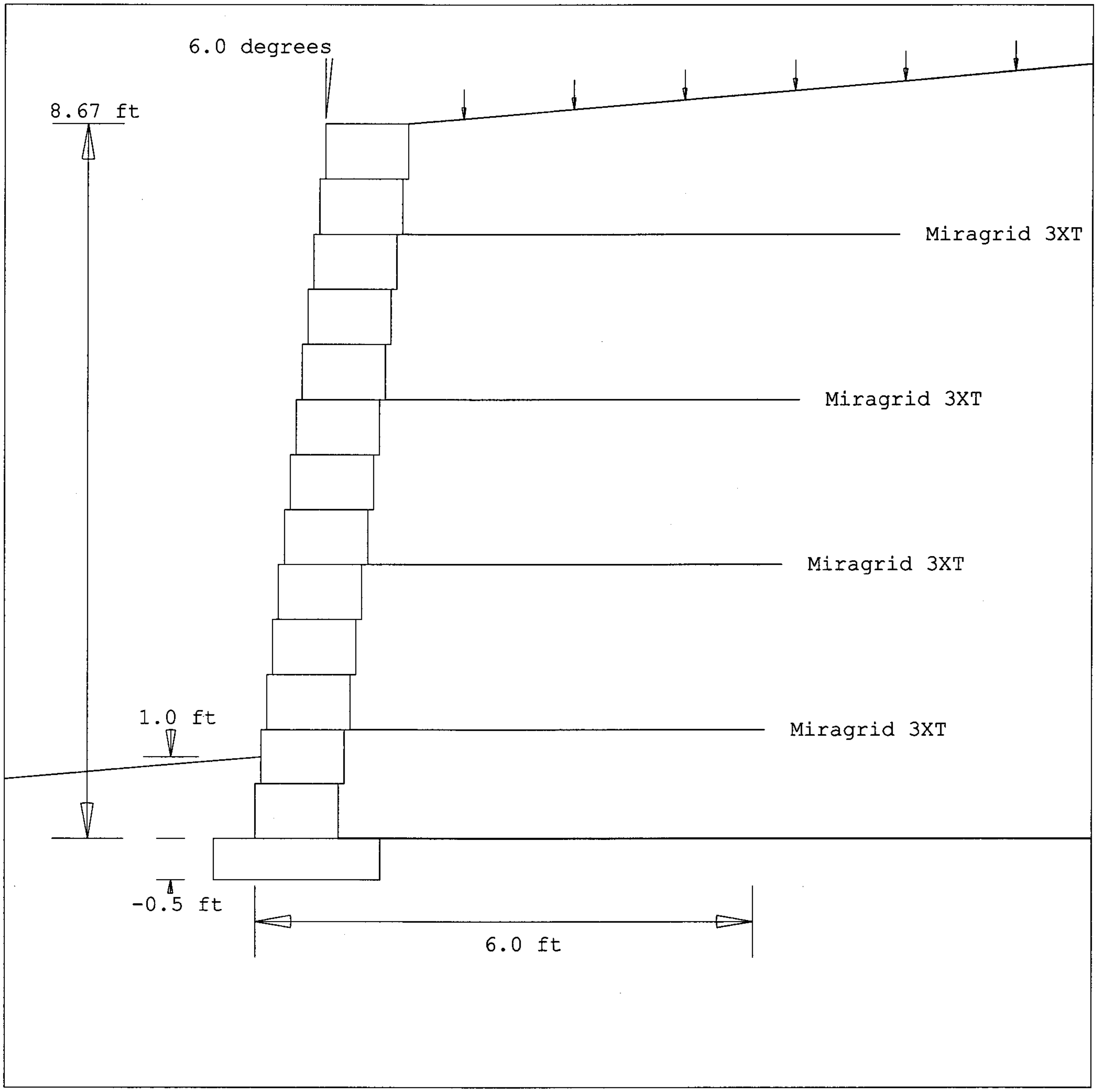
Note: calculated values MEET ALL design criteria

Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	Heel Elev (ft)	Geo Type	Drive Moment (lbs-ft/ft)	Resist Moment (lbs-ft/ft)	Shear Load (lbs/ft) +out -in	Shear Capacity (lbs/ft) (peak)	Shear Capacity (lbs/ft) (deformation)
13	8.0	none	10.9	43.3	34.4	1174.4	1091.3
12	7.33	1	48.1	92.7	78.9	1330.7	1187.5
11	6.67	none	118.3	808.1	-31.1	1487.1	1283.8
10	6.0	none	228.4	1529.5	33.7	1643.4	1380.0
9	5.33	1	385.0	2256.9	108.6	1799.8	1476.3
8	4.67	none	595.0	3650.3	-46.4	1956.1	1572.5
7	4.0	none	865.2	5049.7	48.9	2112.5	1668.8
6	3.33	1	1202.2	6455.3	154.3	2268.8	1765.0
5	2.67	none	1612.9	8526.7	-61.6	2425.2	1861.3
4	2.0	none	2104.0	10604.2	64.1	2581.5	1957.5
3	1.33	1	2682.4	12687.8	200.0	2737.9	2053.8
2	0.67	none	3354.6	15437.3	-156.2	2894.2	2150.0
1	0.0	none	4127.7	18192.9	0.0	3050.6	2246.3

Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	Heel Elev (ft)	Geo Type	Connection Load (lbs/ft)	Connection Capacity (peak) (lbs/ft)	Connection Capacity (deformation) (lbs/ft)
12	7.33	1	164.7	1453.7	940.3
9	5.33	1	240.1	1504.2	972.2
6	3.33	1	331.5	1554.8	1004.1
3	1.33	1	502.2	1605.3	1036.1



Project Identification:

Project
Name: **Mattheisen Residence Allan Block Wall**
Section:
Data Sheet: **Allan Block Class Blocks**

