"Green Roofs represent an elegant opportunity to simultaneously mitigate environmental problems and create immediate life-enhancing value."

Leslie Hoffman
Executive Director, Earth Pledge

GREEN ROOF ADVISORY GROUP

Report to Austin City Council
October 28, 2010

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Cover photo courtesy of Ed Jarger, American Hydrotech

ACKNOWLEDGEMENTS

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GRAG would like to acknowledge and thank Council Member Chris Riley and Policy Aide Marisa Ballas for their support of the group's efforts.

Executive Summary

CHARGE AND PROCESS

On August 27, 2009, Austin City Council charged the Green Roof Advisory Group (GRAG) to work with City staff to explore the feasibility of offering energy and stormwater credits and other incentives, based on performance, to encourage the creation of green roofs in the City. GRAG produced a policy document that included recommendations regarding those credits and incentives that would be appropriate for promoting green roofs in Austin. The stakeholder group was drawn from the fields of design, development, and green building and includes input from local green roof organizations and the Lady Bird Johnson Wildflower Center.

In order to accomplish these goals, GRAG established monthly meetings to occur from August 2009 to October 2010, formed separate committees to focus on specific green roof topics, and assisted staff in formulating a framework for interdepartmental review. We worked extensively with staff from the Watershed Protection Department; Austin Energy Green Building; and the Austin Climate Protection Program. The staff engaged other departments such as Planning and Development Review, Parks and Recreation Department, Public Works, and the Austin Water Utility. Through joint, collaborative efforts of staff and the stakeholder group, GRAG was able to assess the value green roofs within City of Austin policy, initiate discussions on best practices for green roofs in Austin, and develop a Five-Year Policy Implementation Plan.

ADVISORY GROUP EFFORTS

GRAG stakeholders and staff have engaged in and accomplished the following:

- Developed consensus on the public and private benefits of green roofs as a component of green infrastructure, including improved air quality, stormwater abatement, urban heat island mitigation, open space, wildlife habitat, and others.
- Completed a review of green roof incentive and credit policies of other cities in North America.
- Established a database of green roofs in Austin.
- Documented existing City of Austin policies and incentives which encourage green roofs.
- Analyzed potential policies that could be developed to encourage green roofs.
- Developed proposals to integrate green roofs into departmental program efforts.

- Advocated for green roofs as a Public Benefit Option during the public hearings on the Downtown Density Bonus Plan.
- Supported the inclusion of green roof policy and benefit education on a City of Austin website.
- Developed a proposal for green roof monitoring research.
- Advocated for an increase in Austin Energy green roof rebates.
- Developed Five-Year Policy Implementation Plan.
- Initiated a framework for green roof design considerations.
- Organized a public seminar by a green roof industry leader on green roof water retention modeling.
- Provided an outreach seminar to present GRAG's efforts and solicit public feedback.
- Integrated principles from *Water Conservation 2020: Strategic Recommendations* into green roof recommendations.
- Developed and presented the interim and final reports to selected Boards and Commissions and the City Council.

KEY FINDINGS AND CONCLUSIONS

Status of Green Roof Policy Development

Since the Green Roof Advisory Group was the first combined stakeholder and staff body sponsored by the Council to review the status of green roof policy in the City and to bring together various diverse green roof initiatives, there is no surprise that there is not a unified green roof policy across City departments. Many of our key findings and recommendations have sought to bridge this gap.

In 2007, Austin Energy coordinated a departmental and staff perspective white paper called *Growing Austin's Living Roofs*. The white paper was written in conjunction with Watershed Protection, Water Conservation and the Planning and Development Review departments.[1] It examined the many challenges and benefits of green roofs in Austin from the perspective of staff's area of expertise. Prior to GRAG, there was no documentation of other cities' policies and programs, no overall Austin policy in support of green roofs, and no database of successfully implemented green roofs in the City.

> *Benefits of green roofs include urban heat island mitigation, reduction of energy demand, improvement of air quality, creation of green space for social and recreational use, wildlife habitat, local food production, and stormwater attenuation.*

Through our joint deliberations, we have further established within GRAG that the multiple benefits of green roofs in Austin far exceed any one benefit. Multiple benefits include urban heat island mitigation, reduction of energy demand, improved of air quality, creation of green space for social and recreational use, wildlife habitat, local food production, and

[1] *Growing Austin's Living Roofs*. City of Austin Departmental and Staff Perspective White Paper, December 2008.

stormwater attenuation. We have also acknowledged that these benefits can be difficult to quantify. Different City departments may only address a specific benefit, making it a challenge to calculate the *cumulative* positive impacts of green roofs.

Review of other cities' green roof policies for incentives and credits, such as Portland, Chicago, and Toronto, have shown that those municipalities are far ahead of Austin in development of a robust framework to support green roofs. Through research, GRAG discovered that green roof policy development tends to follow a six phase time line:[2]

- Phase 1: Introduction and Awareness
- Phase 2: Community Engagement
- Phase 3: Action Plan Development and Implementation
- Phase 4: Technical Research
- Phase 5: Program and Policy Development
- Phase 6: Continuous Improvement

GRAG asserts that Austin is in Phase 3 of policy development with the establishment of the Green Roof Advisory Group. By bringing together professionals with knowledge of green roofs all over Austin, GRAG has begun to synthesize the knowledge base. As a result, staff in the Watershed Protection Department and at Austin Energy have initiated an inventory of existing green roofs, documenting their location and various attributes.

Green Roofs in Austin's Code

Review of existing City code uncovered several existing open space credits and requirements referring to open space which may be able to be accomplished by the use of green roofs. Some of these requirements refer to Planned Unit Development (PUD) requirements, multifamily residential, parkland dedication, etc. Minor effort is required to educate staff and the development community about the availability of green roofs to satisfy these requirements.

During this extensive review of code, it was determined that although green roofs are mentioned in different areas of the code, there is not one central location where a citizen can go to retrieve the information. GRAG acknowledged the need for education and advocated for a green roof web page on the City's website as a repository for all green roof information. Austin Energy's Climate Protection Program has agreed to develop the web page as a component of the existing Urban Heat Island section of the Climate Protection Program's website. This new green roof section of the website will house Austin-centric green roof information and benefits, reference specific code requirements which are satisfied by green roof infrastructure, publish monitoring data, and promote green roof construction. A complementary internal website for City Staff may also be developed.

[2] Lawlor, Gail et al. "Green Roofs: A Resource Manual for Municipal Policy Makers," Canada Mortgage and Housing Corporation, May 2006.

Research and Monitoring

The Watershed Protection Department (WPD) determined the need for monitoring research, a Phase 4 activity, to document the performance of green roofs for stormwater detention prior to giving credit for green roofs. Two efforts have been initiated to close this gap. First was the review of existing water retention modeling data specific to Austin provided by a leading green roof manufacturer. Second was the funding of monitoring research at the Lady Bird Johnson Wildflower Center. In addition, results of ongoing monitoring of an Austin green roof by WPD staff will be made available.

Design and Performance Considerations

Watershed Protection Department and Austin Energy (AE) underscored the need for development of design considerations for green roofs. GRAG has embarked upon the effort of creating baseline standards, but will require more time to flesh out and finalize the design considerations discussed in this report into tangible performance standards that can be published for use by staff and the development community.

Water Conservation and Green Roofs

During the timeframe of GRAG's efforts, the Citizens Water Conservation Implementation Task Force Report to City Council, *Water Conservation 2020: Strategic Recommendations*, was published.[3] Many of the water conservation policies presented were in alignment with policies that GRAG supports, such as use of water conserving landscape and irrigation technologies, use of non-potable water, use of greywater, and more. (See section VI, Alignment with Water Conservation 2020 Strategic Recommendations, for details.)

Green Roof Density Bonus

During the timeframe of GRAG's efforts, the draft *Downtown Density Bonus Plan* was presented to Council. Through GRAG's research into different cities' green roof policies, it was revealed that density bonus incentives are the green roof incentive most often implemented by policy makers. Similarly, the green roof density bonus option was one of the benefits most often selected by the private sector in exchange for increasing entitlements. This, coupled with the fact that the hottest area of the urban heat island and the area with the most impervious cover and stormwater runoff is the downtown core, led GRAG to recommend that green roofs be one of the individual Public Benefit Options in the Density Bonus Plan.

> *Through GRAG's research into different cities' green roof policies, it was revealed that density bonus incentives are the green roof incentive most often implemented.*

While one position is that green roofs are optional in the Gatekeeper Sustainability requirement, GRAG believes that there is not enough incentive present unless green roofs are a separate, standalone option for selection.

