

# BroadStone 8" Walls

## Masterplan

### St. Louis County, MO

#### GENERAL DESIGN NOTES

1. The following effective strength design parameters were assumed in the preparation of structural calculations for the Keystone retaining wall system:

	$\phi$	c (psf)	$\gamma$ (pcf)
Reinforced Soil	28°	0	120
Retained Soil	28°	0	120
Foundation Soil	28°	0	120

Soil types and design properties shall be confirmed by the Owner or its geotechnical engineer prior to wall construction. Keystone accepts no responsibility for the interpretation or verification of subsurface conditions.

2. The system has been evaluated for internal stability and simple external sliding and overturning. Minimum factors of safety utilized for wall design:

Sliding	1.5	Pullout	1.5
Overturning	2.0	Connection	1.5
Gravity Overturning	1.5	Shear	1.5
Bearing	2.0	Uncertainties	1.5

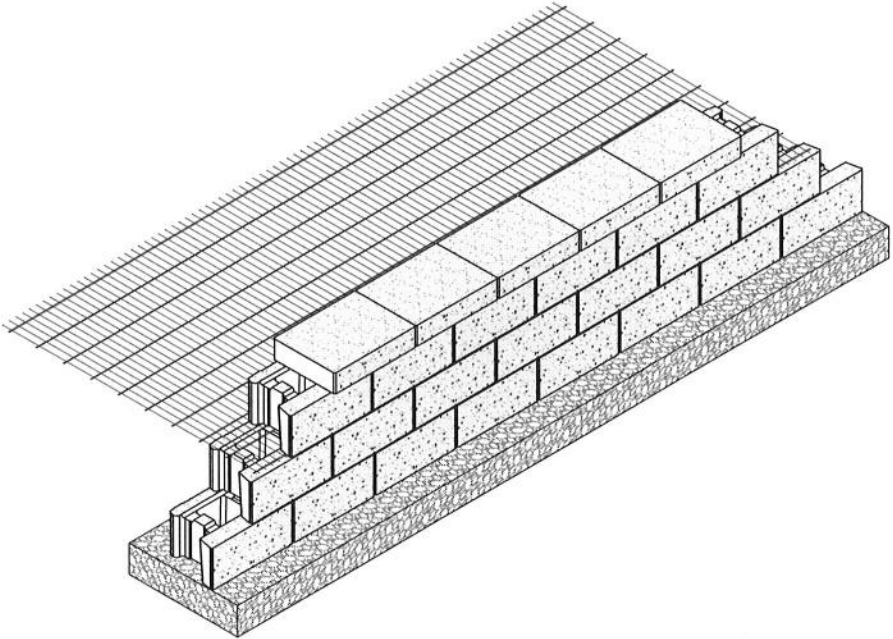
3. The walls are designed to support the following maximum surcharge loadings:

Standard Design: Level Backslope 50 psf  
Live Load: 50 psf  
Backslope: Level  
Standard Design: Level Backslope 120 psf  
Live Load: 120 psf Offset 3.0' Behind Wall Face  
Backslope: Level  
Standard Design: Sloping Backslope  
Live Load: 50 psf  
Backslope: 3H:1V Maximum Steepness  
Standard Design: Tiered Wall  
Live Load: 50 psf  
Backslope: Level Above and Between Tiers

4. The wall foundation soils at each wall location shall be capable of safely supporting 2000 psf or as indicated on the wall elevations without failure or excessive settlement. Local bearing capacity shall be confirmed by the site engineer.

5. The Contractor shall provide surface and subsurface drainage, grading, and erosion control during and after wall construction to avoid damage to the wall structure.

6. The Contractor is responsible for obtaining all permits and easements necessary for wall construction. The Contractor is responsible for protecting adjacent property from wall construction activities.



#### DRAWING INDEX

Description	Sheet No.
Title Sheet	1
Standard Design: Level Backslope - Elevation and Typical Wall Sections	2
Standard Design: Level Backslope (120 psf) - Elevation and Typical Wall Sections	3
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Typical BroadStone 8" Unit Details	9
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#### QUALITY ASSURANCE PROVISIONS

1. Wall construction shall be monitored by a qualified Engineer to verify field conditions. If this work is not performed by the site geotechnical engineer, the geotechnical engineer shall be consulted in those matters pertaining to soil conditions and wall performance.

2. The foundation soils at each wall location shall be inspected by the Engineer and any unsuitable soils or improperly compacted embankment material removed and replaced as directed by the Engineer prior to wall construction to provide adequate bearing capacity and minimize settlement.

3. All wall excavation and retained soils shall be inspected for groundwater conditions and any additional drainage provisions required in the field shall be incorporated into the wall construction as directed by the Engineer.

4. Wall backfill material shall be tested and approved by the Engineer for use in the reinforced soil zone meeting the minimum requirements of the approved design plans.

5. All soil backfill shall be tested by the Engineer for moisture, density, and compaction periodically (every 2' vertically, 100'-200' c/c) meeting the minimum requirements of the approved design plans or project specifications or site engineer.

6. Wall construction shall be periodically inspected by the Engineer to ensure the geogrid reinforcement elevations and lengths are installed in accordance with the approved design plans.

7. All wall elevations, grades, and backslope conditions shall be verified by the Engineer in the field for conformance with the approved design plans. Any revisions to the structure geometry or design criteria shall require design modification prior to proceeding with construction.

#### STL County Approved Master Plan Numbers

Single tier wall up to 5'8" w/level backfill	728-18-29
Single tier wall up to 5'8" w/level backfill and surcharge	728-18-30
Single tier wall up to 5'8", 3:1 max slope no surcharge	728-18-31
Two tier wall up to 3'8" w/ level surcharge	728-18-32

Proposed Retaining Walls Are Designed In Accordance With National Concrete Masonry Association (NCMA 3rd Edition), 2009 International Residential Code (09-IRC) And 2009 International Building Code (09-IBC).

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No.	Date	Revision	By

**KEYSTONE**  
HARDSCAPES  
4444 W 78th St, Minneapolis, MN 55435  
952-897-1040

I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.  
**Patrick J. Stiemke**  
PE-2017026137

Designed By:  
BJB  
Checked By:  
PJS  
Scale:  
No Scale

Title: Title Sheet  
Project: BroadStone 8" Walls Masterplan St. Louis County, MO  
Date: 6/20/2018  
Project No: 18-STD-BS8  
Drawing No: 1

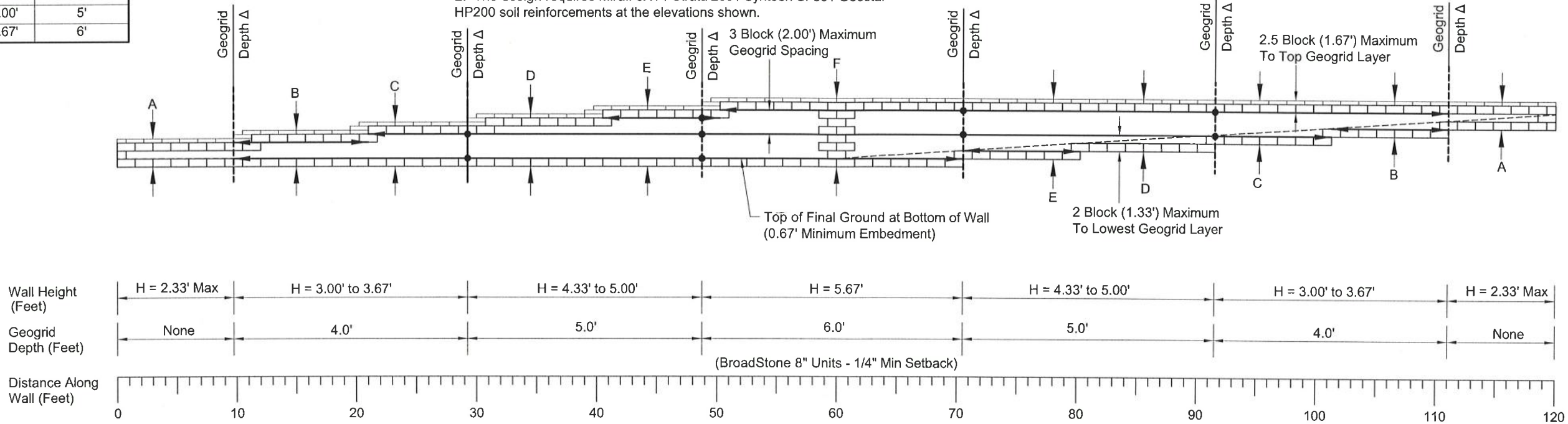
Section	Height	Geogrid Depth
A	2.33' Max	None
B	3.00'	4'
C	3.67'	4'
D	4.33'	5'
E	5.00'	5'
F	5.67'	6'

General Notes:

- The wall shall be constructed with BroadStone 8" units using the 1/4" setback (1H:32V Batter).
- The design requires Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200 soil reinforcements at the elevations shown.

