



Green Roofs

Weston Solutions, Inc./GreenGrid™

What is a Green Roof?

- A roof substantially covered with vegetation
- The first documented green roofs were the Hanging Gardens of Babylon
- Currently about 100 million sf of green roofs in Europe
- Popularity in the United States growing



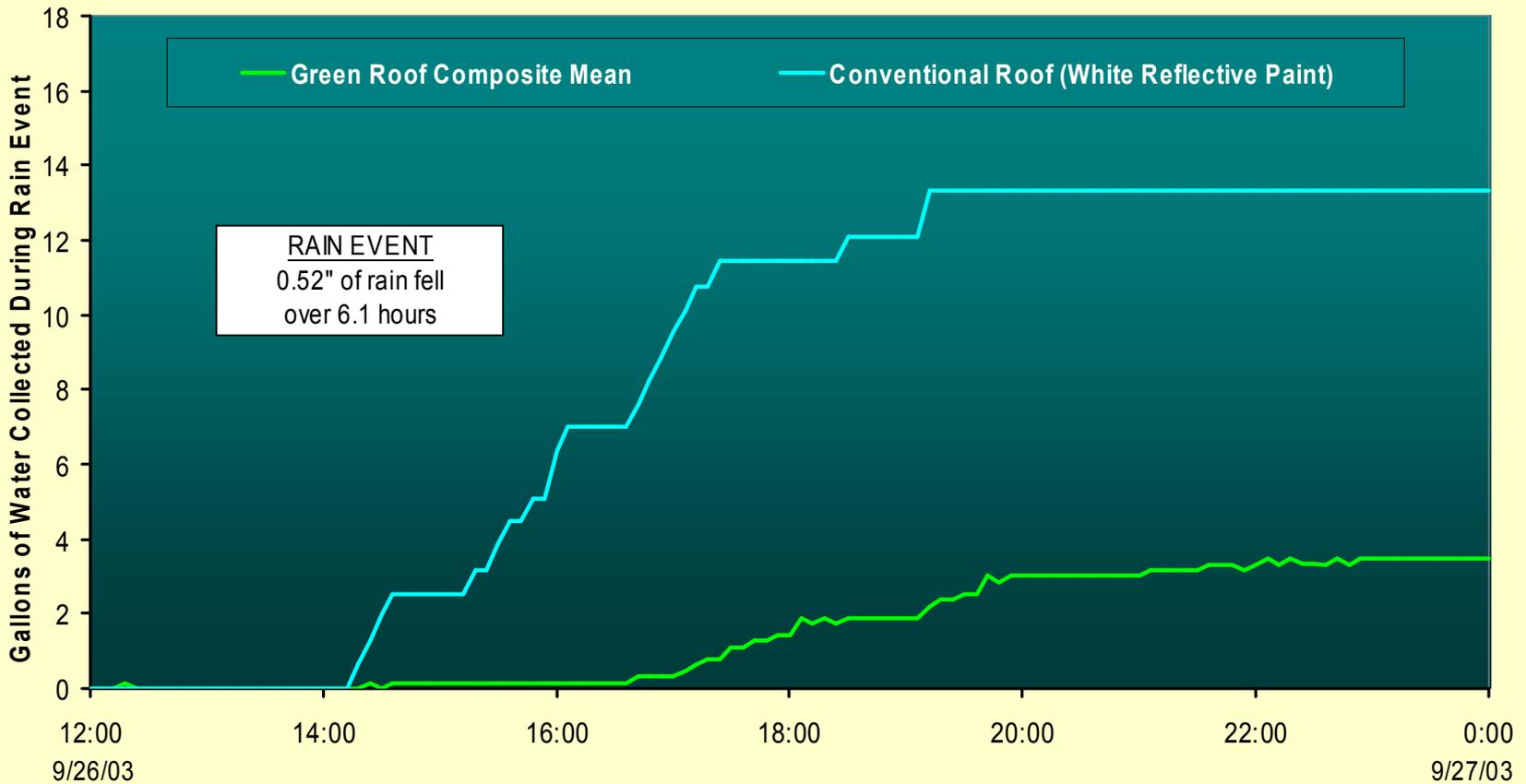
Rockefeller Center in New York has had green roofs since the 1930's





