DATE: August 11, 2009

TO: Interested Persons

FROM: Office of the City Clerk

SUBJECT: NOTICE OF EXPIRED FILE STATUS

In 2005, the Council approved a policy wherein all Council files pending before the City Council, which have not been placed on a Council or Committee agenda for consideration for a period of two years or more, are deemed "received and filed." The City Clerk is responsible for the administration of this process.

Quarterly, on the last day of March, June, September and December of each year, the City Clerk administratively closes all received and filed Council files. This letter provides notice that this Council file, and its subject matter, is no longer active as of July 1, 2009. This Council File is deemed closed.

FRANK T. MARTINEZ
City Clerk

KAREN E. KALFAYAN
Executive Officer

When making inquiries relative to this matter refer to File No.

CITY OF LOS ANGELES
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

Office of the
CITY CLERK
Council and Public Services
Room 395, City Hall
Los Angeles, CA 90012
Council File Information - (213) 978-1043
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Fax: (213) 978-1040

CLAUDIA M. DUNN
Chief, Council and Public Services Division
www.cityclerk.lacity.org

CF 04-0074

April 18, 2007

Karen L. Sisson
City Administrative Officer
200 North Main Street, Room 1500
Los Angeles, CA 90012

Detrich B. Allen, General Manager
Environmental Affairs Department
200 North Spring St., Ste. 1905 & 2005
Los Angeles, CA 90012

REQUEST FOR REPORT

At its meeting held April 10, 2007 (continued from February 13 and 27, 2007), the Planning and Land Use Management (PLUM) Committee considered the report from the Department of Public Works, Bureau of Engineering (BOE) relative to rooftop green spaces as an energy efficiency mechanism, in response to May 2, 2006, Council action requesting the BOE and Bureau of Sanitation, Environmental Affairs Department (EAD), Department of Building and Safety, Department of City Planning, Los Angeles Department of Water and Power, General Services Department, and City Administrative Officer (CAO) to prepare a proposal to incorporate rooftop green spaces as an energy efficient mechanism, and related matters, pursuant to Motion (Reyes - Perry). **(Also referred to Energy and Environment Committee)**

The PLUM Committee approved the recommendation, however requested that the CAO and EAD report back to the PLUM Committee in 45 days relative to: (1) the feasibility of including the building on First and Chicago Streets in Boyle Heights in the pilot green rooftop program; and (2) sources of funding.

Barbara Greaves, Legislative Assistant
Planning and Land Use
Management Committee, 213-978-1068

Attachment:

cc: Avo Davidian, Legislative Assistant, Energy and Environment Committee
Department of Public Works, Bureau of Engineering,
Attn: Gary Lee Moore, City Engineer

#040074ltr

CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

GARY LEE MOORE, P.E.
CITY ENGINEER

1149 S. BROADWAY, SUITE 700
LOS ANGELES, CA 90015-2213

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February 8, 2007

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is a report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings. This report was prepared following an oral report to the PLUM Committee on August 8, 2006.

Recommendations:

1. Direct the City Engineer to report back to the PLUM Committee on the progress of the projects chosen for a pilot green roof program.
   - Include the South Los Angeles Neighborhood City Hall in Council District 9 as part of the green roof pilot program (new construction).
   - Select one or more additional projects from the list of potential buildings as pilot projects. (new construction or retrofit construction).

2. Direct the Environmental Affairs Department (EAD) to apply for appropriate sources of grant funding for use in green roof design, planting, monitoring, maintenance, and other activities to support the pilot program. Direct EAD to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

3. Direct the City Administrative Officer to identify additional funding for the selected projects.

4. Direct the City Engineer to work with EAD and the Green Roofs Task Force on project elements as they move forward.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot projects. While all objectives may not be met in a single project, this list is intended to assist with the decision:

Objectives for Pilot Project:

1. Clear environmental benefits.
2. Visible although not necessarily accessible to the public.
3. Fundable, with maintenance dollars identified.
4. Technically feasible.
5. Accessible for monitoring.
6. Over an inhabited and conditioned space.
7. Achievable in the near term.
8. Possibly identify two similar projects for comparison, such as: a) one intensive[1] roof and one extensive[1] roof; b) one with a green roof and one without a green roof; c) green roof on new construction and a green roof retrofit to an existing building in order to compare the performance.
9. Possibly identify a green roof to replace lost ground level green space.

---

[1] 1. "***Intensive* roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive* green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

10. Possibly locate where storm water concerns are greatest (such as Sun Valley).

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - United States Department of Energy
    - United States Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations and non-profit organizations

Approach

- The Bureau of Engineering (BOE) spoke with each of the Council offices in whose district the proposed projects are located, and with the operating departments for the potential building sites.

- BOE met with American Institute of Architects Los Angeles Committee on Environment (COTE) and discussed options for green roofs for City projects. COTE is very supportive of green roof projects and made a number of useful suggestions. COTE expressed support in particular for the South Los Angeles Neighborhood City Hall that is in design, and support for the Reptile and Insect Center at the Zoo as pilot projects.

- BOE arranged a tour of the green roof on the Los Angeles Unified Theodore Alexander Jr. Science Center School in Exposition Park. In attendance were representatives from the Mayor's office, General Services Department, and BOE. The tour was very informative on maintenance issues, as well as on the selection of plants. First year maintenance is crucial for plant establishment, perhaps requiring hand watering during hot summer months. After the first year, as the roof surface may not be readily visible, it is important to monitor the functioning of the irrigation system on a regular basis.

- BOE arranged for a visit by Sarnafil (green roof vendor for the Chicago City Hall green roof) to investigate the possibility of placing a green roof atop City Hall's low rise wings.

Options for City Projects

BOE solicited project nominations from:

- Building Programs Managed by BOE:
  - Proposition F: Fire Stations and Animal Care Facilities.
  - Proposition Q: Police Facilities.
  - Los Angeles Zoo.
  - Recreation and Cultural Facilities: Recreation and Parks Facilities.
  - Municipal Facilities Program: Facilities for Various Departments
- Port of Los Angeles.
- Los Angeles Department of Water and Power (LADWP).
- Los Angeles Department of Recreation and Parks.

List of Potential Projects – New Construction:

South Los Angeles Neighborhood City Hall

Location: 4301 S. Central Avenue – CD9
Description: 7,400 sq.ft. field office with green roof, 1,900 sq. ft. training room with metal roof
Construction Budget: $7.3M
Completion: January 2009
Consultant: Paul Murdoch Architects
Status: 98% Design Completed
Project Manager: BOE
Client: Council District 9

Comments: This is already being designed with an intensive green roof that will be accessible to the public. BOE has sought and received a proposal for monitoring the performance of the green roof for this project (approximately $100,000), although funds for monitoring have not yet been identified. As available, additional funding could be applied to monitoring the performance of the green roof. EAD is pursuing funding interest from a nonprofit organization. Monitoring tasks could include measuring temperatures on the roof and the underside of the roof deck; affects of soil moisture on temperature; ambient air temperature; and other factors deemed relevant.

Reptile and Insect Interpretive Center - the HISS Center

Location: 5333 Zoo Drive – CD4
Description: Approximately 9,000 sq. ft.
Construction Budget: $7.8M
Completion: September 2009

Consultant: Portico Group
Status: 15% Design Completed
Project Manager: BOE
Client: Zoo Department

Comments: The Reptile & Insect Interpretive Center is a new exhibit that will replace the Los Angeles Zoo and Botanical Garden's current Reptile House. This exhibit will accommodate the current reptile, amphibian, and invertebrate collections. The approximately 30,000 square foot site for the proposed display of both indoor and outdoor animal exhibits is located within the Aquatic Region of the Zoo.

The Mayor's office has expressed interest in placing a green roof on this project. COTE considered this a very strong candidate for a green roof. A green roof could be an additional element of the botanical collection at the Zoo, and add to the display of the significant link between plants, animals, and people – an ecosystem approach. The green roof would be designed to minimize any potential negative impacts on the animals that will be on display. Also, this roof would be visible to visitors of the Zoo from an elevated public walkway and the Tree Top Terrace where special Zoo events are held. Additional funding will need to be identified for the green roof.

Mar Vista Garden Center and Child Care Center
Location: CD-11
Description: 4000 sq. ft. Childcare center for low-income housing
Construction Budget: $2.0 M
Completion: December 2009
Consultant: Not yet identified.
Status: On hold awaiting site acquisition.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is strongly in favor of a green roof for this project. The base project, however, is under funded. Funding for the green roof could be pursued via a grant.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sq. ft. Maintenance & Admin (5,000 sq. ft. green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 70% Construction Documents

Client: Port of Los Angeles

Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD-4
Description: Fire Station
Construction Budget: $8.7M
Completion: Approximately December 2009, depending on site acquisition
Consultant: From the Proposition F Approved List
Status: On hold awaiting site acquisition
Project Manager: BOE
Client: Fire Department

Comments: The project site is not yet identified. If it is decided that the green roof is an important sustainability component of the project, contributing to meeting the Council mandate for LEED Certified, this feature would need approval from the Proposition F Administrative Oversight Committee. With approval of the Oversight Committee and concurrence from the City Attorney's office, funds from the Proposition F Program contingency could be applied to this project for the green roof. The Council Office is supportive of the green roof for this project. The Fire Department expressed support for exploring the green roof option, if it can be done cost effectively. As the pre-design has not yet started, the incremental cost increase for a heavier structure and the green roof components can be considered early in the design process. The project will likely be multi-story, and the community room could be located to have a direct line-of-sight to the green roof. The green roof should be considered only over a conditioned space for optimum long term benefit.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq. ft. gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Completion: Not known.
Consultant: Not yet identified.
Status: On hold awaiting additional funding.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is very supportive of adding a green roof to this project. However, the base project is short funded. Also, previously prepared plans may be used for the site which would make it difficult for a green roof on this project.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq. ft. gym and support areas
Construction Budget: $13M
Completion:
Consultant: Rios and Associates
Status: 20% Design Completed
Project Manager: BOE
Client: Recreation and Parks

Comments: This project is in the middle of the Van Nuys/Sherman Oaks Park, and the Council office is in favor of a green roof for the project. The design team has suggested a portion of the building be covered with a green roof, a roof area that would be visible from the entire park. Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008, and additional funding will have to be identified for the green roof.

Ascot Park Educational Center
Location: CD14
Description: 10,000 -15,000 sq. ft. educational center
Construction Budget: $10M - $12M
Completion: Not yet established.
Consultant: Not yet identified.
Status: Programming
Project Manager: Recreation and Parks Advance Planning Group
Client: Recreation and Parks

Comments: Recreation and Parks has suggested that this project would be a good location for an earth-sheltered building, partially buried in the hillside. Ascot Park is a former LADWP property that has been opened to the public as new open space. Recreation and Parks is discussing the requirements for the Educational Center. This project may be eligible for State Bond funding.

List of Potential Projects – Existing Buildings:

City Hall
Location: 200 N. Main Street
Construction Budget: $1M
Completion: Approximately 2 years from initiation.
Consultant: NA
Status: NA

Project Manager: NA
Client: General Services Department

Comments: This would be a high profile retrofit opportunity to install a green roof on the low-rise wings of City Hall, as was done with the existing Chicago City Hall. Approximately 24,000 sq. ft. of roof area is available for a green roof.

The installation of a green roof would require an investigation of the capacity of the roof to carry the additional weight. It would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal registry of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

A Sarnafil representative visited the building with BOE, and has prepared a report detailing the requirements of placing an extensive green roof on the low-rise wings of the City Hall. The proposed extensive green roof would be placed over the existing roof which is approximately 3 years old. Excluding the areas allocated to the mechanical systems, there is approximately 24,000 sq. ft. available for the green roof. The cost of installation would be approximately $1,000,000. If structural upgrades are required, BOE would not recommend proceeding. Based on the investigation to date, pending the structural review, a green roof for City Hall is feasible.

Environmental Learning Center - West
Location: Hyperion Treatment Plant, 12000 Vista Del Mar - CD11
Description: 20,300 sq.ft., 2-story Learning Center with green roof
Construction Budget: $8.5M
Completion: July 2009 (Construction)
Consultant: Camp, Dresser & McKee, Inc. (CDM)
Status: 10% Design Completed
Project Manager: BOE
Client: Bureau of Sanitation

Comments: This project will renovate an existing, unoccupied Administration Building into the Environmental Learning Center - West (ELC-W). The ELC is being developed to address the need for increased public education about how urban activities affect the evironment. The building will be an example of environmentally sensitive engineering through the use of solar photovoltaic panels, skylights, and a green roof. This project is being designed with an extensive green roof.

Other Project Possibilities

- The Los Angeles Unified School District (LAUSD) is preparing working drawings for a new high school in Taylor Yard, High School #13, and is pursuing the addition of an ancillary environmental learning center which could have a green roof. Council District 1 is interested in assisting LAUSD in identifying funds for this green roof.
- Other existing City buildings.
- LADWP Projects: LADWP has initiated an effort to pilot a LEED building, and might consider a green roof.
- California Redevelopment Agency/Los Angeles (CRA/LA): The CRA/LA has demonstrated a commitment to sustainable design and to LEED on various projects.
- Airport projects.
- City funded affordable housing projects.
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit).

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Extensive Roof

	New Bldg *	Existing Bldg *
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$40 per sq ft	$35-$45 per sq ft
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

* The information is based on bids received for a Department of Recreation & Parks building in the new Taylor Yard park.

Intensive Roof

	New Bldg	Existing Bldg **
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$35-$45 per sq ft	$45-60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

** It is rare an existing building could support an intensive green roof.

The prices for a green roof installation will likely drop as demand increases and more installers exist.

In terms of maintenance, a green roof installation would either need guardrails for or another approved fall protection system to protect employees who would be performing maintenance. Safe access would also have to be provided to the green roof areas. Also, employees will need to be training on proper maintenance procedures.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the

specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor in the project.

- Protection of the roof membrane results in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in savings in replacement costs.

- Lower ambient air temperatures directly reduces the urban heat island effect and slows the formation of ozone pollution.

- A green roof could result in savings on energy heating and cooling costs, depending on the ratio of height to width of the building, the climate, and the type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one story building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.

- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.

- Cost savings from increased stormwater retention and filtration and decreased need to expand or rebuild related infrastructure.

- Less impervious surface, as calculated for Standard Urban Stormwater Management development permits by the Bureau of Sanitation, which reduces stormwater needing to be mitigated.

- Contributes to meeting greenhouse gas emissions reductions and to climate change concerns by reducing building energy needs.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs (EAD) and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance, and data collection and analysis, and report back to the PLUM Committee.

To date, EAD has contacted organizations and groups it deals with on a regular basis. While there is increasing interest in green roof projects, specific funding opportunities targeting green roofs are limited. EAD has expanded its search to include green building, stormwater reduction, and other related funding programs

that might consider funding a green roof project. EAD staff also coordinates with groups involved with urban heat island issues and green roofs, and is active in sharing funding ideas with staff at other cities. We are also utilizing eCivis to locate grants for the development of green roofs through water mitigation, improvement of energy efficiency, public education, CEQA mitigation measures, and replacement of open space.

Once pilot projects are identified by City Council, there may be a short turnaround time to apply for funds once an appropriate opportunity is identified. Thus, EAD requests the authority to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

E. Green Roof Activities in Other Cities

Chicago, Illinois

As of October 2006, there are more than 250 public and private green roofs totaling more than 1 million square feet that are under design or construction in Chicago. These include private, not-for-profit, and public developments receiving financial or other types of public assistance from the City, as well as Planned Developments and Lakefront Protection Ordinance Developments.

The Chicago City Hall began as a demonstration project - part of the City's Urban Heat Island Initiative - to test the benefits of green roofs and how they affect temperature and air quality. The garden consists of 20,000 plants of more than 100 species, including shrubs, vines and two trees. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

Like all green roofs, the Chicago City Hall rooftop garden is intended to improve air quality, conserve energy, reduce stormwater runoff, and help lessen the urban heat island effect.

The rooftop garden mitigates the urban heat island effect by replacing what was a black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75% of a 1 inch rainfall before there is stormwater runoff.

Chicago has recently begun the "Green Roof Grants Program" for residential and small commercial building owners. Applicants can qualify for $5,000 for a Green Roof Project. This new grant program will enable home owners and small businesses to install green roofs.

Milwaukee, Wisconsin

The Milwaukee Metropolitan Sewage District (MMSD) is investing in green infrastructure projects to reduce combined sewage/stormwater overflow discharges and mitigate stormwater runoff. One approach is the installation of green roofs. Seven green roofs have been installed throughout the region, including atop a housing project for senior citizens and a facility for people with disabilities. The green roof at the housing project is 20,000 square feet and is expected to retain 85% of a 2-inch rainfall. Rain gardens and retention basins used for on-site irrigation receive the remaining 15%.

MMSD has financially assisted four other green roofs for the purpose of stormwater reduction. The four roofs are as follows:

- The roof of MMSD's headquarters (3,500 sq. ft. structure).
- The University of Wisconsin-Milwaukee's Great Lakes Water Institute (10,000 square foot structure).
- The Urban Ecology Center.
- The Milwaukee County Zoo.

Toronto, Canada

Toronto has initiated a Green Roof Incentive Pilot Program. Sixteen successful applicants were approved as part of the pilot program. The goal of this program is to encourage green roof construction in the City. In 2006, the Toronto City Council approved the Green Roof Pilot Program, allocating $200,000 from Toronto Water's budget to encourage green roof construction. Eligibility for this program was opened to any private property owner in the City of Toronto, regardless of building size and type, as long as the building is capable of supporting a green roof that meets the specifications and requirements, and has a water account with the City. Additionally, it is hoped that the program will:

- Result in the construction of a variety of green roof types which could be used for education and promotional purposes.
- Provide an opportunity to showcase various green roof technologies and planting styles.
- Provide a grant of $10 per square meter of eligible green roof area up to a maximum of $20,000.

Other Locations

Located in Pacific Palisades, the Getty Villa has an extensive green roof on the top of a parking garage.

Located in Pasadena, the Art Center has an extensive green roof on their South Campus building.

Thank you to the Environmental Affairs Department for their assistance with this report. If you have any questions, please contact Deborah Weintraub, Deputy City Engineer, at (213) 485-5499.

Sincerely,

Gary Lee Moore

Gary Lee Moore, P.E.
City Engineer

DJW:tlw

CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

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http://eng.lacity.org

August 3, 2006

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is an interim report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings.

Recommendation:

Direct the City Engineer to analyze the viability of the installation of a green roof on the two low rise wings of City Hall, and report back to the PLUM Committee within 90 days on the scope, design and construction costs, maintenance costs, and schedule.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot project:

Objectives for Pilot Project:

1. Clear environmental benefits
2. Visible to the public
3. Fundable, with maintenance dollars identified

4. Technically feasible

5. Accessible for monitoring

6. Over an inhabited and conditioned space

7. Achievable in the near term

8. Possibly identify two similar projects for comparison, one intensive[1] roof and one extensive[1]roof, or one with a green roof and one without green roof, in order to compare the performance

9. Possibly identify a green roof to replace lost ground level green space

10. Possibly locate where storm water concerns are greatest (such as Sun Valley)

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - Federal Department of Energy
    - Federal Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations such as the California Endowment, the Hewlett Fund, the Graham Foundation

[1] 1. ***"Intensive* roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive* green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

Options for City Projects

- Bureau of Engineering solicited project nominations from:
  - Proposition F: Fire stations and Animal Care Facilities
  - Port of Los Angeles
  - Proposition Q: Police Facilities
  - Other Municipal Facilities Projects
  - Los Angeles Department of Water and Power
  - Los Angeles Zoo

- List of Nominated Projects – New Construction:

Council District 9 - Neighborhood City Hall
Location: 4301 S. Central Avenue – CD9
Description: 7,400 sf field offices with green roof, 1,900 sf training room
Construction Budget: $7.3M
Consultant: Paul Murdoch Architects
Status: 90% Construction Documents
Client: Council District 9
Comments: This is already being designed with an intensive green roof that will be accessible to the public. Additional funding could be applied to monitoring the performance of the green roof.

Reptile and Insect Center
Location: 5333 Zoo Drive – CD4
Description: 9,000 sf
Construction Budget: $7.8M
Completion: September 2009
Consultant: Portico Group
Status: Pre-design
Client: Zoo Department
Comments: Additional funding will need to be identified for the green roof. This roof will be visible to the public from an elevated public walkway that will rise 30' to a treetop terrace.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sf. Maintenance & Admin (5,000 sf green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 40% Construction Documents
Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD 13
Description: Fire Station
Construction Budget: $8.7M
Status: On hold awaiting site acquisition
Completion: Approximately December 2009
Comments: Project timeline not yet established. Additional funding will have to be identified for the green roof.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq ft gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Status: On hold awaiting additional funding
Comments: Council office is very supportive of adding the green roof to this project. Base project is short funded.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq ft gym and support areas
Construction Budget: $13M
Status: Design
Comments: Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008.

Fred Roberts Gymnasium
Location: 4600 S. Honduras – CD 9
Description: 11,000 sq ft gym & support areas (7,000 sq ft green roof)
Construction Budget: $4.5M
Status: Schematic design
Comments: Base project is short funded.

- Other Project Suggestions – Existing Buildings:

City Hall
Description: A high profile, retrofit opportunity would be to install a green roof on the low rise wings of City Hall, as was done with the Chicago City Hall.

Comments: This would require an investigation of the capacity of the roof to carry the additional weight. This would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal register of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

Other Project Possibilities

- Other existing City buildings such as existing neighborhood City Halls
- Airport projects
- City funded affordable housing projects
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit)

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Intensive Roof

	New Bldg	Existing Bldg (It is rare an existing building could support an intensive green roof.)
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$45 per sq ft	$40-$60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

Extensive roof

	New Bldg	Existing Bldg
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$20 per sq ft and up	$25 per sq ft and up
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

As a basis for comparison, the Bureau of Engineering has also contacted the designers for the new Los Angeles Unified School in Exposition Park, the Theodore Alexander Junior Science Center, which is a new building with an intensive green roof. This information is not yet available.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor for that project.

- Protection of roof membrane resulting in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in decreased maintenance and savings in replacement costs.
- Savings on energy heating and cooling costs, depending on the size of the building, climate and type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one storey building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.
- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.
- Cost savings from increased stormwater retention and decreased need to expand or rebuild related infrastructure.
- Decreased cost of meeting greenhouse gas reductions and adapting to climate change by reducing the "Urban Heat Island Effect" and the need for interior building insulation.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance and data collection and analysis, and report back to the PLUM Committee.

Sincerely,

Deborah J. Weintraub, AIA
Deputy City Engineer

DJW:tlw
J:\DJW\Word\Plum Cmtt Report 080306_1.doc

cc: Sarai Bhaga, Sr. Administrative Analysis II
City Administrative Officer

Gretchen Hardison, Environmental Affairs Officer
Environmental Affairs Department

Lambert Giessinger, Architect Associate II
Department of Planning

Gary Lee Moore, P.E.
City Engineer

Mahmood Karimzadeh, Program Manager
Architectural Division

AIA Los Angeles

A Chapter of the American Institute of Architects

04-0074

March 7, 2007

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council
C/o Barbara Greaves
City Clerk - City Hall Room 350
City of Los Angeles
200 N. Spring Street
Los Angeles, CA 90012

Re: **Rooftop Green Spaces as Energy Efficiency Mechanism**

Dear Councilmember Reyes:

On behalf of the AIA Los Angeles Board of Directors, I am writing to express our enthusiastic support of Deborah Weintraub, AIA and the Bureau of Engineering's recommendations for a pilot program to demonstrate green roof technology in City Buildings.

The AIA/LA Committee on the Environment has been in active discussion with BOE about green roofs for City projects and is highly encouraged by the City's leadership to develop a more sustainable community.

In particular, we are supportive of Rooftop Green Spaces being implemented on the South Los Angeles Neighborhood City Hall project, the Ascot Park Education Center, the Mar Vista Garden and Child Care Center and the Reptile and Insect Interpretive Center at LA City Zoo.

Additionally, we are *highly* supportive of a feasibility study as to the possibilities of implementing an iconic & high-profile green roof system for Los Angeles City Hall on Main Street.

As we strive to develop a City of design excellence with elegance in density, AIA Los Angeles favor's the BOE's recommendations to implement rooftop green spaces as an energy efficiency mechanism, which in addition to creating a more aesthetically pleasing community helps to make our City more healthy, livable and accessible.

Very truly yours,

Mike Enomoto, FAIA
President
AIA Los Angeles

Cc. Deborah Weintraub, AIA & Gary Lee Moore, P.E.

Wiltern Center
3780 Wilshire Boulevard, Suite 800
Los Angeles, CA 90010
213.639.0777 FAX: 213.639.0767
www.aialosangeles.org

(4)

04-0074

CONTINUED FROM 2-13-07

Report from the Department of Public Works, Bureau of Engineering (BOE) relative to rooftop green spaces as an energy efficiency mechanism, in response to May 2, 2006, Council action requesting the BOE and Bureau of Sanitation, Environmental Affairs Department, Department of Building and Safety, Department of City Planning, Los Angeles Department of Water and Power, General Services Department, and City Administrative Officer to prepare a proposal to incorporate rooftop green spaces as an energy efficient mechanism, and related matters, pursuant to Motion (Reyes - Perry). **(Also referred to Energy and the Environment Committee)**

Fiscal Impact Statement Submitted: No

DISPOSITION cont to 3-27-07 PLUM.

(5)

06-2444

CONTINUED FROM 12-19-06 AND 2-13-07

Motion (Huizar - Reyes) requesting a report from the Department of Building and Safety (DBS) regarding an information technology strategic plan which provides mobile computer technology to field personnel and integrates the information currently contained in a number of separate information systems which support the City's land development processes, including the Code Enforcement Information System, the Plan Check and Inspection System, and the Citywide Nuisance Abatement Program; and that the City Attorney review the Department of Building and Safety's current utilization of the System Development Fund regarding its legality; and make recommendations for new or revised Ordinances, as necessary, to expand the uses of the System Development Fund to support implementation of the Department of Building and Safety's overall comprehensive information technology strategic plan. **(DBS to report)**

DISPOSITION_____

(7)

04-0074

Report from the Department of Public Works, Bureau of Engineering (BOE) relative to rooftop green spaces as an energy efficiency mechanism, in response to May 2, 2006 Council action requesting the BOE and Bureau of Sanitation, Environmental Affairs Department, Los Angeles Department of Building and Safety, Department of City Planning, Los Angeles Department of Water and Power, General Services Department, and City Administrative Officer to prepare a proposal to incorporate rooftop green spaces as an energy efficient mechanism, and related matters, pursuant to Motion (Reyes - Perry). **(Also referred to Energy and the Environment Committee)**

Fiscal Impact Statement Submitted: No

DISPOSITION cnt'd 2-20-07 FC

(8)

06-3218
APCSV 2006-6477
ZC
CD 3

TIME LIMIT: 3-19-07; LAST DAY FOR COUNCIL ACTION: 3-16-07

Report from the South Valley Area Planning Commission and Ordinance effecting a Zone Change from RA-1 to (T)(Q)R1-1 for the proposed demolition of an existing 3,058 square foot single-family dwelling and a 400 square-foot detached carport structure and the proposed construction of two single-family dwellings, one-story, 14 feet, six inches high, on two 10,700 square foot lots for property at 18624 West Roscoe Boulevard. (Note: a parcel map, for subdivision purposes has yet to be filed and will require a separate public notice and hearing before the Advisory Agency at a later date.)

