

Stratavault™

Modular Soil Cell System including operation
as Strataflow™ stormwater BMP

INSPECTION, MAINTENANCE & REPAIR MANUAL



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1 Introduction

This document explains how to operate, maintain, and repair your Stratavault™ soil cell system: an engineered soil vault system designed to ensure that trees can flourish in demanding urban environments. The patented system provides structural surface support while establishing critical space for tree roots to grow and for soil to remain uncompacted, drainable, and properly aerated.

The system is primarily comprised of multiple columnar support modules that are interlocked to form a rigid structural matrix. The base of the matrix sits on a compacted rock subbase, with the middle section filled with soil media, and the top of the structure forming a deck suitable to support surfaces such as sidewalks, roads, or flower beds. Depending on the application requirements, the system can include water distribution, aeration, and drainage piping systems, as well as filtration media and stormwater intake screening.

1.1 Operation - How Strataflow™ Systems Work

From stand-alone bioretention street trees (*Figure 1*) to complete stormwater treatment and storage systems (*Figure 2*), Strataflow systems can be designed as needed with multiple inflow and outflow configurations. While there are multiple design configurations, each system utilizes the same flow pathways. Water flows into the system either actively through an onsite irrigation network connection or passively through surface run-off, infiltration through permeable pavement, or via piping connected to stormwater drains or catch basins. Excess water can infiltrate into the surrounding environment or outflow through a perforated drainage pipe connected to a standard stormwater piping.

Inlet Configurations

Active Water Sources

The water distribution pipe is directly connected to an onsite irrigation network.

Passive Watering Sources

1. Surface Runoff: Stormwater flows off of hard surfaces and into the top of the treepit.
2. Permeable Pavement: Stormwater flows into the treepit by seeping through porous pavement, which acts to filter the water.
3. Stormwater Pipe Connection
 - The inlet drainage piping is directly connected to a stormwater grate or other type of catchment basin.
 - This connection includes a removable and cleanable intake filter to trap trash and other debris.
 - The drainage pipe is typically installed in the upper layers of the soil vault, with sections of the pipe perforated to allow stormwater to seep into the soil.

Outlet Configuration

Drainage piping that is connected to an outside stormwater drain.

Figure 1. Stand-alone Stratavault™ Treepit System



Figure 2. Strataflow™ Raingarden Stormwater Treatment/Storage System

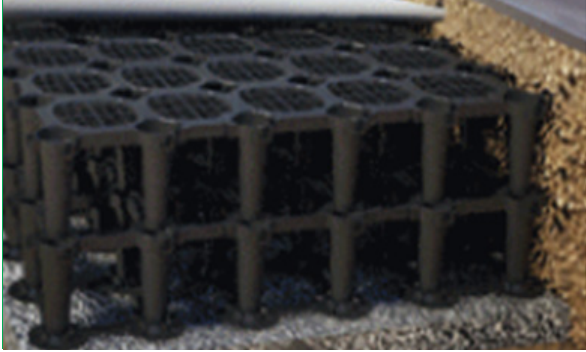


1.2 System Components

Depending on the application requirements, the Strataflow System can be configured with one or more of the following components.

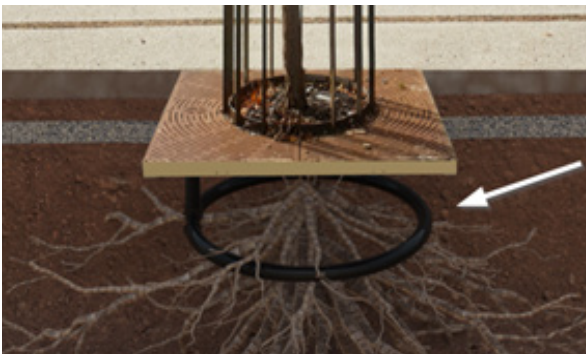
Stratavault™ Cells Modules/Matrix

Comprised of several interlocked load-bearing modules, this matrix gives structural support to pavements & traffic loads. It also provides essential voids for uncompacted soil, tree roots, service pipes & conduits, and aeration & drainage piping.



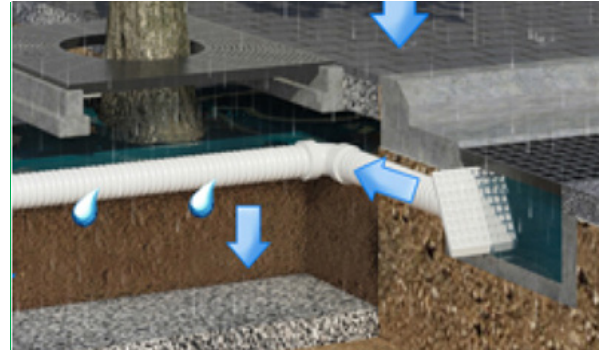
Snorkil™ Rondo & Plaza Aeration and Irrigation Piping System

A perforated piping system that circulates air and distributes water and nutrients. It is connected to the tree grate and accessible via a hinged lid. It includes a double-barbed pipe connection, enabling connection to multiple types of irrigation piping systems.



