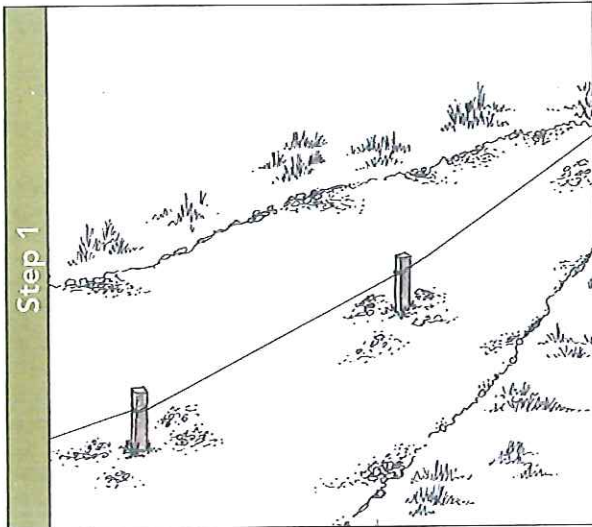


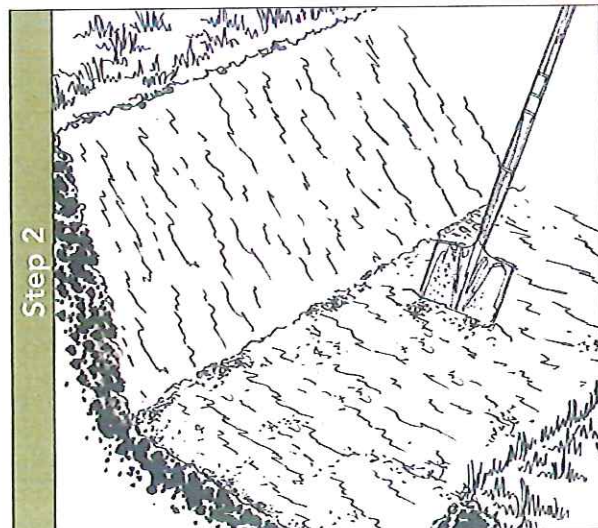
## **2- What are the installation steps?**



## 1. Site Examination / Permitting

Select the location and length for the retaining wall. Call before you dig! Calling 811 before every digging job gets your underground utility lines marked for free and helps prevent undesired consequences. Digging without calling can disrupt service to an entire neighborhood, harm you and those around you and potentially result in fines and repair costs.

Take the necessary measurements, prepare plans, research zoning requirements for your area and obtain proper building permits for your project. Local permitting may require a soils investigation and/or engineered documentation and drawings.



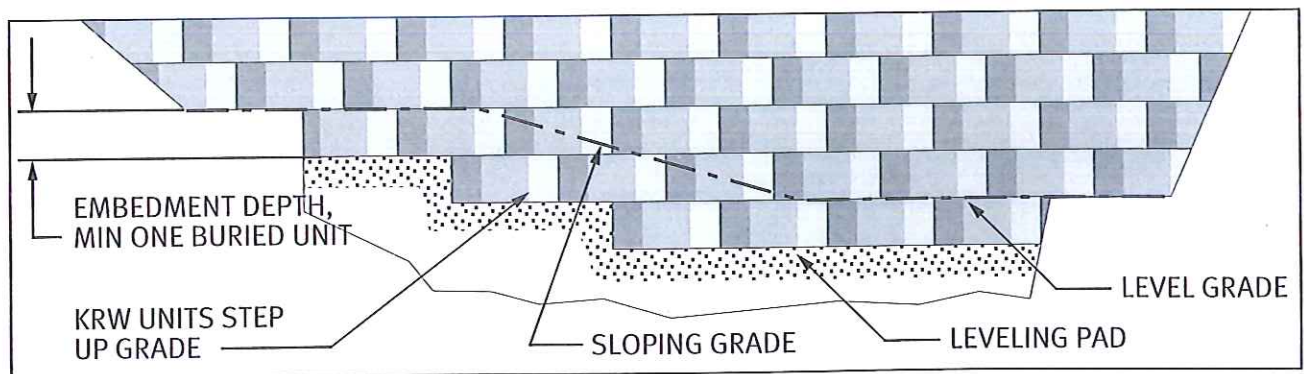
## 2. Excavation / Embedment

Verify that the layout dimensions are correct and excavate to the lines and grades shown on the construction drawings or to field dimensions. Remove all surface vegetation, organic soils and debris; verify that the foundation subgrade is in proper condition prior to leveling pad installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

### Embedment Recommendations

For small Keystone gravity walls, a minimum 1 inch (25mm) of embedment is recommended for every unit of height (i.e., H/8) or 6 inches minimum, which ever is greater. For reinforced soil Keystone walls, the minimum depth of embedment as a ratio to wall may be determined in the following table from the NCMA Design Manual for Segmental Walls (2009):

FIGURE A:1



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## Installation: Step-by-Step

Slope in Front of Wall	Min. Embedment
Minimum Requirement	0.5 ft (150mm)
Horizontal (walls)	H/20
Horizontal (Abutments)	H/10
3H:1V	H/10
2H:1V	H/7

### Note:

Project plans, specifications, and design codes may require minimum embedments that exceed the minimums recommended by NCMA.