Applicant: Timothy C. Trinh MND
Fiscal Impact Statement Submitted: Yes, by Commission
Commission Vote: 5-0

DISPOSITION

(9)

06-3168
CPC 2005-4972
ZC GPA
CD 4

TIME LIMIT AND LAST DAY FOR COUNCIL: 2-27-07

Report from the Mayor, Director of Planning, and City Planning Commission and Resolution relative to a General Plan Amendment to the Sherman Oaks-Studio City-Toluca Lake-Cahuenga Pass Community Plan from Low Density Residential to Low Medium Density Residential and to the Hollywood Community Plan from Low II Density Residential to Low Medium II Residential; and Ordinances for a concurrent Zone Change from R3-1 to [Q]RD1.5-1 within the Sherman Oaks-Studio City-Toluca Lake-Cahuenga Pass Community Plan for properties in Subarea A: 3148, 3154, 3160, 3165, 3168, 3170, Barbara Court; 3216, 3227, 3223, 3217, 3213, 3209 Bennett Drive; 3187, 3188 Cadet Court; 3200, 3202, 3204, 3206, 3208, 3210, 3222 Dos Palos; and 3159 Oakcrest Drive; and a zone change from R3-1-1 to [Q]RD1.5-1 within the Hollywood Community Plan for properties in Subarea B: 3121, 3117, 3109, 3101, 3057, 3051, 3045, 3041, 3033, 3029 and 3023 Hollycrest Drive to correct inconsistent General Plan designations and zoning for 25 lots within the subject Community Plans, subject to Conditions of Approval. (Planning Department states that there is no proposed project at this time.)

Applicant: City of Los Angeles (Director of Planning) ND
Commission Vote: 5-0
Fiscal Impact Statement Submitted: Yes, by Commission

DISPOSITION_____

(10)

03-1791-S7
CD 12

Application filed by Silva Derderian (Vic Toroyan, Representative), requesting a hardship exemption from the Old Granada Hills Interim Control Ordinance (No. 177159), for the proposed construction of two new single-family dwelling units on Lot 269 and 270. Each dwelling unit will consists of 2,007 square feet of living area, 17 feet 11 inches in height, with living room, dining room, kitchen, three bedrooms, and two baths for property at 17537 (Lot 269) and 17541 (Lot 270) Los Alimos Street. (Lot 269 consists of at total of 9,500 square feet and Lot 270 consist of at total of 10,380 square feet). (May be received and filed, inasmuch as the applicant has withdrawn his application.)

DISPOSITION_____

CITY OF LOS ANGELES SPEAKER CARD

Date	THE CITY COUNCIL'S RULES OF DECORUM WILL BE ENFORCED.	Council File No., Agenda Item, or Case No.
02/13/2007		04-0074 (1)

I wish to speak before the PLANNING & LAND USE MANAGEMENT COMM.
Name of City Agency, Department, Committee or Council

Do you wish to provide general public comment, or to speak for or against a proposal on the agenda? (✓) For proposal ( ) Against proposal ( ) General comments

Name: STUART MAGNUSON

Business or Organization Affiliation: STUDIO NOVA A ARCHITECTS INC.

Address: 4337 W. 59TH ST, LA CA 90043
Street City State Zip

Business phone: 323 292-0909 Representing: AIA COMMITTEE ON THE ENVIRONMENT

CHECK HERE IF YOU ARE A PAID SPEAKER AND PROVIDE CLIENT INFORMATION BELOW: ☐

Client Name: _____ Phone #: _____

Client Address: _____
Street City State Zip

Please see reverse of card for important information and submit this entire card to the presiding officer or chairperson.

CITY F LOS ANGELES SPEAKER ARD

Date	THE CITY COUNCIL'S RULES OF DECORUM WILL BE ENFORCED.	Council File No., Agenda Item, or Case No.
7-13-07		7

I wish to speak before the PLUM
Name of City Agency, Department, Committee or Council

Do you wish to provide general public comment, or to speak for or against a proposal on the agenda? ( ) For proposal ( ) Against proposal ( ) General comments

Name: Doug Mensman

Business or Organization Affiliation: _____

Address: _____
Street City State Zip

Business phone: _____ Representing: CD4

CHECK HERE IF YOU ARE A PAID SPEAKER AND PROVIDE CLIENT INFORMATION BELOW: ☐

Client Name: _____ Phone #: _____

Client Address: _____
Street City State Zip

Please see reverse of card for important information and submit this entire card to the presiding officer or chairperson.

CITY OF LOS ANGELES
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

GARY LEE MOORE, P.E.
CITY ENGINEER

1149 S. BROADWAY, SUITE 700
LOS ANGELES, CA 90015-2213

http://eng.lacity.org

February 8, 2007

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is a report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings. This report was prepared following an oral report to the PLUM Committee on August 8, 2006.

Recommendations:

1. Direct the City Engineer to report back to the PLUM Committee on the progress of the projects chosen for a pilot green roof program.
   - Include the South Los Angeles Neighborhood City Hall in Council District 9 as part of the green roof pilot program (new construction).
   - Select one or more additional projects from the list of potential buildings as pilot projects. (new construction or retrofit construction).

2. Direct the Environmental Affairs Department (EAD) to apply for appropriate sources of grant funding for use in green roof design, planting, monitoring, maintenance, and other activities to support the pilot program. Direct EAD to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

3. Direct the City Administrative Officer to identify additional funding for the selected projects.

04-0074

4. Direct the City Engineer to work with EAD and the Green Roofs Task Force on project elements as they move forward.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot projects. While all objectives may not be met in a single project, this list is intended to assist with the decision:

Objectives for Pilot Project:

1. Clear environmental benefits.
2. Visible although not necessarily accessible to the public.
3. Fundable, with maintenance dollars identified.
4. Technically feasible.
5. Accessible for monitoring.
6. Over an inhabited and conditioned space.
7. Achievable in the near term.
8. Possibly identify two similar projects for comparison, such as: a) one intensive[1] roof and one extensive[1] roof; b) one with a green roof and one without a green roof; c) green roof on new construction and a green roof retrofit to an existing building in order to compare the performance.
9. Possibly identify a green roof to replace lost ground level green space.

---

[1] 1. *"**Intensive** **roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. **Extensive** **green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."*
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

10. Possibly locate where storm water concerns are greatest (such as Sun Valley).

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - United States Department of Energy
    - United States Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations and non-profit organizations

Approach

- The Bureau of Engineering (BOE) spoke with each of the Council offices in whose district the proposed projects are located, and with the operating departments for the potential building sites.

- BOE met with American Institute of Architects Los Angeles Committee on Environment (COTE) and discussed options for green roofs for City projects. COTE is very supportive of green roof projects and made a number of useful suggestions. COTE expressed support in particular for the South Los Angeles Neighborhood City Hall that is in design, and support for the Reptile and Insect Center at the Zoo as pilot projects.

- BOE arranged a tour of the green roof on the Los Angeles Unified Theodore Alexander Jr. Science Center School in Exposition Park. In attendance were representatives from the Mayor's office, General Services Department, and BOE. The tour was very informative on maintenance issues, as well as on the selection of plants. First year maintenance is crucial for plant establishment, perhaps requiring hand watering during hot summer months. After the first year, as the roof surface may not be readily visible, it is important to monitor the functioning of the irrigation system on a regular basis.

- BOE arranged for a visit by Sarnafil (green roof vendor for the Chicago City Hall green roof) to investigate the possibility of placing a green roof atop City Hall's low rise wings.

Options for City Projects

BOE solicited project nominations from:

- Building Programs Managed by BOE:
  - Proposition F: Fire Stations and Animal Care Facilities.
  - Proposition Q: Police Facilities.
  - Los Angeles Zoo.
  - Recreation and Cultural Facilities: Recreation and Parks Facilities.
  - Municipal Facilities Program: Facilities for Various Departments
- Port of Los Angeles.
- Los Angeles Department of Water and Power (LADWP).
- Los Angeles Department of Recreation and Parks.

List of Potential Projects – New Construction:

South Los Angeles Neighborhood City Hall

Location: 4301 S. Central Avenue – CD9
Description: 7,400 sq.ft. field office with green roof, 1,900 sq. ft. training room with metal roof
Construction Budget: $7.3M
Completion: January 2009
Consultant: Paul Murdoch Architects
Status: 98% Design Completed
Project Manager: BOE
Client: Council District 9

Comments: This is already being designed with an intensive green roof that will be accessible to the public. BOE has sought and received a proposal for monitoring the performance of the green roof for this project (approximately $100,000), although funds for monitoring have not yet been identified. As available, additional funding could be applied to monitoring the performance of the green roof. EAD is pursuing funding interest from a nonprofit organization. Monitoring tasks could include measuring temperatures on the roof and the underside of the roof deck; affects of soil moisture on temperature; ambient air temperature; and other factors deemed relevant.

Reptile and Insect Interpretive Center - the HISS Center

Location: 5333 Zoo Drive – CD4
Description: Approximately 9,000 sq. ft.
Construction Budget: $7.8M
Completion: September 2009

Consultant: Portico Group
Status: 15% Design Completed
Project Manager: BOE
Client: Zoo Department

Comments: The Reptile & Insect Interpretive Center is a new exhibit that will replace the Los Angeles Zoo and Botanical Garden's current Reptile House. This exhibit will accommodate the current reptile, amphibian, and invertebrate collections. The approximately 30,000 square foot site for the proposed display of both indoor and outdoor animal exhibits is located within the Aquatic Region of the Zoo.

The Mayor's office has expressed interest in placing a green roof on this project. COTE considered this a very strong candidate for a green roof. A green roof could be an additional element of the botanical collection at the Zoo, and add to the display of the significant link between plants, animals, and people – an ecosystem approach. The green roof would be designed to minimize any potential negative impacts on the animals that will be on display. Also, this roof would be visible to visitors of the Zoo from an elevated public walkway and the Tree Top Terrace where special Zoo events are held. Additional funding will need to be identified for the green roof.

Mar Vista Garden Center and Child Care Center
Location: CD-11
Description: 4000 sq. ft. Childcare center for low-income housing
Construction Budget: $2.0 M
Completion: December 2009
Consultant: Not yet identified.
Status: On hold awaiting site acquisition.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is strongly in favor of a green roof for this project. The base project, however, is under funded. Funding for the green roof could be pursued via a grant.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sq. ft. Maintenance & Admin (5,000 sq. ft. green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 70% Construction Documents

Client: Port of Los Angeles

Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD-4
Description: Fire Station
Construction Budget: $8.7M
Completion: Approximately December 2009, depending on site acquisition
Consultant: From the Proposition F Approved List
Status: On hold awaiting site acquisition
Project Manager: BOE
Client: Fire Department

Comments: The project site is not yet identified. If it is decided that the green roof is an important sustainability component of the project, contributing to meeting the Council mandate for LEED Certified, this feature would need approval from the Proposition F Administrative Oversight Committee. With approval of the Oversight Committee and concurrence from the City Attorney's office, funds from the Proposition F Program contingency could be applied to this project for the green roof. The Council Office is supportive of the green roof for this project. The Fire Department expressed support for exploring the green roof option, if it can be done cost effectively. As the pre-design has not yet started, the incremental cost increase for a heavier structure and the green roof components can be considered early in the design process. The project will likely be multi-story, and the community room could be located to have a direct line-of-sight to the green roof. The green roof should be considered only over a conditioned space for optimum long term benefit.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq. ft. gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Completion: Not known.
Consultant: Not yet identified.
Status: On hold awaiting additional funding.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is very supportive of adding a green roof to this project. However, the base project is short funded. Also, previously prepared plans may be used for the site which would make it difficult for a green roof on this project.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq. ft. gym and support areas
Construction Budget: $13M
Completion:
Consultant: Rios and Associates
Status: 20% Design Completed
Project Manager: BOE
Client: Recreation and Parks

Comments: This project is in the middle of the Van Nuys/Sherman Oaks Park, and the Council office is in favor of a green roof for the project. The design team has suggested a portion of the building be covered with a green roof, a roof area that would be visible from the entire park. Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008, and additional funding will have to be identified for the green roof.

Ascot Park Educational Center
Location: CD14
Description: 10,000 -15,000 sq. ft. educational center
Construction Budget: $10M - $12M
Completion: Not yet established.
Consultant: Not yet identified.
Status: Programming
Project Manager: Recreation and Parks Advance Planning Group
Client: Recreation and Parks

Comments: Recreation and Parks has suggested that this project would be a good location for an earth-sheltered building, partially buried in the hillside. Ascot Park is a former LADWP property that has been opened to the public as new open space. Recreation and Parks is discussing the requirements for the Educational Center. This project may be eligible for State Bond funding.

List of Potential Projects – Existing Buildings:

City Hall
Location: 200 N. Main Street
Construction Budget: $1M
Completion: Approximately 2 years from initiation.
Consultant: NA
Status: NA

Project Manager: NA
Client: General Services Department

Comments: This would be a high profile retrofit opportunity to install a green roof on the low-rise wings of City Hall, as was done with the existing Chicago City Hall. Approximately 24,000 sq. ft. of roof area is available for a green roof.

The installation of a green roof would require an investigation of the capacity of the roof to carry the additional weight. It would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal registry of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

A Sarnafil representative visited the building with BOE, and has prepared a report detailing the requirements of placing an extensive green roof on the low-rise wings of the City Hall. The proposed extensive green roof would be placed over the existing roof which is approximately 3 years old. Excluding the areas allocated to the mechanical systems, there is approximately 24,000 sq. ft. available for the green roof. The cost of installation would be approximately $1,000,000. If structural upgrades are required, BOE would not recommend proceeding. Based on the investigation to date, pending the structural review, a green roof for City Hall is feasible.

Environmental Learning Center - West
Location: Hyperion Treatment Plant, 12000 Vista Del Mar - CD11
Description: 20,300 sq.ft., 2-story Learning Center with green roof
Construction Budget: $8.5M
Completion: July 2009 (Construction)
Consultant: Camp, Dresser & McKee, Inc. (CDM)
Status: 10% Design Completed
Project Manager: BOE
Client: Bureau of Sanitation

Comments: This project will renovate an existing, unoccupied Administration Building into the Environmental Learning Center - West (ELC-W). The ELC is being developed to address the need for increased public education about how urban activities affect the evironment. The building will be an example of environmentally sensitive engineering through the use of solar photovoltaic panels, skylights, and a green roof. This project is being designed with an extensive green roof.

Other Project Possibilities

- The Los Angeles Unified School District (LAUSD) is preparing working drawings for a new high school in Taylor Yard, High School #13, and is pursuing the addition of an ancillary environmental learning center which could have a green roof. Council District 1 is interested in assisting LAUSD in identifying funds for this green roof.
- Other existing City buildings.
- LADWP Projects: LADWP has initiated an effort to pilot a LEED building, and might consider a green roof.
- California Redevelopment Agency/Los Angeles (CRA/LA): The CRA/LA has demonstrated a commitment to sustainable design and to LEED on various projects.
- Airport projects.
- City funded affordable housing projects.
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit).

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Extensive Roof

	New Bldg *	Existing Bldg *
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$40 per sq ft	$35-$45 per sq ft
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

* The information is based on bids received for a Department of Recreation & Parks building in the new Taylor Yard park.

Intensive Roof

	New Bldg	Existing Bldg **
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$35-$45 per sq ft	$45-60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

** It is rare an existing building could support an intensive green roof.

The prices for a green roof installation will likely drop as demand increases and more installers exist.

In terms of maintenance, a green roof installation would either need guardrails for or another approved fall protection system to protect employees who would be performing maintenance. Safe access would also have to be provided to the green roof areas. Also, employees will need to be training on proper maintenance procedures.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the

specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor in the project.

- Protection of the roof membrane results in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in savings in replacement costs.

- Lower ambient air temperatures directly reduces the urban heat island effect and slows the formation of ozone pollution.

- A green roof could result in savings on energy heating and cooling costs, depending on the ratio of height to width of the building, the climate, and the type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one story building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.

- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.

- Cost savings from increased stormwater retention and filtration and decreased need to expand or rebuild related infrastructure.

- Less impervious surface, as calculated for Standard Urban Stormwater Management development permits by the Bureau of Sanitation, which reduces stormwater needing to be mitigated.

- Contributes to meeting greenhouse gas emissions reductions and to climate change concerns by reducing building energy needs.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs (EAD) and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance, and data collection and analysis, and report back to the PLUM Committee.

To date, EAD has contacted organizations and groups it deals with on a regular basis. While there is increasing interest in green roof projects, specific funding opportunities targeting green roofs are limited. EAD has expanded its search to include green building, stormwater reduction, and other related funding programs

that might consider funding a green roof project. EAD staff also coordinates with groups involved with urban heat island issues and green roofs, and is active in sharing funding ideas with staff at other cities. We are also utilizing eCivis to locate grants for the development of green roofs through water mitigation, improvement of energy efficiency, public education, CEQA mitigation measures, and replacement of open space.

Once pilot projects are identified by City Council, there may be a short turnaround time to apply for funds once an appropriate opportunity is identified. Thus, EAD requests the authority to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

E. Green Roof Activities in Other Cities

Chicago, Illinois

As of October 2006, there are more than 250 public and private green roofs totaling more than 1 million square feet that are under design or construction in Chicago. These include private, not-for-profit, and public developments receiving financial or other types of public assistance from the City, as well as Planned Developments and Lakefront Protection Ordinance Developments.

The Chicago City Hall began as a demonstration project - part of the City's Urban Heat Island Initiative - to test the benefits of green roofs and how they affect temperature and air quality. The garden consists of 20,000 plants of more than 100 species, including shrubs, vines and two trees. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

Like all green roofs, the Chicago City Hall rooftop garden is intended to improve air quality, conserve energy, reduce stormwater runoff, and help lessen the urban heat island effect.

The rooftop garden mitigates the urban heat island effect by replacing what was a black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75% of a 1 inch rainfall before there is stormwater runoff.

Chicago has recently begun the "Green Roof Grants Program" for residential and small commercial building owners. Applicants can qualify for $5,000 for a Green Roof Project. This new grant program will enable home owners and small businesses to install green roofs.

Milwaukee, Wisconsin

The Milwaukee Metropolitan Sewage District (MMSD) is investing in green infrastructure projects to reduce combined sewage/stormwater overflow discharges and mitigate stormwater runoff. One approach is the installation of green roofs. Seven green roofs have been installed throughout the region, including atop a housing project for senior citizens and a facility for people with disabilities. The green roof at the housing project is 20,000 square feet and is expected to retain 85% of a 2-inch rainfall. Rain gardens and retention basins used for on-site irrigation receive the remaining 15%.

MMSD has financially assisted four other green roofs for the purpose of stormwater reduction. The four roofs are as follows:

- The roof of MMSD's headquarters (3,500 sq. ft. structure).
- The University of Wisconsin-Milwaukee's Great Lakes Water Institute (10,000 square foot structure).
- The Urban Ecology Center.
- The Milwaukee County Zoo.

Toronto, Canada

Toronto has initiated a Green Roof Incentive Pilot Program. Sixteen successful applicants were approved as part of the pilot program. The goal of this program is to encourage green roof construction in the City. In 2006, the Toronto City Council approved the Green Roof Pilot Program, allocating $200,000 from Toronto Water's budget to encourage green roof construction. Eligibility for this program was opened to any private property owner in the City of Toronto, regardless of building size and type, as long as the building is capable of supporting a green roof that meets the specifications and requirements, and has a water account with the City. Additionally, it is hoped that the program will:

- Result in the construction of a variety of green roof types which could be used for education and promotional purposes.
- Provide an opportunity to showcase various green roof technologies and planting styles.
- Provide a grant of $10 per square meter of eligible green roof area up to a maximum of $20,000.

Other Locations

Located in Pacific Palisades, the Getty Villa has an extensive green roof on the top of a parking garage.

Located in Pasadena, the Art Center has an extensive green roof on their South Campus building.

Thank you to the Environmental Affairs Department for their assistance with this report. If you have any questions, please contact Deborah Weintraub, Deputy City Engineer, at (213) 485-5499.

Sincerely,

Gary Lee Moore

Gary Lee Moore, P.E.
City Engineer

DJW:tlw

Barbara has
the CF

CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

GARY LEE MOORE, P.E.
CITY ENGINEER

1149 S. BROADWAY, SUITE 700
LOS ANGELES, CA 90015-2213

http://eng.lacity.org

August 3, 2006

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is an interim report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings.

Recommendation:

Direct the City Engineer to analyze the viability of the installation of a green roof on the two low rise wings of City Hall, and report back to the PLUM Committee within 90 days on the scope, design and construction costs, maintenance costs, and schedule.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot project:

Objectives for Pilot Project:

1. Clear environmental benefits
2. Visible to the public
3. Fundable, with maintenance dollars identified

4. Technically feasible

5. Accessible for monitoring

6. Over an inhabited and conditioned space

7. Achievable in the near term

8. Possibly identify two similar projects for comparison, one intensive[1] roof and one extensive[1] roof, or one with a green roof and one without green roof, in order to compare the performance

9. Possibly identify a green roof to replace lost ground level green space

10. Possibly locate where storm water concerns are greatest (such as Sun Valley)

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - Federal Department of Energy
    - Federal Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations such as the California Endowment, the Hewlett Fund, the Graham Foundation

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[1] 1. ***"Intensive* roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive* green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

Options for City Projects

- Bureau of Engineering solicited project nominations from:
  - Proposition F: Fire stations and Animal Care Facilities
  - Port of Los Angeles
  - Proposition Q: Police Facilities
  - Other Municipal Facilities Projects
  - Los Angeles Department of Water and Power
  - Los Angeles Zoo

- List of Nominated Projects – New Construction:

  Council District 9 - Neighborhood City Hall
  Location: 4301 S. Central Avenue – CD9
  Description: 7,400 sf field offices with green roof, 1,900 sf training room
  Construction Budget: $7.3M
  Consultant: Paul Murdoch Architects
  Status: 90% Construction Documents
  Client: Council District 9
  Comments: This is already being designed with an intensive green roof that will be accessible to the public. Additional funding could be applied to monitoring the performance of the green roof.

  Reptile and Insect Center
  Location: 5333 Zoo Drive – CD4
  Description: 9,000 sf
  Construction Budget: $7.8M
  Completion: September 2009
  Consultant: Portico Group
  Status: Pre-design
  Client: Zoo Department
  Comments: Additional funding will need to be identified for the green roof. This roof will be visible to the public from an elevated public walkway that will rise 30' to a treetop terrace.

  Trans Pacific Container Terminal - Maintenance and Repair Building
  Location: 500 W. Water Street. – CD 15
  Description: 40,000 sf. Maintenance & Admin (5,000 sf green roof space)
  Construction Budget: $13M
  Completion: March 2009
  Consultant: Port of Los Angeles in-house design
  Status: 40% Construction Documents
  Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD 13
Description: Fire Station
Construction Budget: $8.7M
Status: On hold awaiting site acquisition
Completion: Approximately December 2009
Comments: Project timeline not yet established. Additional funding will have to be identified for the green roof.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq ft gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Status: On hold awaiting additional funding
Comments: Council office is very supportive of adding the green roof to this project. Base project is short funded.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq ft gym and support areas
Construction Budget: $13M
Status: Design
Comments: Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008.

Fred Roberts Gymnasium
Location: 4600 S. Honduras – CD 9
Description: 11,000 sq ft gym & support areas (7,000 sq ft green roof)
Construction Budget: $4.5M
Status: Schematic design
Comments: Base project is short funded.

- Other Project Suggestions – Existing Buildings:

City Hall
Description: A high profile, retrofit opportunity would be to install a green roof on the low rise wings of City Hall, as was done with the Chicago City Hall.

Comments: This would require an investigation of the capacity of the roof to carry the additional weight. This would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal register of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

Other Project Possibilities

- Other existing City buildings such as existing neighborhood City Halls
- Airport projects
- City funded affordable housing projects
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit)

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Intensive Roof

	New Bldg	**Existing Bldg** (It is rare an existing building could support an intensive green roof.)
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$45 per sq ft	$40-$60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

Extensive roof

	New Bldg	**Existing Bldg**
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$20 per sq ft and up	$25 per sq ft and up
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

As a basis for comparison, the Bureau of Engineering has also contacted the designers for the new Los Angeles Unified School in Exposition Park, the Theodore Alexander Junior Science Center, which is a new building with an intensive green roof. This information is not yet available.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor for that project.

- Protection of roof membrane resulting in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in decreased maintenance and savings in replacement costs.
- Savings on energy heating and cooling costs, depending on the size of the building, climate and type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one storey building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.
- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.
- Cost savings from increased stormwater retention and decreased need to expand or rebuild related infrastructure.
- Decreased cost of meeting greenhouse gas reductions and adapting to climate change by reducing the "Urban Heat Island Effect" and the need for interior building insulation.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance and data collection and analysis, and report back to the PLUM Committee.

Sincerely,

Deborah J. Weintraub, AIA
Deputy City Engineer

DJW:tlw
J:\DJW\Word\Plum Cmtt Report 080306_1.doc

cc: Sarai Bhaga, Sr. Administrative Analysis II
City Administrative Officer

Gretchen Hardison, Environmental Affairs Officer
Environmental Affairs Department

Lambert Giessinger, Architect Associate II
Department of Planning

Gary Lee Moore, P.E.
City Engineer

Mahmood Karimzadeh, Program Manager
Architectural Division

FRANK T. MARTINEZ
City Clerk

KAREN E. KALFAYAN
Executive Officer

When making inquiries relative to this matter refer to File No.

ITY OF LOS ANGELI
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

Office of the
CITY CLERK
Council and Public Services
Room 395, City Hall
Los Angeles, CA 90012
Council File Information - (213) 978-1044
General Information - (213) 978-1133
Fax: (213) 978-1040

CLAUDIA M. DUNN
Chief, Council and Public Services Division

04-0074

May 3, 2006

PLACE IN FILES

MAY 05 2006

DEPUTY

Councilmember Reyes
City Attorney
Planning Department,
Director of Planning
Department of Building & Safety,
General Manager
Environmental Affairs Department

Councilmember Perry
City Administrative Officer
Bureau of Engineering
Department of Water and Power
Fire Department
Bureau of Sanitation
Department of General Services

RE: INCORPORATING ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM

At the meeting of the Council held May 2, 2006, the following action was taken:

Attached report adopted..... X
Attached motion ( ) adopted.....
Attached resolution adopted.....
FORTHWITH.....
Ordinance adopted.....
Motion adopted to approve communication recommendation(s).....

