STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
PO Box 47600, Olympia, WA 98504-7600 • 360-407-6000

October 15, 2024

Mr. Ed Munoz
CityGreen LLC
444 W Ocean Blvd, Ste 707
Long Beach, CA 90802Toronto, Ontario M4S 3ES

RE: StrataCell and StrataVault for Stormwater Runoff Filtration

Dear Mr. Munoz:

The Washington State Department of Ecology (Ecology) finds the StrataCell and StrataVault systems are functionally equivalent to a bioretention facility when used for treating stormwater. The media specifications for the StrataCell and StrataVault systems must adhere to the guidelines for Bioretention areas, found in BMP T7.30 in the 2024 Stormwater Management Manual for Western Washington (SWMMWW) or the BMP F6.23 in the 2024 Stormwater Management Manual for Eastern Washington (SWMMEW). The sizing procedure must also adhere to the procedure outlined in the Bioretention area of the manuals mentioned above or the procedure City Green submitted to Ecology for design of the StrataCell and StrataVault using WWHM 2012.

Contractors may use the StrataCell or StrataVault system at project sites without seeking additional Ecology approval. Ecology cannot endorse this product or its manufacturer. You must follow manufacturer installation recommendations.

For more information, contact Douglas C. Howie, P.E. at douglas.howie@ecy.wa.gov or (360) 870-0983.

Sincerely

Douglas C. Howie

Douglas C. Howie, P.E.
Stormwater Engineer
Program Development Services
Water Quality Program

cc: Carla Milesi, TAPE Coordinator Washington Stormwater Center

STRATACELL® AND STRATAVAULT™ – USING THE WESTERN WASHINGTON HYDROLOGY MODEL (WWHM 2012) TO SIZE AND EVALUATE WATER QUALITY AND FLOW CONTROL PERFORMANCE

Prepared for
CityGreen® Systems

Prepared by
Herrera Environmental Consultants, Inc.

STRATACELL® AND STRATAVAULT™ – USING THE WESTERN WASHINGTON HYDROLOGY MODEL (WWHM 2012) TO SIZE AND EVALUATE WATER QUALITY AND FLOW CONTROL PERFORMANCE

Prepared for
CityGreen® Systems
200-1920 Yonge Street
Toronto, Ontario M4S 3ES

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

March 3, 2015

CONTENTS

FIGURES

Introduction

StrataCell® and Stratavault™ are interlocking soil cells that provides high strength support for pavements and traffic loads while providing large volumes of uncompacted soil for tree root systems and stormwater storage. The engineered plastic modules interlock to create void space beneath pavement. Similar to bioretention systems, StrataCell® and Stratavault™ provide treatment and reduce peak flows and durations as water ponds and infiltrates through the soil media.

This document includes hydrologic modeling procedures for evaluating compliance of StrataCell® and Stratavault™ systems with the Ecology stormwater requirements presented in the 2012 Stormwater Management Manual for Western Washington (SWMMWW) using the Western Washington Hydrologic Model (WWHM) 2012. This guidance provides step-by-step instructions for sizing StrataCell® and Stratavault™ to meet Ecology's Minimum Technical Requirements for on-site stormwater management (#5), water quality treatment (#6), and flow control (#7).

For guidance on general model setup, including selection of precipitation series, representation of pre-developed and post-developed (mitigated) land covers, and general model framework, refer to the WWHM2012 Manual and Appendix III-B of the 2012 SWMMWW.

Applicability and Compliance

The applicability of Ecology's Minimum Requirements to a particular project is determined based on the type and size of the proposed development relative to Ecology-defined thresholds outlined in the 2012 SWMMWW. Refer to Volume 1, Chapter 2, of the 2012 SWMMWW to determine stormwater requirements for a particular project.

The following sections supplement the 2012 SWMMWW by providing additional guidance to support designers in using StrataCell® and Stratavault™ to partially or fully comply with the Minimum Requirements. On sites where multiple requirements are triggered for a given surface, the designer must meet each of the requirements at the designated point of compliance.

Minimum Requirement #6 - Water Quality Treatment

Per the 2012 SWMMWW, sites triggering Minimum Requirement #6 must infiltrate or filter at least 91 percent of the total runoff volume through a soil mix that meets Ecology's requirements for bioretention soil media. Using continuous hydrologic modeling (described in the *Modeling Guidance* section, below), the designer can size StrataCell® or Stratavault™ to provide basic, enhanced, and oil control treatment for a contributing pollution-generating surface provided the soil media meets the criteria for Default Bioretention Soil Media (BSM) or Custom Bioretention Soil Mixes as described in Volume V of the 2012 SMMWW.

Minimum Requirement #7 – Flow Control

Per the 2012 SWMMWW, sites triggering Minimum Requirement #7 (Flow Control) are required to match pre-developed condition stormwater discharge durations for the range of pre-developed discharge rates from 50 percent of the 2-year peak flow up to the 50-year peak

flow. A forested land cover is typically the target pre-developed condition; however, the 2012 SWMMWW outlines criteria for matching alternate "pre-project" conditions. Should a project satisfy those criteria, it would be subject to a less protective (e.g., pasture or existing) flow control standard. Refer to the 2012 SWMMWW to determine if a project qualifies for these provisions.

For infiltrating StrataCell® and Stratavault™ systems, facilities are sized to meet the prescribed range of stormwater discharge durations using the methods described in the *Modeling Guidance* section, below. Where infiltration is infeasible, underdrains may be used to collect and convey filtered water. In these cases, designers can use a treatment train and/or an orifice to restrict flow from the underdrain to meet flow control requirements. Guidance for sizing facilities with an underdrain is provided in the *Modeling Guidance* section.

In addition to the Ecology-prescribed flow control requirements, many jurisdictions have other flow control standards to target their specific needs. One common requirement for combined sewer overflow control involves reducing the 1-year storm to a specified percentage of the unmanaged runoff (e.g., 95 percent reduction in the 1-year peak flow). The designer should evaluate these standards via continuous hydrologic modeling as described below.

Minimum Requirement #5 – On-site Stormwater Management

Per the 2012 SWMMWW, sites triggering Minimum Requirement #5 (On-site Stormwater Management) are required to either:

- Meet the Low Impact Development (LID) Performance Standard (i.e., match pre-developed-condition [typically forest] stormwater discharge durations for the range of pre-developed discharge rates from 8 percent of the 2-year peak flow up to 50 percent of the 2-year peak flow).
- Implement BMPs from Ecology's prescribed Lists 1 and 2 (provided in the 2012 SWMMWW) for each surface type (e.g., roofs, roadway).

