A Spring 2007 Project of the UGA Environmental Practicum

Athens-Clarke County City Hall

Green Roof Proposal and Guide

ATHENS-CLARKE COUNTY CITY HALL

Green Roof Proposal and Guide

Tammy Andros (andros@uga.edu) 706-338-3089
Ted Maclin (tmaclin@uga.edu) 706-201-5816
UGA Environmental Practicum
April 2007

Section 4 (with below exception) was researched and written by practicum students Mike Kline and Barrett Malone. Section 4 *V. Liability for Stormwater Runoff* was researched and written by Emily Franzen, UGA River Basin Center.

This project is made possible, in part, by US EPA Clean Water Act 319 program funds, administered by the Georgia Environmental Protection Division, Non-Point Source Program. The University of Georgia River Basin Center is part of the UGA Institute of Ecology and is co-directed by Laurie Fowler and Ron Carroll. For questions regarding the Initiative or this report, please contact the project manager:

Christine Rodick
UGA River Basin Center
110 Riverbend Road
Athens, GA 30602
(706) 542-9745
christine.rodick@gmail.
http://www.rivercenter.uga.edu

Table of Contents

INTRODUCTION **1**

Questions and Answers 1
benefits and costs 2
Budget and Project Development 4
Maintenance 4
Roof Failures and Repairs 5

SITE DESCRIPTION AND PLANS **6**

Site Location 6
Site Design 8
Option #1: Loose Laid System 9
Option #2: Modular System 10
Budget 11
Option #1: Loose Laid System 11
Option #2: Modular System 12
Site Maintenance 12
Site Construction 13

ADDITIONAL INFORMATION **14**

Funding 14
Incentivizing Green Roofs in ACC 15
Green Roofs and Public Relations 17
opportunities for public educational 19
Social Learning Benefit 19
Signage 19
K-12 EducationalOpportunities 20
Information Sources 22
Other References 22

POTENTIAL LEGAL ISSUES **24**

I. ramifications of historic district designation 24
II. structural issues 28
III. potential issues of liability 28
IV. stormwater drainage issues 29
V. liability for stormwater runoff 31
VI. conclusion 32

GUIDELINES FOR FURTHER GREEN ROOF DEVELOPMENT **33**

Introduction 33
Site Evaluation Checklist 33

APPENDIX **35**

Abstract

The Athens-Clarke County (ACC) Unified Government is seeking to improve stormwater management practices in the downtown Athens area. They wish to install a green roof on the east balcony of ACC City Hall as a stormwater reduction pilot project. To assist the ACC unified government in this process, we have developed (1) a site plan for a green roof on the east balcony of City Hall including options for layouts, plant materials, etc.; (2) text describing (a) project budget and potential funding sources, (b) physical issues such as construction materials, weight limitations and structural needs, potential for roof failure and associated repair, (c) benefits of a green roof program and risks to avoid; (d) legal issues including compliance with local historic preservation ordinances and building warranties, and (e) opportunities for public education; and (3) guidelines that ACC can use to evaluate future green roof projects.

Section 1

Introduction

A green roof for the Athens-Clarke County City Hall may be the first step to downtown stormwater reductions.

The Athens-Clarke County (ACC) Unified Government is seeking to improve stormwater management practices in the downtown Athens area. They wish to install a green roof on the east balcony of ACC City Hall as a pilot stormwater reduction project. Stormwater runoff is a major contributor to nonpoint-source pollution and flood risk. Green roofs provide stormwater reduction as well as numerous other benefits—ecological, economic, social, and educational—which make them logical additions to public buildings. As part of the University of Georgia's Environmental Practicum, we have developed this proposal to outline specific potential benefits, costs, and risks of green roofs and to provide a plan for a green roof on the Eastern balcony of the ACC City Hall building.

ACC officials have mentioned the possibility of installing other green roofs on public buildings in the downtown area, and much of the information in this proposal will be useful for consideration in developing other sites. The first section of the proposal includes general information on green roofs, taken largely from the work of UGA River Basin Center faculty member Tim Carter, PhD, who studied green roofs for his dissertation and built the first green roof in Athens. The second section of the proposal includes the site description, site plans, materials, and budgets. Section three includes information on possible funding sources, and educational and public relations possibilities related to green roofs. Section four discusses legal issues related to this proposal. Section five is a set of guidelines for the development of additional green roofs in the downtown area.

Green Roof Questions and Answers

Q: What is the difference between an extensive green roof and an intensive green roof?
A: Extensive green roofs use a thin substrate layer has a growing media and small plants to reduce load. Because they are lighter, they are often used to cover extensive areas. They are also easiest to maintain. Intensive green roofs are more like rooftop gardens, using much deeper soil. They have the same maintenance needs as any other garden. There are also semi-intensive roofs, which fall between

those extremes. Always consult with a structural engineer to be sure a specific roof is suitable.

Q: What are the structural loading requirements for installation of an extensive green roof?
A: Extensive green roofs weigh between 10 and 35 lb/square foot.

Q: What is the difference between a loose laid green roof system and a modular green roof system?
A: Loose laid or built-up systems involve the separate installation of the components of a green roof assembly, and products often come from multiple companies. Modular systems combine components of a green roof assembly into one product, usually contained in a plastic tray.

Q: What about maintaining the roof?
A: Green roofs should include walkways for maintenance access. Maintenance of the "green" portion of the roof is generally low, since drought-tolerant, cold-hardy plants are used. Maintenance of the underlying roof is actually lower in the case of green roofs, since the plantings on the roof act as protection. In the event that the roof itself does require maintenance, the plantings on the roof can be lifted away and later replaced. For more information, see Maintenance, page 4.

Q: Do green roofs need fertilizer?
A: That depends on the plants and growing media used, but for drought-tolerant extensive green roofs in general, no.

Q: What types of plants are used on an extensive green roof?
A: There are many choices, but drought- and cold-tolerant plants such as *Sedum*, hens-and-chicks, *Delosperma*, and ornamental onions are preferred.

Q: How visible will the green roof be from the ground?
A: As visible or invisible as you want it to be. Visibility from the ground is a function of plant height and soil depth, and suitable green roof plants come in heights from a few inches to a few feet.

Green Roofs: Benefits and Costs

The adoption of green roof systems can have numerous benefits, as summarized in Table 1. While some benefits, such as a reduction in the size of required storm sewer pipes, are dependent on wide-scale green roof adoption, other benefits may be recognized at a smaller scale. A summary of generalized green roof costs and benefits (Table 2) and green roof construction costs (Table 3) follow. The financial costs and benefits of a green roof are proportional to the scale of the roof. For a small installation, like the proposed roof on the east balcony of the ACC City Hall, the greatest benefit may be as proof-of-concept for future construction, since actual cost savings on such a small roof will be minimal.

Table 1: Benefits of Extensive Green Roof Systems (From Carter 2006)

Category	Benefit
Construction and maintenance	-extends the roof life
Stormwater management	- may reduce storm sewer pipe size - reduces need for alternative stormwater BMPs - may reduce stormwater utility fees
Energy and insulation	- additional insulation - energy savings
Air quality	- nitrogen oxide uptake
Habitat/greenspace	- increases bird and insect habitat
Urban heat island	- reduces ambient air temperatures

Table 2: Costs and Benefits per square meter of roof (From Carter 2006)

	Year	Unit values ($/m^2)
Cost		
Traditional roof construction and maintenance	0 and 20	83.78
Green roof construction and maintenance	0	155.41
Social benefits (Green Roofs)		
Avoided stormwater BMP cost	0	9.06
Energy	1-40	0.37
Air quality	1-40	0.11
Private benefits (Green Roofs)		
Stormwater utility fee credit	1-40	0.04
Energy savings	1-40	0.37
Air quality	1-40	0.11

Table 3: Generalized Additional Green Roof Construction Costs (from Carter 2006)

	Cost range ($/m^2)
Specialized roofing material	5.92 – 32.61
Growing media	5.62 – 6.78
Plants (21 plugs/m^2)	9.69 – 10.12
Crane rental	14.90
Labor	7.84
Total	**43.97 – 72.25**

Budget and Project Development

The design process for a green roof project is full of possibilities and depends on the needs and goals of the green roof system. Each green roof project is different and can be very complex. This type of project requires professionals from many different fields to ensure success. These professionals may include the following actors: architect, landscape architect, structural engineer, civil engineer, environmental engineer, roofing consultant, horticulturist, general contractor, landscape maintenance contractor, and irrigation specialist. Greenroof construction requires coordination and cooperation across these diverse disciplines.

Project goals should be established in a pre-design phase when the client and designer discuss desired benefits and features for the green roof design. Costs may vary significantly due to regional differences. For example, the types of materials needed for the green roof project vary because of temperature and average rainfall. Whether there is local availability of greenroof products or not can significantly impact a budget due to freight costs alone. To save money on transportation costs, and in following with the principles of sustainable development, it is best to source products from as close to the project site as possible. When possible, local companies or those with southeast regional offices were contacted for the purpose of this project.

The budget development section and cost estimation information from *Green Roofs for Healthy Cities Greenroof Design 101 Introductory Course Participant Manual* is the best currently available. This information is included in the Appendix as a guide for ACC to use to develop a budget for future green roof projects.

Green Roof Maintenance

All roofs require regular maintenance whether they are green or conventional. In the case of a green roof, plant failure is the initial concern because of the harsh environment of a rooftop. Plants need time to become established to ensure long-term success. In times of severe drought in the plants will require water. The amount will depend on the type of plant material used and should be decided based on the advice of horticulturalists or grounds maintenance persons.

A maintenance plan should be designed as part of the initial design process. Some green roof projects are of such size, Chicago's Millennium Park for example, that one part of the green roof may be finished and require maintenance such as irrigation and other normal landscape services while the remainder is still under construction.

Roof Failures and Repairs

According to Steven Peck, Director of *Green Roofs for Healthy Cities,* green roof failures are extremely rare and are typically minor (such as some plant replacement).

The only major roof failure discussed by Mr. Peck was due to an engineering error that did not account for a structural loading capacity issue, point loading of the materials during construction, which resulted in a partial roof collapse.

Other examples of roof failures are penetration of the waterproof membrane during or after green roof construction, major loss of plant material due to too much or too little water, and clogging of the filter fabric impeding drainage. Failures can be caused by faulty maintenance, construction or products.

Roof replacement strategies are a necessary part of the maintenance plan to prepare for the unlikely event of failure or other repairs. In the case of modular systems, a green roof contained in large trays, it is easy to lift and remove the modules to access the waterproofing membrane if maintenance or repair is needed. In the case of a loose laid system, a green roof that is laid on site in multiple layers, plants would need to be removed and stored in a greenhouse or nursery environment, growing media removed, and the underlying root barrier, drainage layer, filter fabric, etc. rolled up to get to the underlying waterproof membrane for repairs.

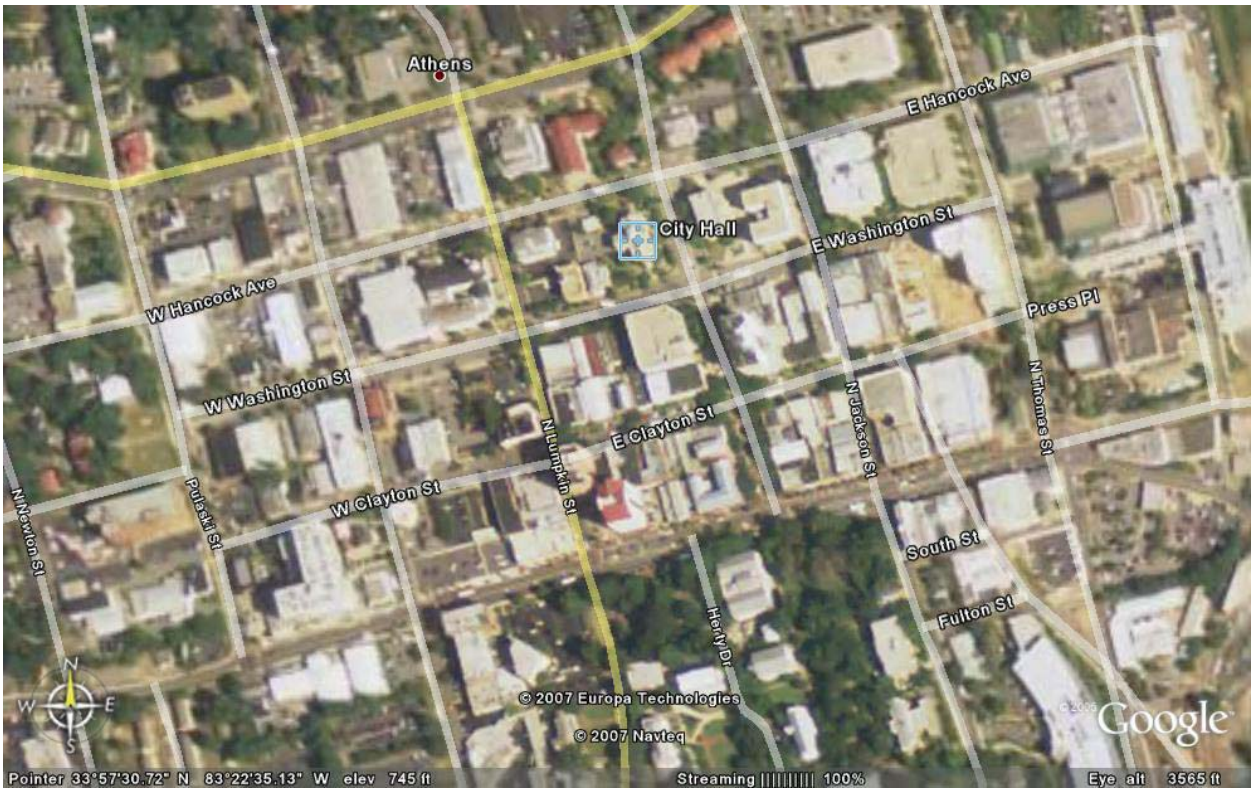
Section

2

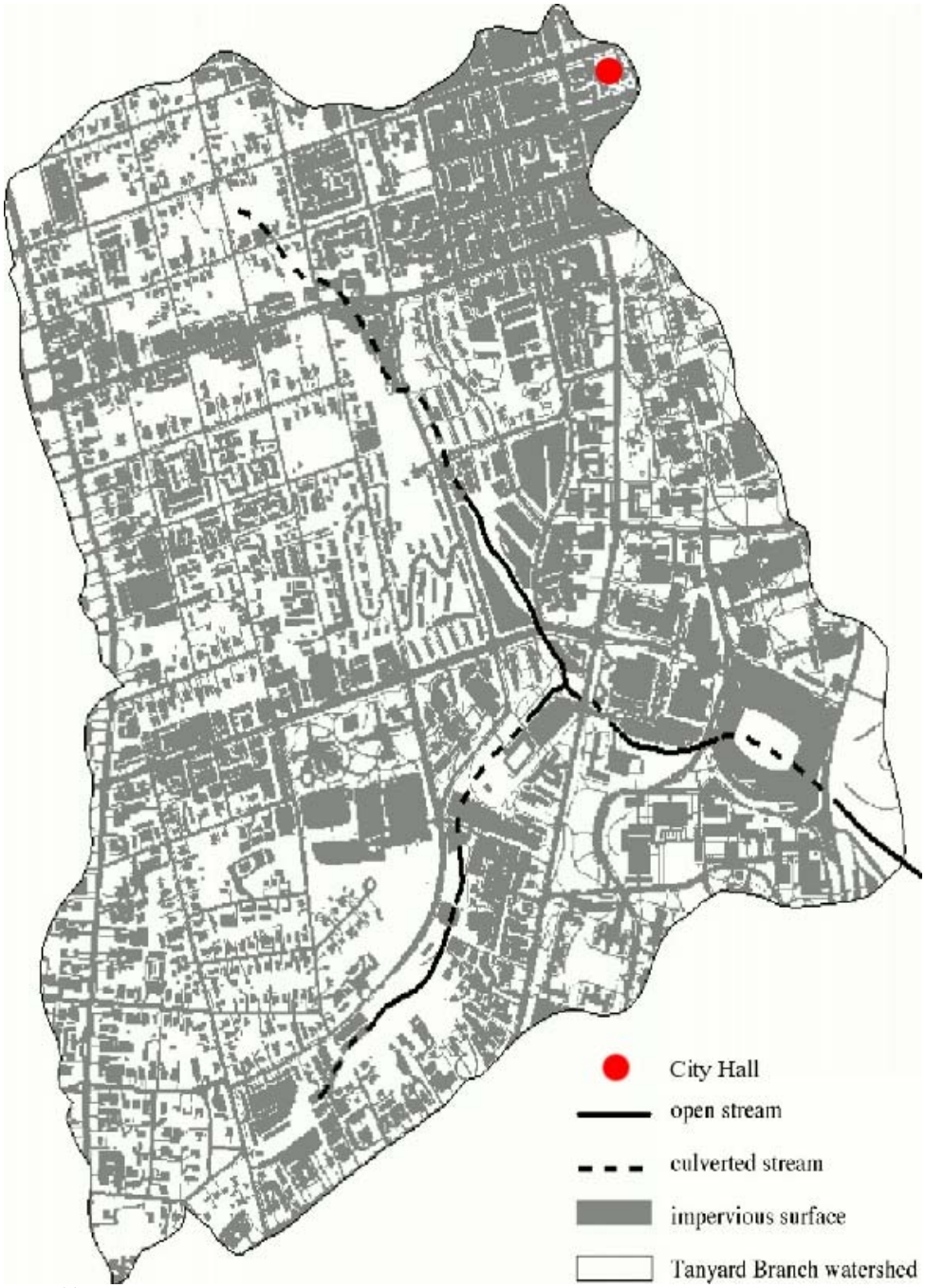
Site Description and Plans

Two possible designs for the ACC City Hall green roof provide flexibility and ease of maintenance.

Site Location



Map 1: *Downtown Athens; note the dominance of impervious surfaces, especially roofs.*



Map 2: Tanyard Branch watershed and City Hall, showing impervious surface.