### Sloping Toe

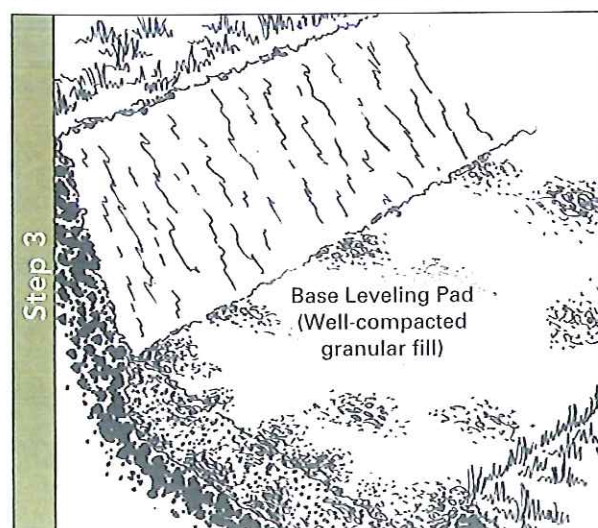
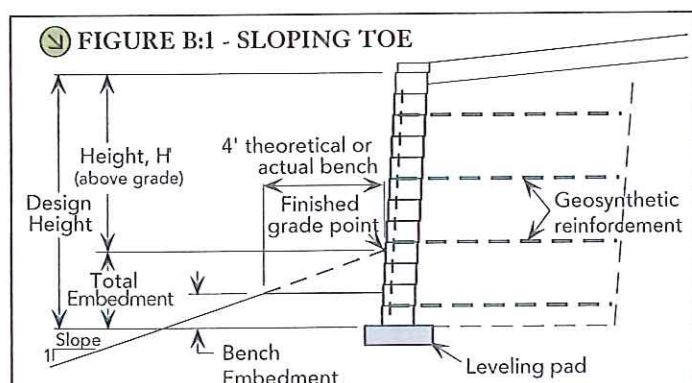
The minimum embedment required with a slope in front of the wall should be based on the establishment of a minimum 4 feet (1.2m) horizontal bench in front of the wall and establishing a minimum embedment from that point. Fill slopes usually have poor compaction near the edge of slope and all slopes are subject to erosion and surficial instability (see figure B:1).

The depth of embedment should be increased when any of the following conditions occur:

- Weak bearing soils
- Potential scour of wall toe
- Submerged wall applications
- Significant shrink/swell/frost properties of foundation soils

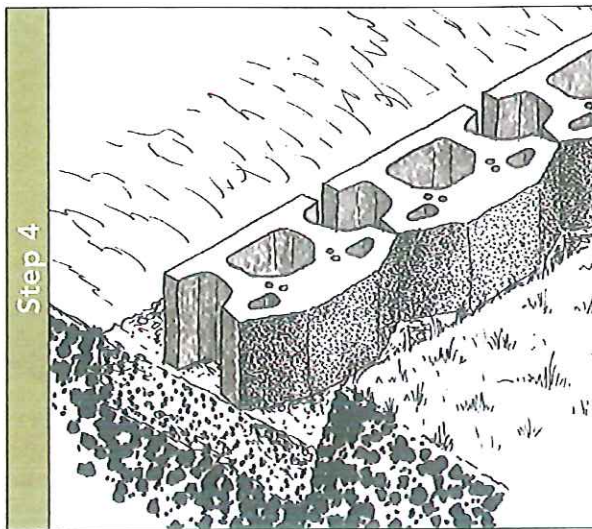
### Note:

The required embedment depth for Keystone walls may become a controversial issue. The International Building Code (IBC) recommends a 1 foot minimum or below prevailing frost depth, which ever is greater for foundations. AASHTO recommends a 2 foot minimum or below prevailing frost depth which ever is greater for retaining structures. These minimum recommended depths are based on rigid foundation systems and are not totally applicable to flexible systems, which function properly with significantly less embedment. The proper embedment depth is a function of the structure size and type, the underlying soils, and the site geometry, especially toe slopes. It is significantly more important to properly inspect the foundation area when excavated, determine the limits of removal and replacement of unsuitable materials, and then confirm the final embedment depth for stability and bearing given the site conditions.