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[3] Citizens Water Conservation Implementation Task Force, *Water Conservation 2020: Strategic Recommendations*, March 2010. Available from: www.ci.austin.tx.us/watercon/downloads/cwcitfpolicydocument_v10_march22_final.pdf

Green Roofs on City Buildings

While reviewing the charge of the GRAG with various City departments, many City personnel were unaware the Austin City Hall had a green roof that was designed as an environmental education model and had been nationally recognized as an exemplary green roof project. It was clear that more green roof education should be provided to City staff, the City Hall green roof performance should be monitored and documented, and the City Hall green roof should be used as a model to educate the public about the benefits of green roofs.

With the success of the City Hall project, the Public Works Department (PW) is investigating the potential of green roofs for any new City building projects. In particular, GRAG supports the inclusion of at least one additional green roof to the City's portfolio in the next five years.

Outreach and Education

As GRAG assessed the state of green roofs in Austin, it became evident that continued outreach and education were important to the progress of promoting and implementing green roofs. While the website will move green roofs forward, there is need to provide a more focused outreach effort to various organizations and entities. This effort is not the charge of GRAG, but individuals and organizations represented by its members could certainly continue to provide seminars, green roof tours, and other forms of publicity.

NEXT STEPS

Five-Year Policy Implementation Plan

Once GRAG identified the need for various green roof activities which obviously could not be accomplished in one year, GRAG developed a Five-Year Policy Implementation Plan.

> *The Five-Year Policy Implementation Plan was developed to systematically support the increased use of green roofs in Austin.*

Staff worked with various City departments to create reasonable goals for each year which cumulatively ensure that green roofs would remain on the policy and program agenda and budget. (See section VII. Next Steps for the Five-Year Policy Implementation Plan.)

The Five-Year Policy Implementation Plan was developed to systematically support the increased use of green roofs in Austin. The primary basis for the Five-Year Plan was the Policy and Incentives Matrix (see section VII. Next Steps), developed by staff, which reviewed a wide range of options to offer credits, incentives, and other measures to encourage the use of green roofs in Austin. These options ranged from potential changes specific to Austin's regulatory system to measures used by other cities across the world. The GRAG and staff worked to identify the most feasible and productive of these options. Staff also met with targeted City departments to solicit staff input and recommendations for measure. The GRAG and support staff then developed a Five-Year Plan to carry out the most important measures, with the five-year period beginning in October 2010. Policy

options were prioritized in years one though five according to their ease of execution and their critical-path nature for the development of future program elements.

Request for GRAG Extension

The Green Roof Advisory Group requests a one year extension to initiate the implementation of the group's recommendations outlined in the Five-Year Plan and to provide a solid basis for ongoing policy development. The existing, mutually supportive relationship between City staff and GRAG stakeholder members is an important key to assisting the City in implementation of green roof policy goals.

GRAG stakeholders and City staff recognize the need for continued GRAG activities to complement future staff efforts and most effectively promote green roofs in the City.

The existing, mutually supportive relationship between City staff and GRAG stakeholder members is an important key to assisting the City in implementation of green roof policy goals.

The critical need for the establishment of green roof design considerations into performance based criteria for successful green roofs was identified. The development of the design considerations, however, is a substantial undertaking and was not possible to accomplish within the one-year timeframe allotted by Council for GRAG activity. Therefore, the task was pushed forward into Year 1 of the Implementation Plan. Additional Year 1 stakeholder tasks include support for staff educational activities, continued advocacy for green roofs as a density bonus public benefit option, assessment of green roof monitoring research, and progress review of policy recommendations for incentives and credits.

I. The Case for Green Roofs

Why are green roofs proliferating throughout the world as well as in Austin? Use of "green infrastructure" to help mitigate the environmental impact of the built environment has become increasingly important as our world continues to urbanize. Rooftops are one of the few available areas within the "concrete jungle" to reintroduce vegetation. Green roofs have the potential to be an important tool and powerful symbol in fulfilling the City of Austin's vision as leader among sustainable cities. Not only can a green roof provide aesthetic views when seen from adjacent buildings, the technology can offer many potential environmental, cultural, and economical public and private benefits. Because some of a green roof's attributes may be enhanced with irrigation to keep the roof's vegetation alive during dry weather, water stewardship is an important consideration in green roof design, implementation and maintenance.

> *Rooftops are one of the few available areas within the "concrete jungle" to reintroduce vegetation.*

The benefits of green roofs align well with Austin's environmental and cultural priorities. They include:

- Vegetation cleans and cools the air, improving air quality and reducing the urban heat island effect.
- Rooftop vegetation cools a building's roof, reducing cooling season energy use, which in turn reduces greenhouse gas emissions.
- The life expectancy for cooler roof membranes under green roofs can be over twice that expected for other roofs. Waste from standard roofing accounts for 10 million tons/year in the US according to the U.S. EPA.[4] Long-lasting roofs are more sustainable and reduce landfill use.
- Green roof systems can prevent sound from both entering and leaving a building, potentially helping reduce inner city noise pollution.
- A green roof can be designed to detain and retain stormwater runoff, potentially reducing flood events and serving as an integral component to protect water quality.

[4] U.S. EPA. *Building-Related Construction and Demolition Materials Amounts*, March 2009. Available from: www.epa.gov/osw/conserve/rrr/imr/cdm/pubs/cd-meas.pdf.

- Many urban dwellers have poor access to green space. Accessible green roofs can improve quality of life by providing an urban oasis. Property values can also increase with a green roof properly integrated into a building's use.
- Green roofs can help provide habitat for wildlife such as birds and butterflies, particularly in areas where ground level habitat is scarce.

GRAG explores these issues in detail in the Green Roof Advisory Group Interim Report dated March, 2010.

II. Advisory Group Charge and Process Overview

The Green Roof Advisory Group was convened and directed to explore the feasibility of offering energy and stormwater credits and other incentives, based on performance, to encourage the creation of green roofs in the City.

CHARGE FROM CITY COUNCIL

Per Council Resolution Number 20090827-057 passed and approved by the City Council on August 27, 2009, the Green Roof Advisory Group was convened and directed to explore the feasibility of offering energy and stormwater credits and other incentives, based on performance, to encourage the creation of green roofs in the City.

Specifically, the resolution charged the Advisory Group as follows:

1. The stakeholder group shall produce a policy report that includes recommendations regarding credits and other incentives to promote green roofs in the City.

2. The stakeholder group shall work with City staff.

3. The stakeholder group shall provide Council with an interim progress report on or before February 25, 2010 and shall present a final report to Council on or before August 26, 2010 and extended to October 28, 2010.

4. The stakeholder group shall be drawn from the fields of design, development, and green building, and include input from local green roof organizations and the University of Texas at Austin's Lady Bird Johnson Wildflower Center.

GREEN ROOF ADVISORY GROUP PROCESS

Membership

As the Council sponsor of the resolution, Council Member Chris Riley invited individuals representing the various groups and organizations with a stakeholder interest in green roofs to be members of GRAG. The intent was to provide a balanced perspective among design professionals, green building advocates, developers, and academics. A policy was set that

any interested parties would be given an opportunity to review the Interim Report for direct feedback prior to production of the final report. GRAG Members are listed in the Acknowledgements at the beginning of the report.

Throughout the duration of GRAG, various interested citizens have attended individual meetings and offered comment for consideration.

Staff members from Watershed Protection, Austin Energy, Austin Water Utility, and Public Works have provided extensive support to GRAG in its initiatives. In particular, GRAG would like to thank Matt Hollon, Watershed Protection, Maureen Scanlon, Austin Energy Green Building, and Leah Haynie, Austin Energy Urban Heat Island for their diligent pursuit of our charge. The robust allocation of staff resources to the promotion of green roofs in the City is appreciated.

Committees

To facilitate more focused research, discussion, and analysis, GRAG members formed smaller committees in the first and second halves of the group's activity period. A complete list of committee members is found in Appendix G. The group felt strongly that the committee structure allowed a measure of efficiency important to achieve results in a short time. The activities of the committees were as follows:

Executive Committee

The Executive Committee (Excom) was made up of the Chair and Co-chair and two primary staff members. The Excom met as needed to determine direction and focus for GRAG. The development of the work product was a creative process which necessitated continual regrouping to ensure an agreed upon path to produce the best result was followed. Since there had been no green roof policy prior to the formation of GRAG, the Excom sought to assess the progress and determine the most advantageous approach to accommodate both stakeholder and staff concerns.

Site Committee

The Site Committee met to discuss five topics in detail to explore potential incentives and credits at the site level of development:

1. Flood detention (existing and potential options)
2. Watershed impervious cover (green roofs vs. pervious cover)
3. Zoning (zoning impervious cover, building height, open space, and other density and community considerations)
4. Water quality (retention-irrigation systems, biofiltration, treatment trains, green roofs as standalone water quality controls, and sizing of water quality volume)
5. Water conservation considerations (including soil depth)

The findings of these meetings are compiled in the Policy and Incentives Matrix located in Appendix A.