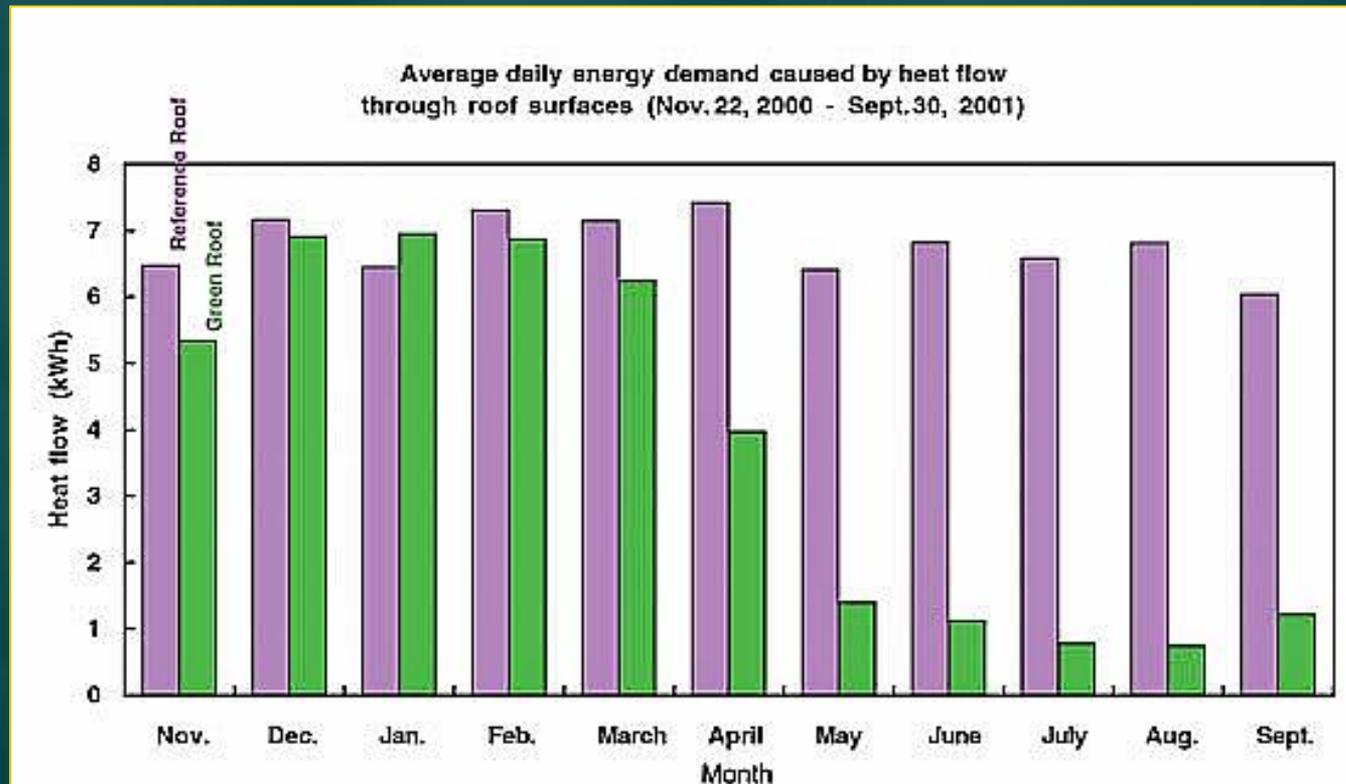
Reduces and Detains Storm Water Runoff

STORM WATER RUNOFF PERFORMANCE FOR LOW VOLUME, SLOW DRIZZLE STORM EVENT



Insulates Roof Resulting in Reduction in Heating and Cooling Costs

- Can reduce average daily energy demand by up to 75%
- Reduced energy demand translates to smaller mechanical equipment and lower capital costs





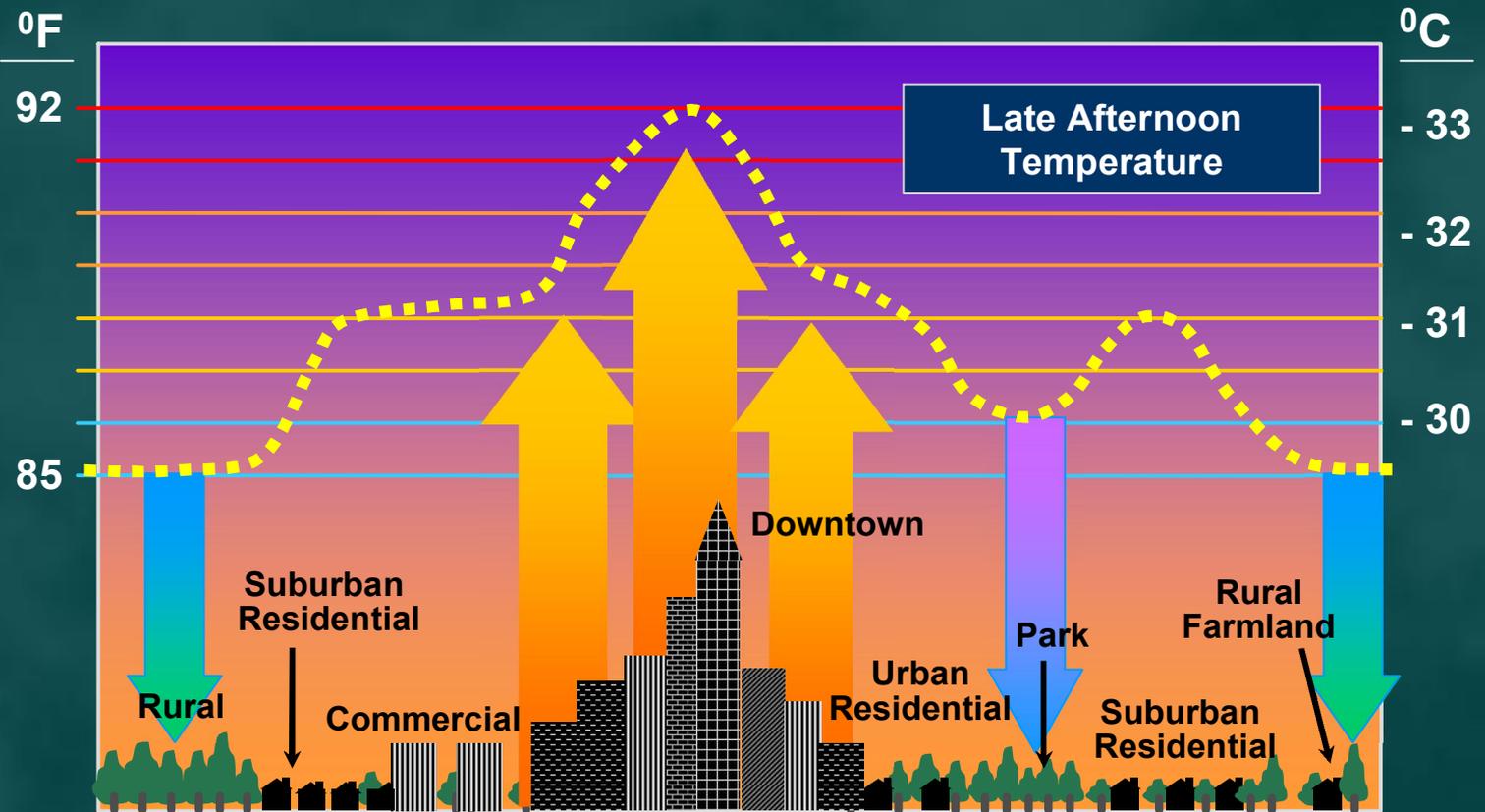


Reduces the Urban Heat Island Effect That Causes:

Temperatures in cities to be 6-10 degrees above normal which...

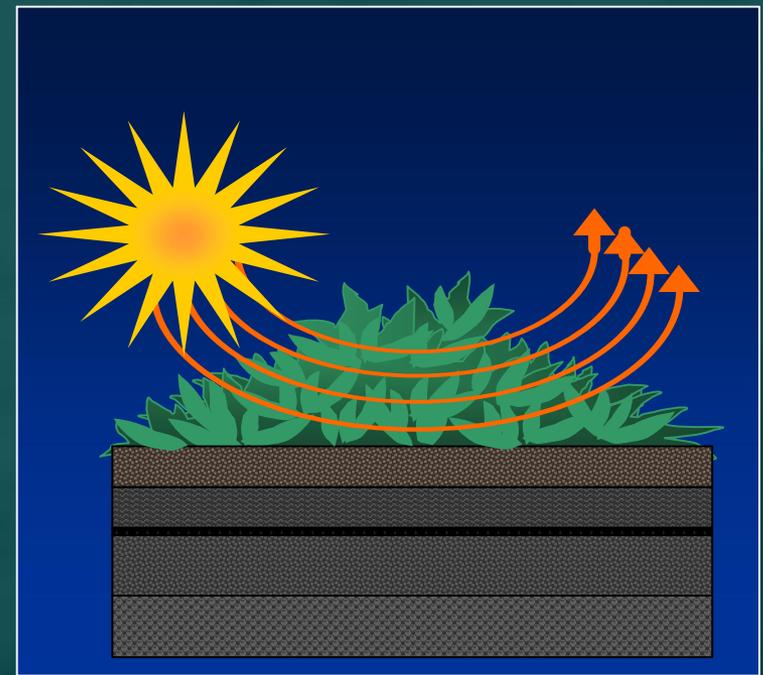
- Changes weather patterns
- Causes HVAC systems work harder, using more energy
- Intensifies air pollution -- ozone
- Makes life in the summer even more uncomfortable