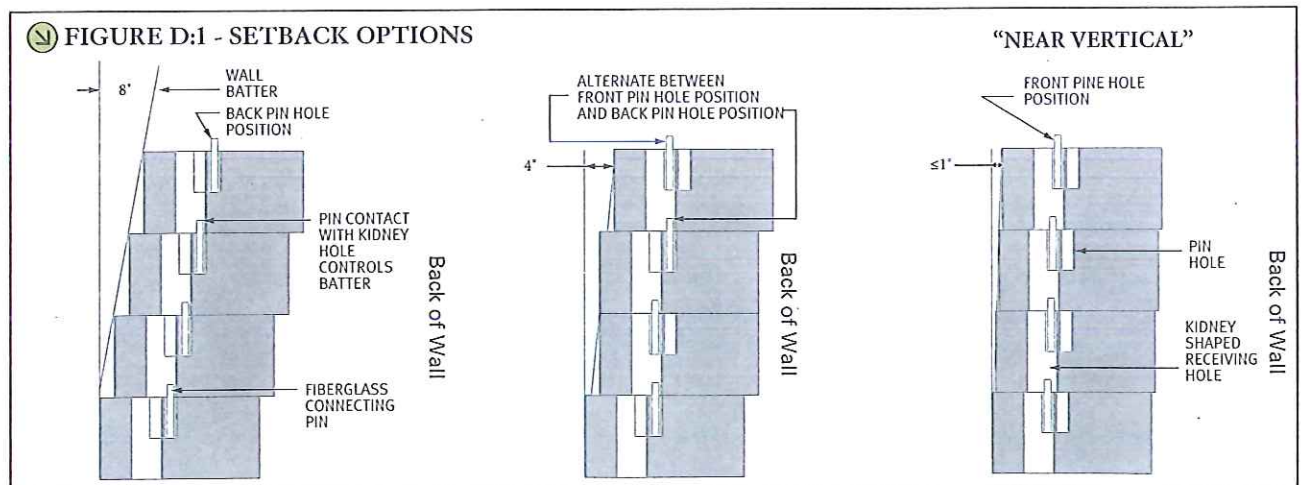
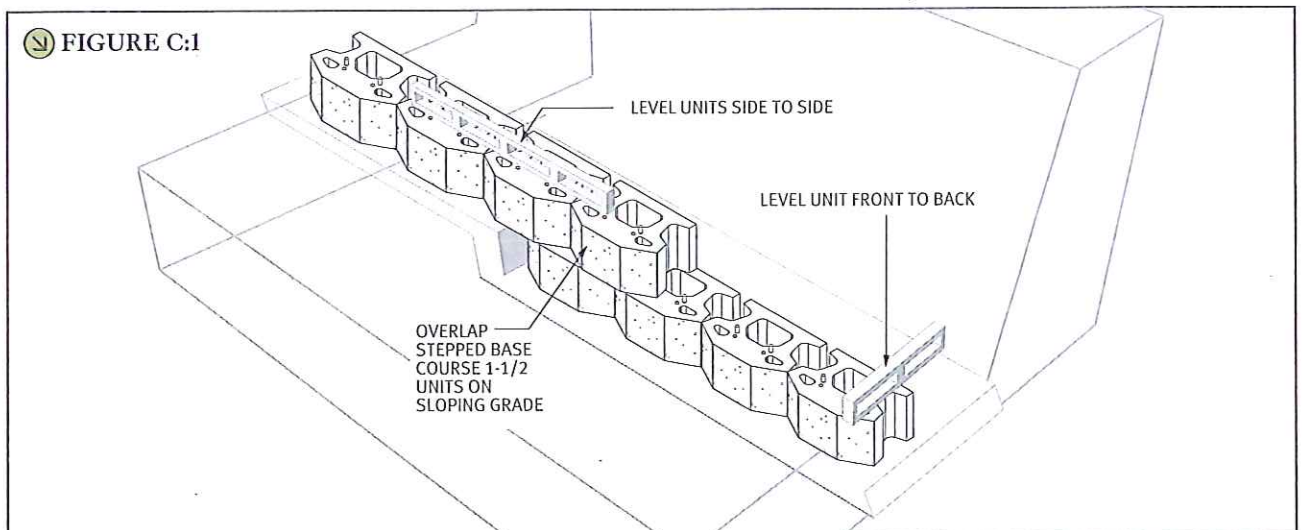
### 3. Prepare the Base Leveling Pad

Start the leveling pad at the lowest elevation along the wall alignment (see Figure A:1). The minimum leveling pad width shall be unit depth + 12 inches. The leveling pad shall consist of 6 inches of well compacted (95% Standard Proctor or greater) angular granular fill (road base or ½ inch to ¾ inch {10-20mm} crushed stone). Concrete is also acceptable to use as a leveling pad. Step the leveling pad up in 8 inch increments at the appropriate elevation change in the foundation. Do not use rounded material, i.e. PEA GRAVEL or SAND for leveling pad material.



## 4. Install the Base Course

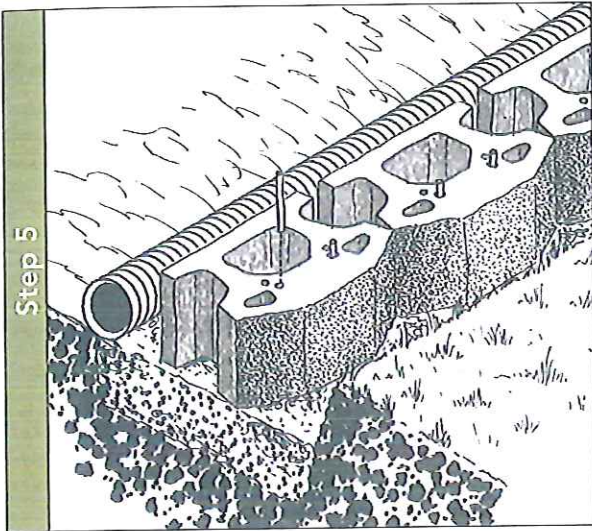
Place the first course of Keystone units (Compac II Units shown) end to end (with face of wall corners touching, do not leave gaps between units) on the prepared base. The pin holes should face upward, as shown. Ensure that all units are in full contact with the base and properly seated by gently pounding each block corner, and level as required. At base elevation changes (see Figure C:1) for installation reference. Leveling the first course is critical for accurate and acceptable results. Lay out corners and curves in accordance with the "Corners and Curves" section of this manual (p. 37).



