LondonBoulder™

Where Strength Meets Style

LondonBoulder Engineering & Installation Guide

LONDONBOULDER™

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Where Strength Meets Style

With the natural aesthetics of a boulder wall and the strength and reliability of traditional segmental retaining wall units, LondonBoulder is the perfect solution when strength and style are a necessity.

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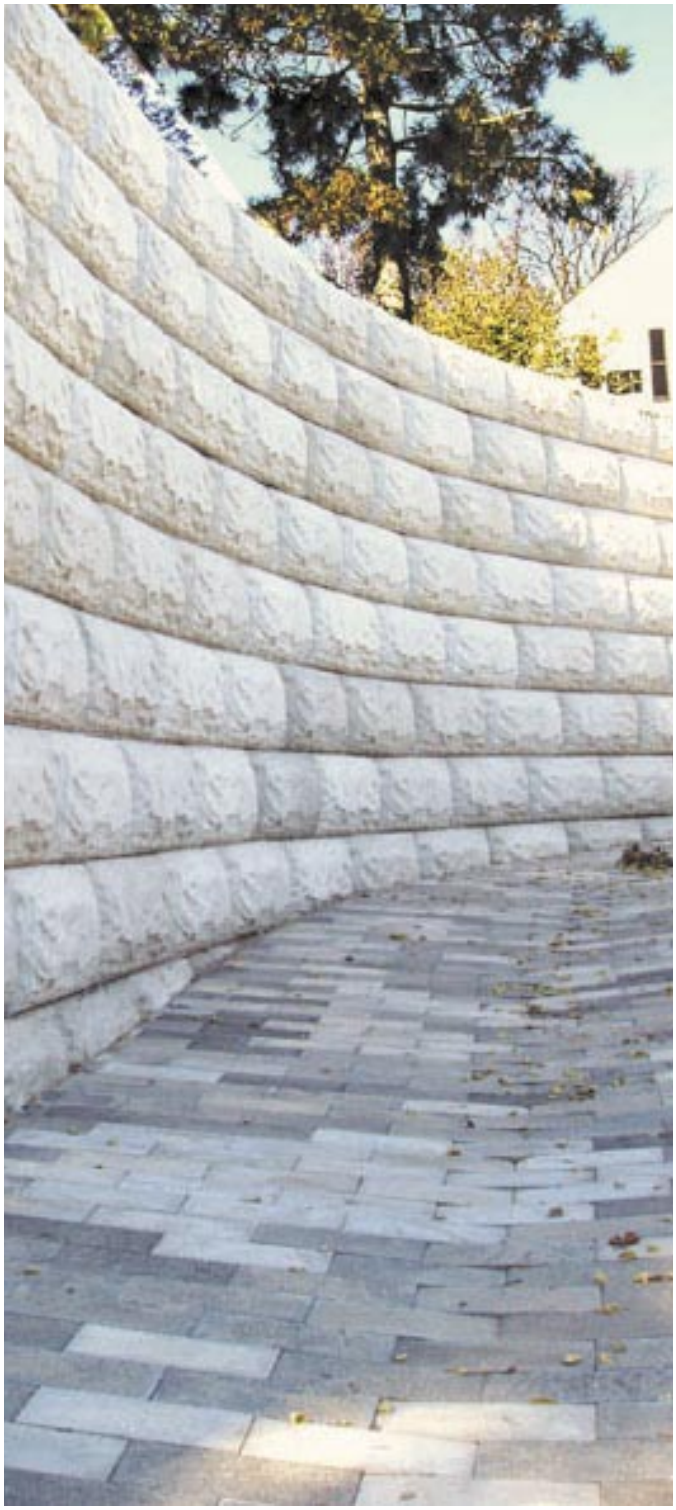
Designing a wall involves more than just calculating the number of courses and amount of grid it will take to cover a desired length.

When bringing a project from idea to reality, careful planning at the early stages goes a long way toward minimizing costs, repairs and other project setbacks. Proper consideration of construction site features, obstacles and constraints is essential for a cost-effective design and will influence the final product.



TERRAIN GEOMETRY

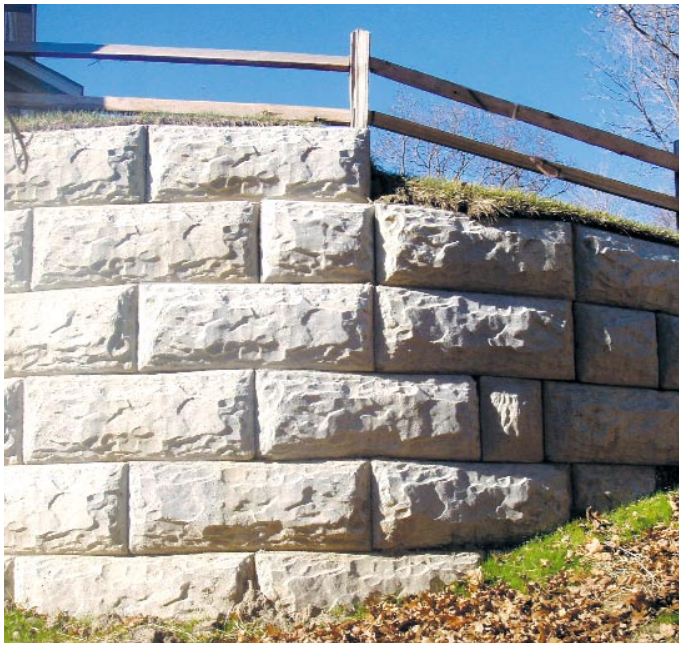
The first consideration when planning a LondonBoulder wall is to look at the site topography. Careful examination of changes in terrain elevation will help reduce excavation costs. Plan for adequate drainage and other remedies to channel water away from your wall.

Other important aspects to consider at this stage are whether adjacent construction, waterways or other terrain features could have an effect on the design and performance of the wall in the future.

GRADING

Careful examination of terrain grading both above and below the planned wall is essential. Slopes above the wall will create overloads, whereas a sloping grade at the wall footing typically decreases the available resistance to the design loads.

Grading can also create problems if it channels or retains water on or near the wall.



NEARBY STRUCTURES

If they are close to the wall, loads created by structures such as buildings, parking lots, storage areas, etc. can have an impact on final design. Depending on the circumstances and relative duration, these loads may be classified as either LIVE or DEAD.

For example, slopes are generally considered DEAD loads, whereas loads coming from parking lots may be classified as LIVE, due to their shorter duration. DEAD loads, e.g., building loads, or loads from a tiered wall may contribute to the overall stability of the wall, depending on closeness to the wall edge. Surcharges increase the stress on block and reinforcing grids. Keep in mind that these facts will contribute to a balanced design.

LIVE loads, such as those resulting from bulk storage, vehicular traffic, etc. may act both as stabilizing and destabilizing forces in your design. Typically, a conservative design approach is to neglect any live loads as part of the resisting set of forces in design.

As a rule of thumb, surcharge loads that are at a distance of twice the height of a wall below can be neglected in a design.

UTILITIES

If applicable, make sure the design includes planning for utilities running through the wall or into the backfilled portion of it.

SOILS

Soils are important not only because they will ultimately bear the weight of the designed wall structure, but also because their properties directly affect the design.

Typically, well-graded coarse sands have better design properties than finer soils, like clay. Particles in sand fill voids and interlock better than uniform granular soils or clays, resulting in stronger structures.

Soils that are expansive, or organic (peats, etc.) should be avoided as fill material when building walls. Granular soils that are too coarse or sharp should be avoided as fill material, since they may damage the reinforcing grid. If the site has unsuitable soils (disturbed soils, soft, expansive, chemically aggressive, etc.) they must be excavated and replaced with appropriate materials prior to any other work.

WATER

One crucial site characteristic that must be checked before any design is carried out is the presence of groundwater. The presence of a water table too close to the bottom of the foundation pad (less than 2/3 the height of the wall), or suspicion of a seasonally shifting water table can dramatically reduce the integrity of the wall if left unchecked.

Also, be sure to check for the presence of waterways or moving floodwaters that could cause scour of the foundation at the top of the wall. Make sure that terrain features do not bring surface water near the wall. If that is the case, the design should include details to ensure water gets diverted from the structure. These include swales over and around the top of the wall, slopes,“curling” the ends of the wall into the slope or bank, impervious soil tightly compacted at key locations, etc. These provisions should not be confused with internal drainage within the wall structure, typically comprised of granular aggregate drainage directly behind the wall face, drain tile pipes, and chimney drains behind the reinforced soil mass.

SETBACK

One of the benefits of LondonBoulder is its ability to be built both vertically and with a setback using the same boulder unit. This level of versatility allows the LondonBoulder line to be useful in a variety of environments while meeting a number of landscaping needs. However, careful consideration must be taken when determining whether to build the wall with or without a setback. Although setback walls have the ability to retain larger amounts of earth than vertical walls, they add a level of difficulty when it comes to project planning and design. As indicated in the chart below, each course in a setback wall has an approximate setback of 6 inches, which, in the context of the wall's vertical face, equates to an 18.43 degree batter. If this setback is not considered, the desired layout may be impossible to realize once the minimum radius of curvature of the LondonBoulder units has been reached. **See Figure D on page 7.** The following table should help you calculate the setback for each additional LondonBoulder course that is applied to the project. **See Figure A.**

Course	Height	Setback
1	18" (1.5')	na
2	36" (3.0')	6" (0.5')
3	54" (4.5')	12" (1.0')
4	72" (6.0')	18" (1.5')
5	90" (7.5')	24" (2.0')
6	108" (9.0')	30" (2.5')
7	126" (10.5')	36" (3.0')
8	144" (12.0')	42" (3.5')
9	162" (13.5')	48" (4.0')
10	180" (15.0')	54" (4.5')
11	198" (16.5')	60" (5.0')
12	216" (18.0')	66" (5.5')
13	234" (19.5')	72" (6.0')
14	252" (21.0')	78" (6.5')
15	270" (22.5')	84" (7.0')
16	288" (24.0')	90" (7.5')
17	306" (25.5')	96" (8.0')
18	324" (27.0')	102" (8.5')
19	342" (28.5')	108" (9.0')
20	360" (30.0')	114" (9.5')

Figure A

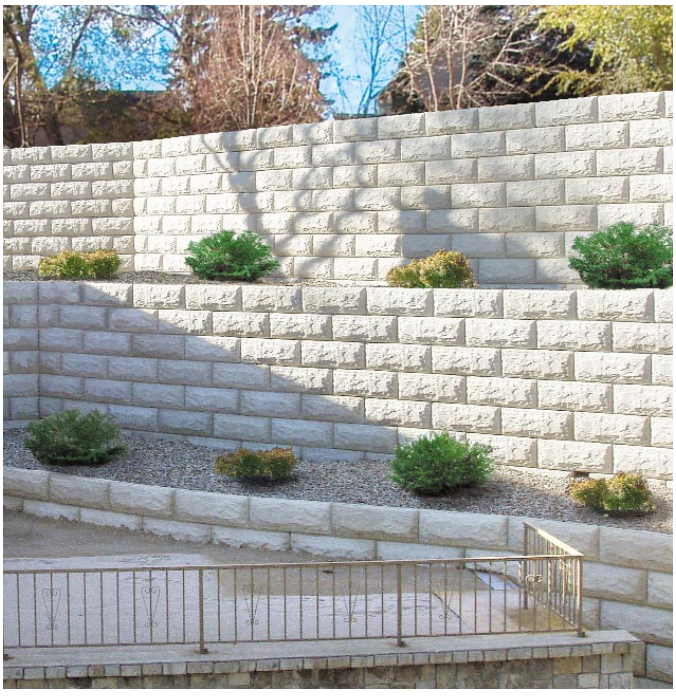
UNREINFORCED WALLS

A retaining wall is a structure that resists the forces from a soil mass by virtue of its own weight. In many cases, a simple gravity wall (with no geogrid reinforcement required) will be all that is needed to retain a soil mass. The soil is kept in place by the sole weight of the stacked concrete blocks. When this weight alone is not enough, the use of reinforcement grid brings together a larger mass of soil to counteract the pressures of the retained soil.

