DEEPROOT SILVA CELL

RESTORING ECOSYSTEM SERVICES TO THE URBAN ENVIRONMENT

INTEGRATED TREE, SOIL AND STORMWATER SYSTEM
The Silva Cell is a modular building block for containing unlimited amounts of healthy soil beneath paving while supporting traffic loads and accommodating surrounding utilities. The Silva Cell is filled with high-quality, uncompacted soil to grow trees and manage the rate, quality and volume of stormwater. The modular system can be easily sized to accommodate the needs of any site without compromising effectiveness or site design.

By combining on-site stormwater management with expanded rooting volumes for healthy tree growth, Silva Cells create an unparalleled ability to restore ecological function to developed areas.

SOIL, TREES AND STORMWATER

Increasing attention is being paid to soil, and the conclusion is inescapable – soil matters. A Report by the National Research Council commissioned by the United States Environmental Protection Agency concludes:

“Nearly all of the associated problems [of urbanized watersheds] result from one underlying cause: loss of the water-retaining and evapotranspiring functions of the soil and vegetation in the urban landscape.”


The report goes on to state:

“Stormwater Control Measures that harvest, infiltrate, and evapotranspire stormwater are critical to reducing the volume and pollutant loading of small storms.”

2. Ibid. 8.

The Silva Cell integrates trees and soil with stormwater management, utilizing the proven capacity of soils to act as an underground bioretention system. When rainfall moves across impermeable paving, it picks up pollutants. As it is channeled off-site, it deposits these pollutants in oceans, lakes, rivers and wetlands. This non-point source runoff, a leading cause of urban pollution, is significantly mitigated by use of the Silva Cell. Through soil filtration, bioremediation and evapotranspiration, the Silva Cell treats stormwater directly on-site, restoring ecosystem services and saving money while protecting one of our most valuable resources.

SOIL IS CRITICAL TO THE LONG TERM SUSTAINABILITY OF DEVELOPMENT SITES.

Provide the basis for healthy vegetation, treat stormwater as a resource, and restore ecosystem services with the Silva Cell.

The more healthy soil is available to trees, the bigger they can grow – and the bigger a tree grows, the more significant environmental and social benefit it provides. USDA Forest Service research shows that a tree with a 30-inch diameter removes 70 times the pollution of a tree with just a 5-inch diameter. Typically, urban tree growth is stunted by limited access to soil and poor soil quality. Buckling sidewalks from roots are hazardous and a major cost to repair. The Silva Cell overcomes these challenges by providing unlimited soil volumes without compromising above ground surface area.

APPLICATIONS

The Silva Cell can be used in a wide variety of applications. Some of the most common are:

- STREETSCAPES AND PLAZAS
- BREAK-OUT ZONES
- PARKING LOTS
- GREEN ROOFS/ON-STRUCTURE
- GREEN WALLS

Each of these applications can be designed to optimize tree growth and stormwater management.

For more information on different types of Silva Cell applications see pages 7-8, or contact us at info@deeproot.com or (415) 781-9700.

HOW THE SILVA CELL WORKS

MODULAR DESIGN ACCOMMODATES ANY SITE

SUPPORT TRAFFIC LOADING WHILE PROVIDING UNCOMPACTED SOIL VOLUMES FOR LARGE TREE GROWTH AND ON-SITE STORMWATER MANAGEMENT.

Each Silva Cell is composed of a frame and a deck. Frames can be stacked one, two, or three units high before they are topped with a deck to create a maximum amount of soil volume for supporting tree root growth and stormwater management.

**Material Specifications**
- Fiberglass reinforced, chemically-coupled, impact modified polypropylene.
- Galvanized steel tubes.

**Frame Dimensions**
- Length: 48" (1200 mm)
- Width: 24" (600 mm)
- Height: 16" (400 mm)

**Deck Dimensions**
- Length: 48" (1200 mm)
- Width: 24" (600 mm)
- Height: 2" (51.5 mm)

**Capacity**
- Void capacity: approximately 92%
- Soil capacity: approximately 10 ft³ (0.28 m³)

---

**Diagram:**

- **Frame:** Steel reinforcing tubes
- **Deck:** Steel reinforcing tubes
- **Dimensions:** Length, Width, Height
- **Materials:** Fiberglass, Polypropylene, Galvanized steel
The Silva Cell can support vehicle loading up to AASHTO H-20 rating of 32,000 lbs. (14,500 kgs) per axle. This rating refers to the ability of a roadway to safely accommodate 3-4 axle vehicles, such as a large semi-truck and trailer.

The tables and associated paving conditions listed here are represented in our standard product details and specifications.

Loading standards vary worldwide and your particular project may have different needs. Please consult with Deep Root to review and optimize the use of the Silva Cell to your project requirements.