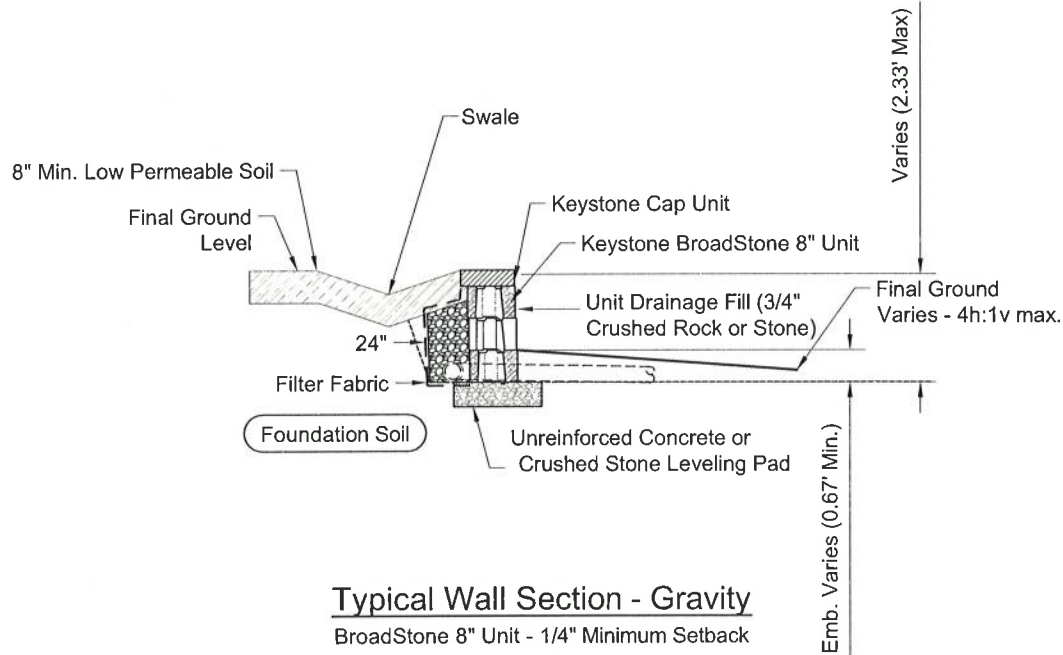
Legend:

Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200



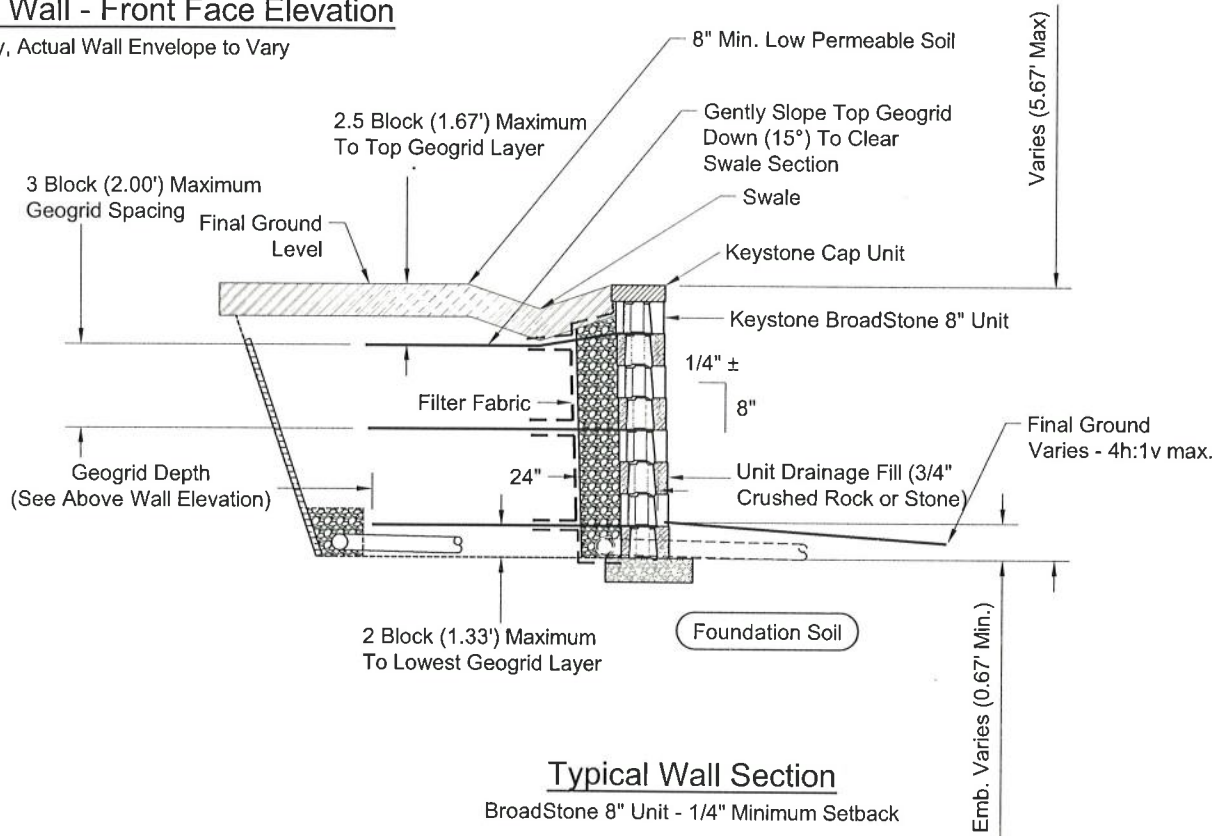
Typical Keystone Level Wall - Front Face Elevation

For Illustration Purposes Only, Actual Wall Envelope to Vary



Typical Wall Section - Gravity

BroadStone 8" Unit - 1/4" Minimum Setback



Typical Wall Section

BroadStone 8" Unit - 1/4" Minimum Setback

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**STIEMKE**  
Patrick J. Stiemke, P.E.  
PE-2017026137

Designed By: BJB	Title: Level Wall Elevation	Date: 6/20/2018
Checked By: PJS	Project: BroadStone 8" Walls Masterplan St. Louis County, MO	Project No: 18-STD-BS8
Scale: 1" = 10'		Drawing No: 2



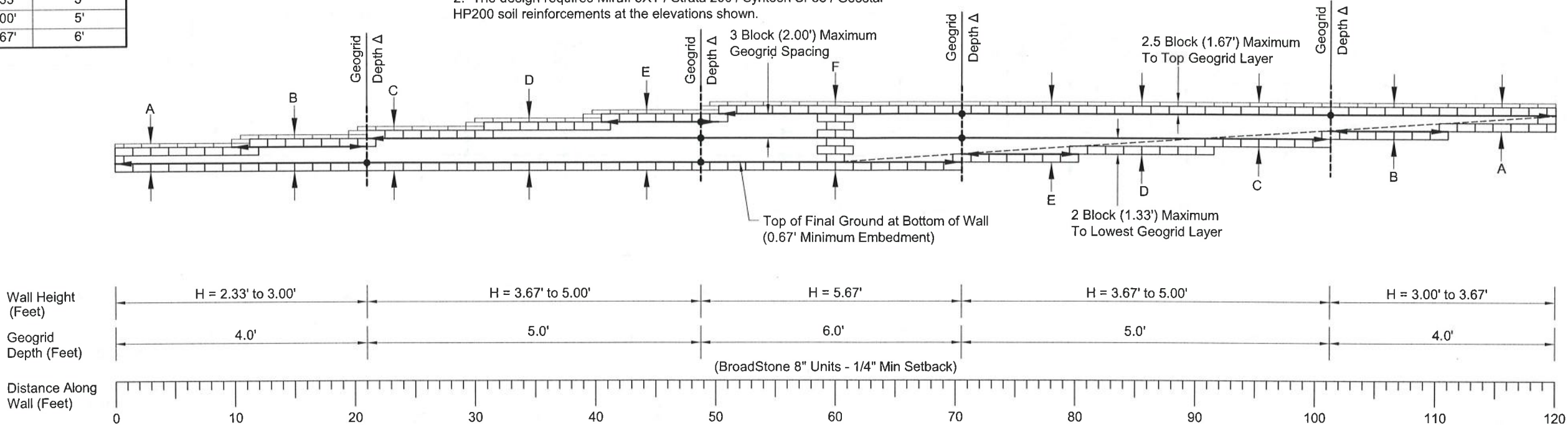
Section	Height	Geogrid Depth
A	2.33'	4'
B	3.00'	4'
C	3.67'	5'
D	4.33'	5'
E	5.00'	5'
F	5.67'	6'

General Notes:

- The wall shall be constructed with BroadStone 8" units using the 1/4" Min setback (1H:31.8 Batter).
- The design requires Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200 soil reinforcements at the elevations shown.

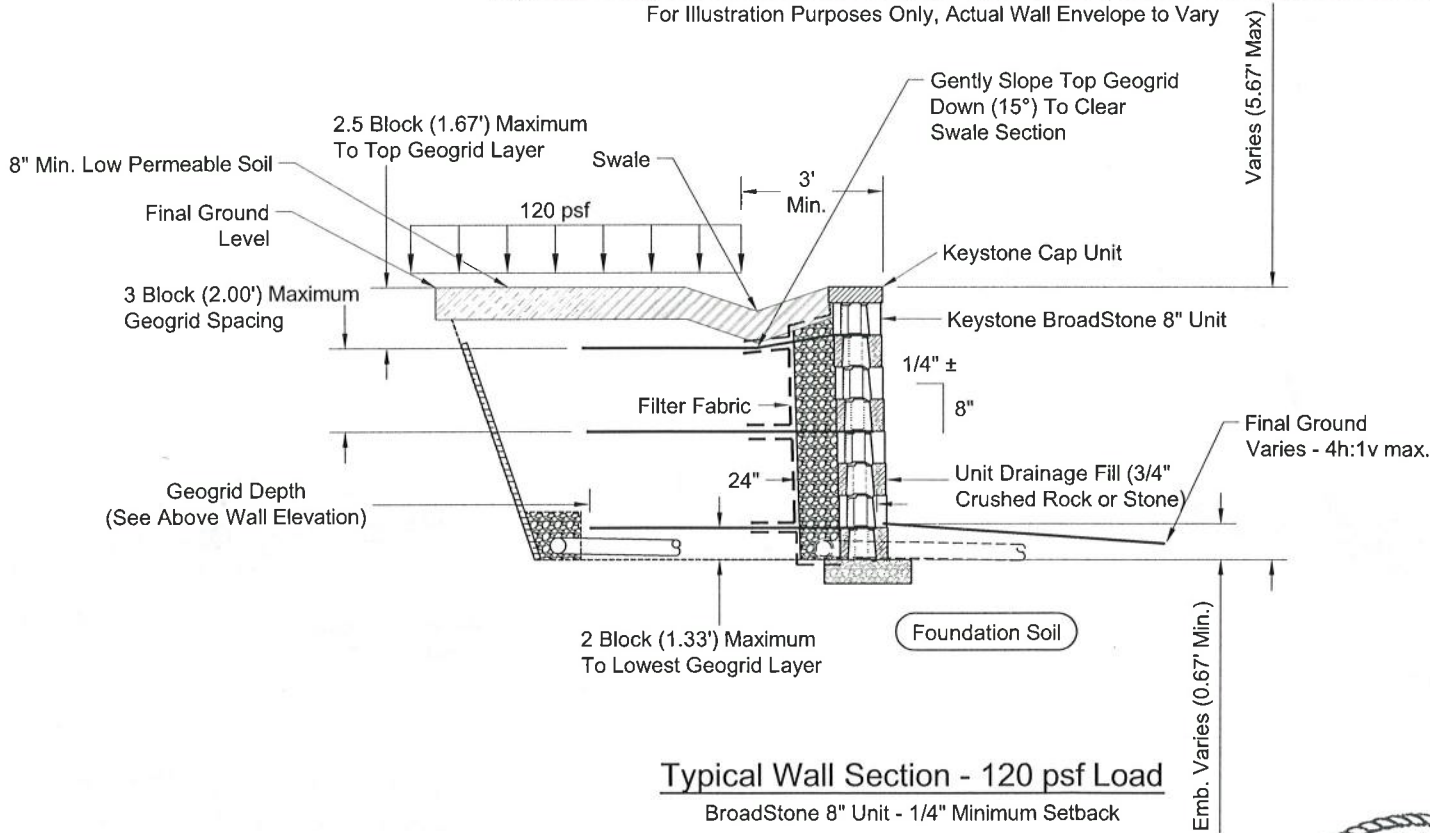
Legend:

Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200



Typical Keystone Level Wall (120 psf Load) - Front Face Elevation

For Illustration Purposes Only, Actual Wall Envelope to Vary



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Patrick D. Spierke, PE-2017026137

Designed By:

BJB

Checked By:

PJS

Scale:

1" = 10'

Title:

Level 120 psf Wall Elevation

Project:

BroadStone 8" Walls  
Masterplan  
St. Louis County, MO

Date:

6/20/2018

Project No:

18-STD-BS8

Drawing No:

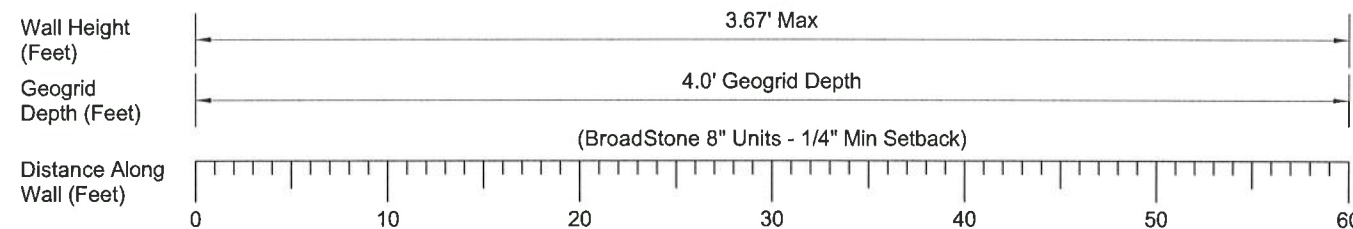
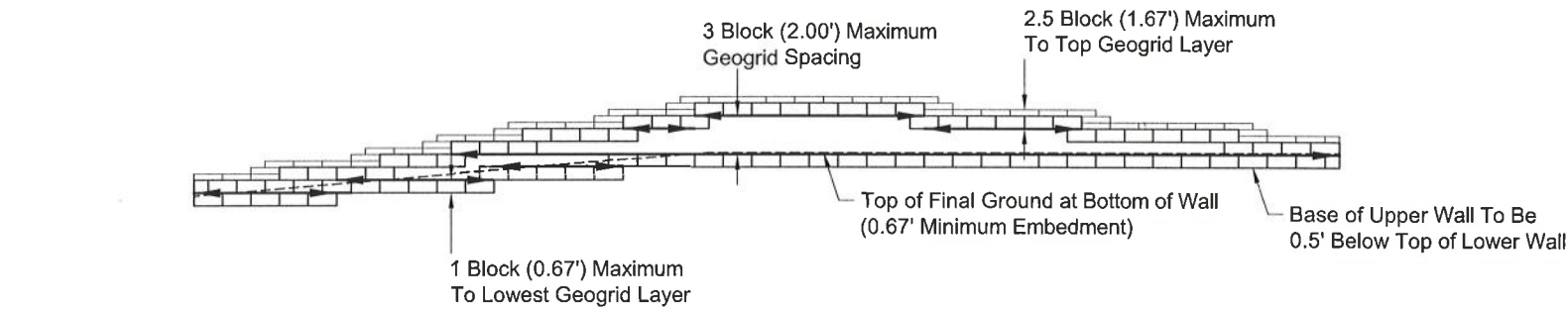
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General Notes:

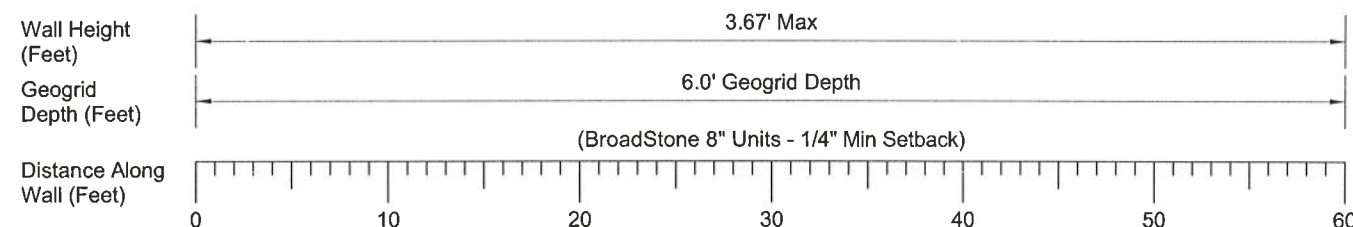
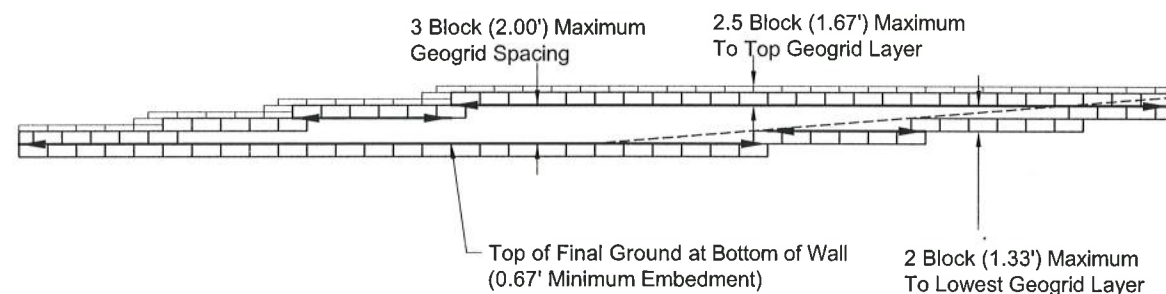
1. The wall shall be constructed with KEYSTONE BroadStone 8" units using the 1/4" Min Setback (1H:32V Batter).
2. The design requires Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200 soil reinforcements at the elevations shown.

Legend:

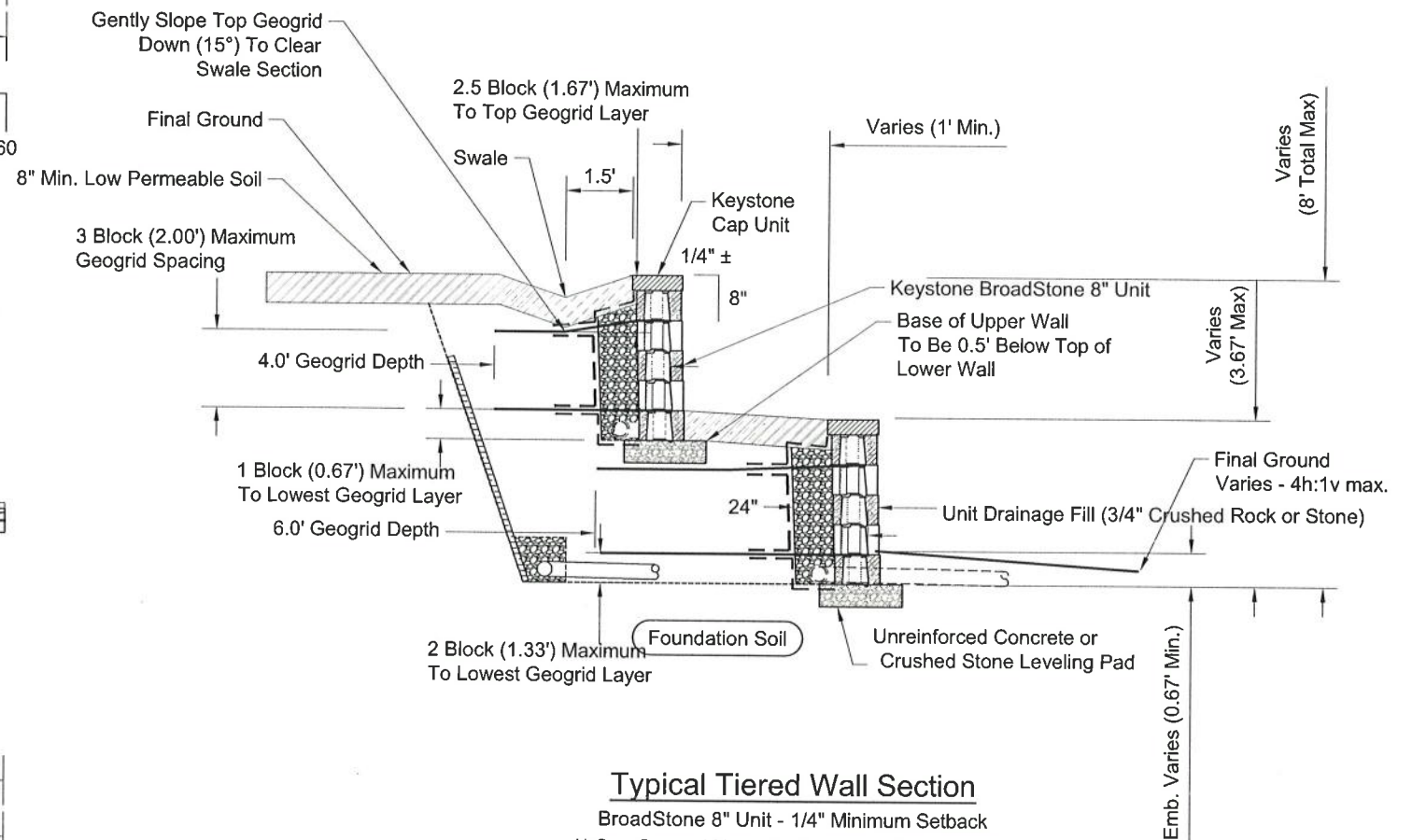
Mirafi 3XT / Strata 200 / Synteen SF35 / Geostar HP200



