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Green Roofs in the Garden City: Exploring the Opportunities for Green Roof Policies in Missoula, Montana

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Professional Paper

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Executive Summary

Purpose

The purpose of this paper is to examine the practice of green roofing and municipal policy tools used to promote this practice, and to determine which of these, if any, would be politically, practically, and economically feasible for the City of Missoula, and make appropriate recommendations.

To accomplish this, three research components were carried out:

1. An examination of the practice of green roofing, including a brief history of the practice, definitions of green roofs, a delineation of green roof benefits, potential obstacles to adopting the practice, and concerns specific to Missoula conditions.
2. An exploration of six policy tools to locally encourage green roofing, along with case examples in the United States and abroad.
3. A stakeholder analysis of views on green roofing based on interviews with a range of Missoula stakeholders, including City administrators, the architecture and building community, conservation organizations, and other Missoula residents and organizations.

Community involvement is essential to successfully crafting effective local approaches to municipal sustainability. Policymakers must rely on stakeholder input when considering how best support the public good. An analysis of stakeholder policy preferences and views gathered in this report makes it possible to draw conclusions regarding the opportunities to promote green roofing in the City of Missoula and offer recommendations suitable to local conditions such that the public and private benefits of green roofs can be enjoyed.

The research and analysis led to six recommendations as to how the City of Missoula could promote the practice of green roofing through policy measures, beginning with education, awareness, and demonstration projects.

Background and Need

In the Rocky Mountain West, global climate change is expected to result in warmer air temperatures, increased risk of wildfires, diminished winter snowpack, alteration in timing

and intensity of summer runoff, and impacts to wildlife, the natural environment, and local economies. The State of Montana, Missoula County, and the City of Missoula all have acknowledged the threats climate change poses and are taking steps to address these challenges at a time of high energy costs when energy savings matter more than ever.

Green roofs and sustainable building design in general are important tools of local government and the private sector to be more energy efficient, save money and reduce community carbon footprints. It is estimated that roof surfaces cover between 21% and 26% of these urbanized areas. Roofs therefore offer a compelling solution to a number of pressing fiscal and climate change-related issues.

In response to this opportunity, the sustainable building method of green roofing has been increasingly deployed across Europe and in the United States, with many communities adopting policy measures to encourage or require the practice.

In recent decades, Germany has used a number of policy tools to encourage green roofing, and by 2001 had become the world leader in green roofing with around 145 million square feet (3,329 acres) of roof area greened. These and other successes brought attention to the practice and green roof policies in Europe and the United States. Nevertheless, greater awareness of the benefits of green roofs is needed for more widespread adoption.

Green Roof Benefits and Obstacles to Adopting the Practice

Green roofs are increasingly recognized to offer a host of benefits to building owners, contractors and the greater community, including:

- Improved energy performance
- Extended roof lifespan
- Better stormwater management
- Reduction of the urban heat island effect
- Improved air quality and public health
- Increased habitat and biodiversity
- Greater amenity and aesthetic value
- Improved environmental image
- Support for local economies.

These benefits are described in detail in the body of this paper.

However, three common obstacles limit the widespread adoption of the practice:

1. Green roofs can cost between 15% and 100% more than a conventional roof.
2. Green roofs can be installed only on buildings capable of bearing the extra weight of the green roof system.

3. Compared to conventional roofs, green roofs require more maintenance such as irrigation and occasional plant upkeep, though newer systems are engineered to reduce these needs.

Green Roof Policy Tools and Case Examples

My research identified the following six policy tools used by municipalities to promote green roofing:

1. Feasibility studies tailored to local economic and climatic conditions to evaluate effectiveness and develop best practices. For example, the City of Chicago conducted a study to test green roof performance under controlled conditions, and the City of Seattle is in the process of conducting a similar study.
2. Demonstration green roof projects that raise awareness in the community and disseminate information. For example, the Chicago City Hall building features a 20,000 square foot demonstration green roof project, and the City of Portland provides a directory of existing green roof projects through its green roof web portal.
3. "Lead by example" policies requiring green roofs for all city-owned buildings to further raise awareness and set a tone of leadership. For example, the City of Portland requires all new City-owned facilities, wherever practical, to incorporate a green roof with at least 70% coverage.
4. Indirect financial incentives including reductions in associated building and permitting costs such as stormwater sewerage access fees. For example, the City of Portland offers up to a 35% discount on municipal stormwater fees for buildings incorporating a green roof.
5. Direct financial incentives, typically in the form of upfront grants to help offset the expense of green roof installation. For example, the District of Columbia offers grants of $5 per square foot of green roof installed, and the City of Milwaukee issues grants for green roof construction through its sewerage district.
6. Mandatory building design standards requiring partial or full green roofs for new and existing structures. For example, the City of Toronto mandates a certain amount of green roofing for every new development with a roof area of at least 2,000 square meters (21,500 square feet), and Tokyo requires green roofs for all new buildings with a roof area of at least 1,000 square meters (10,750 square feet).