Owner: **Steve and Sara Mattheisen**
Client:

Prepared by: **Ericka J. Koss**
Date: **7/9/07**
Time:

Data file: **p:\2007 projects\07-134 (mattheisen residence)\07-134 mattheisen residence allan block_8 ft static**

Licensed to: **Marcella Mae Boyer**
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WAVancouver WA 98663

License Number: **0510935**

Project Identification:

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Date: **7/9/07**
Time:

Data file: **p:\2007 projects\07-134 (mattheisen residence)\07-134 mattheisen residence allan block_8 ft seismc**

Type of Structure: **Geosynthetic-Reinforced Segmental Retaining Wall**
Design Methodology: **NCMA Method A**

Seismic Analysis Details:

Peak Ground Acceleration (PGA) ratio	**0.14**

Wall Geometry:

Design Wall Height (ft)	**8.67**
Embedment Wall Height (ft)	**1.0**
Exposed Design Wall Height (ft)	**7.67**
Minimum Levelling Pad Thickness (ft)	0.5
Number of Segmental Wall Units	**13**
Hinge Height (ft)	**8.67**
Wall Inclination (degrees)	**6.0**

Slopes:

Front Slope (degrees)	**5.0**
Back Slope (degrees)	**5.0**
Infinite Back Slope	

Uniformly Distributed Surcharges:

Live Load Surcharge	**none**
Dead Load Surcharge	**none**

Soil Data:	*Soil Description:*	*Cohesion (psf)*	*Friction Angle (degrees)*	*Unit Weight (pcf)*
Reinforced Soil	**crushed rock**	N/A	**38.0**	**130.0**
Retained Soil	**native residual soil**	N/A	**32.0**	**110.0**
Levelling Pad Soil	**crushed rock**	N/A	**38.0**	**130.0**
Foundation Soil	**native residual soil**	**100.0**	**32.0**	**110.0**

Segmental Unit Name: **Allan Block Classic**

Segmental Unit Data:

Cap Height (in)	**none**
Unit Height (Hu)(in)	**8.0**
Unit Width (Wu)(in)	**12.0**
Unit Length (in)	**18.0**
Setback (in)	**0.841**
Weight (infilled) (lbs)	**130.0**
Unit Weight (infilled) (pcf)	**130.0**
Center of Gravity (in)	**6.0**

Segmental Unit Interface Shear Data:

Properties	*Ultimate Strength Criteria*	*Service State Criteria*
Minimum (lbs/ft)	**1018.0**	**995.0**
Friction Angle (degrees)	**61.0**	**48.0**
Maximum (lbs/ft)	**5800.0**	**3900.0**

Geosynthetic Reinforcement Types and Number:

Type	*Number*	*Name*
1	**4**	**Miragrid 3XT**

Geosynthetics Properties:

Strength and Polymer Type:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength (lbs/ft)	**3000.0**	**N/A**	**N/A**
Polymer Type	**polyester**	**N/A**	**N/A**

Reduction Factors:	*Type 1*	*Type 2*	*Type 3*
Creep (=1.00 for seismic analysis)	**1.00**	**N/A**	**N/A**
Durability	**1.10**	**N/A**	**N/A**
Installation Damage	**1.10**	**N/A**	**N/A**
Overall Factor of Safety	**1.50**	**N/A**	**N/A**

(Dynamic) Allowable Strength:	*Type 1*	*Type 2*	*Type 3*
Ta (lbs/ft)	**1652.89**	**N/A**	**N/A**

Coefficient of Interaction:	*Type 1*	*Type 2*	*Type 3*
Ci	**0.9**	**N/A**	**N/A**

Coefficient of Direct Sliding:	*Type 1*	*Type 2*	*Type 3*
Cds	**0.9**	**N/A**	**N/A**

Connection Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	**1420.0**	**N/A**	**N/A**
Friction Angle (degrees)	**11.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**1837.0**	**N/A**	**N/A**
Service State Criterion:			
Minimum (lbs/ft)	**919.0**	**N/A**	**N/A**
Friction Angle (degrees)	**7.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**1162.0**	**N/A**	**N/A**

Geosynthetic-Segmental Retaining Wall Unit Interface Shear Strength:	*Type 1*	*Type 2*	*Type 3*
Ultimate Strength Criterion:			
Minimum (lbs/ft)	**1018.0**	**N/A**	**N/A**
Friction Angle (degrees)	**61.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**5800.0**	**N/A**	**N/A**
Service State Criterion:			
Minimum (lbs/ft)	**995.0**	**N/A**	**N/A**
Friction Angle (degrees)	**48.0**	**N/A**	**N/A**
Maximum (lbs/ft)	**3900.0**	**N/A**	**N/A**

Coefficients of Earth Pressure and Failure Plane Orientations:

Seismic Coefficent (k(int))	**0.183**
Seismic Coefficent (k(ext))	**0.07**
Reinforced Soil (static) (Ka)	**0.186**
Reinforced Soil (static) (Ka horizontal component)	**0.176**
Reinforced Soil (static + dynamic) (Kae)	**0.307**
Reinforced Soil (static + dynamic) (Kaeh horizontal component)	**0.29**
Orientation of failure plane from horizontal (degrees)	**57.76**
Retained Soil (static) (Ka)	**0.247**
Retained Soil (static) (Kah horizontal component)	**0.222**
Retained Soil (static + dynamic) (Kae)	**0.298**
Retained Soil (static + dynamic) (Kaeh horizontal component)	**0.268**
Orientation of failure plane from horizontal (degrees)	**48.87**

Results of External Stability (Seismic) Analyses:

	Calculated	*Design Criteria*
FOS Sliding	**3.35**	**1.5 OK**
FOS Overturning	**4.62**	**1.5 OK**
FOS Bearing Capacity	**11.96**	**2.0 OK**
Base Reinforcement Length (L) (ft)	**6.0**	**5.2 OK**
Base Eccentricity (e)(ft)	**0.28**	N/A
Base Eccentricity Ratio (e/L-2e)	**0.05**	N/A
Base Reinforcement Ratio (L/H)	**0.69**	**0.6 OK**

Note: calculated values MEET ALL design criteria

Detailed Results of External Stability Analyses:	*Calculated Values:*
Total Horizontal Force (lbs/ft)	**1466.5**
Total Vertical Force (lbs/ft)	**6905.5**
Sliding Resistance (lbs/ft)	**4915.0**
Driving Moment (lbs-ft/ft)	**5177.1**
Resisting Moment (lbs-ft/ft)	**23894.1**
Bearing Capacity (psf)	**15152.5**
Maximum Bearing Pressure (psf)	**1267.4**

Results of Internal Stability (Seismic) Analyses:

SRW Unit #	*Geosyn Type*	*Elev (ft)*	*Length (ft)*	*Anchor Length (ft)* > 1.0	*FOS Over-stress* > 1.0	*FOS Pullout* > 1.5	*FOS Sliding* > 1.5	*Layer Spacing (ft)* < 4.0
12	**1**	**7.33**	**7.0**	**2.15**	**4.96**	**2.07**	**16.2**	**OK**
9	**1**	**5.33**	**6.0**	**2.2**	**4.77**	**4.23**	**9.28**	**OK**
6	**1**	**3.33**	**6.0**	**3.25**	**4.11**	**8.25**	**6.83**	**OK**
3	**1**	**1.33**	**6.0**	**4.3**	**3.06**	**10.96**	**5.47**	**OK**

Note: calculated values MEET ALL design criteria

Note: Seismic analysis may not give the lowest factors of safety for FOS against reinforcement over-stress in internal stabilty calculations. Be sure to check current design using static analysis option.

Detailed Results of Internal Stability Analyses:

SRW Unit #	*Geosyn Type*	*Elev (ft)*	*Allowable Strength (lbs/ft)*	*Tensile Load (lbs/ft)*	*Pullout Capacity (lbs/ft)*	*Sliding Force (lbs/ft)*	*Sliding Capacity (lbs/ft)*
12	**1**	**7.33**	**1652.9**	**333.5**	**689.7**	**126.1**	**2042.4**
9	**1**	**5.33**	**1652.9**	**346.3**	**1466.0**	**369.2**	**3425.6**
6	**1**	**3.33**	**1652.9**	**402.1**	**3316.9**	**704.1**	**4808.7**
3	**1**	**1.33**	**1652.9**	**539.6**	**5911.7**	**1131.0**	**6191.9**

Results of Facing Stability (Seismic) Analyses:

SRW Unit #	*Heel Elev (ft)*	*Geosynthetic Type*	*FOS Over-turning* **> 1.5**	*FOS Shear (peak)* **> 1.5**	*Shear (deformation)* **< 0.02 x Hu**	*FOS Connection (peak)* **> 1.5**	*Connection (deformation)* **< 0.75 in**
13	**8.0**	**none**	**1.5**	**13.42**	**OK**	**-**	**-**
12	**7.33**	**1**	**0.79***	**7.34**	**OK**	**4.36**	**OK**
11	**6.67**	**none**	**4.11**	**-**	**-**	**-**	**-**
10	**6.0**	**none**	**4.35**	**30.58**	**OK**	**-**	**-**
9	**5.33**	**1**	**4.03**	**10.84**	**OK**	**4.34**	**OK**
8	**4.67**	**none**	**4.5**	**-**	**-**	**-**	**-**
7	**4.0**	**none**	**4.51**	**33.55**	**OK**	**-**	**-**
6	**3.33**	**1**	**4.34**	**11.7**	**OK**	**3.87**	**OK**
5	**2.67**	**none**	**4.47**	**-**	**-**	**-**	**-**
4	**2.0**	**none**	**4.44**	**35.77**	**OK**	**-**	**-**
3	**1.33**	**1**	**4.32**	**12.35**	**OK**	**2.97**	**OK**
2	**0.67**	**none**	**4.36**	**-**	**-**	**-**	**-**
1	**0.0**	**none**	**4.31**	**-**	**-**	**-**	**-**