Keystone Tiered Top Wall - Front Face Elevation  
For Illustration Purposes Only, Actual Wall Envelope to Vary



Keystone Tierd Bottom Wall - Front Face Elevation  
For Illustration Purposes Only, Actual Wall Envelope to Vary



Typical Tiered Wall Section

BroadStone 8" Unit - 1/4" Minimum Setback

\*\* See General Notes for Drainage Requirements

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Patrick J. Stiemke, P.E. NUMBER PE-2017026137

Designed By:	BJB	Title:	Tier Wall Elevation	Date:	6/20/2018
Checked By:	PJS	Project:	BroadStone 8" Walls Masterplan St. Louis County, MO	Project No:	18-STD-BS8
Scale:	1" = 10'			Drawing No:	5



General Notes:

Rear drainage pipe should be included when:  
Groundwater or seepage is present in retained soils  
Springs or seasonal seepage potential is noted in geotechnical report  
Reinforced soil of lower permeability than retained soils  
Generally, additional drainage material such as aggregate drains & fabrics and/or drainage composite nets are used in conjunction with rear drainage pipe as directed.

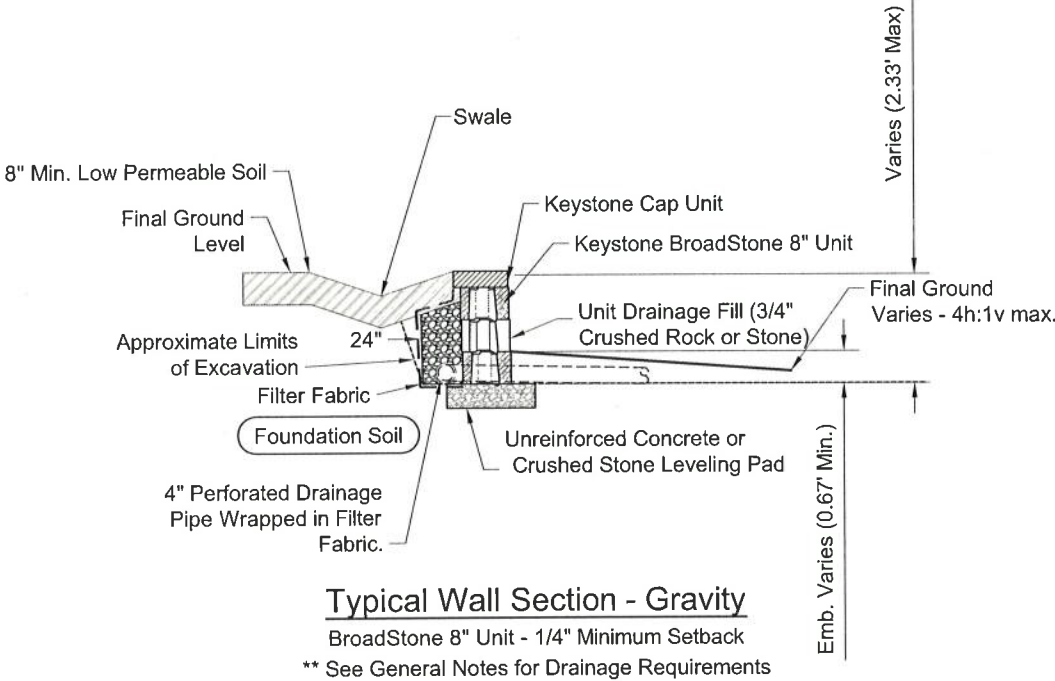
When above conditions are not present or groundwater conditions are not a factor, the rear drainage pipe may be omitted or alternately located behind units at the base of the drainage fill.

Alternate raised drain pipe locations may only be used when:  
Grading at base does not allow gravity outlet of pipe.  
There is no storm sewer system to outlet pipe directly into.

Drainage pipe is not required directly behind the wall units for conventional wall construction where retained soils are not a source of groundwater such as fill wall construction or cut walls into relatively dry banks. When required, the size, location, and type of specific drainage materials should be completed as directed by the onsite geotechnical engineer.

A geotextile filter fabric separator is required between the unit drainage material and site backfill soil in any application where freewater is expected upon the wall face such as in a detention pond or along waterways where the high water level may be above the bottom of wall. Use of filter fabric shall extend a minimum of 1 foot above the anticipated high water level.

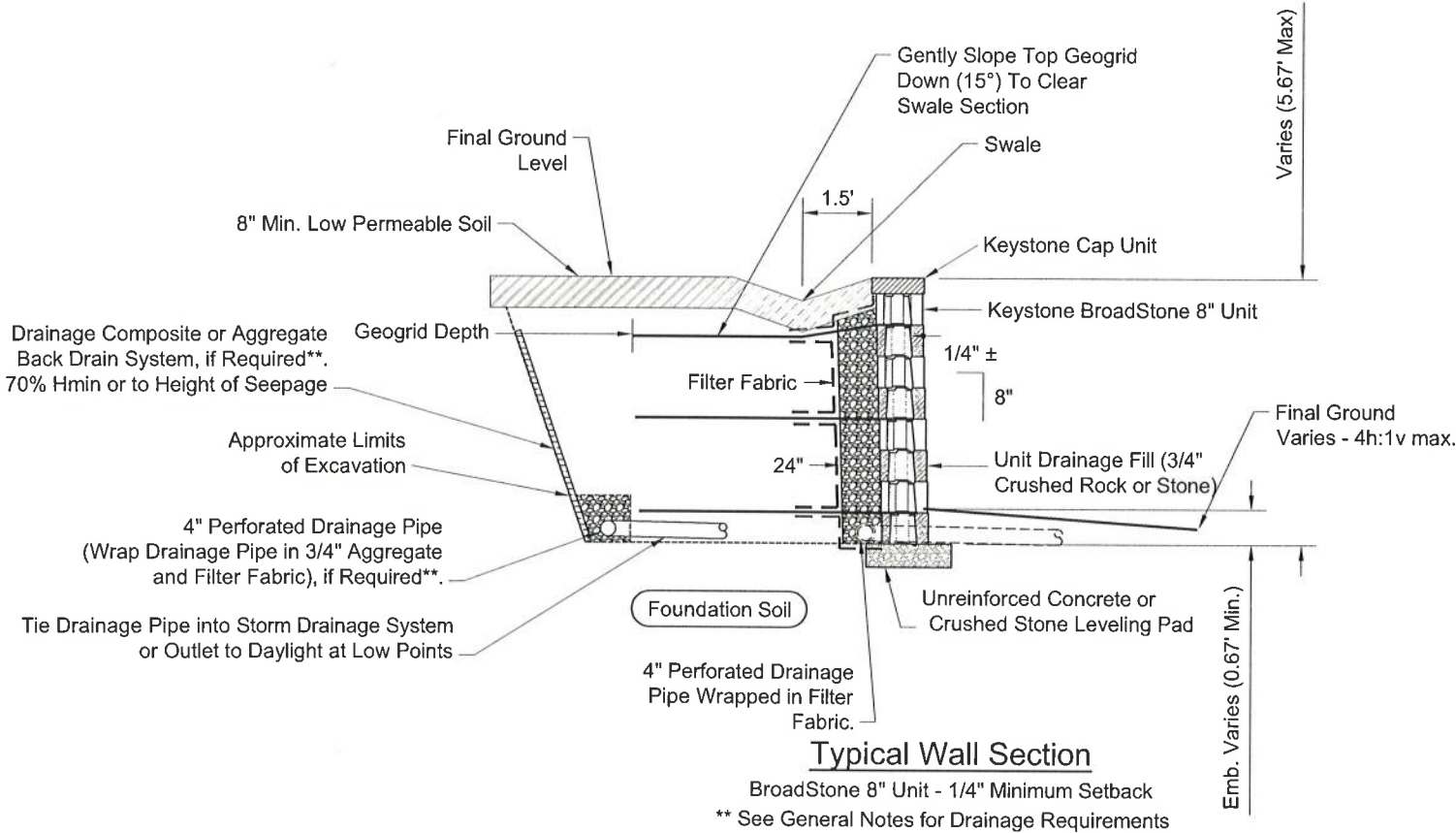
A fence, railing, guardrail or other protective barrier is typically required along the top of all walls as required by the site engineer and local codes. The choice, location, and compliance to local codes of the appropriate barrier system is the responsibility of the owner and its site engineer.