Stakeholder Analysis

In order to offer City decision makers recommendations on how to most effectively approach this issue, I sought input from a wide range of Missoula-area stakeholders, which were asked a series of open-ended questions regarding:

1. The practice of green roofing and the policies used by other communities.
2. The extent to which they or their organization had been involved with green roofs.
3. Whether they would be in favor of the City of Missoula taking measures to encourage green roofs.
4. Their views on actions the City could take to promote green roofing, including a City-led demonstration green roof project, a "lead by example" policy for all City buildings, financial incentives, and mandatory building design standards.
5. Their ranking of these options in order of preference and their reasons for their rankings.

In April 2011, 22 individuals were interviewed in 16 separate interview sessions. Interviewees included:

- 6 City administrators
- 9 members of the architecture, building and design community
- 4 representatives from the conservation community
- 1 representative of the Missoula Downtown Association
- 2 representatives from the green building industry.

Twelve out of 16 interviewees expressed support for the City taking official action to promote green roofing in Missoula. These views were shared primarily by the "Architecture, Design and Building", "Conservation", and "Other" stakeholder groups. City administrators mostly declined to opine, in favor of leaving such decisions up to policy makers.

With a few exceptions, policy options were ranked in the following order of preference by the diverse set of stakeholders interviewed:

1. A City-led demonstration green roof project
2. A City "lead by example" policy
3. Financial incentives
4. Mandatory building design standards.

As shown in the table below, 12 interviewees also supported a City effort toward education on green roof benefits and best practices for Missoula's climate. These stakeholders viewed the dissemination of this information as an essential step toward widespread green roof

adoption. Many stakeholders also said that voluntary, nonmonetary incentives would be much more preferable than financial ones.

*Summary of Green Roof Preferences for All Stakeholder Groups**

Rank	Demonstration Project	Lead by Example Policy	Financial Incentives	Mandatory Policy	Education/ Information
1st	12		1		
2nd	1	10	2	1	
3rd	1	1	11		
4th				12	
Other	1†	2±	1±	2±	12†

* Values shown indicate the number of interviewees giving 1st through 4th rankings for various green roof policies
† Supported or gave qualified support, but not ranked
± Mentioned but not ranked

In sum, stakeholders conveyed a surprising amount of consensus regarding their policy preferences.

Recommendations

In developing recommendation for City officials regarding green roofs, this exploratory research sought to keep closely in mind the City's budget limitations, Missoula's small size relative to other cities promoting green roofing through policy measures, our climate, and the deep importance to Missoula residents of protecting the environment and quality of life.

These considerations and stakeholders' strong consensus view to begin with education, demonstration and awareness-raising contributed to the following six recommendations regarding how the City could best promote green roofing and encourage more widespread adoption in the community:

1. Educating citizens about green roofing benefits and best practices.
2. Establishing a City-led demonstration green roof project.
3. Better defining green roofs within the City Building Code.
4. Passing a nonbinding resolution in support of green roofing in Missoula.
5. Adopting a strong sustainable building policy for the City of Missoula.
6. Offering nonmonetary incentives for building owners and contractors interested in installing green roofs (including allowing green roofs to meet landscaping requirements in the Missoula City Zoning Ordinance and offering building height bonuses where appropriate).

In order to build support and establish a sound foundation for green roofing in Missoula, implementing these recommendations should begin with:

- Education on green roof benefits and best practices.
- Establishing standards for green roofs in the Missoula Building Code.
- Passing a nonbinding resolution from the City Council in favor of the practice.

Once these priorities are in place, I recommend that the City leaders consider the other recommended actions, in particular:

- Nonmonetary incentives for green roof installation
- A City-led green roof demonstration project, and
- A renewed City commitment to sustainable building practices.

Of these, nonmonetary incentives may be the most practical next step, as they enjoy broad support and could be enacted with minimal budget impact and minor updates to the Missoula Zoning Ordinance.

If it were accounted for with lifecycle pricing, whereby the lifetime cost of building operations were considered prior to-construction, a City-led demonstration green roof project may also prove to be financially feasible as a next step. Such an option was strongly supported by interviewed stakeholders.

Although stakeholders also supported a stronger City commitment to sustainable building practices, bold action by the City may prove difficult at this time. Nevertheless, green roof policy measures deserve serious consideration in the near future, for example, during the drafting and implementation of Missoula's Climate Action Plan. Green roofs offer many beneficial opportunities that can only be enjoyed if they are sought out.