Generally, if the terrain is level, with appropriate soil and no surcharges or water masses nearby, unreinforced vertical walls can be built up to a height of 9.6 feet, while walls that are installed with a setback can reach heights of up to 14.1 feet. If soil and terrain conditions are not ideal, it is strongly recommended that the project be reviewed by a qualified licensed professional (P.E.). **See "Unreinforced Height Limits for LondonBoulder" for more detailed information.**

REINFORCED WALLS

When your wall design calls for taller walls, or incorporates special conditions such as tiers, slopes, or surcharges behind the wall, reinforcing grid or "Double Walls" may be required to stabilize the wall. (See page 14 for additional information on Double Walls.) Grid layers work by bringing together a larger mass to aid the wall in resisting the forces exerted by the retained soil. See grid reinforcement details beginning on page 16.



Unreinforced Height Limits for LondonBoulder

Assumptions related to engineering:

- No surcharge or back slope present
- Soil unit weight of 120 pcf
- Minimum 1' embedment
- Backfill compacted to minimum 95% Proctor
- Safety factors: 1.5 against sliding; 2.0 against overturning
- Heights apply only to soil type with indicated friction angles
- Construction follows adequate industry practice

The following chart represents height limits related to vertical or setback walls constructed in soil with varying degrees of friction angles. Chart does not include checks for global stability or presence of water.

SOIL	VERTICAL	SETBACK
$\phi = 34°$	9.6'	14.1'
$\phi = 32°$	8.5'	12.3'
$\phi = 30°$	7.8'	11.1'
$\phi = 28°$	7.0'	9.7'

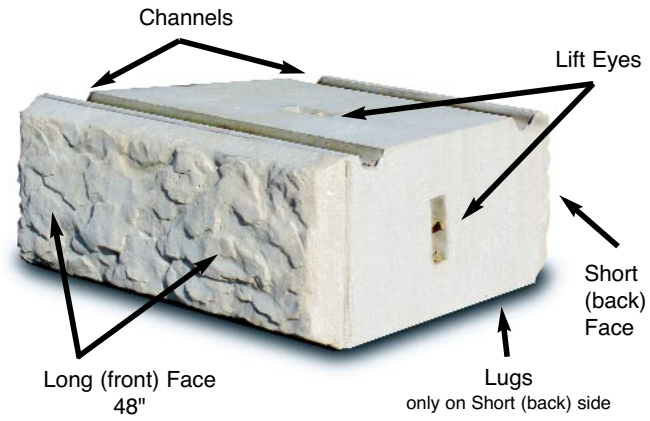
This chart is for estimating tasks and reference only. It is the user's responsibility to ensure that a final, project-specific design is reviewed, approved, and sealed by a registered Professional Engineer, based on actual soil conditions. It is the project owner's responsibility to ensure the adequacy of the designed retaining wall incorporated into the overall project through a specification. The specification should include factors which affect the overall integrity of the retaining wall such as location, interaction with other project components, and engineering aspects including but not limited to site soil bearing capacity, global slope stability, presence of underground or surface water, etc. Specification of excavation, trenching or any other construction procedures and corresponding safety specifications are the responsibility of the installer, who shall adhere to sound industry practice and provide additional support during construction if needed.

EXCAVATION/BASE PREPARATION

1. LondonBoulder recommends that wall elevations be set using a laser level and stakes prior to excavation. This will greatly enhance the efficiency and accuracy of the entire project.
2. Foundation soil shall be excavated to the lines and grades of the construction drawings and as required for base course installation. Use caution to ensure that the foundation is not disturbed beyond the indicated depths. As shown in **Figure B**, base trench shall be excavated to a minimum of 60" wide and 12" deep. Use compacted backfill material to fill over-excavated areas. It is permissible to use a layer of non-woven landscape fabric along the three sides of the trench to maintain a barrier between the surrounding foundation and the base material to be put down later.
3. Using granular, inorganic material such as class five, crushed stone, or recycled concrete, place the base leveling pad in the excavated trench such that it maintains a width of 60" and a depth of 12" after compaction. Compaction should meet or exceed 95% Standard Proctor and should be achieved through the use of a mechanical plate compactor.
4. Lean concrete with a minimum 28-day compressive strength of 2,500 psi may be substituted for the granular base material. Granular base material may also be top-dressed with a minimum 3" thick layer of lean and unreinforced concrete. Reinforced footings must be placed below the frost line.
5. Final base must be uniform, level, and well compacted to provide the best possibility for a smooth, hassle-free wall installation. Achieving this standard in the base will also help to limit the number of future repairs that may be necessary due to sections of sagging wall and other base-related failures.
6. Level compacted base material from side to side and front to back.
7. A drainage pipe should be installed on walls exceeding 4.5 feet. The drainage collection pipe should daylight into a storm sewer manhole or to a sloped area lower than the pipes behind the walls. The main collection drainpipe just behind the block facing shall be a minimum of 4" in diameter (Reference #4 on page 7). **See Figure F on page 8.**

Recommended Construction Tolerances		
Vertical	± 1" / 10 ft	3" maximum
Horizontal	Straight lines: ± 1" / 10 ft	3" maximum
Rotation	From design wall batter: 2º	
Bulging	1.00" / 10 ft	

ANATOMY OF THE LONDONBOULDER



BASE PREPARATION/FIRST COURSE

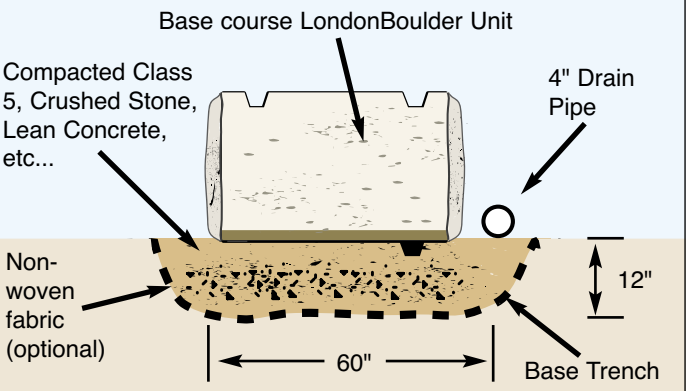


Figure B

TOP VIEW - LONDONBOULDER WALL

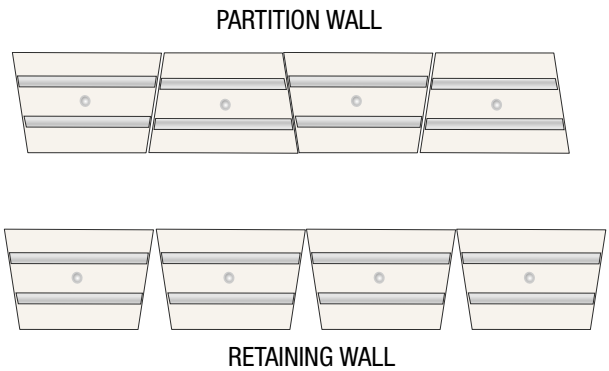


Figure C

SETTING THE FIRST COURSE

1. Always start the base course at the lowest elevation of the wall. In the case of a base elevation that varies, refer to **Figure E**. LondonBoulder recommends a two block overlap when stepping up from one course to the next.

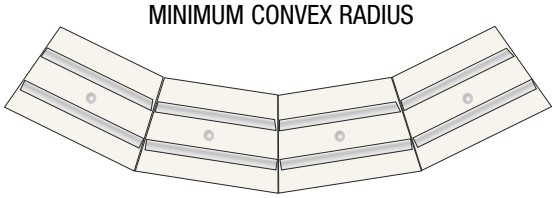
2. Place the first course of LondonBoulders directly on the leveling base pad, check to ensure that they are properly aligned and leveled. The bottom surface of each unit should be in full contact with the base. If units have lugs, removing them may be necessary prior to placing as base course. This can be accomplished using a concrete chisel or other appropriate tool. Adjacent units should be in contact with one another at the front face if constructing a retaining wall, and along all inside edges if constructing a partition wall (this is accomplished by reversing every other trapezoidal unit inside the two end units). **See Figure C on page 6.**

3. Alignment of a straight wall may be best achieved by using a string line or laser level. If building a convex or concave wall, it may be helpful to run a radius string from an established center point. **See Figure D** for minimum radius information.

4. If the wall exceeds 4.5', or if recommended by local practices or conditions, place perforated or slotted PVC or corrugated HDPE pipe behind the first course of LondonBoulder units. LondonBoulder recommends that the drain pipe be at least 4" in diameter and surrounded by a minimum of 1 square foot of drainage stone. **See Figure B on page 6.** In special situations where water and drainage play a bigger role in the design, "weep holes", larger drainage stone, larger drain pipe with sock, and/or filter fabric behind the drainage stone may be warranted. Contact a P.E. for recommendations and details.

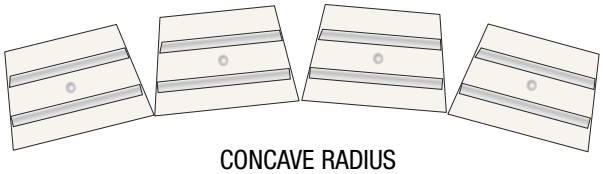
TOP VIEW - CURVED RETAINING WALL

MINIMUM CONVEX RADIUS



Minimum Convex Radius with Setback	
Courses	**R (*)**
1	10'-09"
2	11'-05"
3	12'-00"
4	12'-08"
5	13'-04"
6	14'-00"
7	14'-07"
8	15'-03"
9	15'-11"
10	16'-07"
11	17'-03"
12	17'-10"
13	18'-06"
14	19'-02"
15	19'-10"
16	20'-06"

(*) Top course or one-course wall leave a 1/4" gap at the back of the block.