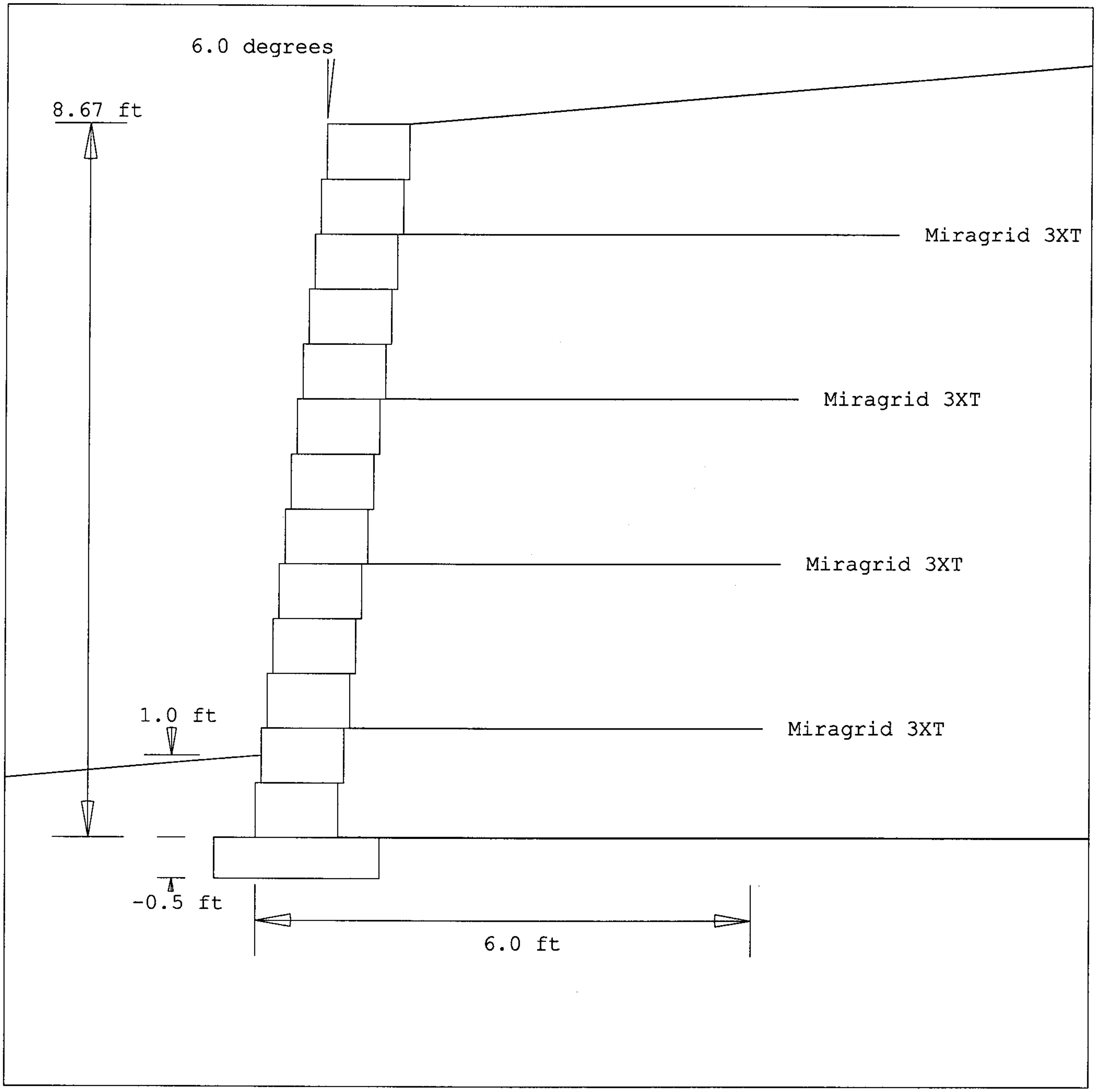
Note: * value does NOT MEET design criterion (1 occurrences)

Detailed Results of Facing Stability Analyses (Moment and Shear):

SRW Unit #	*Heel Elev (ft)*	*Geo Type*	*Drive Moment (lbs-ft/ft)*	*Resist Moment (lbs-ft/ft)*	*Shear Load (lbs/ft) +out -in*	*Shear Capacity (lbs/ft) (peak)*	*Shear Capacity (lbs/ft) (deformation)*
13	**8.0**	**none**	**28.8**	**43.3**	**87.5**	**1174.4**	**1091.3**
12	**7.33**	**1**	**118.1**	**92.7**	**181.2**	**1330.7**	**1187.5**
11	**6.67**	**none**	**271.9**	**1117.4**	**-52.4**	**1487.1**	**1283.8**
10	**6.0**	**none**	**494.4**	**2148.0**	**53.7**	**1643.4**	**1380.0**
9	**5.33**	**1**	**789.6**	**3184.8**	**166.1**	**1799.8**	**1476.3**
8	**4.67**	**none**	**1161.9**	**5230.4**	**-61.8**	**1956.1**	**1572.5**
7	**4.0**	**none**	**1615.2**	**7282.2**	**63.0**	**2112.5**	**1668.8**
6	**3.33**	**1**	**2153.7**	**9340.0**	**193.9**	**2268.8**	**1765.0**
5	**2.67**	**none**	**2781.5**	**12440.4**	**-71.1**	**2425.2**	**1861.3**
4	**2.0**	**none**	**3502.9**	**15546.8**	**72.2**	**2581.5**	**1957.5**
3	**1.33**	**1**	**4321.8**	**18659.3**	**221.7**	**2737.9**	**2053.8**
2	**0.67**	**none**	**5242.4**	**22848.1**	**-162.2**	**2894.2**	**2150.0**
1	**0.0**	**none**	**6269.0**	**27043.0**	**-0.3**	**3050.6**	**2246.3**

Detailed Results of Facing Stability Analyses (Connections):

SRW Unit #	*Heel Elev (ft)*	*Geo Type*	*Connection Load (lbs/ft)*	*Connection Capacity (peak) (lbs/ft)*	*Connection Capacity (deformation) (lbs/ft)*
12	**7.33**	**1**	**333.5**	**1453.7**	**940.3**
9	**5.33**	**1**	**346.3**	**1504.2**	**972.2**
6	**3.33**	**1**	**402.1**	**1554.8**	**1004.1**
3	**1.33**	**1**	**539.6**	**1605.3**	**1036.1**



Project Identification:

Project Name: **Mattheisen Residence Allan Block Wall**
Section:
Data Sheet: **Allan Block Class Blocks**

Owner: **Steve and Sara Mattheisen**
Client:

Prepared by: **Ericka J. Koss**
Date: **7/9/07**
Time:

Data file: **p:\2007 projects\07-134 (mattheisen residence)\07-134 mattheisen residence allan block_8 ft seismc**

GeoPacific
Engineering, Inc.
Real-World Geotechnical Solutions
Investigation • Design • Construction Support

07-126920 REV 01-B

April 18, 2007
Project No. 05-9239

Steve and Sara Mattheisen
10151 SW Lancaster Road
Portland, Oregon 97219
Fax No. 503-244-1419

Copy: CK Engineering, Luke Lee, Fax 503-638-9818

Subject: **RECOMMENDED PARAMETERS FOR RETAINING WALL DESIGN**
MATTHEISEN RESIDENCE
10151 SW LANCASTER RAOD
PORTLAND, OREGON

References:
1. *Geotechnical Engineering Report, Mattheisen Residence, Portland, Oregon,* GeoPacific report dated September 5, 2006.
2. *Geotechnical Review of Potential Landslide Hazard, Mattheisen Residence, Portland, Oregon*, GeoPacific Engineering, Inc. letter report dated June 1, 2005.