Frank T. Martinez

City Clerk
jr

5-2

TO THE COUNCIL OF THE
CITY OF LOS ANGELES

FILE NO. 04-0074

Your PLANNING AND LAND USE MANAGEMENT Committee

reports as follows:

	Yes	No
Public Comments	XX	

PLANNING AND LAND USE MANAGEMENT COMMITTEE REPORT relative to incorporating rooftop green spaces as an energy efficiency mechanism.

Recommendations for Council action, initiated by Motion (Reyes - Perry):

1. DIRECT the Bureau of Engineering (BOE), in conjunction with the Environmental Affairs Department (EAD), Los Angeles Department of Building and Safety (LADBS), Department of City Planning (DCP), Los Angeles Department of Water and Power (LADWP), Bureau of Sanitation (BOS), General Services Department (GSD), City Administrative Officer and other appropriate departments, to prepare a proposal for a pilot program to demonstrate Green Roof technology on City buildings. Departments shall report back to City Council in 90 days for approval of the pilot program with the following information:

   a. One or more options for new City projects that could incorporate a green roof that is designed for environmental benefits rather than public access.
   b. An estimate of related additional costs of design, construction, and operation and maintenance of the green roof.
   c. A set of procedures to collect and record specific data from the pilot program, including but not limited to actual energy costs/savings, storm water retention data, and related factors.
   d. A plan to identify potential opportunities to fund the pilot project and the data collection efforts.

   Based on the 90-day report by BOE, and upon City Council approval, a lead department will be designated to conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

2. APPROVE the Green Roofs Resource Guide "Green Roofs - Cooling Los Angeles" developed by the EAD and authorize City Departments to use and distribute the Guide as administrative guidance and background information to further the goals of the Green Roofs Program.

3. DIRECT EAD, in coordination with BOE, LADBS, DCP, LADWP, BOS, and GSD to address the need for education and outreach on Green Roofs, for both City staff and members of the public, to encourage the development of green roof projects in the City of Los Angeles.

Fiscal Impact Statement: The EAD reported that there is no anticipated impact on the General Fund.

Summary:

At its meeting held on April 18, 2006, the Planning and Land Use Management (PLUM) Committee considered the Motion (Reyes - Perry) that the City Council request the Environmental Affairs Department (EAD), as lead, to form a Task Force with the assistance of the Department of General Services, Planning Department, Building and Safety, Los Angeles Fire Department, Bureau of Engineering, Department of Water and Power, City Administrative Office, City Attorney, and any other appropriate department, which implements a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism, and which uses among other cities mentioned in the text of this Motion, the City of Tokyo's roof garden ordinances as a model as detailed in the attachment; and that the abovementioned Task Force prepare and present a report of its findings for consideration by the Planning and Land Use Management (PLUM) and Environmental Quality and Waste

Management Committees within 45 days. The Committee also considered the report submitted by the EAD dated April 18, 2006.

The EAD report dated April 18, 2006, notes that several cities in the United States and worldwide have begun their own programs to promote the use of green roofs for heat island mitigation, stormwater retention, open space and other environmental benefits. Examples include the following:

- Tokyo, Japan uses green roofs to mitigate the heat island effect. Its large population and growing industry produce heat that has been difficult to offset. Tokyo's ordinance requires new buildings with over 1,000 square meters (1,196 sq. yd.) of roof area to cover at least 20 percent of the surface with greenery. New publicly funded buildings with roofs as small as 250 square meters (299 sq. yds.) are also required to add greenery. The plan's goal is to add 2,965 acres of new plant life to the city. The government offers subsidies for greening projects.

- Portland, Oregon uses eco-roofs (green roofs) to reduce stormwater runoff, counter urban heat island effects and improve air quality and energy efficiency. A Green Investment Fund was created to provide resources for green building practices. Portland also provided a zoning bonus allowing for additional building square footage, depending on the percentage of the building's roof that was dedicated for a green roof.

- Chicago, Illinois uses green roofs to reduce urban runoff and has created municipal demonstration projects to develop professional expertise. Chicago's green roof program started with a 20,300 square foot demonstration roof on Chicago City Hall. This project
retained over 75% of the volume from a one-inch storm, thus preventing runoff from entering the sewer system.

- Milwaukee, Wisconsin installed seven green roofs, including one on the Highland Gardens senior housing project. This 20,000 square foot green roof was installed for $380,000 and is designed to retain 85% of a 2-inch rainfall.

- Vancouver, British Columbia, Canada installed over 30 green roofs in the area. The Central Branch of the Vancouver Public Library has a 20,000 square foot green roof and showed a 49% reduction in the volume of stormwater runoff when compared to a conventional roof.

Examples of private buildings include:

- San Bruno, California: A green roof was incorporated on the GAP headquarters building with a layer of grass and plants on a six-inch layer of soil. This layer of greenery acts as insulation and also absorbs rain and air pollution.

- Newport Beach, California: Designers incorporated a green roof on the Peter & Mary Muth Interpretive Center in Upper Newport Bay for a CEQA mitigation (visual impacts).

- Irvine, California: Architects designed a green roof for the new Ford Motor Land Service Corporation in Irvine. The installation is designed to provide a stable growing environment for the plant community; maximize the efficient use of water resources; and accommodate and control runoff from rainfall.

According to EAD, current City policy (Council File No. 02-0182) requires all City department construction building projects 7,500 square feet or larger in size to achieve the "Certified" level of the Leadership in Energy and Environmental Design (LEED) System. A Green roof is an accepted measure under LEED standards and can garner from one to fourteen points toward LEED certification.

In summary, EAD concluded that, the Task Force did not find any City ordinances that would impede the construction of a green roof. However, the Task Force feels that a mandatory program requiring new City buildings to include green roofs would be premature at this time, due to the current lack of experience, uncertainty of costs related to design and construction, potential lack of funding available and competing strategies for LEED points and rooftop space. The Task Force recommends that a voluntary approach would be more appropriate, with a City operated pilot program and education program to begin. Upon City Council approval, designated departments would conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

The pilot program would allow for a better understanding of the associated costs, give City staff direct experience with green roof design and construction, and allow for data collection to verify the benefits and future cost savings. The Task Force identified two tools for education: the Green Roofs Resource Guide, and an overview brochure (to be written) that would describe the process for developing such a roof in the City of Los Angeles. To effectively distribute these educational tools, the Task Force felt these publications should be available at all City departments that would be involved in permitting green roofs. In addition, the named departments will coordinate to address the need for training and education of City staff on the topic of green roofs.

The PLUM Committee approved the recommendations contained in the April 18, 2006, EAD report.

The matter is hereby submitted to Council for consideration.

Respectfully submitted,

PLANNING AND LAND USE MANAGEMENT COMMITTEE

MEMBER	VOTE
REYES:	ABSENT
HUIZAR:	YES
WEISS:	YES

BG:ys
4-25-06
#040074

Rept
ADOPTED
MAY 02 2006
LOS ANGELES CITY COUNCIL

COUNCIL VOTE

May 2, 2006 10:46:13 AM, #4

ITEM NO. (8)
Voting on Item(s): 8
Roll Call

CARDENAS	Yes
GREUEL	Yes
HAHN	Yes
HUIZAR	Yes
LABONGE	Yes
PADILLA	Yes
PARKS	Absent
PERRY	Yes
REYES	Yes
ROSENDAHL	Yes
SMITH	Yes
WEISS	Absent
WESSON	Yes
ZINE	Absent
*GARCETTI	Yes

Present: 12, Yes: 12 No: 0

PLANI AND LAND USE MANAGEMENT MITTEE
SUGGESTED NOTIFICATION OF COUNCIL ACTION

Council File No. 04-0074 **sign**

	Applicant/Appellant/Owner	Representative
		~~See attached~~

- ✓ Council Member(s) Reyes & Perry
- ___ Office of the Mayor (w/file) - Section ___
- ✓ City Attorney ~~(w/blue slip)~~ - Attn:
- ✓ City Administrative Officer (CAO)
- ___ Chief Legislative Analyst (CLA)
- ✓ City Planning Department - ~~Attn: Mark Lopez (w/copy of Ordinance)~~
- ✓ Director of Planning
- ___ Office of Zoning Administration
- ___ Advisory Agency
- ___ Geographic Information Section - Attn: Fae Tsukamoto
- ___ Information Technology Agency - (large projects)
- ✓ Bureau of Engineering, ~~Land Development & Mapping Division~~ - (generally most cases)
- ___ Department of Transportation, Traffic/Planning Sections - (generally most cases)
- ✓ Department of Building & Safety ~~c/o Zoning Coordinator~~ - (generally most cases) GM
- ___ Residential Inspection Unit - Mail Stop 115 - (SPE; HE; CU; ICO; ZC; generally most cases)
- ___ Bureau of Street Lighting, "B" Permit Section - (all zoning cases)
- ✓ Department of Water and Power - (DB & large projects)
- ✓ Fire Department - (all zoning & hillside cases)
- ___ Police Department - (beer & wine; adult entertainment, revocations)
- ___ Community Development Department
- ___ Los Angeles County Assessor - (CU appeals & large projects)
- ___ Cultural Affairs Department
- ✓ Environmental Affairs Dept
- ✓ Bureau of Sanitation
- ✓ General Services Dept
- ___

CITY OF LOS ANGELES SPEAKER CARD

Date 4/18/06

Council File No., Agenda Item, or Case No. #4

I wish to speak before the PLUM Committee
Name of City Agency, Department, Committee or Council

Do you wish to provide general public comment, or to speak for or against a proposal on the agenda? (X) For proposal ( ) Against proposal ( ) General comments

Name: Alejandra Marroquin

Business or Organization Affiliation: STRATEGIC CONCEPTS IN ORGANIZING & POLICY EDUCATION S.C.O.P.E.

Address: 1715 W. Florence St Los Angeles CA 90047
Street City State Zip

Business phone: _____ Representing: Community

CHECK HERE IF YOU ARE A PAID SPEAKER AND PROVIDE CLIENT INFORMATION BELOW: ☐

Client Name: _____ Phone #: _____

Client Address: _____
Street City State Zip

Please see reverse of card for important information and submit this entire card to the presiding officer or chairperson.

CITY OF LOS ANGELES SPEAKER CARD

Date: 4/18/06

Council File No., Agenda Item, or Case No.: CF04-0074 ITEM 1

I wish to speak before the _____
Name of City Agency, Department, Committee or Council

Do you wish to provide general public comment, or to speak for or against a proposal on the agenda? ( ) For proposal ( ) Against proposal ( ) General comments

Name: _____

Business or Organization Affiliation: _____

Address: _____
Street City State Zip

Business phone: _____ Representing: _____

CHECK HERE IF YOU ARE A PAID SPEAKER AND PROVIDE CLIENT INFORMATION BELOW: ☐

Client Name: _____ Phone #: _____

Client Address: _____
Street City State Zip

Please see reverse of card for important information and submit this entire card to the presiding officer or chairperson.

#1

ENVIRONMENTAL AFFAIRS
DEPARTMENT

DETRICH B. ALLEN
GENERAL MANAGER

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ROOM 2005 MS 177
LOS ANGELES, CA 90012
(213) 978-0840

CITY OF LOS ANGELES
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

April 18, 2006

Honorable Eric Garcetti, President
Los Angeles City Council
c/o City Clerk
Room 395, City Hall
Los Angeles, CA 90012

Subject: CF 04-0074 Incorporate Rooftop Green Spaces as an Energy Efficiency Mechanism

RECOMMENDATIONS

The Environmental Affairs Department (EAD) recommends that the City Council undertake the following actions:

1. Direct the Bureau of Engineering (BOE), in conjunction with the Environmental Affairs Department (EAD), Los Angeles Department of Building and Safety (LADBS), Department of City Planning (DCP), Los Angeles Department of Water and Power (LADWP), Bureau of Sanitation (BOS), General Services Department (GSD), City Administrative Officer and other appropriate departments, to prepare a proposal for a pilot program to demonstrate Green Roof technology on City buildings. Departments shall report back to City Council in 90 days for approval of the pilot program with the following information:

    a. One or more options for new City projects that could incorporate a green roof that is designed for environmental benefits rather than public access.
    b. An estimate of related additional costs of design, construction, and operation and maintenance of the green roof.
    c. A set of procedures to collect and record specific data from the pilot program, including but not limited to actual energy costs/savings, storm water retention data, and related factors.
    d. A plan to identify potential opportunities to fund the pilot project and the data collection efforts.

    Based on the 90-day report by BOE, and upon City Council approval, a lead department will be designated to conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

2. Approve the Green Roofs Resource Guide "*Green Roofs – Cooling Los Angeles*" developed by the EAD and authorize City Departments to use and distribute the Guide as administrative guidance and background information to further the goals of the Green Roofs Program.

3. Direct EAD, in coordination with BOE, LADBS, DCP, LADWP, BOS, and GSD to address the need for education and outreach on Green Roofs, for both City staff and members of the public, to encourage the development of green roof projects in the City of Los Angeles.

FISCAL IMPACT STATEMENT

There is no anticipated impact on the General Fund.

BACKGROUND

In Council File 04-0074, the City Council directed the EAD to form and lead a Task Force including the GSD, DCP, LADBS, Los Angeles Fire Department (LAFD), BOE, LADWP, City Administrative Officer (CAO), City Attorney, and any other appropriate department, to investigate the potential to implement a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism. The Task Force was also requested to prepare and present a report of its findings for consideration by the Planning and Land Use Management (PLUM) and Environmental Quality and Waste Management (EQ & WM) Committees.

Green Roofs in Other Cities

Several cities in the United States and worldwide have begun their own programs to promote the use of green roofs for heat island mitigation, stormwater retention, open space and other environmental benefits. Examples include the following:

- Tokyo, Japan uses green roofs to mitigate the heat island effect. Its large population and growing industry produce heat that has been difficult to offset. Tokyo's ordinance requires new buildings with over 1,000 square meters (1,196 sq. yd.) of roof area to cover at least 20 percent of the surface with greenery. New publicly funded buildings with roofs as small as 250 square meters (299 sq. yds.) are also required to add greenery. The plan's goal is to add 2,965 acres of new plant life to the city. The government offers subsidies for greening projects.
- Portland, Oregon uses eco-roofs (green roofs) to reduce stormwater runoff, counter urban heat island effects and improve air quality and energy efficiency. A Green Investment Fund was created to provide resources for green building practices. Portland also provided a zoning bonus allowing for additional building square footage, depending on the percentage of the building's roof that was dedicated for a green roof.
- Chicago, Illinois uses green roofs to reduce urban runoff and has created municipal demonstration projects to develop professional expertise. Chicago's green roof program started with a 20,300 square foot demonstration roof on Chicago City Hall. This project

retained over 75% of the volume from a one-inch storm, thus preventing runoff from entering the sewer system.

- Milwaukee, Wisconsin installed seven green roofs, including one on the Highland Gardens senior housing project. This 20,000 square foot green roof was installed for $380,000 and is designed to retain 85% of a 2-inch rainfall.
- Vancouver, British Columbia, Canada installed over 30 green roofs in the area. The Central Branch of the Vancouver Public Library has a 20,000 square foot green roof and showed a 49% reduction in the volume of stormwater runoff when compared to a conventional roof.

Examples of private buildings include:

- San Bruno, California: A green roof was incorporated on the GAP headquarters building with a layer of grass and plants on a six-inch layer of soil. This layer of greenery acts as insulation and also absorbs rain and air pollution.
- Newport Beach, California: Designers incorporated a green roof on the Peter & Mary Muth Interpretive Center in Upper Newport Bay for a CEQA mitigation (visual impacts).
- Irvine, California: Architects designed a green roof for the new Ford Motor Land Service Corporation in Irvine. The installation is designed to provide a stable growing environment for the plant community; maximize the efficient use of water resources; and accommodate and control runoff from rainfall.

Current City Policy

Current City policy (CF02-0182) requires all City department construction building projects 7,500 square feet or larger in size to achieve the "Certified" level of the Leadership in Energy and Environmental Design (LEED) System. A Green roof is an accepted measure under LEED standards and can garner from one to fourteen points toward LEED certification.

DISCUSSION

Green Roofs Task Force

The EAD formed the Green Roofs Task Force and held several task force and sub group meetings, along with many other conversations and correspondence. The meetings were held to educate City staff on the topic of green roofs and gather input from City departments as to what it would take for Los Angeles to implement a green roofs program. The Task Force identified two types of green roofs: "extensive green roof," which is low-maintenance with no public access and designed primarily for environmental benefits, and the second, an "intensive green roof," which features garden elements and public access. Additional issues discussed included:

- costs (life cycle costs compared to a conventional roof)
- access (potential need for exits and fire escapes)
- load (design and engineering requirements)
- building retrofits (weight, support, and presence of asbestos or other hazardous materials)
- potential incentives to encourage development of green roofs

Task Force discussions confirmed that existing City ordinances do not preclude the construction of green roofs. Task Force members also felt that no new ordinances were needed, nor were modifications needed to existing ordinances to allow construction of green roofs. However, education and outreach is needed to inform City staff, developers and the public about the potential for including green roofs on buildings. The Task Force also discussed possible sources to fund the design and construction of green roofs. In addition, the Task Force discussed design requirements, height limits, safety requirements, as well as potential pilot projects. To enhance outreach efforts to the public, the Task Force discussed developing a short, easy-to-follow brochure for the public that would describe appropriate steps to follow when considering a green roof in the City of Los Angeles.

The Task Force also created short-term goals and long-term goals including:
1) Pilot project: Identify one new construction and one existing City building for green roof pilot projects.
2) Make further recommendations to City Council once data from these pilot projects is available.
3) Educate the public and City departments about green roofs.

As a part of the Task Force effort, EAD developed a draft resource guide "Green Roofs - Cooling Los Angeles," with input from the Task Force. Task Force members were asked to review and provide comments on the draft document to ensure accuracy and readability.

Deliverables
The draft resource guide "*Green Roofs – Cooling Los Angeles*" is attached to this report for your consideration. The resource guide can serve as a "how to" guide for City departments and private building owners and developers within the City of Los Angeles who are interested in developing green roof projects. It also addresses the environmental and economic benefits of green rooftops, such as reducing the heat island effect, reducing storm water runoff, and reducing energy costs. The draft resource guide was sent to an outside group of professionals for their review and comment. This group consisted of the consultants for Los Angeles Community College District's Green Building program, the Natural Resources Defense Council (NRDC) – which is currently working on developing green roofs, and Rana Creek – private architects who have designed green roofs. Minor corrections were made but overall, the resource guide received praise for its useful information and ease of reading. The Task Force would like to reproduce the resource guide for distribution to City staff and the public (as a cost saving measure, the Guide will be made available online).

CONCLUSION

In summary, the Task Force did not find any City ordinances that would impede the construction of a green roof. However, the Task Force feels that a mandatory program requiring new City buildings to include green roofs would be premature at this time, due to the current lack of experience, uncertainty of costs related to design and construction, potential lack of funding available and

competing strategies for LEED points and rooftop space. The Task Force recommends that a voluntary approach would be more appropriate, with a City operated pilot program and education program to begin. Upon City Council approval, designated departments would conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

The pilot program would allow for a better understanding of the associated costs, give City staff direct experience with green roof design and construction, and allow for data collection to verify the benefits and future cost savings. The Task Force identified two tools for education: the Green Roofs Resource Guide, and an overview brochure (to be written) that would describe the process for developing such a roof in the City of Los Angeles. To effectively distribute these educational tools, the Task Force felt these publications should be available at all City departments that would be involved in permitting green roofs. In addition, the named departments will coordinate to address the need for training and education of City staff on the topic of green roofs.

Thank you for your consideration of this report. If you or your staff has any questions or comments, please contact me at (213) 978-0840 or Gretchen Hardison of my staff at (213) 978-0852.

Sincerely,

Detrich B. Allen
General Manager

DBA:gh:jpg

DRAFT

Green Roofs - Cooling Los Angeles

Environmental Affairs Department
City of Los Angeles
201 N. Figueroa St., Suite 2005
Los Angeles, CA 90012

2006

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PREFACE

This draft handbook has been prepared in partial response to Los Angeles City Council motion CF#04-0074, Incorporate Rooftop Green Spaces as an Energy Efficiency Mechanism. This motion directed the Environmental Affairs Department (EAD) to lead the formation of a City task force for the purpose of developing and implementing "...a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism..." To support the Green Roof Task Force, the EAD researched green roof options and assembled information on numerous case studies and guideline development efforts in North America, Europe, and Japan. EAD subsequently utilized consultant assistance to expand and summarize the available research, determine its applicability to potential projects in the Los Angeles area, and incorporate practical and procedural information from the Task Force members into a plan for the development of green roofs in the City of Los Angeles. This report is intended to serve as an initial "how to" handbook and reference guide to facilitate green roof development by the City as well as other public entities and private building owners within the City interested in developing green roof project

I. Introduction

WHAT IS A GREEN ROOF?

We use the term "green roof" to refer to a permanent roof-top planting system that allows for the sustained presence of live plants covering a significant portion of a building's roof. As described in more detail later in this report, green roofs can provide a range of environmental, economic, and social benefits. Green roofs have been widely adopted for many years in some countries (most notably Germany) but are a relatively new concept in the United States.

Green roofs fall into one of two primary types: intensive and extensive. *Intensive* roofs are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 in (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. *Extensive* green roofs, on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of these benefits apply to intensive green roofs as well, intensive roofs are generally built for other reasons whereas extensive roofs are strictly designed with these benefits in mind.

WHAT ARE THE BENEFITS OF A GREEN ROOF?

Green roofs provide a host of potential benefits to building owners and the surrounding community. During warm weather, green roofs are cooler than conventional roof surfaces, thus helping to reduce energy consumption for air conditioning and mitigating the urban heat island effect which produces higher temperatures in core urban areas (where most surfaces are covered by concrete and pavement) than in surrounding, less developed areas. Like other forms of vegetation, green roofs also help filter pollutants such as fine particulate matter and toxics gases from the air and their cooling effect can help reduce ozone pollution (smog). Green roofs also help prevent water pollution by filtering polluted runoff and greatly reducing the total amount of runoff that reaches the storm sewer system. Other benefits of green roofs include

- Increased thermal insulation of the roof thus promoting further energy savings for heating and cooling.
- Green roofs shield the water-proof roofing membrane from the elements, thus greatly extending membrane life and generating potential savings on reroofing costs.
- Increased sound absorption resulting in less reflection of noise into the surrounding area and less penetration of noise into the building.
- Green roofs provide additional natural habitat for birds and insects in urban areas. Some green roofs may also be suitable for helping threatened indigenous species.
- Intensive green roofs offer potential for organic food production and provide a social gathering place.

- Aesthetic benefits of adding additional "green" area in an urban environment.
- Accessible green roofs (generally only of the *intensive* variety) can provide recreational benefits and amenity space without using up valuable property space.

In recognition of these many valuable benefits of green roofs, some cities in the U.S. have developed incentive programs to promote both the retrofitting of green roofs on existing buildings and the use of green roof designs for new construction. Most common are financial incentives tied into the reduction in storm water runoff from green roofs. In addition, the environmental benefits of green roofs have been recognized in the Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council. Building designs incorporating a green roof covering at least 50% of the roof area can earn one LEED rating point for urban heat island reduction and one point for storm water management.

SCOPE AND PURPOSE OF THIS REPORT

This report is intended to provide the reader with an introduction to basic green roof concepts: what they are, how they are built and what benefits they provide. Also included in this report is information designed to help facilitate the development of a green roof pilot project in the City of Los Angeles. Since a specific location for a pilot project has not been identified, we do not provide site-specific information such as design drawings, detailed engineering specifications or specific cost estimates here. However, this report is designed to serve as a useful starting point for anyone interested in developing and evaluating a green roof installation in Los Angeles. Once a suitable site has been selected, the roof design, installation, maintenance, and monitoring can be conducted by a suitable team of engineers, landscape architects and other professionals using information from this report and the sources cited herein.

Information provided in this report focuses primarily on extensive green roofs. While much of the discussion here is also applicable to intensive roofs, the emphasis on environmental benefits and the fact that most roofs are not designed for daily access by building occupants (thus precluding development of an intensive green roof) dictates our focus on extensive green roofs.

Benefits of green roofs are described in detail in Section II: *Benefits and Incentives*. Green roof incentive programs that have been adopted by some cities in the U.S. are also described in Section II together with the Los Angeles LEED certification program for City funded projects. Section III: *Planning for the Green Roof* provides information on identifying a suitable location for a green roof project, structural requirements, permitting and applicable building and fire code provisions in Los Angeles, and a comparison of typical cost ranges for green roofs vs. conventional roofs. Also discussed in Section III are potential green roof project funding opportunities via state and federal grant programs. Information on green roof design is provided in Section IV: *Designing the Green Roof*. This section covers preparation of the roof surface, selection of a growing medium for the plants, selecting suitable plant species for the roof, and irrigation requirements. Section V: *Growing and Maintaining the Green Roof* provides information on proper maintenance procedures. An important element of a successful pilot program is a convincing demonstration of the beneficial environmental, economic, and social impacts of the green roof on the urban environment. Section VI: *Quantifying the Benefits* briefly discusses this topic. Finally, Section VII: *Additional Resources* lists and provides contact information for green roof and building/landscape trade organizations, programs, and publications that can be consulted for further information.

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II. BENEFITS AND INCENTIVES

ENVIRONMENTAL BENEFITS

The environmental benefits for which green roofs have received the most attention are improvements in air quality, storm water runoff management and energy efficiency. These benefits are closely interrelated as discussed in more detail below. Other benefits of green roofs include longer roof life, habitat creation, sound absorption and improved aesthetics. Each of these green roof benefits are discussed in more detail below.

Urban Heat Island Reduction and Associated Air Quality Benefits

Over the past 70 years as the City of Los Angeles has grown, temperatures in the city have increased. It has been reported that the high temperature in Los Angeles has shown a steady increase from 97 degrees Fahrenheit (36 C) in 1937 to 105°F (40 C) in the 1990s (HIG, 2000). This trend of increasing temperatures with increasing urbanization is commonly referred to as the Urban Heat Island (UHI) effect. Scientists believe that a significant cause of this effect is the replacement of areas covered by vegetation with dark colored building materials such as those commonly used on roads and roofs. These building materials absorb much of the sun's energy and become very warm, thus contributing to the UHI effect. Replacing dark roof surfaces with green roofs can help reverse this trend.