For infiltrating StrataCell® and Stratavault™ systems, facilities are sized to meet the prescribed range of stormwater discharge durations using the methods described in the *Modeling Guidance* section, below. As with the flow control standard, it is difficult to meet the LID Performance Standard requirements with underdrained facilities. Further, it is infeasible to fully satisfy these requirements with underdrained facilities on sites where the pre-developed condition is forest. However, on sites where the requirement is to match existing flow durations, an underdrained StrataCell® or Stratavault™ can be sized to meet the LID Performance Standard (provided the contributing area is sufficiently large). The designer should determine the required facility footprint and orifice diameter based on the area contributing runoff to the StrataCell® or Stratavault™ using continuous hydrologic modeling as described in the *Modeling Guidance* section, below.

As an alternative to complying with the quantitative LID Performance Standard, the designer may specify a StrataCell® or Stratavault™ to partially or fully satisfy the On-site Stormwater Management requirements per Ecology's prescribed lists. To meet the list requirements for

bioretention, the StrataCell® or Stratavault™ facility area must be 5 percent of the contributing area.

Modeling Guidance

The following guidelines apply to the sizing and evaluation of StrataCell® and Stratavault™ systems in WWHM 2012 using the "Bioretention" element. CityGreen does not recommend using earlier versions of the model (e.g., WWHM4) to size or evaluate the performance of StrataCell® or Stratavault™ because the bioretention swale element in older versions of the software has limited functionality. Specifically, the WWHM2012 element allows for explicit representation of the detention function of both the bioretention soil (via infiltration into the soil media) and orifice control at the underdrain, yielding more accurate estimates of the flow control performance of StrataCell® and Stratavault™.

For additional information on WWHM assumptions and modeling guidance, including background information on precipitation and evaporation series selection and scaling, soil classification, HSPF parameter values, guidance for flow and water quality related standards, and other model features, refer to the following documents:

- Volume III and Volume V of the 2012 SWMMWW
- Volume III, Appendix III-B, and Appendix III-C (Part 2) of the 2012 SWMMWW
- WWHM 2012 User's Manual

This document serves as supplementary guidance to that provided in the WWHM User's Manual and 2012 SWMMWW. Users are responsible for ensuring that they adhere to the standards and modeling requirements outlined in current versions of the 2012 SWMMWW and the WWHM User's Manual.

Part 1: Select Precipitation and Define the "Pre-Developed" Scenario

1. **Define site precipitation**:
    a. Click the location of the project on the map to select the site precipitation series in the "Map Information" dialog box.

2. **Add and characterize the pre-developed area**:
    a. Click the "General Project Information" button in the toolbar to open the Schematic window.
    b. Select the "Predeveloped Scenario**"** in the Schematic window.
    c. Drag and drop the "Land Use Basin**"** element (listed under "Basic Elements") into the schematic editor (denoted as a grid to the right of the Scenarios toolbar).
    d. Click on the basin and enter the pre-developed area by land use type (e.g., acres of roof).

For evaluation of StrataCell® and Stratavault™ performance relative to Ecology Minimum Requirements #5 and #7 determine the appropriate target "pre-developed" condition for the development site. Note the target pre-developed land cover is typically forested;

however, the 2012 SWMMWW outlines criteria for matching alternate "pre-project" conditions.

3. **Set the "point of compliance" at the pre-developed land use basin outlet**:
   a. Right click on the Basin and select "Connect to Point of Compliance**".**
   b. Verify appropriate outlets are checked and click "Connect".

      Always select both surface flow and interflow, and select groundwater flow only when observations of groundwater expression on the site support modeling of groundwater.

Part 2: Define the "Mitigated" Scenario

Figure 1 shows the "Mitigated" scenario schematic editor screen.

1. **Add and characterize the area contributing runoff to the StrataCell® or Stratavault™**:
   a. Selected the "Mitigated Scenario" in the Schematic window.
   b. Drag and drop the "Land Use Basin" element (listed under "Basic Elements") into the schematic editor (denoted as a grid to the right of the Scenarios toolbar).
   c. Click on the basin and enter the mitigated area by land use type (e.g., acres of roof).
2. **Add the StrataCell® or Stratavault™ BMP**:
   a. Drag and drop the "Bioretention" element (listed under "Pro Elements") into the schematic editor.
3. **Route flows from the contributing drainage area (denoted by the Land Use Basin element) to the StrataCell® or Stratavault™ in the Schematic editor**:
   a. Right click the "Land Use Basin" element, select "Connect to Element**".**
   b. Click on the bioretention element defined in Step 5 to connect the basin element to the bioretention element.
   c. Select desired flows to route from basin to bioretention swale in the "From Basin to Conveyance" pop-up dialog box (options include surface flow, interflow, and groundwater).

      Always select both surface flow and interflow, and select groundwater flow only when observations of groundwater expression on the site support modeling of groundwater.
   d. Click "OK" to return to the Schematic editor.

Note: If the design includes a diversion structure to limit the peak inflow rate of water to the StrataCell® or Stratavault™ system, include a flow splitter in the model to allow only certain flows to be directed to the bioretention element. Drag and drop the Flow Splitter element (listed under "Basic Elements") into the schematic editor. Connect the basin to the

flow splitter and connect the flow splitter to the bioretention element. Click on the flow splitter to set either a flow threshold or the specific dimensions of the control structure. Note which flow splitter outlet is being directed to the bioretention element when connecting the two elements in the schematic editor. Set a simultaneous point of compliance at both the outlet of the bioretention element and the flow splitter outlet that is not connected to the bioretention element to ensure analysis of performance reflects total runoff from the site, not just the diverted fraction. Refer to the WWHM 2012 User's Manual for more information on modeling flow splitters.