Green Roof Site Design

The site location designated for this Athens-Clarke County green roof pilot project is historic City Hall, built in 1904. The roof top to be greened is the east side porch roof top facing College Avenue.

Site Details:

- Urban downtown
- Historic structure, built 1904, and located in the Athens-Clarke County Downtown Historic District
- Roof is over open exterior porch
- Flat with a slight slope in towards center, drains more toward north and south ends of roof
- Upper roof potentially drains slightly to site
- Structural loading capacity unknown at this time
- Concrete roof deck
- Waterproof membrane new, re-roofed less than one year ago
- Waterproof membrane: cold process asphalt sheets, torch applied, sheet is modified asphalt reinforced with polyester and fiberglass, two ply (two layers applied: bottom layer smooth, top layer is the gray gravelly surface visible)
- Morning sun, afternoon shade, small bits of shade cast by banister throughout the day
- East facing, exposed
- Tree species nearby: Dogwood, Ash, Oak, Dawn Redwood, Elm, Crape Myrtle
- Shrub species nearby: Spirea, Indian Hawthorn, Azalea, Holly
- Total square footage (inside edge of the banister): 132 ft.^{2} (12.26 m^2)
- Total usable square footage (inside 1' wide access path): 90 ft.^{2} (8.36 m^2)

Design Intent/Goals:

- Manage stormwater
- Reduce heat island effects
- Demonstration site/pilot project
- Not accessible on foot by the public
- Visible from indoors
- Non-irrigated
- Low maintenance
- Public education

An extensive green roof is the choice for this location based upon the site characteristics. The lightest weight for this green roof is necessary because (1) this is a porch roof and (2) it is a historic building. Structurally this roof was not expected by the designer to support a weight greater than 35 lbs./ft.^{2}, and this was a consideration when creating the design options. Extensive green roofs are

typically designed for sites that have this type of weight restriction. A structural engineer will be consulted prior to construction to verify the structural loading capacity of the porch roof.

The depth of the system has been designed to be no more than 6" in order to address the concern of the green roof altering the appearance of the façade of this historic building. At this depth, and using plant materials that do not exceed 4" to 6" in ultimate growth height, the appearance of the building will be unaltered. This design will prevent visibility of the green roof from street level. In accordance with the design guidelines of the Historic Preservation Commission, no new additions such as this green roof should alter the appearance and distract from the historic character of City Hall.

In both design options a minimum 1' border will be maintained inside of the banister for maintenance purposes. This border will also act as another layer of protection to prevent visibility from street level.

It should be noted that this is not a typical site for a green roof because it has no roof lip to contain stormwater and prevent drainage over the side of the roof. While rainfall is absorbed by green roofs, at this site some rain will run off and drain to the sidewalk below because the entire roof will not be covered and there is no roof lip to prevent runoff. An edging material has been included to hold in the growing media and plants to prevent solids from washing over the roof edge (see Permaloc in options 1 and 2).

Option #1: Loose Laid System

The first choice for this particular site is a loose laid system. A loose laid system allows for more design flexibility and opportunities. Pieced together with products supplied from multiple companies, a designer is better able to customize in order to meet the needs and goals of the green roof system. Loose laid systems typically have a lower cost than modular systems (see option budgets). Multiple professionals are typically involved in the design and installation process. This option allows for a total of 90 ft^2 of green roof.

A loose laid system offers flexibility and cost savings.

Materials:
Colbond EnkaRetain & Drain 3111 filter fabric, drainage and retention assembly

- Unique retention mat can hold 10 times its weight in water
- One piece system assembled by manufacturer and warranted
- Local office in Sugar Hill, GA

Permaloc GeoEdge light weight aluminum edging to retain media

- Designed for the green roof industry, very light weight
- Prevents media from washing away due to lack of roof edge/lip
- Increases aesthetics with a clean and attractive border

James Greenhouses, various succulents (primarily sedum)

- Colbert, GA company
- Wide variety of green roof plant material

ItSaulNatural, growing media

- Quality engineered green roof growing media
- Atlanta-based company with experience

Polyethylene sheeting

- Root barrier protection for waterproof membrane
- Must be 8 mil minimum

Water Holding Capacity of Option #1:
Per Allan Wingfield, Colbond-USA Building Products Architect, EnkaRetain & Drain holds 137 gallons of water/ft^2. This is equal to 18.33 oz/ ft^2 (1.15 lbs/ ft^2). The total weight of EnkaRetain & Drain saturated is 22.33 oz/ ft^2 (1.39 lbs/ ft^2). For this 90 ft^2 system, that translates to 12.888 gallons of stormwater retained and slowly absorbed by plant material and transpired to the atmosphere. This system could hold an estimated 2" of rainfall (where 1" of rain = 5 gallons) and prevent it from running off to the ground below.

Weight of Option #1:
Plant materials typically weigh no more than 1 lb/ft^2, growing media is estimated at 22 – 26.6 1bs/ft^2 (wet and drained) and the EnkaRetain & Drain system weighs 1.39 lbs/ft^2 (saturated). The Permaloc edging will be a border weighing approximately 4 oz. for each foot of material for a total of approximately 20 lbs for the edging material. The total weight of this loose-laid system is estimated to be no more than 29 lbs/ft^2.

Option #2: Modular System

A modular system is more expensive, but easier to install.

A modular system is quicker and easier to install and is essentially a "one-stop shopping" method of designing a green roof. Modular systems combine components of a green roof assembly into one product, usually contained in plastic trays, and laid directly on the waterproof membrane. This option allows for a total of 80 ft^2 of green roof because of the manufactured size of the modules.

Materials:
GreenGrid® modular green roof system

- Complete system including drainage assembly, growing media and plants
- 2'x4'x4' modules, 10 modules total

Permaloc GeoEdge light-weight aluminum edging to retain media

- Designed for the green roof industry, very light weight
- Increases aesthetics with a clean and attractive border, hiding the divisions between the trays

Polyethylene sheeting

- Root barrier protection for waterproof membrane
- Must be 8 mil minimum

Water Holding Capacity of Option #2:
The GreenGrid® system can retain up to 99% of a 1-inch rainfall. Data is included in the appendix that shows stormwater retention capability of the 4" modules specified for this project.

Weight of Option #2:
Per the product literature, the GreenGrid® system weighs between 15 – 18 lbs/ft^2.

Budget

Option #1: Loose Laid System

Vendor	Product	Description	Amount/Cost	Total Price
Colbond-USA	EnkaRetain& Drain 3111	Filter, drainage & retention assembly	$1.25/ ft^2, require 100 ft^2	*$125 + freight
Permaloc	GeoEdge, 4"wall x 3" base, Mill Finish	Lightweight aluminum edging	$3.70/ft, require 51 ft. of edging	†$189 + freight of approx. $50
James Greenhouses	Plant materials	Various succulents	3 trays @ 70 plugs/tray ($.48 - $.57/plug , $33.60 - $39.90/tray)	††$100.80 - $119.70, free pick up
ItSaulNatural	Growing media	Extensive product	$85/ yd^3, require 2 yd^3 of media (90 ft.^{2} =1.11 yd^3)	**$170 + freight
Landscape/Building supply company - any	Polyethylene plastic, root barrier	.8 mm min. thickness (FM Global standards)	100 ft.^{2}	$20 - $30
	Installation, consultants, project management & design	Volunteers	$0.00	$0.00
			Total	$654.80 - $683.70
			Total After Donations	$70.00 - $80.00

Option #2: Modular System

Vendor	Product	Description	Amount/Cost	Total Price
Green Grids, Weston Solutions	Green Grids modular green roof	2'x4'x4' modules	$12 - $15/ft.², 10 modules for 80 ft.²	$960 - $1200
Permaloc	GeoEdge, 4"wall x 3" base, Mill Finish	Lightweight aluminum edging	$3.70/ft, 48 ft. of edging	†$178 + freight
Landscape/Building supply company – any	Polyethylene plastic, root barrier	.8 mm min. thickness (FM Global standards)	100 ft.²	$20 - $30
	Installation, consultants, project management & design	Volunteers	$0.00	$0.00
			Total	$1,158 - $1,408
			Total After Donations	$1,030 - $1,280

* Lenetta Heiland at Colbond will donate materials & delivery cost.
† Bob Anderson at Permaloc will donate material & ACC pays delivery.
†† Ken and Leah James will donate plant materials, ACC to pick up.
**Ernie Higgins will donate growing media, ACC to pick up.

Site Maintenance

The maintenance for both options proposed is minimal. In the case of severe drought a periodic watering will help extend the life of the plants. Visual inspection of both the green roof system and the porch roof should be conducted at least twice a year. Minor horticultural maintenance, possibly monthly, may be necessary to prevent weed invasion before the plants reach their full growth size. Weeds should be removed by hand. No pruning, fertilizing, or application of herbicides or insecticides will be necessary. The type of plant materials used in this green roof (primarily sedums) do not benefit from additional nutrients beyond the organic matter provided in the growing medium.

It is further recommended that no chemicals should ever be used on this green roof. Since this is not a typical site for a green roof because it has no roof lip preventing drainage over the edge of the building, rainfall amounts greater than the retention capacity of each system (see options 1 and 2) have the potential to drain to the sidewalk below and eventually to the stormwater drains.

Site Construction

Once a decision is made as to which option will be pursued, the following is suggested:

- Contact company representatives to order or reserve materials
- File for permits: Certificate of Appropriateness from Historic Preservation Commission and possibly permitting from the Building Inspection Office
- Contact professionals and volunteers
- Contact media
- Install green roof system from root barrier up to growing media as soon as materials are received
- Install plants on the site in October for best chance of plant survival in our area

The team of professionals that will assist with the construction of this site would ideally be composed of the following: landscape architect, roofer, structural engineer, historic preservationist, ACC buildings manager, ACC grounds maintenance and horticulturist. As the project progresses, more specialties may be required for consultation, which is normal for a green roof project.

Many of these professionals are already involved in this project and would potentially continue their participation as volunteer consultants. Commercial Roof Management company representative Adam Yelton (the company that recently re-roofed this site), expressed interested in donating his time as a consultant to receive the experience.

Those who construct the green roof may be ACC employees along with volunteers from UGA. River Basin Center faculty member Tim Carter is willing to continue his involvement. Professor Alfie Vick of the School of Environmental Design has expressed the possibility of involving one of his studio classes in this project. Additionally, the two students who participated in this project have stated their interest in seeing this project through to the installation of the green roof.

Section 3

Additional Information

Possible funding sources, educational links, and the "public face" of green roofs have impacts on installation and design.

Funding

Municipalities are currently using the internal funding to cover most if not all of the cost of green roof infrastructure projects. Athens-Clarke County has already established a stormwater utility fee system and could possibly fund much of the cost of green roofs through stormwater fees collected.

There are a number of routes that a municipality can take to find external funding. First they may look to organizations that may have a mutual interest in green roof infrastructure in Athens. Then they may look to the green roof industry for support.

Non-governmental organizations whose mission can be linked to the benefits of green roofs may possibly assist with funding or assist with contacts that may lead to funding. Southface in Atlanta is one of these organizations and is committed to green building. While Southface doesn't provide funding, they are involved in many projects in the areas of stormwater management, rain water harvesting and green roofs to name a few.

Environmental agencies often have funding available that can be tied to green roof implementation. The Atlanta City Hall project was partially funded by a grant from the Georgia Environmental Facilities Authority.

Research-oriented organizations, whether they are academic or private, may have an interest in green roof projects and wish to be involved. Their involvement may be through monetary donations or donations of material, expertise and services. An example of this is the research presented in this project, provided by the UGA River Basin Center through a grant-funded service learning course.

The green roof industry is still in its beginnings in North America and particularly in the Southeast. Because of this, partnerships can be created with manufacturers of green roof products that will benefit both parties. Manufacturers need to get the word out about their products and generate interest, and they would like to see more municipalities implementing policies and programs to encourage growth in the green roof industry. Industry support may be in the form of materials or shared expertise.

Company representatives in the green roof and conventional roof industry expressed interest in being involved in this pilot green roof project for Athens. Colbond-USA offered to donate their products, assist in marketing, and give seminars on green roofs upon request. Ernie Higgins at ItSaulNatural volunteered to donate his product for this project and is willing to share information. Adam Yelton may act as a volunteer roofing consultant. Bob Anderson at Permaloc offered to donate materials. Ken and Leah James of James Greenhouses offered to donate the plant materials. All companies contacted were interested in the potential for future green roof projects in Athens.

Incentivizing Green Roofs in ACC

Many cities in North America such as Chicago, Portland and New York have implemented policies promoting green roofs. It is vital that municipalities be supportive of public and private policy programs to encourage the proliferation of green roofs. Encouraging private roof space for public gains can be leveraged through some of the following:

Direct incentives through density bonuses, fast-track permitting, green space allocation, and direct investment or grants (such as tax credits).

Indirect incentives through low-interest loans, energy efficiency incentives and stormwater rebates or fee reductions.

Additionally, regulatory measures, outreach strategies, technical assistance programs and training programs are other policy programs that a number of cities have put into place encouraging green roof construction on private roofs.

Chicago: Urban heat island effect reduction is their main goal. The city enacted an energy code requiring a reduction in heat radiating surfaces. Green roof research is ongoing at the Chicago Center for Green Technology. Private-sector green roof development is a priority. Chicago is providing heat management grants to encourage this. Additionally, they are providing zoning bonuses for an increase in density to developers using green roofs. Chicago currently has more square footage of green roofs than any other North American city.

The City of Chicago created the Department of the Environment (DOE) to assist Chicago Mayor Richard M. Daley with green initiatives and to coordinate green

efforts throughout the City. DOE is involved in the policies, programs, and regulations related to green building, green roofs, public education, and the development of the City's Environmental Action Agenda. Green roof information is available on the DOE website and that website also acts as a portal to other Chicago-area websites about green roofs.

In order to further the cause of making Chicago the greenest city in the country, a grant program for green roofs was established in 2005 and is administered through the DOE. Owners of residential and small commercial buildings may apply for $5,000 grants to help with the planning and installation of green roofs.

Portland: Water pollution prevention is the major impetus for the use of green roofs. Salmon is an endangered species in that area. Stormwater and groundwater quality issues have driven the green roof movement. Their split-fee system has funded public green roof projects. Portland charges for (1) water consumption/sanitary discharge and treatment and (2) storm water management (35% for drainage on property and 65% for drainage onto public streets). Landowners are more responsible for their stormwater runoff as a result. Portland was able to raise awareness among landowners about the stormwater management benefits of green roofs. This was evident through the private sector construction of green roofs that soon followed policy and program implementation.

The city of Portland continues to provide technical assistance and incentives to encourage green roof projects through their Office of Sustainable Development (OSD). This office was established to "advance the principles of sustainability" as stated on the OSD website.

The Green Investment Fund (GIF) was established through a partnership between the City of Portland OSD, Water Bureau, Bureau of Environmental Services and Energy Trust of Oregon, Inc. The GIF is a competitive grant program that funds projects designed and built to meet aggressive and integrated resource conservation goals. Private green roof projects have been funded through this program.

The OSD hosts classes on green building projects regularly. OSD also provides a resource for information about sustainable building practice workshops and classes being held in Portland through their website.

New York City: Reducing stormwater runoff and water pollution are their major goals. Urban ecology studies have been conducted here, namely the New York Ecological Infrastructure Study. "The New York Ecological Infrastructure Study (NYEIS) is a unique multidisciplinary research project that investigates the form and function of "ecological infrastructure" for New York City's built environment and landscape." (http://www.earthpledge.org/gr-pub.html). The Earth Pledge Foundation, an influential nonprofit organization, is helping green the rooftops of New York City

(http://www.greeninggotham.org) and provides a "green roof toolbox" as an educational tool.

In our local economy the green industry has grown exponentially in recent years, landscape companies and plant nurseries in particular. With this strong growth in the green industry, there is potential for the green roof industry to gain a strong foothold in Athens as it has already been doing so in the Atlanta area.

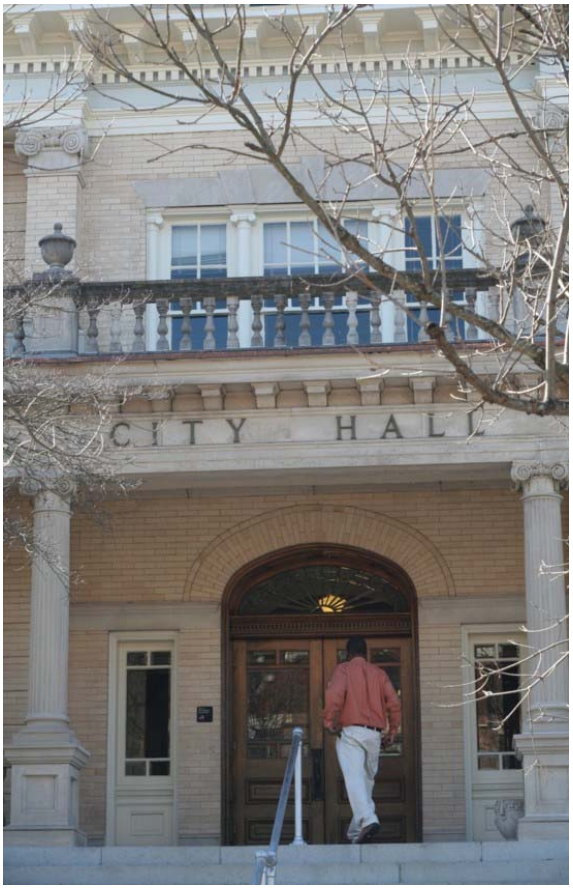
The green industry is not the only group that could benefit from the proliferation of green roofs. Roofing companies also stand to benefit greatly, and they are receiving many contracts for the installation of green roofs in the Atlanta area (per personal conversation with ItSaulPlants staff member). This is most likely due to a lack of qualified professionals in the fields of landscape architecture, engineering, architecture and others such professions that are knowledgeable in the installation of greenroofs, and roofing companies seem to be the most logical choice for many developers. Roofers certainly play an important part in the design and construction of green roofs, but they are only one member of a complex green roof team.