Physical load testing was completed by TRI Environmental in order to determine the ultimate allowable stress of the Silva Cell. The applied stress values from the applied loading on the pavement surface were determined using Sigma/W, a finite element program, for each of the design cases. These values were compared to the ultimate allowable stress (considering a minimum safety factor of 1.45). In all cases, the material self weight is used.

The values in the table to the right are the applied stresses due to various loading scenarios and are calculated based on having the ground surface loads dissipated through the pavement surface.

<table>
<thead>
<tr>
<th>Pavement Material</th>
<th>English Allowable Stress</th>
<th>Metric Allowable Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 cm pavers</td>
<td>146.8 kN/m² (kPa)</td>
<td>21.3 psi</td>
</tr>
<tr>
<td>2.5 cm sand base</td>
<td>146.8 kN/m² (kPa)</td>
<td>18.7 psi</td>
</tr>
<tr>
<td>30.5 cm of aggregate</td>
<td>129 kN/m² (kPa)</td>
<td>15.0 psi</td>
</tr>
<tr>
<td>4˝ of asphalt concrete</td>
<td>103 kN/m² (kPa)</td>
<td></td>
</tr>
<tr>
<td>4˝ of Portland Cement Concrete</td>
<td>103.4 kN/m² (kPa)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pavement Material</th>
<th>English Allowable Stress</th>
<th>Metric Allowable Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cm of asphalt concrete</td>
<td>146.8 kN/m² (kPa)</td>
<td>21.3 psi</td>
</tr>
<tr>
<td>10 cm of Portland Cement Concrete</td>
<td>146.8 kN/m² (kPa)</td>
<td></td>
</tr>
<tr>
<td>7 cm of aggregate</td>
<td>129 kN/m² (kPa)</td>
<td>18.7 psi</td>
</tr>
<tr>
<td>8 cm pavers</td>
<td>103 kN/m² (kPa)</td>
<td>15.0 psi</td>
</tr>
<tr>
<td>12.7 cm of Portland Cement Concrete</td>
<td>103.4 kN/m² (kPa)</td>
<td></td>
</tr>
</tbody>
</table>

TYPICAL H-20 AXLE LOADING AT THE PAVEMENT SURFACE

In the recommended allowable stress that can be applied to the deck and represents a minimum safety factor of 1.45 when compared to the ultimate allowable stress value.

Factor of Safety

<table>
<thead>
<tr>
<th>Pavement Material</th>
<th>English Allowable Stress</th>
<th>Metric Allowable Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Material</td>
<td>English Allowable Stress</td>
<td>Metric Allowable Stress</td>
</tr>
<tr>
<td>Pavement Material</td>
<td>English Allowable Stress</td>
<td>Metric Allowable Stress</td>
</tr>
<tr>
<td>Pavement Material</td>
<td>English Allowable Stress</td>
<td>Metric Allowable Stress</td>
</tr>
<tr>
<td>Pavement Material</td>
<td>English Allowable Stress</td>
<td>Metric Allowable Stress</td>
</tr>
</tbody>
</table>
The Silva Cell can be used in a wide variety of tree and stormwater management applications of any size.

Silva Cells make it possible for streetscapes, plazas and parking areas to support healthy, thriving trees without compromising above ground surface areas. They can act as a bridge, linking street tree roots up with nearby soil volumes like parks and lawns in break-out zone applications, and they can support green walls and green roofs to help transform otherwise under-utilized spaces into living resources.

The Silva Cell can be applied to different green building certification programs, including LEED and BREEAM. Please contact us at info@deeproot.com to learn more.

**STREETSCAPES / PROMENADES / COURTYARDS**

Streetscape and On-Structure (New York, NY)
- Total soil volume per tree: 820 – 1,000 ft³ (23 – 28 m³)
- Total Silva Cells: 1,150 frames, 390 decks
- Installation type: Trees
- Client: Lincoln Center Development Project

Recent renovations of Lincoln Center emphasize a truly green approach to development – the Bosque and streetscape applications utilize the soil volume provided by the Silva Cells to achieve that design vision.

Streetscape (Toronto, Canada)
- Total soil volume per tree: 688 ft³ (19.5 m³)
- Total Silva Cells: 260 frames, 130 decks
- Installation type: Trees and stormwater
- Watershed area treated: 8,288 ft² (770 m²)
- Water volume treated: 656 ft³ (18.5 m³)*
- Client: Toronto Water

Silva Cells were installed under a parking lane and sidewalk and filled with bioretention soil. Runoff from the roadway and adjacent buildings flows into the system for pollutant removal and tree growth.

