

# TERRAMOD™

Modular Bioretention System

## CSI Specification

33 46 59 Concrete Modular Biofiltration Cells



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# PART ONE - GENERAL

## 1.1 RELATED REQUIREMENTS

- A. Section 01 33 00** – Submittals: Shop Drawings, Product Data, and Samples
- B. Section 01 57 13** – Temporary Erosion and Sediment Control
- C. Section 31 00 00** – Earthwork: Excavation, Trenching, Backfill, and Compaction
- D. Section 32 13 00** – Rigid Paving
- E. Section 32 16 00** – Curbs, Gutters, Sidewalks and Driveways
- F. Section 32 31 19** – Decorative Metal Fences and Gates
- G. Section 32 91 00** – Planting Preparation
- H. Section 32 93 00** – Plants
- I. Section 32 94 00** – Planting Accessories
- J. Section 33 40 00** – Storm Drainage Utilities

## 1.2 SUMMARY

- A. This section includes a modular bioretention system and related accessories.

## 1.3 REFERENCE STANDARDS

### A. American Association of State Highway and Transportation Officials (AASHTO)

- 1. **AASHTO M105** – Gray Iron Castings

### B. American Society for Testing and Materials (ASTM)

- 1. **ASTM A48, CL.30B** – Gray Iron Castings
- 2. **ASTM A82** – Steel Wire, Plain, for Concrete Reinforcement
- 3. **ASTM A185** – Steel Welded Wire Reinforcement, Plain for Concrete
- 4. **ASTM A496** – Steel Wire, Deformed, for Concrete Reinforcement
- 5. **ASTM A497** – Steel Welded Wire Reinforcement, Deformed for Concrete
- 6. **ASTM A615** – Deformed & Plain, Carbon-Steel Bars for Concrete Reinforcement
- 7. **ASTM B209** – Aluminum & Aluminum Alloy Sheet and Plate
- 8. **ASTM C32** – Sewer and Manhole Brick (Made from Clay or Shale)
- 9. **ASTM C139** – Concrete Masonry Units for Construction of Catch Basins and Manholes
- 10. **ASTM C150** – Portland Cement
- 11. **ASTM C478** – Precast Reinforced Concrete Manhole Sections
- 12. **ASTM C595** – Blended Hydraulic Cement
- 13. **ASTM C857** – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
- 14. **ASTM C858** – Underground Precast Concrete Utility Structures
- 15. **ASTM C891** – Installation of Underground Precast Utility Structures
- 16. **ASTM C990** – Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- 17. **ASTM C1107** – Packaged Dry, Hydraulic Cement Grout (Non-Shrink)
- 18. **ASTM D698** – Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

## 1.4 DEFINITIONS

- A. **BMP:** Best Management Practices
- B. **TSS:** Total Suspended Solids
- C. **LID:** Low Impact Development

## 1.5 SUBMITTALS

The following shall be submitted by the Contractor in accordance with Section 01 33 00 Submittal Procedures:

### A. Product Data for the following:

#### a. Modular Bioretention Cells

1. Product specifications to include but not limited to specification sheets, brochures, and performance claims
2. Installation procedures
3. Shop Drawings shall be provided to include details for fabrication, construction, reinforcement, joints, assembly, and any accessory items. Shop drawings shall be annotated to indicate all materials to be used and applicable material standards, required tests of materials, and all design assumptions for structural analysis
4. Operation & Maintenance Manual

#### b. Full Capture Internal Bypass Overflow Catch Basin and Screens

1. Product specifications to include but not limited to specification sheets, brochures, and performance claims.
2. Installation procedures.
3. Shop Drawings shall be provided to include details for fabrication, construction, reinforcement, joints, assembly, and any accessory items. Shop drawings shall be annotated to indicate all materials to be used and applicable material standards, required tests of materials, and all design assumptions for structural analysis.
4. Operation & Maintenance Manual.

#### c. Full Capture Pre-Treatment and Bypass Overflow Catch Basins

1. Product specifications to include but not limited to specification sheets, brochures, and performance claims.
2. Installation procedures.
3. Shop Drawings shall be provided to include details for fabrication, construction, reinforcement, joints, assembly, and any accessory items. Shop drawings shall be annotated to indicate all materials to be used and applicable material standards, required tests of materials, and all design assumptions for structural analysis.
4. Operation & Maintenance Manual.