Green Roofs and Public Relations

ACC government officials are clearly concerned about storm water management and the urban heat island effect in the urban landscape of downtown Athens, Georgia. Below are a few points about green roofs ACC may share when working with the media. ACC is advised to create a plan that will help to gain acceptance of green roofs within the government and among the general public.

1. Attract environmentally conscious sections of the public to move to the Athens area.
2. Raise the environmental awareness image of Athens, Georgia. A future visible and ideally accessible (intensive) green roof would most effectively communicate this environmental attitude.
3. At least one LEED point gained for 50% green roof coverage and at least one for stormwater management. This follows ACC policy on future governmental green building construction.
4. Bird species have successfully nested on urban green roofs around the world. Butterflies, reptiles, bees and many other species have been attracted to the habitats created on rooftops through green roofs. Consultation with ecologists at UGA would assist with identifying such a species. This bird or butterfly could become the symbol, or face, of the green roof movement in Athens.
5. A green roof designed to represent the endangered native plant communities found at Georgia native granite outcrops (such as Arabia Mountain and Heggie's Rock) could partner ACC and UGA in a research study. Their native habitats are harsh environments much like a rooftop and these plants are subject to severe drought. Possibilities for studies are topics

such as landscape and native plant communities (landscape architecture), endangered plant conservation (State Botanical Garden research), growing media trials (crop and soil science) and certainly others.



Opportunities for Public Education

Social Learning Benefit

Although the technical knowledge needed for construction of green roofs has been present for many years and the economic benefits have become clear in recent projects, purely technical and economic views fail to recognize the social nature of buildings. Even less tangible benefits of green buildings such as "civic pride, urban regeneration, added value of good design, corporate identity, health and well-being, and educational attainment" posit humans as rational actors making decisions based primarily on broadly-defined economic welfare (Macmillan 2006). However, lighting, water flow, roof design, even the sound of a toilet's flush are, to some degree, socially determined phenomena and must become socially acceptable before they achieve wide adoption. Seen through this lens, buildings are less concrete products of technology and economics and more a "material product of competing social practices" (Guy 2006). The construction of green roofs in public spaces is one step toward changing those social practices by increasing the public's familiarity with green roofs, thereby encouraging the further development of green roofs on private property.

Signage

Since green roofs are not always visible from street level, we recommend the creation of signs in the building lobby and along the walk way entering the building to point out the green roof and highlight its benefits. Signage should include:

- One or more photographs of the completed green roof
- A short paragraph or bulleted list of green roof benefits
- A diagram showing the layered construction of a green roof
- Credits acknowledging donors of materials

A sample of a possible sign is included on the next page.

The Athens-Clarke County City Hall Green Roof

The East balcony roof of the ACC City Hall building is equipped with a green roof, a shallow soil and plant layer designed to:
-decrease stormwater runoff
-provide wildlife habitat
-reduce the urban "heat island" effect
-improve air quality

Green roofs require little maintenence and can provide savings by reducing stormwater fees and acting as an extra insulation layer, thereby reducing energy usage.

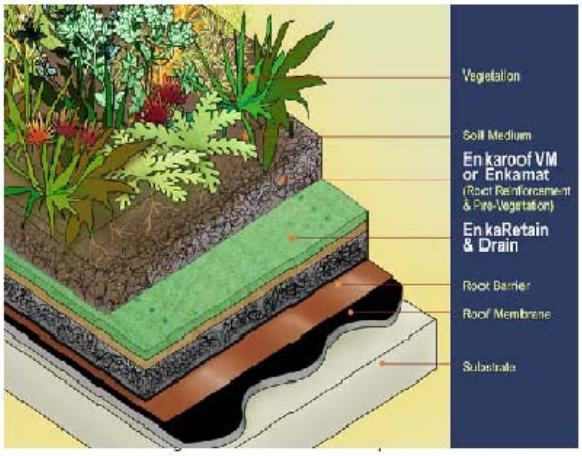


Illustration 1: A sample of a possible green roof sign for the ACC City Hall

K-12 Educational Opportunities

Green roofs, like rain gardens and rainwater harvesting systems, provide opportunities for public education among elementary, middle and high school students. Table 1 shows Georgia State Education Standards supported by the construction of green roofs. A creative teacher should be able to draw numerous other connections to other state standards. Teachers may take their students to the city hall conference for them to view the green roof or they can use photographs of the green roof to open discussion on water resource issues, plant biology (particularly the biology of xerophytic plants), and human impacts on ecosystems.

A green roof can also be used as a teaching aide as part of a larger curriculum on rain, climate, or watersheds. *Working with Watersheds* 7th grade curriculum is available at http://www.rivercenter.uga.edu/education/watersheds2006/main.htm.

Table 4: Georgia State Education Standards Supported by Green Roofs

		Grade												
Georgia Performance Standard (GPS)	**Description**	**K**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
AG-PSB-16	The student explains the water-plant relationship and describes how water and other materials move through the plant.										x	x	x	x
S4E3	Students will differentiate between the states of water and how they relate to the water cycle and weather.					x								
S1E2	Students will observe and record changes in water as it relates to weather.		x											
BCS-LEB12	The student explains laws and regulations that apply to the environment and energy.										x	x	x	x
SB4	Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.										x	x	x	x
SEV5	Students will recognize that human beings are part of the global ecosystem and will evaluate the effects of human activities and technology on ecosystems.										x	x	x	x
AG-BAS-3	The student distinguishes between types of environmental natural resources and draws conclusions about human impact on the environment.										x	x	x	x
S3L2	Students will recognize the effects of pollution and humans on the environment.				x									
SEV1	Students will investigate the flow of energy and cycling of matter within an ecosystem and relate these phenomena to human society.										x	x	x	x
S6E3	Students will recognize the significant role of water in earth processes.							x						
SES6	Students will explain how life on Earth responds to and shapes Earth systems.										x	x	x	x

Green Roof Information Sources and References

Publications:

Green Roofs/Ecological Design and Construction. Earth Pledge Foundation. Schiffer Publishing, 2005. Atglen, PA.

Green Roof Plants: a Resource and Planting Guide. Edmund C. Snodgrass and Lucie L. Snodgrass. Timber Press, 2006. Portland, OR.

Planting Green Roofs and Living Walls. Nigel Dunnett and Noel Kingsbury. Timber Press, 2004. Portland, OR.

Green Roof Design 101: Introductory Course, Second Edition, Participants Manual. Green Roofs for Healthy Cities. Green Roofs for Healthy Cities, 2006. Toronto, Canada.

Websites:

Colbond-USA http://www.colbond-usa.com
Earth Pledge Foundation http://www.earthpledge.org/
EPA: Green Roofs http://www.epa.gov/hiri/strategies/greenroofs.html
Georgia Environmental Facilities Authority http://www.gefa.org/
GreenGrid® Modular Roofs http://www.greengridroofs.com/
Green Roofs for Healthy Cities http://www.greenroofs.net
Greening Gotham http://www.greeninggotham.org
Greenroofs.com Projects - Atlanta City Hall Green Roof
http://www.greenroofs.com/projects/pview.php?id=65
Greenroofs.com http://www.greenroofs.com/
ItSaulPlants http://www.itsaulplants.com/
Permaloc - Aluminum Landscape Edging and Restraints http://www.permaloc.com/
Southface http://www.southface.org/
Timothy Carter, Ph.D. (website and publications) http://tlclimb.myweb.uga.edu/
Urban Habitats (online journal): Special Issue: Green Roofs and Biodiversity.
http://www.urbanhabitats.org/v04n01/introduction.html

Other References

Carter, Timothy L.
2006 Vegetated roofs for urban ecosystem remediation: performance and policy in the Tanyard Branch watershed, University of Georgia.

Carter, Timothy L., and C. Rhett Jackson
2007 Vegetated roofs for stormwater management at multiple spatial scales. Landscape and Urban Planning 80:84-94.

Carter, Timothy L., and Todd Rasmussen
2006 Hydrologic Behavior of Vegetated Roofs. *In* Journal of the American Water Resources Association Paper #05090. Middleburg, VA: American Water Resources Association.

Kadas, Gyongyver
2006 Rare Invertebrates Colonizing Green Roofs in London. Urban Habitats 4(1):66-86.

Guy, Simon
2006 Designing urban knowledge: competing perspectives on energy and buildings. Environment & Planning C: Government and Policy 24(5):645-659.

Macmillan, S.
2006 Added value of good design. Building Research & Information 34(3):257-271.

Section 4

Potential Legal Issues

Issues of historic preservation and structural integrity must be addressed before the green roof can be constructed.

I. RAMIFICATIONS OF HISTORIC DISTRICT DESIGNATION

a. City Hall

The Athens-Clarke County City Hall was built by L.F. Goodrich of Augusta, architect, and J.W. Barnett, contractor, in 1904, on the highest point in the downtown business district.[1] Constructed on "solid Lexington granite on the first floor and light buff brick with oolitic limestone trimmings on the upper floors," City Hall rises to a height of 99 feet and is 103 feet across the front and 85 feet deep.[2] Today, City Hall houses the Mayor's Office and several Athens-Clarke County government offices.[3] In addition, the second floor contains a courtroom chamber that serves as the Municipal Court during the day and the Commission Chamber for evening meetings of the Athens-Clarke County Mayor and Commission.[4] Due to its location in downtown Athens, City Hall lies in an area now designated as the Athens-Clarke County Downtown Historic District.

---

1 See Virtual Tour of Athens Landmarks, ACC Online, http://www.athensclarkecounty.com/tour/tour3.htm (last visited March 23, 2007). See also City of Athens History, ACC Online, http://www.athensclarkecounty.com/history/athens.htm (last visited March 23, 2007).

2 See Virtual Tour of Athens Landmarks, supra note 13.

3 Id.

4 Id.

b. Downtown Historic District and the Historic Preservation Commission

The Athens-Clarke County Downtown Historic District is a section of downtown Athens – covering areas from Broad Street to East Dougherty Street - designated as such by the Mayor and Commission as a "formal recognition of the historic value of the area and the important role that it serves in the history of Athens."[5] Because of the inherent value in protecting this historic district, development of new buildings and additions to existing structures –including City Hall – are subject to the design guidelines adopted by the Athens-Clarke County Historic Preservation Commission (HPC).[6] These guidelines serves as a "means of preserving the historic resources of the Downtown Historic District while accommodating compatible development and redevelopment" while conveying "general policies about alterations to existing structures, additions, new construction and site work."[7]

The HPC was created by the enactment of Sec. 8-5-2 of the Athens-Clarke County Code of Ordinances to aid the local government in their pursuit of historic preservation.[8] Members are appointed by majority vote of the Athens-Clarke County Mayor and Commission.[9] Responsible for "promoting, protecting and preserving the historic, cultural and aesthetic heritage of designated historic districts,"[10] one of the goals of the HPC is to oversee any possible additions to buildings in the Downtown Historic District and to apply the design guidelines in determining the appropriateness of such additions.

---

5 See The Athens Clarke County Planning Department, http://www.accplanning.com/hpresources_list.php (last visited April 4, 2007). For a complete map of the Downtown Historic District, see http://www.accplanning.com/tigeradmin/open_file.php?filename=1169140102_HP--Downtown.pdf&author=ACFawP.U05Fcw (last visited April 4, 2007).

6 See generally, Downtown Historic District Design Guidelines, available at http://accplanning.com/tigeradmin/open_file.php?filename=1169495252_Adopted Downtown Guidelines.pdf&author=ACFawP.U05Fcw (last visited March 23, 2007).

7 Id. at 1.

8 See The Code of Athens-Clarke County, Georgia, available at http://www.municode.com/services/mcsgateway.asp?sid=10&pid=12400 (last visited March 23, 2007).

9 Design Guidelines, supra, note 18, at 7.

10 Id.

c. Certificate of Appropriateness

Before an addition to a Downtown Historic District structure can be built, it is necessary to obtain a Certificate of Appropriateness (COA).[11] A COA is required before a building permit can be issued for any "alteration of the size, shape or façade of a designated historic property."[12] As City Hall is located in the Downtown Historic District and is thus a designated historic property, an application for a COA will have to be filed with the HPC before any construction on a proposed green roof atop City Hall can occur. The HPC will use the design guidelines as an aid in determining whether to issue a Certificate of Appropriateness.[13]

A completed application for a COA should be submitted to the HPC "no later than the first Wednesday of the month in order to be heard at the regular monthly meeting of the HPC."[14] Once the HPC has reviewed the COA application, the commission will approve, approve with conditions, or deny an application. If the HPC fails to act within forty-five days after the COA has been filed, this failure to act will constitute approval.[15]

If a COA is issued and the project will cost more than $100, then applications for appropriate permits, such as electrical, mechanical, and plumbing, should be submitted to the Building Inspection Office.[16] Once these permits are obtained, work can begin on the project. If the COA is denied, the applicant may then appeal to the Mayor and the Commission within thirty days after notification of denial.[17] If the COA is still denied, the applicant can then appeal to the Superior Court of Athens-Clarke County.[18]

---

11 A COA application can be obtained by visiting the Athens-Clarke County Planning Department website, available at http://www.accplanning.com/hpresources_list.php. Upon visiting the website, click on the "COA Application" link at the top to pull up a PDF of the application.

12 Design Guidelines, supra, note 18, at 7.

13 Id. at 1.

14 Id. at 8.

15 Id.

16 Id. at 9.

17 Id. at 8.

18 Id. at 9.

d. Application of the Design Guidelines

As mentioned, in determining whether a COA is issued, the HPC draws heavily upon the design guidelines. While all sections of the guidelines are applied as a whole, certain sections will be of particular importance when considering a proposed green roof on the balcony of City Hall. For one, as the balcony on City Hall already exists, the Design of Alterations section of the guidelines will likely be consulted. One important concept is that "alterations should be designed to avoid destruction of key features and so that one may continue to interpret the historic character of the property."[19] As the green roof may also be considered an addition, the Design of Additions section will probably play a role in aiding the HPC's decision. The Additions section states that, "when planning a new addition to an historic structure, negative effects such as loss of original materials, damage to structure or over-scaled additions should be minimized."[20] In addition, though used as a balcony, the proposed area that would contain the green roof technically functions as a roof, and thus the specific criteria for roof additions may control, among those that the addition "is modest in character, so it will not attract attention from the historic facade" and "distinguishable as new, albeit in a subtle way."[21] Further, City Hall represents an institutional property, and as such, the Institutional Properties section of the guidelines will be used in determining the appropriateness of a green roof. Criteria include that an addition to an institutional property "appear subordinate to the historic building" and "provide a human scaled street edge that is interesting to pedestrians."[22] Finally, the Design Guidelines for New Construction section will apply. Fortunately for a green roof project, one concept in this section that stands out is the notion that "change is anticipated in the area; it is not to be frozen in time."[23] Each of these sections will play an important role in the HPC's decision-making process.

While the ultimate decision of whether to issue a COA for a green roof atop City Hall will be made by the HPC, it appears likely that the proposal would pass muster. Particular steps can be taken to increase the likelihood of approval. Early consultations with the HPC are encouraged when considering a project that will need a COA to continue. In addition, tailoring the proposal to fit within guidelines as specified in this memo can dramatically aid an application for a COA. Approval for a proposed green roof project on City Hall will hinge in part on the

---

19 Id. at 48.

20 Id. at 58.

21 See id. at 59.

22 Id. at 60.

23 Id. at 61.

exact nature of the green roof, how it affects the historic character of City Hall, and whether it fits within the design guidelines.

II. STRUCTURAL ISSUES

According to the facilities administrator of Athens-Clarke County, Robert Baird, the installation of a green roof above one of the City Hall porches would most likely be very feasible. However, there is certainly a need for a thorough structural inspection.[24] Highly skilled craftsmen used quality materials to build the City Hall in 1903 but, over the years, the construction drawings were either poorly kept or lost. As a result, a few badly damaged sheets are all that remain of the original plans.[25] None of these remaining drawings have information that describes the construction components of the porch roofs where the green roof is proposed.[26]

Recently, an Athens-Clarke County work team replaced the roofing systems above the porches and found that there was a concrete deck.[27] However, little is known beyond the fact that the concrete deck exists. Because of the existence of this concrete deck, Mr. Baird believes that the roof would easily support a green roof system, but also believes that, before this project could progress to the point of installation, that a structural analysis would need to be carried out.[28] A structural engineer would perform this analysis to determine the Live and Dead load capacities of the roofs. Because this is a public building, safety is of the utmost concern to the Athens-Clarke County officials and it is clear that thorough testing must be carried out before any roof modification is done.

III. POTENTIAL ISSUES OF LIABILITY

Unanswered questions:

-Current Roof Warranty / Effect Green Roof Would Have
-Load Rating
-Cost, Liability, Design Certification
-Insurer/ Reinsurer

---

24 Email from Robert Baird, ACC Facilities Administrator (Mar. 16, 2007) (on file with author).

25 Id.

26 Id.

27 Id.

28 Id.

IV. STORMWATER DRAINAGE ISSUES

The fact that green roofs help reduce stormwater runoff is one of the major benefits of installing such systems. Not only is reduced runoff good for the overall well being of the city, but it may also result in reduced utility charges. The reduced utility charges that would, potentially, result from the installation of a green roof would help to offset the initial cost and maintenance costs of such a system in non-public buildings. Under Sec. 5-5-7 of the Athens-Clarke County Code of Ordinances, the local government is permitted to charge service and user fees for stormwater management services, systems and facilities.[29] These fees are meant to cover the operating expenses, capital investments, and reserve accounts associated with stormwater management.[30]

The stormwater utility fee is based on a formula set by the Athens-Clarke County Commission.[31] Each piece of developed property within Athens-Clarke County is classified by the director, who is responsible for determining the impervious area, land area, land use or other factors as may be needed to asses the stormwater fee.[32] The stormwater charge is actually made up of three different charges: the base charge, the quantity charge, and the quality charge.