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Chapter 1: Introduction

Global climate change, driven by changes in the atmospheric abundance of greenhouse gases, solar radiation, and land surface properties, poses grave threats to the environment and the modern human lifestyle and is anticipated to continue well into the 21st century (IPCC 2007). Climate change is predicted to have serious ramifications for the Rocky Mountain West, affecting water and land use, energy consumption, wildlife stewardship, and a host of other contentious issues (Bates et al. 2010). Specifically, climate change is expected to impact the Rocky Mountain West through warmer air temperatures, increased risk of wildfires, diminished winter snowpack, and alterations in timing and intensity of summer runoff. Climate change also threatens to impact outdoor recreation and tourism industries, which comprise the fifth largest employer in the State of Montana (Saha et al. 2010).

As constituent communities of this region, the State of Montana, Missoula County, and the City of Missoula all have recognized the threats posed by global climate change and expressed interest in engaging the challenges it poses to the local environment, economy and lifestyle. In November of 2007, Montana Governor Brian Schweitzer committed the State of Montana as a partner in the Western Climate Initiative, a collaborative organization of independent jurisdictions including seven States working to "identify, evaluate, and implement policies to tackle climate change at a regional level," (Western Climate Initiative 2011) stating that "climate change is serious and Montana should lead by example" (Elliott 2007). Missoula County Commissioners, acting under advice from the Missoula County Green Government Committee, adopted in 2010 a County Green Building Policy requiring

County facilities to incorporate or support Leadership in Energy and Environmental Design (LEED) sustainable building methods and techniques (Briggeman 2010) in an effort to "provide environmental benefits, create local jobs, improve employee health, productivity and the quality of workspace, enhance asset value, and achieve the highest, most cost-effective environmental performance possible over the life of County projects" (Missoula County 2010). In Missoula, Mayor Engen's embrace of the U.S. Conference of Mayors' Climate Protection Commitment, a pledge to address climate change issues on a local level, the execution of Missoula's Greenhouse Gas Inventory, an analysis of the City's greenhouse gas emissions and targets for improvement, and the enactment of Resolution #7241, an energy efficiency and greenhouse gas reduction policy for municipal buildings, are steps toward mitigating the impacts of climate change at a local level (Saha et al. 2010). However, these efforts are aimed primarily at addressing municipal activities, leaving plenty of room for initiatives focused on opportunities in the broader community.

Urban areas present several challenges within the context of the campaign against global climate change, as built environments have been a significant cause of environmental degradation in previously undeveloped landscapes (Carter and Keeler 2007). In urban spaces both residential and nonresidential, between 21% and 26% of land area is accounted for by roof space (Getter and Rowe 2006). Roofs therefore offer a compelling target for addressing a number of urban environmental and climate change-related issues. To take advantage of this opportunity, one historical practice, green roofing, has seen increased deployment in Europe and parts of North America since the mid-20th century. As green roofs can offer a host of benefits, including improved building energy efficiency, prolonged lifespans for roofing membranes, alleviation of the urban heat island effect, reduction in

stormwater volume, improved water quality, improved urban habitat, and valuable urban amenity space, cities have begun to use a variety of policy tools to encourage this practice. As discussed below, the City of Missoula – residents, business owners, and the municipal government – may benefit from the City adopting one or more of these policies to encourage this practice; however, given the contentious nature of climate change issues such a policy is more likely to be successful if driven by a community-driven effort.

This research project intends to investigate the practice of green roofing and the policy tools used to promote them, with the goal of determining what, if any, green roof policies or other actions may be politically and logistically feasible in the City of Missoula. Chapter 2 of this report, "Green Roofs: Practice, Benefits, and Considerations", defines green roofing, identifies the two types of green roofs, and provides a brief history of the practice from ancient times up to today. It also provides a detailed list of the benefits green roofs can offer to building owners and municipalities, addresses common concerns regarding the practice, and examines two important considerations specific to Missoula. Chapter 3, "Green Roof Policies and Case Studies", identifies and defines the policy tools used in other jurisdictions to encourage the practice of green roofing. It identifies a number of jurisdictions employing such measures, and examines them to gain a sense of those programs' goals, structures, and outcomes. Chapter 4, "Stakeholder Analysis", begins with an explanation of the importance of local stakeholder opinions to the crafting of City policies and initiatives. It presents fourteen interviews with 22 Missoula-area stakeholders from City administration, the building and architecture community, business organizations, local conservation organizations, and the green roof industry. It analyzes these interviews to determine the level of familiarity with green roofs among Missoula stakeholders, thoughts

and concerns about the practice and the policy tools available to help promote it, and preference rankings for these policy options. The project concludes with Chapter 5, "Conclusions and Recommendations", in which the information gained through the previous three sections is evaluated to determine what benefits Missoula may stand to gain from wider deployment of green roofs and what, if any, green roof policy is politically and logistically feasible for Missoula, and to offer recommendations to City decision makers and administrators on how to best go about promoting green roofs in the Garden City.