Building Committee
The Building Committee identified the public and private benefits associated with green roofs focusing on vertical build-out rather than site. The committee gathered research on the effects green roofs have on energy consumption and peak summer energy, roof longevity and landfill issues, urban heat island, air quality, aesthetics, habitat creation, interior and exterior sound attenuation, increased tax base, and public and private amenity space. The building committee further considered green roof initiatives and synergies with existing City of Austin initiatives such as Zero Waste, Climate Protection Plan, Energy Efficiency, Urban Heat Island Mitigation, Watershed Protection, Water Conservation, Green Building, Green Garden Initiative, Great Streets, and others.

Density Bonus Incentives Committee
The Density Bonus Incentives committee researched green roof density bonus incentives in other cities, such as Portland and Chicago, (see Appendix E), and reviewed the proposed Downtown Density Bonus Program. GRAG determined that downtown Austin would benefit the most from a standalone Green Roof Public Benefit Option. A letter was sent to City Council outlining a proposal to add a Green Roof Public Benefit Option found in Appendix B. Subsequently, Council authorized a stakeholder group led by the Planning Commission to review the proposed Density Bonus Program. The consensus of the stakeholder group was that green roofs were a worthy Public Benefit Option. The Planning Commission recommended that green roofs be added to the Density Bonus Program. Currently, the entire Downtown Plan is being prepared for Council review later this year.

Community Outreach Committee
The Community Outreach Committee was formed to educate the community about the efforts of GRAG through comment solicitation and an outreach seminar. Multiple stakeholder groups were identified and contacted via email by GRAG for feedback on the interim report. The 17 stakeholder groups contacted are listed in Appendix I. See "Public Review" below for more detail on specific outreach activities.

Design Considerations Committee
The Design Considerations Committee began determining what performance standards for green roof design should be considered. Multiple meetings were held where the complexities of soil depth, mulch, and other possible factors were discussed in detail. Several topics were identified and are discussed in section IV of this report. The considerations include green roof size, soil media depth, plant cover and variety, drainage, water use, visibility, access, and maintenance requirements.

Policy and Incentives Matrix Committee
Staff from Watershed Protection, Planning and Development Review, Austin Energy, Public Works, Economic Growth and Redevelopment Services, and Parks and Recreation collaborated in their review of existing City code and national and international green roof strategies to identify potential credits, incentives, and other

measures to encourage the creation of green roofs in Austin. A summary table (see Appendix A) was developed which described the potential optional codes, description of current status and concerns, potential improvement, advantages and disadvantages of anticipated impacts, and staff recommendations. The main headings are: Zoning, Energy Conservation, Air Quality & Climate Protection, Watershed Protection, and Financial Incentives. The overall findings and the options with the most promise are included in the Five-Year Policy Implementation Plan (see section VII).

Five-Year Policy Implementation Plan Committee
The leaders of the Five-Year Plan committee were the Chair and staff lead from Watershed Protection. Input to the plan was given by additional staff and stakeholder members. The basis for the Five-Year Plan was the Policy and Incentives Matrix. Specific policy options were prioritized for staff development in years one, two, three, etc. according to their ease of execution and their critical path nature for the development of future program elements. Potential GRAG tasks were added with stakeholder review.

Interim and Final Report Committee
The report committee convened to facilitate the development of the written interim and final reports to City Council detailing GRAG activities and recommendations. The process of creating each of the reports began with group consensus as to the structure of the document, delegation of writing and editing tasks to appropriate Advisory Group members, and final editing and design.

Decision-Making
As much as feasible, the method of decision making was consensus. However, due to the fast paced nature of the process, bimonthly updates of staff progress, and the separate efforts of the various committees, some of the final elements within the work product are a compilation of committee reports. Opportunity was given for member feedback if some portions of work product did not have full support. In these cases, the outline of the product was approved within the Council-approved timeframe.

Public Review
The outreach committee notified stakeholder groups via email of the interim report and solicited comments. Comments were received by email and are compiled in Appendix I. The interim report was also posted on Council Member Chris Riley's website with a link for submitting comments.

Stakeholder groups were also invited to a seminar on green roofs held on June 3, 2010 at the Carver Branch library. The seminar included an introduction by Council Member Riley on a vision of Austin made more livable through green roof infrastructure. GRAG members continued the presentation by defining the components of a green roof, discussed the multitude of benefits and presented green roof incentive programs of other cities. A question and answer session was held at the end of the presentation. Questions and comments were also collected and are included in Appendix I.

Review by Boards and Commissions

GRAG is charged with presenting its results to selected Boards and Commissions, including but not limited to the following: Environmental Board, Resource Management Commission, Design Commission, Parks and Recreation Board, and Planning Commission. (See Appendix J for individual comments of Board and Commission members.)

III. The State of Green Roofs in Austin

Austin's green roof community has learned that green roofs can succeed. A broad spectrum of intensive and extensive installed systems have demonstrated attributes critical to their successful application in Austin's climate. A wide variety of heat and drought hardy native plant species have proven themselves on local green roofs. The engineered soil depth and associated components can be selected to support rooftop vegetation through the most severe environmental conditions. After a green roof's components are carefully selected, determining the roof's water needs and sources is critical to rooftop vegetation performance, particularly in our climate. Access to sufficient water for plants is the central factor in maintaining a green roof's optimal performance.

The green roof design considerations evaluated by GRAG are based on those roofs in the local portfolio that can be learned from and observed. Public interest in Austin green roofs has outpaced implementation, and while interest and momentum continues to build for installing green roofs, examples of their application are limited. Based on lessons learned in other American cities as well as abroad, local incentives would spur more green roof construction.

CITY OF AUSTIN GREEN ROOF MONITORING EFFORTS

> *GRAG recommends that the City of Austin engage in further green roof monitoring and design experimentation.*

In the summer of 2006 the Water Quality Monitoring Section of the City of Austin's Watershed Protection Department began monitoring runoff quantity and quality from a green roof installed at a local shopping center. Monitoring also began on a green roof installed at a private residence the following summer. See Appendix D for a summary of the results of those monitoring efforts. GRAG recommends that the City of Austin engage in further monitoring and design experimentation so that conclusions may be drawn that support the effective and sustainable design of green roofs as the technology matures, as well as potential incentives.

PROJECT PROFILES

The following project profiles are included to provide detail about a select few of the growing number of green roofs already established and contributing to the development of best practices and lessons learned in Austin. The roofs represented here span multiple

diverse building and owner types, soil depths, plant palettes, water use profiles, and other design considerations. See Appendix C for a map and table that inventories Austin's green roofs. The City, along with input from GRAG members, will maintain and expand the list as Austin's green roofs proliferate and data becomes more robust.

Austin City Hall

Location: Downtown Austin

Project type: Institutional

Year installed: 2005

Description: The Austin City Hall green roof is comprised of two publicly accessible green roof systems: the first is a plaza on top of underground parking, the second is a terrace over occupied space. Construction is cast-in-place concrete. Maintenance is contracted at once per week.

Photos courtesy of M. Knox, R. Manning, E. Jarger, A. Wong

Awards: Green Roof Award of Excellence from Green Roofs for Healthy Cities in 2008 for the Intensive Institutional Category; Certificate of Exceptional Merit from National Wildlife Federation; 1st LEED Gold Project in Austin

Green roof area: Over parking garage: 11,145 square feet; over occupied space: 2,480 square feet

Green roof type: Intensive, monolithic, 3 feet of soil depth

Reason for green roof: Sustainability, educational model, wildlife habitat, aesthetic, amenity

Green roof components: Garden Roof Assembly, American Hydrotech

Vegetation: Native trees, shrubs, and groundcover

Water Use: Efficient irrigation technologies such as stream bubblers and drip irrigation to minimize water use by applying water directly at the plant roots. No potable water was used due to the availability of ground water as the source.

Amenities: Waterfall uses HVAC condensation

Lessons learned: Construction scheduling issues need thorough review and coordination. Maintenance needs to be tailored to green roof considerations.

Austonian Condominiums

Location: Downtown Austin

Project type: High-rise residential condominium

Year installed: 2010

Description: The Austonian green roof is a privately accessible terrace serving as a backyard for residents of the building. The terrace offers a place to relax, cook, entertain and swim. The terrace is more than 12,000 square feet in size. It sits on the top of the building's ten-story pedestal. Construction is cast-in-place concrete.

Photos courtesy of Thomas McConnell

Green roof area: 6,420 square feet

Green roof type: Extensive, monolithic, 4 – 7 inches soil depth (616 square feet) and intensive, monolithic, 16 – 18 inches soil depth (5,804 square feet) with two tree wells 5 feet deep.

Reason for green roof: Aesthetic, amenity, reduce ambient temperature

Green roof components: Garden Roof Assembly, American Hydrotech

Vegetation: Over 65 native and adaptive drought-tolerant plants including two clusters of Red Oak trees, ground cover, lawn, shrubs, and an herb garden.