Urban Heat Island Profile



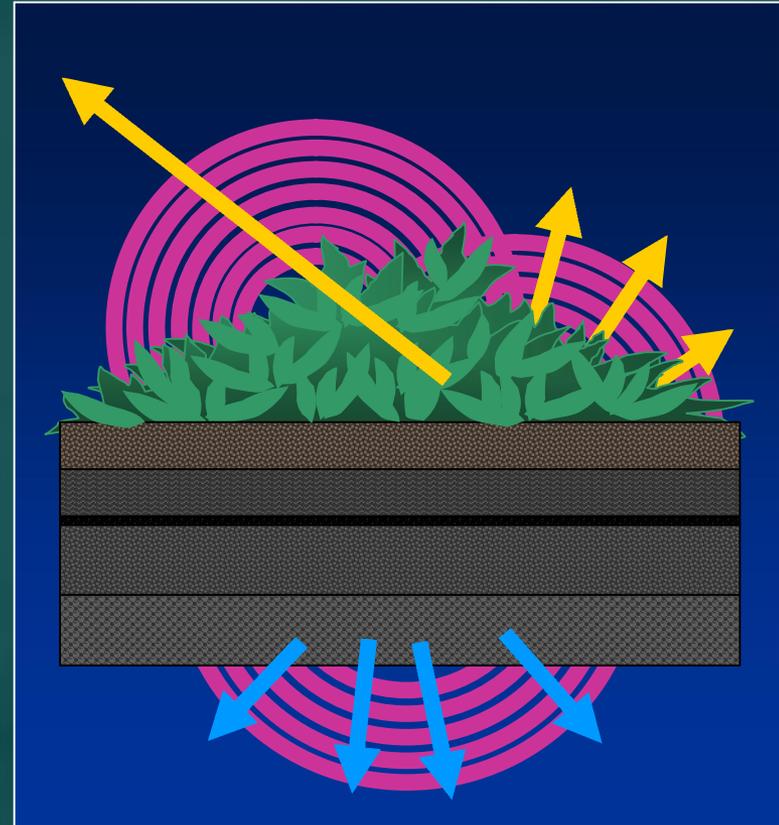
Green Roofs Combat the Urban Heat Island Effect:

- The greening of 6% of a city's buildings would reduce summertime urban temperatures by ~ 3 to 4°F (Environment Canada)
- A Weston study for the City of Chicago concluded that greening 50% of the roofs in the city would save \$100M in energy demand annually, ~720 MW of power
- Reduces the amount of heat being absorbed by dark roof tops, pavement, etc. in the city
- Transpiration of plants - cooling effect



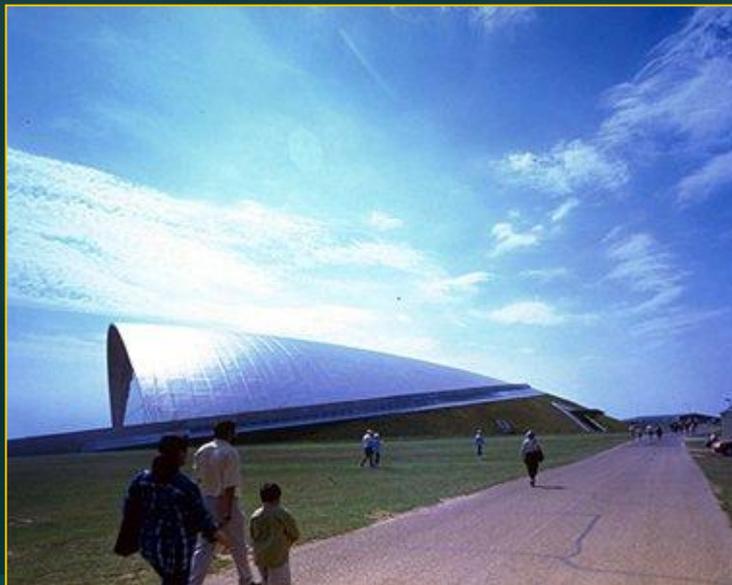
Green Roofs Improve Air Quality and Reduce Noise Levels

- 16 sf of grass can remove more than 0.5 lbs of dust and provide enough oxygen for 1 person annually
- Take up of CO₂ and smog forming chemicals (Nox and SOx) directly by plants
- Indirectly through reduction in energy demand
- Carbon sequestration - carbon taken out of air and stored in long term pools in root biomass
- Green Roofs can reduce indoor sound by about 10 decibels or more, depending on roof soil depths and plant types.



Aesthetic Appeal

- Provides a softer perspective to the urban landscape
- In greenfield settings, helps hide and disguise a building's presence





Provides Habitat as a 'Stopping Off Place' for Birds and Insects



Provides LEED™ Credit

- Credit for stormwater runoff
- Part of the equation for energy credit
- Rapidly Renewable Materials
- Urban heat island credit
- Recycling credit
- Regional Materials



LEED™

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN



Case Study: City of Chicago

Urban Heat Island Program City Hall Green Roof





Chicago Decided Attack Its Urban Heat Island Issues

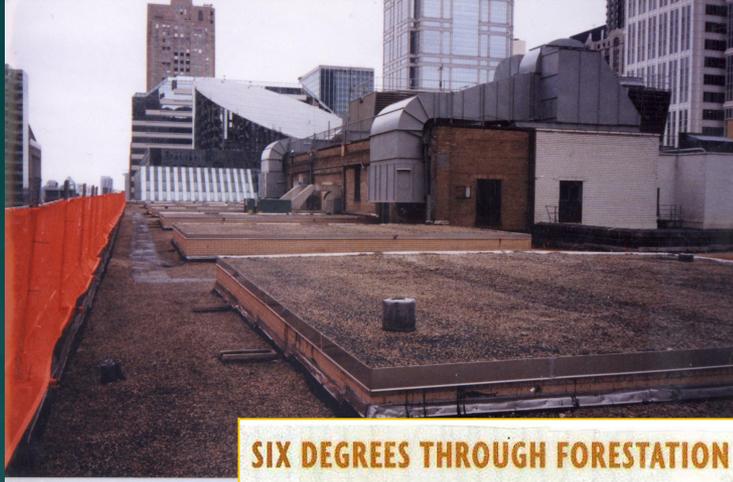
- Lighter colored asphalt
- Breaking up vast parking lots with green areas
- White, light colored roofs specifications
- More vegetation
- Pocket parks
- **Green Roofs**