As requested, GeoPacific Engineering, Inc. (GeoPacific) developed retaining wall design parameters for retaining walls planned for the Mattheisen Residence. This letter is intended to completely replace the sections titled "Permanent Below-Grade Structural Walls" and "Retaining Wall Design Parameters (Nonstructural)" of the above referenced report (Reference 1). This letter should be considered supplemental to the above-referenced reports. The conclusions, recommendations, uncertainties and limitations of that report remain applicable, except as modified herein. The recommended geotechnical parameters are based on our understanding of the subsurface conditions as described in the above referenced reports.

Retaining Wall Design Parameters - Static

We understand the retaining walls will be designed by CK Engineering. Three retaining walls are planned as shown in Figure 2. Based on conversations with CK Engineering, we understand Wall 1 and Wall 3 will be concrete cast-in-place, and may be either restrained or unrestrained, depending on the calculated deflection at the top of the wall as determined by the wall designer. Based on our test pit explorations (Reference 1), Wall 1 will likely support very stiff native soils and Wall 2 and 3 will likely support undocumented fill. All walls are planned having level backslopes. Based on conversations with Steve and Sara Mattheisen, we understand the walls are planned such that uphill walls are a minimum horizontal distance of at least 1.5H away from the back of the downhill retaining walls, where H is the total height of the wall. Should retaining walls or other structures be located with in this zone of influence of a retaining wall, walls should be designed for the appropriate surcharge loading. We understand Wall 3 will support a vehicle surcharge. We typically recommend using a vehicle surcharge of 250 psf, however the wall designer should verity the type of traffic loads anticipated and revise this value as necessary.

Lateral earth pressures against below-grade retaining walls depend upon the inclination of the back-slope, degree of wall restraint, type of backfill, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any surcharge loads. At-rest soil pressure is exerted on a subsurface wall when the wall is restrained against rotation. Such restraint may be the result of an inherently stiff wall or if the wall is braced by rigid structural elements, such as a floor system. In contrast, active soil pressure will be exerted on a subsurface wall if the top of the wall is allowed to rotate or yield a distance of roughly 0.001 times its height or greater.

Table 1 presents lateral earth pressures for use in design, for cases of active (unrestrained walls) and at-rest (restrained walls) earth pressure, for walls having a level backslope. Values are given for the various soil types anticipated. Passive earth pressures and frictional coefficients are also included. These values are ultimate and do not include a factor of safety; a suitable factor of safety should be included in the overall design.

Table 1. Lateral Earth Pressures for Retaining Wall Design

Soil Type	Friction Angle (deg.)	Unit Weight (pcf)	Active E.P. (pcf)	At-Rest E.P. (pcf)	Passive E.P. (pcf)	Friction Coeff.
Undocumented Fill (Wall 2 and 3)	25	120	49	69	300	-
Engineered Fill (Crushed Rock)	36	130	34	54	500	0.50
Fine Grained Eng. Fill / Undisturbed Native Soil (Wall 1)	30	120	40	60	360	0.45

The above recommendations assume no adjacent surcharge loading. If the walls will be subjected to the influence of surcharge loading within a horizontal distance less than 1.5H from the back of the wall, where H is the total height of the wall, the walls should be appropriately designed for the surcharge loading.

The recommendations assume that drainage provisions, as described below, will be included in the design of the walls. Accordingly, the recommended lateral earth pressures do not include hydrostatic pressure.

Retaining walls should be founded on competent native soils or engineered fill placed to project specifications (see referenced geotechnical report). For these soil conditions, an allowable soil bearing pressure of 2,000 psf should be used for retaining wall design. This value may be increased to 3,000 psf for transient loads such as seismic or wind. Footing excavations should be trimmed neat and the bottom of the excavation should be carefully prepared. Loose or softened soil should be removed from the footing excavation prior to placing reinforcing steel bars.

The lateral load resistance of retaining wall footings will be a combination of sliding resistance of the wall base on the underlying soil and passive earth pressure against the embedded portion of the wall. The upper most foot of embedment should be neglected in passive earth pressure calculations. The lateral load resistance of retaining walls may be evaluated using the parameters recommended in Table 1.

Retaining Wall Design Parameters - Seismic

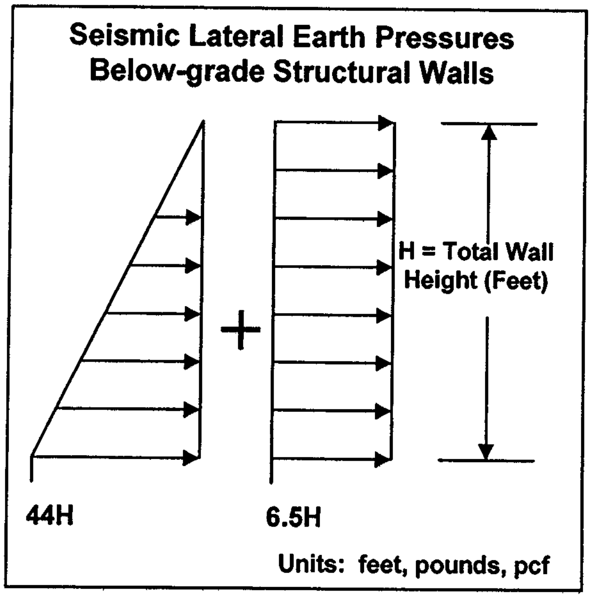
The following seismic wall design parameters are presented for both restrained and unrestrained walls up to 10 feet high, with level backslopes. This analysis assumes the wall will retain predominantly be backfilled using compacted granular soil. Lower seismic design values would result for crushed rock materials. For other wall restraint, backfill or slope conditions, please contact GeoPacific for additional recommendations.