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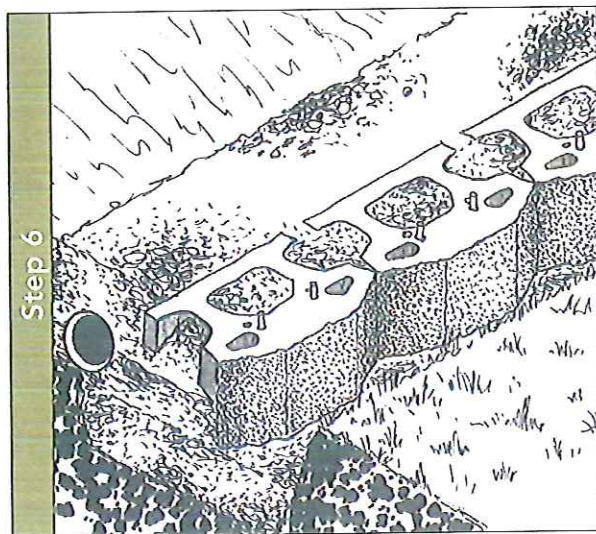


## Installation: Step-by-Step



### 5. Insert the Fiberglass Pins/Drainage Pipe

Keystone units have 3 setback options, near vertical, ½ inch setback and 1 inch setback (see Figure D:1). For the near vertical option, place the pins in the front pin holes, or for the 1 inch minimum setback, place the pins in the rear pin holes (see Figure E:1). Once placed, the pins create an automatic setback and alignment for the additional courses (see Figure F:1). When required, install drainage pipe behind wall unit and outlet drain to storm system or daylight as required.



### 6. Install Unit Drainage Fill/Backfill and Compaction.

Once the pins have been installed, provide ½-¾ inch (10-20mm) crushed stone unit drainage material to a minimum total distance of 24 inch (610mm) from wall face. Fill all open spaces between units and open cavities/cores with the same unit drainage material. Place the wall backfill behind the unit drainage fill in maximum 8 inch (200mm) lifts and compact to 95% Standard Proctor Density or 92% Modified Proctor Density with the appropriate compaction equipment. Use only hand operated equipment within 3 feet of the retaining wall face.

FIGURE E:1 - PIN INSTALLATION DIAGRAM

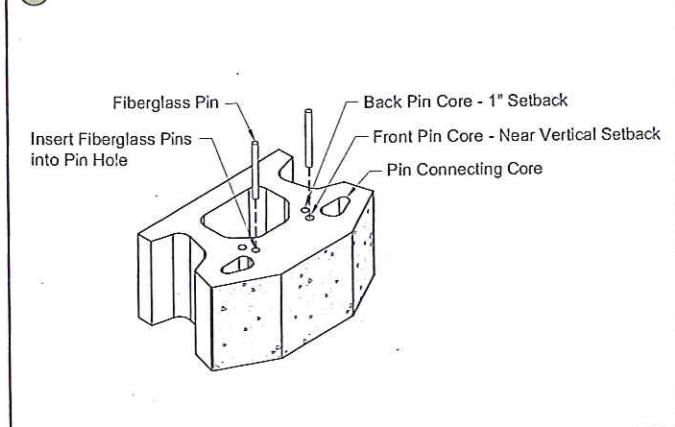
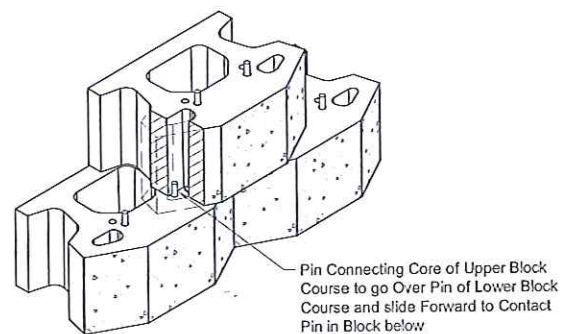
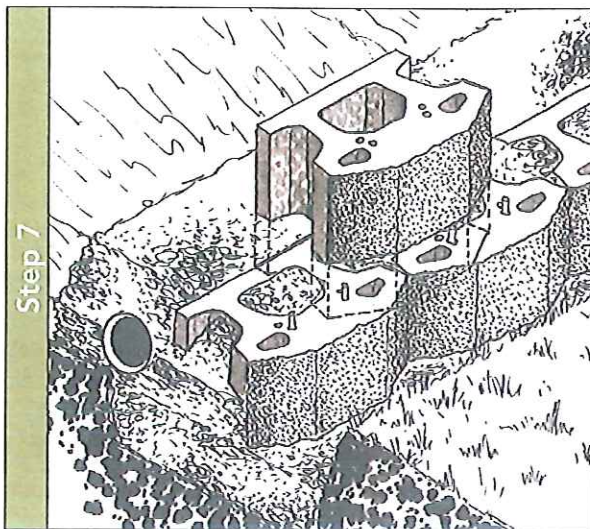


FIGURE F:1 - CONNECTION DIAGRAM



If drainage is required due to excess water or the design engineer's plans call for a drainage pipe to be installed, add the drain tile behind the tails on the base course. Drainage pipe should maintain positive drainage to daylight, outlet the drainpipe at low point or ends of wall.