Typical Wall Section - Gravity

BroadStone 8" Unit - 1/4" Minimum Setback

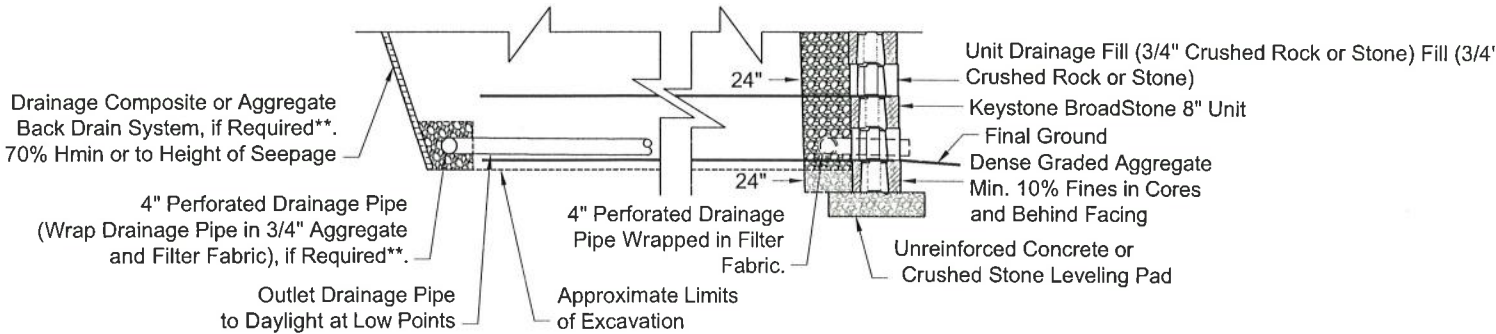
\*\* See General Notes for Drainage Requirements



Typical Wall Section

BroadStone 8" Unit - 1/4" Minimum Setback

\*\* See General Notes for Drainage Requirements



Alternate Raised Drain Pipe Locations

Only Used When Site Geometry Requires Drain Pipe to be Raised in Order to Outlet at Face

\*\* See General Notes for Drainage Requirements

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Patrick J. Stelmke, P.E.  
PE-2017026137

Designed By: BJB	Title: Typical Wall Section	Date: 6/20/2018
Checked By: PJS	Project: BroadStone 8" Walls Masterplan St. Louis County, MO	Project No: 18-STD-BS8
Scale: No Scale		Drawing No: 6

General Notes:

Rear drainage pipe should be included when:  
Groundwater or seepage is present in retained soils  
Springs or seasonal seepage potential is noted in geotechnical report  
Reinforced soil of lower permeability than retained soils  
Generally, additional drainage material such as aggregate drains & fabrics and/or drainage composite nets are used in conjunction with rear drainage pipe as directed.

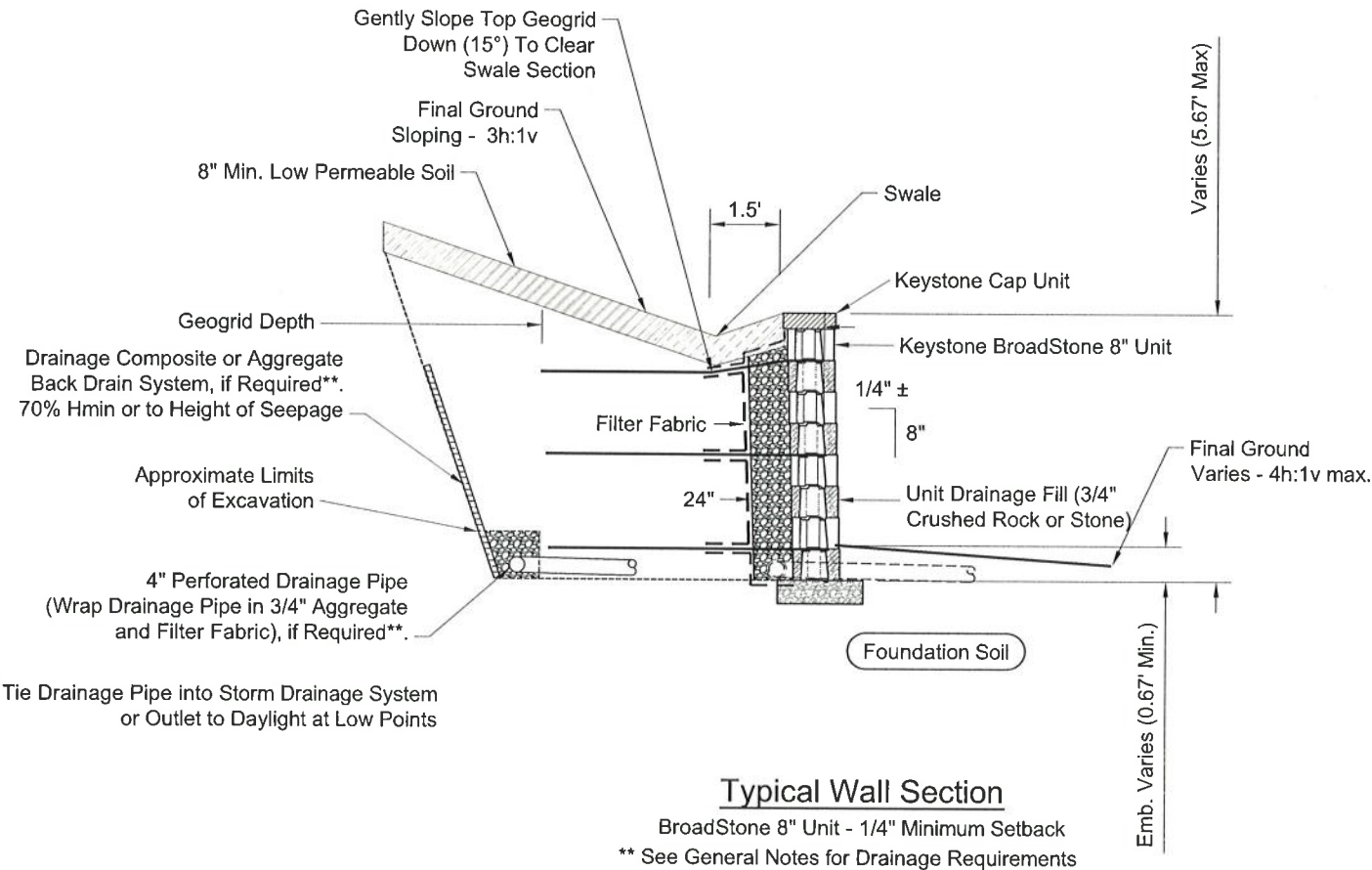
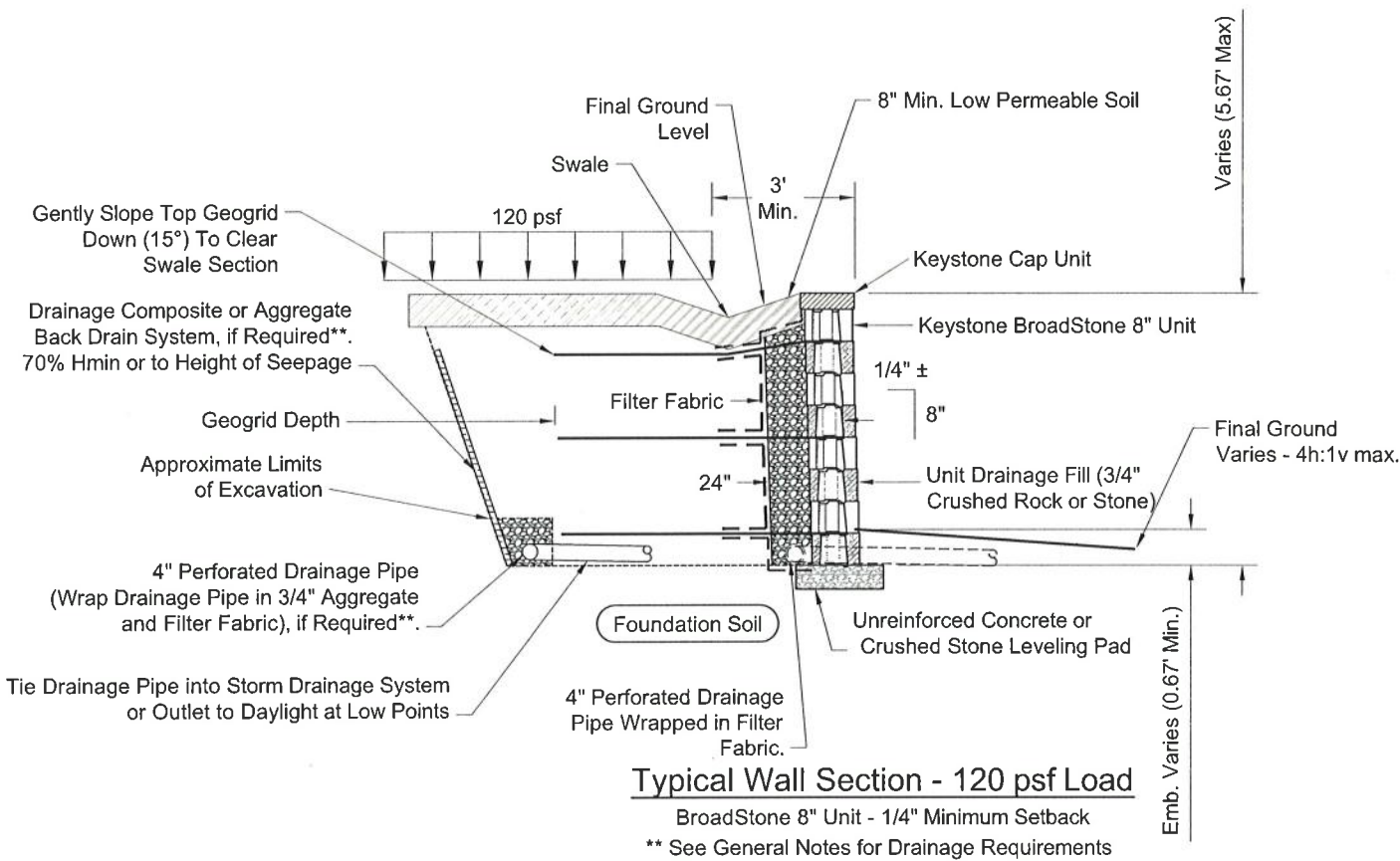
When above conditions are not present or groundwater conditions are not a factor, the rear drainage pipe may be omitted or alternately located behind units at the base of the drainage fill.