There are several ways in which green roofs act to reduce the Urban Heat Island effect. First, a dark colored roof will absorb far more of the sun's energy than a green roof. That energy will then radiate from the dark roof as heat. Results from the Chicago City Hall green roof have shown the summer afternoon surface temperature on an adjacent black tar roof to be as much as 50° F (28 C) hotter than the temperature on the City Hall's green roof. Even a nearby light colored roof had a peak temperature 11° F (6 C) higher than that of the green roof (City of Chicago, 2001). A green roof can attain an even lower surface temperature than a light colored roof due to the cooling provided by the plants' use of water via a process referred to as evapotranspiration. Depending on the type of plant, up to 99.9% of the water drawn up through the roots may be transpired through the leaves (CSU, 2002). Heat energy is drawn from the surrounding air to convert that water to water vapor, which produces a cooling effect. The evapotranspiration of 40 gallons (150 liters) of water (about what is transpired by a medium, properly watered tree in one day) would provide enough cooling to offset the heat produced by one hundred 100-watt lamps, burning eight hours per day (Rosenfeld et al, 1997).

The amount of cooling a green roof provides through evapotranspiration will depend greatly on the climate and on the design and management of the green roof. Cooling via evapotranspiration is directly related to the quantity of water delivered to the green roof. In Los Angeles, where the average annual precipitation is 15" (38 cm) (WRCC, 2004), rainfall would supply an average of between nine and ten gallons per square foot of roof space annually (370 to 410 liters per square meters annually). Most of this precipitation occurs during the cooler weather months (November through March). Thus if cooling were to be provided by evapotranspiration during the summer, the water would need to be supplied by irrigation.

On many green roofs, it will be most practical to install drought resistant plants to minimize irrigation requirements and ensure healthy plants. Though these green roofs will provide less evaporative cooling, they will still provide cooling thanks to decreased absorption of sunlight and the increased thermal insulation from plants and growing media. Other water management options include using gray water for irrigation or storing runoff occurring during heavy precipitation periods for later use. These options are discussed in more detail in Section IV.

Elevated temperatures contribute to poor air quality. A study by Lawrence Berkeley National Laboratory's Heat Island Group found that increasing the reflectivity of manmade surfaces and adding vegetation over just 15 percent of the convertible area in the Los Angeles Basin would reduce summer temperatures by 6 degrees Fahrenheit (3 C). This group further estimated that, due to the dependence of smog formation on temperature, ozone (the chief component of smog) would be reduced by about 10% (HIG, 2000). Temperature reductions have the added benefit of decreasing energy demand as less energy is needed for air conditioning. This leads to further improvements in air quality by reducing the burning of fossil fuels at power plants and thus lowering emissions.[1] A study conducted for the City of Chicago found that greening all the City's rooftops would cut peak energy demand by 720 Megawatts (Velasquez, 2004). The Heat Island Group estimates that the 5 to 9 degree (3 to 5 C) possible reduction of the Urban Heat Island would save Los Angeles ½ to 1 Gigawatt in peak power (HIG, 2000).

Aside from the air quality benefits associated with reducing the urban heat island, green roofs filter particulate matter from the air and absorb greenhouse gases. Though little research has been done to quantify the air filtration capacity of green roofs, by one estimate 1 square meter of grass roof can remove approximately .22 lb/year (0.1 kg/year) of airborne particulates (GRHC, 2002). Gasoline fueled passenger vehicles typically produce on the order of 2.5×10^{-5} lb (.01 g) of particulate matter per mile of travel.[2] Assuming 10,000 miles are driven by a vehicle in a year, that's .22 lb (0.1 kg) of particulate matter per year. Thus, while it is one of the smaller benefits of green roofs, one square meter of green roof could offset the annual particulate matter emissions of one car.

The benefit of green house gas sequestration by a green roof is also difficult to quantify. However, as the City of Los Angeles is in the process of updating the City's Climate Action Plan, originally issued in March 2001, it is worth noting that green roof plants will act as a greenhouse gas sink. The practice of planting trees to offset carbon emissions has gained wide acceptance. The Energy Information Administration (EIA) reported a total of 32 urban forestry projects implemented in 2002. A total of 15,904 tons (14,428 metric tons) of carbon dioxide is estimated to have been sequestered by these projects. The plants on an extensive green roof act on a smaller scale than do the trees used in these projects. However, the EIA does cite one project using prairie grasses, which probably have a more comparable carbon sequestration capacity, as having sequestered close to 770 tons (700 metric tons) of carbon in 2002. Unfortunately, the area covered by the project was not cited so this result can't be applied to estimate the potential sequestration capacity of a roof-sized area (EIA, 2004).

[1] See Stoeckenius et al. (2001) for a more detailed discussion of the interaction between the urban heat island and air quality in Los Angeles.

[2] Based on a typical estimate obtained from the U.S. Environmental Protection Agency's MOBILE6 vehicle emission factor model.

Water Quality

Stormwater management has become a pressing issue for many cities. As urban development continues, more and more of the city is covered by impervious surfaces (streets, buildings) that do not retain precipitation and thus produce greater and greater volumes of polluted runoff. The negative consequences of stormwater contaminated with trash, oil and other toxins entering natural bodies of water are well established. Title IV of the clean water act states that large cities must obtain a permit for stormwater discharges and develop procedures to mitigate impacts on water quality. The City of Los Angeles is no exception. On a rainy day up to 10 billion gallons (38 billion liters) of water flows off the rooftops and streets of L.A. County and into the storm drain system, carrying with it everything from heavy metals to paint thinner (LA SWP, 2004). This water eventually arrives at the Los Angeles area bays and beaches making coastal waters unsafe for swimming or fishing and damaging local marine ecosystems. The City of Los Angeles must undertake a number of mitigating measures in order to comply with the National Pollutant Discharge Elimination System (NPDES) Permit, which applies countywide, and was issued to the County of Los Angeles. One measure that many other cities have identified for reducing stormwater runoff is installing green roofs.

The City of Portland Bureau of Environmental Services has found that the quantity of precipitation that a green roof captures and evaporates ranges between 10 and 100 percent (BES, 2004) with individual values dependent upon the design of the roof and the nature of the precipitation event. Different growing media have different water capacities, depending upon their depth and texture. Generally speaking, soil with fine particles and greater depth will have a greater water capacity (NebGuide, 1996). However, the growing media used for extensive green roofs is specially engineered to be lightweight and relatively shallow while retaining the ability to support plant growth. Roofscapes Inc. reports that a typical green roof with just three inches of growing media can be designed to reduce annual runoff by more than 50 percent (Roofscapes Inc., 2002).

The volume of a precipitation event that is captured by the green roof is only partially dependent on the design of the green roof. Any green roof will, after a certain quantity of rainfall, become saturated and incapable of retaining more water. To deal with this eventuality, many systems include a cistern which captures the excess precipitation as it leaves the roof and stores it for irrigation during prolonged dry periods.

Some of the water that is captured by the roof will be used for plant growth; even more will be returned to the air by direct evaporation or evapotranspiration; and finally a portion of it will slowly percolate through the soil and exit the roof as runoff. But in addition to the quantity of runoff from a green roof, there are several important differences in the timing and quality of runoff that results from a green roof as compared to that of a conventional roof. The rainfall that is not captured by a green roof will be released over a longer period of time than the runoff from a conventional roof. As shown in Figure II-1, runoff from a conventional roof occurs immediately after the rainfall event and with a flowrate per unit surface area nearly equal to that of the precipitation rate. In contrast, the runoff from a green roof occurs over a period of hours following the rainfall and never reaches the high flowrates of the conventional roof. This slowing of the runoff lowers the force of the stormwater which reduces the ability to carry off trash and lessens the strain on the storm drain system.

The runoff that slowly seeps through the green roof media tends to be of much higher quality than the runoff from a conventional roof. Runoff from a green roof is of a significantly lower temperature than that from a conventional roof. This is important due to the disruption that warm stormwater can cause in the ecosystems of streams, rivers and the ocean. Also, it has been estimated that up to 30 percent of the nitrogen and phosphorus contained in runoff from urban areas originates in the dust that accumulates on rooftops and other surfaces. The green roof acts as a filter, screening out this contamination (Miller, 2003).

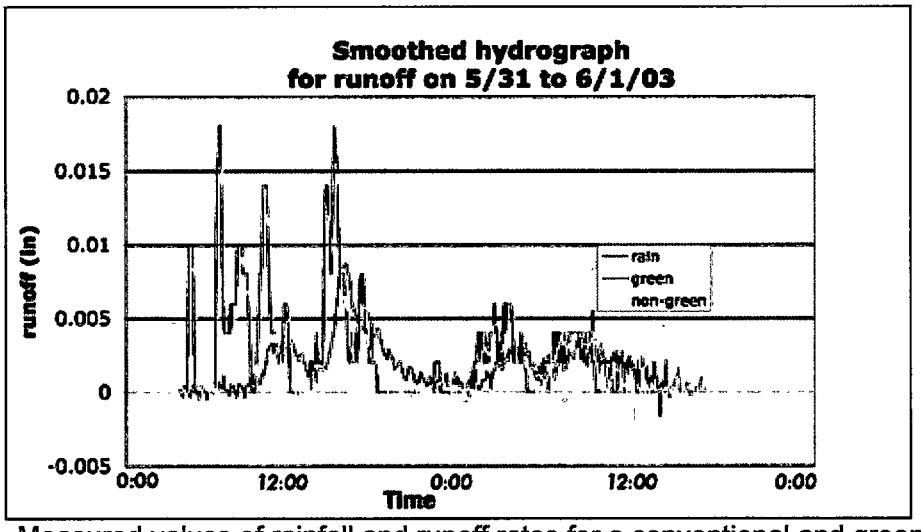


Figure II-1. Measured values of rainfall and runoff rates for a conventional and green roof. Source: PSCGRR, 2004.

Reductions in stormwater volume and improvements in stormwater quality that can be achieved through the installation of green roofs have been a tremendous motivating force in the development of green roofs in cities from Berlin, Germany to Portland, OR. Some cities have subsidized or even mandated the installation of green roofs to improve stormwater management. The multiple benefits that can be achieved and the relatively low cost when compared to costly stormwater management infrastructure projects make green roofs an appealing option for stormwater management plans.

Energy Efficiency

Potential energy savings associated with green roofs have already been discussed above in terms of controlling the urban heat island effect for air quality benefits. But the potential energy savings of green roofs warrant consideration independent of the air quality benefits they offer. A reduced cooling load would be particularly advantageous in Los Angeles given the importance of air conditioning as a fraction of total energy consumption and recent concerns about generating capacity. Direct savings in energy costs from installing a green roof are also one of the factors that offset the cost of installation.

A green roof keeps an individual building cool in several ways. First, less of the sun's energy goes to heating up the roof of the building. The plants reflect some sunlight and absorb the rest, but they do not radiate the absorbed energy in the form of heat to the extent that conventional

rooftops do. A conventional rooftop reradiates some of the suns energy it absorbs back into the air, warming the building's surrounds, and radiates some of the absorbed energy into the building itself. Both of these heating pathways have been shown to increase demand for energy for cooling.

Another way in which a green roof can provide energy savings is via increased insulation. A green roof provides an additional barrier between the building's interior and the hot (or cold) environment. In this way it acts much like conventional insulation materials. But in addition to the mere value of its bulk, a green roof effectively shields the building's structural surface from the wind by trapping a layer of still air over the roof. Still air forms an effective thermal barrier on the surface of a building; as opposed to moving air, which greatly increases the transfer of heat from the surrounding environment into the building (or draws warmth from the building on cool days). Wind can decrease the energy efficiency of a building by 50 percent (Peck et al, 1999). Thus by protecting the surface of the building from the surrounding environment the green roof helps to maintain the temperature differential between the interior and exterior of the building.

In contrast to the energy savings mechanisms described above which relate to protecting the building from the environment, the final way in which a green roof saves energy on hot days is by cooling the environment around the building. The cooling effect of evapotranspiration was discussed in detail in the section on the urban heat island.[3] One study has estimated the direct savings from the combined mechanisms is a 50 percent savings on air conditioning for the top story of the building but no other studies have been conducted comparing the relative importance of the various mechanisms combined that allow green roofs to help keep buildings cool on hot days(Velasquez, 2004).

More than just benefiting the individual property owner, the increased energy efficiency offered by green roofs serves the entire community. Modeling by the Heat Island Group has indicated that by adding vegetation and lightening roof and road surfaces in just 15 percent of the possible areas of the Los Angeles Basin, summer temperature could be reduced by 6 degrees Fahrenheit (3 C) (HIG, 1999). Based on the relationship between temperature and energy use shown in Figure II-2, this would translate into upwards of ½ Gigawatt less peak power, worth more than $100,000 per hour (HIG, 1999).

[3] Cooling via evapotranspiration is minimal during cold weather.

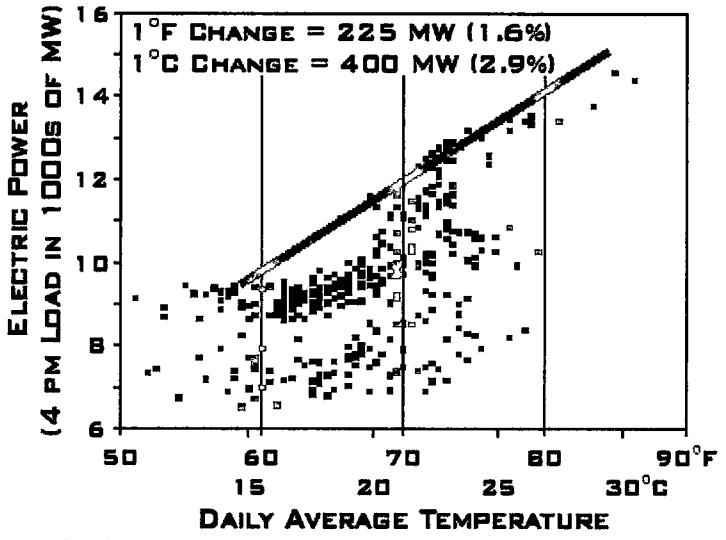


Figure II-2. Peak Load for Southern California Edison in 1988. Source: HIG (1999).

Additional Benefits

There are some other very practical additional benefits associated with green roofs:

They have proven to be an effective form of noise reduction. Tests have indicated that 5 inches of growing medium can reduce noise by 40 Db (Peck et al, 2001). The green roof at GAP Inc. Headquarters in San Bruno, CA is estimated to attenuate sound transmission by up to 50 Db. This is an important consideration given that the building is located just a couple miles from San Francisco International Airport. In Germany, where green roofs are relatively common, the Frankfurt International Airport has installed green roofs on buildings below the approach flight path to mitigate the impact of an airport expansion project (Roofscapes Inc., 2002c). In the United States, the Federal Aviation Administration classifies average noise levels above 65 dB as "significant"; this designation is one factor considered in providing federal funds for noise mitigation projects (FAA, 2004). Noise from aircraft operations can easily exceed this level: take- off noise of a Boeing 747 measured at ground level directly under the aircraft 4 miles (6500 m) from the start of the take-off roll can reach 100 dBA (FAA, 2002). For buildings located near airports, especially those with limited alternatives for noise reduction technologies (e.g. those with no attic space), a green roof offers a potential solution to the problem of reducing aircraft noise.

Green roofs also offer a greatly extended lifespan over that of a conventional roof. Where the membrane of a conventional roof is more exposed to the elements and thus wears relatively quickly, the membrane of a green roof is shielded by a protective layer of plants and growing media. A green roof can easily last 35 to 40 years whereas a conventional roof will only last 15 to 20. Having to replace the roof only about half as often is not only more convenient, it also reduces the quantity of roofing materials that need be disposed of and equates to substantial savings that represent one of the most important offsets of the higher initial cost of a green roof.

And finally, less quantifiable but no less important benefits of green roofs are those related to habitat, both animal and human. Green roofs can be designed as a stepping stone through the urban environment for birds and insects or as a sanctuary for certain plant or animal species. The Toronto City Hall Demonstration Project provides two distinct sanctuaries. It

includes a black oak prairie ecosystem and a separate native butterfly plot (GRHC, 2002). Green roofs also improve the human environment. Most would agree that the view of a green roof is much more aesthetically pleasing than that of a conventional roof. In some cases, green roofs have been used to blend a building into its environment, such as the GAP Headquarters' roof which features native grasses that help it blend into the surrounding hills. In a more urban environment, green roofs are more likely to offer relief from the surroundings, providing green interludes in a landscape dominated by concrete.

INCENTIVE PROGRAMS

Several existing or potential future programs add to the attractiveness of installing green roofs in Los Angeles. In all likelihood, as the image of a green city becomes increasingly politically and economically appealing and as the penalties in energy expenses and noncompliance with environmental regulations for not being green increase, the list of incentives will grow. The major existing incentive for the City of Los Angeles is achieving LEED certification.

Existing Incentives

Effective July 1, 2002, all City of Los Angeles building projects 7,500 square feet (700 square meters) or larger are required to achieve Leadership in Energy and Environmental Design (LEED) 'Certified' standards (Council File 02-0182). A number of LEED certified City buildings have already been designed, including police and fire stations, a teaching center and an animal services center (Weintraub, 2003). LEED certification is awarded based on a point system that gives a building points for numerous different conservation measures (26 points achieves certification). Among the possible measures are stormwater management, the use of landscaping and exterior design to reduce heat islands, optimization of energy performance and improving thermal comfort (US GBC, 2001). One or more of these measures could be met or partially met with the installation of a green roof. One green roofs design guide indicates that 50 percent or greater coverage of the roof by a green roof can earn one point for reducing heat islands and that a green roof can contribute to a point for stormwater management (Oberlander et al, 2002). Indeed, the Premier Automotive Group headquarters in Irvine, CA was awarded a least one LEED point for its extensive green roof thus contributing to its achievement of LEED certification (US GBC, 2003). Thus far, none of the City's LEED building designs have included a green roof. However, as the success of the Premier Automotive Group building shows, green roofs could be a valuable component of future designs.

Potential Future Incentives

In acknowledging the stormwater retention benefits of green roofs, some cities have granted runoff charge reductions and/or increased building size to lot area ratios to buildings with green roofs. One example is the City of Portland, Oregon, which added the installation of a green roof, or, an "ecoroof" (a term widely used in Portland) as a floor area ratio bonus option in 2001. Under this condition a developer is allowed one or three square feet of bonus per square foot of green roof for a green roof that covers 30+ percent or 60+ percent of the roof, respectively. In addition, the City of Portland will offer property owners a reduction in their stormwater drainage fee if they install a green roof. The details of the stormwater charge reduction program have not been determined (Liptan, 2004).

Like Portland, the City of Los Angeles has implemented a stormwater runoff charge to offset the costs of building infrastructure to comply with water quality regulations. The annual fee is determined by the amount of runoff from each property and runs about $23 per equivalent dwelling unit. However, it is quite possible that this charge will be increased in the future. The need to install infrastructure to comply with regulations is surpassing the funds generated from the current stormwater charge (City of LA, 2003). A reduced stormwater charge for buildings with green roofs, founded on the stormwater reduction benefits they provide, could be an enticing future incentive for developers.

The City of Los Angeles is currently updating the Climate Action Plan, first issued in March of 2001. The Climate Action Plan estimates the CO2 emissions from City of Los Angeles government operations. The Climate Action Plan estimates that by using the mitigation measures listed in the plan, a 30 percent reduction from the City's 1990 levels would result by 2010 (LA EAD, 2001). Given their value in reducing energy consumption and hence the burning of fossil fuels and their potential as a carbon sink, green roofs could be considered for inclusion in such a plan. For example, the City of Cambridge, MA has taken that step by including green roofs in its Climate Protection Plan (City of Cambridge, 2004).

III. PLANNING FOR THE GREEN ROOF

A number of elements must be considered in the design of a green roof. The unique characteristics of each building site dictate such things as maximum roof load limits, accessibility, and the rooftop microclimate which influences plant selection and watering needs. City Building and Fire Codes contain provisions that influence green roof design. These design considerations are discussed in the following sub-sections. Also described here are estimated costs for installing and maintaining a green roof and potential sources of state and federal funding support for green roof projects.

PICKING A SUITATABLE LOCATION

Not every building is equally suitable for a green roof. There are many factors to consider such as ease of access to the building and the proposed roof area, climate and the potential for achieving maximum benefits. These factors will play an important role in constraining the design of the green roof and in determining the impact, both environmental and political, of the installation.

New or Retrofit

The first distinction that must be made is whether a green roof will be installed on a new or existing building. In most cases it will be significantly less expensive to add a green roof to new construction rather than adding one to an existing building. Adding a green roof in the design stage will also allow greater flexibility in the design of the green roof and greater potential to maximize green roof benefits. Yet a retrofit project offers some unique possibilities for demonstrating green roof benefits.

The cost of green roofs generally varies from $15 to $25 per square foot ($160 to $270 per square meter) for replacing a conventional roof with a green roof and from $10 to $15 per square foot ($110 to $160 per square meter) to install a green roof that has been included in new construction (BES, 2004). This cost difference between a retrofit project and a new project is not surprising. It is similar to the cost difference between reroofing a conventional roof versus installing a conventional roof on a new building. As Table III-1 shows, for both a new roof and a retrofit the cost of a green roof is roughly comparable to that of a conventional roof when the life of the roof is considered. The General Services Division has indicated that the City of Los Angeles's conventional roofing costs fall at the lower end of the spectrum presented in Table III-1, ranging from as little as $1.55 to $4.60 per square foot (Reeser, 2004). Presumably this is due to lower local costs for labor and materials than those contributing to the cost estimates in Table III-1. Lower local labor and materials costs would similarly decrease the cost of installing a green roof.

Table III-1. Cost Comparison of a Green Roof Versus a Conventional Roof and a Retrofit Versus a New Roof.

	Retrofit/Reroof				New Roof			
	Green Roof		Conventional Roof		Green Roof		Conventional Roof	
	Low End	High End	Low End	High End	Low End	High End	Low End	High End
Initial Cost*	$15.00	$25.00	$5.00	$20.00	$10.00	$15.00	$3.00	$9.00
Roof Life	35	40	15	20	35	40	15	20
Initial Cost Annualized Over Roof Life**	$1.03	$1.66	$0.51	$1.74	$0.69	$1.00	$0.31	$0.78

*Source: BES, 2004. **An annual interest rate of 6% has been used to make this comparison.

If the motivation of a project is to demonstrate the advantages of a green roof, then a retrofit may be most suitable. Generally, more lead time would be involved in new construction than in a retrofit due to the time required to design, fund, permit and construct an entire building before the green roof can be installed. This delay may be unappealing if the objective is to transfer technology to an audience that can then consider implementing that technology in their upcoming projects. As a demonstration, a retrofit also offers the opportunity to make before and after comparisons on the quantifiable benefits of a green roof such as building energy consumption and roof temperature. Provided the existing conventional roof is in need of reroofing, then as Table III-1 demonstrates, the cost of retrofitting with a green roof falls within the range of conventional reroofing costs. Similarly, for new construction, building with a green roof involves costs roughly similar to the upper end of conventional roof construction costs.

Access

Whereas intensive green roofs may be implemented to provide open space for recreation and relaxation, extensive green roofs are implemented solely to achieve the many environmental benefits described in Section II. As a result, extensive green roofs are rarely designed with the idea of allowing building residents or the general public routine access to the roof. Even for an extensive green roof, however, it may be desirable to provide some access for educational purposes. In both types of green roofs, some degree of access is necessary for installation and maintenance.

Of the 14 green roof projects reported by the City of Portland, six allow limited public access (Hauth, 2004). Access to an extensive green roof does not mean allowing the public to tread wherever they wish over the roof. Most roof structures are not designed to support such activity and most green roof plants would not respond well to being stepped upon (Peck, 2004). Access is provided to educate, enhance appreciation and encourage the general adoption of green roofs. Although for a demonstration project it would seem nearly essential to provide public access, doing so is not a simple matter. Again, most existing roofs have not been designed to support or provide for the safety of people. Providing public access might require costly structural modifications. Other ways to view the roof could be considered if direct roof access is impractical. The roof may be viewable from a nearby vantage point, or a virtual tour of the roof could be offered on the Internet through a web page offering details of the roof's design and construction and results of monitoring activities.

At a minimum, the roof will need to be accessible for construction and maintenance. In the construction phase, the ease of access to the roof can make a considerable difference in the cost of the project. Moving the materials to the roof by elevator and/or stairwell is less expensive in labor and/or equipment costs than doing so via utility ladders or by crane (Peck et al, 2001). Maintenance activities (plant care, roof membrane inspections) may be performed weekly, monthly or only a few times a year depending upon whether an automated irrigation system is installed and how much care the plants require. The majority of green roof owners in the City of Portland that reported the frequency with which they perform plant care said they did so only once per year. Most of these green roofs are established, and Portland receives adequate rainfall such that more frequent maintenance is no necessary. See the information in "Maintenance" and "Irrigation" later in the Section. At least one experienced green roof contractor recommends several annual inspections (Peck et al, 2001). Only if irrigation were to be performed manually, would maintenance personnel need to regularly access the roof more frequently than once per month. Reporting their summer watering schedule, some Portland area green roof owners who water manually stated that they irrigate as frequently as a few times a week, where others reported watering only every two weeks. Most said they did so on an "as needed" basis (Hauth, 2004). Section 3210 of California Occupational Health and Safety regulations provides general guidance on the safety precautions necessary for maintenance workers at elevated locations. The California Department of Occupational Health and Safety can be consulted for details (California DOHS, 562-944-9366).

Location

Two buildings on opposite sides of the city or even on opposite side of a street may present vastly different needs for a successful green roof. Temperature, winds, sun exposure and water availability can differ over small distances depending upon the particular topography. Also worth noting is that the social and political impact of a green roof can vary greatly from one location to the next.

In order to highlight some of the key factors that should be taken into account when selecting a site for a green roof, we will examine two hypothetical candidate buildings. One building is the Van Nuys City Hall pictured in Figure III-1, the other is the Central Library seen in Figure III-2.

Figure III-1. Van Nuys City Hall (top center of image). Source: TerraServer, 2004.

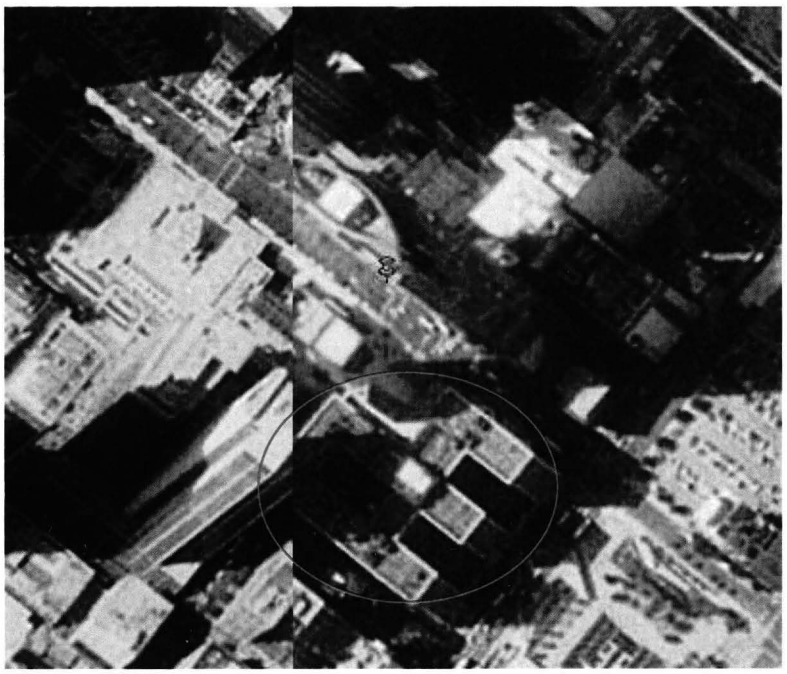


Figure III-2. Central Library (bottom center). Source: TerraServer, 2004.