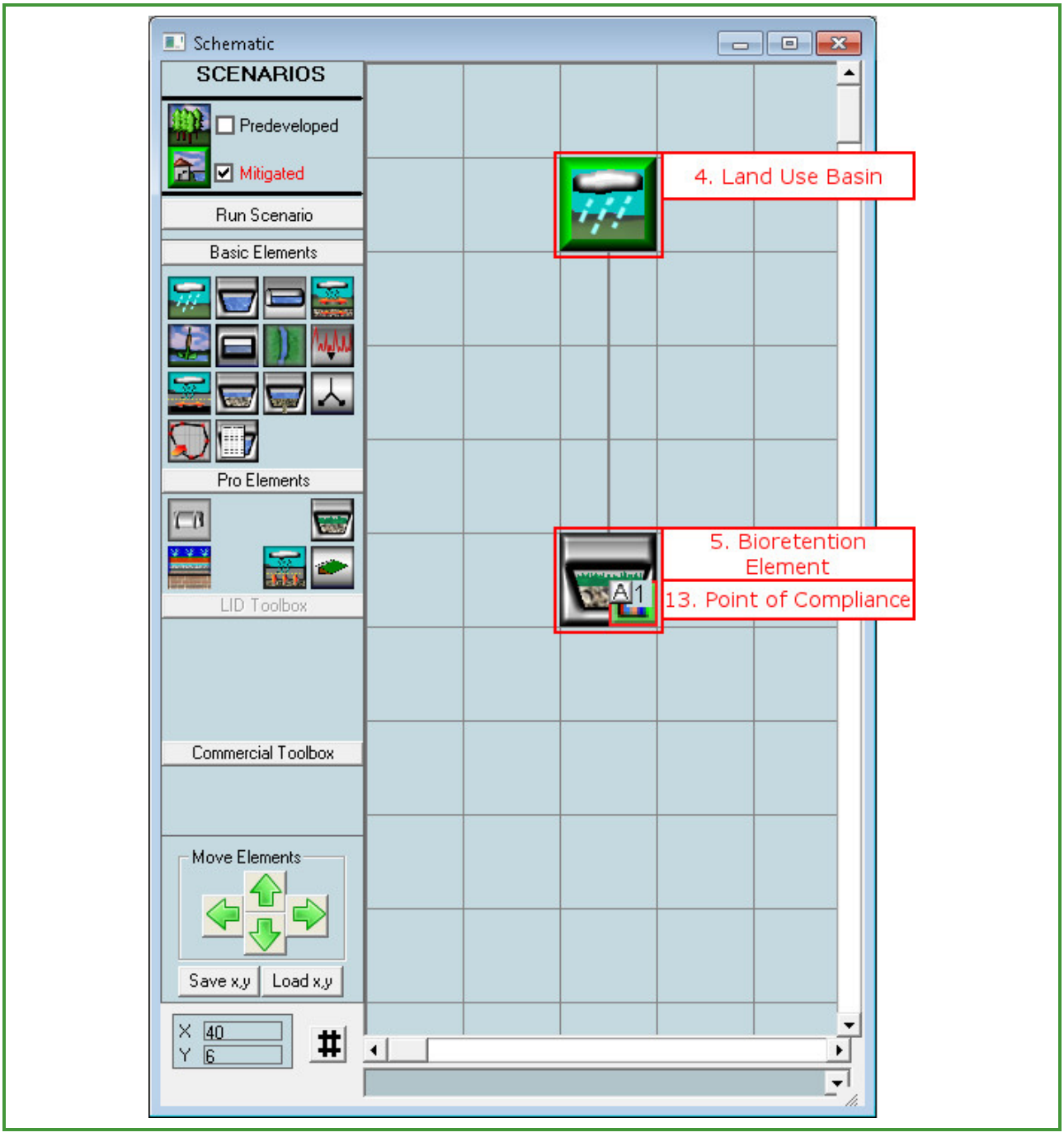


Figure 1. Schematic Editor for the "Mitigated" Scenario.

Part 3: Define the StrataCell® or Stratavault™ System

1. **Define the facility type**:
   a. Click on the "Bioretention" element to bring up the Bioretention editor (see Figure 2).
   b. Ensure the "Use Simple Bioretention" box is unchecked.

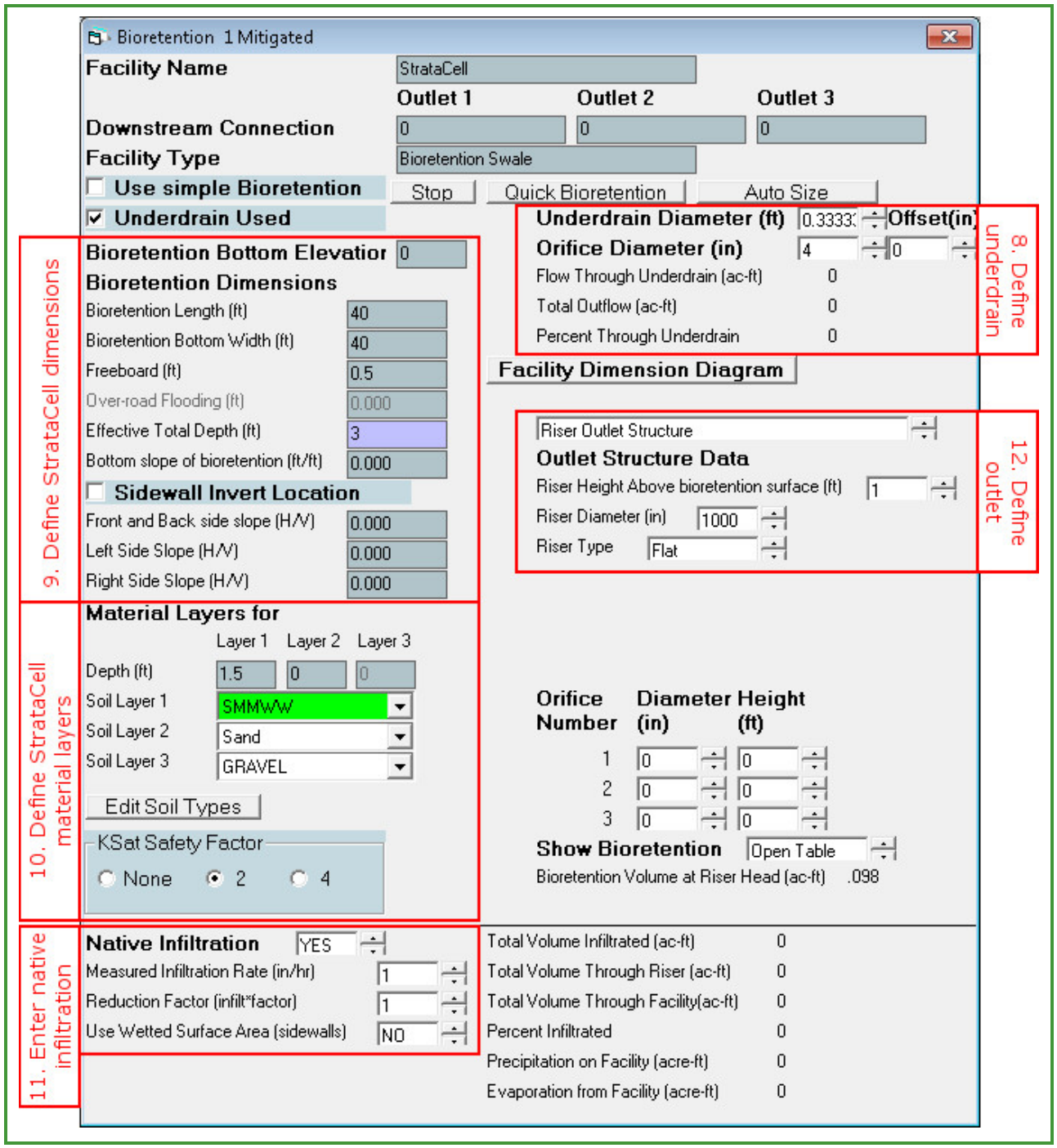


Figure 2. Bioretention Element Screen.

