SUDDEN VALLEY COMMUNITY ASSOCIATION
RETAINING WALL REPLACEMENT

DESIGN REPORT

Prepared by:
WILSON ENGINEERING
805 Dupont Street
Bellingham, WA. 98225
(360) 733-6100

Prepared for:
Sudden Valley Community Association
4 Clubhouse Circle
Bellingham, WA 98226

Wilson Project No. 2016-078
August 2016

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CONTENTS

1.0 Introduction

The railroad tie retaining walls in Sudden Valley are aging and are in need of replacement. Two prominent locations are along Windward Drive and on the golf course path, adjacent to the clubhouse. In response to the Sudden Valley Community Association's (SVCA) request for retaining wall replacement options, Wilson engineering has prepared three retaining wall design options and provided cost estimates for each. The first of the three designs, Option "A", provides a gravity block wall that does not require a building permit for construction and may be installed in any location that meets the design criteria listed in Section 2.0. The second and third designs, Option "B" and "C", provide designs for reinforced retaining walls that should be considered when the site conditions do not allow the use of Option "A". The reinforced retaining walls, Options "B" and "C" are described in Section 3.0.

2.0 Option "A" – Gravity Block Wall

Whatcom County Planning and Development does not require building permits for retaining walls meeting the following criteria:

1. Walls less than four feet tall, from the bottom of the footing to the top of the wall
2. Slopes of less than 3:1, horizontal to vertical, behind the wall
3. No surcharge above and behind the wall.

When these conditions are met and a soils investigation at the site confirms that the soils are not high in clay content the use of Option "A" is recommended.

Option "A" is a gravity block wall built from Keystone Standard Blocks on a foundation of graded crushed surfacing. Installation of the new wall will require the demolition of the existing wall, excavation of enough material behind the wall to provide room for construction, installation of a perforated drain pipe bedded in drain rock behind the toe of the wall and backfill with gravel upon completion. Details for Option "A" are provided in Exhibit A.

The estimated cost of constructing a retaining wall using Option "A" is approximately $50 per face foot. The details of the cost estimate are listed in Table 1.

ITEM #	MATERIAL	UNIT	UNIT PRICE
1.0	**RETAINING WALL OPTION "A" - Gravity Block Wall**		
1.1	Demolition of Existing Retaining Wall, Including Disposal	FF	$2.00
1.2	Excavation and Backfill	CY/FF	$5.25
1.3	5/8" Crushed Rock (WSDOT 9-03.9(3))	TON/FF	$0.30
1.4	Drain Rock (WSDOT 9-03.11(2) 4" Cobbles)	TON/FF	$3.00
1.5	Perforated Drain Pipe	LF/FF	$0.50
1.6	Keystone Standard Block Wall with delivery and pallet charges	FF	$15.00
1.7	Keystone Wall Caps	EA/FF	$1.25
1.8	Cap Adhesive	TUBE/FF	$0.30
2.0	**Labor**		
2.1	Foreman	Hr/FF	$2.14
2.2	Laborer	Hr/FF	$4.50
3.0	**Equipment**		
3.1	Backhoe	Hr/FF	$13.00
4.0	**Temporary Erosion Control (Lump Sum Bid Item)**		
4.1	Erosion and Sedimentation Control Installation and Removal	FF	$1.50
	Esitmated Gravity Retaining Wall Price Per Face-Foot		**$48.74**

Table 1 – Cost estimate details for construction of the Gravity Block Wall, Option "A" per face-foot.

3.0 Options "B" & "C" – Reinforced Retaining Walls

Option "B" or Option "C" should be considered when the replacement retaining wall will be taller than four feet, if the site will not allow a finished grade behind the wall of less than 3:1 (horizontal to vertical) or if there are existing structures, parking areas or other conditions that apply a surcharge behind the wall or when the soils at the site have a high clay content. Options "B" and "C" include methods for reinforcing the wall by including geogrids or soil anchors to provide added stability.

3.1 Option "B" – Reinforced Block Wall

Option "B" is a reinforced block wall that utilizes Keystone Standard block units and includes a geogrid for added stability. Option "B" requires a building permit and, if deemed necessary by Whatcom County, structural calculations. Option "B" should be used when the site conditions will not allow construction of Option "A". If the wall height exceeds 7 feet further engineering design or selection of another wall design may be required based on site soil conditions.

Option “B” is a reinforced block wall built from Keystone Standard Blocks on a foundation of graded crushed surfacing. Installation of the new wall will require the demolition of the existing wall and excavation of enough material behind the wall to provide room for installation of the geogrid reinforcement. The geogrid should be installed for the entire length of the wall, between the third and fourth course of Keystone blocks, and extended back five feet, at a minimum, from the face of the wall. Install a perforated drain pipe bedded in drain rock behind the toe of the wall and backfill with gravel upon completion. Details for Option “B” are provided in Exhibit A.

The estimated cost of constructing a retaining wall using Option “B” is approximately $75 per face foot. The details of the cost estimate are listed in Table 2.

ITEM #	**MATERIAL**	UNIT	UNIT PRICE
1.0	**RETAINING WALL OPTION "B" - Reinforced Block Wall**		
1.1	Demolition of Existing Retaining Wall, Including Disposal	FF	$2.00
1.2	Excavation and Backfill	CY/FF	$31.15
1.3	5/8" Crushed Rock (WSDOT 9-03.9(3))	TON/FF	$0.30
1.4	Drain Rock (WSDOT 9-03.11(2) 4" Cobbles)	TON/FF	$3.00
1.5	Perforated Drain Pipe	LF/FF	$0.50
1.6	Keystone Standard Block Wall with delivery and pallet charges	FF	$15.00
1.7	Keystone Wall Caps	EA/FF	$1.25
1.8	Cap Adhesive	TUBE/FF	$0.30
2.0	**Labor**		
2.1	Foreman	Hr/FF	$2.14
2.2	Laborer	Hr/FF	$4.50
3.0	**Equipment**		
3.1	Backhoe	Hr/FF	$13.00
4.0	**Temporary Erosion Control (Lump Sum Bid Item)**		
4.1	Erosion and Sedimentation Control Installation and Removal	FF	$1.50
	Esitmated Reinforced Retaining Wall Price Per Face-Foot		**$74.64**

Table 2 – Cost estimate details for construction of the Reinforced Block Wall, Option “B”

3.2 Option “C” – Air Placed Concrete

Option “C” utilizes air-placed concrete to construct a replacement retaining wall in order to minimize the space required for installation. The demolition and excavation required for this design provides minimal disturbance to the existing slope behind the wall and the surrounding area. This option could be used on the slope below the clubhouse at the edge of the golf cart path. Details for Option “C” are provided in Exhibit B.

The construction process of the air-placed concrete retaining wall requires the following steps:

1. Demolition of the existing wall to expose the native soil behind

2. Excavation of existing soil and placement of 1-foot depth of CSTC for wall foundation

3. Reinforcement options include:

    a. Piles
    b. Helical Soil Anchors
    c. 'Manta Ray' MR-88 Soil Anchors

4. Installation of rebar reinforcement. Rebar will be tied to the soil anchors or reinforcement piles

5. Installation of Air-Placed concrete against the exposed earth surface, to be built up around the rebar reinforcement to a final thickness of six to eight inches. Weep holes along the base of the wall will provide for groundwater drainage

The estimated costs for construction of a replacement retaining wall using Option "C" with reinforcement is approximately $100 per face foot. The details of the cost estimate are listed in Table 3.