Only about 15 miles (24 km) apart, these two locations experience different temperatures and receive differing amounts of precipitation (see Table III-2). These temperature and precipitation differences combined with the different microclimates of the two buildings to create two unique rooftop environments.

Table III-2. Annual Climate Summaries (1971-2000) for San Fernando (Van Nuys City Hall)[4] and L.A. Civic Center (Central Library).

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	Civic Center	68	69	70	73	75	79	84	85	83	79	71	69	75.6
	San Fernando	66	70	73	74	78	86	92	92	87	80	68	65	77.8
Average Min. Temperature (F)	Civic Center	50	51	53	55	59	62	65	66	65	61	52	49	57.4
	San Fernando	43	44	44	45	50	55	59	60	56	50	42	42	49.4
Average Total Precipitation (in.)	Civic Center	3.3	3.9	2.7	1.0	0.3	0.1	0.0	0.2	0.3	0.4	1.1	2.1	15.27
	San Fernando	3.4	2.0	1.3	0.3	0.2	0.0	0.0	0.0	0.0	0.4	1.6	2.9	12.13

Source: WRCC, 2004

[4] San Fernando is the closest climate station to Van Nuys. The San Fernando Station and Van Nuys, though separated by a distance of approximately 9 miles, are both located in the San Fernando Valley and have similar climates in comparison to downtown Los Angeles.

As seen in Figure III-2, the Central Library stands six floors tall and is dwarfed be the adjacent U.S. Bank Tower, the tallest building in Los Angeles County. Located just to the west of the Central Library, the U.S. Bank Tower is seen casting an afternoon shadow over the roof of the library. In contrast, the Van Nuys City Hall receives less shading due to the distance separating it from taller buildings. It does however shade the flat portion of the roof where a green roof could be placed with its own 452-foot (138m) tower. Shading of a roof causes dramatic temperature fluctuations. Monitoring has shown that when the Chicago City Hall's green roof falls in the shade of a neighboring building around 4pm, the temperature of the roof drops between 10 and 15 degrees Fahrenheit (6 and 8 C) until it is exposed once again an hour later (City of Chicago, 2001).

The Los Angeles Central Library appears to receive a great deal of shading from the U.S. Bank Tower. This would protect the plants on the roof from the most intense afternoon sun but perhaps limit the cooling benefits that would be achieved by a green roof. The Van Nuys City Hall might experience a similar effect, but only on the section of the roof that is shaded by the tower. Between the two buildings, given the average 7-degree maximum temperature difference in the summer (June – August) plus the shading effects, there could be a 17 to 22 degree Fahrenheit (9 to 12 C) temperature difference between the two roofs at different points during the day. These factors have implications for the design and maintenance that will be required at each site. For example, they must be taken into consideration when selecting plant species and planning irrigation schedules.

Another important aspect of the rooftop microclimate is wind speed. In general, wind speed doubles for every ten-story increase in height. The urban topography can also block and funnel winds creating unusually weak or strong winds in unexpected locations. Strong winds can erode the rooftop media and dehydrate plants if proper precautions are not taken (City of Chicago, 2001b). In even moderately windy locations it is advisable to follow the precaution taken at the Chicago City Hall, which was to install a biodegradable mesh over the media to protect it from the wind until the plants are sufficiently established to take over that role (City of Chicago, 2001; Peck et al, 2001).

Temperature, sun exposure and wind intensity are all important climatic factors that will determine the design necessary to ensure the viability of a green roof. (Also see Section IV Designing the Green Roof.) However, the propagation of green roofs throughout the City of Los Angeles may depend just as much on the social and political climate. This would be especially important for a demonstration project. One thing that could be assured by careful site selection is the visibility of the project. Returning to the Van Nuys City Hall and the Central Library, both appear to be locations where the project would receive high recognition. Both buildings' roofs are visible from nearby buildings and both buildings are open to the public. It may therefore be possible to offer a vantage point from which the roof can be viewed from inside the building or at least a space that could be used for an informational exhibit. Such amenities could lessen concerns about providing public access to the roof itself. Indeed, a location where the roof can be viewed but not accessed may be desirable to set a precedent of extensive green roofs as environmental and aesthetic assets despite the lack of accessibility.

There are other elements of the site selection apart from its location, which could contribute significantly to the success of a green roof installation. The design of the building itself will in several ways determine the potential benefits that can be achieved by a green roof. Two factors will be instrumental in determining the cooling effect of the green roof. First, the energy savings

would be most impressive in a building with a high roof area to volume ratio. As noted in Section II, the energy savings on cooling are approximately 50% for the floor immediately below the roof (Velasquez, 2004). Hence a lower building with a broad roof area that can be covered by the green roof will show the greatest overall energy savings. In the case of an existing building, both energy savings and potential to diminish the urban heat island effect would be greatest for a building with an existing dark colored conventional roof. Dark colored roofs absorb far more of the sun's energy and through the radiation of that energy as heat cause a far greater impact on building energy use and urban temperature increase than do light colored roofs (City of Chicago, 2001; HIG, 2000). In an effort to maximize the net environmental benefit of the project an ideal site would also provide the opportunity to irrigate the green roof using graywater. The Premier Automotive Group headquarters in Irvine, CA has successfully implemented a graywater irrigation system for their green roof which has proven a great success (Borghese, 2004; Roofscapes Inc., 2004). Irrigation requirements will be discussed further in Section IV.

STRUCTURAL REQUIREMENTS

Many of the most significant constraints on the design of a green roof are imposed by the structure of the roof. These constraints are especially important in the case of a retrofit project. The slope and maximum load of the roof are the most important structural elements to consider.

Pitch Limitations

Though green roofs have been installed in some cases on roofs with slopes of forty percent and more, doing so greatly increases the complexity of a project. To safely install a green roof on a roof with a pitch of greater than 2.5 inches per foot (about equal to a 20 percent slope) requires supplemental anchoring. Without additional support, the green roof may slide under its own weight (Miller, 2003). On the other hand, a perfectly flat roof would not provide ideal drainage conditions. For proper drainage, a minimum pitch of 1" in 10" (10 percent slope) is preferable (Kerry, 2004). Thus, there is an ideal range between approximately 10 and 20 percent slope. This is not to say that a green roof cannot be installed on roofs with a slope that falls outside this range. It should merely be considered that if one is installing a green roof on a roof with less than 10 percent slope, then care should be taken to ensure proper drainage. And if one is installing a green roof on a roof with a slope of greater than 20 percent then some additional cost of securely anchoring the green roof should be anticipated. The exposure that the pitch of the roof presents to the sun and wind is also important to consider. A roof could quite possibly have two distinct microclimates defined by different exposures. In the Los Angeles climate, plants on a section of roof with a southern exposure will need to be especially hardy and well cared for to survive the intense sun. This will affect plant selection and the design of a maintenance plan, topics that will be discussed further in Section IV and V.

Load Requirements

The modern extensive green roof features an engineered growth media that is much less dense than natural soil. Typical natural soil weighs approximately 100 pounds per cubic foot (1,600 kg per cubic meter) when wet. If five inches of natural soil were place on a roof, it would weigh

more than 40 pounds per square foot (or about 190 kg per square meter for 12 cm of soil) (Peck et al, 2001). The saturated weight of engineered media used for today's green roofs commonly falls in the range of 10 to 25 pounds per square foot (50 to 120 kg per square meter) (BES, 2004). This substantial weight reduction allows green roofs to be installed on many existing roofs without the need for structural reinforcement. Of course, if a green roof is included in the design of a new building, the roof structure can be engineered to supply much more freedom in media type and depth which will allow for a wider range of plant species. Table III-3 presents the range of green roof installations offered by one company for different load limitations.

Table III-3. Example of Green Roofs Available as a Function of Weight.

Saturated Weight	Plant Species
13 – 17 lbs	Flower Carpet. Plant families: Sedum
17 – 23 lbs	Aromatic Garden. Plant families: Sedum, Sedum and herbs.
25 – 35 lbs	Savannah. Plant families: Sedum, Sedum and meadow grasses.
35 – 45 lbs	Meadow1. Plant families: Meadow grasses and turf.
35 – 50 lbs	Meadow 2. Plant families: Deeper depth than meadow.

(Roofmeadow, 2003b)

For any green roof project in Los Angeles, a licensed structural engineer or architect, as required by Sections 5538 and 6745 of the California Business and Professions Code, will need to ensure that the building's structure will support the additional dead load and earthquake load of the green roof (Lee, 2004). If the roof will be accessible to the public, the structure will also need to support an additional live load. This engineering analysis of the roof structure will define the maximum weight of the green roof. In many cases, the position of supporting columns in the building's structure will lead the maximum permissible weight to vary across the roof, allowing more flexibility of design in some areas. Without such an analysis there is no way to safely determine an appropriate design. However, one clue has been identified to determine the feasibility of a green roof project before enlisting a structural engineer. Many roofs are ballasted, which means they are covered by a layer of material (often gravel) that by its weight holds the roof membrane in place. The common river rock ballast weighs approximately 12 pounds per square foot (59 kg per square meter) (Greenroofs.com, 2003). The ballast would be unnecessary in a green roof system, which would immediately free up approximately 12 lbs/sf (59 kg/sq m) for the green roof.

PERMITTING REQUIREMENTS

Given the rather recent entrance of green roofs into the US marketplace and certainly into Southern California, clear procedures for permitting them have yet to be developed, although there are no regulations prohibiting green roofs. Information obtained from various City of Los Angeles departments regarding green roofs indicates that the design and safety criteria relating to extensive green roofs are for the most part similar to those associated with a conventional roof and are likely to be easily addressed in the design of the green roof.

Building Permit

Green roofs are not explicitly mentioned in the Los Angeles Building Code (Lee, 2004). For the current process in the City of Los Angeles, please see Figure III-3. As with any other project, plans need to be approved by the City of Los Angeles Department of Building and Safety. In other cities, green roof professionals have found that the wet weight of the green roof is treated as an additional dead load and regulated as such under the guidelines of the International Code Council (ICC) (Miller, 2003). It is reasonable to expect that the same will be true for the City of Los Angeles; the City's Building Code is based on the 1997 Uniform Building Code and published by the ICC. The additional concern regarding loading in the Los Angeles area will be the earthquake load. Consultations with personnel in the Department of Building and Safety indicate that a permit will be issued for the construction of an extensive green roof so long as the dead load and earthquake load of the roof is safely within the supporting capacity of the building structure. Again, ensuring that the design meets those guidelines will require the services of a licensed structural engineer, civil engineer or architect as required by Sections 5538 and 6745 of the California Business and Professions Code (Poursabahian, 2004; Poursabahian, 2004b).

Fire Safety Provisions

Some important issues have been raised regarding the fire hazard presented by a green roof. These concerns relate to the flammability of materials on the roof, occupancy of the roof and fire department access to the building via the roof. The Building Code prohibits combustible materials on the roof of buildings over a specified height without having adopted certain precautions (Hernandez, 2004). The first measure that is recommended by green roof professionals is to avoid installing plant species such as mosses and grasses that would be particularly flammable if allowed to dry out (Greenroofs.com, 2003). However, if certain precautions are taken it should not be necessary to limit plant selection based on these criteria. If a sprinkler system were to be installed that could be activated in case of fire, that would be sufficient for the Los Angeles Fire Department. The Fire Department may also grant a variance in the absence of a sprinkler system if a maintenance plan shows that the roof will be maintained in such a condition that it will not present a fire hazard (Hernandez, 2004). The irrigation required to prevent plants from becoming flammable varies greatly between plant species. Sedums, with their fleshy water-storing leaves would not easily burn, even in near drought conditions. In contrast, many mosses would burn easily after only a brief dry spell. Thus, the frequency of watering needed to prevent fire danger will depend on the species present. Chapter 5, Article 7, Division 21 of the Los Angeles Municipal Code (the LA Fire Code is Chapter 5, Article 7 of the LAMC) presents the LAFD's current guidelines on what vegetation presents a fire hazard (LAMC, 2003).

Roof occupancy concerns would generally not be applicable to extensive green roofs due to their usual inaccessibility. However, in the case of a demonstration project, allowing for visits by small groups may be a desirable attribute. Intensive green roofs are designed for frequent access with minimal restrictions and thus require special treatment. General access by building occupants to the roof requires specific safety measures (railings, etc.) as specified in the Los Angeles Fire Code.

The allowable rooftop access is determined by two factors, the allowable *occupant load* determined by the Fire Department, and the o*ccupancy type* defined by the Building Code. The

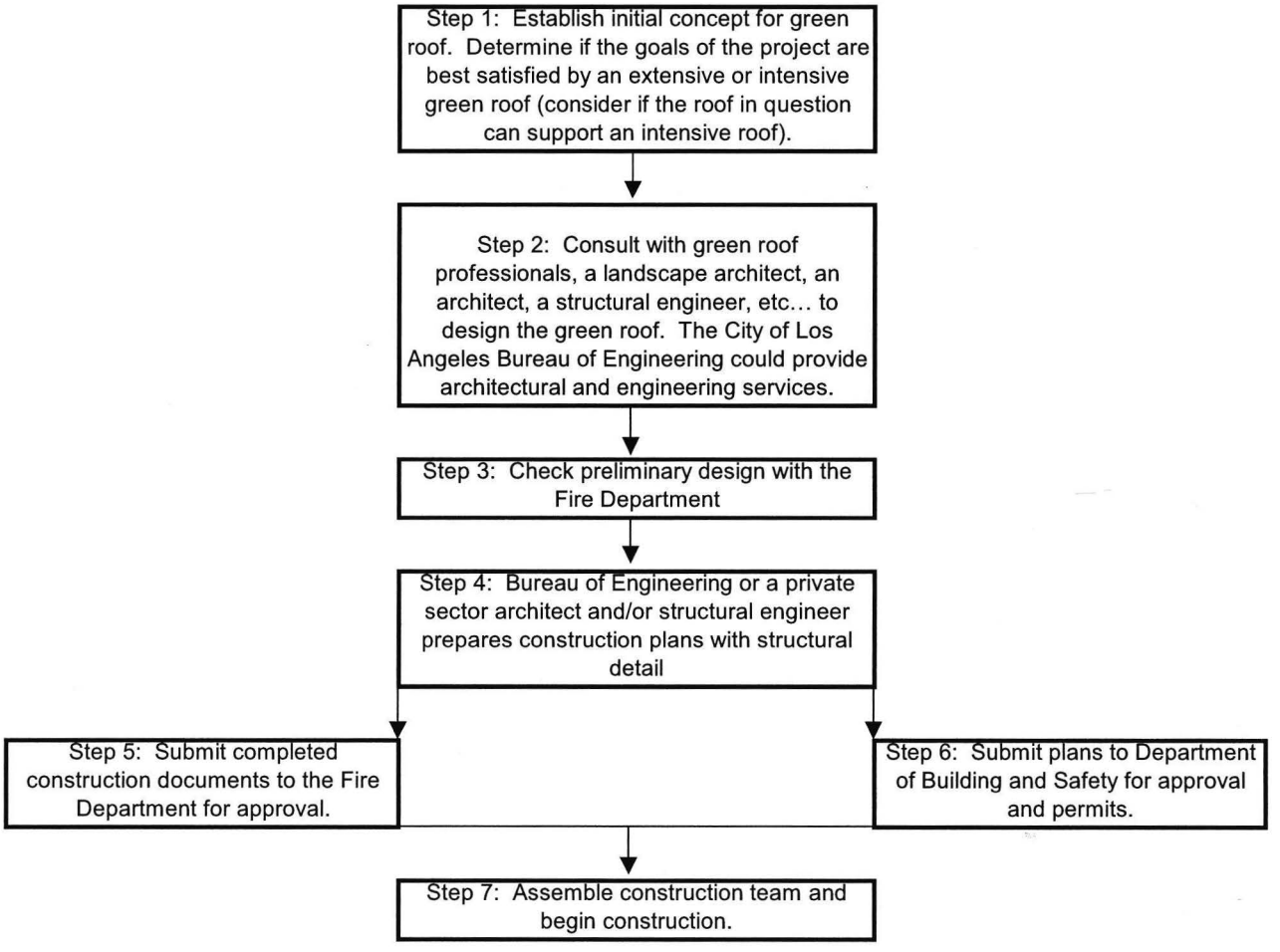
method used by the Fire Department to determine the allowable occupant load is detailed in Chapter 5, Article 7, Division 33 of the LAMC. Table 5B of the City of Los Angeles Building Code defines the characteristics necessary for a given occupancy type to be permitted on the roof of distinct building types (Poursabahian, 2004). The LA Department of Building and Safety (LADBS) in coordination with the LAFD have recently stipulated that certain roof uses on apartment buildings can be classified as "R-1" occupancies instead of the more restrictive "A" type occupancy (Hill, 2004). Even in the case that an assemblage was allowable, it would most likely need to be of limited size. For example, an assemblage of over ten or more occupants would require the availability of a second stairway exit per Section 91.1004.2.3 of the City of Los Angeles Building Code. (Hernandez & Malki, 2004). Additional exits would be required for assemblages of 500 occupants or more. The occupant load determines the number of exits and the Occupancy determines whether an occupied roof is permitted for a specific building. (Poursabahian, 2004b). In addition, any accessible green roof requires compliance with the Los Angeles Building Code, Chapter 11B. For more information on rooftop occupancy type and occupant load, readers should consult the Los Angeles Building Code and the City's Fire Code.

The Fire Department will also be concerned about preserving roof access for firefighters in case of emergency. The Fire Department wants existing access to roofs and access the roof provides to the building to remain unobstructed. Preserving emergency access to the roof should not be a problem. Green roof professionals commonly recommend leaving a 24" (61 cm) non-vegetated perimeter around the edge of the roof as a fire break and to ease access for firefighters (Greenroof.com, 2003). Existing access points such as skylights, roof hatches, stairwells, etc should not be obstructed (Hernandez, 2004). In addition, the Fire Department sometimes ventilates buildings by cutting through the roof. This is not a concern for concrete or metal clad roofs, as those types are not cut. But in the case of a roof type that could be cut, the Fire Department wishes to preserve that possibility. Doing so could mean demonstrating that the green roof could either be quickly moved, or it may mean maintaining areas of the roof without vegetation. The Fire Department can be contacted for a walk through of a site in order to determine the best course for addressing these concerns (John Vidovich, Building Standards Unit, City of Los Angeles Fire Department, 213-482-6907).

PROCEDURE

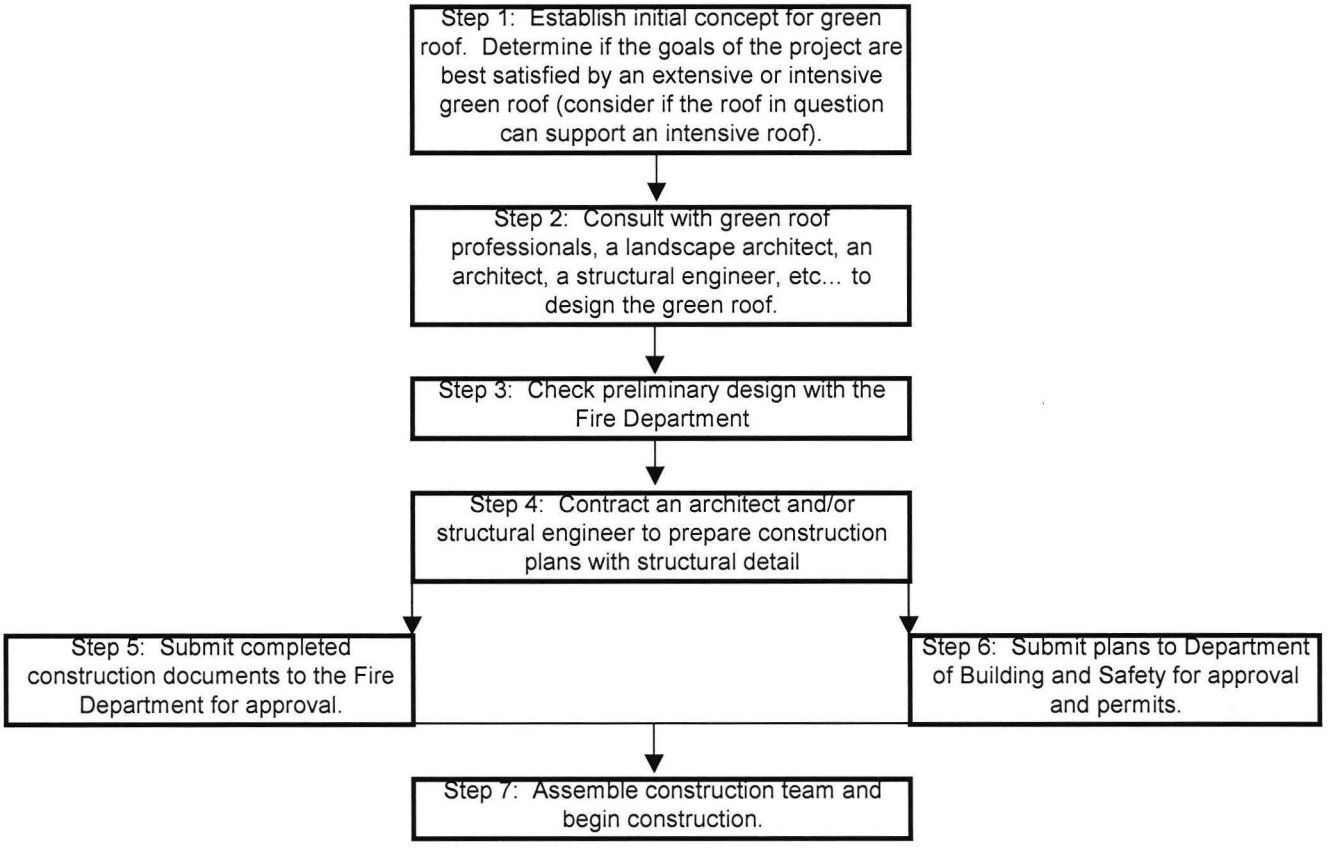
There are some necessary steps common to all green roofs. Steps outlined in this section relate to obtaining the required approvals from those City of Los Angeles departments that will be involved in a green roof project. Figure III-3 shows the path that a public agency in the City of Los Angeles would follow to implement a green roof; Figure III-4 shows the corresponding process for non-city owned buildings. Incorporating a green roof in certain types of City projects may require additional approval from the City's Planning Department. Contract the Planning Department if the project falls under an existing Planning document, such as the "Mulholland Corridor Specific Plan," or for any entitlement actions. This approval would need to be obtained at the same time as the Department of Building and Safety's plan check (Step 6 in Figures III-3 and III-4). Contact information for the departments indicated in Figures III-3 and III-4 can be found in Section VII.

Figure III-3. Procedure for a Public Agency to Implement a Green Roof.



Note: Changes to existing Planning documents, or new entitlement actions require the approval of the Planning Department.

Figure III-4. Procedure for a Private Entity to Implement a Green Roof.



Note: Changes to existing Planning documents, or new entitlement actions require the approval of the Planning Department.

COSTS (DESIGNING, BUILDING, MAINTAINING)

The cost of a green roof is highly variable depending upon the complexity of the design and the existing roof conditions. For the purpose of this discussion, unless otherwise stated, it will be assumed that the roof has sufficient structural support and the only costs will be those directly involved in the design and construction of the green roof. We are still left with a wide range of costs depending upon the complexity of the design and whether it is new construction or a retrofit. The cost estimates described in this section provide a basis for determining what can be achieved at what expense.

Design and Build

The cost of the Chicago City Hall green roof retrofit (Figure III-5) was about $1.5 million, or about $75 per planted square foot ($810/sq m) (a conventional reroofing would have cost an estimated $1 million). This project includes both extensive and intensive portions. The Multnomah County Building green roof retrofit (Figure III-6) in Portland, Oregon, another green roof, cost only $17 per square foot ($180/sq m) to construct. Costs can vary between different green roofs depending on the complexity of the design.

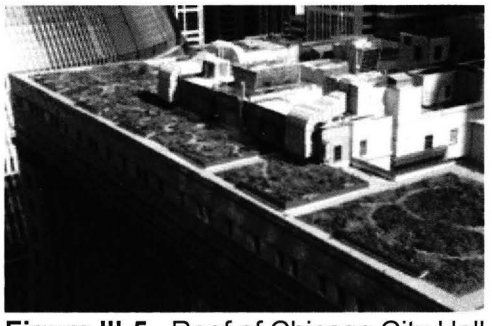


Figure III-5. Roof of Chicago City Hall

Figure III-6. Section of Multnomah County Building Roof.

A survey of extensive green roofs in the Portland area revealed costs from under $10 per square foot ($110/sq m) to just over $20 per square foot ($220/sq m) (Hauth, 2004). The Portland Bureau of Environmental Services provides a similar estimate, suggesting green roofs cost from $10 to $25 per square foot ($110 to $270/sq m) including labor, materials and structural upgrades. A conventional roof costs from $3 to $20 per square foot ($30 to $220/sq m) (BES, 2004). According to a consultant on the project, the green roof on the GAP headquarters in San Bruno, CA cost approximately $24 per square foot ($260/sq m) (Kephart, 2004). In comparison to the Portland green roofs, the cost of the GAP green roof is higher as the GAP roof was one of the first green roof projects by an American corporation, completed in 1995, where most of the Portland area green roofs were constructed in the last few years. The costs of green roofs have declined, and the GAP green roof would probably only cost $11 to $14 per square foot ($120 to $150/sq m) today (Kephart, 2004).

The costs of a green roof are higher than those of a conventional roof due to the greater complexity of the system involved and to the greater specialization required of the roofing contractor. Roughly, the costs of a green roof can be broken down as follows (Peck et al, 2001):

POTENTIAL FUNDING SOURCES

There are some potential funding sources that could help to defray the higher upfront cost of a green roof. The grants that have successfully been obtained by past green roof projects have capitalized on the most established and easily quantified benefit of green roofs which is stormwater management. However, as the energy efficiency, air quality, and urban heat island benefits are gaining wider attention, they too may provide avenues for funding.