The base charge may be imposed on any developed property within Athens-Clarke County in order to cover the administrative costs of the stormwater utility.[33] Both the base charge and the quantity charge are based on the "equivalent runoff unit" (ERU), which represents 2, 628 square feet of impervious area.[34] There are seven categories of land, each with its own ERU rating.[35] For example, small single-family homes are charged at a rate of 0.6 ERUs when calculating the base and quantity charges. The City Hall would almost certainly fall under the sixth

---

29 See The Code of Athens-Clarke County, Georgia, available at http://www.municode.com/services/mcsgateway.asp?sid=10&pid=12400 (last visited April 11, 2007).

30 Id.

31 Id.

32 Id.

33 Id.

34 Id.

35 Id.

category, "Other", because it is not a single or multiple-family dwelling and is not agricultural land. The charges for the "Other" category are equal to the total impervious area divided by the square footage of an ERU (2,628 sq ft).[36] The base charge is currently calculated at a rate of $2.07 per ECU, while the quantity charge is currently calculated at a rate of $0.86 per ECU (see chart below).[37]

The quality charge reflects the services provided to treat stormwater or compensation for the difference in pollutants from properties of different land use.[38] This charge is also based on a categorization of the land's development.[39] There are six categories in this section, ranging from "undeveloped" to "commercial industrial development".[40] A building in the area surrounding the City Hall, for example, would fall into the fourth category, "high density residential/ institutional/ public", which is given a water quality rating of 1.3. This rating is then multiplied by the ERU and the current rate of $0.57 (see chart below).[41]

Stormwater Utility Charge Formula:

Base Charge.....	$ 2.07 × ERU
Quantity Charge.....	$ 0.86 × ERU
Quality Charge.....	$ 0.57 × ERU × Water Quality Factor

Sec. 5-5-11 of the City Ordinances lays out a procedure for applying for credits and adjustments to service charges.[42] If the installation of a green roof were able to reduce the amount of impervious surface area for a given area of land, it would be possible to get credits or an adjusted stormwater utility rate. In order to obtain a credit, the landowner must make a written application to the director, along with any application fee, and any information necessary for the director to establish

36 Id.

37 Id.

38 Id.

39 Id.

40 Id.

41 Id.

42 Id.

eligibility for credits or adjustment.[43] Applicants must also have an approved maintenance plan on file with the director and the property must have on-site stormwater management and treatment facilities (in this case the green roof would act as such).[44]

The maintenance plan should set out what steps will be taken in order to ensure that the stormwater management system will properly offset a certain amount of stormwater.[45] Factors such as how often the system will be inspected and an engineering analysis of the imperviousness of the surface should be included in the plan.[46] After a maintenance plan is approved, the Athens-Clarke County Public Works Department inventories it on a list. County officials inspect the systems about once a year to make sure that they are in compliance with the maintenance plan.[47]

V. LIABILITY FOR STORMWATER RUNOFF

Another advantage of green roof systems in Athens-Clarke County would be a reduction in the landowner's liability for damage caused to adjacent lots by stormwater runoff emanating from the landowner's property. Under Georgia law, a lot that naturally receives runoff from a higher lot during a storm event due to gravitational forces owes a servitude to the higher lot. This means that the lower lot is obligated to receive the water that naturally runs from the higher lot, provided the owner of the higher lot has done nothing to increase the runoff flow by artificial means. Mayor of Albany v. Sikes, 94 Ga. 30 (1894). However, if the owner of the higher lot artificially increases the volume of runoff that the lower lot receives by concentrating it and directing it and thereby causing damages to the lower lot, then the owner of the higher lot is liable in a lawsuit for nuisance or trespass. Id. Ways of artificially increasing stormwater runoff volume include (but are not limited to) paving part or all of the higher lot so as to make it impervious, constructing buildings upon the lot, grading the lot so as to alter the natural flow pathways of stormwater, or constructing gutters, sewers, ditches, or drains which concentrate water so as to throw it against [the lower lot] in larger volume than would naturally flow. See Goldsmith v. Elsas, 53 Ga. 186 (1874).

---

43 Id.

44 Id.

45 Interview with Jason Peek, Engineering Administrator, ACC Transportation and Public Works Department (Apr. 6, 2007).

46 Id.

47 Id.

In Georgia, parties found liable for trespass or nuisance associated with stormwater runoff violations have been ordered to halt construction or redirect the stormwater via an injunction. Baumann v. Snider**,** 243 Ga.App. 526 (2000). Georgia courts also routinely award attorneys fees and compensatory damages, covering the costs of repair and land devaluation, to aggrieved landowners. Id. In addition, punitive damages are awarded to landowners when the violating party willfully, Ready-Mix Concrete Co. v. Rape, 98 Ga. App. 503, 509 (1948); Little v. Chesser, 256 Ga.App. 228 (2002), or with conscious indifference, Baumann v. Snider**,** 243 Ga.App. 526 (2000), causes an increase in the volume of stormwater runoff that flows onto s the lower property. In recent years, Georgia courts have increasingly awarded punitive damages in stormwater runoff lawsuits, with the largest of such awards valued in the millions of dollars. Id.; Sumitomo Corporation of America v. Deal, 256 Ga.App. 703 (2002); Stacy Shelton, Builder *Ordered to Pay 2.3 Million Over Stormwater Runoff*, ATLANTA J. CONST., May 12, 2005. Thus, a green roof system may be an important tool in managing stormwater runoff resulting from construction activities by limiting the potential liability in which this increased volume of runoff can result.

VI. CONCLUSION

Based on an initial investigation into the legal and administrative issues that may arise in the Athens-Clarke County administration's attempt to install a green roof on a portion of the City Hall, it seems that the project would likely run into no major problems and could be approved for installation relatively easily. The size and scale of the roof are small enough that it is unlikely to raise concerns by the Historic Preservation Commission and the structure of the City Hall roof appears to be more than sufficient to hold the added weight of a green roof. The fact that the green roof is designed to reduce stormwater runoff will, potentially, help with the city's overall drainage and will likely reduce the City Hall's overall stormwater runoff. The Facilities Administrator, Robert Baird, and the Mayor, Heidi Davison, are, apparently, on board with the project. This means that the project will, hopefully, receive the attention and support it needs to get off the ground. The installation of a green roof on the Athens-Clarke County City Hall would be a small but important step in the "greening" of Athens. The roof would help raise awareness of the methods and technologies currently available to help protect the environment and reduce maintenance and utility costs.

Section

5

Guidelines for Further Green Roof Development

Evaluation and planning for future green roof sites.

Introduction

As ACC moves toward the construction of more green roofs in the downtown area, these guidelines will help in site selection, planning, and roof development. This list may be copied and distributed separately from the complete Proposal and Guide.

Site Evaluation Checklist

To evaluate an appropriate green roof site, ACC should consider the following criteria:

Roof Condition

-The ideal roof is flat or lightly sloping.

-Roof has a new or nearly new surface and is free of structural defects.

-Metal and tile roofs are usually not suitable.

-Consider unusual roof features (skylights, turrets, etc.) or recurring leaks in need of repair.

-An ideal time for a green roof is when replacing or repairing the existing conventional roof.

Roof structure

-The roof must be structurally capable of supporting the green roof weight based on a completed design plan (including the weight of plants, wet

substrate, all other layers, point loading of materials during installation, maintenance personnel, and equipment).

Access

-At a minimum, access must allow for maintenance and loading of supplies. Depending on the level of general use, two access points may be required.

Design

-Choose a general design type: intensive, extensive, or semi-intensive. **Intensive** roofs are deeper, heavier, have larger plants, and require garden-type maintenance; **extensive** roofs have smaller plants with less diversity, a shallow substrate layer, are lighter, and require little maintenance. **Semi-intensive** roofs fall between those two extremes.

-Develop a design plan. Local landscape architects, landscapers and/or roofers may be contracted to develop a design. Eventually, it may be beneficial for ACC employees to attend training classes, such as those offered by *Green Roofs for Healthy Cities* (www.greenroofs.net).

Cost

-The budget development section and cost estimation information from *Green Roofs for Healthy Cities Greenroof Design 101 Introductory Course Participant Manual* is the best cost estimating guide currently available. This information is included in the appendix as a guide for ACC to use to develop a budget estimate when evaluating future green roof projects.

Permitting

-A historic preservation "Certificate of Appropriateness" must be obtained, if the building lies within a historic district.

-A building permit may be necessary.

Maintenance

-Although a green roof extends the life of the underlying roof (typically X2), regular maintenance is required.

-Intensive green roofs require the same level of maintenance as an ornamental garden.

-Extensive green roofs may only require two maintenance visits a year. During times of extreme drought, occasional watering will extend plant life.

Appendix

a

Appendix

Additional information on budgets, vendors, and case studies.

Site Design Drawings

Budget Development Cost Estimator

Company and Product Information for:
- **Colbond-USA**
- **James Greenhouses**
- **ItSaulNatural**
- **Green Grids**
- **Permaloc Corporation**

Atlanta City Hall Pilot Green Roof Project Case Study
Medical Building – Colbond Product Case Study

Municipal Case Studies – Policy and Programs

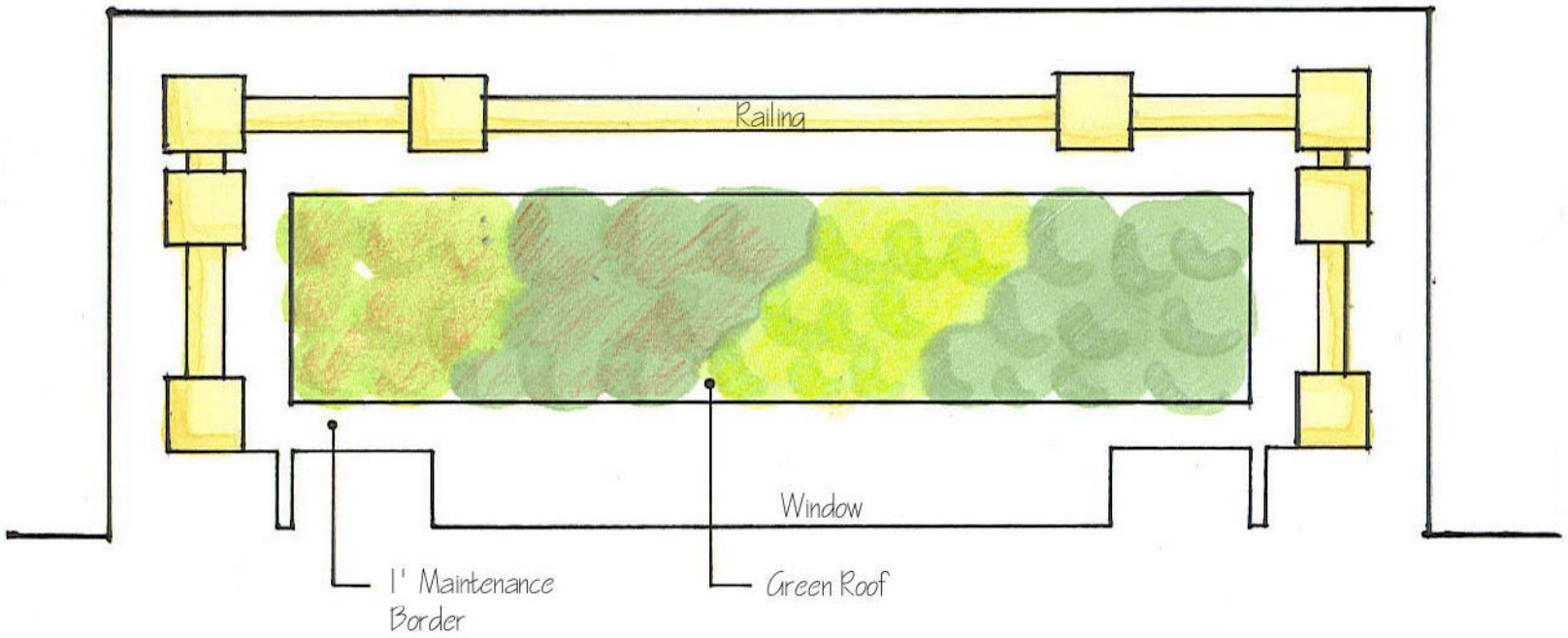
Green Roofs In New York – green roof infrastructure public information web page example

ACC CITY HALL GREEN ROOF

GREEN ROOF VIEW FROM WINDOW

T. ANDROS
UGA, RIVER BASIN CENTER
5-2007

N



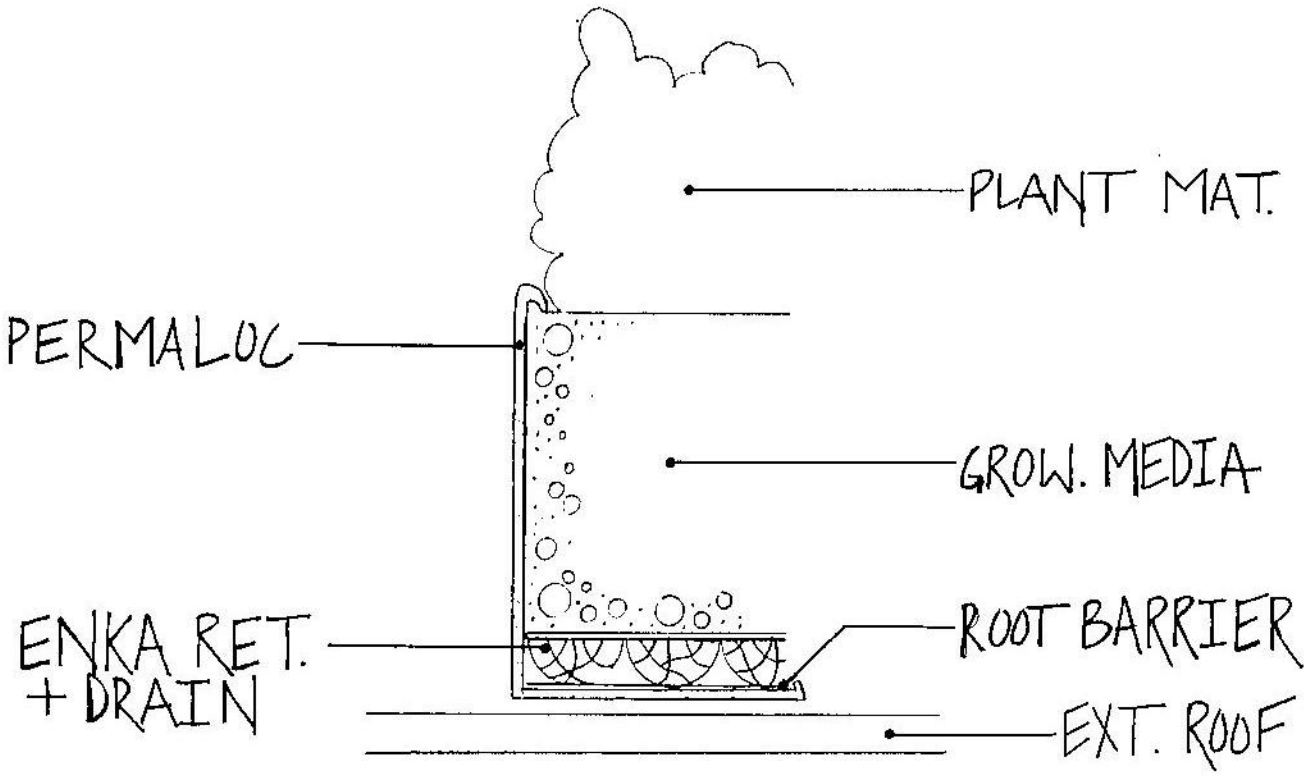
ACC CITY HALL GREEN ROOF CONCEPT

T.ANDROS
UGA, RIVER BASIN CENTER
5-2007

SCALE: 1/4" = 1'

NOTES:

- DO NOT WRAP ROOT BARRIER OVER PERMALOC
- FILL MEDIA ONLY TO TOP OF PERMALOC



GREEN ROOF DETAIL

SCALE: 1/2" = 1"

T. ANDROS
LIGA, RBC 5-2007

5.4 Budget Development

There are infinite possibilities for green roof design. Projects depend upon available technologies, the client's objectives, capital and maintenance budget, and the constraints and opportunities of the location. No two green roofs are the same, and each needs to have the costs and benefits calculated individually. There are many variables that influence the capital and maintenance costs of green roofs:

- Retrofit vs. new construction projects (e.g. the potential need for structural upgrades and re-roofing costs).
- Accessibility (e.g. railings and lighting).
- Degree to which maintenance is required.
- Market maturity.

Extensive green roofs typically require higher upfront capital costs (2 times more than a traditional roof), which are typically paid back over the life cycle of the building. For example, in some markets an extensive green roof has cost between 10 to 15 USD per square foot. Costs may vary by region and *Table 5.4.1* should only be used as a general guide. Not all green roofs require all of the cost elements described therein. A cost of $0.00 in the table indicates that the element may not be required in the design.

As seen in *Section 3.0* the cost of green roofs are prohibitively high. There are four means through which the cost of this technology can decrease over time:

- Public incentives at municipal, state/provincial, or federal levels
- Product development and technical innovation
- Integration with other building systems and programs
- Market expansion through improved delivery and training

5.4.1 Cost Estimation

Cost factors are aspects of the project that are often controlled by the design team and will determine the expense of a particular element. The price ranges below are not recommendations but rather represent a survey of historical prices for each element throughout North America.

Table 5.4.1 Green Roof Cost Ranges and Factors*

ELEMENT	PRICE RANGE (USD)	COST FACTORS
DESIGN	4-8% of project cost	Size and complexity of project.
PROJECT ADMIN. / SITE REVIEW	6-12% of project cost	Size and complexity of project and number of professions involved.
INITIAL STRUCTURAL EVALUATION	$0 (new) -$3000 (retrofit)	New versus existing building, Quality of documentation.
(RE) ROOFING WITH HIGH-QUALITY MEMBRANES	$0-12 / ft^2	Types of components, size, accessibility and the number of roof penetrations.
DRAINAGE	$1-$5.50 / ft^2	Type of drainage layer, size of project.
FILTER CLOTH	$0 -$0.50 / ft^2	May not be required.