Alternate raised drain pipe locations may only be used when:  
Grading at base does not allow gravity outlet of pipe.  
There is no storm sewer system to outlet pipe directly into.

Drainage pipe is not required directly behind the wall units for conventional wall construction where retained soils are not a source of groundwater such as fill wall construction or cut walls into relatively dry banks. When required, the size, location, and type of specific drainage materials should be completed as directed by the onsite geotechnical engineer.

A geotextile filter fabric separator is required between the unit drainage material and site backfill soil in any application where freewater is expected upon the wall face such as in a detention pond or along waterways where the high water level may be above the bottom of wall. Use of filter fabric shall extend a minimum of 1 foot above the anticipated high water level.

A fence, railing, guardrail or other protective barrier is typically required along the top of all walls as required by the site engineer and local codes. The choice, location, and compliance to local codes of the appropriate barrier system is the responsibility of the owner and its site engineer.



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NUMBER  
PE-2017026137

Patrick J. Stenke, P.E.

Designed By: BJB	Title: Typical Wall Section	Date: 6/20/2018
Checked By: PJS	Project: BroadStone 8" Walls Masterplan St. Louis County, MO	Project No: 18-STD-BS8
Scale: No Scale		Drawing No: 7



General Notes:

Rear drainage pipe should be included when:  
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Springs or seasonal seepage potential is noted in geotechnical report  
Reinforced soil of lower permeability than retained soils  
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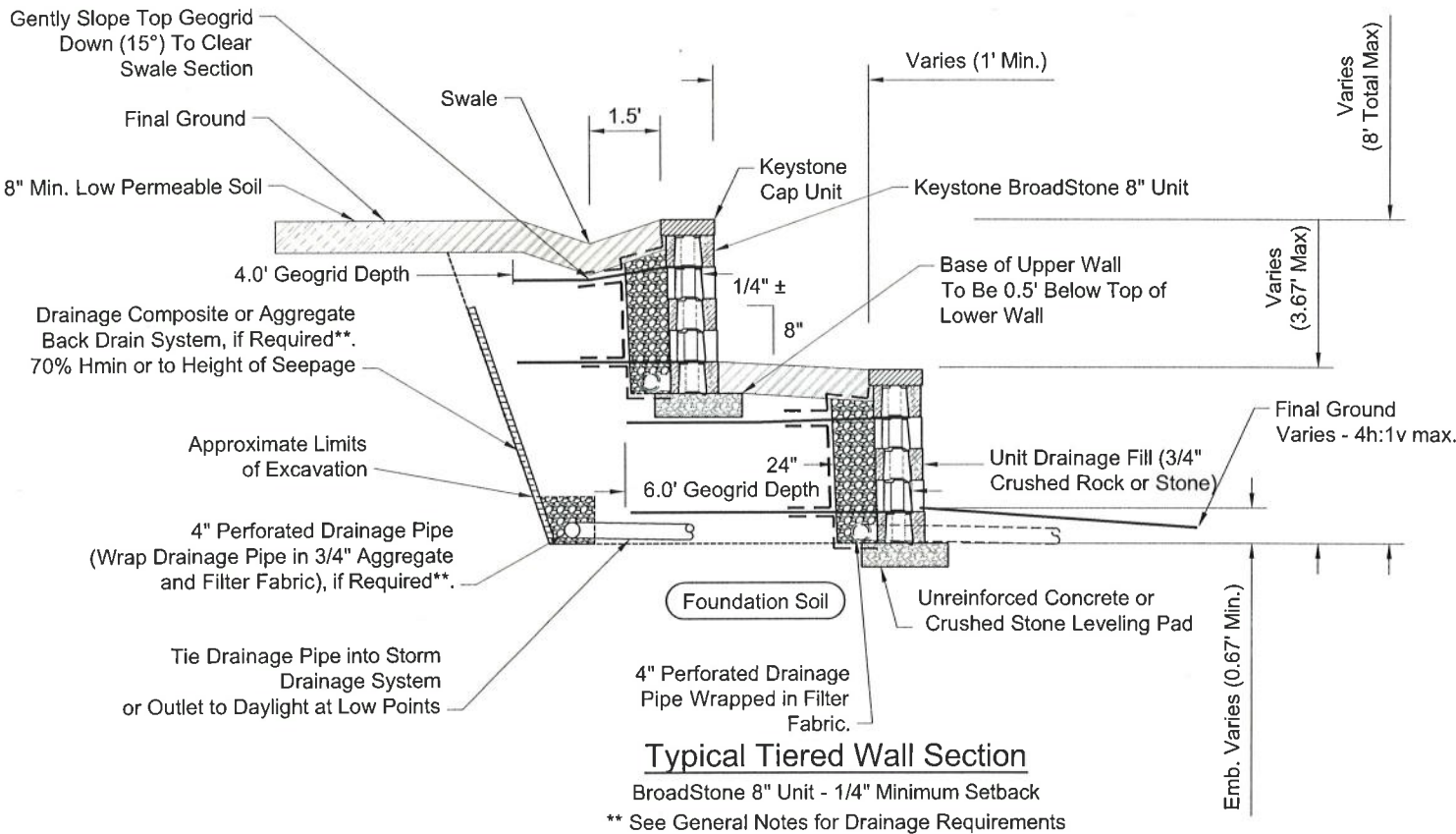
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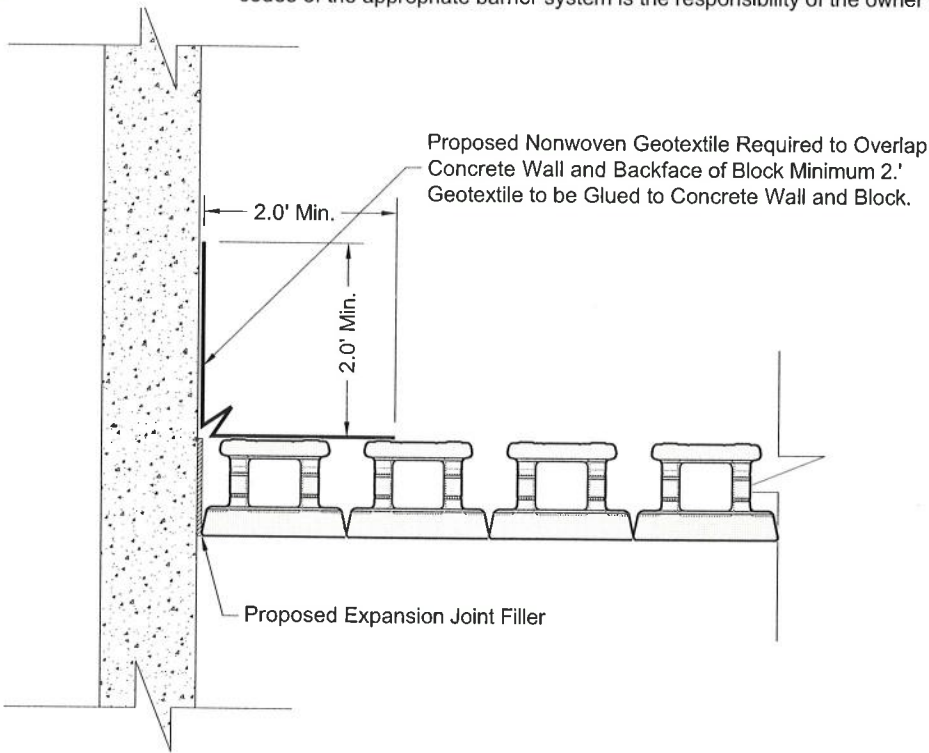
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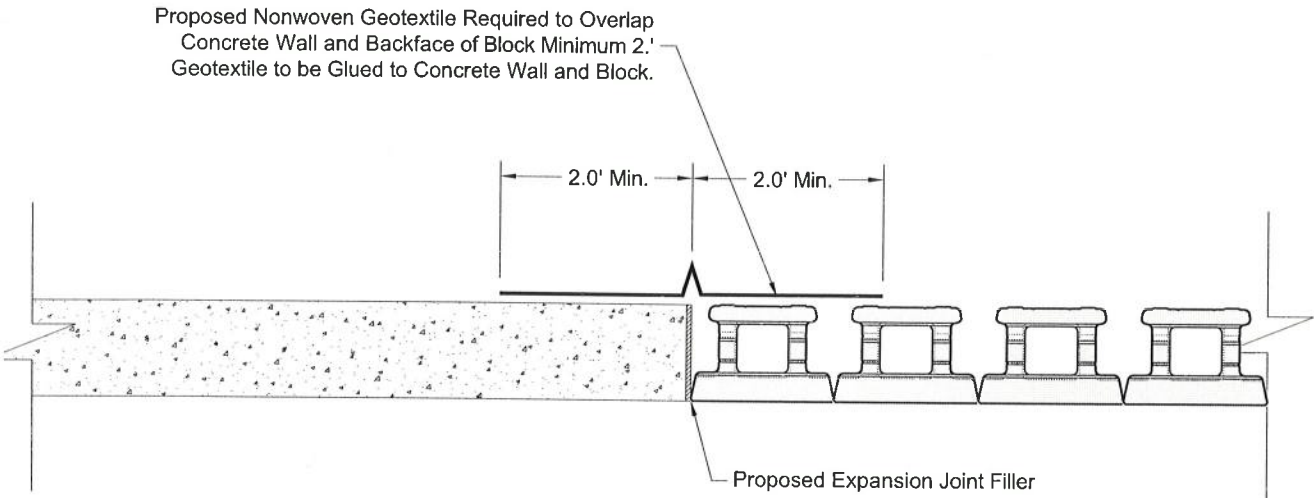
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Typical Tiered Wall Section  
BroadStone 8" Unit - 1/4" Minimum Setback  
\*\* See General Notes for Drainage Requirements