During a seismic event, lateral earth pressures acting on below-grade structural walls will increase by an incremental amount that corresponds to the earthquake loading. A concomitant decrease in passive earth pressure also occurs. Determination of actual loading conditions on retaining walls during earthquakes is extremely complicated. As a result, seismic pressures for commonplace engineering applications are usually estimated using simplified methods, such as the Mononobe-Okabe (M-O) Equation. The M-O equation is a pseudostatic method that shares many of the features and inherent conservatisms of pseudostatic slope stability analyses. For both restrained and unrestrained walls, we recommend using the active equivalent fluid pressure under static conditions plus an incremental rectangular shaped seismic load. When combined, this load is equal to the load calculated for the seismic condition, except that the resultant force acts higher on the wall than a resultant force from a triangular shaped equivalent fluid pressure. For seismic loads, the soil to wall friction is included in the active fluid pressure and therefore these values are less than those recommended for static design.

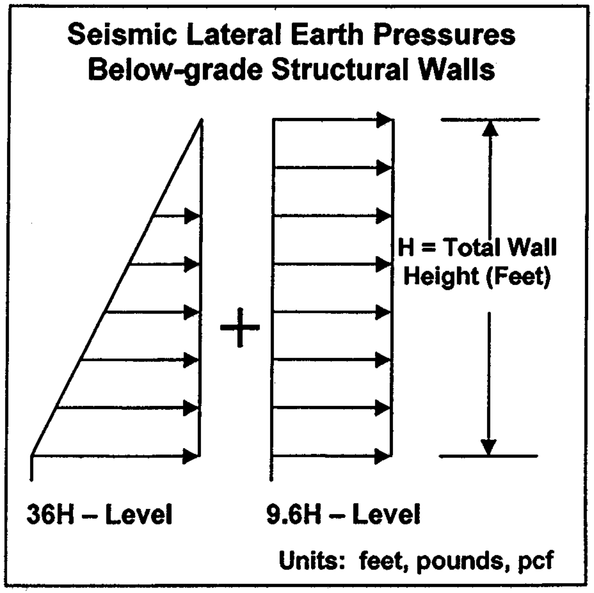
As with slope stability analyses, use of the full value of peak horizontal acceleration, a_{max}, for analysis of below-grade retaining walls would be highly conservative. Use of the commonly applied factor of 0.5 a_{max} for unrestrained and 0.75 a_{max} for restrained is more appropriate. In our opinion this approach provides a reasonable approximation of the actual seismic forces the walls may experience during the design earthquake event.

The attached spreadsheet shows our calculations for the wall design parameters under seismic conditions for walls retaining undocumented fill and for walls retaining native soil. They were calculated using the Mononobe-Okabe (M-O) equation, with a horizontal ground acceleration of 0.137g for unrestrained walls and 0.206g for restrained walls. The USGS seismic hazard maps show the site as having a peak ground acceleration of 0.411g, for the 2% in 50 year maximum considered earthquake (MCE) event. For the design event, we took 2/3 of the MCE value, per the 2003 IBC. We then factored this value by 0.5 for unrestrained walls and 0.75 for restrained walls, to account for the inherent conservatism in pseudostatic methods of modeling seismic forces as discussed above. We incorporated shear strength parameters reflective of the anticipated soil conditions, and assumed a soil-wall interface friction angle of ½ the soil shear strength.

Wall 2 and Wall 3
Unrestrained walls supporting undocumented fill



Wall 1
Restrained wall supporting native soil



Total equivalent fluid pressure for the seismic and static cases were determined from the attached M-O Equation calculation sheets. Recommended lateral earth pressures for below-grade walls is therefore the active equivalent fluid pressure, plus an incremental rectangular shaped seismic load as shown above, where H is the total height of the wall.

General Considerations

We recommend walls be backfilled with imported ¾”-0 crushed rock, compacted to a minimum of 95 percent of Standard Proctor (ASTM D698). Directly behind the wall, a minimum 12-inch wide column of crushed drain rock should be provided, measured horizontally from the back of the wall. Backfill soils behind the wall should be capped with an 8- to 12-inch thick layer of compacted low-permeability soil.

Adequate drainage behind retaining walls is critical to long-term performance. Drainage at the base of the wall should consist of a minimum 4-inch diameter perforated pipe, surrounded in clean drain rock and filter fabric. All water collected by the toe drains should be directed under control to a positive and permanent discharge system such as the storm sewer or daylighted.

GeoPacific should be contacted during construction to verify subgrade strength in wall keyway excavations, to verify that backslope soils are in accordance with our assumptions, and to take density tests on the wall backfill materials.

Structures should be located a horizontal distance of at least 1.5H away from the back of the retaining wall, where H is the total height of the wall. GeoPacific should be contacted for additional foundation recommendations where structures are located closer than 1.5H to the top of any wall. Also, GeoPacific should review wall and grading plans when available to verify conformance with the project geotechnical recommendations.

In our experience, typical acceptable factors of safety for wall stability are 1.5 for static and 1.1 for seismic conditions. However, the wall designer should select appropriate factors of safety based on the design methodology, specifics of the wall configuration and other factors.

———————□□□———————

We appreciate this opportunity to be of service.

Sincerely,

GEOPACIFIC ENGINEERING, INC.