CONCAVE RADIUS

Figure D

TYPICAL STEPPING-UP BOULDER CONSTRUCTION DETAIL

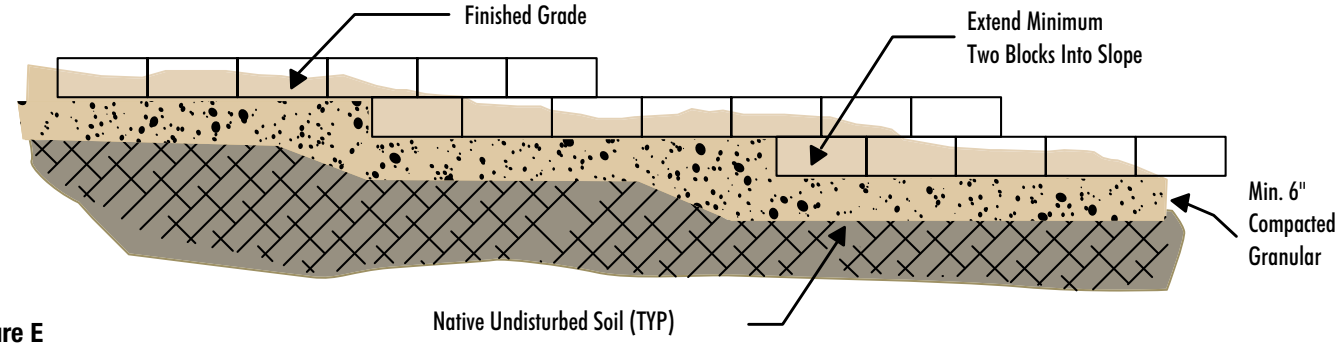
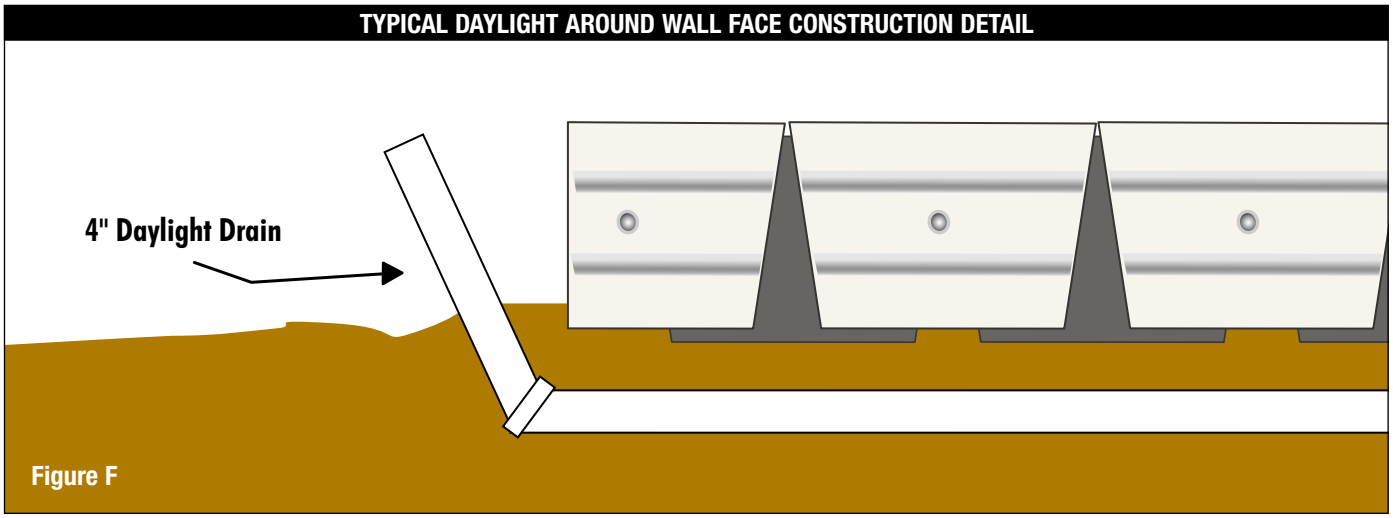


Figure E

BACKFILL

1. All drainage material in the drainfield and infill soils within 3 feet of the wall must be properly compacted using a plate compactor or manual plate tamper.
2. Compact in maximum 9" lifts – i.e. compaction should occur a minimum of 2 times with each course of LondonBoulder units set.
3. Place drainage aggregate behind and up to the height of the LondonBoulder wall. Drainage aggregate shall be placed to a minimum thickness of 12" measured from the back of the LondonBoulder unit. Reference photo to the right.
4. If installing a retaining wall, it is likely that there will be triangular voids between each LondonBoulder that are caused by the trapezoidal shape of the units. **See Figure C on page 6.** (Note that this void will not be present if installing a partition wall). Fill this void with 3/4" drainage rock or equivalent. Reference photo to the right.
5. Large rock and fat clay soils should generally be avoided as backfill material unless approved by a qualified engineer. In addition, soils that are excessively wet, dry, frozen, or inundated with debris should not be used.
6. If required, install geotextile filter fabric between the compacted backfill material and compacted infill soil.
7. If using geogrid reinforcement, be sure to avoid using compacting equipment directly on geogrid. Place the next 9" lift of soil on top of the grid before compacting.



INSTALLING SUCCESSIVE COURSES

1. Ensure the drainage aggregate is level with, or slightly below the top of the LondonBoulder unit.
2. Clean all excess material from the top of the units as well as any debris that may have fallen into the channels that run parallel across the top of each LondonBoulder. Even a small stone can create unevenness or a wobble.
3. Place the next row of LondonBoulder units with the seams offset from the seams of the units below. (**See Figure G** for additional detail on establishing a 1/2 running bond. **See Figure O** on page 14 for reference to a 2/3 running bond.)
4. If installing a setback wall, place and move each LondonBoulder unit so that the bottom lugs engage the back edge of the units below. This will ensure a consistent setback depth of approximately 6 inches.
5. Sight down the wall line to ensure wall straightness. Adjust units as needed to form straight lines and smooth curves. Make sure to check each block to certify that it is level from front to back and side to side. Adjust if necessary. A shim can be used to make small corrections in level.
6. Place drainage aggregate and infill soil as stated previously.
7. Repeat these steps until the wall reaches its final height.

RETAINING WALL - 1/2 RUNNING BOND

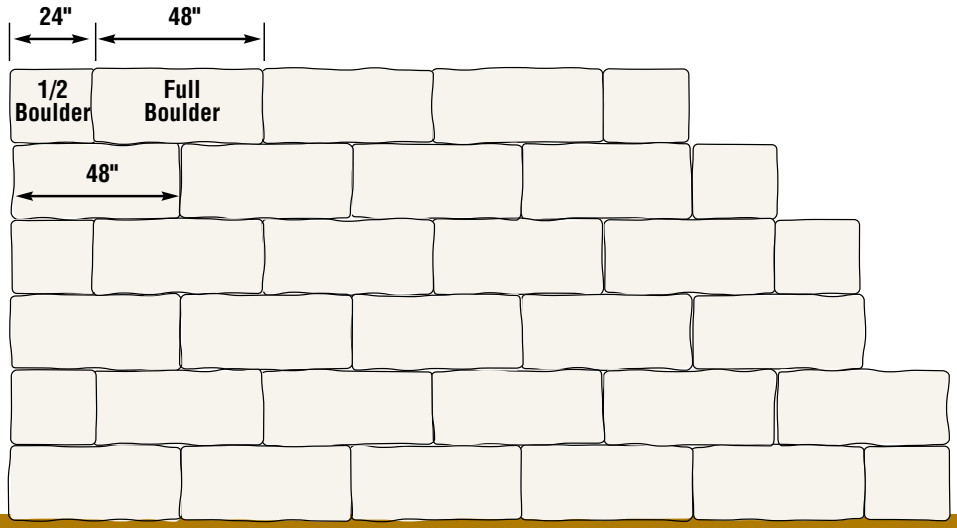


Figure G

USING THE GEOGRID SYSTEM

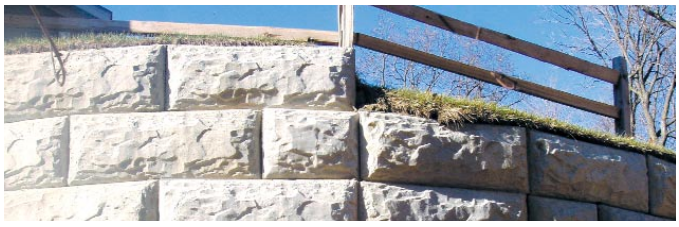
1. Install units up to the designated height of the first grid layer, making sure to backfill and compact behind the wall to a depth equal to the designed grid length.
2. Cut grid to design length as shown on the plans. Make sure the grid covers the back 2/3 of the unit below. Install the grid with the design strength direction perpendicular to the wall face. Seams or overlaps of grid parallel to the wall face are not permitted.
3. The geogrid reinforcement must be laid level upon the block and upon level backfill, compacted to 95% Standard Proctor density.
4. Remove all slack in the geogrid, then anchor it to the compacted backfill and place the next level of LondonBoulders and backfill. These units should be placed on top of the grid.
5. Only hand-operated equipment should be allowed within 3 feet of the wall. Track construction equipment shall not be operated on less than 6" of compacted infill material.

GEOGRID LAYOUT IN CURVES AND CORNERS

Curves and corners in designs need additional considerations for the correct layout of the reinforcing grid. Interior corners will invariably leave gaps between grid sheets, due to the curvature. To close these gaps, install additional reinforcement in places where gaps occur and on the next course above prior to backfilling. **See Figure H.**

In addition, square corners require that the 90° gap be filled with an extension of the reinforcing sheet equal to 25% of the total wall height, on alternate sides of the gap as you go up. **See Figure J on page 11.**

In contrast, exterior corners will always cause reinforcing grids to overlap, which in turn dramatically reduces the load carrying capacity of the grid. To correct this, a minimum of 3" fill must be placed between sheets at those overlap areas prior to backfilling that lift, as shown in **Figure I, and Figure K on page 11.**



INSIDE CURVE GRID LAYOUT (TYP)

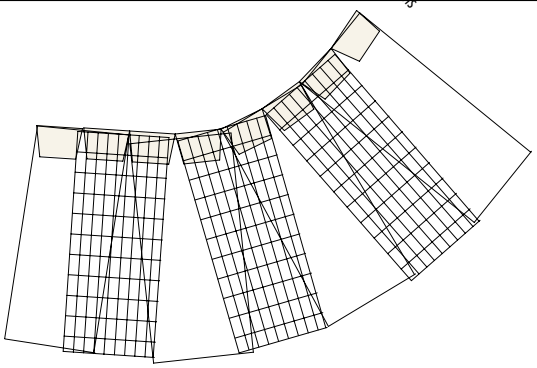
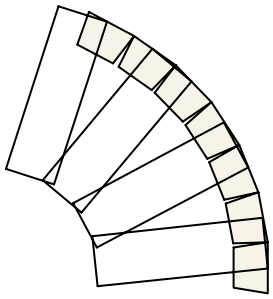


Figure H

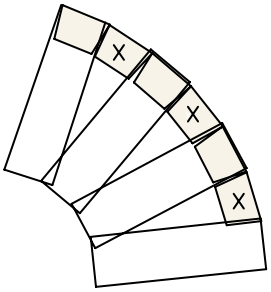
OUTSIDE CURVE GRID LAYOUT (TYP)

Scale: NTS

STEP #1:
Place grid so as to minimize overlap. Place 3" fill between any overlapping edges



STEP #2:
Install the next block course. Mark those blocks where there were gaps left in the grid below. Backfill and compact.



STEP #3:
Place grid over the areas where gaps were left. Backfill and compact. If overlapping, fill as in Step #1.