Table 5.4.1 Green Roof Cost Ranges and Factors*

ELEMENT	PRICE RANGE (USD)	COST FACTORS
GROWING MEDIUM	*Extensive* $2 - $12 / ft^3	Volume / type of growing medium, shipping distances and method of conveyance to roof (crane, blower truck, manual etc).
	Intensive $2 - $20 / ft^3	
VEGETATION	*Extensive* $0.00 - $5.00 / ft^2	May not be required. Type and size of plants, time of year, seeds, cuttings, plugs, mats, pots, shrubs, trees – may require containers and / or anchorage.
	Intensive $1.25 - $10 / ft^2	
INSTALLATION	*Extensive* $2.40 - $6.40 / ft^2	Size of project, sophistication of design, type of planting approach, nature of access to roof.
	Intensive $6.40 – $14.40 / ft^2 (100 to 200 % of material costs)	
MODULAR GREEN ROOF SYSTEM (including vegetation, planting, growing medium & root repellant layer)	*Extensive* $10+ / ft^2	Sophistication of design, shipping, installation, plant species and density.
	Intensive $13+ / ft^2	
STRUCTURAL REINFORCEMENT OF EXISTING ROOF	(cost is highly dependent on existing structure)	May not be necessary. Consult a structural engineer to determine the load carrying capacity of any roof.
EROSION PROTECTION LAYER	$0- 0.30/ ft^2	May not be necessary if growing medium is not left exposed or vegetation is well established.
CURBS / BORDERS	$0 - $20 per linear foot	May not be necessary. Type (pre-cast concrete, aluminum edging, wood, gravel, timber borders, modular systems, recycled products etc.) and length.
WALKWAYS	$0 - $10.20 / ft^2	May not be necessary. Type (pre-cast concrete unit pavers, natural stone, wood decking, recycled products etc) and length.
RAILINGS	$0 - $65.45 per linear foot	May not be necessary. Material (aluminum, brass, wrought iron, welded steel, etc.). Thickness of railing. Number of rails. Roof deck penetration.
MAINTENANCE	*Extensive* $0.25 - $4.10 / ft^2 for the first two years	Size of roof, types of plants, nature of access.
	Intensive $1.00 - $4.10 / ft^2	
IRRIGATION SYSTEM	$0 - $5.00 per linear foot	May not be necessary. Type of irrigation system used and size of project.

*Costs may vary significantly due to regional differences
**Based on 2005 National Construction Estimator

Enkadrain®

Enkamat®

Enkaroof VM®

Colbond Building Products

Green Roof / Roof Garden Products

The thin line between comfort and catastrophe™

Enka-Engineered
BUILDING PRODUCTS

COLBOND

Roof garden plants can be exotic and colorful.

Sedum choices are endless in green roof applications.

Flowering plants add beauty to our habitat.

Green roof structures have been around for hundreds of years, dating back to the 18th century when innovative Northern Europeans constructed them for temperature control in their homes and surface run off water control in towns. Except for widespread use in Germany, it's taken the rest of the world a while to catch on to the multiple environmental benefits green roofs offer.

Benefits of Green Roofs & Roof Gardens

- **Energy Efficient**
  Green roofs reduce building cooling costs by controlling or reducing heat gain.
- **Reduces Urban Heat Island Effect**
  Dark roofs magnify the force of heat by holding onto it or reflecting it back into the urban zone making city life unbearable in summer months. Green roofs absorb the heat without magnifying it which directly contributes to environmental heat control.
- **Improves Microclimate**
  Reduces dust and smog in the air we breathe and produces oxygen we need to live.
- **Stormwater Reduction**
  Green roofs mitigate stormwater runoff saving city drainage systems from overload during peak flows. For municipalities there is a decreased need to expand or rebuild stormwater infrastructure.
- **Aesthetics**
  Green roofs are visually appealing and allow people to make use of garden areas for recreation and pleasure.

Green roofs are divided into two basic types - *intensive* and *extensive.* An intensive green roof is what is typically called a "roof garden." They are traditionally more expensive because the soil medium depths are between 8" and several feet to make growing small trees and a wide variety of other plant species possible. The structure must be built to support heavier loads. Extensive green roofs have a thinner profile which makes them lighter and more economical. The soil medium depth is from 2" - 6". Plants used in this roof type typically require less maintenance.

Colbond Building Products has developed a family of products used for drainage and root reinforcement in multi-layer green roof configurations:

Enkadrain 3811R is a drainage product consisting of a post-industrial recycle polypropylene core of fused, entangled filaments and nonwoven fabric bonded to two sides. The tangled filaments are molded into an elliptical pattern for maximum strength and continuous flow under any load. Smooth, thick Colback® fabric protects the waterproofing membrane and eliminates the need for a protection board. This heavy duty drainage mat conforms to irregular surfaces and corners with complete and effective coverage. Long rolls reduce installation costs by eliminating interlocking and excessive seams.

Enkadrain 3611R & 3615R have the same core as Enkadrain 3811R but have a nonwoven fabric bonded to only one side. This type of Enkadrain is used when extra protection for the waterproofing membrane is not needed.

Enkadrain 9120 is perfect for lateral drainage of roof decks in applications where a thicker air layer is desired. The .8" nylon core of fused, entangled filaments creates a 95% open structure which provides the highest thermal properties available in the Enkadrain product line.

Installation of the rolled Colbond products is easy and fast.

Enkamat 7010 - Root Reinforcement Matrix permanently anchors plant roots on sloped roofs or in high wind conditions. The 95% open structure of Enkamat is designed to ensure that any type of vegetative growth is not restricted when interacting with the mat. As the roots grow they become entwined within the Enkamat, making an extremely stable cover. Its tough root reinforcing system anchors vegetation and provides a holding cavity for the growing medium.

Enkaroof VM is an Enkamat core with a non-woven fabric attached to the bottom side designed for pre-vegetated mat applications. The mat is filled with the growing medium and plants are grown directly in the mat structure. After the plant roots are established and entwined within the Enkamat, the mat is ready for transport. The fabric holds soil medium and vegetation in place while the flexible matting is rerolled and shipped to the installation location. This unique application has been highly successful in Europe.

*Plants are grown directly in Enkaroof VM and transported to the site ready to unroll.***

All geocomposite drains are not created equal. There are significant benefits of using Enkadrain instead of rigid cuspated drains:

- Enkadrain is flexible and will conform to any surface profile
- Enkadrain is safer to work with — it has no sharp edges and corners
- Enkadrain has multi-directional flow (no hard plastic back to trap water)
- Enkadrain will not promote root rot
- Enkadrain contributes to LEED points

Why use Enkadrain instead of mineral drainage layers?

- No aggregate is needed with Enkadrain which reduces the total roof weight
- Enkadrain provides an air layer for better insulation and allows the roots to breathe
- Enkadrain provides multi-directional flow and has proven and predictable flow rates
- Enkadrain has a nonwoven filter fabric attached which helps protect waterproofing membrane from overload and rock penetration
- Aggregate systems do not drain water as well - roots may be exposed to root rot in standing water

Enkadrain was the first drainage composite introduced into the marketplace over 25 years ago. Our European offices in the Netherlands and Germany have tested our products in extensive research studies at the University of Hanover, Germany. Based on this experience shared across the ocean, Colbond has developed relationships in North America with the fastest growing leaders in green roof technology and has been involved in some of the most innovative installations on the continent.

*Enkadrain is manufactured with a 3" fabric overlap for simple seaming.**

*Enkadrain products are flexible, lightweight, and safer for the installation crew to handle.**

Project Name	Location	Enka Products	Size
Epworth Manor Nursing Home	Tyrone, PA	Enkadrain 9010 Enkamat 7010	3,000 sq. ft
Cleveland Environmental Center	Cleveland, OH	Enkadrain 9615 Enkamat 7010	800 sq. ft.
Village Mall	Queens, NY	Enkadrain 9811	56,000 sq. ft.
Union Square	San Francisco, CA	Enkadrain 9812	29,000 sq. ft.
Lyman Woods	Chicago, IL	Enkadrain 9615 Enkamat 7010	2,000 sq. ft.
Wallace Properties	Vermont	Enkadrain 9615 Enkamat 7010	4,000 sq. ft.
Millennium Park	Chicago, IL	Enkadrain 9615	320,000 sq. ft.
Chicago City Hall	Chicago, IL	Enkamat 7004	25,000 sq. ft.
City of Chicago Green Building Coalition	Chicago, IL	Enkamat 7004	5,000 sq. ft.
NJ Statehouse	Trenton, NJ	Enkadrain 9812 Enkadrain 9615	175,000 sq. ft.
International Plaza	Atlanta, GA	Enkadrain 9120	180,000 sq. ft.

Note: 3000R Series drains can be used in place of 9000 Series drains.

Enkadrain will not crush even under the heaviest of loads.

Preparation for the Enkadrain layer at the New Jersey State House.

Union Square in San Francisco, CA is home to the first subterranean parking garage in the United States.

WARRANTY

Colbond Inc. (Colbond) and MFM Building Products Corp. (MFM) warrant that Enkadrain SubSeal Waterproofing System products, when installed in accordance with each product's published installation instructions, are free from manufacture defects for 20 years. This warranty is transferable by the owner of the building structure at the time of initial installation of the Enkadrain SubSeal Waterproofing System products.

Under this warranty Colbond or MFM shall ONLY be liable, at its option, to return the purchase price or replace the Enkadrain SubSeal Waterproofing System product. IN NO EVENT SHALL COLBOND OR MFM BE LIABLE FOR CONSEQUENTIAL DAMAGES OR DAMAGES OF ANY KIND EXCEEDING THE SALE PRICE OF THE ENKADRAIN SubSeal WATERPROOFING SYSTEM PRODUCT FOUND TO HAVE BEEN DEFECTIVE. COLBOND OR MFM MAKES NO WARRANTIES, EXPRESSED OR IMPLIED BY OPERATION OF LAW OR OTHERWISE INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF END USE.

Enkadrain SubSeal Waterproofing System products include, Enkadrain 3611R, Enkadrain 3615R, Enkadrain 3811R, SubSeal-40, SubSeal-60, Enkadri & Drain BTM, and Enkadri Pour & Proof.

We Have Proven Results

From revolutionary one-step below ground drainage and waterproofing systems to roll out sound attenuation matting for residential and commercial buildings, our products are well-known for quality and proven performance. State of the art R&D and production facilities give us the ability to adapt our products to meet the challenges of the constantly changing construction market.

2005 Platinum Level Sponsor

Cover Photo Key

1 Chicago City Hall - Chicago, IL

2 Millennium Park - Chicago, IL

* Photos courtesy of The Garland Company, Inc.

** Photo courtesy of Emery Knoll Farms

Colbond Inc.

Colbond Inc. is a technology-based global producer of multi-dimensional matrix and nonwoven products. Within Colbond there is a world of technical experience spanning the globe. Innovative product development and manufacturing expertise make Colbond a leader in polymer processing technology. Colbond's family of multi-dimensional matrix products are manufactured from nylon, polyolefins, and polyester. The open structure allows for free movement of air, water, resin, and foam. Our technology allows us to heat-bond, glue, ultrasonic weld, and stitch textiles, foils, and paper creating some of the most innovative products available in the market today. For a complete overview of our products sold in the flooring, construction, automotive, civil engineering, and building and industrial markets visit www.colbond.com.

COLBOND

Sand Hill Road
P.O. Box 1057
Enka, N.C. 28728
Tel. (+1) 828-665-5050
Toll Free: (+1) 800-365-7391
Fax (+1) 828-665-5009

email:
enka-engineered@colbond.com

Internet:
www.colbond-usa.com

EnkaRetain & Drain® 3111

Colbond Building Products — Drainage

Description

EnkaRetain & Drain is one of a new generation of products designed specifically for vegetated roofs. This multi-function composite consists of a 50% post-industrial recycled polypropylene drainage core of fused, entangled filaments and a specially formulated water retention fabric bonded to one side. The entangled filaments are molded into a square waffle pattern that maintains the flexible design of other Enkadrain products. The composite water retention fabric consists of a 8 oz/yd² - 100% post consumer recycled non-woven polyester fabric mechanically bonded to a 12 oz/yd² layer of synthetic hydrophilic (water) absorbent matte. The absorbent matte is designed to hold 10 to 12 times its unit weight of water. It is a very strong, durable composite that is extremely resistant to puncture and tearing. The composite is inert to biological degradation and naturally encountered chemicals, alkalis, and acids. This product can help contribute up to 2 LEED points when used in conjunction with other recycled content products. As a part of a green roof it can contribute towards additional LEED points by reducing stormwater runoff, heat islands and energy consumption.

Recommended Applications

- Extensive green roofs
- Intensive green roofs
- Exterior & interior planters
- Landfill caps

Features and Benefits

- Excellent durability
- Protects waterproofing during and after placing of planting media
- Conforms to irregular surfaces and offsets
- Waffle design creates open flow path — even during loading of planting media
- Long rolls reduce installation costs by reducing butt seams and eliminating interlocking
- Recycled content polymer in core and fabric contributes towards LEED points
- Provides superior water holding capacity
- Reduces runoff volume in green roof applications
- 3” fabric overlap flap

Technical Data

Physical Properties

Property	English Units	Metric Units
Core Material	*Recycled Polypropylene*	
Total Thickness	*0.60 in*	*mm*
Total Weight (avg.)	*36.0 oz/yd ^{2}*	*g/m ^{2}*
Core Thickness	*0.40 in*	*mm*
Core Weight (avg.)	*16.0 oz/yd ^{2}*	*g/m ^{2}*

Flow Rates

Pressure	1.0 Gradient	0.1 Gradient
1000 psf	*23.0 gal/min/ft*	*6.9 gal/min/ft*

Typical flow vs. pressure for vertical applications (ASTM D 4716) Sample Configuration: Plate/Enkadrain/Plate
Values are average of machine direction and cross machine direction test results

Colbond Inc.
PO Box 1057
Enka, NC 28728
Telephone 800-365-7391
Fax 828-665-5009

EnkaRetain & Drain® 3111

Colbond Building Products — Drainage

Technical Data

Fabric Properties

Property	English Units	Metric Units	Test Method
Polymer	*Polypropylene Recycled Polyester*		
Fabric Color	*Light Green*		
Weight	*20.0 oz/yd ^{2}*	*g/m ^{2}*	*ASTM D 5261*
Thickness	*165 mils*		*ASTM D-5199*
Grab Strength MD	*135.0 lbs*	*kN*	*ASTM D 4632*
Grab Elongation MD	*70%*	*70%*	*ASTM D 4632*
Mullen Burst Strength	*300 psig*		*ASTM D 3786*
Puncture Strength	*70.0 lbs*	*0.31 kN*	*ASTM D 4833*
Water Holding Capacity	*1000-1200%*		*ASTM D 4250*
Water Holding Capacity	*0.10– 0.15 gal/ft ^{2}*		*ASTM D 4250*

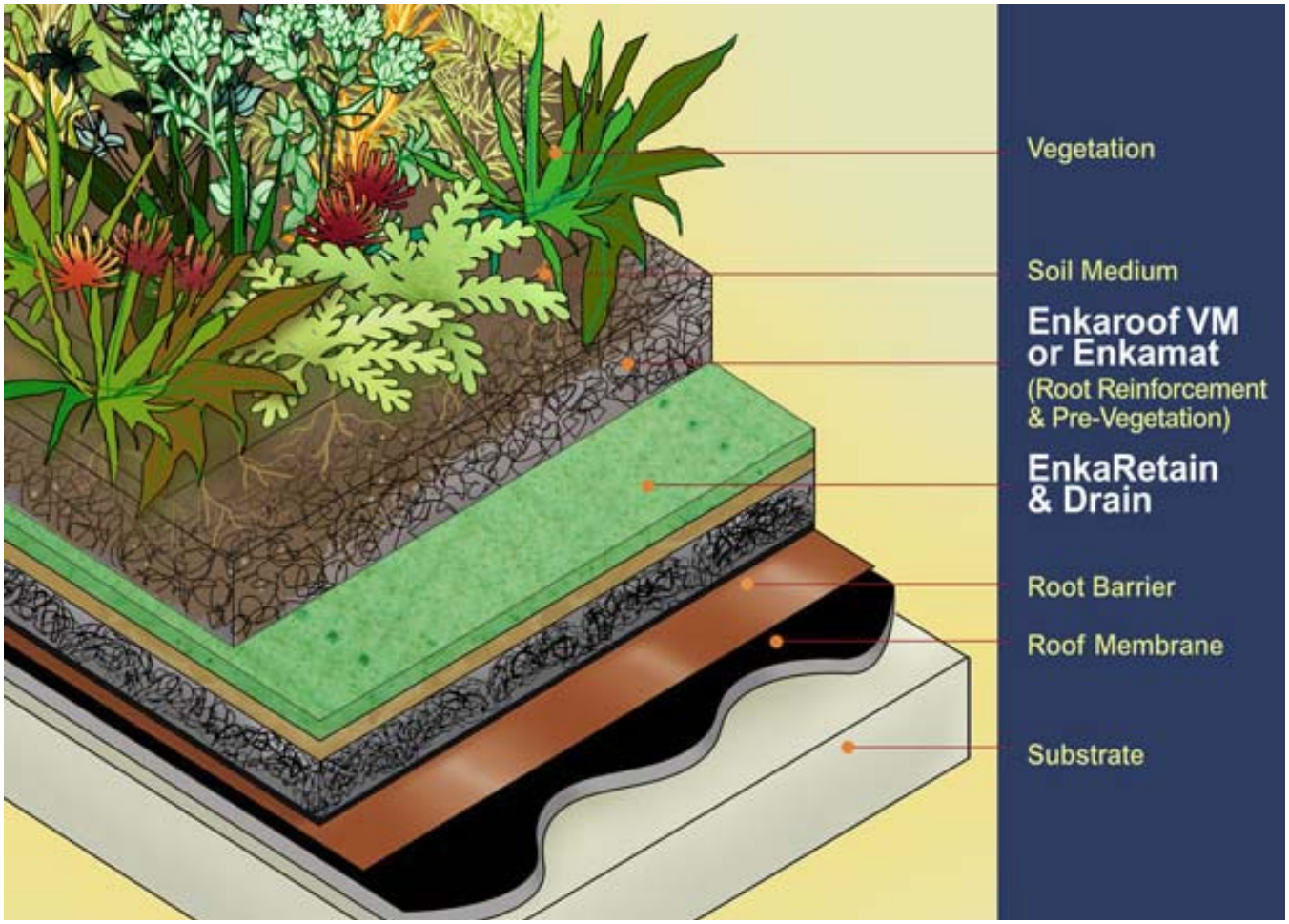
Polymer Properties

Polypropylene has excellent resistance to organic solvents, degreasing agents, acids, and alkalines. It has tensile strength superior to high density polyethylene. It is has a low moisture absorption rate, is resistant to staining, and is very light weight.