Given Mayor Daley's Interest, in 1999 Weston Put Together a Team to:

- Determine the actual benefits to City Hall and Chicago
- Determine if City Hall structure could withstand a green roof –
- Design a green roof for City Hall
- Prepare a general spec for green roofs for the City of Chicago
- Prepare cost projections

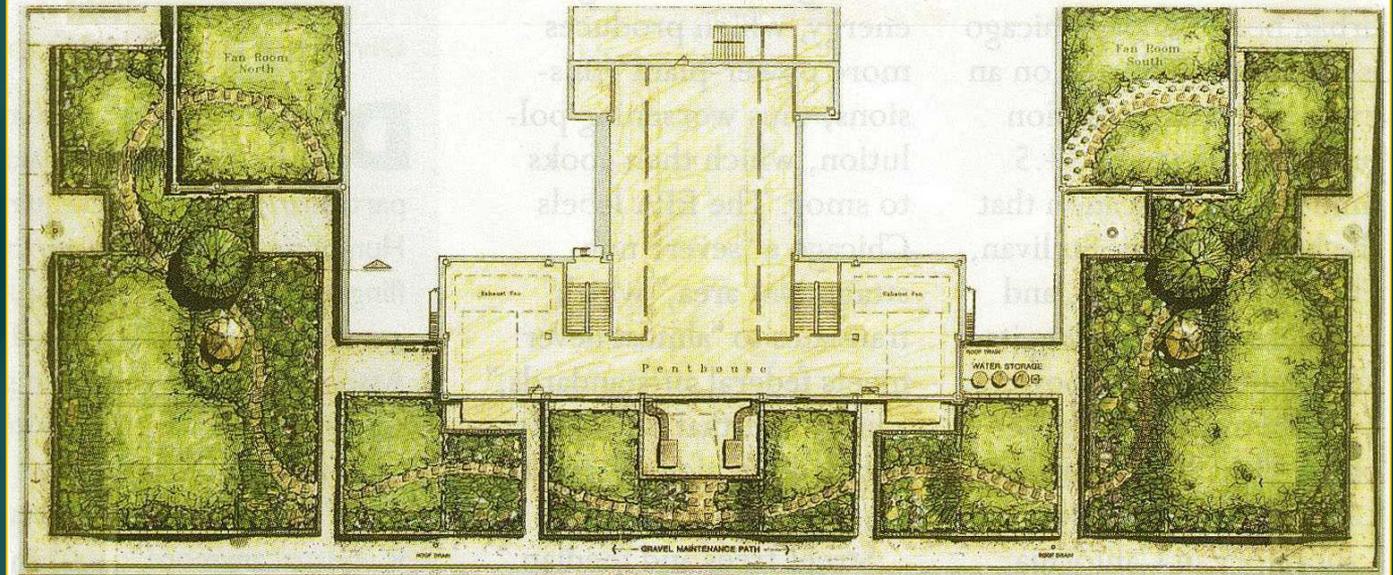


The First Conceptual Plan was for an “Extensive Green Roof”



Existing (Former) Roof

SIX DEGREES THROUGH FORESTATION The plans for City Hall, part of a scheme to take the heat off Downtown.



First Green Roof Design

Definition of an Extensive Green Roof

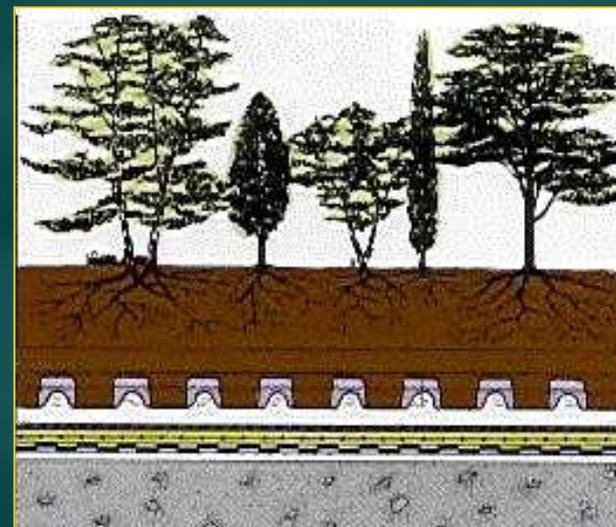
- Shallow soil profile (about 3 inches)
- Plantings include sedums, mosses, grasses, wildflowers requiring little or no irrigation
- Can be built on roofs with slopes up to 33%
- Average weight fully saturated ~ 16 psf (comparable to gravel ballast) to 34 psf



Soil
Protection Root
Barrier Waterproofing
Deck

Chicago Wanted a “Showplace” thus Designed “Intensive” Roof Defined as:

- Soil depths of about 6 or more inches
- Can sustain greater variety of plants
- Can be used for recreation and creation of dramatic spaces
- Avg. wet weight 45-105 psf: 80-200 psf with trees and large shrubs, depending on soil depth



- Soil
- Moisture Barrier
- Drainage Layer
- Root Barrier
- Waterproofing
- Deck

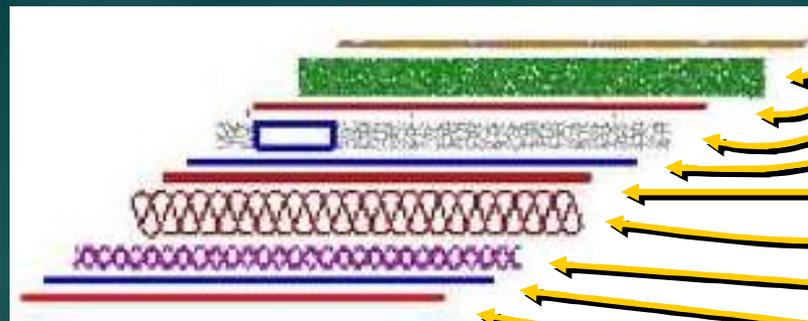
Weston then Assisted the City in Next Steps:

- Bid the project to roofers
- Evaluated bids
- Negotiated with low bidder



The Green Roof at Chicago City Hall Consists of the Following Layers (from the bottom up)

- Waterproof Roof Membrane
- Drainage layer
- Built up insulation (primarily for roof contours)
- Root barrier
- Drainage mixture
- Lightweight manufactured “soil” mixture
- Wind erosion blanket
- Plants



wind erosion blanket
light-weight growth medium
separation fabric
drainage medium
protection fabric
root-barrier membrane
insulation
sheet drain
protection fabric
waterproof membrane

Roof Membrane



Drainage Layer





Built up insulation
Drainage mixture
Manufactured soil
Erosion Blanket



Plants

- City Hall has approximately 20,000 plants
- Two trees
- 100 varieties of plants
- Drip irrigation system with rain barrel backup