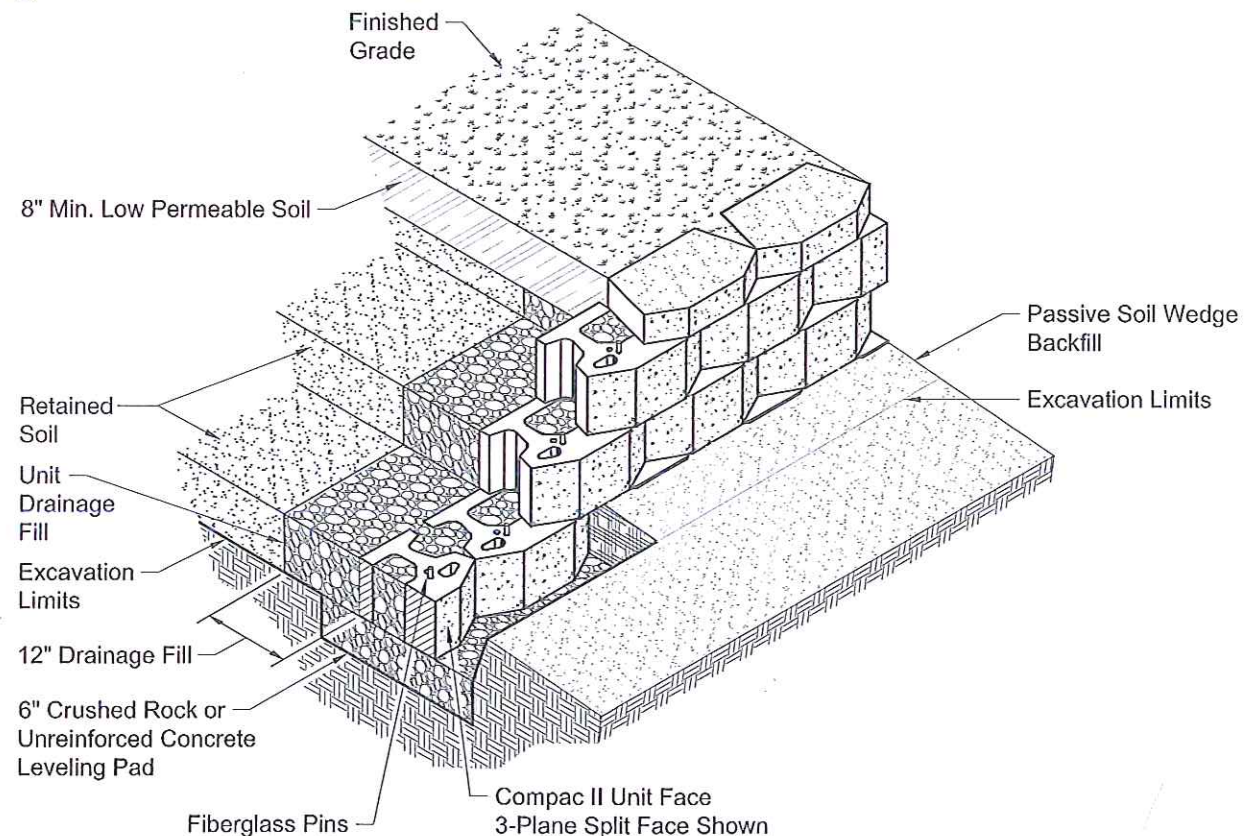




## 7. Install Additional Courses.

Remove all excess unit drainage material from the top surface of the all units. Center the next unit in front of the point where the two units below meet, fitting the pins into the pin connecting core of the above unit. Push the units toward the face of the wall until they make full contact with the pins (see Figure F:1). Check level front to back and side to side, shim the units or grind as necessary. It is important to check level front to back and side to side on every course to maintain proper wall batter and alignment. Proper shimming materials can be any non-degradable material including but not limited to, asphalt shingles, scrap pieces of geogrid, polyester rope, etc... Continue backfilling, installing additional units and checking level to the desired top elevation (see Figure G:1). Follow wall unit and unit drainage fill installation closely with backfill. Maximum stacked vertical height of wall units prior to unit drainage fill and backfill placement and compaction shall not exceed 2 courses, unless special construction techniques are employed to insure complete filling of all units with unit drainage fill. For gravity walls continue this construction sequence to complete the wall, and proceed to Step 10. For geogrid reinforced walls, continue with Step 8 and Step 9.