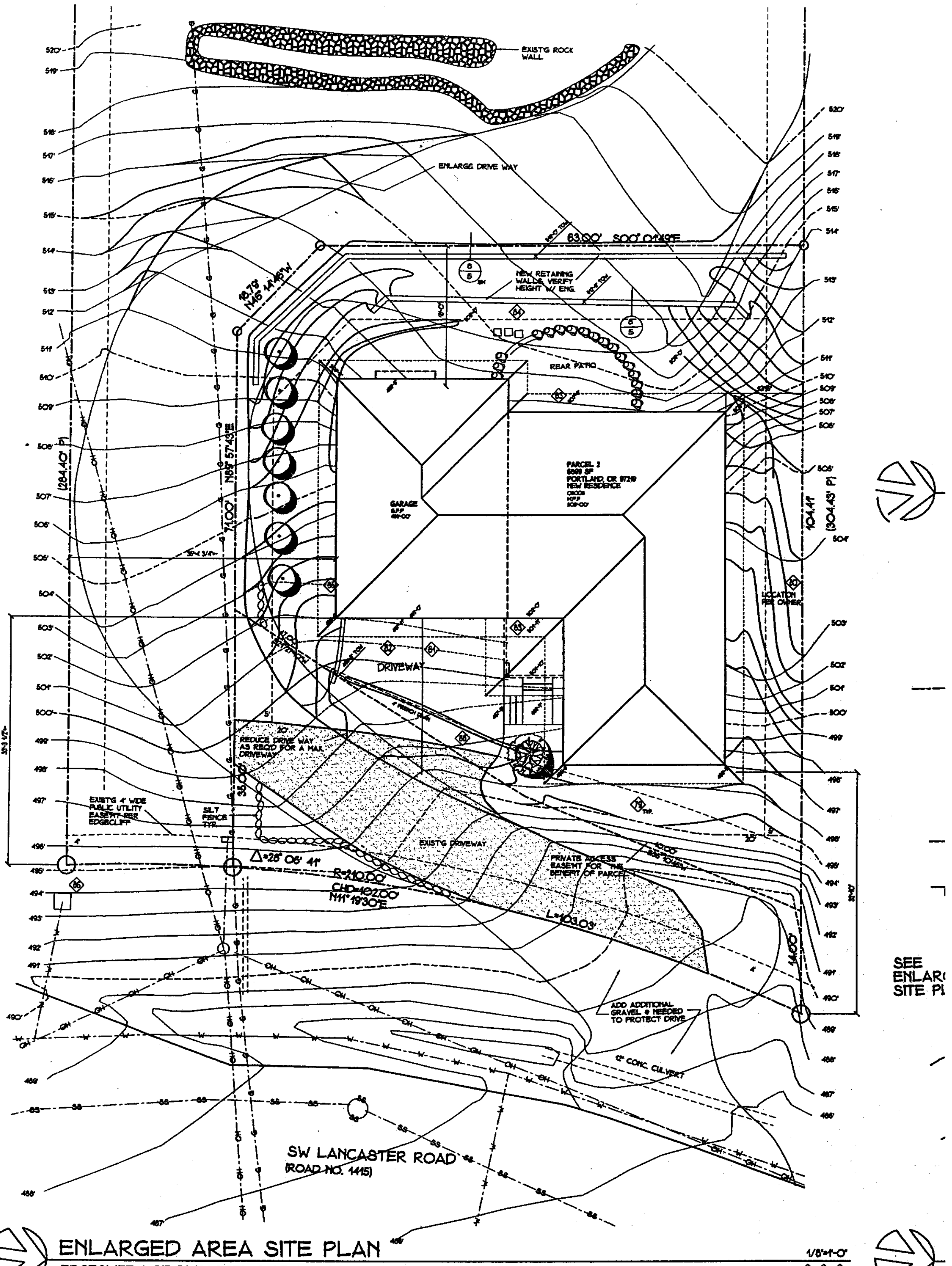
REGISTERED PROFESSIONAL ENGINEER
64,422PE
OREGON
SEPTEMBER 26, 2000
SCOTT L. HARDMAN
EXPIRES: 06-30-2007

4-18-07

Paul Rabay
Project Engineer

Scott L. Hardman, P.E.
Principal Geotechnical Engineer

Attachments: Figure 1 – Site Plan (NW Designer)
Figure 2 – Wall Section (CK Engineering)
M-O Equation Calculation Spreadsheets (2 cases)



ENLARGED AREA SITE PLAN

EDGECLIFF; LOT 56/PARCEL 2 OF PARTITION PLAT 2006-164
PARCEL 2 OF - 10151 SW LANCASTER ROAD
PORTLAND, OREGON 97219
PROPERTY ID# R64986-6540

1/8"=1'-0"