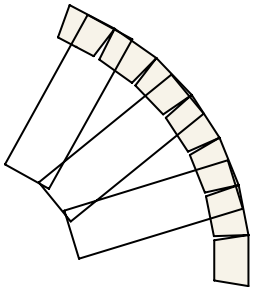


Figure I

INSIDE SQUARE CORNER REINFORCEMENT LAYOUT (TYP)

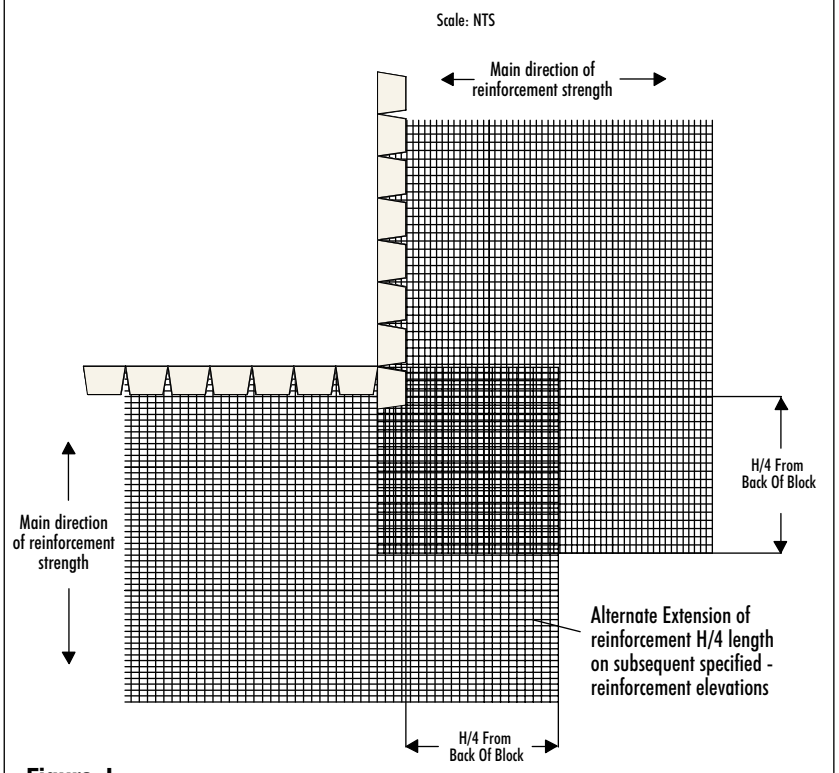


Figure J

OUTSIDE SQUARE CORNER REINFORCEMENT LAYOUT (TYP)

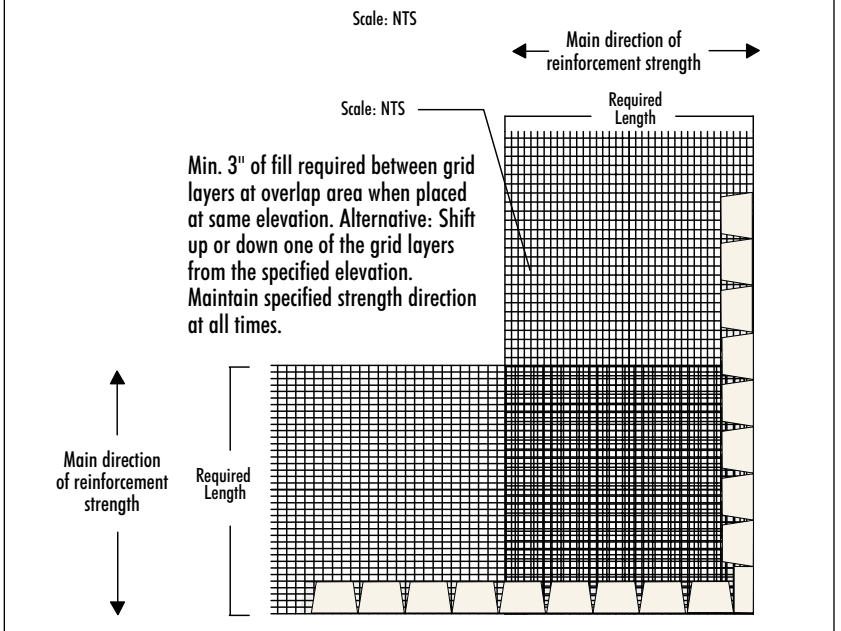


Figure K

CAPPING

1. Make sure the surface of the Cap Boulder, and the block the Cap Boulder is being placed on, is dry and free of debris.
2. Set cap unit in the same manner as LondonBoulder units
3. The back side of the Cap Boulder is recessed 8 inches to allow for the application of soil, sod, rock, mulch or any other fill material the end user deems necessary. The Cap Boulder's sides are tapered to allow for a radius wall if desired.
4. Each end of a course of Cap Boulders can be finished with a Left and/or Right Cap Corner. **See Figure L.**
5. Careful consideration must be taken when using the Cap Corner units at both ends of a wall with two 90° corners. Given the set dimensions of the Cap Corners at 16" and 24", some calculations must be made to ensure that it is possible to fit a set number of units between the two end units.

CAP BOULDER

CAP CORNER BOULDER

CAP CORNER

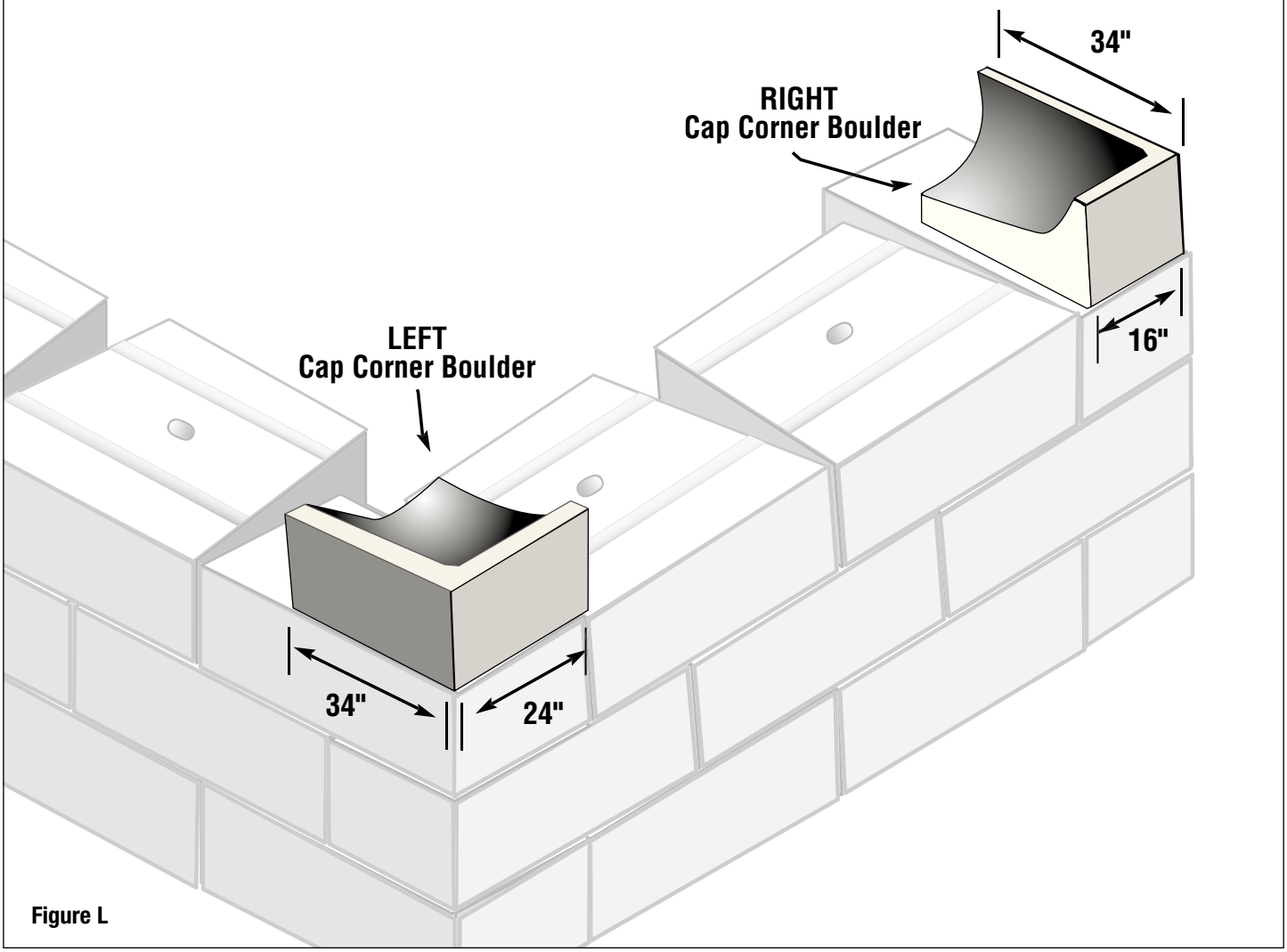


Figure L

90 DEGREE CORNERS

Utilizing its rebar pinning method, LondonBoulder's 90° Return Corner provides a simple, 1-unit system to turn a 90° corner without losing retention strength. Each 90° Return Corner is manufactured with a 3" hole running vertically through the unit. By alternately "flipping and turning" each course, these holes will create a corner core into which a 1" of 3" piece or rebar can be inserted. Since these units are manufactured without lugs for versatility, the rebar pinning system serves as the shear connection for a strong, reliable corner. **See Figure M.**

This method of achieving 90° Corners also continues the 1/2 bond both directions, creating a consistent finish.

90 DEGREE CORNER

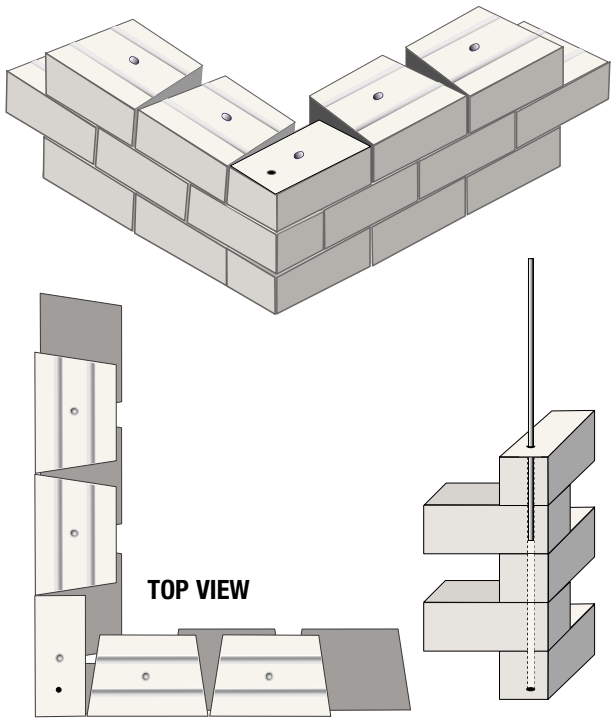


Figure M

SEAWALL

With minor changes to the base leveling pad and the addition of rip rap, LondonBoulder walls can be installed in water settings. However, due to the variety of site-specific variables and restrictions, no wall height charts can be provided for seawall applications. Consult your P.E. for specific details and stamped drawings. **See Figure N.**

TYPICAL SEAWALL DETAIL

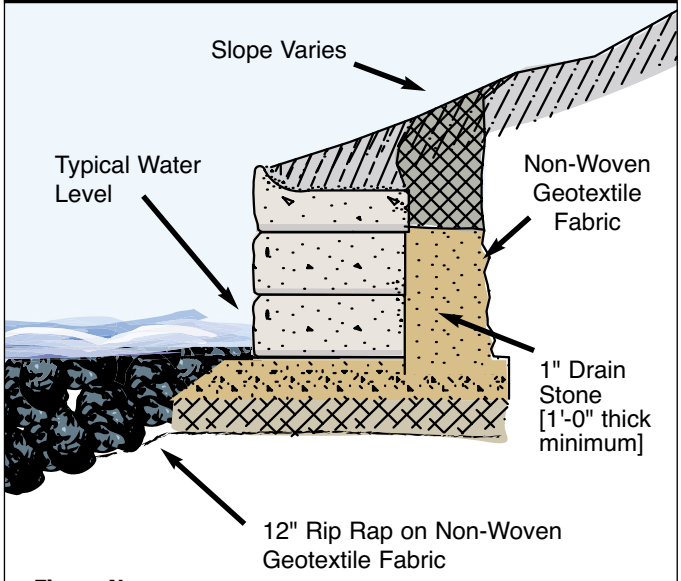


Figure N

90 DEGREE RETURN BOULDER

FREE STANDING PARTITION WALL

With a combination of unique and versatile features including vertical capabilities and a textured face on two sides, the LondonBoulder line can be easily turned into a free standing partition wall.

To build a partition wall, place the first course, beginning with a Full Corner Boulder, so that adjacent units are in contact with one another along all inside edges. **See Figure O.** With the exception of all outside units, the interior of the wall should be made up entirely of Full LondonBoulders placed alternately between "long" and "short" faces. Finish the first course with another Full Corner Boulder. Begin the 2nd course with a 1/2 Corner Boulder and follow it with alternating Full Boulders until reaching the other end where a 2/3 Corner Boulder must be placed. The result is a 2/3 Bond Partition Wall perfect for noise reduction or to block unwanted views.

