

# Valley Stone MSE Specifications

Following specification is for the construction of Valley Stone MSE segmental retaining wall (SRWs). Specifications for segmental retaining wall units are provided in standard Construction Specification Institute (CSI) format.

Section \_\_\_\_\_

## VALLEY STONE PRO RETAINING STRUCTURE

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### PART 1: GENERAL

#### 1.01 Description

- A. Work shall consist of furnishing all materials, labor, equipment, and supervision to install system in accordance with these specifications and in reasonably close conformity with dimensions shown on the plans or as established by the Owner or Owner's Engineer.
- B. Work shall consist of furnishing and installing appurtenant materials required for construction of the retaining wall as shown on the construction drawings.

#### 1.02 Related Work

- A. Section \_\_\_\_\_ - Section - Information Available to Bidders: Geotechnical Report
- B. Section \_\_\_\_\_ - Section - Testing and Inspection Services
- C. Section \_\_\_\_\_ - Section - Site Preparation
- D. Section \_\_\_\_\_ - Section - Earthwork

#### 1.03 Reference Standards

- A. Engineering Design
  - 1. NCMA SRW Design Manual for Segmental Retaining Walls 3<sup>rd</sup> Edition
  - 2. ASTM D 6638 Standard Test Method for Determining the Connection Strength Between Geosynthetics Reinforcement and Segmental Concrete Units
  - 3. ASTM D 6916 Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units
- B. Segmental Retaining Wall Units
  - 1. ASTM C140 - Sampling and Testing Concrete Masonry Units
  - 2. ASTM 1262 Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
  - 3. ASTM C1372 Standard Specification for Dry-Cast Segmental Retaining Wall Units
- C. Geosynthetic Reinforcement
  - 1. ASTM D 4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
  - 2. ASTM D 5262 – Standard Test Methods for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

3. ASTM D 5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
4. ASTM D 5818 – Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics
5. ASTM D 6637 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
6. ASTM D 6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
7. ASTM D 6992 – Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using Stepped Isothermal
8. ASTM D6706 Geosynthetic Pullout Resistance in Soil ASTM D6916 Shear Strength Between Segmental Concrete Units

D. Soils

1. ASTM D 422 Standard Test Method for Particle-Size Analysis of Soils
2. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lb/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>))
3. ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
4. ASTM Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
5. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
6. ASTM D 6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
7. ASTM D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
8. ASTM D 6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
9. ASTM G 51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing

E. Drainage Pipe

1. ASTM F 405 Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings
2. ASTM F 758 Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

Where specifications and reference documents conflict, the Architect/Engineer shall make the final determination of applicable document.

#### 1.04 Approved Segmental Retaining Wall Systems

- A. Suppliers of segmental retaining wall system material components shall have demonstrated experience in the supply of similar size and types of segmental retaining walls on previous projects, and shall be approved by the Owner's Engineer. Each supplier must be approved two weeks prior to bid opening. Systems currently approved for this work are:
- B. Segmental Wall Units
  - 1. Basalite Concrete Products
  - 2. \_\_\_\_\_
- C. Geosynthetic Reinforcements
  - 1. Strata Systems
  - 2. T.C. Mirafi
  - 3. \_\_\_\_\_
- D. Submittals
  - 1. Material Submittals – The Contractor shall submit manufacturer's certifications, 30 days prior to the start of work, stating that the SRW units, geosynthetic reinforcement, reinforced backfill, and gravel fill meet the requirements of Part 2.0 of this specification. The Contractor shall provide a list of successful projects with references showing that the installer for the segmental retaining wall is qualified and has a record of successful performance.
- E. Delivery, Storage and Handling
  - 1. The Contractor shall inspect the materials upon delivery to assure that proper type and grade of material has been received.
  - 2. The Contractor shall store and handle materials in accordance with manufacturer's recommendations and in a manner to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping or other causes.
  - 3. The Contractor shall protect the materials from damage. Damaged material shall not be incorporated into the segmental retaining wall.