Plants

- Half of plants were planted in Fall 2000
- Spring/early summer 2001 shown



Planted Roof 2002 (Standing on Roof)



Planted Roof (Aerial View)



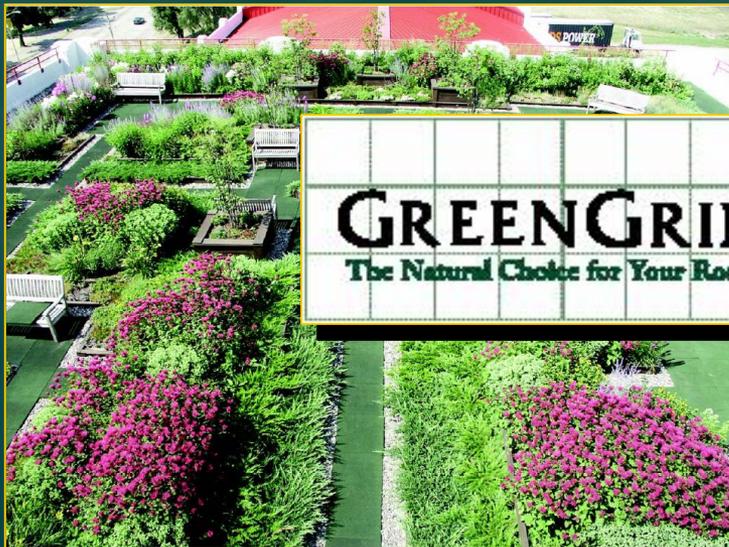
Lessons Learned – Traditional Systems

- Traditional systems often heavy
- Installation of roof and plants time-consuming
- Irrigation systems obtrusive, problematic, designed roof by roof
- Roof repair extremely difficult
- Expensive
- No “complete” system available
- Roof surface replacement required
- Roof requires about 2 years to be “green”



Search for a Better Mousetrap

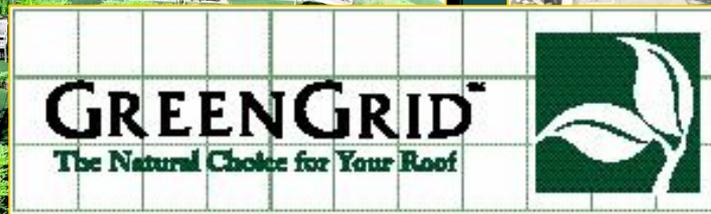
- WESTON recognized benefits and drawbacks of traditional green roofs
- Began discussing new methods with ABC Supply Co. Inc. in 2000.
- The result is a whole new approach to green roofs, the GreenGrid™ System.



GreenGrid™ at ABC Supply, Beloit, Wisconsin



GreenGrid™ at Engine Company 98, Chicago



Presenting the GreenGrid™ System



GreenGrid™ System Elements

ELEMENT DESCRIPTION

- Modules:
Standard – 2 ft. x 4 ft. and 2 ft. x 2 ft. Depth of modules (two depths) 4 in. and 8 in. Also 2 ft. x 2 ft. x 2.5 in. depth.
- Pavers:
Length – 2 ft., width – 2 ft., depth – 1.5 in. Paver material -- Recycled automobile tires. Paver Colors -- Forest green, black, brick.
- Drainage/root barrier medium: Geotextile
- Soil media:
Proprietary mixture consisting of organic and inorganic material.
- Drip irrigation system
Black polystyrene tubing.
- Edge treatments
Wood, composite recycled HDPE/wood (in various colors and designs), metal, various others to order.
- Plants
Perennials, grasses or shrubs specifically selected for climate, hardiness zone, color and size.

Weight of the GreenGrid™ System

The GreenGrid™ System is very light compared with its counterparts:

- **Two and ½ inch depth modules weigh 10 lbs. wet**
- **Four inch depth modules weigh 15 lbs. wet**
- **Eight inch depth modules weigh 28 lbs. wet**



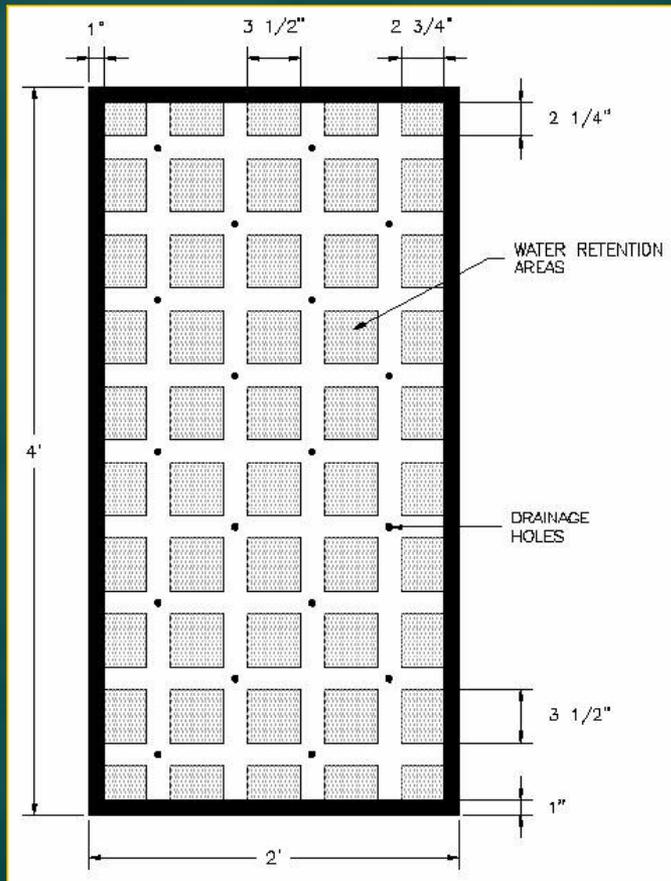
GreenGrid™ at New Federal Courthouse, New Bedford, MA