Stormwater & Drainage Piping System

This system directs stormwater through the treepit system in order to irrigate the tree and to filter stormwater.



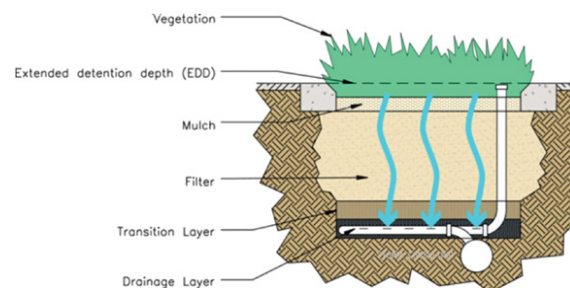
Permeable Pavement

Used to collect rainwater by allowing it to pass through permeable pavers before draining into the treepit.



Filter Media

Layers of soil/aggregate mix designed to filter stormwater and provide plant growing media, with the specific materials varying per site conditions and plant species.



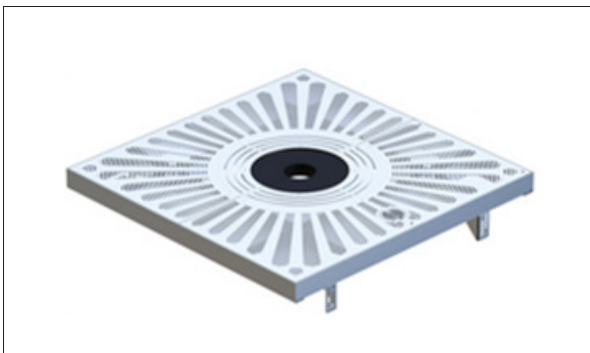
Tree Anchors

Secures and stabilizes the tree Rootball. Tree anchors have different configurations that depend on the application requirement, with some anchor systems including a guy fixing system.



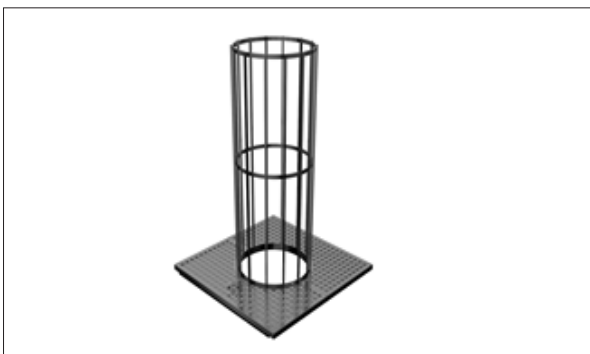
Invisigrate™ Tree Grate

Protects the tree rootball from compaction by distributing surface loads to the surrounding pavement. Additionally, it allows air and water to enter into the soil while keeping out trash and other debris.



Tree Guard

Protects the tree from vandalism and impacts from vehicles and equipment..



2 System Inspection and Maintenance

The following section provides general recommendations for operating and maintaining a Strataflow System. Refer to project-specific documentation and plans for requirements specific to each system.

Maintenance activities will change over the lifetime of the system. These maintenance activities are categorized into two major phases: 1) Establishment Phase and 2) Long-term Phase. **Please see Table 1 for more details.**

Establishment Phase Maintenance | 0 – 24 Months

This phase comprises the construction of the treepit system and the surrounding civil infrastructure, the planting of the tree and other vegetation, and the first 18 – 24 months of tree growth.

Construction Phase Maintenance

Protect the system from high sediment loads caused by construction activities adjacent to the treepit.

It is very important to prevent sediment runoff caused by construction activities from entering into treepit, as this will clog the filter media. If contamination of fine sediment does occur on the surface, it may be possible to remove it manually. However, the filter media may need to be replaced if sediment contaminates deeper layers of the filter media.

Sedimentation Control Methods:

- Install an end-cap or plug on the inlet pipe.
- Place spill dikes or flood bags around the perimeter of treepit opening, raingarden, and permeable pavers.
- Before landscaping, cover the surface of the entire system with geofabric.
- Partition the entire treepit system and direct the sediment flow into a temporary sacrificial sediment forebay.

Plant Establishment Maintenance

1. Irrigation

Irrigate newly planted trees around the rootball as needed; typically required for the first 18 to 24 months.

Note: Irrigating in Arid Environments

Two separate irrigation circuits—as designed by an irrigation designer—are recommended for installations in arid environments. Install one temporary circuit to irrigate the tree rootball for the first 2 years before closing it off; install one permanent circuit to irrigate the entirety of the matrix .