Packaging

Property	English Units	Metric Units
Product ID	*3611-061-4000*	
Core Width	*39.0 in*	*99.1 cm*
Length	*61.5 ft*	*18.6 m*
Area	*22.2 yd ^{2}*	*18.6 m ^{2}*
Area	*200.0 ft ^{2}*	*18.6 m ^{2}*
Roll Diameter	*27.0 in*	*68.6 cm*
Gross Roll Weight	*58.0 lbs*	*26.4 kg*

Colbond Inc.
PO Box 1057
Enka, NC 28728
Telephone 800-365-7391
Fax 828-665-5009


Vegetation
Soil Medium
Enkaroof VM
or Enkamat
(Root Reinforcement
& Pre-Vegetation)
EnkaRetain
& Drain
Root Barrier
Roof Membrane
Substrate

COLBOND

Lenetta Heiland
Regional Sales Manager

T 828-712-4918
F 828-665-5009
E lenetta.heiland@colbond.com
W www.colbond-usa.com

Colbond Inc.
265 Sagamore Cove
Sugar Hill, GA 30518
USA

James Greenhouses
1699 Crawford Smithonia Rd.
Colbert, GA 30628
(706)742-7802

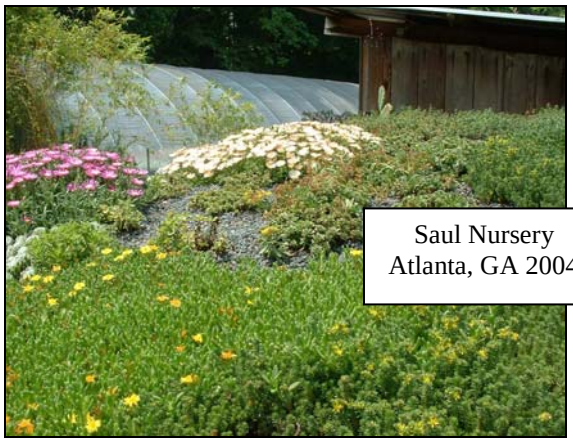
Ken and Leah James

2006-2007 PRICING

	VARIETY	PLUG SIZE	PRICE EACH	ROYALTY	HARDINESS ZONE	DESCRIPTION
	Delosperma cooperi	70	0.48		5-9	Magenta. Succulent foliage. Summer. 4"
	Delosperma cooperi 'Mesa Verde'™ PP#13876	70	0.57	0.12	4-8	Irridescent salmon-pink. Blooms all summer. 2'
	Sedum kamtschaticum	70	0.52		4-9	Gold. Green scalloped leaves. June-Aug. 6"
	Sedum kamtschaticum 'Variegatum'	70	0.52		4-9	Gold. White variegated leaves. June-
NEW	*Sedum makinoi* 'Limelight'	70	0.52		6-9	Tiny chartreuse leaves. Likes some shade. 2"
	Sedum makinoi 'Ogon'	70	0.52		6-9	Tiny gold leaves. Likes some shade. 2"
	Sedum reflexum 'Blue Spruce'	70	0.52		4-9	Yellow. Blue needled foliage. 6"
	Sedum rupestre 'Angelina' PPAF	70	0.52	0.08	3-8	Gold needled foliage w/bronze fall color. 6"
	Sedum sieboldii	70	0.52		3-7	Pink. Handsome gray foliage. Late Summer. 12
	Sedum spectabile 'Neon'	70	0.52		4-9	Neon pink fading to bronze. Upright. Fall. 16"
	Sedum spurium 'Tricolor'	70	0.52		3-7	Pink, white & green foliage. 4"
	Sedum tetractinum	70	0.52		3-7	Yellow. Rounded green leaves. Summer. 6"
	Sedum x 'Autumn Joy'	70	0.52		3-8	Rose-pink fading to bronze. Upright. Fall. 24"
	Sedum x 'Vera Jameson'	70	0.52		3-7	Pink. Bronze leaves. Summer. 12"

STALITE PermaTill®
HORTICULTURAL AGGREGATES
Putting Down Permanent Roots !
A Division of Carolina Stalite Company

GreenRoof Planting Media


Saul Nursery
Atlanta, GA 2004

Extensive Green Roof Media

Stalite Expanded Slate (coarse)	80%
Compost	20%


North Park 400
Atlanta, GA 1997

Intensive Green Roof Media

Stalite Expanded Slate (coarse)	55%
USGA Sand & Stalite (fines) Blend	30%
Compost	15%

For over a decade, Carolina Stalite Company has been providing the most specified and successful green roof growing media in the United States. As the leaders in lightweight aggregate technology for sustainable horticulture we are proud that several of the most prestigious and award winning green roofs in America utilized PermaTill® as the growing media. The long term results are proof…..durability, permeability, and a ten-year track record assure peace of mind.

Specifications Available

Extensive Garden	2"-6" depth
Semi-Intensive Garden	6"-12" depth
Intensive Garden	> 10" depth

FEATURES &/ BENEFITS

- Resists decomposition
- Provides excellent drainage & aeration
- Retains nutrients
- Won't clog filter systems
- Reduces storm water runoff
- Offers increased insulation

Other Sustainable Horticultural Applications with Stalite PermaTill®:

Green Roof Media Plant Requirements

Plants	Minimum Media Depth
Sedums	1" to 3" +
Groundcovers and Grasses	8" to 10" +
Shrubs	18" to 24" +
Large Shrubs, Small Trees	24" to 3' +
Trees	3' +

Structural soils for turf areas and fire lanes ● Structural soils for planting urban trees ● Existing tree root bridging and compaction reduction ● Landscape soil additive for improving aeration and drainage ● Protecting roots from vole damage ● Greenhouse and nursery production ● Bio-retention and rain garden media ● Pathways and decorative stone ● Geotechnical uses ● Permeable pavement

877-737-6284 **www.permatill.com**

ITSAUL NATURAL, LLC

ERNIE HIGGINS

124 FREIGHT LANE, DAHLONEGA, GA 30533
(800) 301-2887 • (706)-864-7664
FAX (706) 864-0521

STALITE *PermaTill®*

ROTARY KILN EXPANDED LIGHTWEIGHT AGGREGATE

CHUCK FRIEDRICH, ASLA
Horticultural Aggregates

Carolina Stalite Company
217 Klumac Rd. - P.O. Box 1037
Salisbury, NC 28144
Email: cfriedrich@stalite.com

1-800-898-3772
704-637-1515
FAX: 704-642-1572
Web Site: www.permatill.com

GREENGRID®
The Natural Choice for Your Roof

The PREMIER Green Roof System

Specifications Summary

ELEMENT	DESCRIPTION
Module sizes ***(nominal)***	2 ft. x 2 ft. x 2.5 in. 2 ft. x 2 ft. x 4 in. 2 ft. x 4 ft. x 4 in. 40 in. x 40 in. x 4 in. 2 ft. x 2 ft. x 2.8 ft. x 4 in. (triangle) 2 ft. x 2 ft. x 8 in. 2 ft. x 4 ft. x 8 in.
Depth of modules ***(three depths)***	2.5 in., 4 in., and 8 in. (nominal)
Weight of planted modules ***(when wet)***	2 in. depth – Approx. 10-12 lb. per sq. ft. 4 in. depth – Approx. 15-18 lb. per sq. ft. 8 in. depth – Approx. 30+ lb. per sq. ft. *(Weight may vary based on requirements for project-specific vegetation selections and variations in regional materials incorporated in growth media.)*
Module material	60% post-industrial recycled High Molecular Weight Polyethylene – 150 mil. (2.5 and 4 in.) – 175 mil. (8 in.)
Module drainage clearance above roof	0.5 in.
Color of modules	Black
Drainage/root resistance medium	3 oz. spunbonded polypropylene geotextile
Growth media	Proprietary mixture consisting of organic and inorganic material
Slip sheet protection fabric	6 oz. non-woven geotextile slip sheet. *(Installation of slip sheet between GreenGrid® modules and roof surface is recommended.)*
Vegetation	Perennials, grasses, or shrubs specifically selected for climate, hardiness zone, color, and size.

OPTIONAL ELEMENTS

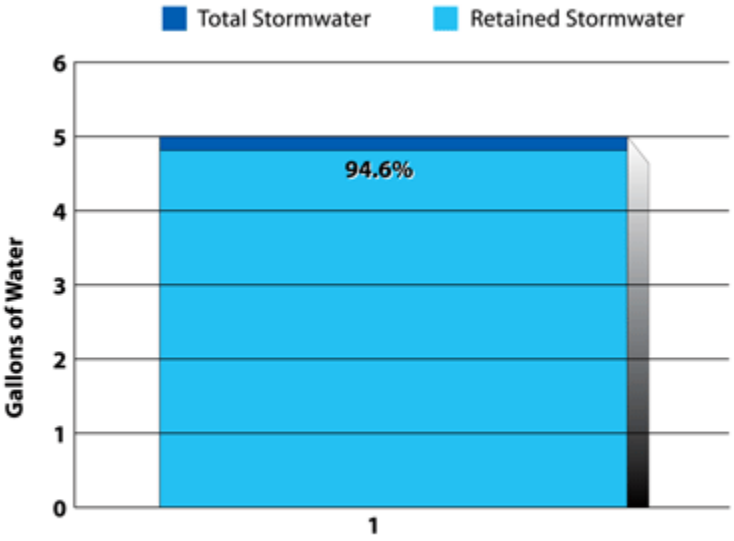
Paver size	2 ft. x 2 ft. (various depths available)
Paver material	100% recycled rubber
Paver colors ***(standard)***	Forest green, charcoal, brick red, black, and blue *(other, non-standard colors available)*
Paver weight	7.5 lb. per sq. ft. *(based on 1.75 in. depth)*
Edge treatments	Aluminum or steel, available in various colors and designs.

WESTON SOLUTIONS

Southern Division – Sales *(GA, TX)* **Georgia** Suite 100 5430 Metric Place Norcross GA 30092-2250	***Georgia Sales*** **Kim Veal** Phone: (770) 325-7942 Fax: (770) 325-7950 Kim.Veal@greengridroofs.com **Kimberly Sanders** Phone: (770) 325-7962 Fax: (770) 325-7950 Kimberly.Sanders@greengridroofs.com

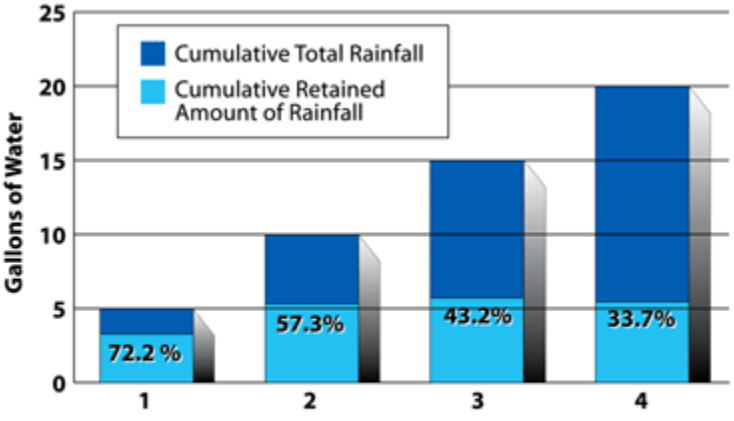
Stormwater Retention for 4-inch Modules, 1-Inch Over 1-Hour Storm Event

Stormwater Retention for 4-Inch Modules, 1-Inch Over 1-Hour Storm Event



Cumulative Water Retention in an 4-inch GreenGrid® Unit During a Simulated 2-Hour Rain Storm

Cumulative Water Retention in a 4-Inch GreenGrid® Unit During a Simulated 2-Hour Rain Storm



GREENGRID®
The Natural Choice for Your Roof

Do-It-Yourself Green Roof Kit

The GreenGrid DIY Kit makes installing a green roof at home easy and affordable. The specially designed plastic modules are lightweight and simple to handle. Each kit is delivered with the 2'X2'X4" modules, a root barrier material, growth media and plants. The assembled modules are placed on a roof to create a green roof.

WESTON SOLUTIONS®

Specifications, Plant Palletes, and Installation Requirements

Components of the GreenGrid® DIY Kit

The DIY Kit is delivered directly to the installation site and consists of four main components – plastics modules, geotextile root & soil barrier, growth media, and plants.

The Plastic Modules

Modules are made of 60% recycled high-density polyethylene and were designed specifically for the purpose of creating green roofs. The 2 foot by 2 foot size makes the modules easy to handle and maneuver.

The Root & Soil Barrier

This geotextile fabric-like material is inserted into the module before the growth media and serves as a barrier to roots and soil media passing through the drainage holes.

The Growth Medium

The growth media has been specially developed to be both light-weight and ideal for supporting the plants that make up a green roof. The growth media comes in sacks measured to fill one module per sack.

The Plants

There are five plant palettes available for selection. Each palette contains plants specifically selected for their hardiness, drought tolerance and low maintenance requirements. Below is a description of each of the palettes available.

Plant palettes

Palette Name	Foliage Color	Flower Color and Flowering Times	
The Blues	Blue to Blue Green	Pinks and Yellows	May to Sept
Fire and Ice	Blues and Redish Greens	Pinks and Yellows	June to Sept
Classic Sedum Mix	Greens, Blues, and Reds	Pinks, Yellows and White	June to July
The Yellow Submarine	Greens and Yellow	Yellows and Yellow-Greens	June to July

Installation Requirements

Structural Capacity - It is the responsibility of the owner to determine if the structural capacity is present to support the GreenGrid Green Roof. Planted modules weigh 15 pounds per square foot when fully saturated with water.

Roof/Surface Condition - The surface intended for the green roof must be in good repair and free from leaks.

Roof/Surface Maximum Slope - The GreenGrid Green Roof System can only be installed on roofs with a slope of less than 5% . Steeper slopes can result in GreenGrid modules sliding off the surface.

Permits and Approvals - Any local permits or approvals are the responsibility of the owner.

Installation - It is the owners decision whether to assemble all of the components on the roof or on the ground. This generally will depend on accessibility of the roof. Care must be taken to assure proper barriers are provided at the roof to eliminate the potential for falling.

For more information or to order your GreenGrid DIY Kit contact us at
847-918-4011 or e-mail us at DIY@GreenGridRoofs.com
(please indicate "DIY Kit" in the subject box of your e-mail)

Installation of a GreenGrid system may require heavy lifting and transporting of modules and appropriate precautions should be taken. If installation is on a roof top or elevated structure appropriate fall protection measures should be taken to protect installers and persons located below the installation. If installation is on an elevated structure or roof that structure must support the weight of the modules and installers during the installation process. Weston Solutions, Inc. assumes no responsibility for the structural integrity of any roof or elevated structure or for the safety of any person involved in the purchase and installation of a GreenGrid DIY system.

GREENGRID
The Natural Choice for Your Roof

DIY Kit

Plant Palettes

Contact us at:
Phone: 847-918-4011
Fax: 847-918-4055
e-mail: DIY@GreenGridRoofs.com

The Blues

Plant Name	Average Height	Average Spread	Foliage Color	Flower Color	Bloom Time
Sedum cauticola 'Lidakense'	8-12″	6-8″	Bluish Red	Pink	Aug-Sept
Sedum reflexum	6-8″	18-24″	Blue	Yellow	July
Sedum rupestre 'Forsteranum'	6-8″	12-18″	Blue	Yellow	June-July

Fire & Ice

Plant Name	Average Height	Average Spread	Foliage Color	Flower Color	Bloom Time
Sedum cauticola 'Lidakense'	8-12″	6-8″	Bluish Red	Pink	Aug-Sept
Sedum album	3-6″	12-18″	Green	White	June-July
Sedum reflexum	6-8″	18-24″	Blue	Yellow	July
Sedum rupestre 'Forsteranum'	6-8″	12-18″	Blue	Yellow	June-July
Sedum spurium "Dragon's Blood"	3-6″	12-18″	Redish Green	Pink	June-July
Sedum spurium "Fuldaglut"	3-6″	12-18″	Redish Green	Pink	July

The Classic Sedum Mix

Plant Name	Average Height	Average Spread	Foliage Color	Flower Color	Bloom Time
Sedum album	3-6″	12-18″	Green	White	June-July
Sedum "Bailey's Gold"	3-6″	12-18″	Green	Golden Yellow	June-July
Sedum spurium "Fuldaglut"	3-6″	12-18″	Redish Green	Pink	July
Sedum kamtschaticum	6-8″	12-18″	Green	Golden Yellow	June-July
Sedum reflexum	6-8″	18-24″	Blue	Yellow	July
Sedum sexangular	6-8″	6-8″	Green	Yellow	June-July

The Yellow Submarine

Plant Name	Average Height	Average Spread	Foliage Color	Flower Color	Bloom Time
Sedum acre	3-6″	12-18″	Green	Yellow	June-July
Sedum "Bailey's Gold"	3-6″	12-18″	Green	Golden Yellow	June-July
Sedum hybridum 'Immergrunchen'	3-6″	18-24″	Green	Yellow	June-July
Sedum kamtschaticum	6-8″	12-18″	Green	Golden Yellow	June-July
Sedum rupestre 'Forsteranum'	6-8″	12-18″	Blue	Yellow	June-July
Sedum sexangular	6-8″	6-8″	Green	Yellow	June-July

Please Note:
Plant substitutions with similar varieties may be required based on location, USDA plant hardiness zone, and plant availability. Similar species will be used to preserve the overall look and character of the specific plant palettes.