The California State Water Resources Control Board (SWRCB) administers three funding sources focusing on water quality, which may offer funds for a green roof. They are: the Clean Water Act Section 3.19 grant, Proposition 13 and Proposition 50. The Section 3.19 grant offers funding to many types of water quality improvement projects. Types of projects that the grant funds under which a green roof could be classified are:

- controlling particularly difficult nonpoint source pollution problems;
- implementing innovative methods for controlling nonpoint sources; and
- demonstration projects (EPA, 2004; Jerkevics, 2004).

Proposition 13 also offers funds for nonpoint source pollution control and Proposition 50 for watershed management. In 2003, the funds made available by the Section 3.19 grant, Proposition 13 and Proposition 50 were consolidated in one watershed protection, watershed management, nonpoint source pollution control grant program. This made available up to $138 million in grants via one application (SWRCB, 2004). According to SWRCB contacts, the 2005 grants will also be awarded through one combined competition. In addition to the grant programs, there is also the State Revolving Fund Loan Program, which offers low interest loans to projects that address nonpoint source pollution. This program is also administered by the SWRCB. More information about these sources of funding can be obtained through the SWRCB webpage (http://www.swrcb.ca.gov/funding/index.html), or by contacting the program administrators (Lauma Jerkevics; SWRCB, Section 3.19 Grant Program; 916-341-5498 and Jim Marshal; SWRCB, Integrated Regional Water Management Grant Program; 916-341-5636).

Funding may also be available based upon the pollution reduction and energy saving characteristics of a green roof. The EPA's Pollution Prevention and Source Reduction grants provide funding for a wide variety of projects aimed at eliminating pollution at the source. A green roof could qualify for one of these grants based upon its air quality and/or water quality benefits. The EPA's Region 9 office awards two or three Source Reduction grants annually in the amount of $25,000 to $50,000. The Source Reduction grants are available for public or private sector entities. In contrast, the Pollution Prevention grants are only available to state agencies (including air districts). Pollution Prevention grants offer funding of up to $200,000. One possible way a local green roof project could gain access to the Pollution Prevention grants would be to partner with an air quality district (Katz, 2004). Requests for proposals for both of these EPA programs are generally available in January. For more information, consult the EPA's Pollution Prevention website (http://www.epa.gov/p2/), or contact the EPA's Region 9 Pollution Prevention Office (John Katz, Pollution Prevention Coordinator, 415-947-3530). At this time, significant sources of funding for green roofs based on energy conservation do not appear to be available. The California Energy Commission offers low interest loans to public agencies pursing energy efficiency measures, but the funding available for a green roof project would be minimal (Mills, 2004).

IV. DESIGNING THE GREEN ROOF

Green roof designs can assume a limitless number of forms within the bounds set by functional requirements and budget. Some of the constraints on the design have already been presented, most notably, the weight limit placed on the green roof by the roof structure and the roof microclimate. This section will present the additional elements of a green roof design required in order to ensure that the desired benefits of the green roof installation are achieved.

LAYOUT

The layout of an extensive green roof must be such that all desirable and mandatory access is allowed for. If it has been decided, based on project goals and the roof structure, that access will and can be granted to the public, it will be necessary to restrict that access to prevent damage to plants (Peck, 2004). It may also be necessary to restrict access based on structural limitations. At Portland's Multnomah County Building (Figure III-4), though the vegetated portion of the roof is extensive in design, public access has been granted to a section of the roof for viewing. This section is clearly delineated from the green roof by a railing. In addition to being necessary to ensure public safety on a rooftop, the railing protects the vegetation and enforces the idea that extensive green roofs are not recreational open spaces.

Mandatory access provisions must be made for fire protection and maintenance personnel. The eventual repairs and replacement that are needed for any roof must also be planned for in the layout of the green roof. The Fire Department's requirements for a green roof, presented in Section III.C can be largely met by the layout of the green roof. Ease of accessibility from all sides of the roof can be maintained by holding the vegetated sections back a minimum of two feet from the edge of the roof. Similar borders around building access points such as doors, skylights and hatches will facilitate entering and exiting the building via the roof. Both of these are also important for maintenance personnel who should have easy access to the roof from the building and who for safety reasons should not need to venture too near the edge of the roof. In fact, one of the California Department of Health and Safety approved safety measures for rooftop maintenance workers is a harness system that would prevent personnel from reaching the edge of the roof (Jett, 2004).

A carefully considered layout can provide for the survival of plants, even beyond the expected 35 to 40 year life of the roof membrane. In the short term, a few well distributed pathways could facilitate the work of building maintenance personnel and prevent plants from being trampled. Though if traffic on the roof will be infrequent, pathways may not be required as the vegetation can support some foot traffic (BES, 2004). In the long term, if an open portion of the roof is available for storing displaced sections of the green roof while the waterproof membrane is repaired/replaced, it will avoid the time and cost of moving green roof materials to and from the roof (Peck et al, 2001). However, the benefits achieved by the green roof will depend on the area of roof that it covers. Greater coverage will lead to greater benefits. Thus, if it is decided to provide for such future storage space, the area preserved should be kept to the minimum necessary.

PREPARING THE ROOF

The structure of a green roof departs from that of a conventional roof beginning with the roof membrane. Most green roof contractors will only guarantee their work if a new membrane is installed along with the green roof. As a result, the most advantageous time to install a retrofit green roof is when the existing membrane is scheduled for replacement. Although a green roof serves the function of protecting the membrane from exposure to the elements, it also exposes the membrane to potential penetration by roots. Roof membranes with some organic content (e.g. bituminous membranes) are particularly vulnerable to root penetration and/or micro-organic degradation (Peck et al, 2001). These types of membranes must be used in conjunction with a chemical or physical root barrier. Other membranes, such as those composed of synthetic rubber or reinforced PVC, generally do not need a root barrier (BES, 2004). An experienced green roof contractor or green roof materials provider will be able to determine if a root barrier is required for a given roof membrane. As seen in Figure IV-1, the waterproof membrane and root barrier form the base layer of the green roof.

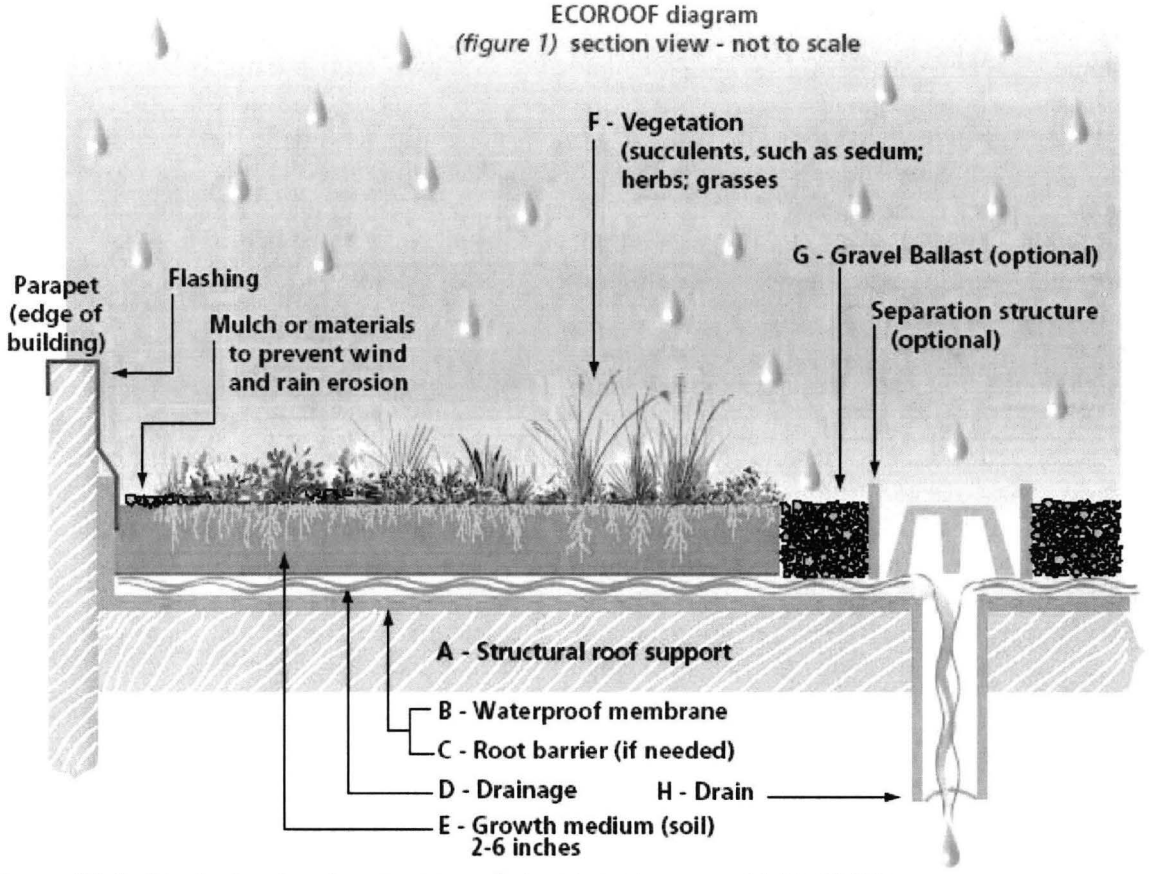


Figure IV-1. Typical extensive green roof structure (source: BES, 2004).

Not depicted in Figure IV-1 is an optional electronic leak detection system. Such a system is not necessary and most green roofs have been implemented without it. However, it is something that some companies are recommending to deal with the difficulty of inspecting/repairing a membrane that is buried under four or more inches of media (Peck et al, 2001). Sometimes

referred to as electric field vector mapping (EFVM), this leak detection technique does not necessarily require installing any additional material during construction of the green roof. It does, however, require that the membrane installed have certain electrical resistance properties. Certain types of EPDM (a rubber membrane) and aluminized membranes will not be compatible with EFVM (Roofscapes Inc., 2002d). Additional information on EFVM can be found on the International Leak Detection website (www.leak-detection.com/news.html). A green roof contractor should be able to provide further information on leak detection technology.

GROWTH MEDIUM

The growth medium is the entire volume of material that will be available to the root system. This part of the system is responsible for storing the water and nutrients that plants need for survival, conveying excess water to drains and doing so in a thin, lightweight layer. At the base of the growth medium is the drainage layer. The first measure to ensure proper drainage is to make sure water is not allowed to enter under the waterproof membrane. This is accomplished by placing flashing around the edges of the roof and around any roof penetrations (e.g. skylights) as indicated in Figure IV-1. Water percolating through a fully saturated layer of growing medium must not be allowed to pool, as this would threaten the impermeability of the roof membrane and create a risk of drowning the plants (Peck et al, 2001). Existing roof drains will normally be sufficient to evacuate water from the roof deck (City of Chicago, 2001b), but first the water must be conveyed to the drains. Drainage is generally provided either by a thin layer of gravel or by a manufactured drainage sheet (BES, 2004). Though both options are perfectly functional so long as they provide a minimum permeability of 7 in/minute (180 mm/minute) (City of Chicago, 2001c), the manufactured drainage sheet has the advantages of being lightweight and of including a fabric filter to prevent the passage of soil particles that could otherwise form obstructions in the drainage layer (Oberlander et al, 2002).

In designing the green roof drainage system, the possibility of capturing the water for later use should be considered. Doing so both reduces the roof's (and potentially the entire building's) water use and further alleviates the strain on the storm drain system caused by a large rainfall event. At a very basic level, the water can be passed from the roof to other plantings around the building. A very practical system would be to collect the runoff in a cistern from which it could be drawn to irrigate the green roof during dry periods. An impressive example of the use of stored runoff is the drainage system at the Peoples' Food Coop in Portland, OR. At that building, the runoff from the green roof is collected in a cistern which supplies both the building's toilets and its irrigation system (Hauth, 2004).

The second portion of the growth medium, which overlays the drainage layer, is the soil or "engineered media". This is a mixture of materials designed to fulfill the same function as natural soil but with about half the density so as to save weight. Soil media for an extensive green roof typically ranges from 2 to 6 inches (5 to 15 cm) in depth (Peck et al, 2001). For example, the Premier Automotive Headquarters in Irvine, CA features a green roof with five inches of media. At least one green roof professional has recommended that 5 inches (13 cm) be considered a minimum depth in the relatively warm, dry South Coast climate (Miller, 2004). Greater soil depth results in greater water storing capacity which will help plants through dry periods but adds weight.

Possible ingredients in the soil mix include: topsoil, compost, perlite, digested fiber, clay or shale, pumice and coir (coconut fiber) (BES, 2004). The major considerations in determining the exact mix for a specific project will be weight constraints and desired water retention. Germany's FLL (Forschungsgesellschaft Landschaftsentwicklung landschaftsbau e.V. or the Research Society for Landscape Development and Landscape Design), which Roofscapes Inc. indicates has been a reliable provider of information on green roofs for over 15 years, gives the guidelines for green roof soil media presented in Table IV-1 (Roofscapes Inc, 2003). Most extensive green roofs will have only one layer of media (multi-layered systems are more common for intensive green roofs) and should thus follow the guidelines in the first column of Table IV-1. Using the saturated density of the one layer extensive green roof together with a minimum recommended depth of 5 inches (13 cm) yields a weight of 21 to 36 pounds per square foot (100 to 180 kg/m^2).

Table IV-1. FLL Recommended Soil Properties of an Extensive Green Roof.

	One Layer (extensive roofs)	**Multi Layered (intensive roofs)**
PHYSICAL PROPERTIES		
Water retention (compressed)	Min. 25%	Min. 35%
Water permeability (compressed)	Min. 2.4 in/min (60 mm/min)	Min. .02 in/min (.6 mm/min)
Air content (saturated)	Min. 25%	Min. 15%
Density (saturated)	50 – 87 lb/cf (0.8 – 1.4 g/cm^3)	62 – 137 lb/cf 1.0 – 2.2 g/cm^3
CHEMICAL PROPERTIES		
pH	6.5 – 9.5	6.5 – 8.0
Salt content of water extracted (if possible)	1 g/liter	
Initial organic matter	3 – 8 percent	
Nitrogen (N) slightly soluble	Max. 60 mg/liter	
Phosphorous	Max. 150 mg/liter	
Potassium	Min. 150 mg/liter	
Magnesium	Max. 120 mg/liter	

Source: City of Chicago, 2001c

As the majority of the materials selected for green roof media are lightweight, high winds can easily blow them from the roof in the period before plants are firmly established and offer complete ground cover. It is generally recommended that a biodegradable mesh be installed over the growth media during construction. This mesh will protect the soil from wind erosion until the plants can perform that function (City of Chicago, 2001).

CHOOSING THE RIGHT PLANTS

Although there is a substantial amount of guidance available on plant selection for green roofs, little of it is directly applicable to climatic conditions in Los Angeles. The majority of the information on green roofs comes from areas receiving much more precipitation than Los Angeles (~15 in/yr, 38 cm/yr), such as Chicago (~36 in/yr, 91 cm/yr) and Portland (~42 in/yr, 107 cm/yr). The same general plant characteristics are applicable in all these areas, but information on the performance of specific species is not currently available for Los Angeles.

The nearly universally recommended plant characteristics for an extensive green roof are:

- perennial or self-sowing
- drought tolerant
- wind tolerant
- able to withstand temperature extremes
- need little mowing, trimming, fertilizer or pesticides
- fire resistant
- provide good ground coverage
- shallow root structure

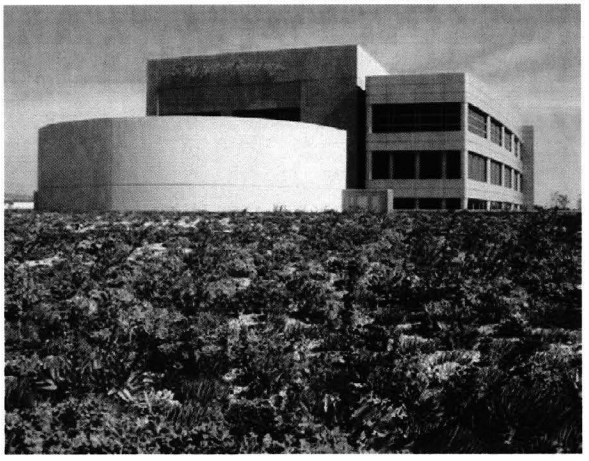
(BES, 2004; Peck et al, 2001)

Plants with these characteristics are much more likely to survive the extreme rooftop climate. They also perform the function of stabilizing the growth medium and require little maintenance. One group of plants which commonly have the above characteristics are referred to as succulents. Of the succulents, sedums and sempervivums are commonly used on green roofs. Of course, the list of plants that will survive on a green roof grows longer as the budget for caring for those plants grows. A study by the Portland Bureau of Environmental Services found the following types of plants on Portland area green roofs:

Sedum, creeping ground covers, wildflowers, fescue, sempervivum, ice plant, native grasses, wetland prairie species, delosperma, non-native wildflowers and grasses, yarrow, ornamental grasses, ornamental shrubs, vines, native evergreen and deciduous shrubs, herbaceous perennials and endangered native species (Hauth, 2004).

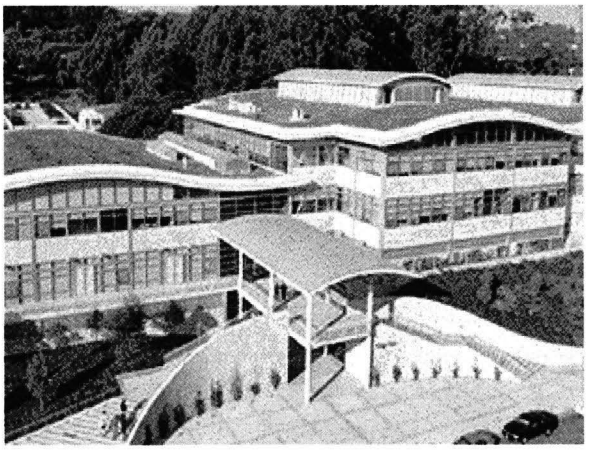
Many of those plants would not be appropriate for Los Angeles, but we see some of the same plants used in successful California projects. Two California projects in particular offer some insight into appropriate plant species. One is the green roof at the Premier Automotive Group headquarters in Irvine (Figure IV-2). That roof is planted with Sedum, Echeveria, Lampranthus, Delosperma, Agave and Aloe (Roofscapes Inc., 2004). The other is the GAP green roof in San Bruno, which is planted with native grasses and wildflowers (Figure IV-3) (GRAE, 2003). There is clearly some overlap between the plant species from Portland area green roofs and those being used successfully in California. Sedums, native grasses and delosperma appear to be generally successful in the green roof environment. Native species are particularly appealing for green roofs. These plants are appropriate for the climate and require little maintenance. They also offer habitat for native species of birds and insects. For example, one California native plant species that is a promising candidate for a green roof is the Chalk Dudleya (Figure IV-4). In addition to having a low water requirement, this species is known to attract hummingbirds which may be viewed as a desirable attribute in some applications (SC HGG, 2004).

Figure IV-2. Green Roof of Premier Automotive Group in Irvine, CA.



Source: Roofscapes Inc., 2004

Figure IV-3. Green Roof of GAP Inc. in San Bruno, CA.



Source: Garmhausen, 2004

Figure IV-4. Chalk Dudleya.

Source: SC HGG, 2004

Most landscape architects who are familiar with the Southern California climate should have a good understanding of what plants will best meet the characteristics listed at the beginning of this section. Those that have an understanding of the specific challenges of a green roof would be best prepared to offer guidance on plant selection. Examples of sun tolerant plant species with low water requirements are listed in Table IV-2. Some of these species may be appropriate for a green roof in Los Angeles but a qualified landscape architect should be consulted for a more definitive list.

Table IV-2. Sun and drought tolerant plant species potentially suitable for green roof applications in the Los Angeles area.

Common Name	Scientific Name	Notes
Gold Tooth Aloe	(Aloe nobilis)	
Golden Barrel Cactus	(Echinocactus grusonii)	
Many species of agave		
Hasse's Dudleya	(Dudleya hassei)	
Beavertail Prickly Pear	(Opuntia basilaris)	
Blue-blad Cactus	(Opuntia violacea santa-rita)	
Chalk Dudleya	(Dudleya Pulverulenta)	Figure IV-4
Felt Plant	(Kalanchoe beharensis)	
Ice Plant	(Delosperma cooperii)	Figure IV-5
Lampranthus	(Lampranthus productus)	
October Daphne	(Sedum sieboldii)	Figure IV-6
Oscularia	(Lampranthus deltoides)	
Purple Stonecrop	(sedum spathulifolium)	Figure IV-7
White Trailing Ice Plant	(Delosperma Alba)	
Brown Sedge	(Carex testacea)	Figure IV-8
Deer Grass	(Muhlenbergia rigens)	
Tussock Sedge	(Carex stricta)	

Figure IV-5. Ice Plant

Source: SC HGG, 2004

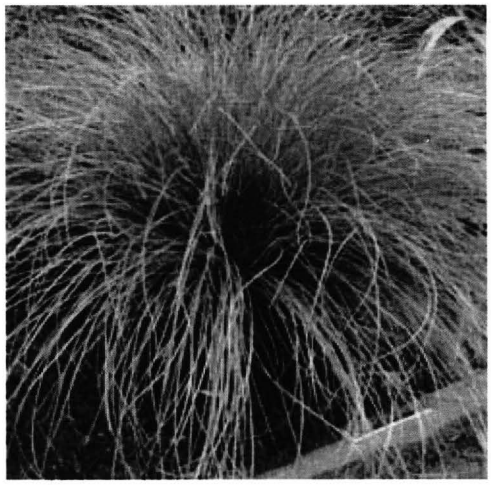
Figure IV-6. October Daphne

Source: SC HGG, 2004

Figure IV-7. Purple Stonecrop

Source: SC HGG, 2004

Figure IV-8. Brown Sedge



Source: SC HGG, 2004

IRRIGATION

Irrigation will be required during the establishment phase of plant development and during dry periods. In wetter climates, it has been possible to limit irrigation to just the establishment phase (Peck et al, 2001). However, it would be unreasonable to expect even fully developed plants to survive the long dry periods characteristic of the Los Angeles area without irrigation. The average monthly precipitation in Los Angeles drops below one inch from May through October (WRCC, 2004). In Portland, average monthly precipitation only drops below one inch in July and August. Yet even in Portland, most green roof owners report irrigating the roof during drier months (Hauth, 2004). In most cases, green roof developers in Los Angeles will seek to minimize water use through appropriate plant selection and use of efficient irrigation techniques.

Methods

There are many different irrigation techniques. The roof may be watered by hand, by a manually operated sprinkler system, or by an automated irrigation system (BES, 2004). Clearly an automated irrigation system will have a greater upfront cost, whereas the manual systems will involve greater annual labor expenditures. Many Portland green roofs use manual watering (Hauth, 2004) but roofs there typically only need to be watered perhaps two or three times per week for two months of the year. A green roof in Los Angeles will likely require more frequent watering and will certainly require watering for more months out of the year. The roof at the Premier Automotive Group headquarters in Irvine actually features two irrigation systems. The first, an automated sprinkler system was used only during the establishment period. The second, an automated drip irrigation system is now used on a regular watering schedule. Drip irrigation is generally more efficient because less water is lost to evaporation but the more uniform coverage provided by sprinkler systems may be preferred for some plantings. A landscape professional should be consulted to determine the optimal sprinkler system design for each specific installation.

Given the comparatively high water needs of a green roof in Los Angeles, an automated drip irrigation system will generally be most appropriate. A drip irrigation system typically delivers 90 percent or more of the water it uses to plants. In contrast, a sprinkler system delivers only 75 – 85 percent due to over-spray and direct evaporation (Stryker, 2001). An automated system also offers a higher efficiency due to the more exact calculation of total water delivery that it offers. An automated drip irrigation system may entail a higher initial cost but savings in water consumption and labor generally make it a more economically efficient choice in the long term and it's certainly the most environmentally friendly option. An assumed efficiency of 90 percent (reflective of drip irrigation) was used to calculate the annual water usage of 0.90 cubic feet per square foot (270 liters per square meter) of roof ($0.020 per square foot or $0.22 per square meter) presented in Section III. If an efficiency of 80 percent is used instead (reflective of a sprinkler system), the water use rises to 1.0 cubic feet per square foot (300 liters per cubic meter) of roof ($0.022 per square foot or $0.24 per square meter). That's a cost increase of about 10 percent or about $20 per year for a 10,000 square foot (930 square meter) roof.

Alternative Sources of Water

Even greater water efficiency can be achieved if captured rainwater or gray water can be used for irrigation. As mentioned in the discussion of the growth medium, drainage from the roof can be directed to a cistern rather than to the City's stormwater drainage system. A green roof can capture between 10 and 100 percent of incident rainfall (BES, 2004). Adopting the midpoint of those values (55 percent), under the average annual precipitation in Los Angeles of about 15 inches (38 cm) (WRCC 2004), a 10,000 square foot (930 square meter) green roof would yield 6,250 cubic feet (177,000 liters) of runoff annually. If all of that were captured, it would supply 70 percent of the estimated annual water needs of the roof.

Yet another water efficient option would be to use gray water to irrigate the green roof. Gray water is wastewater that has not come in contact with toilet waste. Gray water is widely used for landscape irrigation in California. Gray water use requires that a building have two independent

wastewater systems: one for disposal of human waste and the other for all other uses. As the majority of existing buildings have only one combined wastewater disposal system, it will generally not be cost effective to implement a gray water system in an existing building. However, such systems are quite feasible when included in designs for new construction and can be an important element of a total water conservation program. A gray water irrigation system was implemented in the construction of the Premier Automotive Group headquarters and supplies all of the landscape irrigation needs, including irrigation of the green roof (US GBC, 2003). Implementation of such a system requires a permit from the City of Los Angeles Department of Building and Safety. California Administrative Code, Title 24, Part 5 details the California gray water Standards. This and more information on California gray water use can be found through the California Department of Water Resources website (www.dwr.water.ca.gov).

V. GROWING AND MAINTAINING THE GREEN ROOF

There are two distinct phases in the maintenance of a green roof: establishment and continued care. Establishment begins with the installation of the green roof and ends when plants are mature (usually about 2 years). Continued care is the routine maintenance that must be performed over the life of the green roof after plants are established. Two important questions to consider in the installation of a green roof are when it will be installed and what method of plant installation will be used. These choices will have a large impact on the intensity of maintenance that is required during the establishment period of the green roof.

INSTALLATION AND ESTABLISHMENT

There are several different methods for installing plants on a green roof. Plants can be installed in vegetation mats, as plugs or potted plants or as seeds or sprigs. Some of the advantages and disadvantages of each of these methods are presented in Table V-1.

Table V-1. Planting Methods for Green Roofs.