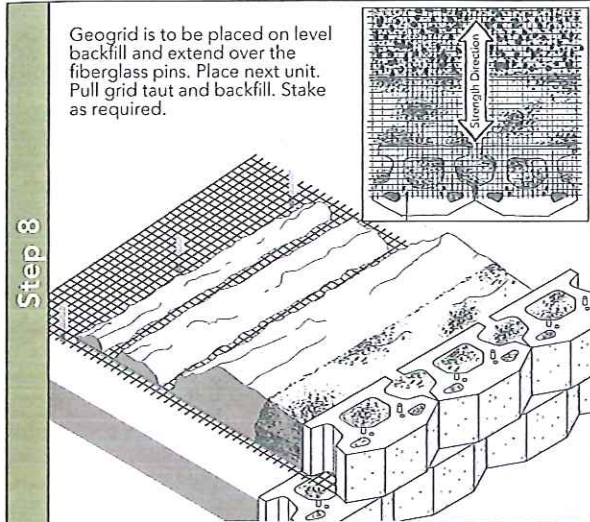
FIGURE G:1 - 3D CROSS SECTION WITHOUT REINFORCEMENT



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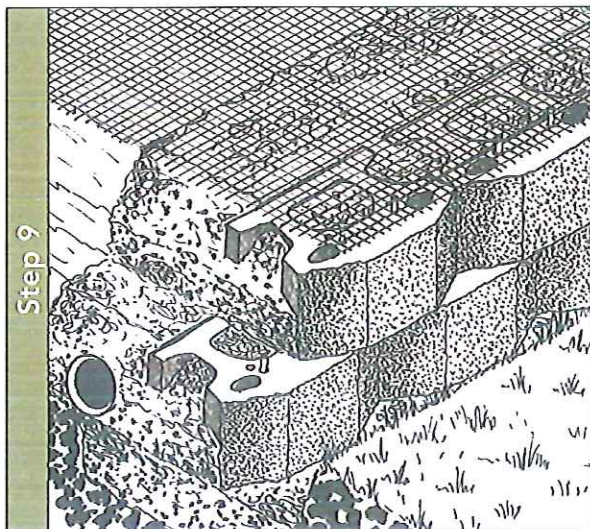


## Installation: Step-by-Step



### 8. Structural Geogrid Installation

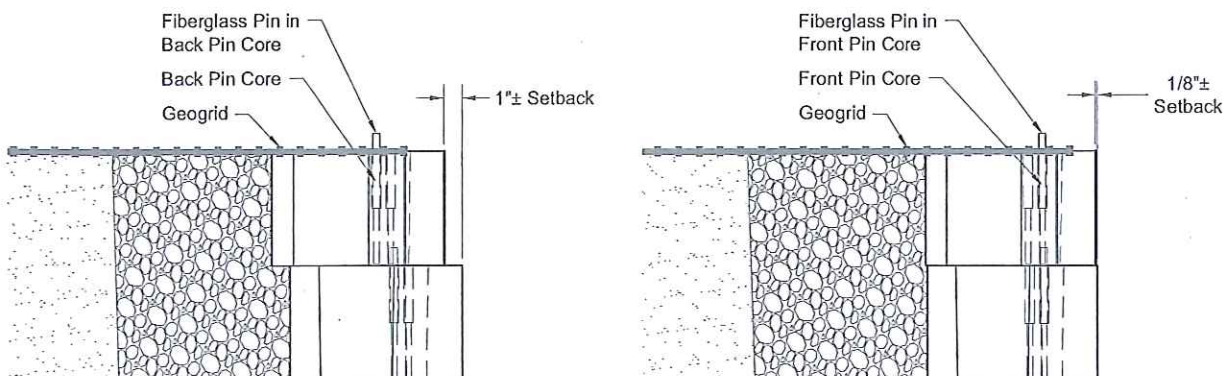
Start at the lowest wall elevation where a geogrid layer will be placed. The geogrid elevations, depths, and strength will be specified in the engineered design for the wall.\* Measure and cut the geogrid material to the specified length. Orient geogrid with highest strength axis perpendicular to the wall alignment. Lay geogrid horizontally on compacted backfill and hook over the pins of the units (see Figure H:1). In general, geogrid will be placed in pieces side-by-side with no gapping, and in a continuous layer along the length of design geogrid elevation, unless a change in elevation is specified in the design. Tension the geogrid by pulling it towards the embankment. Place a stake through the end of the geogrid into the ground to hold it taut and in place. Do not excessively tension geogrid: this may pull units out of proper alignment. Install an additional course of units over the geogrid and insert pins.



### 9. Reinforced Backfill Placement

Proceed with placement of the unit drainage fill and the backfill in the reinforced zone. Specifications for the material to be used as backfill in the reinforced zone should be defined in the engineered plans. Place this material nearest to the units, moving progressively toward the staked end of the geogrid. This procedure will keep the geogrid under tension. Compact the reinforced fill material to 95% Standard Proctor Density (ASTM D698), or 92% Modified Proctor Density (ASTM D1557) or to the compaction requirements in the engineered plans. Install additional courses as described in step 7, until the next reinforcement elevation. Repeat Step 8 and Step 9 (see Figure G:1.1, page 18). Only hand operated compaction equipment shall be allowed within 3 feet of the back surface of the units. At the end of each day's operation, grade the backfill away from the wall and direct runoff away from the wall face.