GREENGRID The Natural Choice for Your Roof DIY Kit

Price List – Spring/Summer 2007

Contact us at:
Phone: 847-918-4011
Fax: 847-918-4055
e-mail: DIY@GreenGridRoofs.com

Material Pricing

Pricing per module with 9-plants per module	
Plant palette options	**Price per module**
Classic Sedum Mix *(min. order of 12 modules)*	$ 45.78
Yellow Submarine *(min. order of 12 modules)*	$ 45.78
Fire & Ice *(min. order of 12 modules)*	$ 45.78
The Blues *(min. order of 12 modules)*	$ 45.78

Pricing per module without plants (plants to be supplied by others)	
Module/Mix/Root Barrier Only *(min. order of 12 modules)*	$ 36.25

Shipping and Handling Prices

Shipping Zones	Modules/Mix/Root Barrier	Plants (for first 12-25 modules)	Plants (for each additional 25 modules)
Zone 1 (Chicagoland Area) - deliveries in this zone are made on Fridays only	$ 114.00 (for every 300 modules)	$45.60	$39.40
All other Zones	Call for Quote		

Please Note:

1) Each module takes up a 4-square foot area

2) Buyers must order the minimum number of modules specified.

3) All orders must be pre-paid.

4) Order lead time is 2 to 3 weeks from receipt of payment. Acceptable methods of payment are check, money order, or Visa/Mastercard/Discover

5) Material and shipping costs are subject to change

6) Customer self pickup is not available

7) Plant substitutions may occur based on availability.

GREENGRID® The Natural Choice for Your Roof

DIY Kit

Order Form – Spring/Summer 2007

For questions regarding this form call
847-918-4011 or Send e-mail to
DIY@GreenGridRoofs.com

Please provide the ship to address for all materials	Contact Information	
Name:	**Daytime phone**	
Ship to address:	**Evening phone**	
	e-mail	

Refer to Price sheet for material and shipping costs

Materials cost Modules	Qty	Price per module	Total price
Classic Sedum Mix *(min. order of 12 modules)*		$45.78	
Yellow Submarine *(min. order of 12 modules)*		$45.78	
Fire & Ice *(min. order of 12 modules)*		$45.78	
The Blues *(min. order of 12 modules)*		$45.78	
Module/Mix/Root barrier Only *(min. order of 12 modules)*		$36.25	
		Materials total	

Shipping Costs	Cost
Shipping cost for modules/mix/root barrier (Zone 1 - $114 for every 300 modules; all others call for quote)	
Plant shipping cost for first 12- 25 modules	$45.60
Plant Shipping cost for each additional 25 modules ($39.40 per each additional 25)	
Shipping cost total	
Materials total	
Grand total	

Payment Options:

To pay by check or money order

- Make check or money order payable to *Weston Solutions, Inc.*
- Mail order form with check or money order to:

Weston Solutions, Inc.
GreenGrid Accounts Payable
750 E. Bunker Court; Suite 500
Vernon Hills, IL 60061

To pay by credit card (Visa, MC, or Discover ONLY) please fill in the following information

Card Type (check applicable box)		**Visa**		**Mastercard**		**Discover**
Cardholders name as it appears on card						
Billing address as it appears on card statement						
Credit Card Account Number		**Exp. Date**		**3-digit security No.** (on back of card)		
Card Holder Signature				**Date**		

Please fax completed Credit Card orders to 847-918-4055

For Office Use Only	**GL Account Number**		**OU Number**	

NOTE: Installation of a GreenGrid® system may require heavy lifting and transporting of modules and appropriate precautions should be taken. If installation is on a roof top or elevated structure appropriate fall protection measures should be taken to protect installers and persons located below the installation. If installation is on an elevated structure or roof that structure must support the weight of the modules and installers during the installation process. Weston Solutions, Inc. assumes no responsibility for the structural integrity of any roof or elevated structure or for the safety of any person involved in the purchase and installation of a GreenGrid® DIY system.

geoedge™

Greenroof Restraint Systems

designing for the future

GeoEdge is a complete line of lightweight aluminum edge restraint products specifically designed for use in a greenroof environment. A sturdy, L-shaped profile provides a stable edge that can be used in a number of rooftop applications. GeoEdge is available with a solid or slotted wall. Wall heights from 1" to 4".

EcoEdge with custom footings prior to install.

Making it easier to be green.

- Strong, tempered aluminum
- Stable L-shaped profile
- Sliding connection system

100% Recyclable
LEED Approved

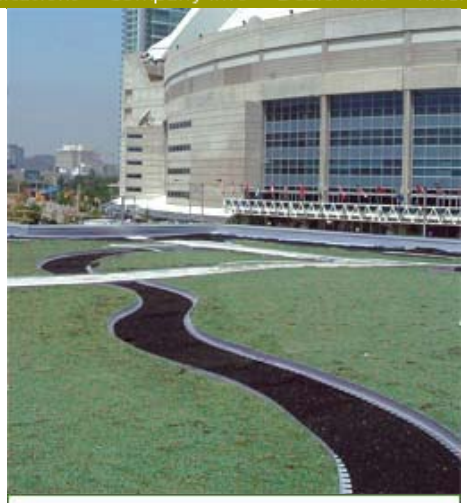
geoedge™

1.800.356.9660
www.permaloc.com

A PRODUCT BY permaloc
WORLD'S BEST LANDSCAPE EDGING

GEO03801

Why Edging?
Why Aluminum?
Why Permaloc?
Product Specs
Ease of Install
References
Do-It-Yourself



Top photo courtesy of Elevated Landscape Technologies

Permaloc GeoEdge™ Restraint System

GeoEdge Applications
GeoEdge Product Specs
GeoEdge Installation Instructions
Download GeoEdge Literature

Product Description

GeoEdge is a complete line of lightweight aluminum edge restraint products specifically designed for use in a greenroof environment.

A sturdy, L-shaped profile provides a stable edge that can be used in a wide variety of rooftop applications.

GeoEdge is available with a solid wall, or a slotted wall to allow for water runoff and drainage. Wall heights from 1” to 4”.

GeoEdge is LEED Approved and is 100% recyclable.

Product Background

GeoEdge is designed to provide a high quality edge restraint system for the emerging Greenroof Industry. Using the proven principles that have made Permaloc's "L"-shaped products the standard in the landscaping industry, we developed a product specifically designed to integrate with greenroof materials.

From residential roofs to large-scale commercial and government projects, GeoEdge offers the greenroof industry a lightweight, flexible restraint that provides a finished look and assures an easy installation.

Product Applications

GeoEdge is engineered for use in greenroof applications. GeoEdge can be used to retain greenroof planting material, as well as pavers and tiles for rooftop walkways. GeoEdge has been proven successful for both Intensive and Extensive Greenroofs. In addition to GeoEdge, many of Permaloc's versatile products have been used for special greenroof applications. Contact Permaloc for the best solution to your greenroof needs.

Design Features

Permaloc GeoEdge offers these unique features:

- GeoEdge has numerous patented features and is performing on installations internationally.
- Wall heights include 1", 1-1/2", 2", 2-1/2", 3", & 4".
- Finishes include Mill Finish and Black DuraFlex (painted).

- A unique sliding connection system provides a continuous installation.

Product Sizes and Finishes

(A) Sizes: (wall x base)

1" x 2-1/4"
1-1/2" x 2-1/4"
2" x 2-1/4"
2-1/2" x 2-1/4"
3" x 3"
4" x 3"

(B) Finishes

Mill Finish	(Natural Aluminum)
Black DuraFlex	(Electrostatically applied baked on acrylic paint)

1 (800) 356-9660 (US & Canada) info@permaloc.com

permaloc®

THE WORLD'S BEST LANDSCAPE EDGING.

2007 WHOLESALE PRICE LIST

Effective January 1, 2007

TERMS & CONDITIONS

1. PRICING: This price list includes Wholesale Prices.

2. SHIPPING: Orders of less than one full box will be subject to a broken pack fee. Refer to product pricing sheet for product packaging. Drop Shipments: Permaloc offers drop shipments directly to your customer or jobsite.

3. CREDIT POLICY: Standard issued terms are 30 days net upon approved credit. Permaloc reserves the right to establish credit terms independent from those listed above or to terminate an open account status at our discretion.

4. RETURNS: There is a 25% restocking charge for returns, which will be deducted from the amount of the credit. All return freight costs will be paid for by the distributor.

5. DAMAGED OR MATERIAL SHORTAGES: Freight bill of lading must be signed "Received Damaged" or "Received Short ___# of packages" at the time of delivery. This is our only recourse to collect damages from freight companies. Please carefully check your shipments immediately upon receipt. Notify your Permaloc salesperson as soon as possible for instructions on how to handle damaged or missing shipments.

6. BUSINESS HOURS: Monday - Friday 7:30AM - 5:00PM Eastern Standard Time.

Permaloc Corporation reserves the right to revise its terms or pricing at anytime.

permaloc
THE WORLD'S BEST LANDSCAPE EDGING.

2007 PRICE LIST

GEOEDGE™ *Prices are per foot.*

		PACKAGING			WHOLESALE PRICING			
		SEC	FEET	STKS	1200 +	600 +	200 +	0+
36100	GeoEdge 1" x 2" Mill Finish	33	264	-	$ 1.16	$ 1.29	$ 1.39	$ 1.50
36103	GeoEdge 1" x 2" Black DuraFlex	33	264	-	$ 1.39	$ 1.55	$ 1.67	$ 1.80
36150	GeoEdge 1.5" x 2" Mill Finish	27	216	-	$ 1.33	$ 1.49	$ 1.60	$ 1.73
36153	GeoEdge 1.5" x 2" Black DuraFlex	27	216	-	$ 1.60	$ 1.79	$ 1.92	$ 2.07
36200	GeoEdge 2" x 2" Mill Finish	22	176	-	$ 1.54	$ 1.72	$ 1.84	$ 1.98
36203	GeoEdge 2" x 2" Black DuraFlex	22	176	-	$ 1.84	$ 2.06	$ 2.21	$ 2.38
36250	GeoEdge 2.5" x 2" Mill Finish	18	144	-	$ 1.77	$ 1.97	$ 2.12	$ 2.29
36253	GeoEdge 2.5" x 2" Black DuraFlex	18	144	-	$ 2.12	$ 2.36	$ 2.54	$ 2.73
36300	GeoEdge 3" x 3" Mill Finish	14	112	-	$ 2.30	$ 2.57	$ 2.75	$ 2.96
36303	GeoEdge 3" x 3" Black DuraFlex	14	112	-	$ 2.76	$ 3.07	$ 3.30	$ 3.56
36400	GeoEdge 4" x 3" Mill Finish	11	88	-	$ 2.87	$ 3.19	$ 3.44	$ 3.70
36403	GeoEdge 4" x 3" Black DuraFlex	11	88	-	$ 3.45	$ 3.84	$ 4.13	$ 4.45

Custom sizes available. Contact Permaloc for more information.

STAKES *Prices are each.*

		PIECES	PACK	WHSL
90120	Mill Finish CleanLine 12" Stake	75	Box	$ 0.97
90123	Black DuraFlex CleanLine 12" Stake	75	Box	$ 1.19
90124	Green DuraFlex CleanLine 12" Stake	75	Box	$ 1.19
90125	Bronze DuraFlex CleanLine 12" Stake	75	Box	$ 1.19
90127	Black Anodized CleanLine 12" Stake	75	Box	$ 1.27
90180	Mill Finish 18" Stake	75	Box	$ 1.50
90183	Black DuraFlex 18" Stake	75	Box	$ 1.79
90184	Green DuraFlex 18" Stake	75	Box	$ 1.79
90185	Bronze DuraFlex 18" Stake	75	Box	$ 1.79
90187	Black Anodized 18" Stake	75	Box	$ 1.93
92080	Steel 8" Stake	80	Box	$ 0.35

SPIKES *Prices are each.*

		PIECES	PACK	WHSL
91100	3/8" x 10" Spiral Steel Spike	250	Box	$ 0.25
91102	3/8" x 10" Smooth Steel Spike	150	Box	$ 0.36

ACCESSORIES *Prices are each.*

		PIECES	PACK	WHSL
95000	1" Universal Sliding Conn-Mill Finish	10	Set	$ 0.25
95003	1" Universal Sliding Conn-DuraFlex	10	Set	$ 0.28
95010	0.75" Sliding Conn-Mill Finish (for 1" AE)	10	Set	$ 0.25
95013	0.75" Sliding Conn-DuraFlex (for 1" AE)	10	Set	$ 0.28
95100	1.75" Quick Clip Connector	5	Set	$ 0.20
95400	4" Splice Mill Finish	5	Set	$ 1.53
95403	4" Splice Black DuraFlex	5	Set	$ 2.20
95404	4" Splice Green DuraFlex	5	Set	$ 2.20
95405	4" Splice Bronze DuraFlex	5	Set	$ 2.20
95450	4" Adj. Grade Change Mill Finish	5	Set	$ 5.33
95453	4" Adj. Grade Change Black DuraFlex	5	Set	$ 6.88
95454	4" Adj. Grade Change Green DuraFlex	5	Set	$ 6.88
95454	4" Adj. Grade Change Bronze DuraFlex	5	Set	$ 6.88
99000	Nylon Washers	250	Bag	$ 0.04
421012	TreeStrap 1" Wide x 12" Poly	100	Box	$ 0.36
421016	TreeStrap 1" Wide x 16" Poly	100	Box	$ 0.40
421018	TreeStrap 1" Wide x 18" Poly	100	Box	$ 0.45
422024	TreeStrap 1" Wide x 24" Nylon	500	Box	$ 0.60
423718	TreeStrap 1" Wide x 18" Biodegradable	100	Box	$ 0.72
423724	TreeStrap 1" Wide x 24" Biodegradable	500	Box	$ 0.97
421085	TreeStrap 3/4" x 250' Spool Poly	1	Roll	$ 19.60

Detailed product information, 3-part specifications and CAD details are available on our website at www.permaloc.com, or by calling 1.800.356.9660.

For quotation, call 1.800.356.9660 or fax your request to 616.399.9770!

13505 Barry St. Holland, MI 49424 ● 1.616.399.9600 ● www.permaloc.com

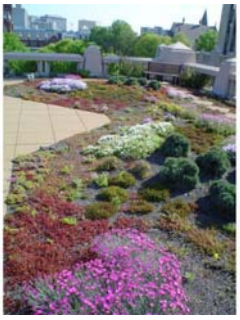
• the greenroof projects database • greenroofs.com

Atlanta City Hall Pilot Green Roof

J-DRain' GRS
Green Roof Drainage System

Project Name: Atlanta City Hall Pilot Green Roof
Year: 2003
Client: The City of Atlanta, GA, Dept. of Watershed Mgmt
Location: Atlanta, GA, USA
Building Type: Municipal/Government
Greenroof Type: Intensive, Test/Research
Greenroof System: Custom
Roof Size: 3000 sq.ft.
Roof Slope: 1.25%
Access: Accessible, Public
Submitted by: Janet Faust

Designers/Manufacturers of Record:
Environmental Manager: Benjamin Taube, City of Atlanta
Landscape Architect: Bill Brigham, City of Atlanta
Waterproofing Specialist: Chris Kramer, Kemper Waterproofing Systems
Greenroof Product Manager, Horticulturalist: Janet Faust, LEED AP, JDR, J-Drain Green Roof System
Engineered Soil: Ernie Higgins, ItSaul Natural
Nursery Owner, Horticulturalist: Bobby Saul, Saul Nurseries
Soil Installation: Andy Erler, Spread Tech
Landscaping Services: Todd Guilmette, Unique Environmental Concepts
Sims Stones: Ted Buell, Christian Amouroux
Paver Installation: Christian Amouroux, Flintstone Paver Installations



The City of Atlanta wishes to set an example of sustainable and ecological design for its citizens with the investment of a 3,000 square foot greenroof on Atlanta City Hall. By implementing this greenroof project, the City of Atlanta hopes to generate reliable technical data on greenroof performance in areas such as energy efficiency, stormwater retention, the extension of roof membrane life span, and plant survival. In addition, it is a goal to conduct research on temperature cooling benefits of greenroofs in the summer months. The most promising result will be increased awareness of greenroof technology benefits to citizens and professionals who could implement this technology.

The most recent event within the City of Atlanta is the adoption of a Sustainable Design standard for municipal financed construction projects. This design standard/ordinance will put into place a mechanism for all municipal financed projects to incorporate environmental and energy efficient design practices much like the nationally know LEED program. As the City progresses and grows, the City Council is committed to codifying residential sustainable design standards. The effort is to promote greenroofs as one of the many measures available for sustainable design and urban heat island mitigation that can be implemented in the City of Atlanta.


The City of Atlanta City Hall Pilot Green Roof is located at the Atlanta City Hall building on the fifth floor adjacent to the City's cafeteria. The project is 3,000 square feet with approximately 2,000 square feet of vegetated area and 1,000 square feet of pavers. The space once functioned as patio, and thus the design sustained the patio area for staff use. Additionally, the greenroof is accessible to all that visit the building. It is visible by surrounding buildings that are above the fifth floor of City Hall.