Water use: Pressurized irrigation system using HVAC condensation collected in eight 1,600 gallon tanks.

Amenities: Pool, fountain, cooking area, dog park, passive gathering spaces

Lessons learned: Sun/shade modeling and calculating solar reflectivity from adjacent tower glazing systems are important to determine appropriate plant species and location. Garden will be monitored during the first year and modified accordingly to assess plant growth and reflectivity throughout the year. Future high-rise development may affect the sun/shade aspect of the garden and its microclimate requiring modifications to plant types and locations.

Dell Children's Medical Center of Central Texas

Location: North Central Austin

Project type: Institutional

Year installed: 2007

Description: The Dell Children's Medical Center site houses two publicly accessible green roofs: a 3,950 sq. ft. Conference Center Garden and a 7,015 sq. ft. garden serving the Chapel, Inpatient Therapy, Patient, Board room and balcony. Roof membrane construction is poured-in-place concrete over high-density rigid foam.

Photos courtesy of TBG Partners

Awards: 1st LEED Platinum hospital in the world

Green roof Area: 10,965 square feet

Green roof type: Intensive, monolithic, 18 inch soil depth

Reason for green roof: Sustainable design principles, aesthetics, addition of an accessible amenity, provide comforting natural area for patients

Green roof components: Garden Roof Assembly, American Hydrotech

Vegetation: Native and adapted drought-tolerant plants

Water Use: Irrigation with City of Austin reclaimed water

Amenities: Outdoor courtyards

Lessons Learned: Increased soil depth for greater moisture holding capacity. Plant loss due to shading by tall buildings and from reflection of heat from windows into courtyards. Owner commitment to ongoing maintenance is important to successful ongoing performance.

Escarpment Village

Location: Southwest Austin

Project type: Retail center

Year installed: 2005

2005

2010

Photos from Growers and Green Grid Roofs.com

Description: First publicly visible green roof to be installed in Austin for a retail center striving for the latest technologies in green building. The green roof provides a view from the mezzanine level of the coffee shop seating area.

Green roof area: 8,000 square feet

Green roof type: Semi-intensive, modular tray system, 6 inch soil depth

Reason for green roof: Sustainability, energy savings, aesthetic amenity

Green roof components: Weston Solutions Green Grid System

Vegetation: Native grasses and shrubs and other plants

Water use: Spray irrigation system using potable water

Amenities: Enhanced view (roof is not accessible)

Lessons learned: A modular tray system was chosen to minimize difficulty of roof maintenance and repair. However, the modular system proved unsuitable for the Central Texas climate. (Monolithic systems have proved to be successful.) A problematic spray irrigation system contributed to nutrient rich potable water runoff. Maintenance by a party knowledgeable of green roof best practices is an important step to improved understanding of ways to improve plant health and minimize nutrient water use and nutrient export.

Hill Country Residence

Location: Southwest Austin

Project type: Residence

Year installed: 2005

Description: Residential green roof to serve as an outdoor room that would help restore disrupted ecosystem services, offer views of the hill country, create habitat and beauty, be an extension of the prairie grass meadow on the property, and require little to no maintenance.

Photos provided by Kathy Zarsky

Green roof area: 1,125 square feet

Green roof type: Monolithic, extensive to semi-intensive, 6-8 inches soil depth

Reason for green roof: Aesthetic, ecological, amenity, thermal insulation

Green roof components: American Hydrotech system, soil media locally formulated and supplied.

Vegetation: Native drought-tolerant plants

Water use: No irrigation, hose bib for infrequent hand watering

Amenities: Small stone paver patio

Lesson learned: A green roof can be a very low-maintenance landscape if plants are allowed to come into their own balance and evolve without much interference. The overall assembly selected, as well as plants, has everything to do with the owner's expectations, budget, sustainability objectives, etc. Careful attention to flashing details should be thought through, regardless of roof type and expectations, as metals will leach. Stormwater runoff from roof is higher in nutrients than undeveloped land and should be directed to ground level vegetation rather than allowed to discharge directly into creeks. (Stormwater runoff quality and quantity of this roof is currently monitored by City of Austin.)

Stanley Studio

Location: Central East Austin

Project type: Studio office

Year installed: 2009

Description: This extensive green roof covers a rectangular studio office space using a non-proprietary system designed for a 1:12 pitch shed roof.

Photos provided by Stanley Studio - Architects

Green roof area: 525 square feet

Green roof type: Extensive, monolithic, 4-5 inches of soil depth

Reason for green roof: Explore shallow depth limit for this region, insulation (thermal, sound), ambient cooling, educational/demo, aesthetic, wildlife habitat

Green roof components: Non-proprietary system of waterproof layer, aluminum edging, drainage/water retention layer, growth media, and plants

Vegetation: Native prairie grasses, wildflowers, ground covers (drought/heat tolerant)

Water use: Intermittent light irrigation during periods of heat and drought; system for using harvested sources (rain and AC condensate) nearing completion

Amenities: Adjacent PV array acts as awning and rainwater catchment for irrigation

Lessons learned: Settling of growth media over time reduces overall depth, mulching key component for moisture retention, prairie grasses prove hardy in extreme conditions, irrigation must occur within narrow dry/moist threshold.

IV. Design Considerations

Incentives and credits offered by the City of Austin for green roof construction relate to the community and environmental benefits the City will receive in return. As a result, it is important that a green roof function successfully. A living, healthy green roof is well-positioned to mitigate against the urban heat island, cut cooling season energy use, reduce stormwater runoff, lengthen the life of roof membranes, and provide valuable urban green space and habitat for wildlife.

But this need for water also means that water conservation techniques need to be considered throughout a green roof's design, to include not only irrigation methodology and prudent selection of water sources including non-potable water, but plant selection and optimization of the moisture-retention ability of the soil and other system layers. A green roof must be designed with water conservation in mind system-wide.

A living, healthy green roof is well-positioned to mitigate against the urban heat island, cut cooling season energy use, reduce stormwater runoff, lengthen the life of roof membranes, and provide valuable urban green space and habitat for wildlife.

Green roof soil media and plants can also be designed to minimize the use of fertilizers which helps preserve downstream water quality. GRAG is charged with determining the performance-based criteria for successful green roofs in Austin.

There are multiple applications for green roofs: residential, multifamily, commercial and retrofit. Depending on the application and the profile of the green roof, the benefit level can vary. For example, roof profiles can range from four-inch to six-inch soil depth planted with native grasses on a residential project to a deeper 24-inch soil profile on a commercial building which allows for a larger variety of plants, such as trees and understory. Both roofs reduce building energy consumption, mitigate urban heat island, and attenuate small storm events. The deeper roof with a wider variety of plant species can achieve a higher level of environmental benefit by providing additional wildlife habitat, increased biodiversity, and greater soil-moisture holding capacity.

The unique characteristics of the Central Texas climate require careful landscape design of the green roof to ensure viability. The periods of drought and punishing heat contrasted with heavy rainfalls, require vegetation that can withstand a multitude of tough conditions.

Therefore, it is important to establish minimum design standards for a green roof to ensure that a minimum level of community benefit is attained.

Two main types of green roof systems have been used in Central Texas; modular systems and monolithic systems. The modular system consists of pre-planted trays placed directly on the roof surface which can easily be removed for maintenance and repair and then put back in place without disturbing growing media or plantings. In contrast, monolithic systems are built in place as one unit on the roof. The monolithic systems have proven successful in the Austin climate whereas the modular systems have not as they separate the soil mass which greatly reduces the moisture holding capacity.

Drainage of the stormwater runoff from a green roof is discharged through a drainage layer below the soil mass. There are multiple drainage options to consider with varying levels of water retention capacity such as absorbent drainage mats, porous layer, or drainage cups. The volume of stormwater retention is dependent on the void space of the drainage layer.

The intended function of the green roof also affects performance expectations. Some will be designed as a green space amenity requiring some level of public and/or private access, others for environmental protection such as reduction in runoff or habitat creation, and others for enhanced landscaping. A performance standard system will need to take into account some factors which extend across all installations such as water use and maintenance access while also considering that standards for some specialized uses will not be applicable for others.

GRAG advocates the development of design considerations to identify the minimum requirements of a green roof. Discussions include consideration of baseline versus higher credit green roofs and how best to create varying requirements. Higher credit roofs would attain a higher level of environmental function and receive a higher level of incentive. Several design considerations were identified to ensure adequate function of the green roof, including: size, soil depth, plant cover and variety, water use, stormwater retention, pollutant removal, pest management, fertilization, mulch, visibility, access, and maintenance requirements. Refer to Appendix H for a summary of the discussion that has occurred to date on these potential criteria.