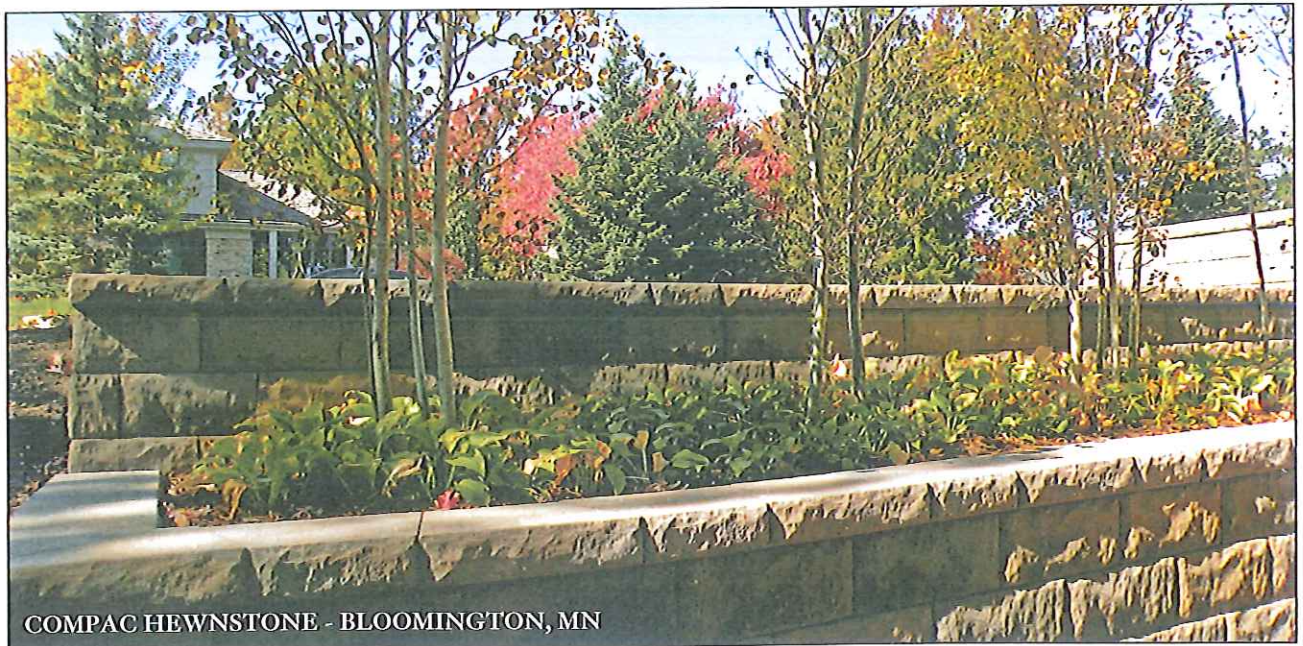
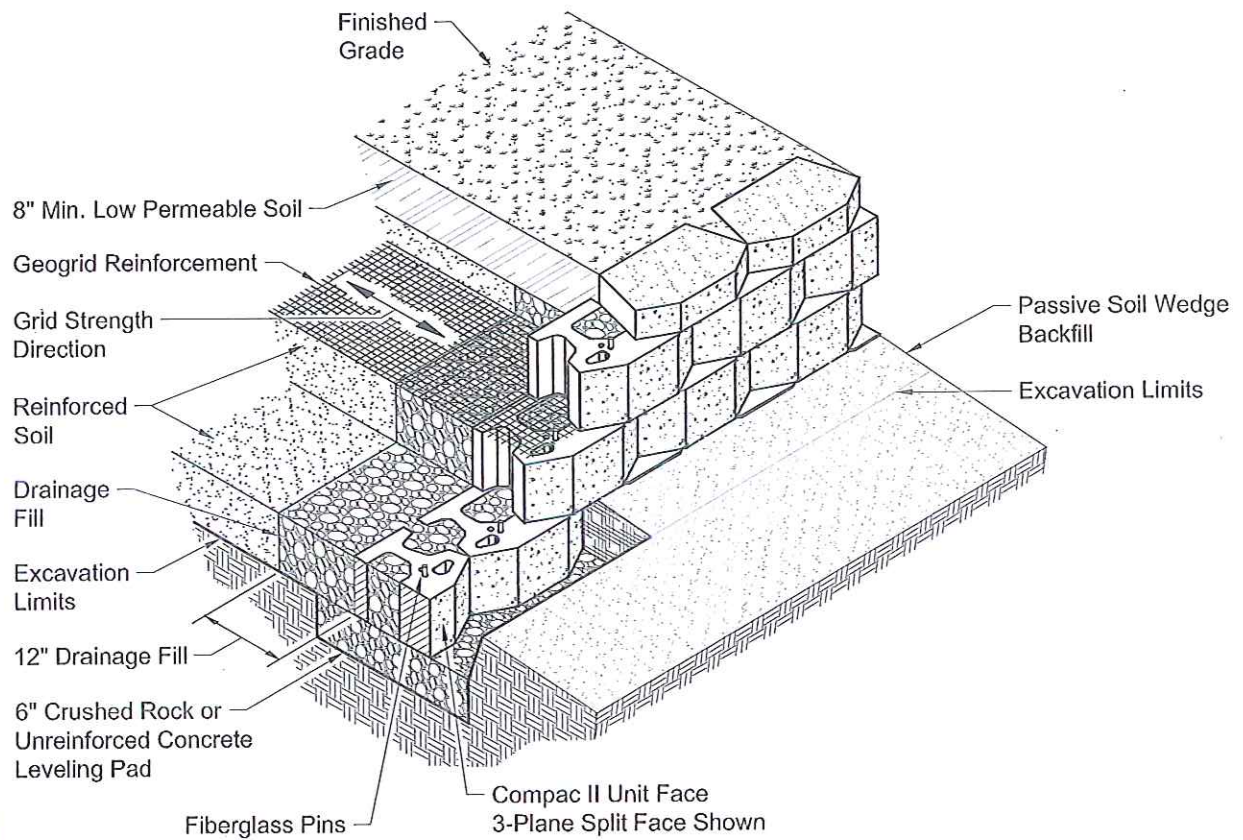
**FIGURE H:1 - SETBACK OPTIONS WITH REINFORCEMENT**



\* For assistance in obtaining engineered drawings for your project, please contact your local Keystone representative.