2. **Define underdrain parameters (if applicable)**:

   a. Check "Underdrain Used" box.

   b. Enter the underdrain pipe diameter in feet.

   c. Enter the orifice diameter. If there is no orifice in the design, set the orifice diameter equal to the underdrain pipe diameter (note the dimensions for orifice diameter are in inches while the pipe diameter is in feet).

   d. Enter an orifice offset height, measured from invert of underdrain (if applicable). Typically this value is 0 inches.

3. **Define StrataCell® or Stratavault™ dimensions**:

   a. Enter StrataCell® or Stratavault™ dimensions in the "Bioretention Bottom Elevation" and "Bioretention Dimensions" section of the dialog box, as follows:

   - **Bioretention Bottom Elevation (ft)** - Set elevation at the model default value of zero or enter the actual elevation of the proposed facility.

     The bottom elevation represents the bottom of the StrataCell® or Stratavault™ facility and serves as a reference elevation for all other facility dimensions.

   - **Bioretention Length (ft)** – Enter the nominal length of the StrataCell® or Stratavault™ system.

     The nominal length of the StrataCell® or Stratavault™ system will be less than the true length of the system due to the volume lost to the StrataCell® or Stratavault™ structure. According to the manufacturer a maximum of 10 percent of StrataCell® and Stratavault™ volume is attributed to the structure. Apply a correction factor to the design length and width of the StrataCell® or Stratavault™ facility. Do not apply a correction factor to the height of the facility as this may affect the hydraulic performance of the system.

   - **Bioretention Bottom Width (ft)** – Enter the nominal width of the StrataCell® or Stratavault™ system.

     Apply correction factor to the design width of the StrataCell® or Stratavault™ system as described in the Bioretention Length section above.

   - **Freeboard (ft)** – Enter the freeboard required per the design or by local jurisdiction requirements

     Freeboard calculated as the depth of storage available from the top of the StrataCell® or Stratavault™ to the outlet riser crest.

   - **Over-road Flooding (ft)** - If applicable, enter the maximum depth of water above the emergency spillway

This design parameter does not apply StrataCell® or Stratavault™ systems because the riser outlet controls overflow from the system instead of a weir or other surface overflow. The model greys out this cell when the user selects "Riser Outlet Structure" as the outlet structure.

- **Effective Total Depth (ft)** – no data entry required

  This value represents the total depth of the facility including the filter media depth, ponding depth (riser height), and freeboard. The model automatically populates this field.

- **Bottom slope of bioretention (ft/ft)** – Set to 0 for a flat bottom facility.

  If the model produces error messages during simulation set bottom slope at a minimum value of 0.001 to reduce model instability.

- **Top and Bottom side slope (H:V)** – Enter a value of 0 to represent vertical side walls

- **Left Side Slope (H:V)** - Enter a value of 0 to represent vertical side walls

- **Ride Side Slope (H:V)** - Enter a value of 0 to represent vertical side walls

4. **Define StrataCell® and Stratavault™ material layers**:

   a. Enter StrataCell® or Stratavault™ material layer types/dimensions, as follows:

   - **Layer 1 Depth (ft) – Enter a depth that represents the soil media depth:**

     Soil layer depth depends on the number of StrataCell® or Stratavault™ units stacked on top of each other and the thickness of the void space (ponding depth) above the media. CityGreen recommends a minimum soil depth of 30 inches for tree root growth. Ecology requires a minimum of 12 inches of bioretention soil media to meet the flow control requirements and a minimum of 18 inches to meet water quality requirements. A maximum void space (ponding depth) of 36 inches is recommended.

   - **Layer 2 and Layer 3 Depth (ft)** – Enter 0 feet

   - **Soil Layer 1** – Select the "SWMMWW" soil type which represents approved criteria for default bioretention soil media. Do not edit this soil type.

   - **Soil Layer 2 and 3 –** NA

   - **KSat Safety Factor** – Select the appropriate safety factor to meet the required hydraulic conductivity

     In accordance with SWMMWW 2012 requirements, use a safety factor of 2 for facilities with a contributing drainage area that is less than 10,000 square feet of impervious surface, less than 5,000 square feet of pollution generating hard surface, or less than 3/4 acre of native vegetation converted to lawn or landscaping. If the contributing drainage area exceeds any of these thresholds apply a safety factor of 4.

5. **Enter native infiltration parameters**:

   a. Enter native soil characteristics, as follows:

      - If native soil is used for infiltration as per the design select "yes" for native infiltration
      - **Measured Infiltration Rate (in/hr)** – Enter measured infiltration rate.
      - **Reduction Factor** – Enter a multiplier reduction factor if applicable, otherwise leave as 1.
      - **Use Wetted Surface Area (sidewalls)** – Select "no" since StrataCell® and Stratavault™ systems have vertical walls.

6. **Define the outlet riser configuration**:

   a. Enter outlet structure characteristics, as follows:

      - Toggle the outlet structure to "Riser Outlet Structure".
      - **Riser Height Above bioretention (ft)** – Enter a riser height equal to the void space (ponding depth) above the soil media layer within the StrataCell® or Stratavault™ system.

        Riser height is equal to the StrataCell® or Stratavault™ system height (10 inches per cell for StrataCell® or 16 inches per cell for Stratavault multiplied by the number of cell layers) minus the soil media depth used in the material layers section. CityGreen recommends a minimum soil depth of 30 inches for tree root growth. Ecology requires a minimum of 12 inches of bioretention soil media to meet the flow control requirements and a minimum of 18 inches to meet water quality requirements. A maximum void space (ponding depth) of 36 inches is recommended.

      - **Riser Diameter (in)** – Enter a very large value for the riser diameter, e.g., 1,000 inches, to ensure capacity is available in the case of high flows when the StrataCell® or Stratavault™ system is saturated.
      - **Riser Type** – Select the flat riser type.

7. **Set "point of compliance" at appropriate outlet(s)**:

   a. In the Schematic window right click the Bioretention element and select "Connect to Point of Compliance", verify appropriate outlets are selected, and click "Connect".

      Note: As described in Step 1, if a flow splitter was used to limit flows to the bioretention element ensure the same point of compliance is also set at the outlet of the flow splitter that is <u>not</u> directed to the bioretention element.

Part 4: Analyze the StrataCell® or Stratavault™ System Performance

This section includes protocol for evaluating StrataCell® and Stratavault™ performance relative to the performance standard prescribed in Minimum Requirements #5, #6, and #7. For a complete summary of Ecology's performance standards and methodologies, see the 2012 SWMMWW and the WWHM User's Manual.