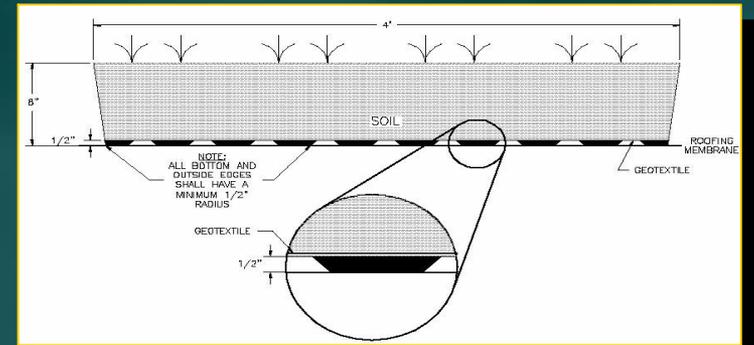
GreenGrid™ at Target, Chicago

Engineered Design

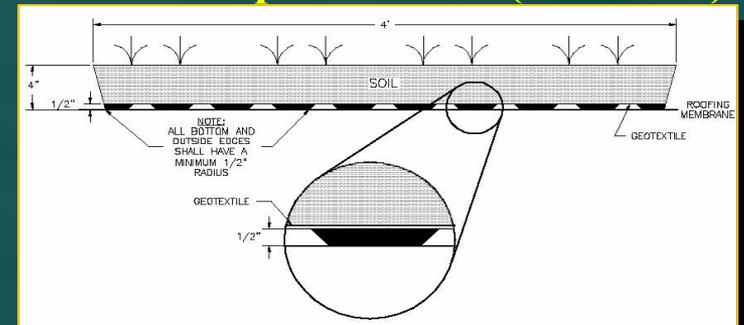
All components of a green roof are contained within the modules:



Module Plan view

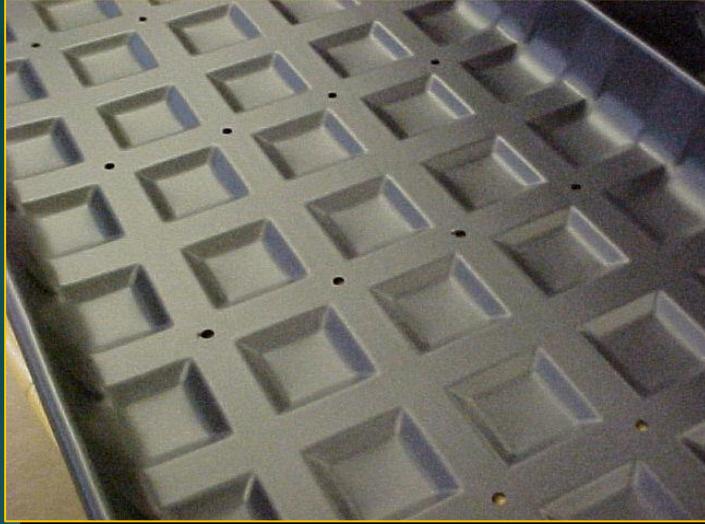


8 Inch Depth Module (Intensive)



4 Inch Depth Module (Extensive)

GreenGrid™ System Module Design



Interior of Module



Bottom of Module



Closeup of Module Bottom



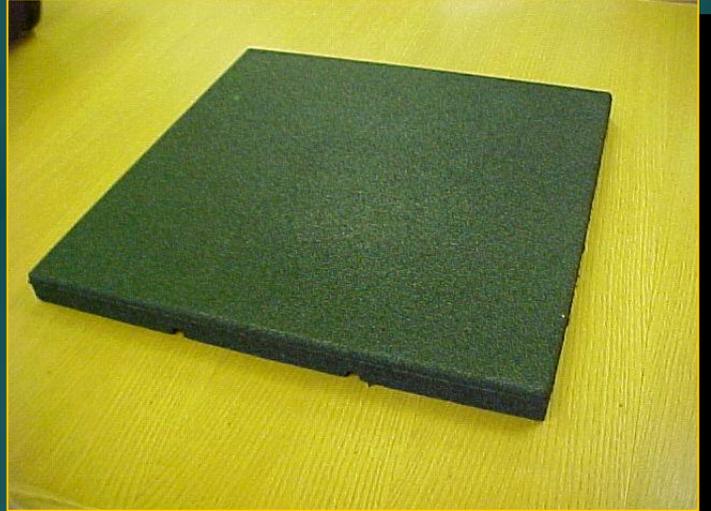
Planted Modules

GreenGrid™ System

Edge Treatment and Pavers



Edge Treatment Detail



Top of 2' by 2' Paver



Edge Treatment



Bottom of 2' by 2' Paver

GreenGrid™ System Comes Preplanted



GreenGrid™ preplanted modules waiting at nursery for installation and at the project site



GreenGrid™ at Apple Computer Store, Chicago

GreenGrid™ at ABC Supply, WI

GreenGrid™ at Chicago Green Home

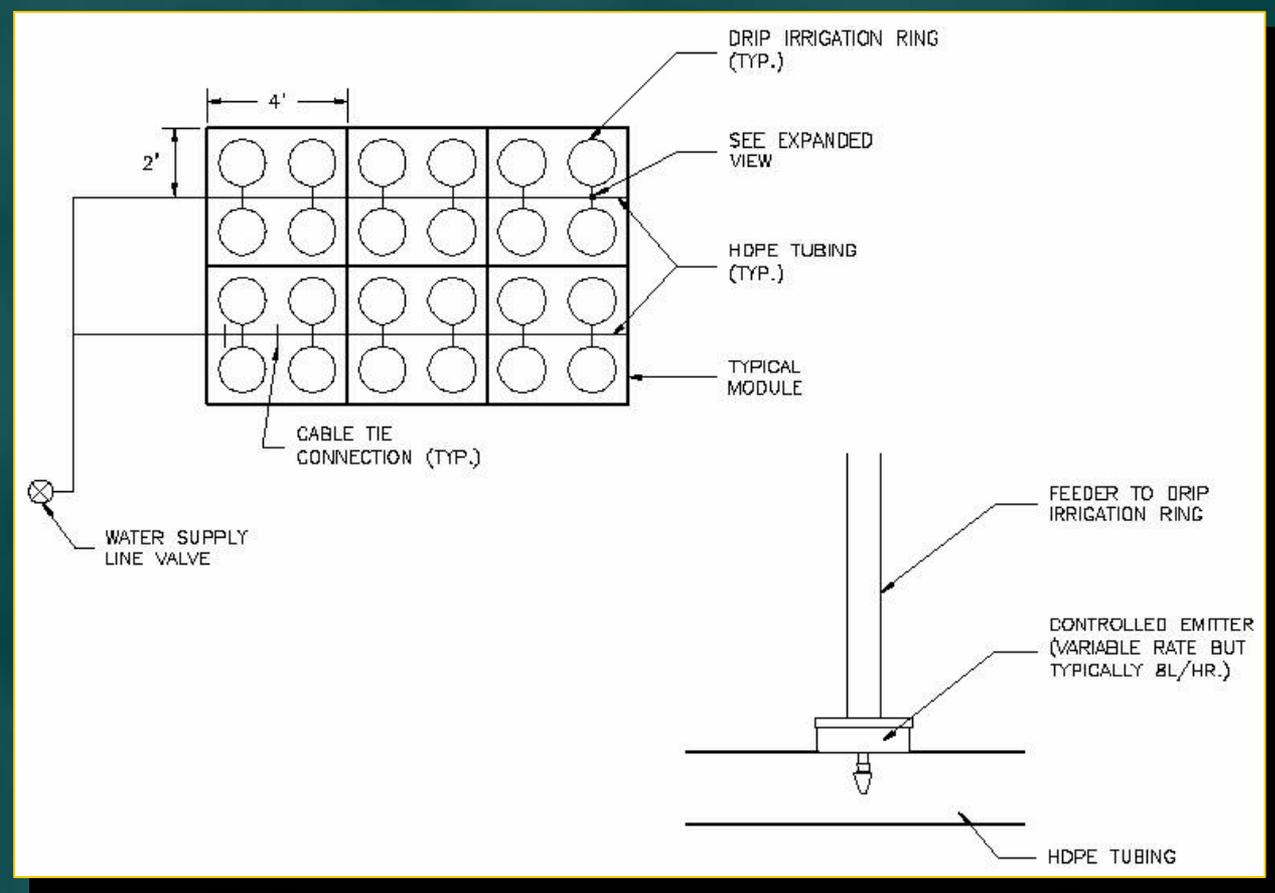
GreenGrid™ preplanted modules just installed