*Based on a 1” (2.5 cm) storm event

Promenade (Vancouver, Canada)
- Total soil volume per tree: 883 ft³ (25 m³)
- Total Silva Cells: 7,000 frames, 3,500 decks
- Installation type: Trees
- Client: City of Vancouver

This Vancouver promenade will be part of the Athletes’ Village for the 2010 Olympic Games. The use of the Silva Cell to realize thriving and long-lived promenade trees will help showcase Vancouver’s focus on green technology.

Streetscape (Amersfoort, Netherlands)
- Total soil volume per tree: 400 ft³ (11.3 m³)
- Total Silva Cells: 54 frames, 17 decks
- Installation type: Trees
- Client: Heijmans

A private company installed Silva Cells to grow large, healthy trees to beautify an outdoor plaza area intended for employee use and enjoyment.

Courtyard (Devonshire, United Kingdom)
- Total soil volume per tree: 460 ft³ (13 m³)
- Total Silva Cells: 80 frames, 40 decks
- Installation type: Trees
- Client: Pitchﬁsh Landscape Design

Silva Cells were installed in a courtyard at the center of a commercial building to enhance its look and feel for patrons and the public.

Parking Lot (Lakeland, FL)
- Total soil volume per tree: 1,000 ft³ (28 m³)
- Total Silva Cells: 1,600 frames, 600 decks
- Installation type: Trees

The trees in this “big box” retailer parking lot had suffered for years from compacted soils, leaving them dead or in serious decline. A recent store renovation with a sustainable initiative added large soil volumes in Silva Cells underneath the new parking lot.

GREEN ROOFS

Green Roof (Vancouver, Canada)
- Total soil volume per tree: 268 ft³ (7.6 m³)
- Total Silva Cells: 20 frames, 20 decks
- Installation type: Trees
- Client: Eckford and Associates

This rooftop balcony tree has access to added soil volumes with the Silva Cell, creating a unique playspace for children and a focal point for the space. As the tree grows it will provide shade and a park-like environment on this south-facing balcony.

BREAK-OUT ZONES

Break-Out Zone (Richmond, Canada)
- Total soil volume per tree: n/a
- Total Silva Cells: 30 frames, 30 decks
- Installation type: Trees
- Client: City of Richmond

Taking advantage of large soil volumes in nearby open planting areas, this playground project used the Silva Cell as a bridge to help tree roots “break-out” of the immediate planting zone and thereby significantly increase soil volume at low cost.

These are just a few of the Silva Cell installations that have been completed.

For more information on these or other installations, please contact us at info@deeproot.com or (415) 781-9700.

PARKING LOTS

The Silva Cell can be used in a wide variety of tree and stormwater management applications of any size.

Silva Cells make it possible for streetscapes, plazas and parking areas to support healthy, thriving trees without compromising above ground surface areas. They can act as a bridge, linking street tree roots up with nearby soil volumes like parks and lawns in break-out zone applications, and they can support green walls and green roofs to help transform otherwise under-utilized spaces into living resources.

The Silva Cell can be applied to different green building certification programs, including LEED and BREEAM. Please contact us at info@deeproot.com to learn more.

**STREETSCAPES / PROMENADES / COURTYARDS**

Streetscape and On-Structure (New York, NY)
- Total soil volume per tree: 820 – 1,000 ft³ (23 – 28 m³)
- Total Silva Cells: 1,150 frames, 390 decks
- Installation type: Trees
- Client: Lincoln Center Development Project

Recent renovations of Lincoln Center emphasize a truly green approach to development – the Bosque and streetscape applications utilize the soil volume provided by the Silva Cells to achieve that design vision.

Streetscape (Toronto, Canada)
- Total soil volume per tree: 688 ft³ (19.5 m³)
- Total Silva Cells: 260 frames, 130 decks
- Installation type: Trees and stormwater
- Watershed area treated: 8,288 ft² (770 m²)
- Water volume treated: 656 ft³ (18.5 m³)*
- Client: Toronto Water

Silva Cells were installed under a parking lane and sidewalk and filled with bioretention soil. Runoff from the roadway and adjacent buildings flows into the system for pollutant removal and tree growth.

*Based on a 1” (2.5 cm) storm event

Promenade (Vancouver, Canada)
- Total soil volume per tree: 883 ft³ (25 m³)
- Total Silva Cells: 7,000 frames, 3,500 decks
- Installation type: Trees
- Client: City of Vancouver

This Vancouver promenade will be part of the Athletes’ Village for the 2010 Olympic Games. The use of the Silva Cell to realize thriving and long-lived promenade trees will help showcase Vancouver’s focus on green technology.

Streetscape (Amersfoort, Netherlands)
- Total soil volume per tree: 400 ft³ (11.3 m³)
- Total Silva Cells: 54 frames, 17 decks
- Installation type: Trees
- Client: Heijmans

A private company installed Silva Cells to grow large, healthy trees to beautify an outdoor plaza area intended for employee use and enjoyment.