#### **d. Bioretention Media Blend and Plantings**

1. Product specifications to include but not limited to specification sheets, brochures, and performance claims.
2. Independent third party certification or test report demonstrating conformance to applicable local or regional BMP standards before the treatment system is installed for the following:
  - | Bioretention Media Performance
  - | Hydraulic Capacity
  - | Certification of adherence to applicable standard
3. Products submitted for consideration as approved equal must be submitted at least two weeks prior to the project bid opening and must be approved by the project Engineer. Submittals for approved equal products must contain a signed letter from an executive officer of the manufacturer stating the alternate is equivalent to all applicable requirements of this specification.

### **1.6 DELIVERY, STORAGE, & HANDLING**

- A. All modular bioretention system components shall be delivered to the site and unloaded with handling that conforms to the manufacturer's instructions for reasonable care. Concrete and internal components shall not be rolled or dragged over gravel or rock during handling. The Contractor shall take necessary precautions to ensure the method used in lifting or placing the system components does not induce stress fatigue in the concrete.

## **PART TWO - PRODUCTS**

### **2.1 MODULAR STORMWATER BIORETENTION SYSTEMS & APPURTENANCES**

#### **2.1.1 Description**

The Contractor, and/or a manufacturer selected by the Contractor and approved by the Engineer, shall furnish all labor, materials, equipment and incidentals required and install all modular precast concrete bioretention systems and appurtenances in accordance with the Drawings and these Specifications. The stormwater bioretention system shall consist of modular precast concrete trench sections that house region specific bioretention media, under drain and peak flow conveyance appurtenances, light and tree modules, and irrigation. The bioretention systems shall be sized and installed per plan and local LID requirements and are intended to treat for pollutants of concern such as TSS, gross pollutants, bacteria, dissolved metals, nutrients, and hydrocarbons.

The Stormwater Bioretention System shall be sized at a hydraulic loading rate of no more than five inches/hour and provide a treatment to impervious area ratio of no less than four percent.

The Stormwater Bioretention System shall contain a modular pre- treatment bay or a modular overflow catch basin that are self-draining and extend the effective life of the soil media. These devices shall contain screens that will not pass any pollutant regardless of density which is five millimeters or larger in size.

The Stormwater Bioretention System shall contain components to incorporate street trees and light modules with no adverse effect to the bioretention system performance and with no disconnect to the bioretention cells.

The Stormwater Bioretention System must include the capability to partition flows, causing all runoff to be diverted into the bioretention cell during low-flow conditions. Flows exceeding the treatment capacity of the unit shall be diverted from the bioretention cells to prevent re-suspension and washout of previously trapped pollutants.

The Contractor shall furnish and install the Modular Stormwater Bioretention Systems complete and operable as shown and as specified herein in accordance with the requirements of the plans and contract documents.

### 2.1.2 Materials and Design

- A.** Concrete for precast Modular Stormwater Bioretention Systems stormwater filtration systems shall conform to ASTM C478, C857 and C858 and meet the following additional requirements:
- 1.** In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20-44 (MS18) loading requirements as determined by a Licensed Professional Engineer.
  - 2.** Sections shall have tongue and groove, ship-lap, or butt joints with a butyl mastic sealant conforming to ASTM C 990.
  - 3.** Cement shall be Type I, II, or III Portland cement conforming to ASTM C 150.
  - 4.** All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or other designate suitable handling strength.
  - 5.** Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with hydraulic cement conforming to ASTM C 595M or ASTM C1107.
  - 6.** Aggregates shall conform to ASTM C33, except that the requirement for gradation shall not apply.
  - 7.** Reinforcement shall consist of wire conforming to ASTM A82 or A496, of wire mesh conforming to ASTM A185 or A497, or Grade 40 steel bars conforming to ASTM A615.
  - 8.** Castings for manhole frames and covers shall be in accordance with ASTM A48, CL.30B and AASHTO M105. The access cover/s shall be designed for HS20-44 traffic loading and shall provide a minimum of 30-inch clear opening.
  - 9.** Brick or masonry used to build the manhole frame to grade shall conform to ASTM C32 or ASTM C139 and shall be installed in conformance with all local requirements.
  - 10.** Diversion weirs, separation chambers, pre-treatment screens, and oil baffle shall be made from concrete, marine grade fiberglass and/or stainless steel and shall conform to ASTM A240
  - 11.** All mounting hardware for internal components shall be made of 304SS and shall conform to ASTM A240



**B.** All internal components including stainless steel bypass manifold, pre- treatment screens, bioretention media, under drain piping, and irrigation piping shall be as specified on the Plans or by the Engineer and shall be provided by the manufacturer.