Chapter 2: Green Roofs: Practice, Benefits and Considerations

This section introduces the practice of green roofing and provides definitions of the two types of green roofs. It gives a brief history of the practice, from its roots in ancient times up to its modern day incarnations. It identifies and describes nine benefits green roofs offer to building owners and the greater community. It explores three obstacles to widespread deployment of green roofs, addressing cost, structural concerns, and maintenance needs. It concludes with two important considerations specific to Missoula, discussing irrigation needs in Missoula's arid climate, and wildfire considerations.

Defining Green Roofs

Green roofing is the practice of installing vegetative roof surfaces in lieu of conventional roofing materials such as asphalt or tar. These are engineered roof systems that include vegetation planted in a growing medium above an underlying synthetic waterproof membrane. With roots in antiquity, this practice has seen a resurgence since the middle 20th century, particularly in Europe but increasingly in North America (Ngan 2004). Green roofs fall into two major categories: intensive and extensive.

Intensive green roofs are probably what most people picture when they hear the phrase "green roof". Named for the "intense" maintenance attention demanded by the plants used, these roofs resemble true gardens (Greenroofs.com 2011a). They utilize substrates of 8-12 inches or deeper in order to create a habitat for a wide range of plants, up to and including shrubs, large grasses, and trees. Intensive green roofs emphasize the active use of the space they fill, and often serve as living and recreational space in crowded areas. In the United States, these are most often encountered in high-profile locations such

as hotels and business centers, as well as being a feature of many high-income residential spaces such as luxury condominiums (Oberndorfer et al. 2007).

Figure 1: An intensive green roof atop Crowne Plaza Hotel, Minneapolis, MN. Photo via www.mngreenroofs.org.

Extensive green roofs, on the other hand, emphasize utilitarian benefits such as improved building energy use and better retention of stormwater runoff. They are a modern modification of the green roof concept, utilizing shallower substrates and a smaller range of plant species. Extensive green roofs are more strictly functional in purpose than intensive green roofs, and require much less maintenance than their intensive counterparts.

They are composed simply. General plans for extensive green roofs normally include an insulation layer, a water- and root-proofing membrane to prevent water and root damage to the roof surface, a growing media layer including gravel for drainage and soil for planting, and the vegetative layer, often composed of hardy, drought-tolerant species such as sedum and mosses. Due to this simple, shallower composition, extensive green roofs are lighter and can be supported by a greater number of buildings without making structural modifications (Oberndorfer et al. 2007).

Figure 2: An extensive green roof and hardscape atop the "Corner" 5-story Higgins St. condominium complex. Photo provided courtesy of Eric Hefty, Missoula architect and developer.

History of green roofs

Before entering an in-depth discussion of the practice and benefits of green roofing and the policies used to promote deployment of the practice, it is fitting to examine briefly the origins of green roofs and their rise within the context of sustainable building design. This section gives an overview of the history of green roofing from ancient times up to the present day, and offers a historical context for the emergence of green roofs policies in Europe and North America.

The earliest green roofs date back to the days of antiquity, in the form of roof and hanging gardens in what is now Syria – the famed "Hanging Gardens" included in the seven wonders of the ancient world (Oberndorfer et al. 2007). They were also used extensively since prehistory in Iceland and in parts of Scandinavia as a standard building method. Here, they were employed not for aesthetic purposes, but rather as an insulation measure and as a response to available building materials (Greenroofs.com 2011a). This method would be mimicked in the 1800s and early 1900s in the United States, as settlers of the Great Plains constructed sod dwellings in response to that region's lack of timber for building (Getter and Rowe 2006).

Around the turn of the twentieth century, green roofing saw a resurgence in Germany. As buildings of this time were commonly roofed with highly flammable tar, they posed a serious fire risk in densely populated areas. This led to a period of experimentation with other roofing materials, including covering roof surfaces with layers of sand and gravel. These sand-gravel roofs were soon seeded by wind dispersal and bird droppings, and began to bloom into rooftop meadows. These accidentally-greened roofs were soon discovered to

pose a lower risk of fire, as well as provide excellent protection for roof materials from the damages of solar radiation (Oberndorfer et al. 2007).

Building on the momentum created with these early experiments, Germany would go on to become a world leader in green roofing. In response to the deterioration of waterproof roofing membranes and other building design issues, German architects and designers in the mid-1960s began to compile techniques and materials for more efficient roofs, among which were green roofs. Research in the 1980s began to reveal the ecological benefits of green roofs, resulting in a high demand for the newly-coined "extensive" green roofs composed of species which could maintain themselves indefinitely. Simultaneously, federal, state and municipal governments began implementing public policies to encourage green roof construction. Through these policies, by 2001 a roof area of 13.5 million square meters (around 145 million square feet) of German roofs had been greened, and by 2003 it was estimated that green roofs comprise 14% of all roof area in Germany (Ngan 2004). These successes encouraged development of green roof techniques and policies in other parts of the world, namely Switzerland, Scandinavia, Canada, and the United States (Ngan 2004), with an estimated 2.1 million square feet of green roof installed in North America by 2006 (Scalia 2006). The movement continues to pick up steam today as communities in the United States strive to address the challenges of urbanization and develop more sustainable cities (Ngan 2004).