#### 1.05 MEASUREMENT AND PAYMENT

- A. Measurement
  - 1. The unit of measurement for furnishing the segmental retaining wall system shall be the vertical square meter (foot) of wall surface from the top of the leveling pad to the top of the wall, including coping. The quantity to be paid shall include supply and installation of the segmental retaining wall system. Excavation of unsuitable materials and replacement with select fill, as directed and approved in writing by the Owner or Owner's Engineer shall be paid for under separate pay items.

B. Payment

1. A. The accepted quantities of segmental retaining wall system will be paid for per vertical square meter (foot) in place as measured from the top of the leveling pad to the top of wall (including coping) block. The quantities of the segmental retaining wall system as shown on plans or as approved by the Owner or Owner's Engineer shall be used to determine the area supplied. Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Geosynthetic Reinforced SRW	SQ. M.

**PART 2: MATERIALS**

2.01 Valley Stone Retaining Wall Units

- A. Valley Stone concrete segmental units shall conform to the requirements of ASTM C 1372 and have a minimum net average 28 days compressive strength of 21 mPa (3,000 psi) and a maximum absorption of 208 kg/m<sup>3</sup> (13 pcf) (for normal weight) as determined in accordance with ASTM C 140. For areas subject to detrimental freeze-thaw cycles, as determined by the Owner or Owner's Engineer, the concrete shall have adequate freeze/thaw protection and meet the requirements of ASTM C 1372 when tested in accordance with ASTM C1262.
- B. Valley Stone SRW units shall match the color, surface finish, and dimension for height, width, depth, and batter as shown on the plans.
- C. Valley Stone units dimensions shall not differ more than 3 mm (1/8 in.), as measured in accordance with ASTM C140. This tolerance does not apply to architectural surfaces, such as split faces.
- D. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Any cracks or chips observed during construction shall fall within the guidelines outlined in ASTM C1372.
- E. Pins used by the retaining wall system shall be supplied by the retaining wall supplier and shall consist of nondegrading polymer or galvanized steel and shall be made for the express use with the Valley Stone units supplied.
- F. Cap adhesive shall meet the requirements of the SRW unit manufacturer.
- G. The following Segmental Retaining Wall Units have been pre-approved:
  1. Valley Stone Units
  2. \_\_\_\_\_
- H. Each course of Valley Stone Units shall be positively interlocked to the preceding course with a minimum shear capacity of 8 kN/m at 7kPa (600 lb/lf at 2 psi) as tested in accordance with ASTM D6916.

- I. In climate where freeze thaw durability is a consideration the following recommendation should be considered.

Minimum Required Net Average Compressive Strength, psi (MPa)		Maximum Water Absorption Requirements lb/ft <sup>3</sup> (kg/m <sup>3</sup> )		
		Weight Classification Oven-Dry Density of Concrete lb/ft <sup>3</sup> (kg/m <sup>3</sup> )		
Average of 3 Units	Individual Unit	Lightweight: Less than 105 pcf (1682 kg/m <sup>3</sup> )	Medium Weight: 105 pcf (1682 kg/m <sup>3</sup> ) to less than 125 pcf (2002 kg/m <sup>3</sup> )	Normal Weight: 125 pcf (2002 kg/m <sup>3</sup> ) or more
3000 psi (20.7 kN/m <sup>2</sup> )	2500 psi (17.2 kN/m <sup>2</sup> )	18 pcf (288 kg/m <sup>3</sup> )	15 pcf (240 kg/m <sup>3</sup> )	13 pcf (208 kg/m <sup>3</sup> )

- J. Valley Stone units shall meet the following constructability and geometric requirements:

- Units shall be capable of attaining concave and convex curves to a minimum radius of 1.8m (72 inches).
- Vertical Wall: Units shall be positively engaged to the unit below so as to provide a maximum of a 6mm (1/4 Inch) horizontal setback per vertical foot of wall height (near vertical)  
OR,
- Setback Wall: Units shall be positively engaged to the unit below so as to provide a minimum of 25mm (1 Inch) horizontal setback per vertical foot of wall height.

