

NYC PARKS & RECREATION

GREEN ROOFS at FIVE BOROUGH

TECHNICAL SERVICES

June 30, 2010

In spring, 2007, the Five Borough Technical Services Division of the New York City Department of Parks and Recreation began a program of installing green roofs of various designs atop the Five Borough Complex on Randall's Island where it is headquartered. To date, the division, together with Parks' Green Apple Corps, has installed 18 systems covering over 20,000 square feet of roof on the west wing of the building.

Taken together, the systems installed at Five Borough will, arguably, comprise the fifth largest green roof in New York City. Moreover, Five Borough's is the only known green roof in the country to feature distinct systems side-by-side. These systems vary by types of growing medium, depth of growing medium, and plant selection.

Background

A green roof is, in essence, a thin layer of vegetation installed atop a traditional flat or pitched roof. The specifics of green roof design vary. However, all green roofs—at their most basic—include the following layers (from the bottom up): waterproofing layer(s), root barrier (to prevent the plantings' roots from growing through the roof), water retention/water drainage layer, growing medium, and plants.

Intensive green roofs are like traditional rooftop gardens and often provide social and recreational uses. They are capable of supporting varied types of plants, including shrubs and even trees. They have growing media (light weight soil or artificial soil mix) with depths of 6" and greater.

By contrast, extensive green roofs are much shallower. They are lighter weight systems that provide primarily ecological and economic benefits. Their growing media are typically less than 6". The plants that are likely to flourish on extensive green roofs include sedums, succulents, Alpine type plants, and certain grasses. Extensive green roofs contain fewer layers than intensive roofs and tend to require less maintenance.

The many benefits of green roofs include:

- Improving water quality: Green roofs reduce the amount of storm water run-off by 50 to 90% and reduce the peak flow rate of run-off. During a 1" rainfall, 100% water retention is achievable. In addition, green roofs filter out 95% of the cadmium, copper, and lead and 30% of the nitrogen and phosphorous in storm water. Storm water retention is also enhanced by the storm water tanks which store water until it is needed to water the plants.
- Mitigating the heat island effect: Green roofs cool the surrounding air and thereby reduce the temperature of the mass of hot air that hovers over cities during the summer. For example, on a 90° F day, a conventional black roof can attain a surface temperature of 150° F.
- Extending the service life of roofs: Green roofs extend the usable lives of roofs by 2 to 3 times (that is, to 40 or even 60 years) because they prevent many harmful ultra-violet rays from reaching roofing materials and because they reduce variations in roof temperature that cause thermal expansion and contraction stresses on roof assemblies.
- Conserving energy: Green roofs insulate the upper floors of buildings on which they are planted. They cool buildings through shading and their plants' evapotranspiration.
- Removing carbon dioxide from the atmosphere: The plants on a green roof convert atmospheric carbon dioxide, a greenhouse gas, into organic compounds, mainly sugars, by using energy from sunlight.
- Reducing air pollutants: Green roofs filter particulates from the air, including those that cause respiratory diseases.
- Reducing sound transmission and reflection: Green roofs can cut down the transmission of noise by as much as 5 to 45 decibels and reduce reflected sound by up to 30 decibels.
- Creating wildlife habitats: Green roofs attract insects, including butterflies and bees; birds; and even other types of vegetation creating biodiversity.
- Improving carbon dioxide/oxygen exchange: 1.5 square meters of vegetation on a green roof produce enough oxygen per year to satisfy the oxygen requirements of one person for a year.
- Improving aesthetics: Green roofs can be aesthetically pleasing adding beauty to residential and commercial buildings.

NYC Parks' 1st Green Roof



In the spring of 2007, Technical Services cautiously installed one pilot green roof system. It was the NYC Parks' Department's first. This 12" deep monolithic layered system is based on an extensive green roof design provided by Barrett Roofs. It measures 20' x 40' (800 square feet). Perhaps its most prominent feature is its growing medium: 6" of **GaiaSoil™**. GaiaSoil™ is a low density mixture of compost and recycled expanded polystyrene foam coated with pectin to make it water absorptive. When dry, it weighs only 10 lbs. per cubic foot. However, because GaiaSoil™ is structurally unstable and easily becomes windborne, a layer of jute mesh had to be installed atop the growing medium as soon as it was installed. Even at a depth of 12", the dry weight of this system is 14 lbs. per square foot and its wet weight is 25 lbs. per square foot. (The wet weight of a system is defined as the system's weight when it is supersaturated with water and cannot retain anymore.) The estimated cost of this roof is between \$25 and \$30 per square foot. This system is planted with nine (9) species of plants native to the New York City metropolitan area. They were purchased from the Greenbelt Native Plant Center on Staten Island.

2008 Green Roof Systems

In the spring and early summer of 2008, Five Borough Technical Services installed 6 variations of extensive green roof system designs and four atypical systems.