DOUBLE WALL

In certain conditions it may be beneficial or necessary to limit site excavation and geogrid installation with the presence of a double wall. Double walls require less excavation and provide earth retention benefits similar to that of geogrid. Typical double walls are only a portion of the height, and do not necessarily run the full length of the finished, exposed wall. **See Figure P.** Consult your local P.E. for details regarding the application of double walls at specific sites.

TOP VIEW - DOUBLE WALL

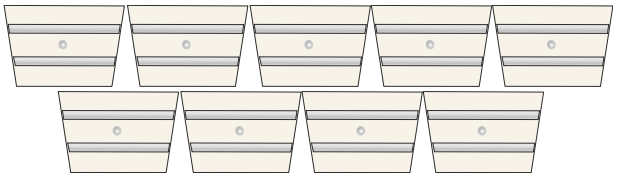


Figure P

PARTITION WALL - 2/3 RUNNING BOND

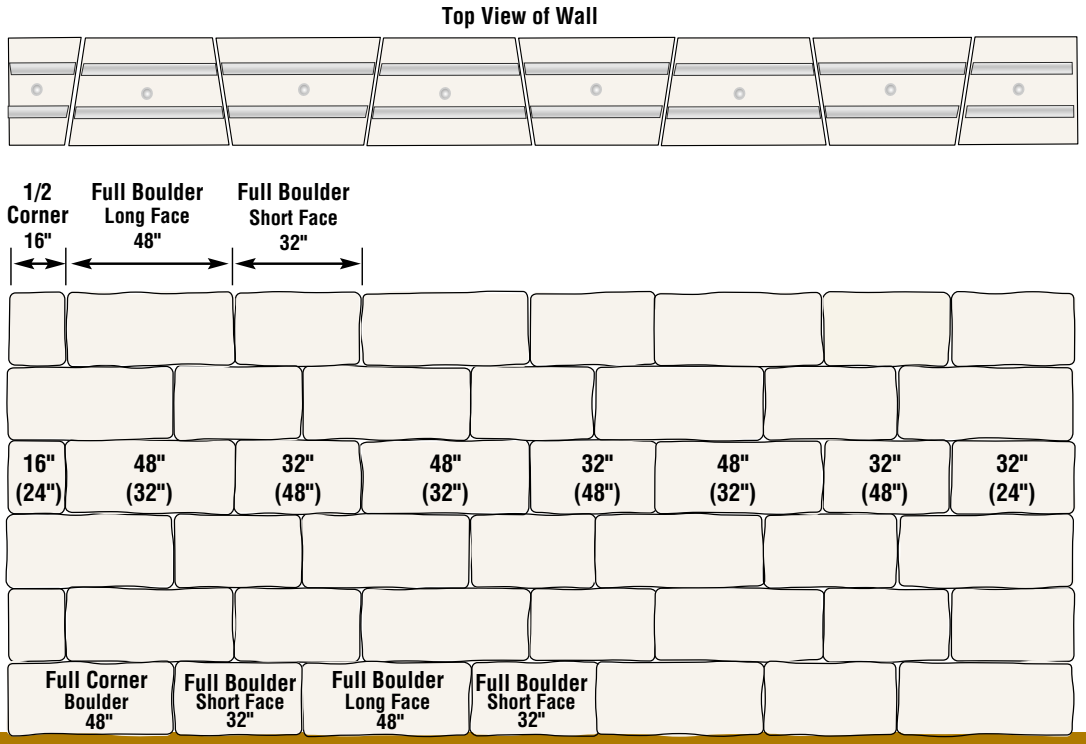


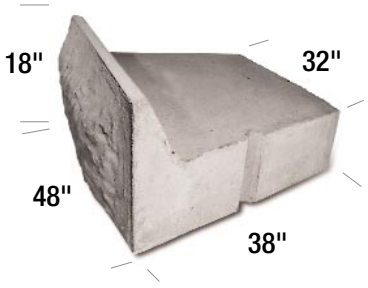
Figure O

LondonBoulder™ Product Specifications

Full Boulder
48 x 18 x 42 (32")
Weight: 2050 lbs.
Sq. Ft. / Block: 6 sq. ft.

1/2 Corner Boulder
24 x 18 x 42 (16")
Weight: 900 lbs.
Sq. Ft. / Block: 3 sq. ft.

90 Degree Return Boulder
48 x 18 x 24
Weight: 1100 lbs.
Sq. Ft. / Block: 6 sq. ft.



Cap Boulder
48 x 18 x 38 (32")
Weight: 1425 lbs.
Sq. Ft. / Block: 6 sq. ft.

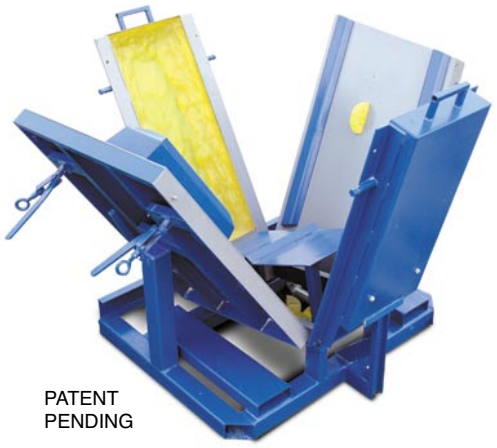
LEFT Cap Corner Boulder
24 x 18 x 34
Weight: 1650 lbs.
Sq. Ft. / Block: 3 sq. ft.

RIGHT Cap Corner Boulder
16 x 18 x 34
Weight: 1600 lbs.
Sq. Ft. / Block: 2 sq. ft.

Full Corner Boulder
48 x 18 x 42 (40")
Weight: 2150 lbs.
Sq. Ft. / Block: 6 sq. ft.

2/3 Corner Boulder
32 x 18 x 42 (32")
Weight: 1450 lbs.
Sq. Ft. / Block: 4 sq. ft.

BOOST YOUR BOTTOM LINE BY PRODUCING LONDONBOULDERS CONTACT US FOR DETAILS



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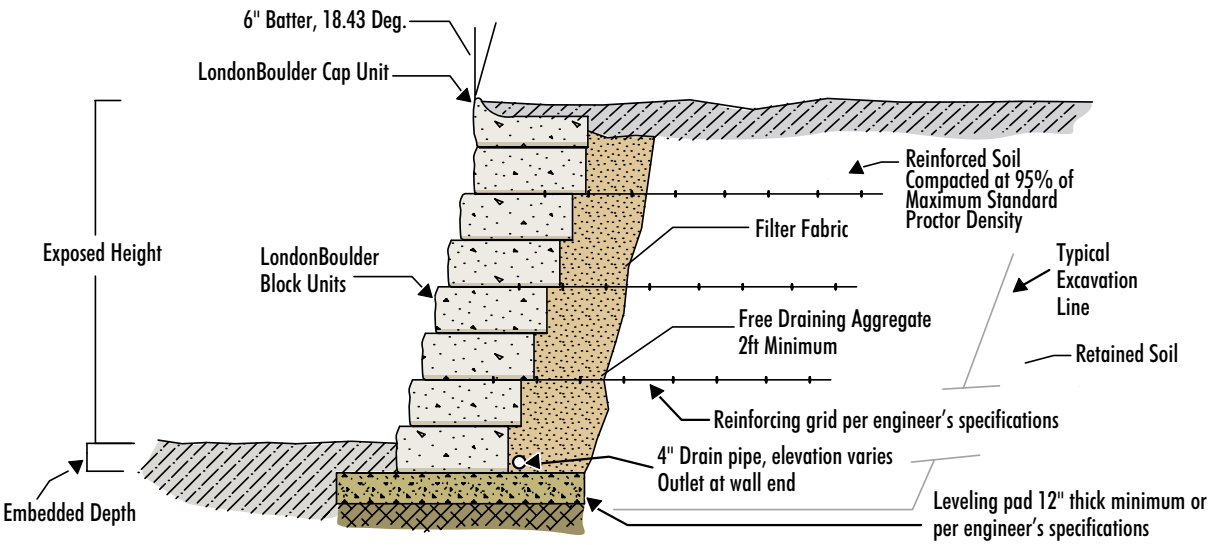
6" Setback - No Slope, No Surcharge

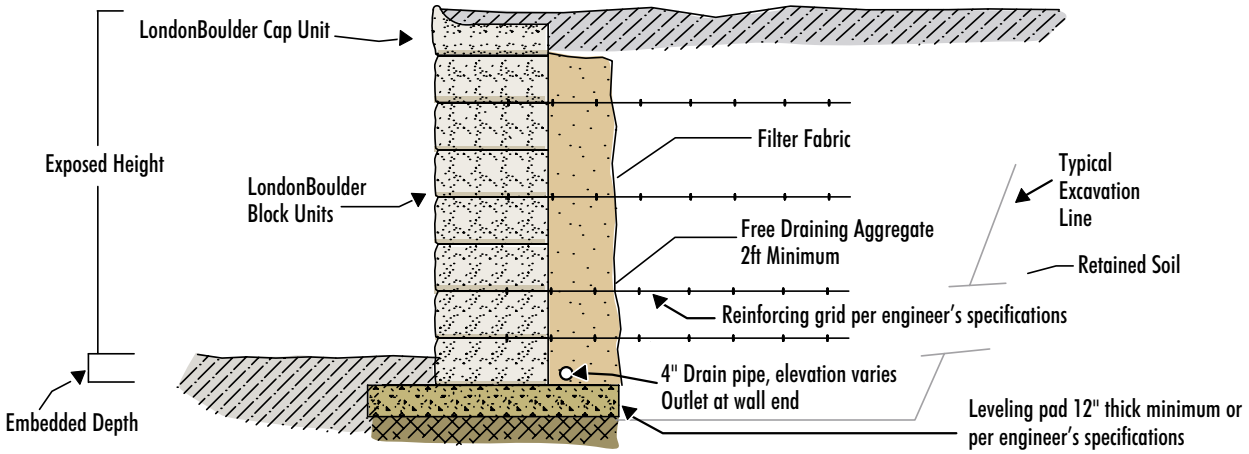


Methodology:
NCMA Design Manual for SRW, 2nd edition. Grid reinforcement LTDS = 1250 lbs/ft. γ = 120 pcf, Sliding SF = 1.5 Overturning SF = 2.0, Global stability checks not included, Soils compacted to min. 95% proctor, No additional surcharges on wall. No water loading. Level wall toe only.