**1.** The bypass manifold and pre-treatment screens shall be fabricated of stainless steel, minimum Type 304, complying with the requirements of ASTM A240.

**2.** The bioretention media shall consist of one or more of the following, as specified on the Plans or by the Engineer:

| Bioretention Soil Blend per local regulation.

| California Regional Water Quality Control Board, San Francisco San Francisco Bay Region 5in/hr Media Blend as blended by Oldcastle Stormwater Solutions.

Specifications per NPDES Permit No. CAS612008, Amendment to Order No. R2-2009-0074, Attachment L, Provision C.3.c.i(1)(b)(vi) - "Specifications of soils for Biotreatment or Bioretention Facilities"

### **2.1.3 Performance**

**A.** Each specified flow or volume based Stormwater Bioretention system shall be capable of treating the potential and expected pollutants of concern.

**B.** Each Stormwater Bioretention shall contain a soil media blend that can maintain a uniform pressure profile across surface area during operation. At the design flow rate the maximum media hydraulic loading rate is not to exceed 0.005gpm/sf of media surface area.

**C.** The Stormwater Bioretention System soil media performance shall be third party verified or the media shall be as required by the local regulations.

**D.** The Stormwater Bioretention System shall be supplied with internal bypass with a minimum capacity not less than the peak design storm as determined by the Engineer.

### **2.1.4 Quality Assurance**

The materials, process and finished Stormwater Bioretention System shall be subject to inspection by the Engineer. Acceptance or rejection of the system shall be based on the Specifications contained in this section. Imperfections may be repaired but subject to the acceptance of the Engineer.

### **2.1.5 Manufacturer**

Each Stormwater Bioretention System shall be a TerraMod® Modular Bioretention System as manufactured by Oldcastle Stormwater Solutions, 360 Sutton Place, Santa Rosa, California 95407. **Phone: (800) 579-8819**

## **PART THREE - EXECUTION**

### **3.1 Earthwork**

- A.** Excavation, trenching, and backfilling shall be as specified in Division 31 Section "Earthwork."

### **3.2 Identification**

- A.** All Stormwater Bioretention Systems shall be identified at the surface level with markings indicating that they are treatment devices.

### **3.3 Inspection**

#### **3.3.1 General**

- A.** Concrete, internals, and accessories, shall be inspected prior to installation and any defective or damaged product shall be replaced.

#### **3.3.2 Bioretention Cell Trench Sections**

- A.** Any trench section with chipped joints or top sections shall be rejected and replaced
- B.** Any section with a fracture or crack greater than 0.10 in. in length or 0.01 in width shall be rejected and replaced.
- C.** Any trench section that has not had at least seven (7) days cure time (including 12 hours steam cure, or 21 days without steam cure) or is out of square shall be rejected and replaced at the owner's discretion.
- D.** Any section with indications of imperfections in mixing and/or molding, honeycombed, or open textured surface, shall be rejected and replaced.
- E.** Any section with indications of patches or repairs shall be rejected and replaced.
- F.** Any section with exposed reinforcing steel, with the exception of the curb and gutter intentionally exposed reinforcement, shall be rejected and replaced.

### **3.4 Structure Installation**

#### **3.4.1 General**

- A.** General Locations and Arrangements: Drawing Plans and Details indicate general location and arrangement of underground storm and drainage piping systems. Location and arrangement of Stormwater Bioretention Systems is critical and design consideration should be taken into account. Install Stormwater Bioretention Systems as indicated herein and as directed by the product manufacturer, to the maximum extent practical. Where specific installation procedure is not indicated, follow the product manufacturer's written instructions.
- B.** All products shall be inspected for defects and cracks before being lowered into the excavation, piece by piece. Any defective, damaged or unsound structure or any product that has had its grade disturbed after laying, shall be taken up and replaced. Open ends shall be protected with a plug to prevent earth or other material from entering the bioretention system during construction. The interior of the bioretention system shall be free from dirt, excess water and other foreign materials as the installation progresses and left clean at the completion of the installation.





### **3.4.2 Trench Excavation**

#### **3.4.2.1 Excavation**

- A.** Excavate trenches to ensure that sides will be stable under all working conditions. Slope trench walls or provide supports in conformance with all local and national standards for safety. Open only as much trench as can be safely maintained by available equipment. Backfill all trenches as soon as practicable, but not later than the end of each working day.
  
- B.** Where trench walls are stable or supported, provide a width sufficient, but no greater than necessary, to ensure working room to properly and safely place and compact side walls and other embedment materials. The space between the bioretention system and trench wall must be wider than the compaction equipment used in the compaction zone.
  