Green Roofs and Benefits

Green roofs offer many potential benefits to both building proprietors and communities, including: improved energy performance; extended roof lifespan; better stormwater management; reduction of the urban heat island effect; improved air quality;

increased habitat and biodiversity; greater amenity and aesthetic value; improved environmental image; and support for the local economy. These benefits are explored in detail below.

Improved Energy Performance

The installation of a green roof greatly enhances a building's thermal performance. Studies indicate that the depth of the growing media, shading from foliage, absorption of ultraviolet radiation by plant species, and evapotranspiration from growing plants can reduce solar energy gain by up to 90% (Getter and Rowe 2006). Green roofs reduce the amount of heat transferred through the roof in warm weather (Del Barrio 1998), reducing the amount of energy transferred between the roof and the atmosphere and resulting in lowered seasonal heating and cooling costs: one Ottawa green roof reduced the amount of heat entering during summer days by 85% and reduced the amount of heat leaving the building in winter by 70% (Liu 2004). Research in Japan found reductions in heat flux on the order of 50% per year (Onmura et al. 2001). One Madrid study found that a green roof reduced the cooling load for an eight-story residential building by 6% in the summer (Saiz et al. 2006). And the cooling load for an average Toronto house was reduced by 60% for the floor directly below the green roof and 25% for the entire building (Oberndorfer et al. 2007). These results were duplicated in a study by the EPA on the performance of green roofs in arid climates, which found a heat gain reduction of 25% for greened roofs compared to only a 4% reduction for a white reflective membrane (U.S. EPA 2009). This results in reduced cooling expense for building owners (Ngan 2004).

This reduced cooling demand can have important consequences in the campaign against climate change, which is anticipated to result in longer, warmer summers for the

Rocky Mountain West (Bates et al. 2010), as the thermal protection provided by green roofs reduces reliance on air conditioning and thereby reduces the municipality's greenhouse gas profile. The emission of ozone, an important greenhouse gas, can also be reduced by decreasing reliance on air conditioning (Banting et al. 2005). Missoula experiences 280 cooling degree days (a measurement of the total number of degrees the average building must be cooled over a year) through the months of June-September (Climate Zone 2011), so green roofs may offer significant alleviation of climate control needs for local buildings through the hot summer months.

Extended Roof Lifespan

Unprotected waterproof roof membranes are susceptible to damage and breakdown due to exposure to ultraviolet radiation, heat, and extreme temperature fluctuation (Nedlaw Living Roofs 2008). Plant material absorbs harmful solar ultraviolet radiation that damages waterproof roofing membranes, and reduces daily temperature fluctuations at the roof level (one study determined the magnitude of temperature fluctuation above a green roof at around 3° C, as opposed to 50° C for a traditional tar or gravel roof) (Getter and Rowe 2006). As a result, green roofs can serve to prolong the lifespan of a building's waterproof roofing membrane. Studies indicate that a traditional roofing membrane will need to be replaced around once every twenty-five years, whereas a green roof will need replacement around once every fifty years. Some proponents claim an even longer lifespan of up to seventy years (Cohen 2009), and some green roofs in Berlin have lasted over 90 years without needing major repairs (Porsche and Kohler 2003). Over the lifetime of a building, this can add up to significant savings for a building owner.

Stormwater Management

Green roofs have important effects on a municipality's water quality and ability to deal with stormwater runoff. Only about 25% of rainwater is absorbed in an urban environment, posing a threat of flooding downriver where channels are inundated beyond their capacity. This stormwater surge can also result in combined sewage overflow (CSO) events, where overwhelmed sewage treatment ponds flood and spill raw sewage into the surrounding watershed; it is estimated that CSO events in New York City result in roughly forty billion gallons of sewage entering the local watershed (Getter and Rowe 2006). Green roofs, on the other hand, remove around 50% of stormwater through absorption by vegetation, and the rest is detained in the growing medium, effectively slowing peak stormwater flows. Green roofs also serve to remove pollutants from rainwater, resulting in cleaner runoff in general (U.S. EPA 2010). When used in conjunction with cisterns, green roofs also present the opportunity for greywater and stormwater recycling for watering, or as a backup fire control measure (Ngan 2004). This benefit may be smaller in Missoula's climate than in other communities such as Portland or Chicago, as rainfall averages a little over 1 inch per month (for a total of 13.5 inches per year) (Climate Zone 2011). However, as a number of older buildings in the downtown area direct their stormwater runoff into the sanitary sewer system, and as the downtown area including much of Higgins Street, Broadway, 5th and 6th Streets, and parts of 3rd and Orange Streets drain directly into the Clark Fork River (Jon Harvala, Environmental Health Specialist, Missoula Water Quality District, personal communication, April 29, 2011), green roofs may nevertheless be able to play a role preventing pollution of Missoula's waterways through stormwater runoff. Furthermore, many buildings in Missoula manage their stormwater through the use of