ITEM #	MATERIAL	UNIT	UNIT PRICE
1	**RETAINING WALL OPTION "C" - Air Placed Concrete**		
1.1	Demolition of Existing Retaining Wall, Including Disposal	FF	$2.00
1.2	Excavation for Foundation	CY/FF	$0.35
1.3	Filter Fabric	SF/FF	$0.75
1.4	5/8" Crushed Rock (WSDOT 9-03.9(3))	TON/FF	$0.30
1.5	Reinforcement Alternates		
1.5a	Helical Soil Anchors 10ft 1-1/2" shaft (installed)	EA/FF	$1.25
1.5b	Manta Ray' MR-88 Soil Anchors (installed)	EA/FF	$0.30
1.5c	W6x20 Reinforcement Piles (installed)	EA/FF	$0.88
1.6	Rebar Reinforcement	LF/FF	$1.25
1.7	Air-Placed Concrete with Weepholes	CY/FF	$75.00
2	**Labor**		
1.10	Foreman	Hr/FF	$2.14
1.11	Laborer	Hr/FF	$4.50
3	**Equipment**		
3.1	Backhoe	Hr/FF	$13.00
4	**Temporary Erosion Control (Lump Sum Bid Item)**		
4.1	Erosion and Sedimentation Control Installation and Removal	FF	$1.50
	Estimated Retaining Wall #2 Alternate A - Helical Anchors Total		**$102.04**
	Estimated Retaining Wall #2 Alternate B - Manta Ray Anchors Total		**$101.09**
	Estimated Retaining Wall #2 Alternate C - Piles Total		**$101.67**

Table 3 – Cost estimate details for construction of the Reinforced Concrete Retaining Wall, Option "C"

4.0 Permitting

Permitting requirements will vary depending on the size and location of each project.

Option A is designed to minimize the permitting requirements but a Natural Resource Notification of Activity will be required at a minimum. Option B and Option C are more involved designs and are likely to require further permitting. The permits likely to be required are listed below with a brief description of their use and requirements. This is not an exhaustive list as each project and location is unique.

4.1 Notification of Activity

- To be submitted when work is to be performed in or near a critical area or Water Resource Special Management Area (such as Lake Whatcom)
- Permit application is to be submitted 10 days before construction is planned to begin
- Permit application fee: $35

4.2 Building Permit

- To be submitted for construction of any reinforced retaining wall (Options B or C)
- Building permits require a Pre-Screening
- Permit application approval is likely to take two (2) months and varies based on the time of year, as summer months see more construction
- Permit application fee schedule:
    - Project Price Permit Fee
    - $2,001 – $25,000……...$60
    - $25,001 - $50,000……...$325
    - $50,001 - $100,000……$575
    - *For complete listing of fees see the Whatcom County Unified Fee Schedule*

4.2 Land Disturbance Permit

- Required if
    - More than 500 square feet of soil is exposed between October 1st and May 31st
    - More than 50 cubic yards of fill or grade occurs
    - *Any* fill, grade or clearing within 300 feet of critical areas
- To be submitted with a building permit
- Permit application fee: $650

4.3 Shoreline Exemption Permit

- Normal maintenance or repair of existing structures may be exempted from a shoreline permit per Whatcom County Code 23.60.022 (B)
- Exemption approval is likely to take three (3) months and varies based on the time of year, as summer months see more construction
- Permit application fee: $550

5.0 Summary of Options

The total cost for each design option is listed below, and outlines the combined costs listed in this report:

5.1 Summary of Option A – Gravity Block Wall (Applicable at Windward Drive)

Notification of Activity Permit.…..... $75

Construction Price (per face foot)….. $50 x face foot of wall

Note: Assumes SVCA will solicit and administer all permits, bids and work by the contractor and no further engineering is required.

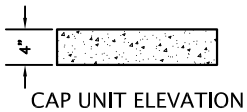
5.2 Summary of Option B – Reinforced Block Wall

Pre-Construction Activity	Cost
**Building Permit……...* **Assumes a construction cost of $50,000 to $100,000*	*$3,500 - $4,500*
Land Disturbance Permit……...	*$800*
Shoreline Exemption Permit……...	*$1,000*
Geotechnical Investigation……	*$2,000 - $3,000*
Survey and Construction Staking…….	*$3,500 - $5,000*
Engineering Design……	*$7,000*
Bid Phase Support……...	*$700 - $1,200*
Construction Support Services…….	*$1,500 - $2,500*
Pre-Construction Estimate of Design, Engineering Permitting and Survey Costs……	**$20,000 - $25,000**
Estimated Construction Cost…….	**$75 x face foot of wall**

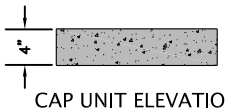
5.3 Summary of Option C – Reinforced Concrete Wall (Applicable at Clubhouse wall)

Activity	Cost
**Building Permit……...*	*$3,500 - $4,500*
**Assumes a construction cost of $50,000 to $100,000*	
Land Disturbance Permit……...	*$800*
Shoreline Exemption Permit……...	*$1,000*
Geotechnical Investigation……	*$2,000 - $3,000*
Survey and Construction Staking……..	*$3,500 - $5,000*
Engineering Design……	*$7,000*
Bid Phase Support……...	*$700 - $1,200*
Construction Support Services…….	*$1,500 - $2,500*
Pre-Construction Estimate of Design, Engineering Permitting and Survey Costs……..	**$20,000 - $25,000**
Estimated Construction Cost……..	**$100 x face foot of wall**

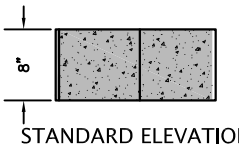
Exhibit ‘A’ – Option “A” Details:
Gravity Block Wall



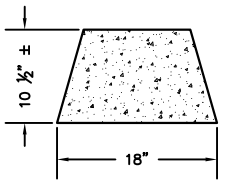
CAP UNIT ELEVATION



CAP UNIT ELEVATION

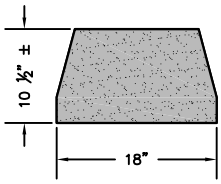


STANDARD ELEVATION



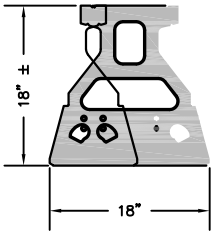
CAP UNIT PLAN

UNIVERSAL
CAP UNIT OPTION



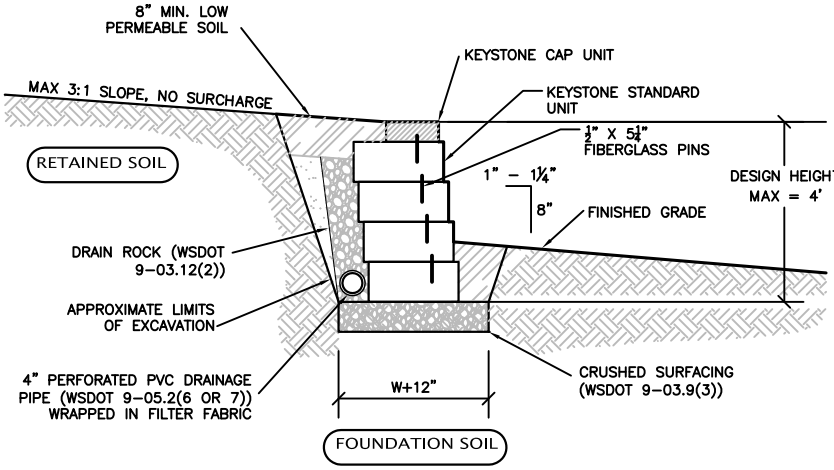
CAP UNIT PLAN

STRAIGHT SPLIT
CAP UNIT OPTION



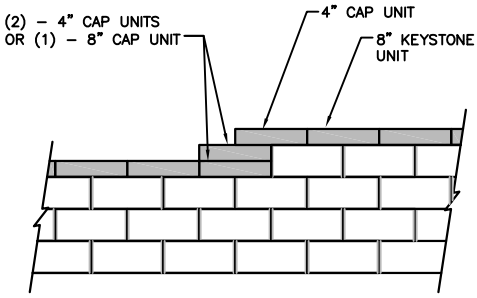
STANDARD PLAN

STANDARD UNIT



TYPICAL GRAVITY WALL SECTION

STANDARD UNIT – 1" SETBACK



NOTE:

1. SECURE ALL CAP UNITS WITH KEYSTONE KAPSEAL OR EQUAL

TOP OF WALL STEPS

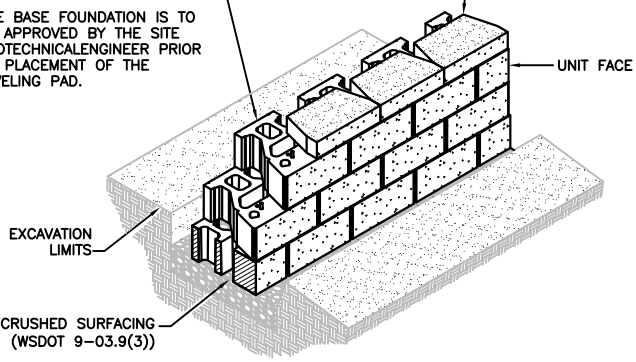
(IF NEEDED)

BASE LEVELING PAD NOTES:

1. THE LEVELING PAD IS TO BE CONSTRUCTED OF CRUSHED STONE OR 2,000 PSI± UNREINFORCED CONCRETE
2. THE BASE FOUNDATION IS TO BE APPROVED BY THE SITE GEOTECHNICALENGINEER PRIOR TO PLACEMENT OF THE LEVELING PAD.

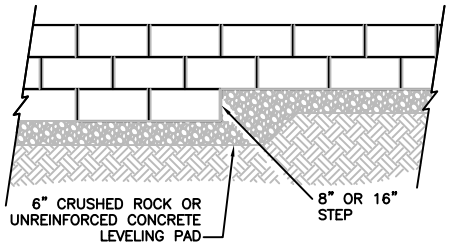
STANDARD UNIT	
WIDTH:	18"
DEPTH:	18"
HEIGHT:	8"
WEIGHT:	108 lbs

CAP UNIT	
WIDTH:	18"
DEPTH:	10 1/2"
HEIGHT:	4"
WEIGHT:	50 lbs



UNIT/BASE PAD ISOMETRIC SECTION VIEW

DIMENSIONS & WEIGHT MAY VARY BY REGION



ELEVATION

NOTE:

1. THE LEVELING PAD IS TO BE CONSTRUCTED OF CRUSHED STONE OR 2000 PSI ± UNREINFORCED CONCRETE.

Wilson
SURVEY/ENGINEERING

WILSON ENGINEERING, LLC
805 DUPONT STREET
BELLINGHAM, WA 98225
(360) 733-6100 • FAX (360) 647-9061

www.wilsonengineering.com

SUDDEN VALLEY COMMUNITY ASSOCIATION

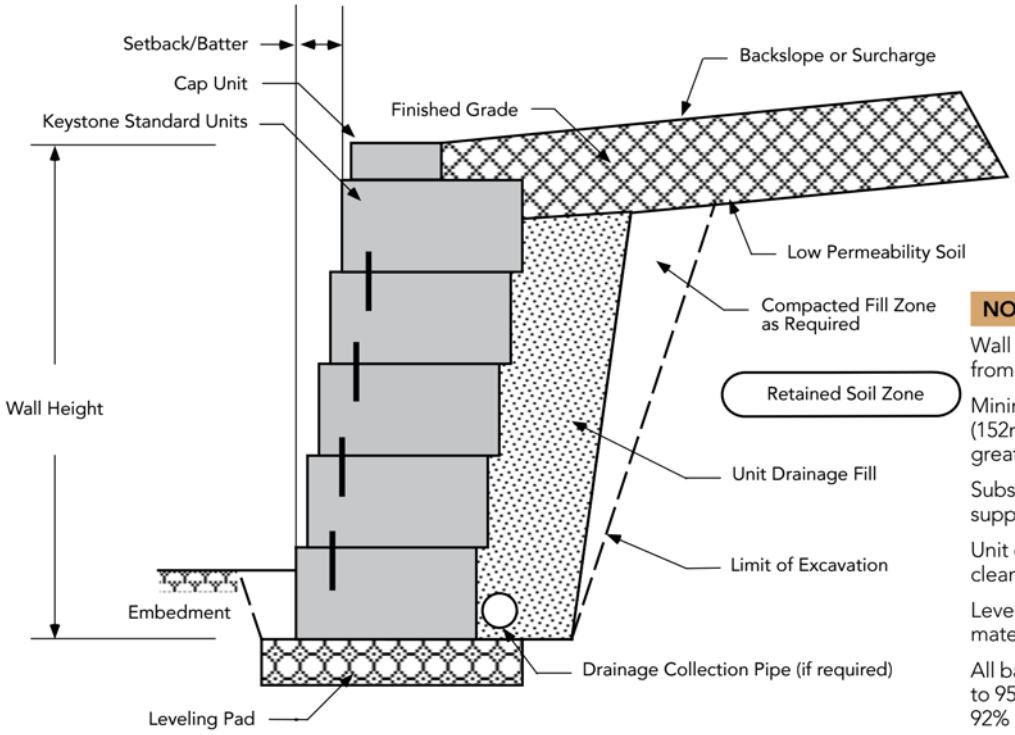
WHATCOM COUNTY WASHINGTON

GRAVITY BLOCK WALL
DETAILS

DATE	SHEET
JULY 2016	1
SCALE	OF
AS SHOWN	
JOB NO.	
2016-078	1

Gravity Wall Schematic

GRAVITY WALL SCHEMATIC



NOTES:

Wall Height (H) is the total height from top to bottom.

Minimum wall embedment is 6 inches (152mm) or Height/8, whichever is greater for level toe.

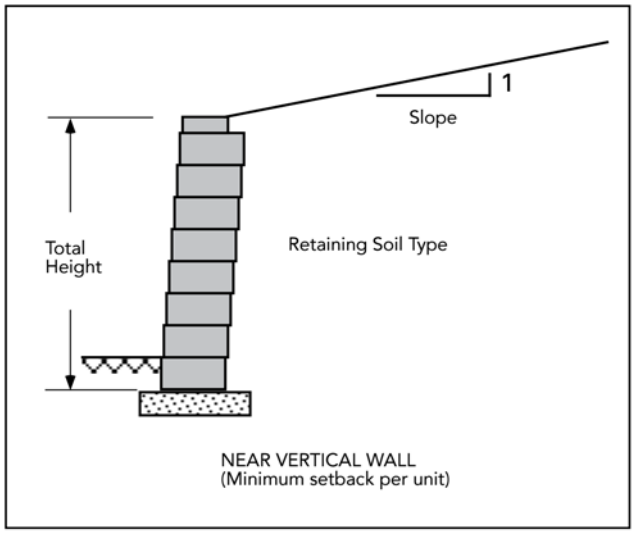
Subsurface soils must be capable of supporting wall system.