#### Geosynthetic Reinforcements

- K. Geosynthetic Reinforcements shall consist of high tenacity PET geogrids, HDPE geogrids, or geotextiles manufactured for soil reinforcement applications. The type, strength and placement location of the reinforcing geosynthetic shall be as shown on the plans. The design properties of the reinforcement shall be determined according to the procedures outlines in this specification and the NCMA Design Manual for Segmental Retaining Walls (3rd Edition, 2009) Detailed test data shall be submitted to the Owner's Engineer for approval at least 30 days prior to construction and shall include tensile strength (ASTM D 4595 or ASTM D 6637), creep (ASTM D 5262), site damage (ASTM D 5818 durability ( FHWA guidance (FHWA NHI-00-043, FHWA NHI-00-044)), pullout (ASTM D 6706 direct shear (ASTM D 5321 and connection (ASTM D 6638) test data.
- L. Included with the raw test data shall be a report that shows that the proposed geosynthetic reinforcements have the following minimum properties:

Property	Geosynthetic Reinforcement		
	Type 1	Type 2	Type 3
Long-Term Design Strength LTDS (lb/ft)			
Coefficient of Pullout Interaction - C <sub>i</sub>			
Coefficient of Direct Sliding - C <sub>ds</sub>			

#### 2.02 Drainage Pipe

- A. The drainage collection pipe shall be a perforated or slotted PVC or corrugated HDPE pipe. The pipe and gravel fill may be wrapped with a geotextile that will function as a filter.

- B. Drainage pipe shall be manufactured in accordance with ASTM F 405 or ASTM F 758.

#### 2.03 Leveling Pad and Unit Fill Material

- A. Material for leveling Pad shall consist of crushed stone placed a minimum of 150mm (6 inches) thick, or lean non reinforced concrete (3 mPa (500 psi)) placed a minimum of 50mm to 100mm (2 to 4 inches) thick.
- B. Unit Fill shall consist of free draining crushed stone.
1. Consolidate Unit Fill by running hand-operated vibrating compaction equipment behind units; do not run mechanical vibrating plate compactors directly on top of bare concrete units. Compact unit fill to a minimum 95% standard proctor density (ASTM D-698) or 92% of modified proctor density (ASTM D-1557).

#### 2.04 Drainage Aggregate

- A. Gravel fill shall be a clean crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D 422:

Sieve Size	Percent Passing
25mm	100
19mm	75 - 100
No. 4	0 - 60
No. 40	0 - 50
No. 200	0 - 5

- B. The vertical drainage layer placed within and behind the SRW unit shall be no less than 600 mm (24-inches) wide as measured from the front face for SRW units up to 500mm (21 inches) deep. For units greater than 500mm (21 inches) (deep) unit fill shall be spilling out the back of the SRW units

#### 2.05 Infill Soil/ Reinforced Backfill

- A. A. The reinforced backfill shall be free of debris and consist of one of the following inorganic USCS soil types: GP, GW, SW, SP, SM, meeting the following gradation as determined in accordance with ASTM D 422.

Sieve Size	Percent Passing
25mm	100
No. 4	100 - 20
No. 40	0 - 60
No. 200	0 - 35 <sup>1</sup>

The maximum size should be limited to 25mm (1.0 in.) for geosynthetic reinforced soil SRWs unless tests have been performed to evaluate potential strength reduction in the geosynthetic due to installation damage.

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<sup>1</sup> Cohesionless, coarse-grained soils, are preferred; finer soils with low-plasticity (i.e., PI of the finer fraction is less than 20) may be used provided the following four additional design criteria are implemented:

- Proper internal drainage is installed.
- Only soils with low to moderate frost heave potential are utilized.
- The internal cohesive shear strength parameter ( $c$ ) is conservatively ignored for stability analysis.
- The final design for critical walls is checked by a qualified geotechnical engineer to ensure that the use of cohesive soils does not result in unacceptable time-dependent movement of the SRW system.

The plasticity of the fine fraction of the reinforced soil shall be less than  $PI < 20^2$ .

- B. The pH of the backfill material shall be between 3 and 9 when tested in accordance with ASTM G 51.

#### 2.06 Geotextile Filter

- A. Drainage geotextile shall have the following minimum properties or shall meet the criteria recommended by the Wall Design Engineer.