2. Inspection

The newly planted tree will need to be inspected every three months to ensure that it is adequately watered, drained, and structurally sound.

3. Tree Anchors

New trees need to be anchored. The Platipus Rootball anchoring system can be used to secure young trees in place without the need for tree stakes. Some models are equipped with a guy wire fixing system; these wires may need to be adjusted as needed to maintain tension.

Long Term Maintenance | 2 – 20+ Years

This phase includes long-term maintenance activities to ensure that the system structure and tree life can last for years to come. Please refer to Table 1. for detailed maintenance procedures.

1. Structural Maintenance

Periodically inspect the system infrastructure components for damage, erosion, and drainage performance. Refer to Table 1. for details.

2. Horticultural Maintenance

Inspect the health of the trees and other vegetation, looking for signs of pests, disease, weeds.

3. Filter Media Maintenance

Remove litter, debris from the surface, and clean-out permeable pavers per manufacturer recommendations.

Winterization

For installations that experience freezing weather conditions, use pressurized air to remove all water from the system piping to prevent damage caused by water expansion.

Table 1. Recommended Maintenance Tasks and Intervals

| MAINTENANCE TASK | RECOMMENDED TOOLS | PROBLEMS & SOLUTION | FREQUENCY |
|--|--|--|---|
| Inspect stormwater collection/drainage piping for blockage at the inlet and outlet. | Pressurized water jet or pipe rod to clear piping. Pipe camera to inspect the piping system for blockage. | Problem: <ul style="list-style-type: none"> Debris trapped in piping or filter. Solutions: <ul style="list-style-type: none"> Clean pretreatment filter. Remove the blockage by using a water jet or pipe rod. | Annually and after major storms. |
| Inspect inlet and outlet structures for signs of erosion. | Grate Hook to remove and replace small, light grates. Manhole Lifting Dolly to remove and replace large, heavy grates | Problems: <ul style="list-style-type: none"> High stormwater inlet velocity Sharp hydraulic drops Solutions: <ul style="list-style-type: none"> Add rockwork as needed to slow velocity and smooth out hydraulic drops. | Annually |
| Inspect the system for damaged components | Varies. See Repairing Strataflow Matrix Components for more details. | Problems: <ul style="list-style-type: none"> Errant traffic Vandalism Solutions: <ul style="list-style-type: none"> Replace damaged components. Consider installing bollards to prevent future occurrences. | Annually |
| Inspect Treepit opening for standing water, trash, and other debris | Rakes, shovels, wheelbarrow | Problems: <ul style="list-style-type: none"> Errant traffic Solutions: <ul style="list-style-type: none"> Remove debris, as necessary. If there is standing water, make sure that the outlet is draining correctly. | Seasonally and after major storms. |
| Trees & Vegetation | Please refer to the tree supplier for recommendations on care and maintenance activities. | | |

3 Repairing Stratavault Matrix Components

Recommended Items:

- As-Built Drawings & Documentation
- Ground Penetrating Radar Equipment
- Hand tools: Shovels, wheelbarrows, rakes, and utility knives.
- Backhoe
- Vacuum Truck
- Soil Storage Equipment

Warnings:

- Do not exceed the maximum surface loading of the Stratavault matrix.
- Do not place heavy surface loads, such as heavy equipment, on an exposed matrix.

3.1 Accessing & Removing Stratavault Modules to Perform Structural Repairs or Utility Work

The following steps describe how to access and remove sections of the Stratavault matrix, such as when adding utility services or when there has been structural damage to the matrix.

1. Precisely locate and outline the extent of the Stratavault matrix by referencing as-built records and/or by using a ground-penetrating radar.
2. Carefully remove the surface treatment, making sure not to exceed the maximum surface loading above the matrix.
3. Once surface treatment has been removed, use hand tools to remove the aggregate and expose the geogrid layer attached to the top deck of the matrix.
4. Use a utility knife to cut and remove the geogrid layer, making sure not to damage the underlying cell modules.
5. Remove the module decks.
6. Remove the soil media using hand tools and/or a vacuum truck. *Note: If the soil is to be re-used, make sure to store it such that it does not become contaminated.*
7. Once the soil is completely removed, disassemble and remove the modules by hand, doing so by disconnecting the module lateral connectors. *Note: Freezing temperatures may require that the modules be removed mechanically using an excavator or backhoe. This type of removal will destroy the modules and thus may need to be replaced.*

3.2 Backfilling a Trench After Removing Stratavault Modules

When it is not possible to replace Stratavault modules that have been removed due to damage or utility work, it will be necessary to backfill the excavated section with non-shrinkable aggregate. This backfilled section must be constructed such that it reinstates both the lateral and vertical support load capacity of the removed Stratavault modules, as well as the originally designed stormwater storage capacity.