Courtyard (Devonshire, United Kingdom)
- Total soil volume per tree: 460 ft³ (13 m³)
- Total Silva Cells: 80 frames, 40 decks
- Installation type: Trees
- Client: Pitchﬁsh Landscape Design

Silva Cells were installed in a courtyard at the center of a commercial building to enhance its look and feel for patrons and the public.

Parking Lot (Lakeland, FL)
- Total soil volume per tree: 1,000 ft³ (28 m³)
- Total Silva Cells: 1,600 frames, 600 decks
- Installation type: Trees

The trees in this “big box” retailer parking lot had suffered for years from compacted soils, leaving them dead or in serious decline. A recent store renovation with a sustainable initiative added large soil volumes in Silva Cells underneath the new parking lot.

GREEN ROOFS

Green Roof (Vancouver, Canada)
- Total soil volume per tree: 268 ft³ (7.6 m³)
- Total Silva Cells: 20 frames, 20 decks
- Installation type: Trees
- Client: Eckford and Associates

This rooftop balcony tree has access to added soil volumes with the Silva Cell, creating a unique playspace for children and a focal point for the space. As the tree grows it will provide shade and a park-like environment on this south-facing balcony.

BREAK-OUT ZONES

Break-Out Zone (Richmond, Canada)
- Total soil volume per tree: n/a
- Total Silva Cells: 30 frames, 30 decks
- Installation type: Trees
- Client: City of Richmond

Taking advantage of large soil volumes in nearby open planting areas, this playground project used the Silva Cell as a bridge to help tree roots “break-out” of the immediate planting zone and thereby significantly increase soil volume at low cost.

These are just a few of the Silva Cell installations that have been completed.

For more information on these or other installations, please contact us at info@deeproot.com or (415) 781-9700.
INTRODUCING DEEPROOT URBAN SOLUTIONS, PROFESSIONAL SUSTAINABILITY SERVICES.

We’re proud to announce Deep Root Urban Solutions, our professional sustainability services team, providing specialized support to architects, landscape architects, engineers and others. We specialize in integrating soil, stormwater, and tree growth into your project. Green infrastructure and sustainability goals are of increasing importance, and achieving these goals requires technical understanding and training in varied fields. We offer time savings on your project by contributing specialty services to help meet your project goals. Peter MacDonagh, ASLA, CSLA, is the Director of Science + Design for the Urban Solutions team. He heads a team of specialists including hydrologists, water resource engineers, tree and soil design specialists, and LEED-accredited professionals, all trained in green infrastructure. We deliver the most ecological and economical return to your site possible. Please contact us for a proposal or presentation.

Peter MacDonagh (ASLA, CSLA, RHS, ISA) is the author of the “Site and Water” portion of the State of Minnesota’s Sustainable Building Guidelines (B3) and completed the award winning Minnesota Soil Bioengineering Handbook for the Minnesota Department of Transportation. He is a Landscape Architect, Horticulturist and Arborist, and serves as an Adjunct Professor at the University of Minnesota.

THE FOLLOWING IS A PARTIAL LIST OF SERVICES. PLEASE LET US KNOW WHAT YOUR NEEDS ARE IF YOU DON’T SEE WHAT YOU’RE LOOKING FOR HERE.

Plans and Details
- Analysis of site plan and site details for efficient Silva Cell use, recommendations
- Analysis of existing Silva Cell layout plan, potential conflicts, recommendations
- Silva Cell layout plan from schematic design to construction documents
- Soil volume and Silva Cell calculations, including economic review of alternatives

Stormwater Design
- Analysis of site plan, site details, pavement details, for efficient Silva Cell use
- Calculations and stormwater modeling based on project components and infrastructure
- Silva Cell system design and layout from schematic design to construction documents
- Construction services (observation, inspection)
- Post Installation Evaluation (PIE) and long-term system evaluation
- Regulatory compliance, NPDES Phase II
- Total Maximum Daily Load (TMDL) Feasibility and Analysis

Tree and Soil Design
- Existing soil and drainage studies
- Planting space and planting soil design
- Tree size/soil volume calculations
- Construction services (observation, inspection)
- Species selection

Shop Drawings
- Independent desktop review of project construction support documents relating to Silva Cell design as requested by the contractor
- Custom, site-specific layout and detailing of Silva Cells, based on project construction documents, for contractor installation

Training
- Contractor training and workshops (in-house and remote)
- Professional training and workshops (in-house and remote)
- Complimentary lunch and learn opportunities, group presentations

NOTE: All Silva Cell layouts and details shall be reviewed and approved by project engineer. Please contact us for more information and to discuss the specifics of your project needs.