Installation Quickly Accomplished



Irrigation System Drawing



Modules Can be Moved for Repairs, New Construction, or Maintenance



**1:20 PM
BEFORE**



2:30 PM • DURING



**4:35 PM
AFTER**

All Components of GreenGrid™ Engineered Through One System



- Modules
- Soil Media
- Plants
- Irrigation System
- Edge Treatments
- Pavers



GreenGrid™ at Univ. Wisconsin – Milwaukee GLWT



GreenGrid™ at Chicago Park District Headquarters



- Water Features
- Furniture

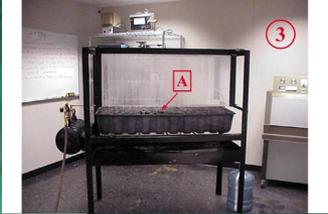
GreenGrid™ at ABC Supply, Inc. Corporate Headquarters

GreenGrid™ Can Be Placed on Any Roof Surface

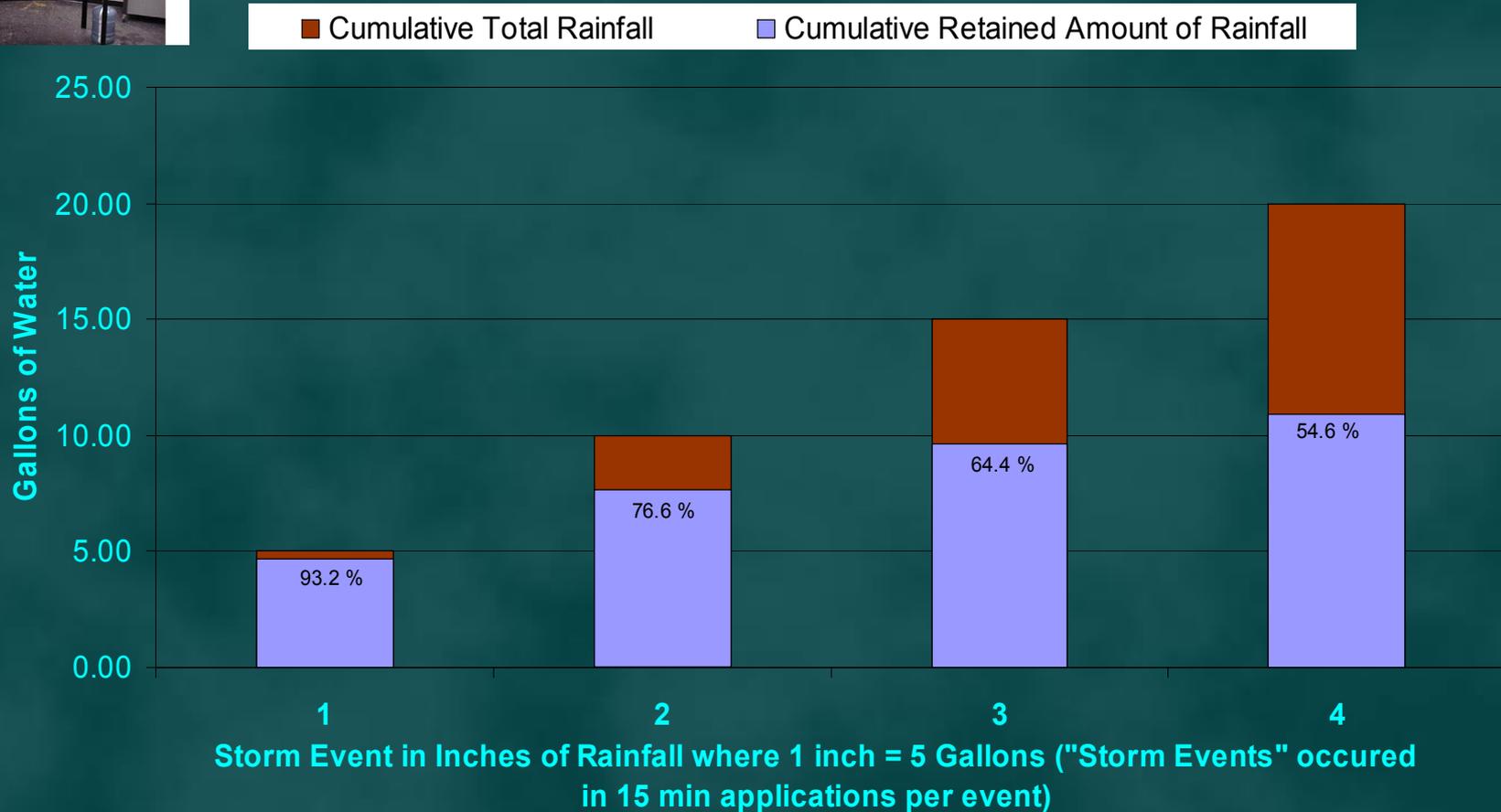


GreenGrid™ at University of Wisconsin, Milwaukee

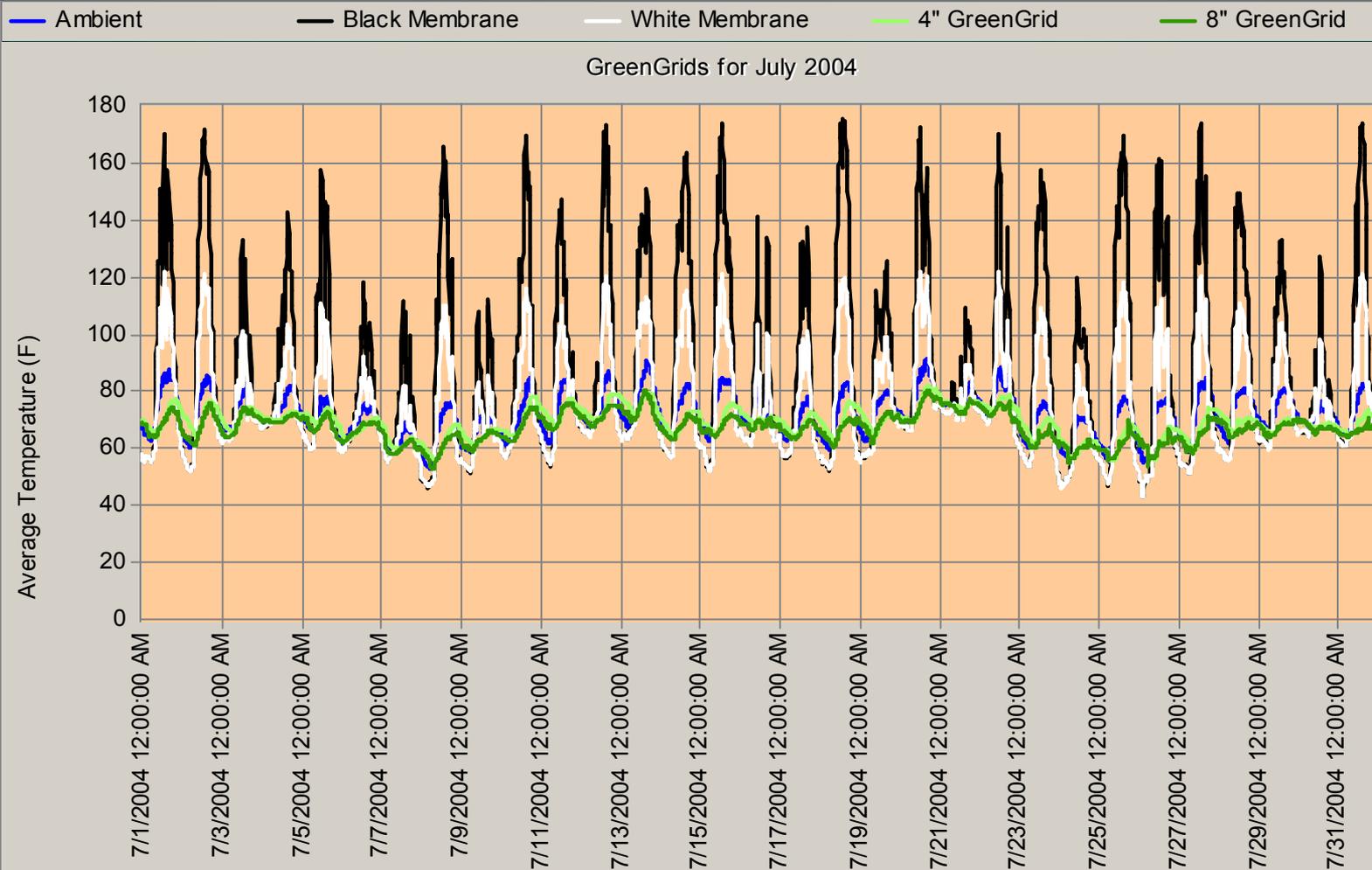
GreenGrid™ System Has Excellent Stormwater Retention Capacities



Cumulative Water Retention in an Eight Inch GreenGrid Unit During a Simulated 2 Hour Rain Storm



GreenGrid™ Representative Temperature Data, July 2004



GREENGRID™

The Natural Choice for Your Roof



GreenGrid™ at Apple Computer Store, Chicago



GreenGrid™ at Milwaukee Municipal Sewerage District Corporate Headquarters, Milwaukee, WI



GreenGrid™ at American Red Cross, Chicago



GreenGrid™ at Engine Company 13, Chicago

GreenGrid™ Benefits Over Traditional Green Roofs

TRADITIONAL SYSTEMS	GreenGrid™ SYSTEM
Systems often heavy	Modules very lightweight
Installation time-consuming/expensive	Installation can be quickly accomplished
Irrigation systems obtrusive, problematic, designed roof by roof	Simple, pre-installed irrigation system
Roof repair extremely difficult	Modules can simply be moved
No “complete” system available	All components of GreenGrid™ engineered and available
Roof surface replacement required	GreenGrid™ can go on any roof surface in good condition
Systems are often expensive	GreenGrid™ competitively priced
Systems often contain PVC in components	All GreenGrid™ modules and pavers made from recycled materials