6" Setback
No Slope, No Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type								
ϕ = 34°	15'-0"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"			
				LENGTH	9'-0"	9'-0"	9'-0"	10'-9"			
	16'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	10'-9"	12'-3"		
	18'-0"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	11'-0"	11'-0"	11'-0"	11'-0"	12'-3"		
	19'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0'	9'-0"	12'-0"	15'-0"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	13'-0"	
	21'-0"	1'-0"	8XT	LEVEL	1'-6'	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	12'-9"	12'-9"	12'-9"	12'-9"	12'-9"	13'-3"	
	22'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"
				LENGTH	13'-6"	13'-6"	13'-6"	13'-6"	13'-6"	13'-6"	14'-9"
ϕ = 30°	12'-0"	1'-0"	5XT	LEVEL	1'-6'	4'-6"	7'-6"				
				LENGTH	7'-3"	8'-0"	9'-9"				
	13'-6"	1'-0"	5XT	LEVEL	1'-6'	4'-6"	7'-6"	10'-6"			
				LENGTH	8'-0"	8'-0"	9'-9"	11'-6"			
	15'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"		
				LENGTH	9'-0"	9'-0"	9'-0"	10'-6"	12'-3"		
	16'-6"	1'-0"	8XT	LEVEL	1'-6'	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	11'-3"	12'-3"		
	18'-0"	1'-0"	8XT	LEVEL	1'-6'	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-9"	10'-9"	10'-9"	11'-3"	12'-9"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6'	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	12'-9"	14'-5"	
	21'-0"	1'-0"	8XT	LEVEL	1'-6'	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	13'-9"	15'-3"
ϕ = 28°	10'-6"	1'-0"	5XT	LEVEL	1'-6'	4'-6"	7'-6"				
				LENGTH	6'-6"	7'-3"	10'-0"				
	12'-0"	1'-0"	5XT	LEVEL	1'-6'	3'-0"	4'-6"	7'-6"			
				LENGTH	7'-3"	7'-3"	8'-3"	10'-6"			
	13'6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"		
				LENGTH	8'-3"	8'-3"	8'-3"	10'-0"	11'-9"		
	15'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"		
				LENGTH	9'-0"	9'-0"	9'-0"	11'-0"	12'-9"		
	16'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	11'-6"	13'-6"		
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-9"	10'-9"	10'-9"	11'-6"	13'-6"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6'
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	13'-3"	15'-0"
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	14'-3"	16'-0"

Vertical - No Slope, No Surcharge

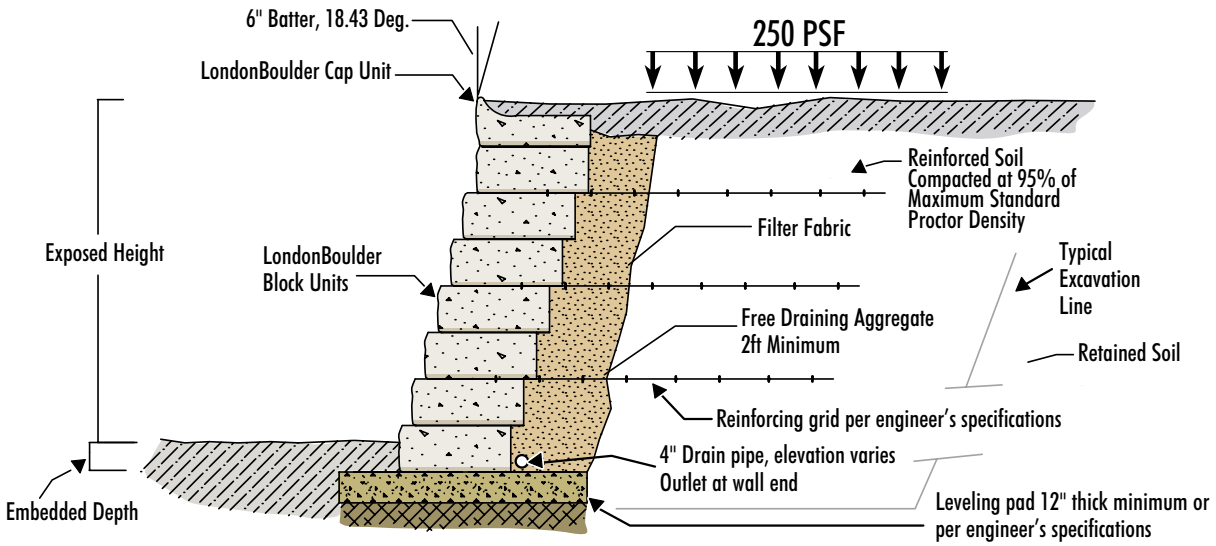


Methodology:
NCMA Design Manual for SRW, 2nd edition. Grid reinforcement LTDS = 1250 lbs/ft. γ = 120 pcf, Sliding SF = 1.5 Overturning SF = 2.0, Global stability checks not included, Soils compacted to min. 95% proctor, No additional surcharges on wall. No water loading. Level wall toe only.

Vertical
No Slope, No Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type										
ϕ = 34°	10'-6"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"						
				LENGTH	6'-3"	7'-3"	9'-3"						
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"					
				LENGTH	7'-3"	7'-3"	9'-3"	12'-0"					
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"					
				LENGTH	8'-0"	8'-0"	9'-0"	11'-0"					
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"					
				LENGTH	9'-0"	9'-0"	10'-0"	12'-0"					
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"				
				LENGTH	10'-0"	10'-0"	10'-0"	11'-0"	13'-0"				
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"			
				LENGTH	10'-9"	10'-9"	10'-9"	11'-0"	12'-0"	14'-0"			
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"		
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	13'-0"	15'-0"		
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"		
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	14'-0"	16'-0"		
ϕ = 30°	7'-6"	0'-6"	8XT	LEVEL	1'-6"	4'-6"							
				LENGTH	6'-0"	8'-3"							
	9'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"						
				LENGTH	5'-9"	6'-9"	9'-6"						
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"						
				LENGTH	6'-3"	8'-0"	10'-0"						
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"					
				LENGTH	7'-3"	7'-3"	9'-0"	11'-3"					
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"				
				LENGTH	8'-0"	8'-0"	8'-0"	10'-0"	12'-3"				
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"				
				LENGTH	9'-0"	9'-0"	9'-0"	11'-6"	13'-6"				
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	13'-6"			
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	12'-3"	14'-6"			
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	11'-0"	13'-3"	15'-6"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	14'-6"	16'-6"	
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	18'-0"	
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	15'-3"	17'-6"	
ϕ = 28°	7'-6"	0'-6"	8XT	LEVEL	1'-6"	4'-6"							
				LENGTH	7'-0"	9'-3"							
	9'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	6'-0"						
				LENGTH	6'-3"	7'-3"	10'-3"						
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"					
				LENGTH	7'-0"	7'-0"	9'-0"	11'-0"					
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"					
				LENGTH	7'-3"	7'-3"	10'-0"	12'-6"					
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"				
				LENGTH	8'-0"	8'-0"	8'-0"	11'-0"	13'-6				
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	12'-0"			
				LENGTH	9'-0"	9'-0"	9'-0"	9'-6"	12'-0"	14'-6"			
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	13'-6"			
				LENGTH	10'-0"	10'-0"	10'-0"	10'-6"	13'-3"	15'-6"			
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	11'-6"	14'-3"	16'-6"		
	19'-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	12'-6"	15'-3"	17'-9"	
	21'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	13'-0"	14'-0"	16'-6"	19'-0"

6" Setback - No Slope, 250 PSF Live Surcharge

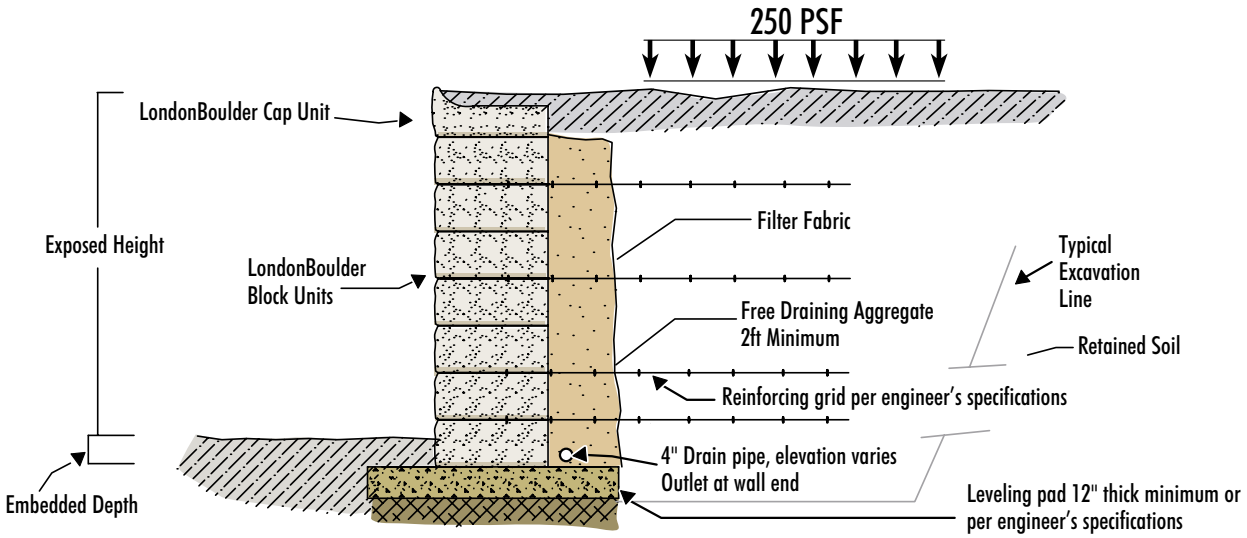


Methodology:
NCMA Design Manual for SRW, 2nd edition. Grid reinforcement LTDS = 1250 lbs/ft. γ = 120 pcf, Sliding SF = 1.5 Overturning SF = 2.0, Global stability checks not included, Soils compacted to min. 95% proctor, No additional surcharges on wall. No water loading. Level wall toe only.

6" Setback - No Slope
250 PSF Live Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type									
ϕ = 34°	12'-0"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"					
				LENGTH	7'-3"	7'-9"	9'-3"					
	13'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"				
				LENGTH	8'-0"	8'-0"	9'-3"	10'-9"				
	15'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"			
				LENGTH	9'-0"	9'-0"	9'-0"	10'-0"	11'-6"			
	16'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	10'-9"	12'-3"		
	18'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	12'-3"		
	19'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	12'-3"	13'-9"	
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	14'-0"	
ϕ = 30°	9'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"					
				LENGTH	6'-6"	7'-3"	8'-6"					
	10'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"					
				LENGTH	6'-6"	8'-0"	10'-6"					
	12'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"				
				LENGTH	7'-3"	7'-3"	9'-0"	11'-0"				
	13'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"			
				LENGTH	8'-0"	8'-0"	8'-0"	9'-9"	11'-6"			
	15-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"			
				LENGTH	9'-0"	9'-0"	9'-0"	10'-6"	13'-0"			
	16'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	11'-6"	14'-6"		
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	12'-0"	14'-0"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	12'-9"	15'-0"	
	21'-0"	1'-6"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"	
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	13'-6"	15'-9"	
ϕ = 28°	7'-6"	0'-6"	5XT	LEVEL	1'-6"	4'-6"						
				LENGTH	7'-0"	10'-0"						
	9'-0"	0'-6"	5XT	LEVEL	1'-6"	3'-0"	4'-6"					
				LENGTH	6'-6"	7'-3"	9'-6"					
	10'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"				
				LENGTH	7'-0"	7'-9"	8'-3"	10-'6"				
	12'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"				
				LENGTH	7'-3"	7'-3"	9'-0"	12'-9"				
	13'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"			
				LENGTH	9'-0"	9'-0"	9'-0"	10'-6"	13'-9"			
	15'-0"	1'-0"	8XT	LEVEL	3'-0"	6'-0"	9'-0"	12'-0"				
				LENGTH	9'-0"	9'-0"	11'-0"	14'-0"				
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	11'-6"	14'-9"		
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	11'-6"	13'-3"	14'-9"		
	19'-6"	1'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	14'-6"	16'-6"	
	21'-0"	1'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	15'-0"	17'-6"