Note: In order to meet Strataflow™ Stormwater system general requirements, there must be a 100 mm (3.94 in.) gap between the matrix deck and a surface treatment that has been designed to meet site load requirements.

Required Materials:

- Geogrid: ProGrid 20/20 or equivalent. Do not use filter fabric.
- Unshrinkable Backfill Material:
 - Can be poorly graded, single-sized durable crushed rock with a curving grade compatible with the aperture size of the geogrid.
 - Size must be no less than 13.2 mm (0.52 in.) sieve.
 - Backfill must be free of fine gravel, sand, and fines.

1. Line the exposed trench with geogrid, making sure to overlap the seams per manufacturer instructions.
2. Backfill the trench in layers of loosely placed and lightly compacted permeable gravel material. Depending on the trench depth, progressively add 80:20 loam soil into the gravel mix in order to encourage root development.
3. Fill the trench until it reaches the level of the growing media in the adjacent modules, taking care not to exceed this level. *Note: In order to meet Strataflow™ Stormwater system general requirements, there must be a 100 mm (3.94 in.) gap between the matrix deck and a surface treatment designed to meet site load requirements.*
4. Place geogrid over the exposed aggregate, making sure to overlap seams per manufacturer instructions.
5. Fill with aggregate base course and replace pavement or surface treatment as required.

3.3 Repairing a Stratavault Matrix

The following section describes how to replace sections of a Stratavault matrix that have been removed due to damage or during utility work. Please refer to Section 3.1 for instructions on accessing the Stratavault modules.

1. Line the excavated section trench with geogrid per manufacturer instructions.
2. Replace the cell modules per the Stratavault Installation Specifications.
3. Replace the soil as per the site requirements, matching the soil in the existing matrix. Fill the soil to the same height as the surrounding matrix soil level.
4. Place geogrid on the surface of the matrix deck. Place geogrid over the exposed aggregate, making sure to overlap seams per manufacturer instructions.
5. Replace aggregate over the surface of the geogrid, filling it until level with the adjacent fill levels.
6. Install pavement or other surface treatment per manufacturer instructions or best practices.

3.4 Replacing a Tree

1. Remove any structure around the tree, including the tree grate and tree guard.
2. Remove mulch and excess soil with hand tools.
3. Remove soil using hand tools and/or a vacuum truck. Note: Do not cut or otherwise damage the Stratavault modules during this process.
4. Coordinate with a skilled arborist to remove the tree.
5. Once the tree has been removed, add new soil at 85 – 90% compaction in order to prevent the replacement tree from settling.
6. Place root barrier around the new soil and surrounding trench.
7. Plant the replacement per arborist recommendations and applicable tree planting specifications.
8. Cover with 51 mm (2 in.) of mulch and replace the tree grate and tree guard.

4 Service & Warranty Information

Stratavault™ / Stratacell™ Warranty by Citygreen™

Citygreen™ warrants to the original purchaser of its Citygreen Stratacell™ SC250 product ("product") and Stratavault™ SV400 product ("product") that at the date of purchase such product will be of merchantable quality, and perform to Citygreen's written specifications for the Product for a period of 20 years when the product is installed and used as specifically provided for in the Citygreen installation guidelines for the Product.

This warranty does not apply to normal wear and tear of the product, nor does this warranty apply to the extent that any failure of the Product to comply with any part of the warranty is caused by abuse, misuse, mishandling, improper assembly, unauthorized alterations or modifications to the product, accident, lack of reasonable care of the Product, or failure to install the Product in accordance with Citygreen's specifications, instructions, manuals and other written material made available to the purchaser of the Product.

For the avoidance of doubt, authorized alterations or modifications to the Product mean the cutting of lateral members of the Product only and provided that such alterations or modifications to the lateral members of the Product have been clearly recorded and documented in Citygreen's Smart Certify QA system (Smart Certify) and subsequently approved by Citygreen via Smart Certify.

This warranty does not apply to events and conditions beyond the control of Citygreen, including, without limitation, ground subsidence and/or settlement, earthquakes, floods, fire, and other natural events, actions of third parties, acts of God and/or Force Majeure.

In the event of a breach of this warranty, Citygreen will provide a replacement Product. Citygreen will not be liable for incidental costs, including, without limitation, removal of the original Product, delivery, installation of the replacement Product, associated labor and equipment costs, and the cost of, and incidental to, other materials and expenses not covered by this warranty.

Citygreen makes no other warranties, express or implied unless the exclusion of such warranties is prohibited by statute. Citygreen shall not be responsible, either in tort or in contract, for any direct, indirect or consequential damages, loss of profits, loss of revenue, loss of use, or any breach of any express or implied warranty, except where such warranty cannot be excluded by statute.

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