injection wells (also known as sumps or dry wells), a practice which raises concerns of stormwater contaminants entering Missoula's groundwater aquifer, especially in rapidly developing areas of the City (Missoula County Water Quality District 2010). Deployment of green roofs in these areas may help mitigate these concerns.

Reduction of the Urban Heat Island Effect

Green roofs have a significant impact on the urban heat island effect, which is responsible for up to a 10% increase in building energy costs (Banting et al. 2005). They provide pervious surfaces in developed areas where once there was only tar or other impermeable membranes, creating a place for water to settle and to cool the surrounding air through evaporation and evapotranspiration. Green roofs also prevent, though reflectance, the absorption and gradual release by urban surfaces of ultraviolet radiation, resulting in overall cooler conditions in urban areas (Getter and Rowe 2006). As discussed in the previous section, green roofs also reduce the reliance on air conditioning which is a major cause of the urban heat island effect (Ngan 2004). It has been found that temperatures above green roofed buildings can be up to 30° C lower than above a traditional roof (Wong et al. 2003), which leads to greater efficiency in cases where air conditioning must be used. As an example, it is estimated that if all eligible roof space in the City of Chicago had green roofs the City would save roughly $100,000,000 annually due to these effects (Getter and Rowe 2006). These green roof benefits also have implications for public health, as the urban heat island can contribute to heat-related illness and deaths (U.S. EPA 2011); one study by the Centers for Disease Control and Prevention (CDC) notes that between 1999 and 2003, heat exposure caused or contributed to 3,442 deaths (CDC 2006). As climate change is anticipated to bring increased heat waves and heat stress, and is

likely to result in increased heat-related sickness and death (CDC 2011), addressing the urban heat island effect will continue to increase in importance. Green roofs may serve as one effective means of addressing this issue.

Improved Air Quality and Public Health

Green roofs present other air quality benefits to municipalities. Ground-level ozone gas concentrations were found to increase 5% for each degree Celsius rise in the Los Angeles basin, as peak air conditioner use corresponded with the hottest part of the day. As discussed previously, green roofs can reduce the reliance on air conditioning, leading to improved air quality (Banting et al. 2005). One German study found that green roofs significantly purify urban air of diesel exhaust, and other studies have shown newly installed green roofs can reduce atmospheric sulfur dioxide by 37% and nitrous oxide by 21%, giving green roofs an important role to play in the avoidance of acid rain. These green roof benefits can help to decrease respiratory morbidity, as measured by absenteeism from work or other activity restrictions, and may help a municipality maintain federally-mandated air quality standards and thus retain federal funding (Getter and Rowe 2006).

Increased Habitat and Biodiversity

Green roofs serve as a source of new urban habitat, enhancing a municipality's biodiversity (Carter and Keeler 2007). They can act as stopover points for migratory species suffering habitat fragmentation, and return areas for plant and animal species that previously inhabited the area. Green roofs may serve as a permanent habitat for plant and invertebrate communities, including bees, beetles, moths, butterflies, earthworms and snails, and for a number of bird species. They may also serve as a habitat for desirable species (for example, one 10 hectare green roof in Zurich, Switzerland is home to over

10,000 orchids, including some rare species) (Ngan 2004). The United Kingdom Green Building Council has made constructing habitat corridors through green roofing a major priority in the City of London's effort to restore habitat and offer return space for endangered species (Carus 2008).

Greater Amenity and Aesthetic Value

Green roofs can add amenity value to a building, resulting in higher demand for rented spaces and the opportunity for rent premiums. They may result in higher tenancy rates in units with visual or physical access to green roofs (Getter and Rowe 2006). One Missoula developer said of the extensive green roof recently installed on the top of a 5-story condominium complex that it paid an "immediate dividend" – the units with access to the green roof and the amenity space it created were "much more attractive" and sold before any other units in the building (Eric Hefty, Eric Hefty and Associates PC, personal communication, May 3, 2010).

Green roofs also enhance the aesthetic and amenity value of a building and its surrounding community. Studies have shown that workers with a view of greenery displayed lower stress levels and blood pressure, and increased positive feelings and productivity (it should be noted that even inaccessible green roofs may provide this benefit when viewed from above) (Getter and Rowe 2006). A green roof demonstration test plot atop Missoula's St. Patrick Hospital, visible from patient rooms, was installed primarily for aesthetic benefits (Moore 2010). When accessible in the form of a park or community garden, they provide amenity space without taking up valuable (and expensive) ground space, and can offer space for food gardening, as in the case of Missoula's Gold Dust low-income housing building.