1. **Evaluate water quality performance**:

   Per the 2012 SWMMWW, sites triggering Minimum Requirement #6 (Water Quality Treatment) are required to infiltrate or filter at least 91 percent of the total runoff volume through a media that meets Ecology's requirements for bioretention soil media. Evaluate water quality performance using the following procedure.

   a. Run both the pre-developed and mitigated scenarios in the schematic editor.
   b. Click on the "Bioretention" element in the mitigated scenario schematic editor to bring up the Bioretention editor.
   c. If an underdrain is used, check that the "Percent Through Underdrain" value is equal to or greater than 91 percent. If an underdrain is not used, check that the "Percent Infiltrated" is equal to or greater than 91 percent.

   If the facility does not infiltrate or filter 91 percent, increase the size of the StrataCell® or Stratavault™ system or reduce the basin area draining to the facility until the standard is met.

2. **Evaluate flow control performance**:

   Per the 2012 SWMMWW sites triggering Minimum Requirement #7 (Flow Control) are required to match pre-developed stormwater discharge durations for the range of pre-developed discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow. The target pre-developed land cover is typically forested; however, the 2012 SWMMWW outlines criteria for matching alternative pre-project conditions. Evaluate flow control performance using the following procedure.

   a. Run both the pre-developed and mitigated scenarios in the schematic editor.
   b. Click the "Analysis" button in the toolbar to open the Analysis window.
   c. Select the desired point of compliance from the tabs in the bottom left portion of the "Analyze datasets" dialog box (e.g., POC 1).
   d. Select the "Stream Protection Duration" standard from the tabs below the analysis screen.

   WWHM 2012 plots the duration curves for the pre-developed and mitigated scenarios and reports whether the facility meets (or "passes") the requirement. Additionally, the WWHM 2012 report file contains information about pre-developed and mitigated flow frequencies, maximum water surface elevations within facilities, and other information relative to common performance standards.

If the facility does not meet the duration standard, increase the size of the StrataCell® or Stratavault™ system, adjust the orifice diameter on the underdrain (if applicable), provide another BMP as part of a treatment train, or reduce the basin area draining to the facility until the standard is met.

3. **Evaluate LID performance**:

   Per the 2012 SWMMWW, sites triggering Minimum Requirement #5 (On-Site Stormwater Management) are required to either meet the LID Performance Standard or implement BMPs from Ecology's prescribed Lists 1 and 2 for each surface type. Evaluate LID performance using the following procedure.

   a. Run both the pre-developed and mitigated scenarios in the schematic editor.

   b. Click the "Analysis" button in the toolbar to open the Analysis window.

   c. Select the desired point of compliance from the tabs in the bottom left portion of the "Analyze datasets" dialog box (e.g., POC 1).

   d. Select the "LID Duration" standard from the tabs below the analysis screen.

   WWHM 2012 plots the duration curves for the pre-developed and mitigated scenarios and reports whether the facility meets or passes the requirement. Additionally, the WWHM 2012 report file contains information about pre-developed and mitigated flow frequencies, maximum water surface elevations within facilities, and other information relative to common performance standards.

   If the facility does not meet the LID duration standard, increase the size of the StrataCell® or Stratavault™ system, adjust the orifice diameter on the underdrain (if applicable), provide another BMP as part of a treatment train, or reduce the basin area draining to the facility until the standard is met.

4611 Morris Road
Edmonton AB T6B 2V9
Canada

Phone: 1 780 462 5064
Fax: 1 780 462 0863
Email: info.wca@citygreen.com

www.citygreen.com

Specifications for Filler Soil for StrataCell®

Structural Soil Cell System

Manual Revision: 2

NOTES TO SPECIFIER:

1. The following specification, Section 32 94 55 Soil Cell Filler Soil, is a master specification, produced by CityGreen and based on their StrataCell system. The specification has been designed to be edited to suit the requirements of a particular project. The specification has been structured and the text prepared to facilitate the editing process which should consist, for the most part, of deleting inapplicable requirements and inserting new text where required. Brackets, thus [ ], contained in the body of the text require that a requirement be inserted or that a choice be made.

2. The specification has been prepared in accordance with the current editions of MasterFormat and SectionFormat published by Construction Specifications Canada and The Construction Specifications Institute of the United States.

3. The specification is based on the assumption that a given project will be carried out under contract, that there will be a complete project specification, including in particular Division 1 General Requirements specifications, and that there will be a consultant administering the contract on behalf of a client owner. If this is not the case, editing will be required to suit the particular circumstances.

4. The specification complements Section 32 94 50 Structural Soil Cells. The content of both sections is coordinated and both should be used on a given project.

5. A significant characteristic of this section is that the filler soil is specified in terms of performance criteria. There are no prescriptive requirements specifying the constituent parts and proportions of the soil mix. The performance approach requires an emphasis on quality control and testing which the specification reflects.

6. Following is commentary on certain specification clauses:

- Clause1.04 Sustainability Requirements: LEED*: If the project is seeking LEED certification, it will be necessary to specify the LEED requirements related to this section in terms of “LEED Performance Requirements” and “LEED Submittals”. This will include, as a minimum, LEED Materials and Resources, e.g. Recycled Content, Regional Materials. Note that the work of this section is part of a larger design concept involving trees and possibly storm water harvesting. These issues will relate to LEED at the design level; LEED requirements specified in this section should be coordinated with design level information to ensure that LEED criteria are fully addressed. It is understood that project level LEED requirements will be specified in Division 1 General Requirements.
- Clause 1.06 Consultant’s Authority: This clause expands the Consultant’s usual authority by giving the Consultant increased powers to deal with quality control issues.
- Clause 1.08 Testing Agency Services: Text requires that the Contractor provide and pay for the services of an independent testing agency. Frequently, the Owner will provide and pay for this service. If this is the case, modify text accordingly.
- Clause 2.02 Performance Requirements: If the project is seeking to meet Washington State Department of Ecology Minimum Requirements #6 and/or Minimum Requirement #7, specify filler soil performance to meet Default Bioretention Soil Media or Custom Bioretention Soil Mix requirements as specified in the current edition of the Stormwater Management Manual for Western Washington.
- Clause 3.02 Filler Soil Schedule: If the project is seeking to meet Washington State Department of Ecology Minimum Requirements #6 and/or Minimum Requirement #7, specify compaction and placement requirements per the current edition of the Stormwater Management Manual for Western Washington.

*LEED – Leadership in Energy and Environmental Design, Green Building Council.

End of Notes to Specifier

1. GENERAL

1.01 SUMMARY

1. Section Includes: Production and supply of filler soil for structural soil cells, including related materials and activities.