GRAG will need additional time to relate the design considerations to various environmental goals, develop the design considerations into performance standards, and align the performance criteria with specific incentives and credits offered by the City of Austin. The goals may depend on which City department is giving credit. For example, a credit from Planning and Development Review (PDR) to satisfy the open space requirement may need a greater percentage of the green roof area for gathering space for those accessing the roof, whereas a greater percentage of roof area for vegetation and a deeper soil depth might be required for stormwater retention credits.

V. GRAG Accomplishments

Developed consensus on the public and private benefits of green roofs as a component of green infrastructure, including improved air quality, stormwater detention, urban heat island mitigation, open space, wildlife habitat, and others. In Phase 1 of its activity period, GRAG engaged in discussion and evaluation within Site and Building committees to develop consensus on the public and private benefits of green roofs. The GRAG Interim Report to City Council dated March 25, 2010 details these findings.

Completed a review of green roof incentive and credit policies of other cities in North America. Staff and stakeholders completed a review of U.S. and international green roof incentive and credit policies in Phase 1 of the GRAG activity period, evaluating potential confluences between those initiatives and existing and potential Austin incentives and credits. For details, see Appendix E, Overview of Green Roof Credits and Incentives in North America.

Established a database of green roofs in Austin. Staff from Watershed Protection compiled an inventory of existing green roofs in Austin using input from GRAG members and City staff as well as a list of projects from the GRoWERS website. The inventory was mapped using GIS software and attributes including project name, address, and land use category (e.g., commercial, single-family residential, institutional) were populated. To date, 23 existing green roofs have been included in the inventory (see Appendix C).

Analyzed potential policies that could be developed to encourage green roofs. Staff met with and obtained input from the following City of Austin Departments: Watershed Protection, Planning and Development Review, Austin Energy, Public Works, Economic Growth and Redevelopment Services, and Parks and Recreation. Each considered potential incentive measures relevant to their mission and their potential inclusion in the Five-Year Policy Implementation Plan.

Developed proposals to integrate green roofs into departmental program efforts. Documented existing City of Austin policies and incentives which encourage green roofs. Staff reviewed and compiled all existing and potential policies and incentives to encourage green roofs. The measures identified ranged from options specific to Austin's regulatory system to measures used by other cities across the world. The compilation forms the Policy and Incentives Matrix presented in Appendix A.

Supported the inclusion of green roof policy and benefit education on a City of Austin website. GRAG proposed the creation of a green roof educational campaign that will serve the larger

Austin community including policy makers, residents, academia, and developers. It is envisioned as a resource for local Austin citizens and people doing business in the Central Texas region. Currently the City of Austin's Urban Heat Island Mitigation (UHIM) program exists primarily as an education and tree planting program, which provides a strong foundation for an expanded green roof program. The goal of the campaign is to increase square feet of green roof space in Austin by a percent to be determined, and the local Central Texas green roof industry by a percent to be determined. (See Appendix F for details on the proposed educational initiatives and website.)

Advocated for an increase in Austin Energy green roof rebates. The newly adopted 2009 energy code requires R-20 insulation and reflective roofs in new construction and retrofits, which is very efficient. Therefore, no commercial energy efficiency rebates are provided for green roofs or reflective roofs at this time. However, green roofs are recognized for reducing energy use by seven to twenty-five percent more than reflective roofs.

Advocated for Green Roofs as a Downtown Density Bonus Public Benefit Option. As part of the Downtown Austin Plan a draft of the *Downtown Density Bonus Program* was presented to Council by the consultant team and staff at Planning and Development Review. The program offered Public Benefit options for selection by the private sector in exchange for increased entitlements. Gatekeeper Requirements set a baseline for participation in the program. Out of the options, the first 50 percent of "bonused floor area" would go to affordable housing and the second 50 percent would go to such benefits as family-friendly housing, child and elder care, cultural uses, historic preservation, and open space.

> *In Portland, the green roof was found to be the most frequently selected option by the private sector in exchange for increasing entitlements.*

Through GRAG's research of different cities' green roof policies, an independent evaluation of Portland's density bonus program found the green roof was the most frequently selected option by the private sector in exchange for increasing entitlements. Portland's green roof floor to area ratio (FAR) bonus is offered on a graduated scale as follows:

Table 1. Summary of Portland's Green Roof Density Bonus Program

Green Roof Size	Density Bonus
10 – 30% of building footprint	1 square foot of building area per square foot of green roof
30 – 60% of building footprint	2 square foot of building area per square foot of green roof
> 60% of building footprint	3 square foot of building area per square foot of green roof

In assessing areas in Austin which could benefit the most from the mitigation characteristics of green roofs, GRAG reviewed urban heat island diagrams and areas with the most impervious cover and stormwater run-off.

> *Current building regulations have no impervious cover limitation for downtown development and have no requirements for landscaping, other than street trees.*

The Downtown core was found to be the epicenter of the urban heat island and the greatest percentage of impervious cover. Current regulations have no impervious cover limitation for downtown development and have no requirements for landscaping, other than street trees. A summary of the impervious cover limits of the Watershed Protection Ordinances is found at www.ci.austin.tx.us/watershed/ordinance_table.htm.

The review of other cities green roof policies and the discovery of Downtown Austin as the area that could benefit the most from green roofs, led GRAG to recommend that green roofs be added as one of the individual Public Benefit Options in the Density Bonus Plan. While one position is that green roofs are optional in the Gatekeeper Sustainability requirement, GRAG believes there is not enough incentive present unless green roofs are a separate standalone option for selection.

As a result, GRAG members participated in stakeholder discussions led by the Planning Commission to review the draft Downtown Density Bonus Program. The group consensus was that green roofs were a worthy Density Bonus Option to be included in the program.

While not a part of a specific density bonus program, the City has seen interest from the downtown development community to offer green roofs in exchange for increased entitlements. On May 26, 2010 a Restrictive Covenant for the Shoal Creek Walk project agreed to provide the following:

> *"Green Roofs. At least 20,000 square feet of green roof design shall be provided as a means to improve the quality of the air, reduce stormwater runoff and improve energy efficiency of the structure beneath. The green roof system shall be designed according to City approved requirements and standards."*

Developed a proposal for green roof monitoring research. Staff evaluated the potential for a green roof monitoring project to better understand whether green roofs can be used in Austin to mimic natural hydrologic regimes and reduce the impacts of urbanization. On June 24, 2010, the Austin City Council approved $10,000 for the Lady Bird Johnson Wildflower Center to study the amount of rainfall runoff two different green roof systems can retain and/or delay in comparison with a conventional impervious conventional roof.

> *City staff evaluated the potential for a green roof monitoring project to better understand whether green roofs can be used in Austin to mimic natural hydrologic regimes and reduce the impacts of urbanization.*

This information will be used by City of Austin Watershed Protection Department staff to calibrate hydrologic models to estimate the quantity of rainfall that green roofs can retain and/or delay on an average annual basis. The Wildflower Center expects to complete the study in 2011.

Organized a public seminar by a green roof industry leader on water retention modeling. April 2010, GRAG sponsored a Water Retention Modeling seminar by American Hydrotech, a well-known green roof manufacturer and installer. The central objective was to explore the use and quantification of green roofs to meet City of Austin water quality and flood detention requirements. American Hydrotech presented a hydrologic model for their proprietary green roof system to the Capital Area Erosion Control Network (CAECN). The tool calculates how their systems retain stormwater runoff in its soil media and drainage layer, slow the rate of rainfall runoff, and provide long-term benefits over "bare" conventional roofs. These calculations have been used to confirm the use of green roof components to comply with LEED requirements.

Several prominent green roof projects in the Austin area have used American Hydrotech's products and did not seek or receive stormwater detention credit for their green roofs. (Where required, detention was provided using conventional stormwater ponds.) However, in the future, American Hydrotech and other companies designing green roof systems can submit proprietary engineering models to the Watershed Protection Department for evaluation and potential use for flood detention credit. (Future site-specific applications using such models might also require additional review.) Green roofs using systems designed using approved models would be able to provide this additional benefit to their projects.

> *Well-directed outreach efforts, including spotlighting exemplary models, can heighten awareness and understanding of green roofs among practitioners and the community.*

Provided an outreach seminar to present GRAG's efforts and solicit public feedback. The outreach committee sought to educate the community on the benefits of green roof infrastructure. Although the response was mostly positive, additional community education through continued outreach effort is important to reach a wider audience.

Developed Five-Year Policy Implementation Plan. The Green Roof Five-Year Policy Implementation Plan was conceived to set in motion a long-range program which recognized the increasing viability of green roofs as a component of green infrastructure for Austin. The primary basis for the Five-Year Plan was the Policy and Incentives Matrix developed by staff which reviewed various aspects of City code that might target green roofs.

The Five-Year Policy Implementation Plan for green roofs was conceived to set in motion a long-range program which recognized the increasing viability of green roofs as a component of green infrastructure for Austin.