Unit drainage fill is ¾ inch (19mm) clean crushed stone.

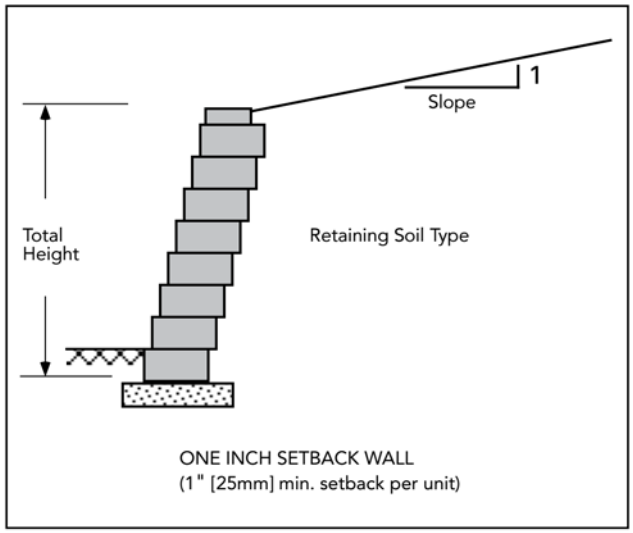
Leveling pad is crushed stone base material.

All backfill materials are compacted to 95% Standard Proctor Density or 92% Modified Proctor Density.

Finished grade must provide positive drainage.



NEAR VERTICAL WALL
(Minimum setback per unit)



ONE INCH SETBACK WALL
(1" [25mm] min. setback per unit)

NEAR VERTICAL - KEYSTONE STANDARD UNITS-18" (457mm)

MAX. HGT.	BACKSLOPE			
Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	4.33' (1.3m)	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)
Silty Sand	3.67' (1.1m)	3.00' (0.9m)	3.00' (0.9m)	3.00' (0.9m)
Silt/Lean Clay	3.67' (1.1m)	3.00' (0.9m)	3.00' (0.9m)	<1.00' (0.3m)

SETBACK OPTION - KEYSTONE STANDARD UNITS-18" (457mm)

MAX. HGT.	BACKSLOPE			
Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	5.67' (1.7m)	5.00' (1.5m)	5.00' (1.5m)	4.33' (1.3m)
Silty Sand	5.00' (1.5m)	4.33' (1.3m)	4.33' (1.3m)	3.67' (1.1m)
Silt/Lean Clay	4.33' (1.3m)	3.67' (1.1m)	3.00' (0.9m)	2.33' (0.7m)

NEAR VERTICAL - KEYSTONE STANDARD UNITS-21" (533mm)

MAX. HGT.	BACKSLOPE			
Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	5.00' (1.5m)	4.33' (1.3m)	4.33' (1.3m)	3.67' (1.1m)
Silty Sand	4.33' (1.3m)	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)
Silt/Lean Clay	3.67' (1.1m)	3.67' (1.1m)	3.00' (0.9m)	2.33' (0.7m)

SETBACK OPTION - KEYSTONE STANDARD UNITS-21" (533mm)

MAX. HGT.	BACKSLOPE			
Soil Type	Level	4H:1V	3H:1V	2H:1V
Sand/Gravel	7.00' (2.1m)	6.33' (1.9m)	5.67' (1.7m)	5.00' (1.5m)
Silty Sand	5.67' (1.7m)	5.00' (1.5m)	5.00' (1.5m)	4.33' (1.3m)
Silt/Lean Clay	5.00' (1.5m)	4.33' (1.3m)	3.67' (1.1m)	3.00' (0.9m)

NOTES:

Calculations assume a unit weight of 120 Pcf (19kN/M^2) for all soil types. Assumed ϕ angles for earth pressure calculations are: Sand/Gravel=34°, Silty Sand=30°, and Sandy Silt/Lean Clay=26°. Non-critical structures with FS>1.5. Gravity wall charts are performed using coulomb earth pressure analysis. (NCMA 3rd Edition) Near vertical walls utilize 1° batter and 1" (25mm) setback walls utilize 8° batter. No surcharges were used in the analysis. Surcharges or special loading conditions will reduce maximum wall heights. Sliding calculations assume a 6" (152mm) crushed stone leveling pad as compacted foundation material. The information provided is for preliminary design use only. A qualified professional should be consulted. Keystone accepts no liability for the use of these tables.

Series III

Height	Width	Depth	Weight
8"	18"	18-21"	82-93 lbs
203mm	457mm	457-533mm	37-42 kg

UNIT COLOR, DIMENSIONS, WEIGHT & AVAILABILITY VARIES BY MANUFACTURER.

Units/Sq.Ft.

1

Series II

Height	Width	Depth	Weight
8"	18"	18-21"	92-97 lbs
203mm	457mm	457-533mm	42-44 kg

UNIT COLOR, DIMENSIONS, WEIGHT & AVAILABILITY VARIES BY MANUFACTURER.

Units/Sq.Ft.

1

Series I

Height	Width	Depth	Weight
8"	18"	18-21"	94-106 lbs
203mm	457mm	457-533mm	43-48 kg

UNIT COLOR, DIMENSIONS, WEIGHT & AVAILABILITY VARIES BY MANUFACTURER.

Units/Sq.Ft.

1

Exhibit ‘B’ – Option “B” Details:
Reinforced Block Wall

Design/Estimating Charts: Reinforced Wall Charts Notes

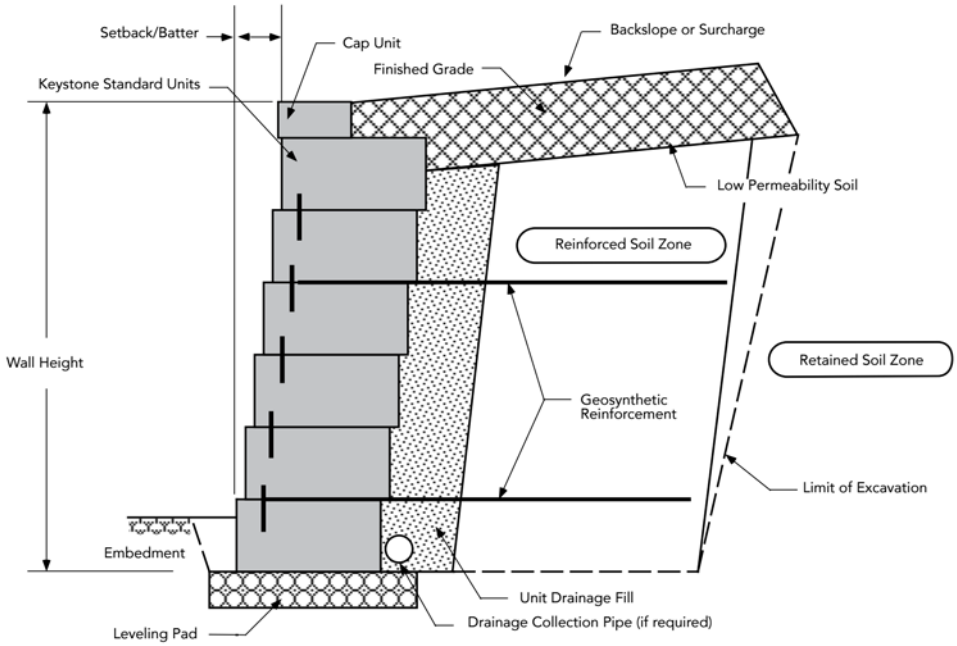
The Keystone reinforced wall charts are graphically presented to show the proper location and lengths of geogrids used with Keystone Standard units at the near vertical and 1 inch (25mm) setback batter (8°). Design heights were set in two block increments beginning at 4.3 feet (1.3m) and ending 11 feet (3.4m). Engineering judgement should be used when interpolating between heights. In general, geogrid should be placed at the design elevation for the entire wall length or until a wall step is reached. Minimum reinforcement lengths were set for 5 feet(1.5m) and a 70% reinforcement length to wall height ratio. Always use the same vertical spacing of geogrid throughout the wall. If your maximum height of wall requires 3 units vertical spacing, then use that spacing even though lower wall heights in the charts may indicate 4 units. Top layers of geogrid shall never be more than 3 units from the top of the wall. Bottom layers of geogrid shall never be more than 3 units from the top of the leveling pad. Insert a geogrid layer at these locations where 3 unit courses are exceeded. 250 psf surcharge is applied 6 inches (152mm) behind the tail of the units. Soil ranges were selected to approximate good, medium and poor soil conditions to cover the typical design range. Wall height is the total height of the wall from the top of the leveling pad to the top of the wall.