FIGURE G:1.1 - 3D CROSS SECTION WITH REINFORCEMENT



COMPAC HEWNSTONE - BLOOMINGTON, MN

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## Installation: Step-by-Step

### 10. Capping the Wall

Follow the same procedures described in Step 6 for proper placement and positioning of the cap units. Complete your wall with the appropriate Keystone capping units. These units are available in a variety of sizes and shapes, including 4 inch (100mm) and 8 inch (200mm) high units. Availability of these units will vary by region. For cap unit descriptions and placement variations see the section, "Wall Finishing", page 65 of this manual. Sweep the lower units clean and make sure they are dry. Use construction adhesive (Keystone KapSeal™) on the top surface of the last course before applying cap units (see Figure I:1).

### 11. Finished Grade and Landscaping

The Keystone Retaining wall is now complete. Final grading, planting or other surface material can now be put into place. Typically an 8 inch thick layer of low permeable soil is installed as the final layer of material. This is to help prevent water infiltration to the retained or reinforced zone of the retaining wall. Remember that finished grade conditions affect the wall's performance. Such conditions should not be altered from the original design. Loading with slopes, parking lots and buildings should be maintained as designed. Any changes to the top of wall finished grade must be evaluated prior to wall completion (see Figures J:1-L:1 for typical cross section details).\*

#### Note:

See Additional Construction Details "Planting Guidelines" for details on proper planting installations for a Keystone retaining wall. Also See Additional Construction Details for other types of top of wall treatment details.

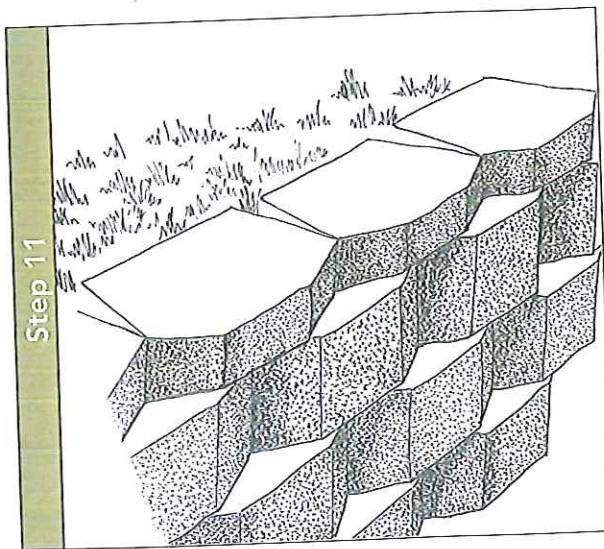
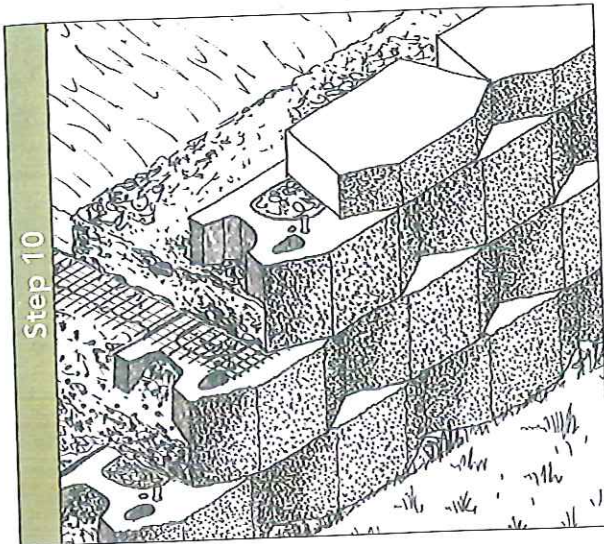
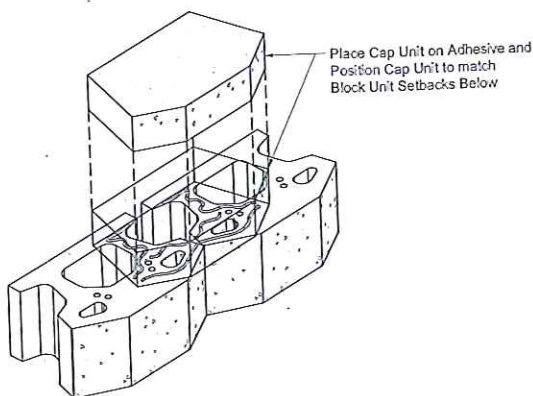
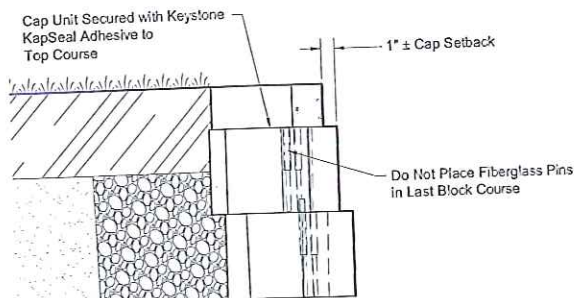


FIGURE I:1 - SECURE THE CAPS



Place Cap Unit on Adhesive and Position Cap Unit to match Block Unit Setbacks Below



#### Note:

Capping options vary by manufacturer

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