Staff worked with various City departments to create reasonable goals for each year which cumulatively ensure that green roofs would remain on the policy and program agenda and budget. Specific policy options were prioritized for staff development in years one, two, three, etc. according to their ease of execution and their critical path nature for the development of future program elements.

Additional attention was given to potential GRAG stakeholder activities that could underscore staff efforts as well as promote green roofs in the City. The critical need for green roof performance standards was identified. The development of the standards was not able to be accomplished within the Council-approved GRAG time frame. Therefore, the task was pushed forward into year one of the implementation plan. An additional year-one stakeholder task was outreach to key design and sustainability organizations.

Initiated a framework for green roof design considerations. The design considerations matrix will be an important tool for identifying the components of a green roof. As green roof credits and incentives become a part of City policy, City staff can use the matrix during the permit processes to determine if a project qualifies for credits and incentives. GRAG has identified a range of potential credits, but some credits, such as parkland dedication, may only be suitable for a higher performing roof that is publicly accessible. Not only is continued development of the minimum requirements of a green roof important, but GRAG should identify the medium and higher credit green roof so that a correlation between the constructed green roof and particular incentives and credits exists.

Integrated Water Conservation 2020 principles into green roof recommendations. A potential increase in green roofs in Austin raises the specter of a proportional increase in potable water use for irrigation.

The Green Roof Advisory Group has made a concerted effort to explicitly align green roof design considerations and policy recommendations with the Water Conservation 2020: Strategic Recommendations report.

While not all green roofs require potable water irrigation—and in dense multifamily construction a green roof would require less water per capita than large lawn areas in single family subdivisions—any possible additional stress on water resources merits thoughtful consideration. The Green Roof Advisory Group has made a concerted effort to explicitly

align green roof design considerations and policy recommendations with the Water Conservation 2020: Strategic Recommendations report released in March 2010.[5]

These efforts included meeting with Susan Butler, Citizens Water Conservation Implementation Task Force chair, documenting shared principles (found in section VI), and inductively considering water conservation and non-potable water use as a core green roof design consideration.

The overall value of green roofs to our local environment depends on all the environmental effects of the technology, and GRAG advocates addressing green roofs' effects on water conservation goals openly and continuing to invite the contribution of City water conservation stakeholders.

Developed and presented the Interim Report and Final Report to the City Council and selected Boards and Commissions. The Council sponsors requested GRAG meet with various Boards and Commissions to present the items discussed in this report. The Boards and Commissions unanimously chose to recommend a one year extension of GRAG and support for implementation of the Five Year Plan. Planning Commission further recommended green roofs be included as a separate stand alone public benefit option in the Density Bonus Plan and the new Central Library be considered to be the next City building with a green roof. Comments are documented in Appendix J.

[5] Citizens Water Conservation Implementation Task Force, *Water Conservation 2020: Strategic Recommendations*, March 2010. Available from: www.ci.austin.tx.us/watercon/downloads/cwcitfpolicydocument_v10_march22_final.pdf

VI. Findings and Recommendations

POLICY AND INCENTIVES

A major focus of the Council resolution and thus of the GRAG and staff support was to identify a comprehensive set of options to incentivize and otherwise encourage the creation of green roofs in Austin. Staff from Watershed Protection, Planning and Development Review, Austin Energy, Public Works, Austin Water, Economic Growth and Redevelopment Services, and Parks and Recreation collaborated in their review of existing City code and national and international green roof strategies to identify potential credits, incentives, and other measures to encourage the creation of green roofs in Austin. A summary table, presented in Appendix A, was developed to describe the potential optional codes, description of current status and concerns, potential improvement, advantages and disadvantages of anticipated impacts, and staff recommendations. This section discusses the high points of this research, but the table in Appendix A should be consulted to better understand each option considered.

For completeness, a wide an array of options are included in the Policy and Incentives Matrix. Not all items in the matrix are expected to be implemented, or even considered, in the short term. Some options will be more suitable and feasible than others. Those with the most promise were included in this report's Five-Year Policy Implementation Plan. Some strategies used by other communities with more mature green roof programs, such as direct or indirect financial incentives, may become appropriate for Austin in the future once green roof initiatives gain more experience and momentum.

The four main headings in the Policy and Incentives Matrix in Appendix A are: (1) Zoning; (2) Energy Conservation, Air Quality & Climate Protection; (3) Watershed Protection; and (4) Financial Incentives. The most promising options in each category were included in the Five-Year Plan and are discussed below.

Zoning

Austin's existing Land Development Code already enables green roofs to count towards key zoning credits and requirements. Since, in most cases, these possibilities are poorly known and/or understood by either City staff or the design and development communities, a great opportunity exists to educate City staff and the public about them. Improved publicity of these options may help encourage the construction of green roofs and would not require significant resources or any additional action by Council.

Austin's existing Land Development Code already enables green roofs to count towards key zoning credits and requirements.

All of the following items are included for early implementation in the Five-Year Plan:

- *Green roofs for PUDs.* Green roofs are a natural fit to help PUDs (Planned Unit Developments) meet minimum requirements for open space & landscaping.
- *Green roofs for PUD Green Building.* Green roofs have the capacity to single-handedly contribute multiple points towards a project's Green Building rating, which is a standard PUD requirement.
- *Green roofs for creative/innovative environmental PUDs.* The PUD system includes a "Tier 2" system to enhance their acceptance, of which environmental innovation is a component; green roofs would logically contribute.
- *Open Space for Multifamily Projects and Commercial Projects.* All multifamily residential developments (apartments and condominiums) and commercial developments over 5 acres in size are required by code to include minimum open space provisions. This mandate can be met using roofs.
- *Green roofs over subsurface parking garages.* A creative use of green roofs is already allowed in that subsurface parking garages covered with 4-foot soil count as "pervious" cover within the urban roadway boundary (area served by the Commercial Design Standards).
- *Green roof parks.* Green roofs may potentially be used to meet parkland dedication requirements under certain circumstances, which is an innovative approach in dense areas with few open space opportunities.

Several zoning-related options were identified that will require Council or City Department action to bring them about. These options include:

- *Downtown Density Bonus.* This option, discussed earlier in this report in more detail, is a cornerstone request of the GRAG. The benefits of their inclusion in a density bonus program would be enormous for green roofs in Austin, not the least of which is the momentum-shifting push that this would provide to make them more common and accessible to the design and development community.
- *Other density bonus options.* Green roofs might also be used to attain density bonus entitlements in other areas, such as North Burnet-Gateway Planning Area, Airport Blvd near Highland Mall, East Riverside Corridor, and the Transit Oriented Development (TOD) districts. All of these areas would greatly benefit from more green open space, lower ambient temperatures, and increased aesthetic appeal.
- *Increased building cover.* Green roofs could be used to potentially increase maximum allowable building cover for projects. Maximum building cover requirements were instituted to limit the built environment from overwhelming adjacent land uses; green roofs serve to soften and counter these negative impacts and a system could be devised to produce a favorable ratio of new building added to increased green roof.

- *Green roofs on all new Central Business District buildings.* An idea needing further research, this Chicago-inspired option would see the systematic greening of Austin's downtown skyline. It is included for consideration for discussion purposes in the Five-Year Plan.

Energy Conservation, Air Quality & Climate Protection

- *Air Quality and Urban Heat Island Mitigation.* The greatest energy conservation benefits for green roofs may come in their ability to assist with urban heat island mitigation and air quality by reducing outdoor ambient temperatures and by filtering particulates in the air. GRAG and AE staff recommend the incorporation of green roofs into this program for education, outreach, and incentives and included this measure in the Five-Year Plan.
- *Energy Rebates.* Future consideration of rebates for green roofs will be given; at present, however, such rebates were judged by AE to not be warranted.
- *Green roofs in lieu of cool roofs.* The Austin Energy Code allows the use of a green roof instead of a high reflectivity roof. But there is no definition of what a green roof is, and AE staff asked for GRAG help in defining green roofs. The proposed GRAG work on the design considerations will help toward this goal.

Watershed Protection

- *Green roofs for flood control.* Methods exist today to incorporate flood control into green roof design (though some options will likely be financially impractical for many applications). A project engineer would have to demonstrate to City staff how such a system would work and be maintained. In the meantime, a study by the Lady Bird Johnson Wildflower Center will seek to better understand the potential flood detention capabilities of several green roof systems.
- *Water quality control research needed.* The benefits of green roofs to improve water quality and flood control over conventional impervious roofs is the subject of much discussion internationally. As cited above, several studies and monitoring efforts have shown promise in reducing the total volume of runoff from green roofs versus those of standard roofs. At this time, water quality credit is not given to green roofs in Austin's Environmental Criteria Manual. (The quantification and assurance of benefits is hampered by the wide variety of proprietary and custom green roof systems and the relative lack of data showing their performance.) More research needs to be done to prove this to be a viable approach in Central Texas. One option, however, is that a private entity could bring forward data and modeling information to demonstrate the function of a particular green roof system. The Environmental Criteria Manual includes provisions for designers to bring forward new concepts and controls for approval for water quality credit. A second approach recommended by this report is the further study of the ability of green roofs to control site hydrology. This recommendation has led to Council approval of funds to have the Lady Bird Johnson Wildflower Center research this issue. The data hereby collected and possible follow-up studies may lead to future design criteria for water quality controls using green roofs.