The charts use Rankine earth pressure for calculations. The following charts assume the use of a coated polyester geogrid with a minimum allowable design strength of: LTDS=1800 plf (26.3 kN/m) Tal=1200 plf (17.5 kN/m). The following geogrid types are suitable with these design charts:

- Synteen SF35 by Synteen
- Miragrid 3XT by TC Mirafi
- Stratagrid 200 by Strata Systems
- 55/30-20 by Huesker Inc.

All geogrid lengths shown are the actual lengths of geogrid required as measured from the front wall face to the end of the geogrid. The charts assume that the walls are constructed in accordance with Keystone specifications and good construction practice. All soil zones (reinforced, retained, and foundation) must be compacted in 8 inch (203mm) lifts to 95% Standard Proctor density or 92% Modified Proctor Density as determined by laboratory testing. The information contained in the design/estimating charts are for preliminary design use only. A qualified professional should be consulted for final design assistance. Keystone accepts no liability for the use of these charts.

REINFORCED WALL SCHEMATIC



NOTES:

Wall Height (H) is the total height from top to bottom.

Minimum wall embedment is 6 inches (152mm) or Height/20, whichever is greater for level toe.

Subsurface soils must be capable of supporting wall system.

Unit drainage fill is ¾ inch (19mm) clean crushed stone.

Leveling pad is crushed stone base material.

All backfill materials are compacted to 95% Standard Proctor density or 92% Modified Proctor density.

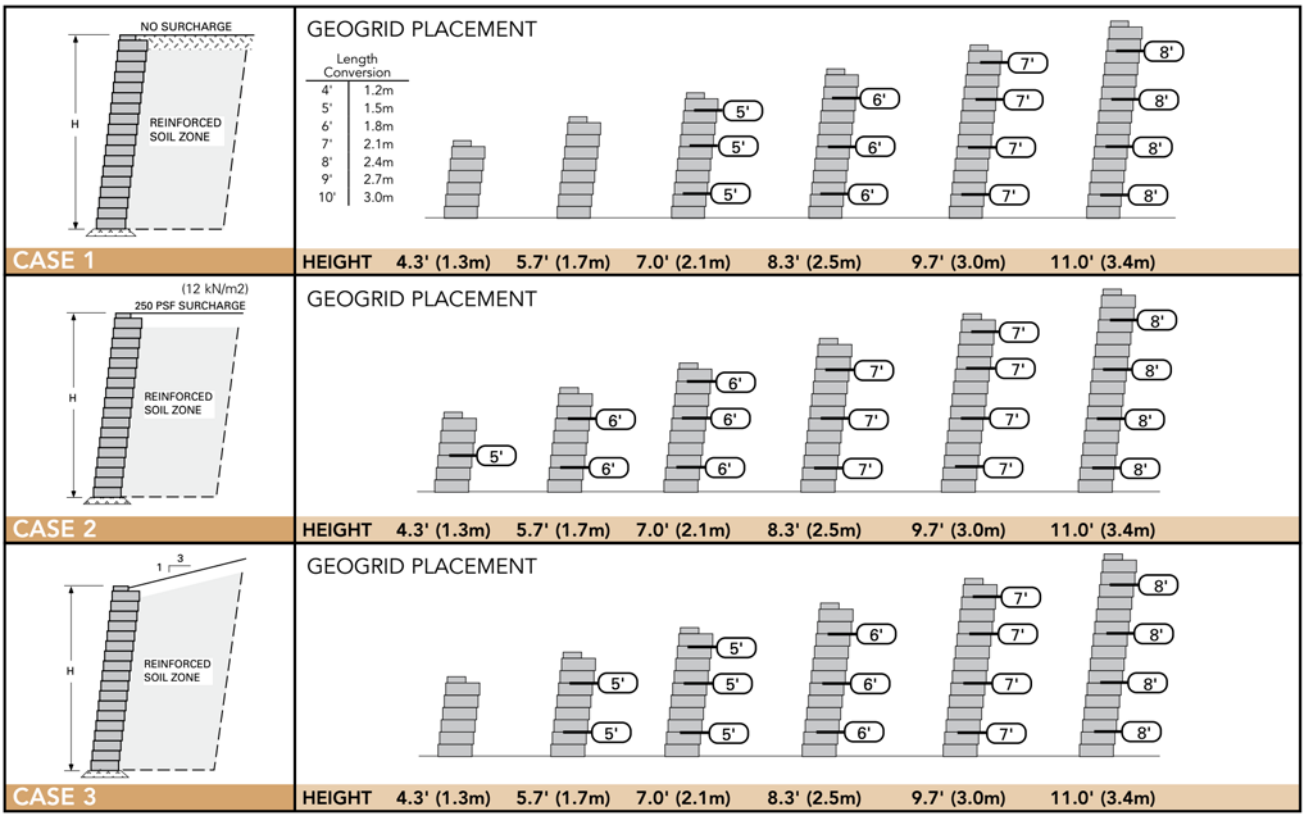
Geogrids must be of appropriate type and length per the design.

Finished grade must provide positive drainage.

The symbol —(5')— indicates location and length of geogrid measured from the front of wall to the end of the geogrid.