Figure 1

Paul Rabay

503-598-8705

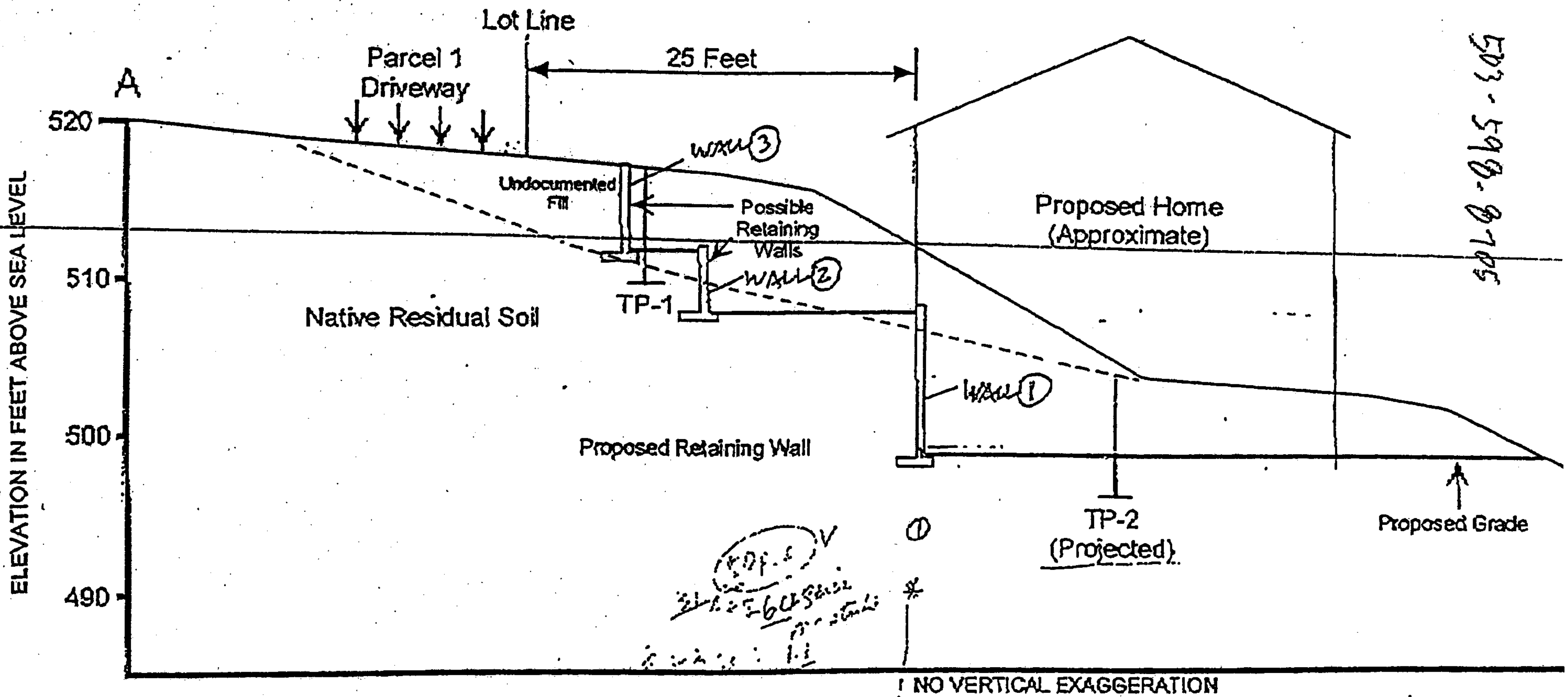


Figure 2

Lateral Earth Pressures for Retaining Wall Design
Mononobe-Okabe Equation (Seismic)
Coulomb Equation (Static)

GeoPacific Engineering, Inc.

Project: Ramble Glen
Proj. No.: 07-1029
Date: 4/18/07

Condition: Seismic, Unrestrained Walls up to 7 Feet in Retained Height with level backslopes

ACTIVE SIDE

Soil Total Unit Weight (pcf)	γ	=	120	
			Degrees	Radians
Soil Friction Angle,	ϕ	=	25	0.436332
Interface Friction Angle,	δ	=	12.5	0.218166
Back of Wall Inclination from Vertical,	θ	=	0	0
Wall Backfill Slope from Horizontal,	β	=	0	0

PASSIVE SIDE

Soil Total Unit Weight (pcf)	γ	=	120	
			Degrees	Radians
Soil Friction Angle,	ϕ	=	25	0.436332
Interface Friction Angle,	δ	=	12.5	0.218166
Back of Wall Inclination from Vertical,	θ	=	0	0
Wall Backfill Slope from Horizontal,	β	=	0	0

horizontal pseudostatic coefficient,	k_h	=	0.137	(2/3 * 1/2 * a_{max})
vertical pseudostatic coefficient,	k_v	=	0.00	
	ψ	=	0.137	

Active Earth Pressure, Static, K_A =	0.367
Active Equivalent Fluid Pressure, Static =	44.1
Active Earth Pressure, Seismic, K_{AE} =	0.476
Active Equivalent Fluid Pressure, Seismic =	57.1

Passive Earth Pressure, Static, K_P =	3.55
Passive Equivalent Fluid Pressure, Static =	426
Passive Earth Pressure, Seismic, K_{PE} =	3.11
Passive Equivalent Fluid Pressure, Seismic =	373

Lateral Earth Pressures for Retaining Wall Design
Mononobe-Okabe Equation (Seismic)
Coulomb Equation (Static)

GeoPacific Engineering, Inc.

Project: Ramble Glen
Proj. No.: 07-1029
Date: 4/18/07

Condition: Seismic, Restrained Walls up to 10 Feet in Retained Height with level backslopes

ACTIVE SIDE

			Degrees	Radians
Soil Total Unit Weight (pcf)	γ	=	120	
Soil Friction Angle,	ϕ	=	30	0.523599
Interface Friction Angle,	δ	=	15	0.261799
Back of Wall Inclination from Vertical,	θ	=	0	0
Wall Backfill Slope from Horizontal,	β	=	0	0

PASSIVE SIDE

			Degrees	Radians
Soil Total Unit Weight (pcf)	γ	=	120	
Soil Friction Angle,	ϕ	=	30	0.523599
Interface Friction Angle,	δ	=	15	0.261799
Back of Wall Inclination from Vertical,	θ	=	0	0
Wall Backfill Slope from Horizontal,	β	=	0	0

horizontal pseudostatic coefficient,	k_h	=	0.206	$(2/3 * 3/4 * a_{max})$
vertical pseudostatic coefficient,	k_v	=	0.00	
	ψ	=	0.206	

Active Earth Pressure, Static, K_A =	0.301
Active Equivalent Fluid Pressure, Static =	36.2
Active Earth Pressure, Seismic, K_{AE} =	0.461
Active Equivalent Fluid Pressure, Seismic =	55.3

Passive Earth Pressure, Static, K_P =	4.98
Passive Equivalent Fluid Pressure, Static =	597
Passive Earth Pressure, Seismic, K_{PE} =	4.09
Passive Equivalent Fluid Pressure, Seismic =	491