Method	Description	Advantages	Disadvantages
Vegetation mats	Similar to sod, pre-germinated mats of plants are laid	-Erosion control -Minimal weed problems -Less watering required than other methods	-Less design flexibility
Plugs or potted plants	Pre-germinated plants are planted individually	-Design freedom -Less care required than with sprigs or seeds	-Need more watering than mats -Need erosion protection -Need weeding and mulching
Sprigs or seeds	Sprigs and seeds can be hand broadcast or seeds can be hydraseeded	-Design freedom -Ease of installation	-Need more watering -Need erosion protection -Need mulching

Source: BES, 2004

As shown in Table V-1, using plugs, potted plants, sprigs or seeds in the installation results in heightened maintenance during the establishment period. The intensity of the additional maintenance will also depend upon what time of year the green roof is installed. Installing the plants in the summer requires relatively heavy irrigation as compared to installing the plants in the fall (Peck et al, 2001). Though installing the plants in the fall generally makes them vulnerable to cold weather conditions, this is much less of a concern in the relatively mild winters of the South Coast as compared to other locations. A landscape architect, or other horticultural expert, can determine the most appropriate time for planting.

Before the green roof plant species achieve a high coverage of the roof area, the green roof will be vulnerable to dehydration and intrusion by weeds. The maintenance plan for the City of Chicago's green roof (http://www.ci.chi.il.us/Environment/rooftopgarden/maintenanceplan.pdf) provides for 3 weeding and watering activities per week during the establishment phase (City of Chicago, 2001d). This plan offers a good example of planning for the care of an extensive green roof. Some sections of this plan describe care for segments of the Chicago roof covered by an intensive type garden; care requirements for an intensive green roof include elements that are not necessary for an extensive green roof.

MAINTENANCE

The maintenance requirements of a green roof decrease substantially after the plants are established. Simple extensive green roofs in a climate offering rooftop conditions similar to those of the plants' native habitat may require as few as two or three inspections per year to check for weeds or damage. At the other end of the spectrum, an intensive green roof could require one or more maintenance activities per week (Peck et al, 2001). The Chicago City Hall maintenance plan provides for a biweekly monitoring program for continued care (City of Chicago, 2001d). Some of the maintenance activities that may need to be performed over the life of the green roof are:

- Inspect overflow drains to make sure they are clear (approx. monthly)
- Check the health and coverage of the vegetation; remove and replace as needed (approx. monthly)
- Weeding (a few times per year to monthly)*
- Mulching (not at all to monthly)
- Inspect the waterproof membrane (annually)
- Pest control (when problems are detected)

(City of Chicago, 2001d; BES, 2004).

Certainly one of the most critical aspects of continued green roof care will be irrigation. Until the water requirements of the green roof are well understood, it will probably be necessary to perform frequent inspections to determine if the plants are receiving just the right amount of water. It is a good idea to routinely monitor weather conditions and adjust the watering schedule accordingly. This can be easily accomplished by using the watering index for Southern California available through the Be Water Wise website (www.bewaterwise.com). The watering index, updated weekly, is designed to help gardeners and landscape maintenance professionals estimate optimal irrigation needs. Once the maximum irrigation requirement for the green roof is determined,[7] the watering index can be used to determine what fraction of that maximum requirement is necessary throughout the year. Modern electronic automatic sprinkler controllers include a watering index adjustment feature which makes implementing the weekly adjustments very easy.

[7] The maximum irrigation requirement is the irrigation needed on a typical hot, dry summer day. An estimate of that requirement can be made using the watering calculator on the Be Water Wise website or by other means. However, a true understanding of the green roof's maximum irrigation requirement will require some initial monitoring.

VI. QUANTIFYING BENEFITS

As discussed in Section II, green roofs offer a wide range of potential environmental, economic, and social benefits. Since green roofs are still a relatively new concept in the Los Angeles area, any new projects are likely to generate interest in measuring these benefits for purposes of demonstrating the advantages of the green roof concept. Convincing, quantitative demonstrations of green roof benefits would go a long way towards promoting wider acceptance among developers and building owners and generating opportunities for additional funding sources and incentive programs. Demonstrations of green roof benefits would generate favorable publicity and promote public awareness and acceptance of green roofs. Results of benefit monitoring could also be used to optimize green roof design for the unique characteristics of the Los Angeles environment.

Some of the green roof benefits described in Section II, such as storm water runoff reduction and near roof temperature reduction, are much more amenable to quantification than others (e.g., aesthetics). Air quality benefits are quantifiable in theory but this is difficult to do in practice because of differences in scale between a single demonstration roof and the entire urban atmosphere. Numerical modeling tools have been used to estimate the air quality benefits of large scale cooling (such as might be associated with the eventual widespread adoption of green roofs) but these results are subject to considerable uncertainty (see Stoeckenius et al., 2001 for a more complete discussion). Even in the case of the more easily evaluated benefits, however, designing a valid controlled experiment is very difficult. For example, even a simple study such as the comparison of near roof temperature at the Chicago City Hall green roof with that at a nearby building presents challenges: there are differences in the shading received by the buildings, in the orientation of the roofs to the sun and in other building characteristics which confound the temperature comparison.

It is strongly recommended that green roof developers interested in a benefit quantification study, partner with an experienced research group conversant with experimental design and potential confounding factors. Collaboration with an established research group also opens up the possibility of tapping into alternative funding sources for the benefits analysis. Some groups that have experience in the design of green roof experiments are:

•Lawrence Berkeley National Laboratory, Heat Island Group (http://eetd.lbl.gov/HeatIsland/CoolRoofs/) – Though not specifically involved in green roof research, the heat island group has performed extensive studies of cool roofing materials and the effect of cool roofing materials and vegetation on the urban climate and energy consumption.
• Michigan State University Vegetative Greenroof Research Program (http://www.hrt.msu.edu/greenroof/index.htm) – The green roof research conducted at MSU includes evaluating the performance of different plant species in the green roof environment and evaluating the stormwater management of green roofs.
• Pennsylvania State University Center for Green Roof Research (http://hortweb.cas.psu.edu/research/greenroofcenter/index.html) – The Center has researched plant growth and spread on green roofs, the performance of different beds and green roof runoff.

• Portland State University (http://www.sustain.pdx.edu/hm_feature_ecoroofs.php) – PSU is engaged in experiments at two buildings in Portland: the Multnomah County Building and the Broadway building.
• British Columbia Institute of Technology Green Roof Research Facility (http://www.greenroof.bcit.ca/) - This facility is host to studies on green roof stormwater management, energy efficiency, species selection, maintenance programs and the transfer of green roof technologies.

One motivation for studying the performance of a green roof is to increase the likelihood of obtaining funding for future projects. The current funding opportunities for green roofs rely almost entirely upon the well-demonstrated runoff reduction capacity of a green roof. Other funding could be made available if benefits, such as energy savings, were demonstrated. For example, Pacific Gas and Electric currently offers a cool roofs rebate program that helps to fund reroofing with cool roof materials. At this point, a green roof is not on the list of approved roof types that are eligible for this rebate (PGE, 2004). A study that demonstrated the energy savings of a green roof could make green roofs eligible for the cool roof rebate and other similar programs.

Even a public demonstration project that is not sufficiently rigorous to withstand the scrutiny of a full scientific peer review process (i.e. that is lacking control of all external variables, rigorous quality of control, or is not sufficiently documented to be entirely verifiable or replicable) would still have value for promoting green roof technology and raising awareness of the environmental challenges that green roofs seek to address. The value of monitoring a green roof project may be as much in what it tells the public about the urban environment as in the quantitative information it offers on green roof effects.

VII. ADDITIONAL RESOURCES

CITY OF LOS ANGELES CONTACTS

Green Roof Task Force
Applicable Services: The Green Roof Task Force commissioned this report and will continue to offer guidance on the implementation of green roofs.
CONTACT: Karen Higgins
Green Roof Task Force
Environmental Affairs Department
City of Los Angeles
213/978-0854

City of Los Angeles Stormwater Program
Applicable Services: This department can provide information about the City of Los Angeles stormwater management activities and the City's runoff charges.
CONTACT: Morad Sedrak
Stormwater Program
Los Angeles Sanitation District
323-343-1577

Department of Building and Safety
Applicable Services: The Department of Building and Safety will revise construction specifications and issue building permits. This department can also offer guidance on what structures and uses are permissible. There is a fee for the construction plan check.
CONTACT: Sia Poursabahian
Department of Building and Safety
Structural Plan Check
Sr. Structural Engineer
213-482-7307

City Planning Department
Applicable Services: Check with this department if the project falls under an existing Planning document or for any new entitlement actions.
CONTACT: Heather Dalmont
City Planning Department
Subdivisions Unit
213-978-1381

Department of Water and Power
Applicable Services: This contact can provide information on the regulations governing the use of graywater in the City of Los Angeles and on general characteristics of graywater systems.
CONTACT: Bill Van Wagoner
Department of Water and Power
Graywater Use
213-367-1138

Fire Department
Applicable Services: Approval from the Fire Department will be required before construction can commence on a green roof. This contact can provide guidance on what measures to take in the design of a green roof in order to meet the requirements of the Fire Department.
CONTACT: John Vidovich
Fire Department
Building Standards Unit
213-482-6907

GREEN ROOF ORGANIZATIONS

The following organizations are responsible for a good deal of the green roof research and promotional activities. They offer information on past projects, on the procedure for implementing a green roof and links to green roof contractors.

EcoRoofs Everywhere
http://www.ecoroofseverywhere.org
This organization provides information (photos, specifications, cost, etc...) on Portland area green roofs projects and is actively involved in community green roof construction projects.

U.S. Green Building Council
www.usgbc.org
The U.S. Green Building Council administers the LEED program and offers some technical guidance on green building.

Green Roofs for Healthy Cities
www.greenroofs.org
Stephen Peck
Executive Director
416.971.4494
speck@cardinalgroup.ca
This network of public and private organizations works to promote the spread of green roofs through research, education and lobbying.

Greening Gotham
www.greeninggotham.org
New York City's online green roof resource, created with support from the United States Environmental Protection Agency. Focuses on raising public awareness and support for green roof development.

GreenRoofs.com
www.greenroofs.com
This website offers descriptions of many current green roof projects, links to green roof research and a directory of green roof contractors.

Northwest Ecobuilding Guild
http://www.ecobuilding.org/proj/ecoroof/index.html
Information on green roof projects in the Northwest and links to green roof suppliers.

RESEARCH GROUPS

Pennsylvania State University – Center for Green Roof Research
http://hortweb.cas.psu.edu/research/greenroofcenter/index.html

Michigan State University – Vegetative Greenroof Research Program
http://www.hrt.msu.edu/greenroof/index.htm

Lawrence Berkeley National Laboratory – Heat Island Group
http://eetd.lbl.gov/HeatIsland/CoolRoofs/

Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V.
Research Association for Landscape Development and Landscape Construction
http://www.f-l-l.de/
(in German)

British Columbia Institute of Technology – Green Roof Research Facility
http://www.greenroof.bcit.ca/

Karen Liu
National Research Council
Institute for Research in Construction
1200 Montreal Road, Building M20
Ottawa, ON K1A 0R6

CITY/STATE GOVERNMENT GREEN ROOF PROGRAMS

Some of the most useful guidance on implementing green roofs in the City of Los Angeles may come from the other cities that have recently initiated green roof programs. Summaries of the green roof programs in Portland, Chicago, Minneapolis - St. Paul and the State of Pennsylvania are provided below.

Portland, OR

Currently the city of Portland, OR, is leading the way in the U.S. with aggressive sustainable design measures which include promoting green roofs. In July, 2002, the City of Portland Office of Sustainable Development (OSD) introduced "Portland LEED," the first U.S. Green Building Council approved local supplement to the USGBC Leadership in Energy and Environmental Design rating system.

Two measures are in place in Portland to make green eco-roof construction easier on the wallet, and a third is being worked on. First, "All building projects in the city that will result in at least 500 square feet (46 square meters) of impervious surface are required to implement stormwater pollution reduction and flow control measures, and green roofs are one of the acceptable measures," (EBN, 2001).

Second, builders can now increase their floor area ratio (FAR) when they include a green eco-roof to cover a minimum of 60% of the roof surface. In March 2001 Portland created a FAR bonus, which grants an additional three square feet of floor area per square foot of green eco-roof to be added to the footprint of the building.

A further measure plans for Portland to reduce stormwater utility fees for buildings with green roofs by July 2006. The City's "Clean River Incentive and Discount Program" is aimed at green roofs atop commercial, industrial, institutional, multi-family and single family residential properties. They had hoped for the program to be in place by now, but logistics regarding the current utility billing system need to be worked out. Replacement of the system has delayed implementation of the new discount program (Mann, 2003).

CONTACT: http://www.cleanrivers-pdx.org/clean_rivers/ecoroof.htm
Tom Liptan
Bureau of Environmental Services
503-823-7267
toml@bes.ci.portland.or.us

Chicago, Illinois

The Chicago Energy Conservation Ordinance went into effect on June 3, 2002 and includes a chapter from Chicago's Urban Heat Island Reduction Initiative which states minimum ASTM standards of solar reflectance and emissivity. The ordinance requires all new and refurbished roofs to install green roofs or reflective roofing. The ordinance had originally been set for implementation for January, 2002, but the City allowed additional time for public awareness and offered workshops to developers, designers and other interested parties. The Ordinance is based on requirements from the International Energy Conservation Code (GRIM, 2002).

Density Bonuses - According to EPA Smart Growth Policy Information, "To create attractive commercial and business districts, the City of Chicago increases development square footage, known as floor area premiums, when such developments include public amenities. Public amenities include plazas, pocket parks, block connections, green roofs, transit improvements, and wider sidewalks among others" (EPA, 2004b). The Chicago Department of Zoning states, "A floor area premium shall be granted for a roof that is covered with plants that reduce the 'urban heat island' effect and storm-water runoff of buildings in the central business district. To qualify for a floor area premium, a minimum of 50 % of the roof area at the level of the green eco-roof or a minimum of 2000 square feet (whichever is greater) shall be covered by vegetation and shall meet..." certain standards.

CONTACT: Kevin M. Laberge
City of Chicago
Department of Environment
30 N. LaSalle St. 25th Floor
Chicago, Illinois 60602
Tel: (312) 742-0463

Minneapolis-St. Paul, Minnesota

The Metropolitan Council Environmental Services has issued the "Minnesota Urban Small Sites BMP Manual" and it includes a chapter on green roofs. The Metropolitan Council is the regional planning agency for the seven county Minneapolis-St. Paul metro area who also operate the wastewater, transit, airport and regional parks systems. The BMP manual is intended for the nonpoint source technical assistance program, and will be used by the 180 or so communities in the region. The chapter was prepared by Barr Engineering Company as one of 40 BMPs that the metro area is focusing on.

CONTACT: http://www.metrocouncil.org/environment/Watershed/BMP/
Karen Jensen
Karen.Jensen@metc.state.mn.us
(651) 602-1401

Pennsylvania

According to the autumn 2000 edition of the Green Eco-roof Infrastructure Monitor (GRIM, 2000), the Pennsylvania Association of Conservation Districts identified green eco-roof infrastructure as a stormwater best management practice in their "Pennsylvania Handbook of Best Management Practices for Developing Areas." For more information, see Charlie Miller's "Vegetated Roof Covers: A New Method for Controlling Runoff in Urbanized Areas." publication in the "Proceedings of the 1998 Pennsylvania Stormwater Management Symposium" (October 21-23, 1998): 1-10.

CONTACT: http://www.pacd.org/products/bmp/bmp_toc.htm
PACD
25 North Front Street
Harrisburg, PA 17101
Phone: 717-238-PACD (7223)

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OTHER USEFUL CONTACTS

EPA Office of Water, Nonpoint Source Control Branch
http://www.epa.gov/owow/nps/
Robert Goo
202-566-1201
Knowledge of programs and policies used to support green roofs at the federal level.

EPA, Region 9, Pollution Prevention
http://www.epa.gov/region09/cross_pr/p2/
John Katz
Pollution Prevention Coordinator
415-947-3530

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Appendix A

Landscape Watering Needs Worksheet

Worksheet for Estimating Landscape Water Needs
adapted from UCCE, 2000

Step 1: Calculate the Landscape Coefficient (K_L)
K_L = Ks x Kd x Kmc

Ks = 0.2 Species Factor for Sedums; from Water Use Classification of Landscape Species (WUCLS in UCCE, 2000)
Kd = 1 Species density for full planting predominately of one species type; UCCE, 2000
Kmc = 1.4 Highest microclimate factor used to account for extreme rooftop conditions; UCCE, 2000
K_L = 0.28

Step 2: Calculate Landscape Evapotranspiration (ETL)
$ET_L = K_L$ X ETo
Los Angeles Daily ETo by Month; UCCE, 2000 Appendix A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
ETo =	0.06	0.08	0.11	0.16	0.18	0.21	0.21	0.2	0.16	0.12	0.08	0.06	inches
ET_L =	0.017	0.022	0.031	0.045	0.050	0.059	0.059	0.056	0.045	0.034	0.022	0.0168	inches
days	31	29	31	30	31	30	31	31	30	31	30	31	
Monthly ET_L	0.521	0.650	0.955	1.344	1.562	1.764	1.823	1.736	1.344	1.042	0.672	0.5208	inches

Step 3: Calculate Net ET_L
Net ET_L = ET_L - P*(PE/100)
P = Precipitation
PE = 50 Estimate of percentage of precipitation that is actually used by plants

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
P =	3.28	3.9	2.72	0.98	0.33	0.07	0.01	0.16	0.26	0.39	1.1	2.06	inches at LA
Net ET_L =	0.000	0.000	0.000	0.854	1.397	1.729	1.818	1.656	1.214	0.847	0.122	0.000	

Step 4: Calculate the Total Water to Apply (TWA)
TWA = ET_L / IE
IE = 90% Estimated Irrigation Efficiency for a drip irrigation system

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly TWA =	0.000	0.000	0.000	0.949	1.553	1.921	2.020	1.840	1.349	0.941	0.136	0.000	inches

Annual TWA = 10.71 inches

Annual Volume = 1542 cubic inches of water per square foot
Cost of Water = $2.20 per HCF; LA DWP, 2004
Annual Cost = $0.020 per square foot of green roof

(7)

04-0074 Motion (Reyes- Perry) that the City Council request the Environmental Affairs Department, as lead, to form a Task Force with the assistance of the Department of General Services, Planning Department, Building and Safety, Los Angeles Fire Department, Bureau of Engineering, Department of Water and Power, City Administrative Office, City Attorney, and any other appropriate department, which implements a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism, and which uses among other cities mentioned in the text of this Motion, the City of Tokyo's roof garden ordinances as a model as detailed in the attachment; and that the abovementioned Task Force prepare and present a report of its findings for consideration by the Planning and Land Use Management (P&LUM) and Environmental Quality and Waste Management Committees within 45 days.

Fiscal Impact Statement Submitted: No

DISPOSITION Status rept only

(8)

03-2003 Motion (Perry-Reyes) that the Planning Department, with the assistance of the City Attorney, prepare and present a report with recommendations which further regulate adult entertainment uses by preventing their location within 500 feet of any "residential frontage," and not simply residential zones as currently codified in Section 12.70 of the Los Angeles Municipal Code (LAMC); further present and discuss the requested report to the PLUM Committee for their review and consideration within 30 days.

Fiscal Impact Statement Submitted: No

DISPOSITION _____

(9)

99-1914-S2 Motion (Greuel - Reyes) that the City Attorney, Department of Building and Safety, and the Planning Department work with Los Angeles Unified School District (LAUSD) to negotiate a mutual understanding of the appropriate time to classify a specified LAUSD construction project as official school property.

Fiscal Impact Statement Submitted: No

DISPOSITION _____

COMMENTS FROM PUBLIC ON ITEMS OF PUBLIC INTEREST
WITHIN COMMITTEE'S SUBJECT MATTER JURISDICTION

IF YOU CHALLENGE THIS COMMITTEE'S ACTION(S) IN COURT, YOU MAY BE LIMITED TO RAISING ONLY THOSE ISSUES YOU OR SOMEONE ELSE RAISED AT THE PUBLIC HEARING DESCRIBED IN THIS NOTICE, OR IN WRITTEN CORRESPONDENCE DELIVERED TO THE CITY CLERK AT OR PRIOR TO, THE PUBLIC HEARING. ANY WRITTEN CORRESPONDENCE DELIVERED TO THE CITY CLERK BEFORE THE CITY COUNCIL'S FINAL ACTION ON A MATTER WILL BECOME A PART OF THE ADMINISTRATIVE RECORD.

THE TIME IN WHICH YOU MAY SEEK JUDICIAL REVIEW OF ANY FINAL ACTION BY THE CITY COUNCIL IS LIMITED BY CALIFORNIA CODE OF CIVIL PROCEDURE SECTION 1094.6 WHICH PROVIDES THAT AN ACTION PURSUANT TO CODE OF CIVIL PROCEDURE SECTION 1094.5 CHALLENGING THE COUNCIL'S ACTION MUST BE FILED NO LATER THAN THE 90TH DAY FOLLOWING THE DATE ON WHICH THE COUNCIL ACTION BECOMES FINAL.

pl0225.wpd

PLANNING AND LAND USE MGT. 7

JAN 14 2004

MOTION

The City of Tokyo, Japan among other cities (e.g. Toronto, Canada, Atlanta, Georgia, Seattle, Washington, Portland, Oregon, Chicago, Illinois, and Baton Rouge, Louisiana) has addressed global warming and enhanced its energy efficiency mechanisms in its city through the implementation of two rooftop garden ordinances as detailed in an August 13, 2002 *New York Times* article, *" 'Heat Island' Tokyo Is in Global Warming's Vanguard."*

The Tokyo Metro Government's Bureau of City Planning, which is the City of Los Angeles' Planning Department counterpart in Tokyo, indicates that the Tokyo Bureau of Environment oversees the ordinances.

The first ordinance is the *"Ordinance on the Conservation and Restoration of Nature in Tokyo,"* and it requires that:

> "Greening areas must be provided on the premises and on rooftops when new buildings are constructed in an area of 1,000 Square Meters (10,760 Square Feet) for private facilities, and in an area of 250 Square Meters (2,690 Square Feet) for public facilities."

The second ordinance is the *"Ordinance on Environmental Protection,"* and it requires that:

> "Plans must also be submitted to include rooftop greenery for new construction in projects with a total floor area of 10,000 Square Meters (107,600 Square Feet) or larger."

It would behoove the City of Los Angeles to implement a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism, and which uses among other cities mentioned in the text of this Motion, the City of Tokyo's roof garden ordinances as a model.

I THEREFORE MOVE that the Council request the Environmental Affairs Department (EAD), as lead, to form a Task Force with the assistance of the General Services Department (GSD), Planning Department, Building and Safety, Los Angeles Fire Department (LAFD), Bureau of Engineering (BOE), Department of Water and Power (DWP), City Administrative Officer (CAO), City Attorney, and any other appropriate department, which implements a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism, and which uses among other cities mentioned in the text of this Motion, the City of Tokyo's roof garden ordinances as a model as detailed in the attachment; and,

I FURTHER MOVE that the abovementioned Task Force prepare and present a report of its findings for consideration by the Planning and Land Use Management (PLUM) and Environmental Quality and Waste Management Committees within 45 days.

PRESENTED BY _____
ED P. REYES
Councilmember, 1st District

JAN 14 2004

SECONDED BY _____

January 9, 2004

FRANK T. MARTINEZ
City Clerk

KAREN E. KALFAYAN
Executive Officer

When making inquiries relative to this matter refer to File No.

CITY OF LOS ANGELES
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

Office of the
CITY CLERK
Council and Public Services
Room 395, City Hall
Los Angeles, CA 90012
Council File Information - (213) 978-1043
General Information - (213) 978-1133
Fax: (213) 978-1040

CLAUDIA M. DUNN
Chief, Council and Public Services Division
www.cityclerk.lacity.org

CF 04-0074

April 18, 2007

Karen L. Sisson
City Administrative Officer
200 North Main Street, Room 1500
Los Angeles, CA 90012

Detrich B. Allen, General Manager
Environmental Affairs Department
200 North Spring St., Ste. 1905 & 2005
Los Angeles, CA 90012

REQUEST FOR REPORT

At its meeting held April 10, 2007 (continued from February 13 and 27, 2007), the Planning and Land Use Management (PLUM) Committee considered the report from the Department of Public Works, Bureau of Engineering (BOE) relative to rooftop green spaces as an energy efficiency mechanism, in response to May 2, 2006, Council action requesting the BOE and Bureau of Sanitation, Environmental Affairs Department (EAD), Department of Building and Safety, Department of City Planning, Los Angeles Department of Water and Power, General Services Department, and City Administrative Officer (CAO) to prepare a proposal to incorporate rooftop green spaces as an energy efficient mechanism, and related matters, pursuant to Motion (Reyes - Perry). **(Also referred to Energy and Environment Committee)**

The PLUM Committee approved the recommendation, however requested that the CAO and EAD report back to the PLUM Committee in 45 days relative to: (1) the feasibility of including the building on First and Chicago Streets in Boyle Heights in the pilot green rooftop program; and (2) sources of funding.

Barbara Greaves, Legislative Assistant
Planning and Land Use
Management Committee, 213-978-1068

Attachment:

cc: Avo Davidian, Legislative Assistant, Energy and Environment Committee
Department of Public Works, Bureau of Engineering,
Attn: Gary Lee Moore, City Engineer

#040074ltr

CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

GARY LEE MOORE, P.E.
CITY ENGINEER

1149 S. BROADWAY, SUITE 700
LOS ANGELES, CA 90015-2213

http://eng.lacity.org

February 8, 2007

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is a report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings. This report was prepared following an oral report to the PLUM Committee on August 8, 2006.

Recommendations:

1. Direct the City Engineer to report back to the PLUM Committee on the progress of the projects chosen for a pilot green roof program.
   - Include the South Los Angeles Neighborhood City Hall in Council District 9 as part of the green roof pilot program (new construction).
   - Select one or more additional projects from the list of potential buildings as pilot projects. (new construction or retrofit construction).

2. Direct the Environmental Affairs Department (EAD) to apply for appropriate sources of grant funding for use in green roof design, planting, monitoring, maintenance, and other activities to support the pilot program. Direct EAD to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

3. Direct the City Administrative Officer to identify additional funding for the selected projects.

4. Direct the City Engineer to work with EAD and the Green Roofs Task Force on project elements as they move forward.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot projects. While all objectives may not be met in a single project, this list is intended to assist with the decision:

Objectives for Pilot Project:

1. Clear environmental benefits.
2. Visible although not necessarily accessible to the public.
3. Fundable, with maintenance dollars identified.
4. Technically feasible.
5. Accessible for monitoring.
6. Over an inhabited and conditioned space.
7. Achievable in the near term.
8. Possibly identify two similar projects for comparison, such as: a) one intensive[1] roof and one extensive[1] roof; b) one with a green roof and one without a green roof; c) green roof on new construction and a green roof retrofit to an existing building in order to compare the performance.
9. Possibly identify a green roof to replace lost ground level green space.