Vertical - No Slope, 250 PSF Live Surcharge



Methodology:
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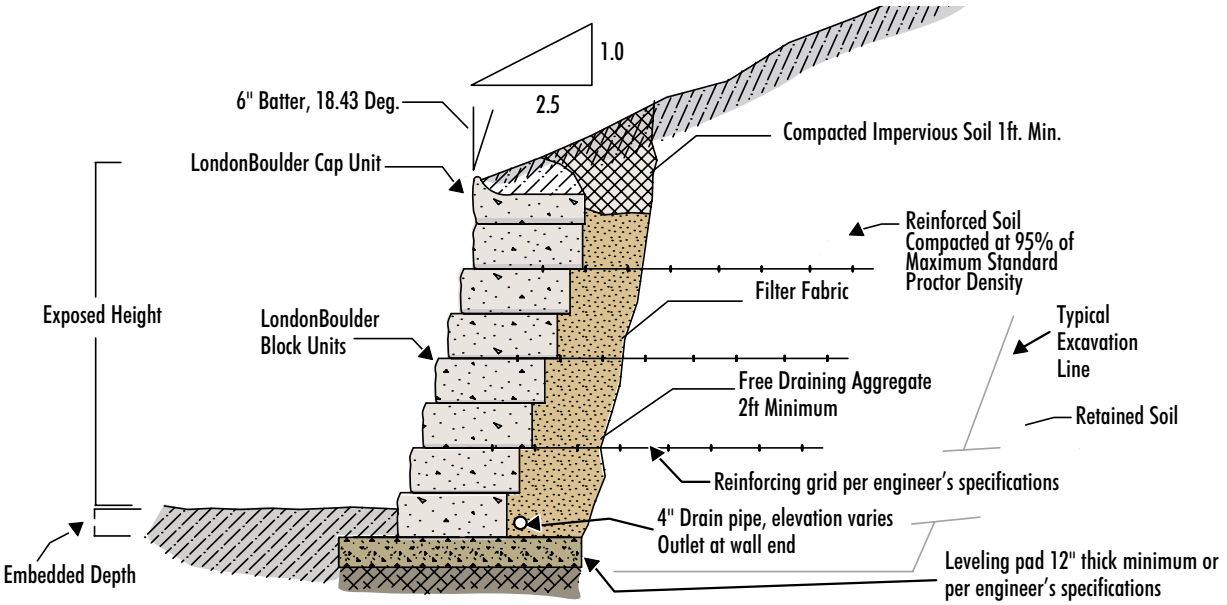
Vertical - No Slope
250 PSF Live Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type										
ϕ = 34°	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"						
				LENGTH	5'-6"	6'-6"	7'-9"						
	9'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"					
				LENGTH	5'-6"	5'-3"	7'-3"	9'-0"					
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"					
				LENGTH	6'-3"	6'-3"	8'-3"	9'-6"					
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"				
				LENGTH	7'-3"	7'-3"	7'-3"	9'-3"	10'-6"				
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"			
				LENGTH	8'-0"	8'-0"	8'-0"	8'-0"	10'-3"	11'-6"			
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"			
				LENGTH	9'-0"	9'-0"	9'-0"	9'-0"	11'-0"	12'-6"			
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	13'-6"		
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	10'-0"	12'-0"	13'-3"		
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	15'-0"	
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	11'-0"	13'-0"	14'-3"	
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	13'-9"	15'-3"	
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	13'-6"	16'-6"	18'-0"
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	14'-9"	16'-0"
ϕ = 30°	6'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"							
				LENGTH	6'-0"	7'-9"							
	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"						
				LENGTH	6'-0"	6'-6"	8'-9"						
	9'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"					
				LENGTH	6'-6"	7'-0"	7'-6"	9'-9"					
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"				
				LENGTH	6'-6"	6'-6"	8'-0"	8'-6"	10'-9"				
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	9'-0"				
				LENGTH	7'-3"	7'-3"	9'-0"	9'-6"	11'-0"				
	13-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	10'-6"			
				LENGTH	8'-0"	8'-0"	8'-0"	9'-6"	10'-0"	12'-9"			
	15-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	12'-0"		
				LENGTH	9'-0"	9'-0"	9'-0"	9'-0"	11'-0"	11'-6"	13'-0"		
	16-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	10'-6"	12'-0"	13'-6"	
				LENGTH	9'-0"	9'-0"	9'-0"	9'-0"	9'-0"	12'-0"	12'-6"	14'-6"	
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	13'-6"	15'-0"	
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	13'-0"	13'-6"	15'-9"	
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	10'-6"	13'-6"	15'-0"	16'-6"
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	15'-0"	16'-9"	17'-6"
	21'-0"	1'-6"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	16'-6"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	15'-0"	15'-6"	17'-9"
ϕ = 28°	6'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"							
				LENGTH	5'-9"	8'-9"							
	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"						
				LENGTH	6'-6"	6'-9"	9'-3"						
	9'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"					
				LENGTH	6'-3"	6'-9"	7'-9"	10'-6"					
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"				
				LENGTH	7'-0"	7'-0"	7'-9"	9-'0"	11'-6"				
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"				
				LENGTH	7'-3"	7'-3"	8'-6"	11'-0"	12'-6"				
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"			
				LENGTH	8'-0"	8'-0"	8'-0"	9-'6"	11'-9"	13'-9"			
	15-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	10'-6"	12'-0"		
				LENGTH	9'-0"	9'-0"	9'-0"	9'-0"	10'-6"	12'-9"	14'-6"		
	16-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	12'-0"	13'-6"	
				LENGTH	10'-3"	10'-3"	10'-3"	10'-3"	10'-3"	12'-0"	14'-0"	15'-9"	
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	15'-0"	
				LENGTH	11'-3"	11'-3"	11'-3"	11'-3"	11'-6"	12'-6"	14'-9"	16'-9"	
	19'-6"	1'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	16'-6"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	13'-0"	15'-3"	17'-9"

6" Setback Wall - 2.5:1 Slope, No Surcharge



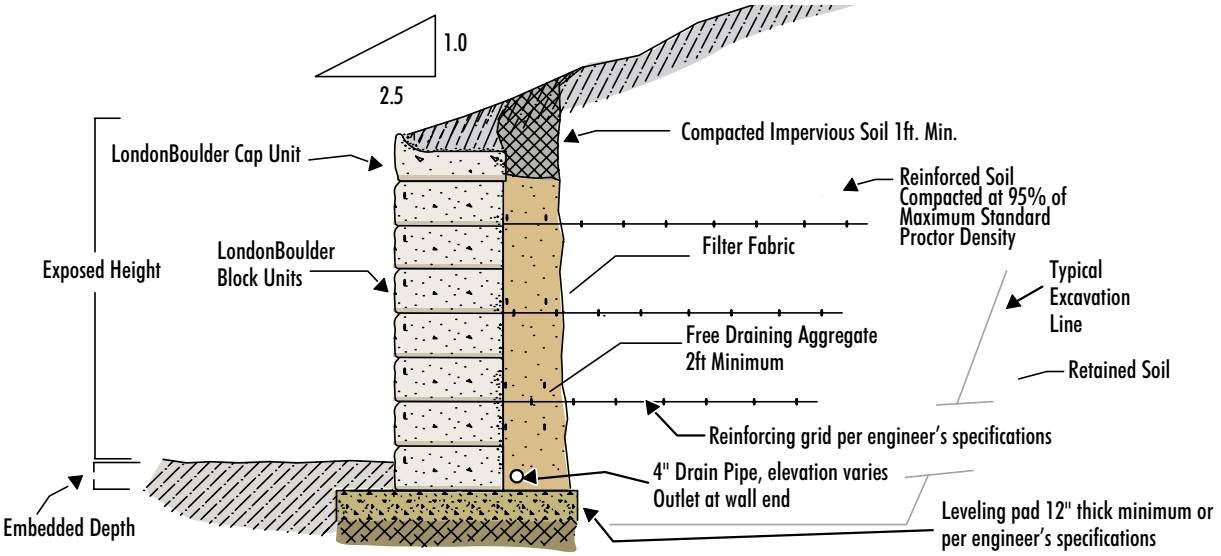
Methodology:
NCMA Design Manual for SRW, 2nd edition. Grid reinforcement LTDS = 1250 lbs/ft. γ = 120 pcf, Sliding SF = 1.5 Overturning SF = 2.0, Global stability checks not included, Soils compacted to min. 95% proctor, No additional surcharges on wall. No water loading. Level wall toe only.

6" Setback Wall
2.5:1 Slope, No Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type										
ϕ = 34°	10'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"						
				LENGTH	6'-6"	8'-3"	10'-0"						
	12'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"					
				LENGTH	7'-3"	7'-3"	9'-0"	11'-0"					
	13'-6"	1'-0"	5XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"					
				LENGTH	8'-3"	8'-3"	10'-0"	12'-0"					
	15'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"				
				LENGTH	9'-0"	9'-0"	9'-0"	10'-0"	12'-0"				
	16'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"			
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	12'-0"	13'-9"			
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"			
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	12'-0"			
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	4'-6"	7'-6"	10'-6"	13'-6"	16'-6"			
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	13'-4"			
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"	15'-0"	18'-0"		
				LENGTH	12'-0"	12'-0"	12'-0"	12'-0"	12'-0"	12'-0"	14'-0"		
ϕ = 30°	9'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"						
				LENGTH	6'-9"	8'-0"	10'-0"						
	10'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"					
				LENGTH	6'-9"	7'-9"	9'-0"	11'-3"					
	12'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"					
				LENGTH	7'-3"	7'-9"	9'-0"	11'-3"					
	13-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"				
				LENGTH	8'-0"	8'-0"	9'-0"	10'-6"	12'-6"				
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"	12'-0"				
				LENGTH	9'-0"	9'-0"	9'-9"	12'-0"	14'-0"				
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"	13'-6"			
				LENGTH	10'-0"	10'-0"	10'-0"	11'-0"	13'-0"	15'-3"			
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	12'-0"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	12'-0"	14'-0"	16'-3"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	13'-6"	16'-6"		
				LENGTH	11'-3'	11'-3'	11'-3'	11'-3'	13'-0"	15'-3"	17'-6"		
	21'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	15'-0"	18'-0"	
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	14'-3"	16'-6"	18'-6"	
ϕ = 28°	7'-6"	0'-6"	5XT	LEVEL	1'-6"	3'-0"							
				LENGTH	7'-3"	8'-3"							
	9'-0"	0'-6"	5XT	LEVEL	1'-6"	3'-0"	6'-0"						
				LENGTH	6'-9"	7'-6"	10'-6"						
	10'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"					
				LENGTH	7'-0"	8'-0"	9'-6"	12'-0"					
	12'-0"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	6'-0"	9'-0"					
				LENGTH	7'-3"	7'-3"	10'-6"	12'-9"					
	13'-6"	1'-0"	5XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	10'-6"				
				LENGTH	8'-0"	8'-0"	9'-3"	11'-6"	14'-0"				
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	12'-0"			
				LENGTH	9'-0"	9'-0"	9'-0"	10'-6"	12'-9"	15'-3"			
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	13'-6"			
				LENGTH	10'-0"	10'-0"	10'-6"	11'-9"	14'-0"	16'-6"			
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	15'-0"		
				LENGTH	10'-9"	10'-9"	10'-9"	11'-6"	12'-9"	15'-3"	17'-9"		
	19'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	16'-6"	
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	12'-9"	14'-0"	16'-6"	19'-0"	
	21'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"	12'-0"	15'-0"	18'-0"
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	14'-0"	15'-3"	16'-9"	20'-3"

 Where Strength Meets Style

Vertical Wall - 2.5:1 Slope, No Surcharge



Methodology:
NCMA Design Manual for SRW, 2nd edition. Grid reinforcement LTDS = 1250 lbs/ft. γ = 120 pcf, Sliding SF = 1.5 Overturning SF = 2.0, Global stability checks not included, Soils compacted to min. 95% proctor, No additional surcharges on wall. No water loading. Level wall toe only.