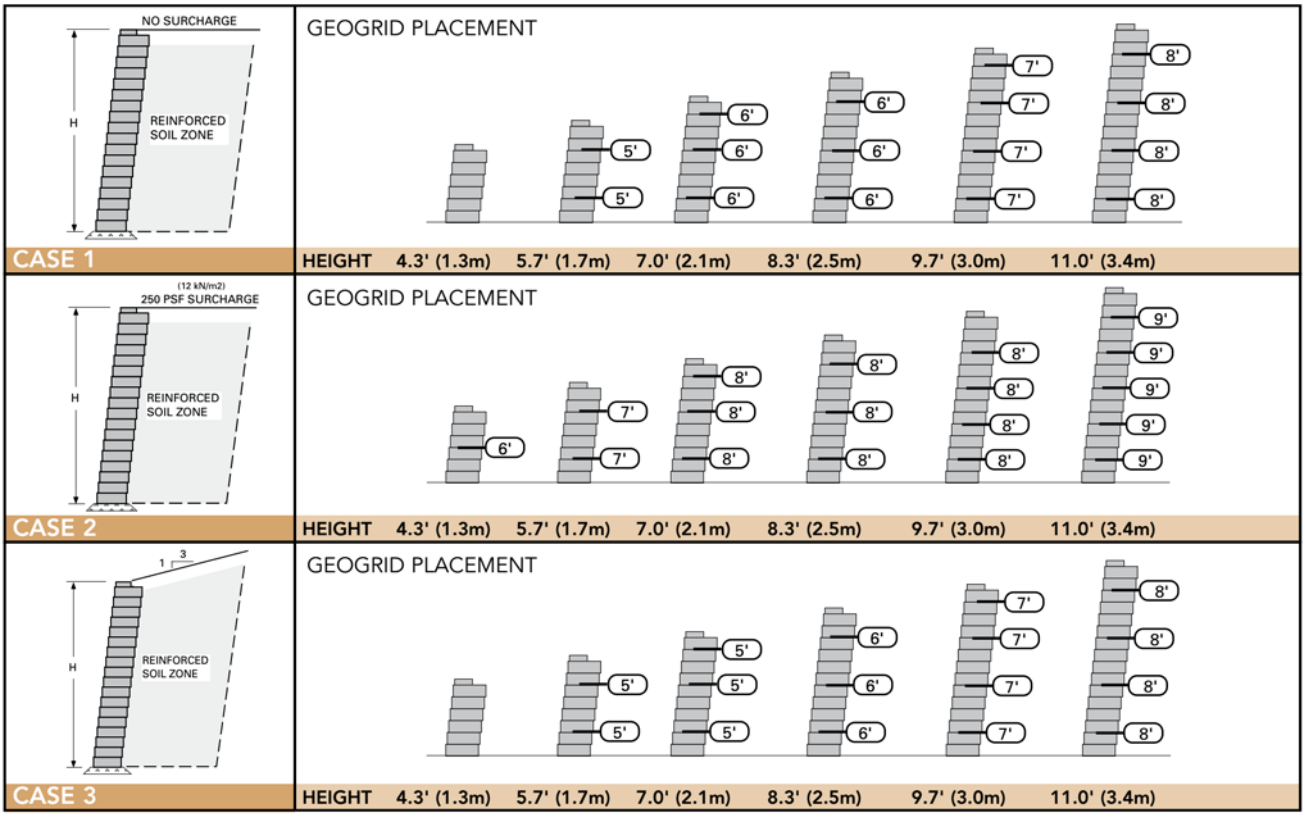
KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

SAND/GRAVEL: ϕ=34°, γ=120 pcf (19kN/m^3)



KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

SILTY SAND: ϕ=30°, γ=120 pcf (19kN/m^3)

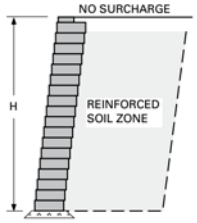


Design/Estimating Charts: Reinforced Wall Charts

KEYSTONE STANDARD UNITS - 1" (25mm) SETBACK

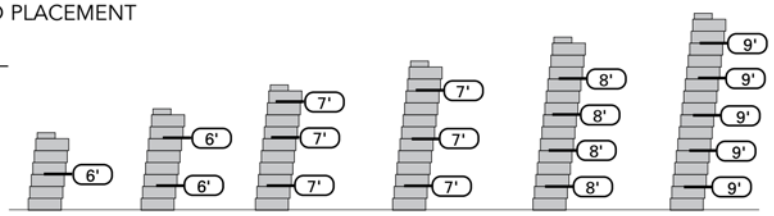
SILT/LEAN CLAY: ϕ=26°, γ=120 pcf (19kN/m^3)

CASE 1



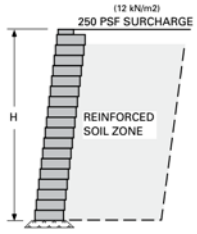
GEOGRID PLACEMENT

Length Conversion	
4'	1.2m
5'	1.5m
6'	1.8m
7'	2.1m
8'	2.4m
9'	2.7m
10'	3.0m

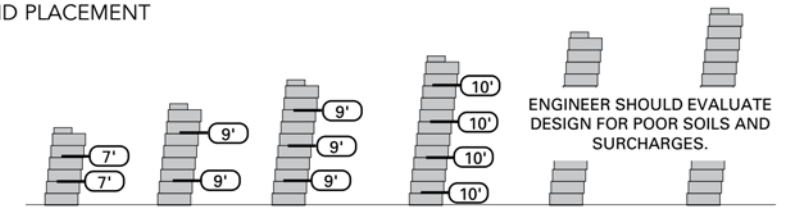


HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

CASE 2

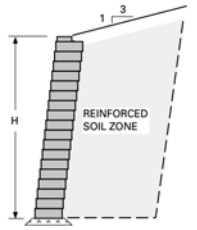


GEOGRID PLACEMENT

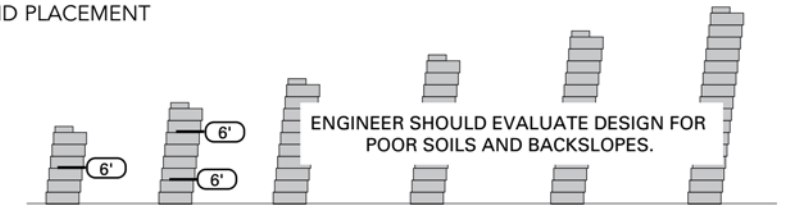


HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

CASE 3



GEOGRID PLACEMENT

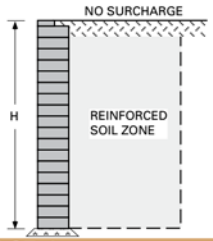


HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

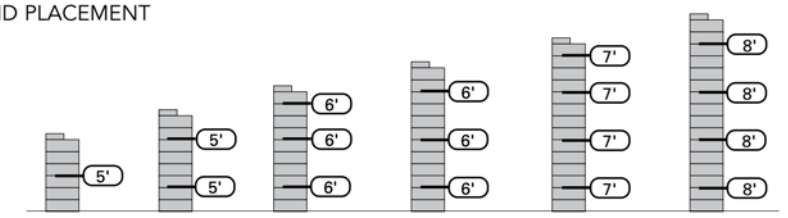
KEYSTONE STANDARD UNITS - NEAR VERTICAL

SAND/GRAVEL: ϕ=34°, γ=120 pcf (19kN/m^3)