- *Existing green roof options for water quality.* In addition, Appendix A documents that several water quality systems are possible now using green roofs, where the green roof serves as a component of a larger, integrated treatment system. Examples include the use of green roofs for re-irrigation of captured stormwater and direct incorporation of existing stormwater controls, such as biofiltration and rain gardens, into a green roof system.
- *Not ready to count green roofs as "pervious" cover.* GRAG and staff considered the possibility of granting partial or complete credit for green roof systems to count as "pervious" rather than "impervious," as they are currently counted. Impervious cover limits and control are one of the cornerstones of watershed protection and a deviation to the use of engineered pervious cover, in this case in the form of a green roof, is a major step. WPD staff judged the City is not at a point where this conclusion is justified.
- *Less runoff allowing smaller water quality controls.* While a green roof might not be reliably considered "pervious," a reasonable middle step would be to acknowledge that they can, if demonstrated, reduce rainfall runoff and therefore be potentially given credit toward reducing the size of downstream water quality controls required for a site. As such, they function (as anticipated by the 2009 EPA report) as integral components in overall "green infrastructure" solutions for environmental protection.
- *Drainage Fee Reduction.* Some communities have used drainage fee reductions to incentivize green roofs. Austin already gives a fee reduction for properly maintained stormwater controls. A green roof, if designed and approved as a stormwater control, would qualify for the drainage fee reduction.

Financial Incentives

Four major categories of financial incentives for green roofs were considered and included in Appendix A. They are as follows:

- Subsidies, Grants, Low-Interest Loans
- Development Process Incentives (Fee Rebates, Expedited Process, Design Support)
- Local Improvement Credits
- Property Tax Credit

All were taken from other US and/or international examples. All have potential and are recommended for exploration in the Five-Year Plan. See Appendix A for more detailed discussion of each.

ALIGNMENT WITH WATER CONSERVATION 2020: STRATEGIC RECOMMENDATIONS

The *Water Conservation 2020: Strategic Recommendations* report details how conservation can reduce the demand placed on water suppliers and thereby increase supply of a limited resource for a growing population.[6] The report specifies a number of water conservation principles, which GRAG supports.

[6] Ibid.

GRAG expresses a strong commitment to aligning green roof design with the following principles of water conservation in Austin:

- Year-round "no more than twice a week" watering schedule
- Use of air conditioning condensate for irrigation
- Use of reclaimed water and other non-potable water sources
- Efficient irrigation systems
- Promotion of native and drought-tolerant plant materials
- Development of water budgets where possible, and working toward water budgeting as an industry standard
- Partnering with City departments that focus on sustainability to create cohesive knowledge base

STRATEGIES MERITING FURTHER ANALYSIS

Data collection

Data collection needs and strategies were thoroughly considered by GRAG and City staff. At the present time, efforts have been concentrated on understanding and better quantifying the potential benefits of green roofs on controlling the quantity of runoff emanating from buildings using these systems. GRAG recommended funding for a study by the Lady Bird Johnson Wildflower Center on green roof impacts on hydrology; Council has approved funding for the project, which is expected to be completed in 2011. Ongoing and past efforts by the Watershed Protection Department have also resulted in the monitoring of two green roof systems in Austin and will be made available in the near future. Additional future studies will likely include research of water quality (e.g., control of nutrients) using green roofs.

Green roof performance data for energy conservation and heat island mitigation already exists from US and international studies. This data needs to be further reviewed for its applicability to green roofs in Austin. Central Texas studies of this topic may or may not be required.

Target Areas of Austin to Focus Green Roof Efforts

Staff has conducted preliminary studies of areas within Austin most suitable for targeting for green roof implementation.

> *Green roofs will likely deliver the greatest net benefit to areas disproportionately devoid of vegetation, open space, and natural areas.*

The results confirm what is intuitively obvious; green roofs will likely deliver the greatest net benefit to areas disproportionately devoid of vegetation, open space, and natural areas. Such areas include intensely impervious hotspots such as downtown, the North Burnet-Gateway Neighborhood Plan area, the East Riverside Corridor, and the Airport Boulevard Corridor near Highland Mall.

All of these areas are potential locations for incentives bonus for green roofs and are included in the Five-Year Policy Implementation Plan. However, many other areas of town, such as commercial and office areas along major roadways and Transit-Oriented Districts (TODs), might also benefit from the introduction of green roofs. Policies encouraging green roofs in these additional areas are a logical extension of pilot efforts in these three target areas.

Inventory Green Roofs in the Region

City staff, using site plan submittals as well as ongoing input from GRAG members, will continue to add green roof projects to the green roof projects inventory. The map will be incorporated into the new green roof website for education and outreach similar to the "Austin's Green Map" showing Austin Energy Green Building-rated and LEED-certified projects.

Evaluate Green Roof Opportunities for Residential and Retrofit Projects

Single-family residential green roofs represent about five percent of known green roofs in Austin. (See Appendix C for a green roof inventory and map.) Few existing areas of code evaluated by GRAG include significant single-family residential opportunities for green roofs. Retrofits make up a smaller proportion of Austin's green roofs. Further evaluation and research is needed to identify barriers and opportunities to increase green roof proliferation in both areas where appropriate.

GRoWERS, a four-year-old Austin green roof organization represented on GRAG, began the pilot phase of their Green Roofs Over (GRO) Austin project in 2009 to facilitate the construction of small, privately owned residential and retrofit green roofs across the Austin area, observing and learning from them in various settings. The goal is to continue to close gaps in the local knowledge of green roofs, primarily in the residential context, and to develop best practices. GRAG may evaluate opportunities to partner with GRoWERS in later phases of work.

Investigate the Potential to Implement Green Roofs on City Buildings

The justification for a green roof on a city building requires comparison of maximized public benefit against the additional investment required. Opportunities for green roofs on the City's inventory of buildings may be limited by utilitarian function, but Capital Improvement Programs and operating expenditures include replacement of existing roofs at end of life, renovations involving roofs, and new buildings. Consideration occurs currently through City Resolutions requiring projects over $2 million construction cost to be certified under the LEED Green Building Rating System. Also, Baseline Sustainability Criteria for smaller projects include consideration of a green roof.

A proactive effort for the City would be to categorize all city-owned roofs with the intent to study, select and seek additional funds for appropriate green roof locations. In addition, the green roof at City Hall should be monitored and analyzed to form milestone reports. A

forecast by a representative of the Department of Public Works estimates that the City has the potential to add at one additional green roof to the City's portfolio in the next five years.

Take Advantage of City Hall as a Green Roof Educational Model

The City Hall green roof was designed to be an environmental educational model for the citizens of Austin and out of town visitors. With its two types of green roofs over the parking garage and over occupied space, the layout offers a green roof educational opportunity.

> *The Austin City Hall green roof was designed to be an environmental educational model for the citizens of Austin and out of town visitors.*

Educational materials, such as brochures, could be developed which explain the components of the different types of green roof and the type of soil, irrigation, and plant palette and could be available at the reception desk in the City Hall lobby to accompany other handouts. Biannual tours in the spring and fall could be advertized and offered to the public. The tours could focus on the green roof challenges and opportunities through design, construction, and on-going maintenance. While for this City of Austin building these activities would likely be led by the City of Austin, similar initiatives could be considered for other green roofs in Austin under other auspices.

VII. Next Steps

In order to accomplish the policy goals determined by the Green Roof Advisory Group, the following Five-Year Policy Implementation Plan is proposed. Staff has identified tasks that could be executed to further promote green roofs within various City departments. Some tasks will be easier to accomplish within Year 1, while others may take a more concerted effort to bring forward. Those tasks that may require more review and coordination have been distributed throughout Years 2-5 accordingly. While some first year tasks are clearly defined, the long range plan is meant to be a dynamic, evolving document which takes into account new information, resources, and priorities.

The goals for policy implementation fall into eight broad categories: Outreach and Education, Design Considerations, Existing Development Options with Green Roofs, Potential Development Options with Green Roofs, Energy Impacts, Innovative Stormwater Management, Green Roofs for City Buildings, and Financial Incentives.

OUTREACH AND EDUCATION

Outreach and education is critical to encourage the implementation of green roofs in the city. Educational activities need to focus on the public and private benefits of green roofs, the availability of city departments to facilitate green roof implementation, and existing Austin green roofs as educational models. Green roof outreach and education should target interdepartmental staff activities, the design and development community, and professional organizations. In particular, GRAG recommends a green roof web page be developed as the central clearing house for all green roof activities in the city.