Vertical Wall
2.5:1 Slope, No Surcharge

	Wall Height (ft)	Embedment (ft)	Geogrid Type													
ϕ = 34°	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"									
				LENGTH	5'-6"	6'-9"	8'-0"									
	9'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"									
				LENGTH	5'-6"	6'-9"	9'-0"									
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"								
				LENGTH	6'-3"	6'-9"	8'-3"	10'-3"								
	12'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"							
				LENGTH	7'-3"	7'-3"	8'-0"	9'-3"	11'-6"							
	13'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"	10'-6"							
				LENGTH	8'-0"	8'-0"	9'-3"	10'-3"	12'-9"							
	15'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"						
				LENGTH	9'-0"	9'-0"	9'-0"	10'-3"	11'-6"	14'-0"						
	16'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	13'-6"					
				LENGTH	9'-0"	9'-0"	9'-0"	9'-0"	11'-6"	12'-9"	15'-0"					
	18'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	15'-0"				
				LENGTH	10'-9"	10'-9"	10'-9"	10'-9"	10'-9"	12'-9"	14'-0"	16'-3"				
	19'-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	12'-0"	13'-6"	16'-6"			
				LENGTH	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	11'-9"	14'-0"	15'-0"	17'-6"			
	21'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"	13'-6"	15'-0"	18'-0"		
				LENGTH	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	12'-6"	15'-0"	16'-3"	18'-6"		
ϕ = 30°	6'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"										
				LENGTH	6'-0"	7'-3"										
	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"									
				LENGTH	6'-0"	7'-6"	8'-0"									
	9'-0"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"								
				LENGTH	7'-0"	7'-0"	8'-6"	10'-6"								
	10'-6"	1'-0"	8XT	LEVEL	1'-6"	3'-0"	6'-0"	7'-6"								
				LENGTH	6'-3"	7'-3"	10'-0"	11'-6"								
	12'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"						
				LENGTH	8'-3"	8'-3"	8'-3"	8'-9"	11'-6"	12'-9"						
	13-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	9'-0"	10'-6"					
				LENGTH	9'-0"	9'-0"	9'-0"	9'-6"	10'-0"	12'-9"	14'-3"					
	15'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	10'-6"	12'-0"				
				LENGTH	9'-6"	9'-6"	9'-6"	9'-6"	10'-0"	11'-6"	14'-3"	15'-6"				
	16'-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	12'-0"	13'-6"			
				LENGTH	10'-6"	10'-6"	10'-6"	10'-6"	10'-6"	11'-6"	12'-9"	15'-6"	17'-0"			
	18'-0"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	13'-6"	15'-0"		
				LENGTH	11'-6"	11'-6"	11'-6"	11'-6"	11'-6"	11'-6"	12'-9"	14'-3"	17'-0"	18'-6"		
	19'-6"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	7'-6"	9'-0"	10'-6"	12'-0"	15'-0"	16'-6"		
				LENGTH	13'-0"	13'-0"	13'-0"	13'-0"	13'-0"	13'-0"	14'-3"	15'-6"	16'-9"	20'-0"		
	21'-0"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	12'-0"	13'-6"	16'-6"	18'-0"
				LENGTH	14'-3"	14'-3"	14'-3"	14'-3"	14'-3"	14'-3"	14'-3"	14'-3"	16'-6"	18'-0"	21'-0"	22'-0"
ϕ = 28°	6'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"										
				LENGTH	7'-0"	8'-9"										
	7'-6"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"									
				LENGTH	6'-6"	7'-6"	9'-3"									
	9'-0"	0'-6"	8XT	LEVEL	1'-6"	3'-0"	4'-6"	6'-0"								
				LENGTH	6'-3"	7'-9"	9'-0"	10'-6"								
	10'-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"						
				LENGTH	7'-0"	7'-0"	7'-9"	9-'0"	10'-6"	12'-6"						
	12'-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"					
				LENGTH	10'-0"	10'-0"	10'-0"	10'-0"	10'-6"	12'-6"	14'-0"					
	13'-6"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"				
				LENGTH	12'-0"	12'-0"	12'-0"	12'-0"	12'-0"	12'-6"	13'-9"	15'-3"				
	15-0"	1'-0"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	12'-0"			
				LENGTH	13'-0"	13'-0"	13'-0"	13'-0"	13'-0"	13'-0"	14'-0"	15'-6"	17'-0"			
	16-6"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	12'-0"	13'-6"		
				LENGTH	14'-6"	14'-6"	14'-6"	14'-6"	14'-6"	14'-6"	14'-6"	15'-6"	17'-0"	18'-6"		
	18'-0"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	12'-0"	13'-6"	15'-0"	
				LENGTH	15'-3"	15'-3"	15'-3"	15'-3"	15'-3"	15'-3"	15'-3"	15'-3"	17'-0"	18'-6"	20'-0"	
	19'-6"	1'-6"	8XT	LEVEL	0'-0"	1'-6"	3'-0"	4'-6"	6'-0"	7'-6"	9'-0"	10'-6"	12'-0"	13'-6"	15'-0"	16'-6"
				LENGTH	17'-0"	17'-0"	17'-0"	17'-0"	17'-0"	17'-0"	17'-0"	17'-0"	17'-0"	18'-6"	21'-0"	22'-0"

PART I: GENERAL

1.01 Description

Work includes furnishing and constructing a "large block" retaining wall to the lines and grades designated on the plan and as specified herein.

1.02 References

A. ASTM C1372 Standard Specifications for Segmental Retaining Wall Units

B. ASTM C94 Ready Mix Concrete

C. ASTM D 3034 Specification for Polyvinyl Chloride (PVC) Plastic Pipe

D. ASTM D 1248 Specification for Corrugated Plastic Pipe.

E. NCMA Design Manual for Segmental Retaining Walls

F. NCMA SRWU-1 Determination of Connection Strength Between Geosynthetics and Segmental Retaining Wall Units

G. NCMA SRWU-2 Determination of Shear Strength Between Segmental Concrete Units

1.03 Delivery, Storage and Handling

A. Contractor shall inspect materials upon delivery to assure that proper material has been received.

B. Contractor shall protect materials. Damaged materials shall not be incorporated into wall.

C. Contractor shall keep materials substantially clean from mud, concrete, adhesives and other like materials.

PART II: PRODUCTS

2.01 MATERIALS

A. Wall units shall be LondonBoulder

B. Wall units shall meet requirements of ASTM C1372, and shall be made with concrete in accordance to ASTM C94 Standards.

C. Performance Criteria shall be as follows, unless otherwise specified:

i. Concrete 28 day strength 4000 psi.
ii. Air Entrainment 6 + or – 1%
iii. Non air-entrained 3000# psi concrete may be used in climates having no freeze/thaw.

D. All units shall be sound and free of defects which may interfere or impair the performance of the wall structure.

E. Wall unit dimensions shall not differ more than 1/2” with the exception of the decorative faces.

F. Exposed face shall be gray. A concrete stain or paint may be applied in the field if specified.

G. Geosynthetic reinforcement shall be as specified in approved testing reports for use as soil reinforcement. Alternate geosynthetics are acceptable provided supplier furnishes testing and engineering evidence of suitability.

H. Base: Material shall consist of drainage aggregate, sand and gravel and/or concrete as shown on the construction drawings. A minimum of 6 inches of compacted base for walls up to 6 ft in height and 1 ft otherwise is required.

I. Drainage aggregate: Fill between units shall consist of free-draining, crushed coarse aggregate that meets the gradation requirements of ASTM 448-86; Standard Classification for Sizes of Aggregate for Road and Bridge Construction, designation 57, 67, 6, 7 or 8.

J. Backfill: Materials are suitable non-organic soils at a moisture content which enables compaction to the specified densities. Unsuitable soils are organic soils and those soils with the USCS classification symbol of CH, OH, MH, OL, or PT. CL soils with a Plasticity Index (PI) greater than 25 are also considered unsuitable soils.

K. Drain tile: The drainage collection pipe shall be a perforated or slotted PVC or corrugated HDPE pipe. The pipe may be covered with a geotextile filter fabric to function as a filter.

2.02 EXTRA MATERIALS

A. Replacement units identical to those installed on the Project.

PART III: EXECUTION

3.01 EXAMINATION

A. Examine the areas and conditions under which the retaining wall is to be erected and notify the Architect or Civil Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected. The wall design engineer shall be promptly notified of any site conditions which may affect wall performance or may require a reevaluation of the wall design.

3.02 EXCAVATION

A. Excavate to the lines and grades shown on the construction drawings. Over-excavation not approved by the owner or duly appointed owner's representative shall not be paid for and replacement with compacted fill and/or wall system components will be required at the Contractor's expense. Do not disturb base beyond the lines shown. The Contractor shall be responsible for the stability of the excavation and its influence on adjacent properties and structures.

3.03 FOUNDATION PREPARATION

A. Foundation soil shall be excavated as required for footing or base dimension shown on the construction drawings, or as directed by the engineer.

B. Soil not meeting the required strength shall be removed, sufficiently oversized from the front of the block and the back of the reinforcement and back-filled with suitable material.

C. Over-excavated areas shall be filled with suitable compacted backfill.

3.04 BASE COURSE PREPARATION

A. Base materials shall be placed as shown on the construction drawings with a minimum thickness of 6 inches for walls up to 6 ft and 12 inches thereafter.

B. Base materials shall be installed upon undisturbed soils, or foundation soils prepared in accordance with Section 3.03.

C. Material shall be compacted so as to provide a level, hard surface on which to place the first course of units.

D. Base materials shall be prepared to ensure complete contact of retaining wall unit. Gaps shall not be allowed.

E. Base materials shall be to the depths and widths shown on the plans.

3.05 ERECTION

A. First course of concrete wall units shall be placed on the prepared base material. Units shall be checked for level and alignment. The top of all units in base course shall be at the same elevation.

B. Ensure that LondonBoulder units are in full contact with base.

C. LondonBoulder units shall be placed side by side for full length of wall alignment. Alignment may be done, by using a string line or offset of wall line.

D. Fill all voids between and within LondonBoulder units with drainage aggregate.

E. A minimum of 12 inches of drainage aggregate shall be placed behind the concrete wall units. Actual amount shall be as specified on design documents.

F. Drain tile shall be installed at the lowest elevation possible to maintain gravity flow of water to outside of the reinforced zone. The drainage collection pipe shall be day-lighted to an appropriate location away from the wall system at each low point or at 50-foot intervals along the wall.

G. Remove all excess fill from top of units and install next course. Ensure drainage aggregate and backfill are compacted before installation of next course.

H. Install each succeeding course. Backfill as each course is completed. Pull the units forward until the locating surface of the unit contacts the locating surface of the units in the preceding course. Pull the units forward as far as possible.

I. Install geosynthetic reinforcement in accordance with geosynthetic manufacturer's recommendations and the design drawings.

3.06 BACKFILL PLACEMENT

A. Reinforced backfill shall be placed, spread and compacted in a manner that will minimize slack in the reinforcement.

B. Fill in the reinforced zone shall be placed and compacted in lifts not to exceed 9 inches in loose thickness where hand operated compaction equipment is used and not exceeding 12 inches loose thickness where heavy, self-propelled compaction equipment is used.

C. All fill placed in the reinforced zone must be compacted to a minimum of 95 percent of the soil's standard Proctor density (ASTM D 698) or as specified by the project geotechnical engineer.

D. Weight and type of equipment (other than lightweight hand operated equipment) allowed to operate on or around the wall shall be approved by the project engineer.

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DISCLAIMER: The suggested design materials presented in this manual are for estimating tasks and reference only. It is the user's responsibility to ensure that a final, project-specific design is reviewed, approved and sealed by a registered Professional Engineer, based on actual soil conditions. It is the project owner's responsibility to ensure the adequacy of the designed LondonBoulder retaining wall incorporated into the overall project through a specification. The specification should include factors which affect the overall integrity of the retaining wall such as location, interaction with other project components, and engineering aspects including but not limited to site soil bearing capacity, global slope stability, presence of underground or surface water, etc. Specification of excavation, trenching or any other construction procedures and corresponding safety specifications are the responsibility of the installer, who shall adhere to sound industry practice and provide additional support during construction if needed.

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Alexandria Concrete Company

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