1.02 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

1. Structural soil cells: Section 32 94 50.
2. Installation of filler soil: Section 32 94 50.
3. Testing of soils and aggregates other than filler soil: Section 32 94 50.

1.03 DEFINITIONS

1. Growing medium is defined as an amended existing topsoil that contains organic matter, is capable of sustaining vigorous plant growth, contains a typical clay content of >25% by mass, complies generally with the typical uses specified in [reference standard], and is free from unwanted matter such as:
    1. Stones, rock and pebbles greater than 10 mm measured by longest dimension
    2. Hard clods or objects greater than 15mm dimension
    3. Roots with a section diameter exceeding 10mm or a length exceeding 100mm
    4. Sticks and rubbish
    5. Material toxic to plants
    6. Materials that may pose a danger to human health, e.g. glass, hard plastic.
2. Filler soil is synonymous with growing medium.

1.04 SUSTAINABILITY REQUIREMENTS: LEED

1. LEED Performance Requirements:
   [ ]
2. LEED Submittals:
   [ ]

1.05 ADMINISTRATIVE REQUIREMENTS

1. Coordination: Coordinate work of this section with other related work and in particular with work specified in clause 1.02.
2. Scheduling: Conform to schedule specified in Section 32 94 50 Structural Soil Cells.
3. Cooperation: Contractor, Consultant and testing agency shall cooperate and coordinate their activities to the fullest extent to ensure that filler soil meets the qualitative and quantitative requirements specified in this Section and that such quality is maintained for the duration of the work.

1.06 CONSULTANT'S AUTHORITY

1. Consultant shall be, in the first instance, the interpreter of the requirements of this Section of the Specifications.
2. Consultant shall have access to the place or places where filler soil mixes are designed and produced.
3. Consultant may require testing of filler soil by testing agency in addition to the testing specified elsewhere in this Section.
4. Consultant may require that changes be made to any proposed filler soil mix.
5. Consultant may reject work that Consultant believes to be defective.
6. Work to be performed by Contractor as a result of Consultant's instructions under this clause shall be performed at no additional cost to Owner and without an extension to Contract Time.
7. Provisions of this clause shall in no way limit Consultant's responsibilities and authority specified elsewhere in the Contract.

1.07 SUBMITTALS

1. Product Data: Submit manufacturer's product data for each type of product to be used. For soils provide testing agency laboratory analysis.
2. Samples: Submit to testing agency, when and as required, samples of each type of filler soil for testing purposes.
3. Qualification Data: Submit proof of qualifications of filler soil supplier and of testing agency.

1.08 TESTING AGENCY SERVICES

1. Provide and pay for the services of an independent testing agency to perform the testing activities specified in this Section.
2. Testing agency shall have an established track record in testing the type of soil required by this specification and shall have soils testing facilities and personnel capable of performing the physical and chemical testing required by this specification. Testing agency personnel shall be experienced in soil mix design and in making soil recommendations.
3. Test materials in accordance with specified standards. In the absence of a specified standard, comply with the relevant ASTM standard.
4. Test Reports: Testing agency shall prepare test reports for all tests performed. Submit copies of test reports to Consultant immediately upon their becoming available.

1.09 QUALITY ASSURANCE PROGRAM

1. Contractor shall establish and maintain a quality assurance program for the purposes of managing the quality of the work. Quality assurance program shall consist of plans, procedures and organizational design necessary to ensure that work of this Section meets the prescriptive and performance requirements specified. The Quality Control, Source Quality Control and Site Quality Control provisions specified elsewhere in this Section shall form part of the Quality Assurance Program.

2. Filler soil supplier shall have an established track record in supplying soil of the type and quality required by these specifications, shall have facilities and personnel capable of preparing soil mixes for review and testing and shall have the production capacity to produce the quantities required for this project.

3. Single Source of Supply: Entire quantity of filler soil required by this project shall be supplied from a single source.

1.10 QUALITY CONTROL

1. Contractor shall establish and maintain a quality control system which shall set parameters for testing, procedures for sampling, sampling intervals, handling of samples (chain of custody), limits/tolerances or confidence intervals for acceptance or rejection status within a sample and allowable variability of test parameters between samples.
2. Quality control system shall include a paper trail that provides for traceability at any point. Each batch of soil shall be identified by date of manufacture, quality, and a corresponding test result and shall link into when material was delivered and where material was placed.
3. Records: Records shall be systematically recorded, indexed, and files so as to be retrievable and accessible to Consultant or quality auditor on a project basis within one working day of requisition.
4. Quality Register: Conformance records shall be stored and maintained such that they are readily retrievable and in facilities that provide a suitable environment to minimize deterioration and to prevent loss.
5. Storage: Quality records shall be available to Consultant at all reasonable times. If requested by Consultant, Contractor shall provide copies of records or test results at no cost to Owner.
6. Non-Conformance:

1.Non-conforming work detected by Quality Control System shall be reported to Consultant via a Non-Conformance Report (NCR) within one working day of being detected.

2. NCRs shall be submitted with all records that indicate a departure from specified requirements. NCR shall indicate a proposed corrective action.

3. If corrective action cannot be determined within one working day, Contractor shall submit a partially completed NCR identifying the non-conformance.

4. Non-conforming products shall not be covered up unless a corrective action has been approved by Consultant and implemented by Contractor.

5. An NCR shall create a hold point which shall apply until conformance has been achieved and Consultant signed an authorization to proceed.

6. Consultant shall issue a Corrective Action Request (CAR) when he detects non-conformance to Contractor's Quality Control System or methods. This will not create a hold point unless specifically stated.

7. When Consultant detects product non-conformance, he will issue a Notice of Non-Conformance (NNC) which will create a hold point and Contractor shall submit an NCR.

8. When there is a discrepancy between Consultant's test results and those of the Contractor, Consultant's results shall prevail except when Consultant may determine a specific audit test procedure to resolve the discrepancy.

9. Contractor shall nominate a complete corrective action for any non-conformance no later than five (5) working days or shall show cause to Consultant for any further delay.

10. Contractor shall indicate on an NCR corrective action to ensure that the Quality Control System remains effective in avoiding recurrence of the non-conformance.

11. Contractor and Consultant shall sign off on all actions under this clause.

12. Work performed by Contractor under this clause shall be at no additional cost to Owner and without an extension to Contract Time.

1.11 QUALITY CONTROL ALTERNATIVES

1. Variations to testing frequencies specified in clause 2.05 may be permitted upon timely submission to Consultant of an alternative testing program that achieves the desired outcome of the quality control program.
2. Materials supplied from operations that have a third party endorsed quality assurance program may be accepted subject to the timely submission to Consultant of the relevant documentation.