DESIGN CONSIDERATIONS

In order for the City to offer green roof incentives and credits, some design considerations need to be reviewed to establish baseline performance criteria. GRAG request for a one year extension includes effort to create these minimum standards.

EXISTING DEVELOPMENT OPTIONS

In some existing development regulations, green roofs already qualify to meet the code. GRAG recommends these options be highlighted to City staff and to the development community.

POTENTIAL DEVELOPMENT INCENTIVES

Existing and proposed development regulations could be modified to include green roofs. GRAG recommends that green roofs be considered as density bonus options and to offset potential building cover increases.

ENERGY IMPACTS

Green roofs provide energy reductions for individual buildings. GRAG recommends that these impacts be evaluated and that green roofs be considered for rebates.

INNOVATIVE STORMWATER MANAGEMENT

Green roofs can be designed to provide retention and runoff control for stormwater management. GRAG recommends City staff work with green roof manufacturers to verify proposed hydrological models for the Austin area. GRAG also recommends continued technological research be conducted to collect field data in our climate.

GREEN ROOFS FOR NEW BUILDINGS

Many cities leading the way in green roof infrastructure require green roofs on new institutional and commercial buildings. Although not a requirement in 1995, a green roof was implemented on the Austin City Hall, with the intent of the green roof being used as an educational model. In the first year of the Five-Year Plan, GRAG recommends the City consider green roofs for any new city building projects. Also, GRAG recommends that at least one new green roof be implemented on a new city building in the next five years. GRAG also suggests, during the second year, to evaluate the feasibility of requiring green roofs on new commercial buildings in the Central Business District.

FINANCIAL INCENTIVES

Financial incentives have been shown to be effective in other cities. GRAG recommends that these be evaluated for implementation in years four and five of the plan.

GREEN ROOFS FIVE-YEAR POLICY IMPLEMENTATION PLAN

(Key to acronyms follows.)

Year One (FY 2010-11)

Activity	*Lead*	*Discussion*
Outreach and Education		
• Green Roof Web page & support materials	AE	Develop; includes items below w/ asterisk (*)
• Green Roof program tracking & report*	AE/WPD/PDRD	Track GR initiatives/5-Year Plan progress
• Staff education and coordination*	Multiple	Done for each initiative; internal web page
• Urban Heat Island integration*	AE	Integrate GR into program
• Green Roof database*	AE/PDRD	Track projects in City maintained database
• City Hall educational model*	AE	Develop educational flyer and tours
• Outreach to focus areas	GRAG	Meet with professional organizations
Green Roof Design Considerations		
• Baseline Performance Criteria	GRAG/AE/	Define minimum standards for City
	WPD	incentivized projects; extend GRAG to accomplish task
Existing Development Options with Green Roofs		
• PUD Open space & landscaping*	PDRD	Show can meet requirements with GRs
• PUD Green Building requirements	AEGB	Show GRs can contribute to score
• PUD use of GR in Tier 2*	PDRD/AE	Show GRs can be "other creative or innovative [environmental] measures"
• Multifamily open space*	PDRD	Show can meet requirements with GRs
• Subsurface parking garage*	PDRD	Show GRs over subsurface garages do not count as impervious
• Parkland dedication using GRs*	PARD	Show can use privately owned and maintained GRs to meet requirements

Potential Development Incentives (require code change & Council approval)		
• GR Density Bonus: Downtown	PDRD	Add green roofs to program
• Building cover increase with GR	PDRD	Allow more building cover if offset
Energy Impacts		
• Austin Energy rebates	AE	Evaluate energy impacts & potential rebate incentives
Innovative Stormwater Management		
GR hydrologic study	WPD/WFC	Research of detention & runoff control by LBJ Wildflower Center (WFC)
GR industry water quality control	Industry/WPD	Coordinate with staff to verify hydrologic model for WQ credit (option exists throughout 5-year period)
Green Roofs for New Buildings		
GR on City Buildings	PWD	Evaluate feasibility & funding of green roofs for all new City buildings per Council resolutions 20071129-045 & 20071129-046

Year Two (FY 2011-12)

Activity	*Lead*	*Discussion*
Outreach and Education		
• Green Roof Web page & support materials	AE	Continue funding allocation
• Green Roof program tracking & report	AE/WPD/PDRD	Track GR initiatives to show progress
• Green Roof project database*	AE	Track projects to show progress
Incentives for Green Roofs		
• Austin Energy rebates	AE	Implement rebate if warranted, pending evaluation results from Year 1
• North Burnet/Gateway GR density bonus	PDRD	Needs Council approval; follows Downtown density bonus

Innovative Stormwater Management		
• Water quality evaluation	WPD	Evaluate option to allow a limited number or pilot projects in DDZ Watersheds to receive partial WQ credit on condition of monitoring
• Plan for GR/LID design competition	WPD/GRAG	Follow City of Houston example
Planning for Green Roof for City Building		
• Collect, evaluate data on buildings	PWD	Create inventory of existing & proposed COA buildings/roofs, select subset for further GR consideration per Council resolutions 20071129-045 & 20071129-046
Green Roofs for New Buildings		
• GR on New Commercial Buildings	GRAG/PDRD	Evaluate feasibility of green roofs for all new buildings within the Central Business District

Year Three (FY 2012-13)

Activity	*Lead*	*Discussion*
Outreach and Education		
• Green Roof program tracking & report*	AE/WPD/PDRD	Track GR initiatives to show progress
• Green Roof project database*	AE	Track projects to show progress
Incentives for Green Roofs		
• Airport Blvd. Corridor GR density bonus	PDRD	Needs Council approval; follows Downtown & N. Burnet/Gateway density bonuses
Innovative Stormwater Management		
• Flood detention and/or WQ sizing credit	WPD	Pending Wildflower Center results & possible other follow-up studies
• Hold GR/LID design competition	WPD/GRAG	Follow City of Houston example

Year Four (FY 2013-14)

Activity	*Lead*	*Discussion*
Outreach and Education		
• Green Roof program tracking & report*	AE/WPD/PDRD	Track GR initiatives to show progress
• Green Roof project database*	AE	Track projects to show progress
Innovative Water Quality Controls		
• Green Roof as WQ control	WPD	Evaluate feasibility to add ECM Criteria for green roofs; pending Wildflower Center results & additional follow-up studies
Subsidies, Grants, Low-Interest Loans		
• Funding Allocation	EGRSO	Develop criteria pending staff review

Year Five (FY 2014-15)

Activity	*Lead*	*Discussion*
Outreach and Education		
• Green Roof program tracking & report*	AE/WPD/PDRD	Track GR initiatives to show progress
• Green Roof project database*	AE	Track projects to show progress
Development Process Incentives		
• Fee Rebates, Expedited Process & Design Support	PDRD	Develop Incentive Program

Key to Acronyms

AE	Austin Energy
COA	City of Austin
DDZ	Desired Development Zone (Urban & Suburban watersheds)
EGRSO	Economic Growth & Redevelopment Services Office
FY	Fiscal Year
GR	Green Roof
GRAG	Green Roof Advisory Group
LID	Low Impact Development (design strategy to limit environmental impact)
PDRD	Planning and Development Review Department
PWD	Public Works Department
WFC	Lady Bird Johnson Wildflower Center
WPD	Watershed Protection Department
WQ	Water Quality

PROPOSED EXTENSION OF ADVISORY GROUP TIMEFRAME

GRAG developed a proposed Five-Year Policy Implementation Plan which outlined efforts and initiatives that would be reasonable to achieve within the timeframe of the Implementation Plan. In particular, GRAG identified critical path tasks for the first year that were not able to be addressed within the timeframe approved by Council for GRAG, but would be necessary to achieve in order to provide a solid basis for further policy development. To this end, GRAG requests to continue its efforts for one year after presentation of the final report to Council to accomplish the following:

- Develop of green roof design considerations for commercial building projects.
- Support for the development of green roof web page and other educational initiatives.
- Advocate for green roofs as a public benefit option for the Downtown Density Bonus Plan.
- Assess City funded green roof monitoring research.
- Provide progress review of staff implemented year one policy incentive and credit initiatives.

During this time staff could continue to develop the proposals of the Policy and Incentives Matrix and provide feedback on the viability of the Design Considerations within individual departments, as well as consider the feedback of local professional organizations and additional stakeholders. If ordinance changes to encourage green roofs are able to be proposed, then, with Council direction, staff could take them through the Legal Department and subsequently send to the Codes and Ordinances sub-committee of the Planning Commission for feedback and review prior to presenting back to Council for approval.

GRAG believes that without continuation, the momentum currently achieved could go for naught and the potential within the final report never realized. However, with the continuation of GRAG, the group can assist staff in providing a baseline level of green roof policy support that will solidly secure its position within City programs and codes.