Roof requires about 2 years to be “green”	Instant green roof since system comes preplanted

Sample of GreenGrid™

Green Roof Completed Projects



- Apple Computer Store – Chicago, IL – 2,368 sf
- Washington State School for the Blind, Ogden Resource Center – Vancouver, WA – 6,680 sf
- Center for Urban Ecology, National Park Service, Washington D.C. – 7,048 sf
- Chicago Transit Authority, Substation at Montrose and Clifton – Chicago, IL – 2,544 sf
- Target Corporation, West Addison Store – Chicago, IL – 9,664 sf
- Green Homes. Chicago – 350 sf
- Target Corporation, South Loop Store – Chicago, IL – 7,128 sf
- Great Lakes Water Institute – Milwaukee, WI – 6,476 sf
- Milwaukee Metropolitan Sewerage District – Milwaukee, WI – 3,780 sf
- Northwestern Memorial Hospital – Chicago, IL – 1,440 sf
- Calpine Corporation Headquarters – Houston, TX – 2,280 sf
- Chicago Architecture Foundation – Part of *Big and Green* display.
- ABC Supply Corporate Headquarters, Beloit WI – 12,000 sf
- Chicago Dept. of General Services, Four Firestations, Chicago II – 10,000 sf
- Hastings Federal Building, New Bedford, Mass. – 3,716 sf
- Fifth Third Bank – Chicago, IL – 1,880 sf
- Pennsylvania Dept. of Environmental Protection - Norristown, PA – 1,360 sf
- Friedman Properties/Bovis Lend Lease, Chicago, IL – 10,424 sf
- Chicago Park District – 600 sf
- Milwaukee Housing Authority – Milwaukee, WI – 20,036 sf
- Green Bungalows, Chicago – 350 sf
- Private Residence – Salt Lake City, UT – 256 sf
- KOR Realty Group, 612 Flower Street Condominiums – Los Angeles, CA – 1,912 sf
- Nature Center at Shaker Lakes – Cleveland, OH – 184 sf
- Milwaukee County Zoo – Milwaukee, WI – 3,000 sf
- Brewer's Hill – Natty Boh – Baltimore, MD – 12,000 sf
- Mulehide Corporation, WI – 700 sf
- American Red Cross of Greater Chicago – Chicago, IL – 3,184 sf

GREENGRID™

The Natural Choice for Your Roof