1.12 DELIVERY, STORAGE AND HANDLING

1. Refer to Section 32 94 50.
2. When filler soil has been produced and approvals given, protect stockpiled material from rain, wind erosion and other detrimental weather effects.
3. When filler soil is being loaded, ensure that loading equipment does not pick up underlying material and that tires and tracks do not till other material into the mix.
4. When filler soil is delivered to installation site, ensure that haul vehicles and equipment are properly sanitized so as to contain no foreign soil, aggregate, asphalt and other matter that might contaminate filler soil.

2. PRODUCTS

2.01 FILLER SOIL TYPES

1. Following [is the soil type] [are the soil types] required by this specification:

1. Type 'A': [ ]
2. Type 'B': [ ]
3. Type 'C': [ ]

2.02 PERFORMANCE REQUIREMENTS

1. Filler soils shall meet performance requirements specified in Appendix 'A'.
2. [Washington State Department of Ecology soil performance requirements for filler soil.]

2.03 DESIGN AND PREPARATION OF FILLER SOIL MIXES

1. Each proposed filler soil mix shall be tested and analysed for its chemical and physical properties. Contractor shall collect a sufficient number of samples to accurately characterize the resource and if required, determine the amendments required to meet specified requirements.
2. Prior to any growing medium amendment, conduct laboratory testing to confirm soil condition.
3. Perform testing on stockpiled growing medium that has been dedicated for use on this project.
4. Testing frequency shall be as specified in clause 2.05.
5. Supply filler soil for installation from certified stockpiles that have been tested at the rate specified in clause 2.05 and shown to comply with specified requirements.
6. When a stockpile has been tested and certified, no further material shall be added to it.

2.04 UNSUITABLE MATERIAL

1. Unsuitable material is material brought to site by Contractor that fails to comply with specified requirements. Unsuitable material may ultimately be approved for use if sufficient documentation and supporting laboratory testing from a qualified agronomist is submitted to Consultant proving that proposed material is equivalent or superior to specified material.
2. Costs associates with testing, reworking, removal or replacing unsuitable material shall be borne by Contractor.

2.05 SOURCE QUALITY CONTROL

1. Test filler soil as follows:

FILLER SOIL TYPE	APPLICATION	KEY QUALITY VERIFICATION REQUIREMENTS	MINIMUM TEST FREQUENCY
GROWING MEDIUM	Growing medium for filling structural soil cell matrix.	Appendix 'A'	Three (3) at approval then one (1) per $100m^3$ or part thereof.

3. EXECUTION

3.01 SITE QUALITY CONTROL

1. Consultant may require testing of filler soil that has been delivered to and stored on site, or that has been installed in soil cell matrix. Such testing shall be performed under provisions of clause 1.07.

3.02 FILLER SOIL SCHEDULE

1. Filler soil shall be placed to the lines, grades, and thickness shown on the Plans.
2. [Washington State Department of Ecology placement requirements for filler soil.]
3. Place filler soil as follows:

TYPE	USAGE	LOCATION
'A'	Growing medium.	
'B'		
'C'		

3.03 APPENDIX 'A'

Appendix 'A' Filler Soil Performance Requirements is attached.

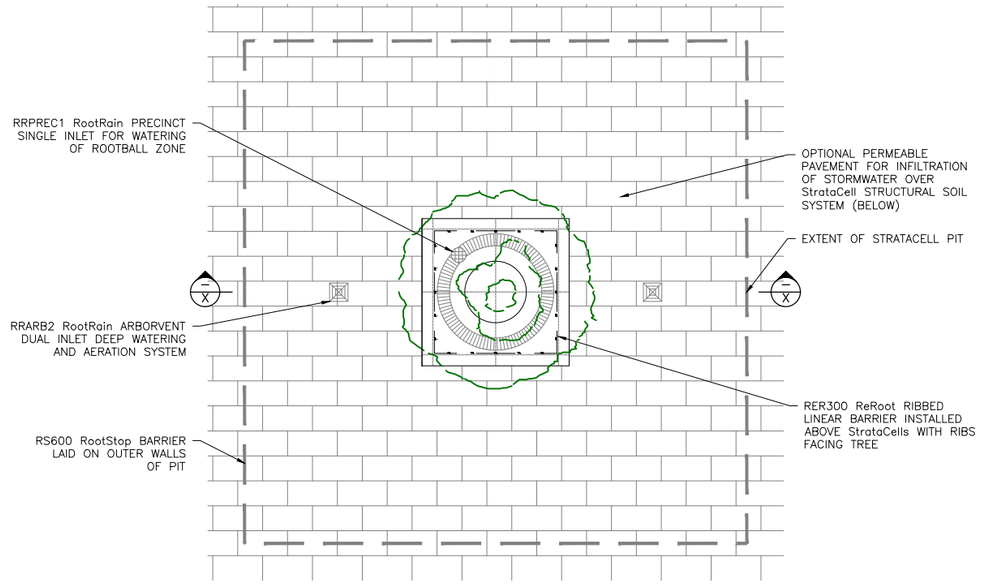
END OF SECTION

APPENDIX 'A' FILLER SOIL PERFORMANCE REQUIREMENTS

Type 'A' Growing Medium shall meet following requirements:

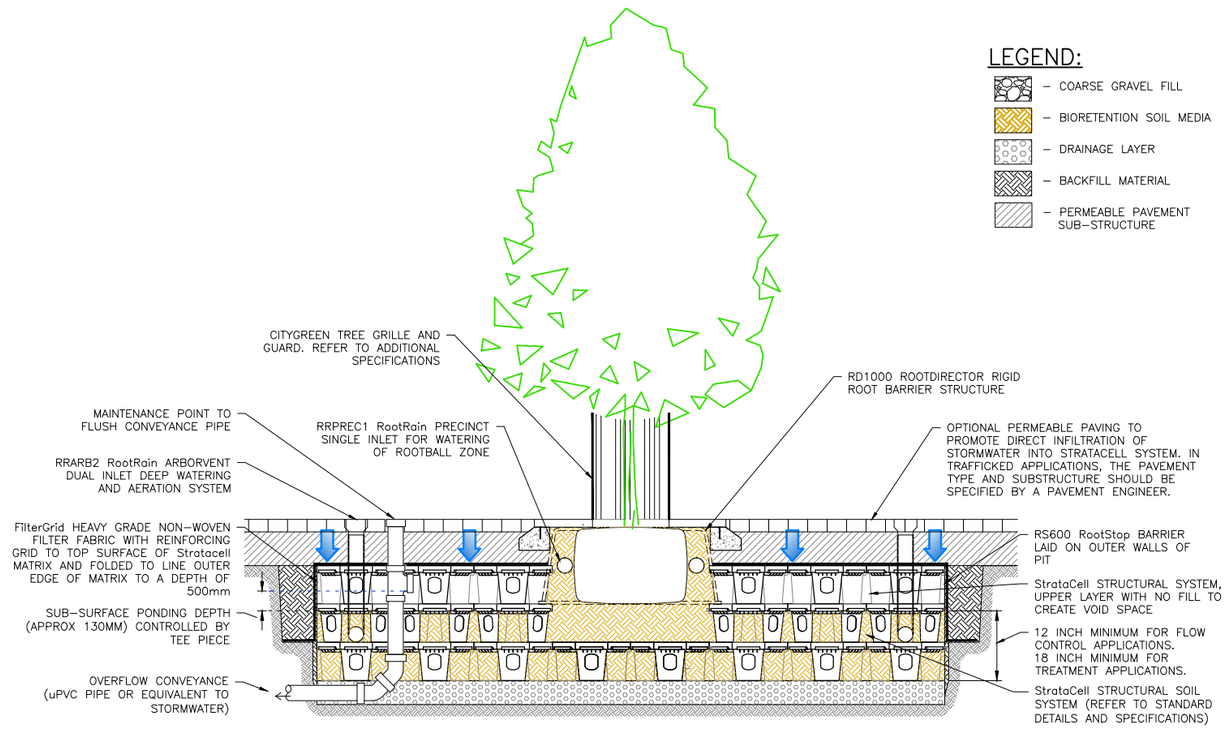
ITEM		**UNITS**	**GROWING MEDIUM FOR STRUCTURAL SOIL CELLS**
Ph	**In H_20 (1:5)**	Ph units	6.0 to 7.2
	In $CaCl_2$ (1:5)	Ph units	5.8 to 6.8
Electrical Conductivity (1:5)		Ds/m	<2.5
Cation Analysis	**Sodium**	% eCEC	<5
	Potassium	% eCEC	<5 to 15
		mg/kg	>262
	Calcium	% eCEC	60 to 75
		mg/kg	>1600
	Magnesium	5 eCEC	15 to 25
		mg/kg	>365
	Ca:Mg	Ratio	3 to 10
	Ca:K		10 to 30
	Mg:K		2 to 10
	Aluminium	%eCEC	<2
	Cation Exchange Capacity	Meq/100g	>25
Phosphate	**P sensitive planting**	mg/kg	5 to 15
	General plantings		80 to 150
Ammonium + Nitrate		mg/kg	50 to 100
Sulphate		mg/kg	40 to 100
Micronutrient Analysis	**Iron**	mg/kg	76 to 278
	Manganese	mg/kg	>20
	Zinc	mg/kg	6 to 15
	Copper	mg/kg	7 to 30
	Boron	mg/kg	1.4 to 2.7
Organic Matter		% by mass	3.0 to 8.0
Toxicity Index		mm	>70
Wettability		mm/minute	>5
Dispersibility	**In H_20**	-	1 or 2
	In $CaCl_2$	-	1 or 2

END OF APPENDIX



STRATACELL TREE PIT WITH POROUS PAVER SURROUND – DETAILED PLAN

SCALE 1:25



SECTION X – STRATACELL TREE PIT WITH POROUS PAVER SURROUND

SCALE 1:20

LEGEND:

- – COARSE GRAVEL FILL
- – BIORETENTION SOIL MEDIA
- – DRAINAGE LAYER
- – BACKFILL MATERIAL
- – PERMEABLE PAVEMENT SUB–STRUCTURE

GENERAL NOTES

THIS DRAWING IS FOR SCHEMATIC PURPOSES ONLY AND SHOULD NOT BE RELIED UPON FOR CONSTRUCTION. PROJECT DESIGNER MUST DETERMINE StrataCell SYSTEM, PIPE SIZING, LOCATION, OVERFLOW DESIGN AND FILTRATION AREA TO MEET PROJECT REQUIREMENTS.

REFER TO THE CITYGREEN DESIGN GUIDE AND StrataCell STANDARD DETAILS AND SPECIFICATIONS FOR MORE INFORMATION.

A MINIMUM SOIL DEPTH OF 12 INCHES SHALL BE USED TO PROVIDE FLOW CONTROL AND A MINIMUM SOIL DEPTH OF 18 INCHES SHALL BE USED TO PROVIDE RUNOFF TREATMENT IN ACCORDANCE WITH WASHINTON STATE DEPARTMENT OF ECOLOGY REQUIREMENTS.

SOIL DEPTH, SUB–SURFACE DEPTH AND FREEBOARD MUST MEET LOCAL JURISDICTION DESIGN STANDARDS.

BIORETENTION SOIL MEDIA MUST MEET DESIGN STANDARDS SPECIFIED IN THE LATEST EDITION OF THE WASHINGTON STATE DEPARTMENT OF ECOLOGY'S STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON.

MANAGEMENT OF SURFACE SOLIDS

STORMWATER SHALL OPTIONALLY PASS VIA PERMEABLE PAVEMENT FOR ADDED (OPTIONAL) INFILTRATION PRIOR TO DISTRIBUTION THROUGH THE StrataCell SYSTEM.

REGULAR REMOVAL OF SOLIDS WILL BE REQUIRED FROM THE SURFACE OF THE PERMEABLE PAVEMENT. THIS WILL ENSURE INFILTRATION CAN BE MAINTAINED AND SERVICE LIFE OF THE SYSTEM CAN BE EXTENDED. A STREET SWEEPER OR EQUIVALENT SHOULD ADEQUATELY REMOVE SOLIDS FROM SURFACE

AutoCAD FILE.

CIVILCAD FILE.

DISCLAIMER: ALL FOUNDATION DETAILS TO BE VERIFIED BY QUALIFIED PROJECT ENGINEER. THE MANUFACTURER DISCLAIMS LIABILITY RESULTING FROM ANY LOSS OR DAMAGE INCURRED FROM THEIR PRODUCTS, OR THEIR INSTALLATION METHOD, EITHER DIRECT OR CONSEQUENTIAL.

No.	Date	Amendment Details	Initial

No.	Date	Amendment Details	Initial

citygreen URBAN LANDSCAPE SOLUTIONS
transforming grey spaces into green

Client: CITYGREEN URBAN LANDSCAPE SOLUTIONS

Surveyed by:	–
Geotechnical by:	–
Datum: –	Coord: –
Designed: –	Checked: –
Drawn: –	Approved: –

Job Name: WSUD TREEPIT SYSTEMS
STANDARD DETAIL FOR WESTERN WASHINGTON

Scale: AS SHOWN Dwg No.

Title: STRATACELL TREEPIT (SQUARE) WITH OPTIONAL PERMEABLE PAVEMENT

Sheet No. 1 OF 1 Amdt.