Figure 3: A demonstration extensive green roof sedum strip atop St. Patrick Hospital, Missoula. Photo via www.missoulian.com.

Improved Environmental Image

Green roofs may serve to enhance a municipality's environmental image. They can be a selling point for cities working on reforming their environmental profile, and thus can offer broader economic benefits beyond the energy and building sustainability benefits already listed. (Ngan 2004). This has important ramifications for Missoula, where citizen organizations such as the Sustainable Business Council Missoula already strive to bring new eco-friendly business to the area (Missoula Sustainable Business Council 2010), and the Missoula Downtown Association which has increasingly made sustainability part of its dialogue of effective and thoughtful development of Missoula's downtown area.

Support for the Local Economy

Green roofs enhance the local job market for nurseries, landscape contractors, irrigation specialists, designers, and other green workers, stimulating a municipality's economy and job market (Getter and Rowe 2006). Missoula's neighbors are already benefiting from this effect in the form of Nate Lengacher, a Stevensville farmer who provided the green roof for the Higgins Street "Corner" condominium complex and who has done business as far away as Salt Lake City, Utah and Redmond, Washington (Cohen 2009). Josh Slotnick, a local organic farmer and representative of the non-profit organization Garden City Harvest, says that anything creating new opportunities for local farmers to sell what they grow is a good thing, and that he sees expansion of green roof vegetation growing not as a competition thing, but only as a new opportunity (Josh Slotnick, personal communication, April 28, 2011).

Obstacles

Though green roofs can offer many benefits to building owners and communities, widespread deployment of green roofs faces certain challenges. This section will examine and address these obstacles, including cost, structural concerns, and maintenance.

Cost

The most commonly cited concern regarding green roofs is the cost of installation. Cost estimates range from around 10-14% more to install than conventional roofs (Carter and Keeler 2007) to up to twice as expensive, ranging from $10-15/square foot for new constructions to $15-25/square foot in roof retrofit projects (City of Portland 2009). In Missoula, the developer of the Higgins Street "Corner" condominium building, which incorporates an extensive green roof accessible to tenants, reported that the green roof

project added around $35,000 to the cost of the building (Eric Hefty, Eric Hefty and Associates PC, personal communication, May 3, 2010). Some proponents estimate a reduction in green roof costs of around 20% would make them more affordable than conventional roofs in certain areas (Carter and Keeler 2007).

Some advocates raise the argument that current valuation of green roofs may neglect important factors that would make them more competitive without a reduction in materials or installation costs: one study found that when air quality improvements (e.g. reductions in nitrogen oxides) are considered, green roofs may already pose 20-25% less expense to a community than a conventional roof over a 40-year roof lifetime, though these costs are generally not internalized by private building owners (Clark et al. 2008). However, representatives of the green roof industry state that green roofs pay for themselves over their lifetime by postponing the need to replace waterproof roofing membranes, which they say can last from two to three times as long when protected by a green roof (see interview with Nate Lengacher and Brian Mosley on page 61). Due to this payback cycle, building owners with long ownership horizons such as municipalities, universities and other institutions likely stand the biggest chance of seeing a return on investment. Also, as previously discussed, building owners may recoup part of their investment in the form of energy savings, reduced stormwater management fees (where applicable), and rent premiums for amenity space access. These factors must all be considered when determining the ultimate cost of a green roof project.

Structural Concerns

Because of the weight loading requirements of green roofs, they may pose structural problems that must be addressed before installation, and not all buildings will be

appropriate targets for green roofing. However, buildings using roofing techniques such as the use of asphalt as insulation ballast should be able to install at least an extensive green roof without making major structural changes. One London commercial building using this technique was able to install an extensive green roof at depths ranging from 2-8 cm without modification. Single-ply roofs may find sedum mats their only option due to weight, but may still reap the benefits of green roofs in spite of this limited choice (LivingRoofs.org 2010). New developments in green roof design such as the Xero Flor pre-vegetated blanket system have worked to alleviate this concern, with saturated weights of approximately 7-8 pounds per square foot (Xero Flor Canada 2011). In all cases, building owners should consult with a structural engineer before installation to ensure their roof deck is capable of handling the extra weight, which is a prerequisite for green roofing under Chapter 15 of Missoula's Building Code (Steve Miesmer, City of Missoula Construction Plans Examiner, personal communication, April 12, 2011).