CASE 1

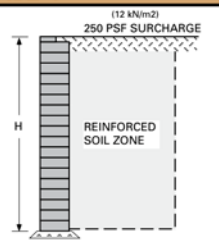


GEOGRID PLACEMENT

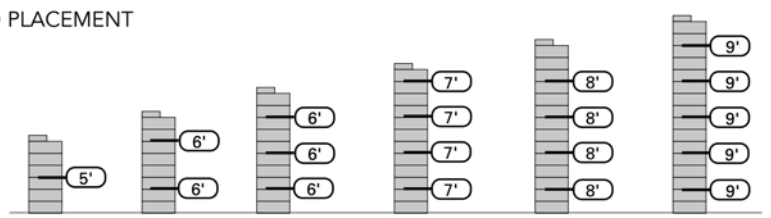


HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

CASE 2

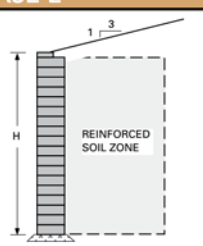


GEOGRID PLACEMENT

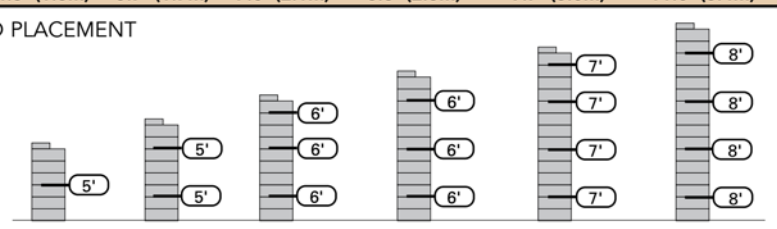


HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

CASE 3



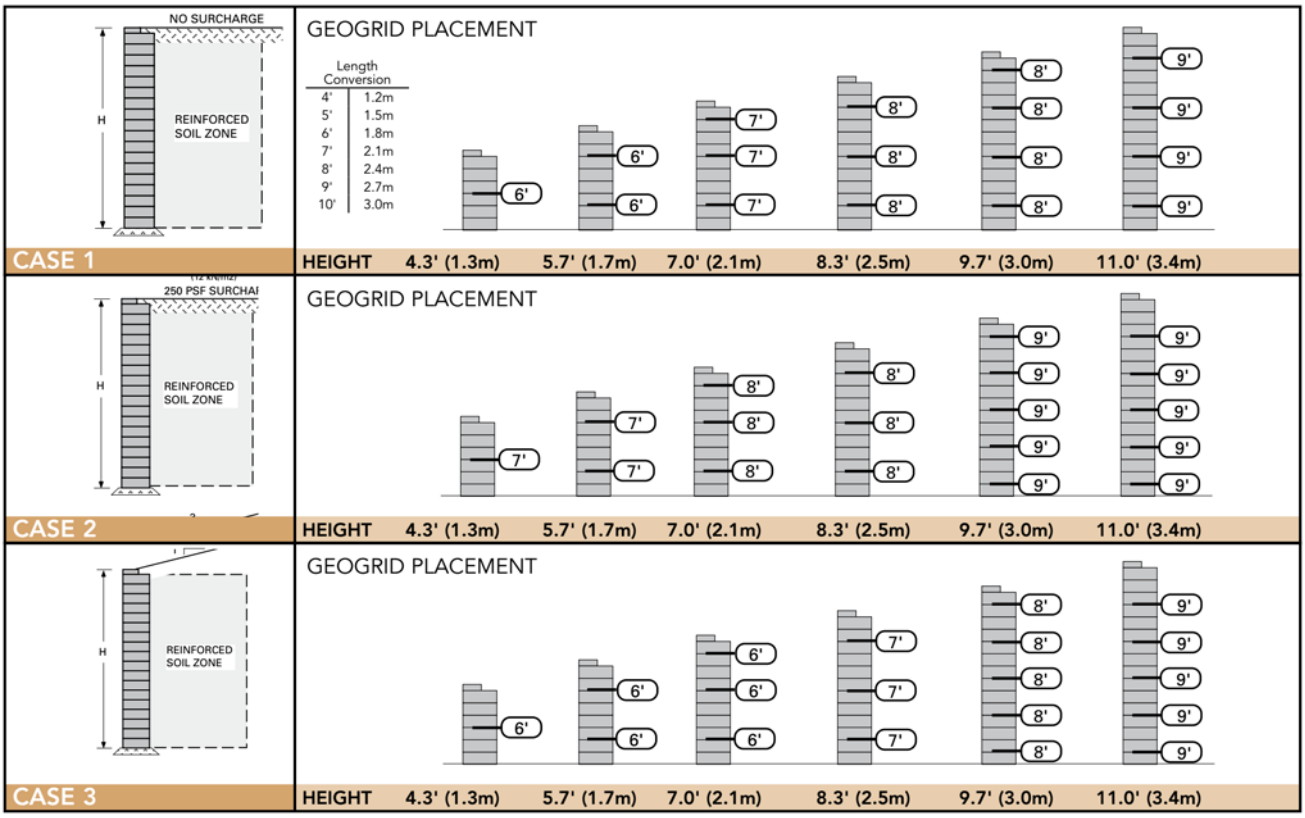
GEOGRID PLACEMENT



HEIGHT	4.3' (1.3m)	5.7' (1.7m)	7.0' (2.1m)	8.3' (2.5m)	9.7' (3.0m)	11.0' (3.4m)

KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILTY SAND: ϕ=30°, γ=120 pcf (19kN/m^3)



KEYSTONE STANDARD UNITS - NEAR VERTICAL

SILTY/LEAN CLAY: ϕ=26°, γ=120 pcf (19kN/m^3)