Section at Concrete Wall



Section at Concrete Wall

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**STIEMKE**  
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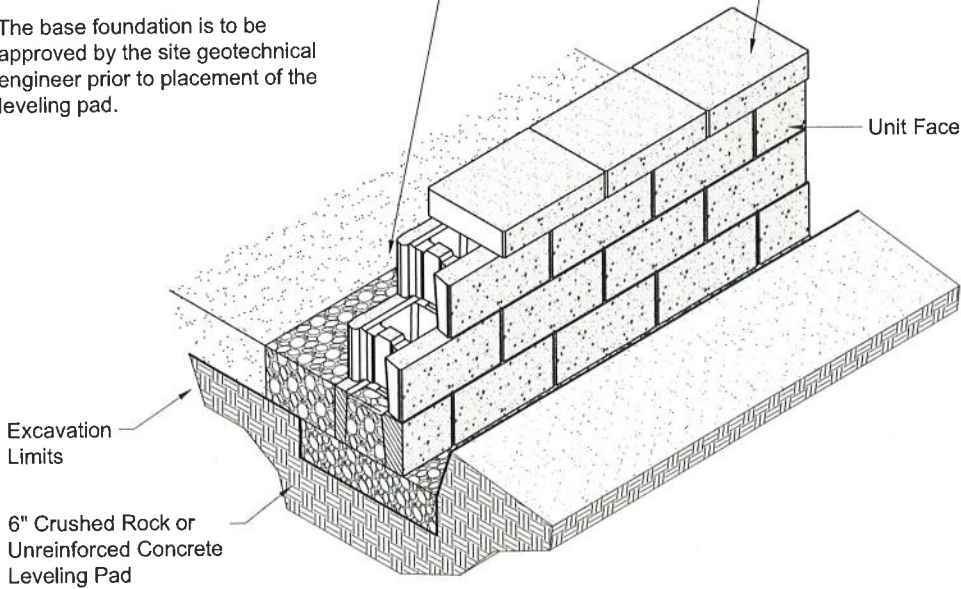
Designed By: BJB	Title: Typical Tiered Wall Section	Date: 6/20/2018
Checked By: PJS	Project: BroadStone 8" Walls Masterplan St. Louis County, MO	Project No: 18-STD-BS8
Scale: No Scale		Drawing No: 8



Base Leveling Pad Notes:

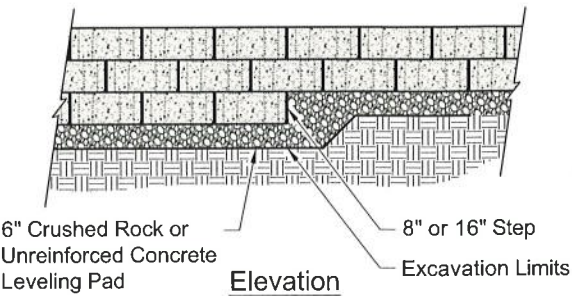
- 1. The leveling pad is to be constructed of crushed stone or 2,000 psi± unreinforced concrete
- 2. The base foundation is to be approved by the site geotechnical engineer prior to placement of the leveling pad.

Broadstone Unit		Cap Unit	
Width:	18"	Width:	18"
*Depth:	12"	*Depth:	13 1/2"
Height:	8"	Height:	4"
*Weight:	72 lbs	*Weight:	80 lbs

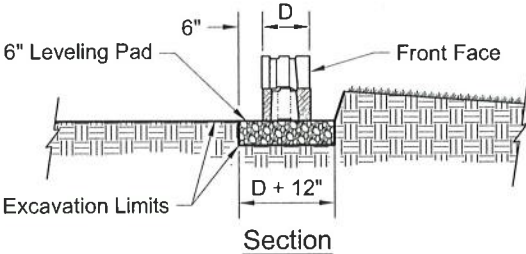


Broadstone Unit/Base Pad Isometric Section View

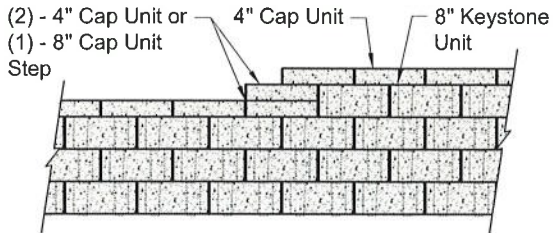
\* Dimensions & Weight May Vary by Region



- Base Leveling Pad Notes:
- 1. Construct leveling pad with crushed stone or 2000 psi ± unreinforced concrete.
  - 2. The leveling pad foundation is to be approved by the site geotechnical engineer prior to leveling pad placement.



Leveling Pad Detail

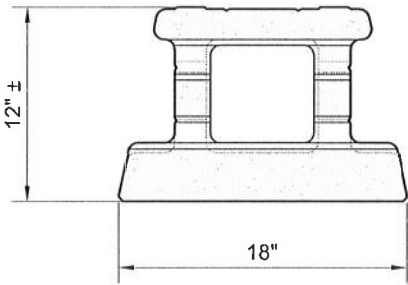


- Note:
- 1. Secure all cap units with adhesive.

Top of Wall Steps



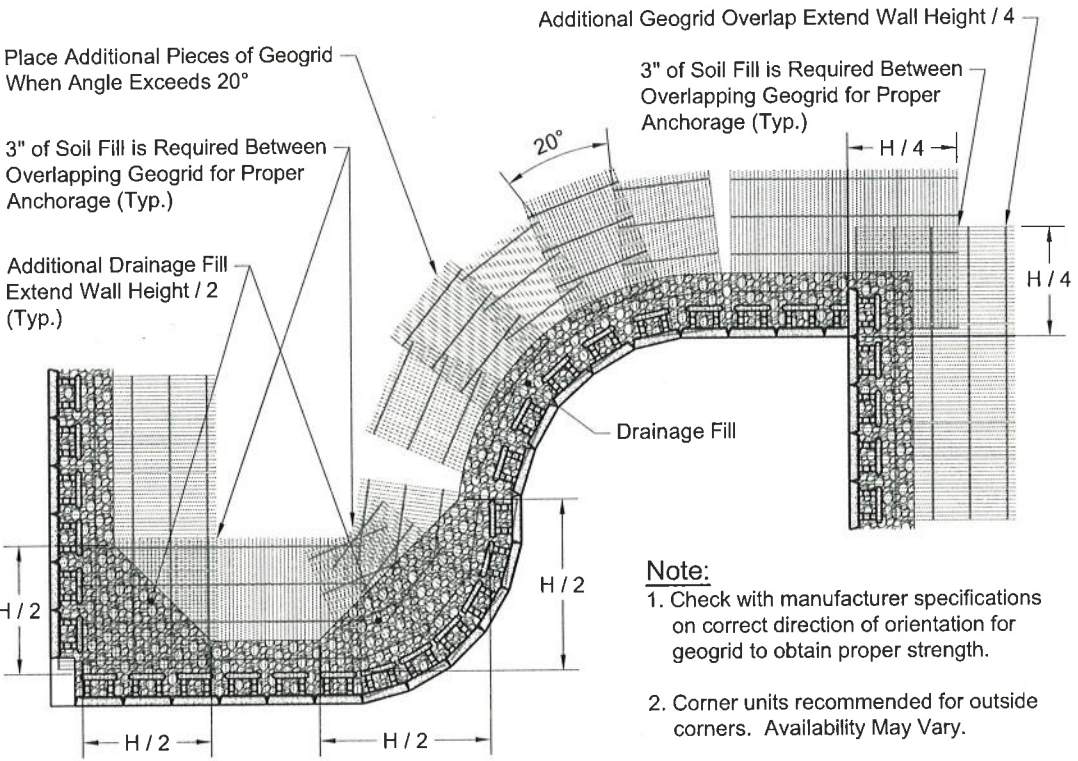
Broadstone Elevation



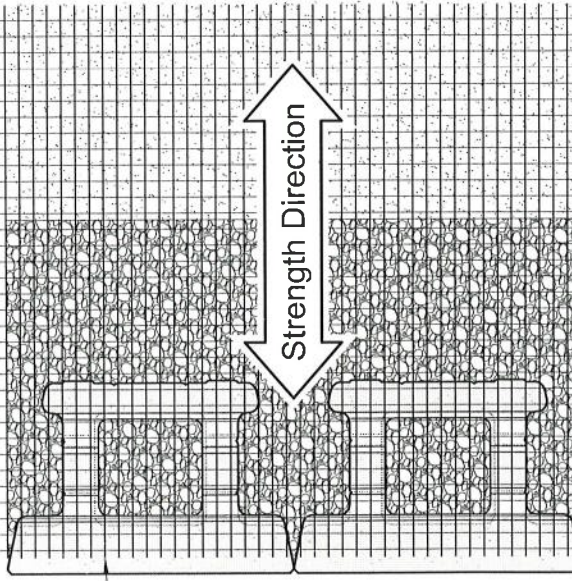
Broadstone Plan

Broadstone Unit

\*Dimensions May Vary by Region



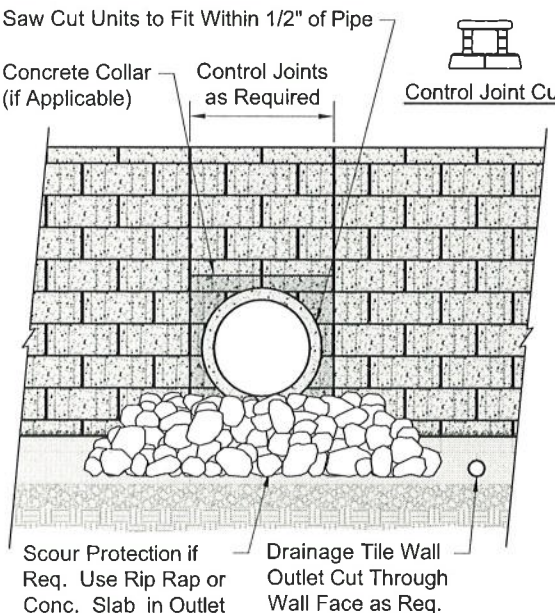
- Note:
- 1. Check with manufacturer specifications on correct direction of orientation for geogrid to obtain proper strength.
  - 2. Corner units recommended for outside corners. Availability May Vary.