---

[1] 1. ***"Intensive* roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive* green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

10. Possibly locate where storm water concerns are greatest (such as Sun Valley).

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - United States Department of Energy
    - United States Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations and non-profit organizations

Approach

- The Bureau of Engineering (BOE) spoke with each of the Council offices in whose district the proposed projects are located, and with the operating departments for the potential building sites.

- BOE met with American Institute of Architects Los Angeles Committee on Environment (COTE) and discussed options for green roofs for City projects. COTE is very supportive of green roof projects and made a number of useful suggestions. COTE expressed support in particular for the South Los Angeles Neighborhood City Hall that is in design, and support for the Reptile and Insect Center at the Zoo as pilot projects.

- BOE arranged a tour of the green roof on the Los Angeles Unified Theodore Alexander Jr. Science Center School in Exposition Park. In attendance were representatives from the Mayor's office, General Services Department, and BOE. The tour was very informative on maintenance issues, as well as on the selection of plants. First year maintenance is crucial for plant establishment, perhaps requiring hand watering during hot summer months. After the first year, as the roof surface may not be readily visible, it is important to monitor the functioning of the irrigation system on a regular basis.

- BOE arranged for a visit by Sarnafil (green roof vendor for the Chicago City Hall green roof) to investigate the possibility of placing a green roof atop City Hall's low rise wings.

Options for City Projects

BOE solicited project nominations from:

- Building Programs Managed by BOE:
  - Proposition F: Fire Stations and Animal Care Facilities.
  - Proposition Q: Police Facilities.
  - Los Angeles Zoo.
  - Recreation and Cultural Facilities: Recreation and Parks Facilities.
  - Municipal Facilities Program: Facilities for Various Departments
- Port of Los Angeles.
- Los Angeles Department of Water and Power (LADWP).
- Los Angeles Department of Recreation and Parks.

List of Potential Projects – New Construction:

South Los Angeles Neighborhood City Hall

Location: 4301 S. Central Avenue – CD9
Description: 7,400 sq.ft. field office with green roof, 1,900 sq. ft. training room with metal roof
Construction Budget: $7.3M
Completion: January 2009
Consultant: Paul Murdoch Architects
Status: 98% Design Completed
Project Manager: BOE
Client: Council District 9

Comments: This is already being designed with an intensive green roof that will be accessible to the public. BOE has sought and received a proposal for monitoring the performance of the green roof for this project (approximately $100,000), although funds for monitoring have not yet been identified. As available, additional funding could be applied to monitoring the performance of the green roof. EAD is pursuing funding interest from a nonprofit organization. Monitoring tasks could include measuring temperatures on the roof and the underside of the roof deck; affects of soil moisture on temperature; ambient air temperature; and other factors deemed relevant.

Reptile and Insect Interpretive Center - the HISS Center

Location: 5333 Zoo Drive – CD4
Description: Approximately 9,000 sq. ft.
Construction Budget: $7.8M
Completion: September 2009

Consultant: Portico Group
Status: 15% Design Completed
Project Manager: BOE
Client: Zoo Department

Comments: The Reptile & Insect Interpretive Center is a new exhibit that will replace the Los Angeles Zoo and Botanical Garden's current Reptile House. This exhibit will accommodate the current reptile, amphibian, and invertebrate collections. The approximately 30,000 square foot site for the proposed display of both indoor and outdoor animal exhibits is located within the Aquatic Region of the Zoo.

The Mayor's office has expressed interest in placing a green roof on this project. COTE considered this a very strong candidate for a green roof. A green roof could be an additional element of the botanical collection at the Zoo, and add to the display of the significant link between plants, animals, and people – an ecosystem approach. The green roof would be designed to minimize any potential negative impacts on the animals that will be on display. Also, this roof would be visible to visitors of the Zoo from an elevated public walkway and the Tree Top Terrace where special Zoo events are held. Additional funding will need to be identified for the green roof.

Mar Vista Garden Center and Child Care Center
Location: CD-11
Description: 4000 sq. ft. Childcare center for low-income housing
Construction Budget: $2.0 M
Completion: December 2009
Consultant: Not yet identified.
Status: On hold awaiting site acquisition.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is strongly in favor of a green roof for this project. The base project, however, is under funded. Funding for the green roof could be pursued via a grant.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sq. ft. Maintenance & Admin (5,000 sq. ft. green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 70% Construction Documents

Client: Port of Los Angeles

Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD-4
Description: Fire Station
Construction Budget: $8.7M
Completion: Approximately December 2009, depending on site acquisition
Consultant: From the Proposition F Approved List
Status: On hold awaiting site acquisition
Project Manager: BOE
Client: Fire Department

Comments: The project site is not yet identified. If it is decided that the green roof is an important sustainability component of the project, contributing to meeting the Council mandate for LEED Certified, this feature would need approval from the Proposition F Administrative Oversight Committee. With approval of the Oversight Committee and concurrence from the City Attorney's office, funds from the Proposition F Program contingency could be applied to this project for the green roof. The Council Office is supportive of the green roof for this project. The Fire Department expressed support for exploring the green roof option, if it can be done cost effectively. As the pre-design has not yet started, the incremental cost increase for a heavier structure and the green roof components can be considered early in the design process. The project will likely be multi-story, and the community room could be located to have a direct line-of-sight to the green roof. The green roof should be considered only over a conditioned space for optimum long term benefit.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq. ft. gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Completion: Not known.
Consultant: Not yet identified.
Status: On hold awaiting additional funding.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is very supportive of adding a green roof to this project. However, the base project is short funded. Also, previously prepared plans may be used for the site which would make it difficult for a green roof on this project.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq. ft. gym and support areas
Construction Budget: $13M
Completion:
Consultant: Rios and Associates
Status: 20% Design Completed
Project Manager: BOE
Client: Recreation and Parks

Comments: This project is in the middle of the Van Nuys/Sherman Oaks Park, and the Council office is in favor of a green roof for the project. The design team has suggested a portion of the building be covered with a green roof, a roof area that would be visible from the entire park. Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008, and additional funding will have to be identified for the green roof.

Ascot Park Educational Center
Location: CD14
Description: 10,000 -15,000 sq. ft. educational center
Construction Budget: $10M - $12M
Completion: Not yet established.
Consultant: Not yet identified.
Status: Programming
Project Manager: Recreation and Parks Advance Planning Group
Client: Recreation and Parks

Comments: Recreation and Parks has suggested that this project would be a good location for an earth-sheltered building, partially buried in the hillside. Ascot Park is a former LADWP property that has been opened to the public as new open space. Recreation and Parks is discussing the requirements for the Educational Center. This project may be eligible for State Bond funding.

List of Potential Projects – Existing Buildings:

City Hall
Location: 200 N. Main Street
Construction Budget: $1M
Completion: Approximately 2 years from initiation.
Consultant: NA
Status: NA

Project Manager: NA
Client: General Services Department

Comments: This would be a high profile retrofit opportunity to install a green roof on the low-rise wings of City Hall, as was done with the existing Chicago City Hall. Approximately 24,000 sq. ft. of roof area is available for a green roof.

The installation of a green roof would require an investigation of the capacity of the roof to carry the additional weight. It would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal registry of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

A Sarnafil representative visited the building with BOE, and has prepared a report detailing the requirements of placing an extensive green roof on the low-rise wings of the City Hall. The proposed extensive green roof would be placed over the existing roof which is approximately 3 years old. Excluding the areas allocated to the mechanical systems, there is approximately 24,000 sq. ft. available for the green roof. The cost of installation would be approximately $1,000,000. If structural upgrades are required, BOE would not recommend proceeding. Based on the investigation to date, pending the structural review, a green roof for City Hall is feasible.

Environmental Learning Center - West
Location: Hyperion Treatment Plant, 12000 Vista Del Mar - CD11
Description: 20,300 sq.ft., 2-story Learning Center with green roof
Construction Budget: $8.5M
Completion: July 2009 (Construction)
Consultant: Camp, Dresser & McKee, Inc. (CDM)
Status: 10% Design Completed
Project Manager: BOE
Client: Bureau of Sanitation

Comments: This project will renovate an existing, unoccupied Administration Building into the Environmental Learning Center - West (ELC-W). The ELC is being developed to address the need for increased public education about how urban activities affect the evironment. The building will be an example of environmentally sensitive engineering through the use of solar photovoltaic panels, skylights, and a green roof. This project is being designed with an extensive green roof.

Other Project Possibilities

- The Los Angeles Unified School District (LAUSD) is preparing working drawings for a new high school in Taylor Yard, High School #13, and is pursuing the addition of an ancillary environmental learning center which could have a green roof. Council District 1 is interested in assisting LAUSD in identifying funds for this green roof.
- Other existing City buildings.
- LADWP Projects: LADWP has initiated an effort to pilot a LEED building, and might consider a green roof.
- California Redevelopment Agency/Los Angeles (CRA/LA): The CRA/LA has demonstrated a commitment to sustainable design and to LEED on various projects.
- Airport projects.
- City funded affordable housing projects.
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit).

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Extensive Roof

	New Bldg *	Existing Bldg *
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$40 per sq ft	$35-$45 per sq ft
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

* The information is based on bids received for a Department of Recreation & Parks building in the new Taylor Yard park.

Intensive Roof

	New Bldg	Existing Bldg **
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$35-$45 per sq ft	$45-60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

** It is rare an existing building could support an intensive green roof.

The prices for a green roof installation will likely drop as demand increases and more installers exist.

In terms of maintenance, a green roof installation would either need guardrails for or another approved fall protection system to protect employees who would be performing maintenance. Safe access would also have to be provided to the green roof areas. Also, employees will need to be training on proper maintenance procedures.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the

specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor in the project.

- Protection of the roof membrane results in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in savings in replacement costs.

- Lower ambient air temperatures directly reduces the urban heat island effect and slows the formation of ozone pollution.

- A green roof could result in savings on energy heating and cooling costs, depending on the ratio of height to width of the building, the climate, and the type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one story building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.

- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.

- Cost savings from increased stormwater retention and filtration and decreased need to expand or rebuild related infrastructure.

- Less impervious surface, as calculated for Standard Urban Stormwater Management development permits by the Bureau of Sanitation, which reduces stormwater needing to be mitigated.

- Contributes to meeting greenhouse gas emissions reductions and to climate change concerns by reducing building energy needs.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs (EAD) and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance, and data collection and analysis, and report back to the PLUM Committee.

To date, EAD has contacted organizations and groups it deals with on a regular basis. While there is increasing interest in green roof projects, specific funding opportunities targeting green roofs are limited. EAD has expanded its search to include green building, stormwater reduction, and other related funding programs

that might consider funding a green roof project. EAD staff also coordinates with groups involved with urban heat island issues and green roofs, and is active in sharing funding ideas with staff at other cities. We are also utilizing eCivis to locate grants for the development of green roofs through water mitigation, improvement of energy efficiency, public education, CEQA mitigation measures, and replacement of open space.

Once pilot projects are identified by City Council, there may be a short turnaround time to apply for funds once an appropriate opportunity is identified. Thus, EAD requests the authority to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

E. Green Roof Activities in Other Cities

Chicago, Illinois

As of October 2006, there are more than 250 public and private green roofs totaling more than 1 million square feet that are under design or construction in Chicago. These include private, not-for-profit, and public developments receiving financial or other types of public assistance from the City, as well as Planned Developments and Lakefront Protection Ordinance Developments.

The Chicago City Hall began as a demonstration project - part of the City's Urban Heat Island Initiative - to test the benefits of green roofs and how they affect temperature and air quality. The garden consists of 20,000 plants of more than 100 species, including shrubs, vines and two trees. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

Like all green roofs, the Chicago City Hall rooftop garden is intended to improve air quality, conserve energy, reduce stormwater runoff, and help lessen the urban heat island effect.

The rooftop garden mitigates the urban heat island effect by replacing what was a black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75% of a 1 inch rainfall before there is stormwater runoff.

Chicago has recently begun the "Green Roof Grants Program" for residential and small commercial building owners. Applicants can qualify for $5,000 for a Green Roof Project. This new grant program will enable home owners and small businesses to install green roofs.

Milwaukee, Wisconsin

The Milwaukee Metropolitan Sewage District (MMSD) is investing in green infrastructure projects to reduce combined sewage/stormwater overflow discharges and mitigate stormwater runoff. One approach is the installation of green roofs. Seven green roofs have been installed throughout the region, including atop a housing project for senior citizens and a facility for people with disabilities. The green roof at the housing project is 20,000 square feet and is expected to retain 85% of a 2-inch rainfall. Rain gardens and retention basins used for on-site irrigation receive the remaining 15%.

MMSD has financially assisted four other green roofs for the purpose of stormwater reduction. The four roofs are as follows:

- The roof of MMSD's headquarters (3,500 sq. ft. structure).
- The University of Wisconsin-Milwaukee's Great Lakes Water Institute (10,000 square foot structure).
- The Urban Ecology Center.
- The Milwaukee County Zoo.

Toronto, Canada

Toronto has initiated a Green Roof Incentive Pilot Program. Sixteen successful applicants were approved as part of the pilot program. The goal of this program is to encourage green roof construction in the City. In 2006, the Toronto City Council approved the Green Roof Pilot Program, allocating $200,000 from Toronto Water's budget to encourage green roof construction. Eligibility for this program was opened to any private property owner in the City of Toronto, regardless of building size and type, as long as the building is capable of supporting a green roof that meets the specifications and requirements, and has a water account with the City. Additionally, it is hoped that the program will:

- Result in the construction of a variety of green roof types which could be used for education and promotional purposes.
- Provide an opportunity to showcase various green roof technologies and planting styles.
- Provide a grant of $10 per square meter of eligible green roof area up to a maximum of $20,000.

Other Locations

Located in Pacific Palisades, the Getty Villa has an extensive green roof on the top of a parking garage.

Located in Pasadena, the Art Center has an extensive green roof on their South Campus building.

Thank you to the Environmental Affairs Department for their assistance with this report. If you have any questions, please contact Deborah Weintraub, Deputy City Engineer, at (213) 485-5499.

Sincerely,

Gary Lee Moore

Gary Lee Moore, P.E.
City Engineer

DJW:tlw

CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

GARY LEE MOORE, P.E.
CITY ENGINEER

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http://eng.lacity.org

August 3, 2006

The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is an interim report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings.

Recommendation:

Direct the City Engineer to analyze the viability of the installation of a green roof on the two low rise wings of City Hall, and report back to the PLUM Committee within 90 days on the scope, design and construction costs, maintenance costs, and schedule.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot project:

Objectives for Pilot Project:

1. Clear environmental benefits
2. Visible to the public
3. Fundable, with maintenance dollars identified

4. Technically feasible

5. Accessible for monitoring

6. Over an inhabited and conditioned space

7. Achievable in the near term

8. Possibly identify two similar projects for comparison, one intensive[1] roof and one extensive[1] roof, or one with a green roof and one without green roof, in order to compare the performance

9. Possibly identify a green roof to replace lost ground level green space

10. Possibly locate where storm water concerns are greatest (such as Sun Valley)

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - Federal Department of Energy
    - Federal Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations such as the California Endowment, the Hewlett Fund, the Graham Foundation

[1] 1. ***"Intensive* roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive* green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

Options for City Projects

- Bureau of Engineering solicited project nominations from:
  - Proposition F: Fire stations and Animal Care Facilities
  - Port of Los Angeles
  - Proposition Q: Police Facilities
  - Other Municipal Facilities Projects
  - Los Angeles Department of Water and Power
  - Los Angeles Zoo

- List of Nominated Projects – New Construction:

Council District 9 - Neighborhood City Hall
Location: 4301 S. Central Avenue – CD9
Description: 7,400 sf field offices with green roof, 1,900 sf training room
Construction Budget: $7.3M
Consultant: Paul Murdoch Architects
Status: 90% Construction Documents
Client: Council District 9
Comments: This is already being designed with an intensive green roof that will be accessible to the public. Additional funding could be applied to monitoring the performance of the green roof.

Reptile and Insect Center
Location: 5333 Zoo Drive – CD4
Description: 9,000 sf
Construction Budget: $7.8M
Completion: September 2009
Consultant: Portico Group
Status: Pre-design
Client: Zoo Department
Comments: Additional funding will need to be identified for the green roof. This roof will be visible to the public from an elevated public walkway that will rise 30' to a treetop terrace.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sf. Maintenance & Admin (5,000 sf green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 40% Construction Documents
Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD 13
Description: Fire Station
Construction Budget: $8.7M
Status: On hold awaiting site acquisition
Completion: Approximately December 2009
Comments: Project timeline not yet established. Additional funding will have to be identified for the green roof.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq ft gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Status: On hold awaiting additional funding
Comments: Council office is very supportive of adding the green roof to this project. Base project is short funded.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq ft gym and support areas
Construction Budget: $13M
Status: Design
Comments: Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008.

Fred Roberts Gymnasium
Location: 4600 S. Honduras – CD 9
Description: 11,000 sq ft gym & support areas (7,000 sq ft green roof)
Construction Budget: $4.5M
Status: Schematic design
Comments: Base project is short funded.

- Other Project Suggestions – Existing Buildings:

City Hall
Description: A high profile, retrofit opportunity would be to install a green roof on the low rise wings of City Hall, as was done with the Chicago City Hall.

Comments: This would require an investigation of the capacity of the roof to carry the additional weight. This would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal register of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

Other Project Possibilities

- Other existing City buildings such as existing neighborhood City Halls
- Airport projects
- City funded affordable housing projects
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit)

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Intensive Roof

	New Bldg	Existing Bldg (It is rare an existing building could support an intensive green roof.)
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$45 per sq ft	$40-$60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

Extensive roof

	New Bldg	Existing Bldg
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$20 per sq ft and up	$25 per sq ft and up
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

As a basis for comparison, the Bureau of Engineering has also contacted the designers for the new Los Angeles Unified School in Exposition Park, the Theodore Alexander Junior Science Center, which is a new building with an intensive green roof. This information is not yet available.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor for that project.

- Protection of roof membrane resulting in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in decreased maintenance and savings in replacement costs.
- Savings on energy heating and cooling costs, depending on the size of the building, climate and type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one storey building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.
- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.
- Cost savings from increased stormwater retention and decreased need to expand or rebuild related infrastructure.
- Decreased cost of meeting greenhouse gas reductions and adapting to climate change by reducing the "Urban Heat Island Effect" and the need for interior building insulation.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance and data collection and analysis, and report back to the PLUM Committee.

Sincerely,

Deborah J. Weintraub, AIA
Deputy City Engineer

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cc: Sarai Bhaga, Sr. Administrative Analysis II
City Administrative Officer

Gretchen Hardison, Environmental Affairs Officer
Environmental Affairs Department

Lambert Giessinger, Architect Associate II
Department of Planning

Gary Lee Moore, P.E.
City Engineer

Mahmood Karimzadeh, Program Manager
Architectural Division

Discuss N Only #3
5/8/06

CITY OF LOS ANGELES
CALIFORNIA

FRANK T. MARTINEZ
City Clerk

KAREN E. KALFAYAN
Executive Officer

When making inquiries relative to this matter refer to File No.

ANTONIO R. VILLARAIGOSA
MAYOR

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CLAUDIA M. DUNN
Chief, Council and Public Services Division

04-0074

May 3, 2006

Councilmember Reyes
City Attorney
Planning Department,
Director of Planning
Department of Building & Safety,
General Manager
Environmental Affairs Department

Councilmember Perry
City Administrative Officer
Bureau of Engineering
Department of Water and Power
Fire Department
Bureau of Sanitation
Department of General Services

RE: INCORPORATING ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM

At the meeting of the Council held May 2, 2006, the following action was taken:

Attached report adopted..... X
Attached motion ( ) adopted.....
Attached resolution adopted.....
FORTHWITH.....
Ordinance adopted.....
Motion adopted to approve communication recommendation(s).....

Frank T. Martinez

City Clerk
jr

B

5-2

TO THE COUNCIL OF THE
CITY OF LOS ANGELES

FILE NO. 04-0074

Your PLANNING AND LAND USE MANAGEMENT Committee

reports as follows:

	Yes	No
Public Comments	XX	—

PLANNING AND LAND USE MANAGEMENT COMMITTEE REPORT relative to incorporating rooftop green spaces as an energy efficiency mechanism.

Recommendations for Council action, initiated by Motion (Reyes - Perry):

1. DIRECT the Bureau of Engineering (BOE), in conjunction with the Environmental Affairs Department (EAD), Los Angeles Department of Building and Safety (LADBS), Department of City Planning (DCP), Los Angeles Department of Water and Power (LADWP), Bureau of Sanitation (BOS), General Services Department (GSD), City Administrative Officer and other appropriate departments, to prepare a proposal for a pilot program to demonstrate Green Roof technology on City buildings. Departments shall report back to City Council in 90 days for approval of the pilot program with the following information:

   a. One or more options for new City projects that could incorporate a green roof that is designed for environmental benefits rather than public access.
   b. An estimate of related additional costs of design, construction, and operation and maintenance of the green roof.
   c. A set of procedures to collect and record specific data from the pilot program, including but not limited to actual energy costs/savings, storm water retention data, and related factors.
   d. A plan to identify potential opportunities to fund the pilot project and the data collection efforts.

   Based on the 90-day report by BOE, and upon City Council approval, a lead department will be designated to conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

2. APPROVE the Green Roofs Resource Guide "Green Roofs - Cooling Los Angeles" developed by the EAD and authorize City Departments to use and distribute the Guide as administrative guidance and background information to further the goals of the Green Roofs Program.

3. DIRECT EAD, in coordination with BOE, LADBS, DCP, LADWP, BOS, and GSD to address the need for education and outreach on Green Roofs, for both City staff and members of the public, to encourage the development of green roof projects in the City of Los Angeles.

Fiscal Impact Statement: The EAD reported that there is no anticipated impact on the General Fund.

Summary:

At its meeting held on April 18, 2006, the Planning and Land Use Management (PLUM) Committee considered the Motion (Reyes - Perry) that the City Council request the Environmental Affairs Department (EAD), as lead, to form a Task Force with the assistance of the Department of General Services, Planning Department, Building and Safety, Los Angeles Fire Department, Bureau of Engineering, Department of Water and Power, City Administrative Office, City Attorney, and any other appropriate department, which implements a process, program, or procedure that will require City facilities to incorporate rooftop green spaces as an energy efficiency mechanism, and which uses among other cities mentioned in the text of this Motion, the City of Tokyo's roof garden ordinances as a model as detailed in the attachment; and that the abovementioned Task Force prepare and present a report of its findings for consideration by the Planning and Land Use Management (PLUM) and Environmental Quality and Waste

Management Committees within 45 days. The Committee also considered the report submitted by the EAD dated April 18, 2006.

The EAD report dated April 18, 2006, notes that several cities in the United States and worldwide have begun their own programs to promote the use of green roofs for heat island mitigation, stormwater retention, open space and other environmental benefits. Examples include the following:

- Tokyo, Japan uses green roofs to mitigate the heat island effect. Its large population and growing industry produce heat that has been difficult to offset. Tokyo's ordinance requires new buildings with over 1,000 square meters (1,196 sq. yd.) of roof area to cover at least 20 percent of the surface with greenery. New publicly funded buildings with roofs as small as 250 square meters (299 sq. yds.) are also required to add greenery. The plan's goal is to add 2,965 acres of new plant life to the city. The government offers subsidies for greening projects.

- Portland, Oregon uses eco-roofs (green roofs) to reduce stormwater runoff, counter urban heat island effects and improve air quality and energy efficiency. A Green Investment Fund was created to provide resources for green building practices. Portland also provided a zoning bonus allowing for additional building square footage, depending on the percentage of the building's roof that was dedicated for a green roof.

- Chicago, Illinois uses green roofs to reduce urban runoff and has created municipal demonstration projects to develop professional expertise. Chicago's green roof program started with a 20,300 square foot demonstration roof on Chicago City Hall. This project
retained over 75% of the volume from a one-inch storm, thus preventing runoff from entering the sewer system.

- Milwaukee, Wisconsin installed seven green roofs, including one on the Highland Gardens senior housing project. This 20,000 square foot green roof was installed for $380,000 and is designed to retain 85% of a 2-inch rainfall.

- Vancouver, British Columbia, Canada installed over 30 green roofs in the area. The Central Branch of the Vancouver Public Library has a 20,000 square foot green roof and showed a 49% reduction in the volume of stormwater runoff when compared to a conventional roof.

Examples of private buildings include:

- San Bruno, California: A green roof was incorporated on the GAP headquarters building with a layer of grass and plants on a six-inch layer of soil. This layer of greenery acts as insulation and also absorbs rain and air pollution.

- Newport Beach, California: Designers incorporated a green roof on the Peter & Mary Muth Interpretive Center in Upper Newport Bay for a CEQA mitigation (visual impacts).

- Irvine, California: Architects designed a green roof for the new Ford Motor Land Service Corporation in Irvine. The installation is designed to provide a stable growing environment for the plant community; maximize the efficient use of water resources; and accommodate and control runoff from rainfall.

According to EAD, current City policy (Council File No. 02-0182) requires all City department construction building projects 7,500 square feet or larger in size to achieve the "Certified" level of the Leadership in Energy and Environmental Design (LEED) System. A Green roof is an accepted measure under LEED standards and can garner from one to fourteen points toward LEED certification.

In summary, EAD concluded that, the Task Force did not find any City ordinances that would impede the construction of a green roof. However, the Task Force feels that a mandatory program requiring new City buildings to include green roofs would be premature at this time, due to the current lack of experience, uncertainty of costs related to design and construction, potential lack of funding available and competing strategies for LEED points and rooftop space. The Task Force recommends that a voluntary approach would be more appropriate, with a City operated pilot program and education program to begin. Upon City Council approval, designated departments would conduct the Green Roof Pilot Program and report back to City Council at six-month intervals on the progress of the program with status information and appropriate recommendations.

The pilot program would allow for a better understanding of the associated costs, give City staff direct experience with green roof design and construction, and allow for data collection to verify the benefits and future cost savings. The Task Force identified two tools for education: the Green Roofs Resource Guide, and an overview brochure (to be written) that would describe the process for developing such a roof in the City of Los Angeles. To effectively distribute these educational tools, the Task Force felt these publications should be available at all City departments that would be involved in permitting green roofs. In addition, the named departments will coordinate to address the need for training and education of City staff on the topic of green roofs.

The PLUM Committee approved the recommendations contained in the April 18, 2006, EAD report.

The matter is hereby submitted to Council for consideration.

Respectfully submitted,

PLANNING AND LAND USE MANAGEMENT COMMITTEE

MEMBER	VOTE
REYES:	ABSENT
HUIZAR:	YES
WEISS:	YES

BG:ys
4-25-06
#040074

Rept
ADOPTED
MAY 02 2006
LOS ANGELES CITY COUNCIL