The plants are predominantly sedums with some perennials, cacti, and herbs. The landscape plan called for over 2,800 plants from 31 species. The growth media varies in depth from 3 to 10 inches, and 70 cubic yards of soil was installed on the roof. Structurally the building was designed to hold approximately 560,000 pounds, or 186 pound per square foot. With the construction of the greenroof, 175,000 pounds (58 pounds per square foot) was added to the structure. The greenroof was designed with no supplemental irrigation system. In the design, a one-inch PVC line was installed along the perimeter of the greenroof as well as from each drainage box to drainage box. The one-inch conduit is available for monitoring equipment or supplemental irrigation if needed. The greenroof was officially completed on December 18, 2003. Mayor Shirley Franklin and City Council informally opened the greenroof to City employees just days after it was completed. The greenroof at Atlanta City Hall has been featured in recent media as a component to green building strategies. In April 2004, the Mayor officially dedicated the greenroof as a feature of City Hall.

Additional thumbnail photos:





See Contact Information for JDR. For project information, contact the Environmental Manager, City of Atlanta, 55 Trinity Ave. SW, Suite 5800, Atlanta, Georgia 30335, 404.330.6230 ext. 5232, Fax 404.658.7631.

Green Roof

EnkaRetain & Drain®

DIVISION 7
DRAINAGE &
WATERPROOFING

Medical Building
14,559 sq. ft. Green Roof

Owner:
Cheyenne 1 Development Group
Houston, TX

General Contractor:
Jacob White Construction Company
Houston, TX

Architect:
Webb Architects
Houston, TX

Engineer:
BGA Engineers, Inc.
Houston, TX

Enka-Engineered
BUILDING PRODUCTS

Medical Building is Solid Gold with a Roof That is Producing a Lot of Green

Even without its 14,559 square foot living roof, the 251 East Medical Center in Webster, TX was green from the beginning. At the project's inception, Developer and General Contractor, Jacob White Construction of Houston, wanted the building to stand apart from all other commercial buildings in the Houston area. This wasn't going to be your typical three-story 48,000 square foot medical building. 251 East would be the first LEED Gold certified building this side of Austin.

As land prices continue to increase around the Houston-metro area, especially in proximity to the hospitals, the availability of affordable medical office space continues to decrease. "It's getting harder and harder for physicians to find space they can afford," said Jeff Mickler, President of Jacob White Construction. "Our goal was to develop prime medical space near the hospital that would be affordable, not only to build but to occupy as well," he added. Achieving affordability meant considering the unconventional, which led Mickler and the project team to take a closer look at the LEED certification process.

The LEED green building rating system—developed and administered by the U.S. Green Building Council, a Washington D.C. based, nonprofit coalition of building industry leaders— promotes sustainable design and construction practices that increase profitability while reducing negative environmental impact and improving occupant health and well-being.

Introduced in 1994, the program is still fairly new. But based on the potential operational savings alone, don't expect projects like 251 East to be the anomaly for long. According to Mickler, a LEED Gold certified building can cost an estimated 50% less to operate than a non-certified building. "Without that savings, we couldn't have justified the project," Mickler said.

To achieve LEED Gold status, the project team, consisting of representatives from Jacob White Construction, Webb Architects, BGA Engineering, McDonald Electric, J&S Mechanical, and Belknap Plumbing, all of Houston, incorporated a variety of energy savings technologies and systems that went well beyond the typical low-E glass. For example, a self-replenishing irrigation network, consisting of 700 linear feet of concrete culverts leading to an underground storage cistern, was built beneath the parking lot. The cistern holds 175,000 gallons of rainwater, enough to supply the facility's entire irrigation and grey water needs, inside and out, reducing city water needs by 70%.

Perhaps the most impressive and ambitious part of the project was the proposed green roof complete with gardens, walking paths, and a lush landscaped area. At 14,559 square feet, it would be the largest green roof in Texas and possibly the entire southwest. The sheer size presented some concerns.

Continued on reverse side...

EnkaRetain & Drain lays completely flat which is critical in horizontal applications.

Specially formulated planting medium and native plants are chosen for the project.

Green roofs provide many benefits — one being a recreation area for occupants.

In November 2005, members of the project team, including Joe Webb of Webb Architects, attended GreenBuild 2005, the US Green Building Council's annual convention in Atlanta. There they met several of the country's leading green roof suppliers who assured the team that a conventional green roof system was well within their budget of $10- $15 per square foot. The project team proceeded accordingly based on those budget figures. "When the actual estimates came in several months later, they were $25 - $35 a square foot," Webb said. That's when the project team went looking for an alternative solution. "We basically had to go back to the drawing board and rethink our whole approach," Webb mentioned.

After evaluating, mixing, and matching hundreds of products and combinations of products, they finally discovered a combination that not only delivers an R68 insulation rating, but costs a fraction of a conventional system and is much quicker to install.

The unique green roof structure began with a 4" layer of rigid foam insulation board with protective coating applied to the concrete /steel roof structure. Next, a 40-mil. reinforced waterproofing membrane was loose-laid over the foam board and was loose-laid to the roof sidewalls and drain assemblies. Finally, the drainage / water retention composite was installed directly on top of the waterproofing membrane. With the structure in place, a 9" soil mixture was specially developed by a local soil consultant who took into consideration proposed plant materials, water retention needs, and the wet weight limit set by the engineers. The specialized soil mass ensures plant growth potential and survivability.

A key to the roof's effectiveness is the drainage / water retention composite, EnkaRetain & Drain, manufactured by Colbond Inc. of Enka, North Carolina. This unique product, designed specifically for green roof and planter applications, consists of a post-industrial, recycled polypropylene drainage core, fused and molded into a square waffle pattern. A super-absorbent water retention fabric is heat-bonded to the drainage core and is designed to hold 10 to 12 times its weight in water.

"We had used a similar Colbond drainage composite on a residential project four years ago, so we were familiar with the technology and performance," Mickler said. "We called them again to see if they had a drainage/retention composite that would work for this size project. That's when they showed us the EnkaRetain & Drain," he explained. Webb proved to be a slightly tougher sell. "I was concerned about the flow rates. Would it be able to move the runoff from the roof quickly enough after a hard rain?" he questioned.

In Denver at GreenBuild 2006, Mickler, Webb, and other project team members met with Colbond representatives to get the hard proof they needed. "We sat down at dinner one night and walked through it all. They were able to document every claim they made. Once I saw it, my comfort factor went from 95% to 100%," Webb said.

While difficult to estimate, Jacob White Construction believes that by using the combination of foam board, membrane, and EnkaRetain & Drain, they were able to save at least two to three weeks as compared to a proprietary system. Energy usage is also on track to deliver hefty savings. The material cost savings alone was in the neighborhood of $250,000.

The environmental impact is equally impressive. Approximately 73% of all rain that strikes the roof is retained in the green roof to sustain the vegetation growth, while the excess (approximately 24,000 gallons a month) is transported to the roof drains that direct it to the underground cisterns for storage. That reclaimed water is used for everything from irrigating the grounds to flushing the toilets.

But at the end of the day, says Mickler, this is not only about saving the environment. "It's about dealing with the realities and challenges of this business in a way that is smart, practical, and sustainable," he mentioned. By all accounts, 251 East Medical Center is all that and more.

The building was completed in January 2007 and will be applying for the LEED Gold certification in March. Based on occupancy rates, Jacob White Construction plans to add a second adjacent building in the future. It will be designed with the same environmental standards in hopes of becoming LEED Gold certified as well.

"We want to show the industry, tenants, and the general public that there is a better way to build," Mickler added.

For more information about these and any other products marketed and manufactured by Colbond Inc. visit www.colbond-usa.com or call 800-365-7391.

COLBOND

1301 Sand Hill Road
P.O. Box 1057
Enka, N.C. 28728
Tel. (+1) 828-665-5050
Toll Free: (+1) 800-365-7391
Fax (+1) 828-665-5009

email: enka-engineered@colbond.com
website: www.colbond-usa.com

Municipal Case Studies

The following cities are leaders in the use of green roofs in urban areas. Only a few are listed here and this certainly does not encompass all the programs and policies each have implemented to promote green roofs in urban environments.

Chicago: Urban heat island effect reduction is their main goal. The city enacted an energy code requiring a reduction in heat radiating surfaces. Green roof research is ongoing at the Chicago Center for Green Technology. Private-sector green roof development is a priority. Chicago is providing heat management grants to encourage this. Additionally, they are providing zoning bonuses for an increase in density to developers using green roofs. Chicago currently has more square footage of green roofs than any other North American city.

The City of Chicago created the Department of the Environment (DOE) to assist Chicago Mayor Richard M. Daley with green initiatives and to coordinate green efforts throughout the City. DOE is involved in the policies, programs, and regulations related to green building, green roofs, public education, and the development of the City's Environmental Action Agenda. Green roof information is available on the DOE website and that website also acts as a portal to other Chicago-area websites about green roofs.

In order to further the cause of making Chicago the greenest city in the country, a grant program for green roofs was established in 2005 and is administered through the DOE. Owners of residential and small commercial buildings may apply for $5,000 grants to help with the planning and installation of green roofs.

Portland: Water pollution prevention is the major impetus for the use of green roofs. Salmon is an endangered species in that area. Stormwater and groundwater quality issues have driven the green roof movement. Their split-fee system has funded public green roof projects. Portland charges for (1) water consumption/sanitary discharge and treatment and (2) storm water management (35% for drainage on property and 65% for drainage onto public streets). Landowners are more responsible for their stormwater runoff as a result. Portland was able to raise awareness among landowners about the stormwater management benefits of green roofs. This was evident through the private sector construction of green roofs that soon followed policy and program implementation.

The city of Portland continues to provide technical assistance and incentives to encourage green roof projects through their Office of Sustainable Development (OSD). This office was established to "advance the principles of sustainability" as stated on the OSD website.

The Green Investment Fund (GIF) was established through a partnership between the City of Portland OSD, Water Bureau, Bureau of Environmental Services and Energy Trust of Oregon, Inc. The GIF is a competitive grant program that funds projects designed and built to meet aggressive and integrated resource conservation goals. Private green roof projects have been funded through this program.

The OSD hosts classes on green building projects regularly. OSD also provides a resource for information about sustainable building practice workshops and classes being held in Portland through their website.

New York City: Reducing stormwater runoff and water pollution are their major goals. Urban ecology studies have been conducted here, namely the New York Ecological Infrastructure Study. "The New York Ecological Infrastructure Study (NYEIS) is a unique multidisciplinary research project that investigates the form and function of "ecological infrastructure" for New York City's built environment and landscape." (http://www.earthpledge.org/gr-pub.html). The Earth Pledge Foundation, an influential nonprofit organization, is helping green the rooftops of New York City (http://www.greeninggotham.org) and provides a "green roof toolbox" as an educational tool.

Tokyo: The green roof movement here was fueled by rising temperatures and environmental health concerns.

Berlin: Green roofs were initially developed by a German roofer (Koch) who designed a fire safe roof that consisted of a growing medium, and plants were allowed to self seed. Germany is a leader in green roofs after many years of research. Reinhard Bornkamm of the Free University of Berlin is often called the "father of modern green roofs."

London: The greater London Authority regional governing body promotes green roofs for biodiversity and sustainable design. Bird habitat loss due to the redevelopment of brown field sites (a particular bird frequented these sites) is what has driven green roof implementation. One recent study showed that 10% of invertebrate species found on London green roofs are nationally rare or scarce (Kadas 2006).

Toronto: The coalition named *Green Roofs for Healthy Cities* was formed here. An ongoing research study called "Green Roof Infrastructure Technology Demonstration Project" is looking into green roof effects on air quality, heat/temperature, energy savings, economic impacts, quality of life, biodiversity and more.

Water | Energy | Urbanization | Hazards | Health | Poverty | Food, Ecology & Nutrition | Ecosystem | Climate & Society

The Earth Institute AT COLUMBIA UNIVERSITY

COLUMBIA 250

Green Roofs in the New York Metropolitan Region

New York Ecological Infrastructure Study (NYEIS)

Study Leaders: Cynthia Rosenzweig, NASA/Goddard Institute for Space Studies and Columbia University Center for Climate Systems Research
William D. Solecki, Hunter College -- City University of New York, Colin Cheney, Earth Pledge

Introduction

A green roof is a roofing assembly that allows for the dispersion of vegetation across all or part of a roof surface. Widespread adoption of green roofs as a roofing technology can potentially address multiple environmental and human health problems in New York City including the urban heat island effect, global climate change, and stormwater runoff. The type of green roof that our research has focused on is lightweight, thin(4 – 6" growing medium), and planted with hardy, drought-resistant plants to minimize weight, cost, and maintenance. This type of green roof is generally referred to as "extensive." (Exhibits A, B, C and D)

Exhibit B. Layers of a green roof

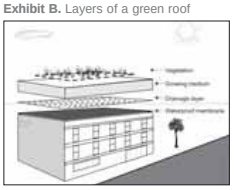


Exhibit C. Hamilton Apts., Portland OR (Source: Env. Services City of Portland Brochure)

Exhibit A. Chicago City Hall (Source: Dunnett and Kingsbury, Planting Green Roofs and Living Walls, 2004)

Exhibit D. Type of vegetation generally planted on green roofs

a) Sedum Fuldaglut *b) Sedum Weihenstephaner Gold*

c) Sedum Spurium *d) Sedum Lidekense*

Green Roof Research Station

A central component of the NYEIS work is the development of a rooftop research station to collect data about green roof performance in New York City and to validate energy and hydrology models. A research roof would also provide a range of possibilities for science and social science research in the coming years, as well as community outreach and education. (Exhibit E)

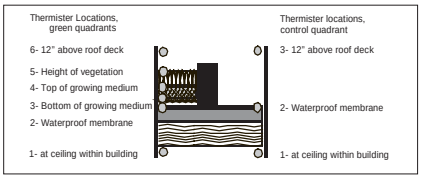


Exhibit E. Green Roof Research Station, temperature monitoring points.

Costs and Benefits

The cost-benefit analysis is divided into two tiers. Tier I includes the benefits and costs of green roofs covered by NYEIS active research and expertise. The analysis indicates that green roofs may not be cost effective at the individual building level, but green roof infrastructure is cost effective when the full range of benefits is considered. (Exhibits F and G)

Private (Building-Level)	Public (City-Level)
Tier I Benefits	
Increased service life for roof membrane	Reduced stormwater runoff expenditures
Reduced energy use for cooling	Reduced urban heat island
Tier II Benefits	
Sound insulation	Improved air quality
Food Production	Reduced greenhouse gas emissions
Aesthetic value	Improved public health
	Aesthetic Value
Costs	
Net cost of green roof	Program administration and setup
Maintenance costs	

Exhibit F. Private and public benefits and costs of green roofs

Green Roof Policy for New York City

In order to evaluate the rationale and form of government support for green roofs in the New York metro region, the following strategic outline should be followed:

1. Education of policymakers and government officials on benefits of individual green roofs, including recognition of other municipal implementation and support structure;
2. Financing of demonstration project for public education and scientific testing;
3. Removal of existing barriers in building and zoning codes, and modification of stormwater laws and energy ordinances, allowing for streamlined construction of green roofs; Drafting and review of regulatory measures, subsidies, zoning bonuses, tax incentives, and sewer rate reduction appropriate to New York metro region conditions and needs, based on thorough evaluation of building and infrastructure level benefits.

Scenario	Performance Scenario		
Tier I	Low	Medium	High
Benefit-Cost Ratio Tier I, Private	0.34	0.46	1.31
Benefit-Cost Ratio Tier I, Private & Public	0.53	0.65	1.57
Tier II	Low	Medium	High
Benefit-Cost Ratio Tier I & II, Private	0.38	0.54	1.85
Benefit-Cost Ratio Tier I & II, Private & Public	0.66	1.02	3.87

Exhibit G. Preliminary cost-benefit analysis results for 50% green roof scenario Tier I (areas of NYEIS active research and expertise) and Tier II (additional potential benefits and costs of green roofs in New York City).

Conclusion

Green roof infrastructure could be a cost-effective way to help solve some of New York City's environmental and human health problems, when multiple private and public benefits are considered together. In North America, green roofs are still a relatively new ecological infrastructure. Therefore, New York City has an opportunity to be a trend-setter in the green roof arena. The New York Ecological Infrastructure Study (NYEIS) is a multidisciplinary research project investigating the potential of green roofs to address multiple environmental and human health problems in New York City. This work was done as part of the New York Ecological Infrastructure Study (NYEIS), a multidisciplinary research project investigating the potential of green roofs to address multiple environmental and human health problems in New York City.

Key Findings

Energy

By cooling the surface of a roof, green roofs can help the region prepare to adapt to global warming, and potentially reduce energy usage, fossil fuel consumption, and greenhouse gas emissions, the cause of global warming.

On average, surface temperatures in July 2003 were 34oF (19°C) higher on the standard roofs during the day and 14°F (8°C) lower at night (Exhibit H).

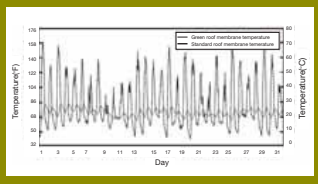


Exhibit H. Average surface temperature on green roofs and standard roofs at Penn State research roofs. (Data provided by Dr. David Beattie)

Urban Heat Island

By providing a vegetated surface, green roofs may reduce outdoor air temperature and the urban heat island effect through evapotranspiration, shading, and increased albedo.

A 50% extensive green roof scenario reduced New York City's average surface temperature by 0.1 – 1.4°F (<0.1 – 0.8°C) (Exhibit I).

Exhibit I. Thermal map of surface temperature in the New York Metropolitan Region. Landsat ETM 7, August 14 2002, 10:30 AM, Band 6

Hydrology

By retaining (and evaporating) and delaying runoff, green roofs can reduce combined stormwater-sewage overflows (CSOs).

Analysis of Penn State data showed that green roofs captured 80% of rainfall during rainstorms, compared to 24% for standard roofs

Simulation of green roof rainfall retention using a simple box model and data from LaGuardia airport showed that a runoff could be reduced by up to 10% at the sewage-shed scale, with a 50% green roof infrastructure scenario.