Geogrid is to be Placed on Level Backfill and on Top of the Units Within 1" of the Face. Place Next Unit. Pull Grid Taught and Backfill. Stake as required.

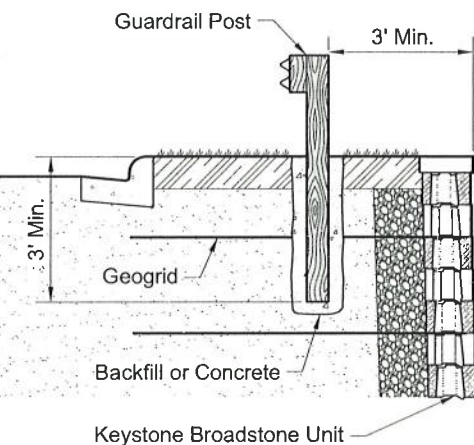
Grid & Pin Connection

- Note:
- 1. For pipes larger than 24", a concrete collar may be cast around pipe for ease of construction and appearance.
  - 2. Provide splash block or concrete gutter for drainage tile wall outlet, scour protection if required.



Typical Pipe Outlet Detail

- Note:
- 1. Guardrail shall be located a minimum of 3' behind wall face with post spacing 6' to 8' per local code requirements.
  - 2. Place sleeve during construction or auger through geogrid layers.
  - 3. Backfill or concrete guardrail post in place.



Typical Guardrail Detail

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No.	Date	Revision	By

**KEYSTONE**  
HARDSCAPES

4444 W 78th St, Minneapolis, MN 55435  
952-897-1040

I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

**STIEMKE**  
Professional Engineer  
PE-2017026137

Designed By:	BJB
Checked By:	PJS
Scale:	No Scale

Title:	Typical Broadstone 8" Unit Details	Date:	6/20/2018
Project:	BroadStone 8" Walls Masterplan St. Louis County, MO	Project No:	18-STD-BS8
		Drawing No:	9



SPECIFICATION GUIDELINES (Short Form)

PART 1: GENERAL

1.01 DESCRIPTION

- A. Work includes furnishing and installing a KEYSTONE retaining wall to the lines and grades shown on the construction drawings and as specified herein.
- B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit fill and backfill to the lines and grades shown on the construction drawings.
- C. Work includes furnishing and installing all related materials required for construction of the retaining wall as shown on the construction drawings.

1.02 REFERENCE STANDARDS

- A. ASTM C1372 Specification for Segmental Retaining Wall Units
- B. ASTM D422 Particle Size Analysis
- C. ASTM D698 Laboratory Compaction Characteristics using Standard Effort.
- D. ASTM D1557 Laboratory Compaction Characteristics using Modified Effort.
- E. ASTM D3034 Polyvinyl Chloride Pipe (PVC)
- F. ASTM D4318 Liquid Limit, Plastic Limit, Plasticity Index of Soils
- G. ASTM D4595 Tensile Properties of Geotextiles - Wide Width Strip
- H. ASTM D5262 Unconfined Tension Creep Behavior of Geotextiles
- I. ASTM D6638 Connection Strength - Reinforcement/Segmental Units
- J. AASHTO M 252 Corrugated Polyethylene Drainage Pipe

1.03 QUALITY ASSURANCE

- A. Owner will be responsible for soil testing and inspection quality control during wall construction and earthwork operations. Contractor shall provide any quality control testing or inspection not provided by the Owner. Owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance.

PART 2: MATERIALS

2.01 DEFINITIONS

- A. Concrete Units - a KEYSTONE modular concrete facing unit, machine made from portland cement, water and mineral aggregates.
- B. Structural Geogrid - a structural geogrid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
- C. Unit Drainage Fill - drainage aggregate which is placed within and immediately behind the modular concrete units.
- D. Reinforced Backfill - Compacted soil which is within the reinforced soil volume as shown on the plans.

2.02 KEYSTONE UNITS

- A. KEYSTONE wall units shall have a minimum 28-day compressive strength of 3,000 psi. Standard weight concrete shall have a maximum moisture absorption of 8% (6% in northern climates).

2.04 RETAINING WALL CONSTRUCTION ADHESIVE

- A. Adhesive shall be Loctite PL 500 or equivalent.

2.05 GEOGRID REINFORCEMENT

- A. Geogrid shall be the type as shown on the drawings having the property requirements described within the manufacturer's specifications and required by the design calculations.

2.06 BASE LEVELING PAD MATERIAL

- A. Material shall consist of compacted crushed stone or unreinforced concrete as shown on the construction drawings.

2.07 UNIT DRAINAGE FILL

- A. Unit fill shall consist of clean 1" minus crushed stone or crushed gravel meeting the following gradation:

Sieve Size	% Passing
1 inch	100
3/4"	75-100
No. 4	0-10
No. 50	0-5

2.08 REINFORCED BACKFILL

- A. Reinforced backfill shall be free of debris or organic material meeting the following gradation tested in accordance with ASTM D422:

Sieve Size	% Passing
2 inch	100
3/4"	75-100
No. 40	0-60
No. 200	0-35

LL < 40 and PI < 15 per ASTM D4318

- B. The maximum aggregate size shall be limited to 3/4" unless field tests have been performed to evaluate potential strength reduction due to installation damage.
- C. Material can be site excavated material when the above requirements are met. Unsuitable soils for backfill (high plastic clays or organic materials) shall not be used in the reinforced soil mass.
- D. Contractor shall submit reinforced fill sample and test results to the Architect/Engineer for approval prior to construction.

2.09 DRAINAGE PIPE

- A. When required, drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M 252, unless otherwise specified.

2.10 GEOTEXTILE FILTER FABRIC

- A. When required, geotextile filter fabric shall be a 4.0 oz/sy, polypropylene, needlepunched nonwoven fabric, unless otherwise specified.

PART 3: EXECUTION

3.01 EXCAVATION

- A. Contractor shall excavate to the lines and grades shown on the construction drawings. Contractor shall be careful not to disturb embankment and foundation materials beyond lines shown.

3.02 FOUNDATION SOIL PREPARATION

- A. Foundation soil shall be excavated as required for leveling pad dimensions shown on the construction drawings, or as directed by the Engineer.
- B. Unsuitable soils shall be removed and replaced with approved compacted material as directed by the Engineer
- C. Over-excavated areas shall be backfilled with approved compacted backfill material.

3.03 BASE LEVELING PAD

- A. Leveling pad materials shall be placed upon an approved foundation as shown on the construction drawings to a minimum thickness of 6".
- B. Aggregate material shall be compacted to provide a dense, level surface on which to place the first course of modular units. Compaction shall be to 95% of Standard Proctor Density as determined in accordance with ASTM D698 or 92% Modified Proctor Density per ASTM D1557. For crushed rock, material shall be densely compacted as determined by visual observation.

3.04 UNIT INSTALLATION

- A. The first course of concrete modular wall units shall be carefully placed on the base leveling pad. Each unit shall be checked for level and alignment.
- B. Units are placed side by side for full length of wall alignment. Alignment may be done by means of a string line or offset from a base line.
- C. Fill all voids in and around the modular units with unit fill material. Tamp or rod unit fill to insure that all voids are completely filled.
- D. Sweep excess material from top of units and install the next course. Ensure that each course is completely unit filled, backfilled and compacted prior to proceeding to next course.
- E. As next course is placed, pull each unit forward, away from the fill zone, engaging the lugs against the course below and backfill as the course is completed. Repeat procedure to the extent of wall height.

3.05 GEOGRID INSTALLATION

- A. Geogrid shall be laid at the proper elevations and orientation as shown on the construction drawings or as directed by the Engineer.
- B. Correct orientation (roll direction) of the geogrid shall be verified by the contractor with the strongest direction placed perpendicular to the wall.
- C. The geogrid shall be laid horizontally on compacted backfill within 1 inch of the face of the units. Place the next course of Keystone units over the geogrid.
- D. The geogrid shall be pulled taut to eliminate loose folds and pretension the reinforcement. Stake or secure back edge of geogrid prior to and during backfill and compaction. Geogrid shall be placed side by side with no gaps.

3.06 FILL PLACEMENT

- A. Backfill material shall be placed in 8" lifts and compacted to 95% of Standard Proctor density as determined in accordance with ASTM D698 or 92% Modified Proctor Density per ASTM D1557. The inplace moisture content shall not exceed the optimum moisture content as determined in accordance with ASTM D698 and be no lower than 3% below optimum moisture content
- B. Backfill shall be placed, spread and compacted in such a manner that minimizes the development of slack or loss of pretension of the geogrid.
- C. Only hand-operated compaction equipment shall be allowed within 3' of the back surface of the KEYSTONE units.
- D. Backfill shall be placed from the wall back towards the embankment to ensure that the geogrid remains taut.
- E. Tracked construction equipment shall not be operated directly on the geogrid. A minimum backfill thickness of 6" is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- F. Rubber-tired equipment may pass over the geogrid reinforcement at slow speeds, [less than 10 mph.] Avoid sudden braking and sharp turning.
- G. At the end of each day's operation, the Contractor shall grade the backfill away from the wall and direct runoff away from the wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.07 CAP INSTALLATION

- A. KEYSTONE Cap units shall be glued to underlying units. Apply construction adhesive to top surface of unit below per manufacturer's instruction and place cap unit into position. Backfill and compact to finished grade with low permeability soil.

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I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

Patrick J. Stenke, P.E.



Designed By:

BJB

Checked By:

PJS

Scale:

No Scale

Title:

Specifications

Project:

BroadStone 8" Walls  
Masterplan  
St. Louis County, MO

Date:

6/20/2018

Project No:

18-STD-BS8

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