AOS ASTM D 4751

Grab Tensile ASTM D 4632

Trap Tear ASTM D 4533

Water Flow Rate ASTM D 4491

Puncture ASTM D 4833

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### PART 3: CONSTRUCTION

#### 3.01 Construction Observation

- A. The Owner or Owner's Engineer should verify the materials supplied by the contractor meet all the requirements of the specification. This includes all submittals and proper installation of the system.
- B. The Contractor's field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

#### 3.02 Excavation

- A. Contractor shall excavate to the lines and grades shown on the project grading plans and SRW plan and profile drawing. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted infill material, or as directed by the Architect/Engineer, at the Contractor's expense.

#### 3.03 Foundation Preparation

- A. Following excavation for the leveling pad and the reinforced soil zone, foundation soil shall be examined by the Owner's Geotechnical Engineer to assure the actual foundation soil strength meets or exceeds the assumed design bearing strength. Soils not meeting the required strength shall be removed and replaced with soil meeting the design criteria, as directed by the Owner's Geotechnical Engineer.

#### 3.04 Leveling Pad Construction

- A. A minimum 150 mm (6 in.) thick layer of compacted granular material shall be placed for use as a leveling pad up to the grades and locations as shown on the construction drawings. The granular base shall be compacted to provide a firm, level bearing pad on which to place the first course of concrete segmental retaining wall units. A leveling pad consisting of 150mm (6 in.) (minimum) thick lean, unreinforced concrete may be used at the wall contractor's option, or if so detailed on the plans. The leveling pad should extend a minimum of 150 mm (6 in.) from the toe and from the heel of the SRW unit.

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<sup>2</sup> For taller applications the PI may be reduced to  $PI < 5$  to 10.

### 3.05 SRW and Geosynthetic Reinforcement Placement

- A. All materials shall be installed at the proper elevation and orientation as shown in the wall details on the construction plans or as directed by the Owner's Engineer. The concrete segmental wall units and geosynthetic reinforcement shall be installed in general accordance with the manufacturer's recommendations. The drawings shall govern in any conflict between the two requirements.
- B. Overlap or splice connections of the geosynthetic in the design strength direction shall not be permitted. The design strength direction is that length of geosynthetic reinforcement perpendicular to the wall face and shall consist of one continuous piece of material. Adjacent sections of geosynthetic shall be placed in a manner to assure that the horizontal coverage shown on the plans is provided.
- C. Geosynthetic reinforcement should be installed under tension. A nominal tension shall be applied to the reinforcement and maintained by staples, stakes, or hand tensioning until the reinforcement has been covered by at least 150mm (6 inches) of soil fill.
- D. Broken, chipped, stained or otherwise damaged units shall not be placed in the wall unless they are repaired, and the repair method and results are approved by the SRW Design Engineer.

### 3.06 Contractor Quality Control

- A. The contractor will perform quality control activities on their work. As a minimum, the contractor shall prepare a daily report of the quality control activities undertaken that day, summarizing all test data, measurements and observations gathered as part of that effort.
- B. The contractor shall provide the Architect/Engineer with a copy of each quality control daily report.

### 3.07 Gravel Fill and Drainage Placement

- A. Gravel fill shall be placed to the minimum finished thickness and widths shown on the construction plans.
- B. Drainage collection pipes shall be installed to maintain gravity flow of water outside of the reinforced soil zone. The drainage collection pipe should daylight into a storm sewer manhole or along a slope at an elevation lower than the lowest point of the pipe within the aggregate drain.
- C. The main collection drain pipe, just behind the block facing, shall be a minimum of 75mm (3 in.) in diameter. The secondary collection drain pipes should be sloped a minimum of two percent to provide gravity flow into the main collection drain pipe. Drainage laterals shall be spaced at maximum 15m (50 ft) spacing along the wall face.

### 3.08 Cap Block Placement

- A. The cap block and/or top SRW unit shall be bonded to the SRW units below using cap adhesive described in Part 2. The block shall be dry and swept clean prior to adhesive placement.

## **PART 1: END OF SECTION**