Two of these extensive roofs utilized 0.032 gauge aluminum trays that were fabricated in Technical Services' own Citywide Shops. Although all the trays are 2' long x 2' wide, **Tray System I** sports a 4" depth while **Tray System II's** were fabricated 6" deep. Both of these green roof systems are modular by design. The individual trays can be temporarily moved to provide easy access to the roof below if the waterproof roof membrane beneath the green roof needs to be inspected or repaired.

Each tray system measures 20' x 40' (800 square feet). Both systems use Rooflite™ growing medium, mainly a mixture of heat-treated clay and organic materials. Tray System I is planted with 440 sedum plugs and 2,000 square feet of sedum cuttings. Tray System II is planted with 1,520 sedum plugs. The plantings in both systems are from the same seven sedum species and were selected for their robustness, contrasting color and texture, and winter interest. A comparison of these two systems as time passes should provide an indication of the effect of growing medium depth on the hardiness of sedum green roofs.

Tray System I has a dry weight of 14 lbs. per square foot and a wet weight of 25 lbs. per square foot. Tray System II has a dry weight of 22 lbs. per square foot and a wet weight of 34 lbs. per square foot. The estimated cost to furnish and install Tray System I is \$22 to \$28 per square foot. The analogous cost for Tray System II is \$24 to \$30 per square foot.



Another modular system installed during spring 2008 consists mainly of **Green Paks™** manufactured by Green Roof Blocks of Florissant, Missouri. Green Paks™ are bags made of high density polyethylene that is weaved. The bags measure 20" x 32" x 4" deep. They are filled with a proprietary growing medium consisting of 80% expanded shale and 20% organic composted pine bark. Green Paks™ were shipped to Technical Services filled with this medium. They were transported to the Roof and then set in place atop a root barrier and drainage mat. Then Green Apple Corps members cut holes in the polyethylene and inserted six (6) sedum plugs per bag. The Green Paks™ system measures 800 square feet. It cost about \$22 to \$28 per square foot to furnish and install. Its dry weight is 12 lbs. per square foot and its corresponding wet weight is 18 lbs. per square foot.



Technical Services planted a fourth modular green roof system last year using **BIOTrays™**, a product of Green Roof Solutions. BIOTrays™ are 17" x 17" x 3" deep trays made of coconut husk fiber. They were purchased empty and then filled with mineral soil and planted with three selected varieties of sedum. Eventually, the BIOTrays™ will break down to form a monolithic system and their decaying components will nourish the mineral soil by providing additional organic matter. The BIOTrays™ cover an area that is 10' x 20' (200 square feet). The approximate cost to furnish and install this system is \$20 to \$26 per square foot. When dry, the BIOTray™ system weighs 12 lbs. per square foot; when saturated with water, it weighs 19 lbs. per square foot.



Last spring Technical Services also installed a shallower version of the GaiaSoil™ system it installed in 2007. Dubbed **Layered System II**, its overall depth is 7" (5" less than the original GaiaSoil™ system). Like its predecessor, Layered System II is monolithic and covers a 20' x 40' (800 square foot) area. It is planted with 825 native plants of 10 species. Layered System II has the lowest dry weight of any system Technical Services has installed to date: 8 lbs. per square foot. Its wet weight is 19 lbs. per square foot. The estimated cost to furnish and install this system is \$17 to \$23 per square foot.



Technical Services also experimented with an extremely simple system last spring. It installed five 10' x 12' x 5" deep plots that consisted of an EPDM roof protection layer covered with Metro-Mix 510 growing medium—a medium usually used in container gardening—and surrounded by wood framing. Unlike every other standard extensive green roof Technical Services installed, this monolithic system does not have a drainage layer. It is planted with 3 species of native plants. Its dry weight is 11 lbs. per square foot and its wet weight is 19 lbs. per square foot. The system costs about \$15 per square foot to furnish and install. This “**Container Growing Medium**” system should provide an indication of how well a green roof can function without a drainage layer and whether one can flourish in a medium not specifically designed for green roofs.



Last summer Five Borough Technical Services also installed a number of atypical “green roof systems.” It built 20 **cedar planter boxes** measuring 3'-0" x 3'-0" x 2'-4" high. The boxes were filled with Metro-Mix 510 growing medium, a 3 gallon size Mugo Pine, Sedum Sieboldiana and Sedum Acre.

Other atypical systems include an **overhead trellis** with a surface area of 650 square feet, but a roof foot print of only 90 square feet; a wood parapet system along the atrium parapet wall; and a metal parapet wall along the west wing’s perimeter.

Also, **elevated planters**, were installed which are used to store extra plants material for fill-ins and are being utilized for a community garden for the office staff.



May 2009 we installed a 2" deep, **Xero Flor Green Roof System** which is an ultra-extensive system developed in Germany. It is comprised of a pre-vegetated sedum mat, water retention fleece, a drainage layer, and a root barrier. Technical Services will install 6,350 square feet of this monolithic system atop the roof of the vehicle maintenance garage. Extremely light, this system's dry weight is only 8 lbs. per square foot and its wet weight is 14 lbs. per square foot.