- C.** When supports such as trench sheeting, trench jacks, trench shields or boxes are used, ensure that support of the bioretention system and its embedment is maintained throughout installation. Ensure that sheeting is sufficiently tight to prevent washing out of the trench wall from behind the sheeting. Provide tight support of trench walls below viaducts, existing utilities, or other obstructions that restrict driving of sheeting.

#### **3.4.2.2 Dewatering**

- A.** Do not lay or embed any section of the Stormwater Bioretention System in standing or running water. At all times prevent runoff and surface water from entering the trench.
  
- B.** When water is present in the work area, dewater to maintain stability of in-situ and imported materials. Maintain water level below pipe bedding and foundation to provide a stable trench bottom. Use, as appropriate, sump pumps, well points, deep wells, geofabrics, perforated under drains, or stone blankets of sufficient thickness to remove and control water in the trench. When excavating while depressing ground water, ensure the ground water is below the bottom of cut at all times to prevent washout from behind sheeting or sloughing of exposed trench walls. Maintain control of water in the trench before, during, and after pipe system installation and until embedment is installed and sufficient backfill has been placed to prevent flotation of the pipe, fitting, or drainage structures. To preclude loss of soil support, employ dewatering methods that minimize removal of fines and the creation of voids in in-situ materials.

#### **3.4.2.3 Removal of Rock**

- A.** Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between exposed rock and the manhole sections of at least 12 inches (0.3m). Rock excavation shall be as specified and defined under section 02300 Earthwork.

#### **3.4.2.4 Removal of Unstable Material**

**A.** Where wet or otherwise unstable soil incapable of properly supporting the manhole structure, as determined by the Engineer, is encountered in the bottom of a trench, such material shall be removed to at least 24 inches below bottom of the structure and replaced to the proper grade with select granular material, compacted as directed by the engineer. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

#### **3.4.3 Bedding**

**A.** A stable and uniform bedding shall be provided for the structures and any protruding features of its joint and/or fittings. The bedding shall be compacted to a minimum of 90% of maximum density per AASHTO T99, or as shown in the plans. Structure bedding shall be a minimum of 6" in thickness. The bedding surface for the structure shall provide a firm foundation of uniform density throughout the entire length of the pipe.

#### **3.4.4 Setting Structures**

**A.** Each structure section shall be thoroughly examined before being placed; defective or damaged sections shall not be used. Structures shall be placed to the elevations as indicated on the plans. Proper facilities shall be provided for lowering structure sections into trenches. Sections shall not be laid in water, and the sections shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches shall be provided as directed by the engineer; see dewatering section.

#### **3.4.5 Jointing**

**A.** Joints shall be constructed as described herein and in accordance with manufacturer's installation instructions.

**B.** All joints shall be thoroughly cleaned. The supplied gasket or mastic shall be installed on the spigot end with the angled surface facing toward the mating surface. Joint lubricant, supplied by the manufacturer, shall be liberally applied to entire interior of bell and gasket on spigot prior to assembly. Sections shall be mated with sections level and plumb to prevent rolling the gasket.

**C.** All Tongue-and-Groove joints shall be thoroughly cleaned. Sections shall be mated and Hydraulic Cement Grout (Non-Shrink) complying with ASTM C1107 shall be applied liberally to the interior and exterior of the joint ensuring all voids are filled completely.



### **3.4.6 Backfilling**

#### **3.4.6.1 General**

Backfill placement and compaction shall be constructed in accordance with the specifications herein and the product manufacturer's published installation guides.

#### **3.4.6.2 Backfilling Cell Sections in Trenches**

After the cell sections and connecting pipes have been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along all sides of pipe in layer depths to ensure minimum compaction density is obtained evenly throughout the backfill material. The backfill shall be brought up evenly on all sides of the structure. Each layer shall be thoroughly compacted with mechanical tampers or rammers. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Engineer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

#### **3.4.6.3 Movement of Construction Machinery**

Movement of construction machinery over a bioretention system at any stage of construction shall be prohibited. Any damaged structure shall be repaired or replaced.

### **3.4.7 Activation of Stormwater Bioretention Systems**

**A.** The Stormwater Bioretention System shall be delivered without the soil media, internal irrigation, and plants installed. The Contractor shall take any and all necessary actions to protect the Bioretention Cells and pre-treatment structures from sediment, debris and other pollutants during the course of construction. The manufacturer shall be contacted a minimum of three weeks prior to completion of construction to schedule activation of the Bioretention Systems.