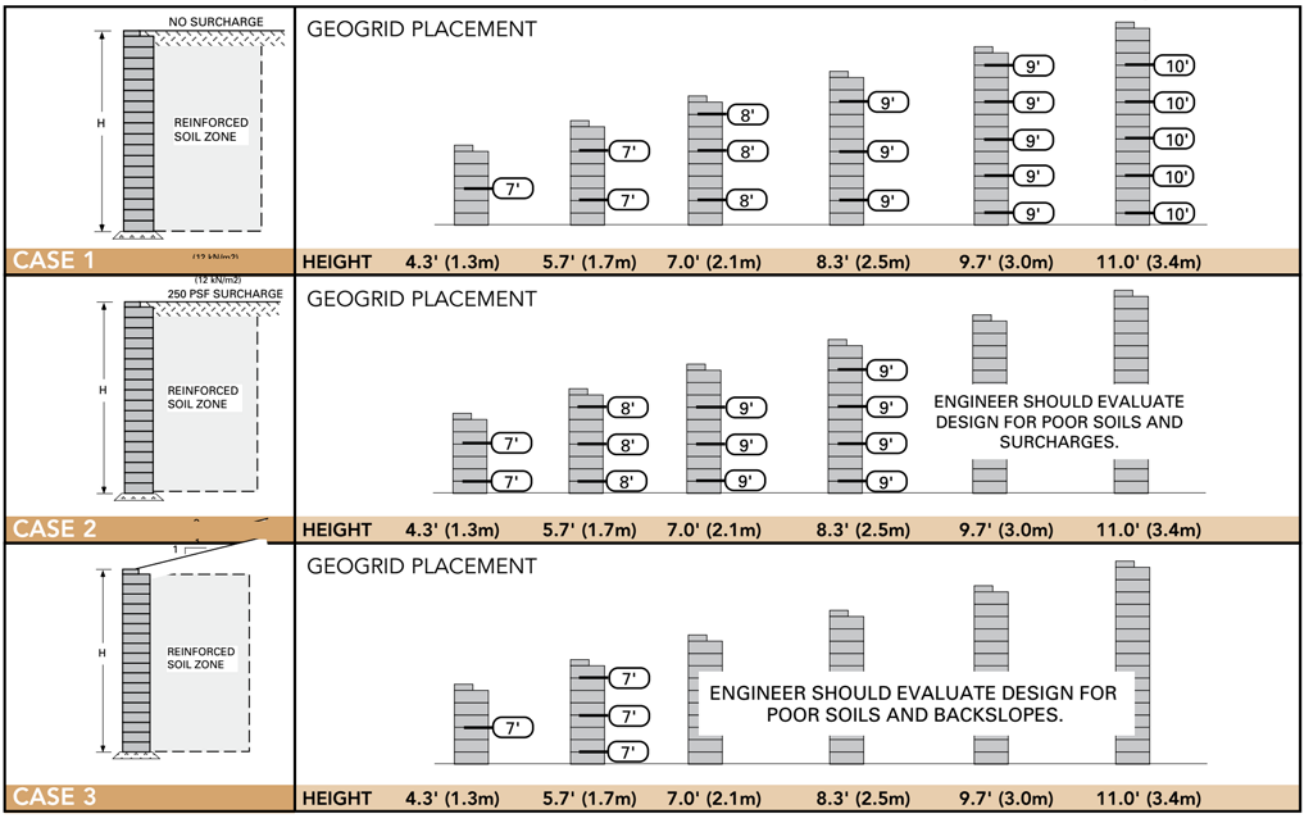
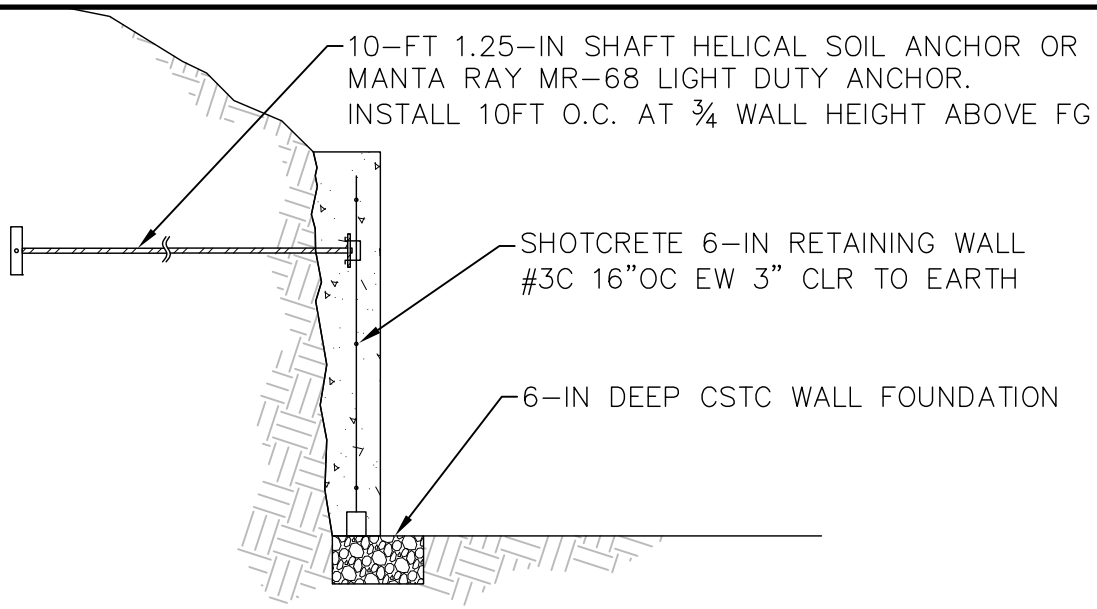
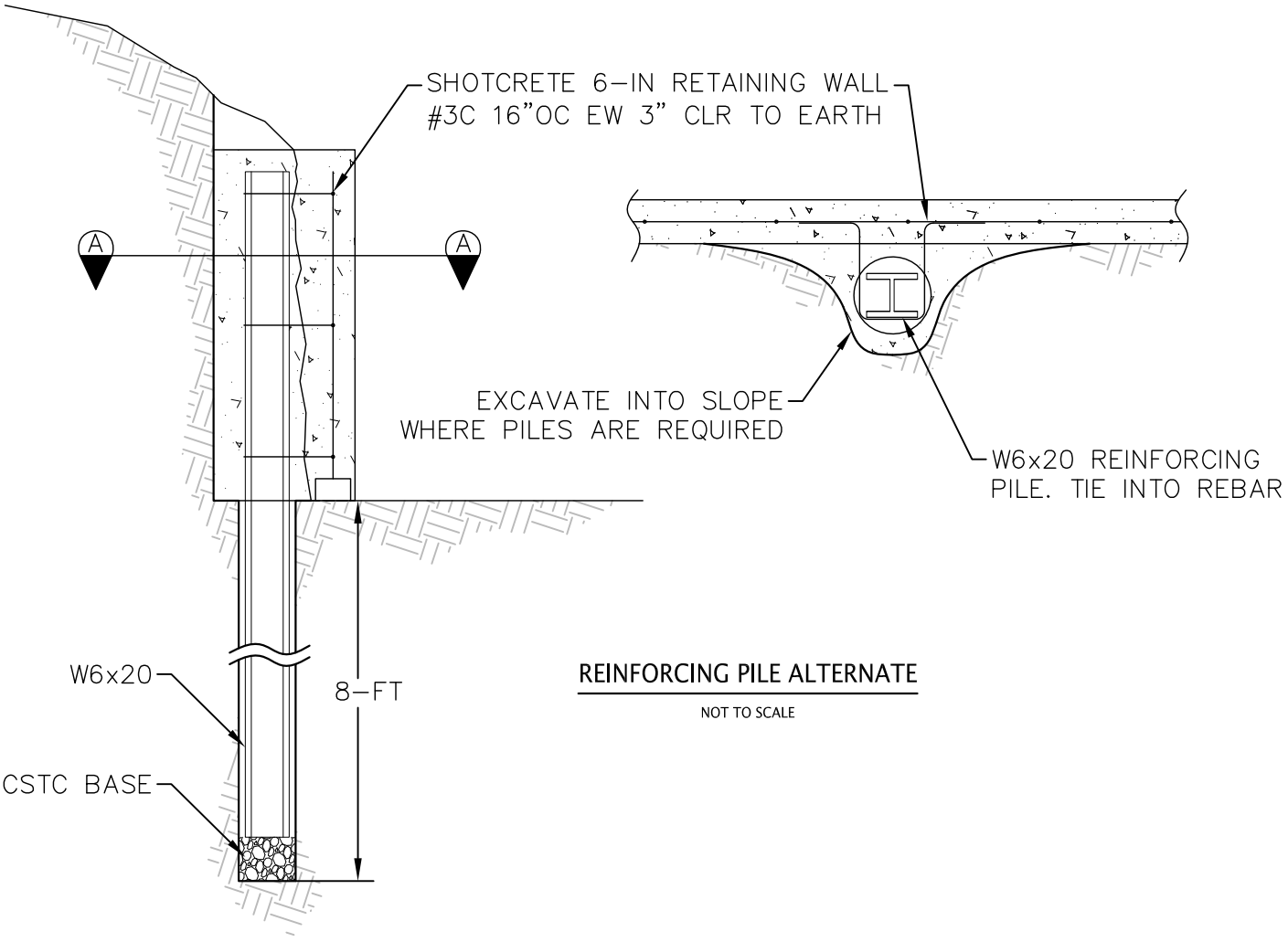


Exhibit ‘C’ – Option “C” Details:
Reinforced Concrete Wall



SOIL ANCHOR ALTERNATE

NOT TO SCALE



REINFORCING PILE ALTERNATE

NOT TO SCALE

Wilson
SURVEY/ENGINEERING
WILSON ENGINEERING, LLC
805 DUPONT STREET
BELLINGHAM, WA 98225
(360) 733–6100 • FAX (360) 647–9061
www.wilsonengineering.com

SUDDEN VALLEY COMMUNITY ASSOCIATION

WHATCOM COUNTY WASHINGTON

REINFORCED CONCRETE WALL
DETAILS

DATE	SHEET
JULY 2016	1
SCALE	OF
AS SHOWN	
JOB NO.	1
2016-078	