June 19th, 2009, Technical Services will install its first pre-vegetated modular system. **GreenGrid® modules** measure 2' x 2' x 4" deep. They are delivered pre-planted with sedum after container size and plant varieties were selected. Each module contains its own built-in root barrier and drainage/water retention features. Technical Services will install 800 square feet of this system. Its dry weight is 10 lbs. per square foot and its wet weight is 14 lbs. per square foot.



June 2009 we install a **green wall system**. Not a green roof system per say, but with many of the same attributes, this will be another first for Technical Services and the Agency. Upon purchasing the raw materials—20" x 20" x 2" plastic grid trays, mineral soil and three different varieties of sedum—the 12 wall panels were constructed this winter within the confines of the Bronx Green House in Van Cortland Park. When the weather permits, this vertically installed system will grace our roof top staircase walls. Units purchased from ELT Easy Green www.eltlivingwalls.com. Trays cost \$70.- each. Plants, plugs and mineral soil costs \$27.- per square foot.



Photo July 09



Photo September 09

June 2009, we installed 650 square feet of another very light weight systems planted with wild flower seed. This wildflower system features a growing medium developed by Five Borough. An 80/20 mix of Metro-Mix 510 (a conventional container growing medium) and Perlite (heated-expanded volcanic material) makes the medium very light weight. Unlike all other systems atop Five Borough, this wildflower system was planted from seed. Once the seeds were planted, jute mesh was placed over the system to prevent wind erosion. The dry weight of this system is 15 pounds per square foot and the wet weight is 29 pounds per square foot.



Also this spring 2009, we installed 800 square feet of a walk able green roof systems planted with sedum and Walk able grass. The atrium system is Five Borough's first walkable green roof. It was installed 4" deep (extensive) with nearly 500 square feet of planted area. The plants were carefully selected to tolerate fluctuating amounts of sun and shade caused by the seasonal changes in the angle of the sun. These plants, creeping myrtle, red wing phlox, and candy stripe phlox, were placed in the non-walkable area while tall fescue was selected for the traffic area due to its resiliency to foot traffic.



October 2009, a 400 square foot Multi Depth Mineral Soil system with Sedum plants and Sedum cutting was installed. This system will show the different growth rates of Sedum in the same bed at different depths of mineral soil. Both the plants and cuttings will be compared. And finally the settlements of mounded mineral soil show how Sedum cutting can help maintain different swales in mineral soil. The average weight is 35lb per square foot and the cost is \$10.-/sf.



April/May 2010, a 4000 square foot Vegetable Roof Garden was installed. 10 - 50 foot long by 6 foot wide planting beds was installed. The growth medium composed of 1/3 mineral soil, 1/3 perlite and 1/3 compost/manure varies in depth but averages out to 7.5 inches. The vegetable planted 12 inches on center are tomatoes, peppers, muskmelons, squash, pumpkins, cabbage, spinach egg pants and herbs. Average weight is 18 lbs/sqft at a cost \$15.-/sqft.



May 2010, Columbia Students 400 sqft test area using 8” Gaia Soil planted with Native plants. This system was installed by student who had no installation experience and they designed the system.



June 22nd, 2010 we installed a 3" deep, **Xero Flor Green Roof System** which is an ultra-extensive system developed in Germany. The same system as the 2” Xero Flor but 1” of mineral soil is placed below the pre-vegetated mat. It is comprised of a pre-vegetated sedum mat, 1” of mineral soil, water retention fleece, a drainage layer, and a root barrier. Technical Services will install 6,350 square feet of this monolithic system atop the roof of the vehicle maintenance garage. Extremely light, this system’s dry weight is only 8 lbs. per square foot and its wet weight is 14 lbs. per square foot.

Future projects

- Bio Roof – an organic based system. Both intensive and extensive.
- Investigating a growing medium that will incorporate recycled **material**, different types of recycled plastic; this growing medium will be housed in planters located on the garage roof.
- In conjunction with the Staten Island Native Plant Center, growing our own green roof **plant material** in various types of **growing media** in order to analyze the success of propagation and possible cost savings.
- Moss system. Light weight system
- Woven low profile sedum mats
- Lower level light weight Monolithic system with native plants.
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Links/publication with the Green Roof

October 2009 GOA Report - <http://globalwarming.house.gov/pubs?id=0011>

LI Sound Study 07-08 report - <http://www.longislandsoundstudy.net/pubs/reports/biennial.0708.pdf>

Daily news - http://www.nydailynews.com/lifestyle/2010/04/06/2010-04-06_high_ceiling_for_goin_green.html

NYC Parks Links http://www.nycgovparks.org/sub_about/go_greener/green_roofs.html

5 Boro Green Roof Handout Jan 2010 artie.rollins@parks.nyc.gov