Maintenance

Green roofs, though largely self-sufficient, do have certain maintenance demands ranging from occasional irrigation to the rare need to regularly inspect the roof's waterproof membrane. These demands are largely a function of the type of green roof involved, with intensive, rooftop garden-like green roofs requiring the most upkeep. Newer extensive green roof systems, if properly installed by knowledgeable professionals, should require little upkeep in terms of trimming as their thin soils promote horizontal rather than vertical growth. Newly-installed extensive green roofs may require irrigation through their first season as plants become established, and occasional irrigation through drought periods.

Green roofs also require yearly fertilization to prevent soil acidification, and occasional weeding to keep out invasive plants (Scholz-Barth 2001).

Missoula Area-Specific Concerns

Due to the area's arid climate, long summer months and sparse summer rainfall, green roofs have special considerations when used in Missoula. This section addresses two issues particular to Missoula's unique conditions: irrigation needs and fire considerations.

Irrigation

Missoula receives significantly less rainfall than other communities seeing wide deployment of green roofs, averaging 13.5 inches of precipitation per year with an average 1.25 inches per month between June and September (Climate Zone 2011). As such, special consideration needs to be given to green roof irrigation needs. Research has shown that the use of local plant species is the best way to reduce the need for significant irrigation; one green roof in Phoenix, Arizona, where June rainfall averages only one-tenth of an inch, utilized succulent species native to surrounding mountainous areas and continues to thrive with minimal irrigation needs (Scalia 2006).

Fire risk

Wildfires, the frequency of which has been a feature of Western Montana and the Rocky Mountain West since time immemorial, are nothing new to Missoulians (Missoula County Office of Emergency Services 2011), and are expected to become more frequent and intense as a consequence of global climate change (Bates et al. 2010). As such, risk of fire is an important consideration for those looking to install a vegetated roof in Missoula.

As mentioned previously, green roofs first began to see a resurgence in modern times as a fire control measure in Germany. Since then, research has continued to demonstrate the fireproofing qualities of green roofs (Köhler 2003, Oberndorfer et al. 2007). Missoula Assistant Fire Chief Jason Deihl says that though the Missoula Fire Department has not had many discussions regarding green roofs, he sees properly irrigated green roofs as potentially being an effective protection against the risk of wildfire, especially in urban-wildland interface areas (Jason Deihl, personal communication, April 29, 2011).

Chapter 3: Green Roof Policies and Case Examples

Though building owners may take the initiative in employing green roofs on their properties, widespread adoption of the practice has been aided by the use of policy tools that serve to generate information and awareness, and incentivize and/or require green roof installation. This Chapter will introduce six policy tools used in the U.S. and other countries to promote the practice of green roofing. It will also present case examples of green roof policies in action in five American cities and three cities outside of the U.S.

Green Roof Policy Tools

As described below, research into green roofing initiatives has identified six policy tools, ranging from information gathering and market mechanisms up to regulatory policies, which a municipality may utilize to promote green roofing in the community (Getter and Rowe 2006).

Though literature on the benefits green roofs confer is extensive, a municipality may choose to undertake **feasibility studies** tailored to local economic and climatic conditions. One such study in Toronto explored the cost savings potential if that city widely employed green roofs, and resulted in a strong recommendation to pursue green roofing simply from a perspective of economic benefits (Banting et al. 2005).

Pilot green roof projects can help a city generate reliable information on energy and stormwater benefits of green roofing, examine costs and benefits, and raise the profile of green roofing in the community. St. Patrick Hospital in Missoula has already installed a vegetative strip atop one wing of their building to judge its efficacy and to evaluate the aesthetic benefits to patients (Moore 2010).

A municipality may attempt to set an example for the private community by requiring green roofs on all eligible public buildings. This "**Lead By Example**" approach functions to raise the profile of green roofing as an environmentally-friendly and economically beneficial option in hopes that the private community follows suit. One example of a community pursuing this policy is North Rhine Westphalia in Germany, which requires "location appropriate plantings" on all state-owned buildings with slopes less than 25 degrees (Ngan 2004).

A city may choose to offer **indirect financial incentives** to encourage green roof deployment, in which building owners are reimbursed for other associated building costs such as sewer access. For example, Bonn, Germany offers a recurring discount on stormwater management fees of approximately $0.30 per square foot of green roof installed (Getter and Rowe 2006).

To more strongly encourage green roofing, **direct financial incentives** may be offered to aid in the expense of installation or to reward green roof maintenance. These incentives may take the form of direct subsidies or tax breaks, or may be approached from the direction of financial disincentives (i.e. assessing a fee for reducing green space by not installing a green roof). One example is Esslingen, Germany, where building owners are compensated for up to 50% of installation costs. Basel, Switzerland offers up to 20% reimbursement for the cost of installing a green roof; within 18 months residents and building owners had greened roof areas equal to seven football fields (Getter and Rowe 2006).

Finally, a community may enforce **mandatory building design standards**, or requirements that any appropriate buildings must have green roofs installed. This policy approach is particularly useful for new developments which may incorporate green roofs into their design rather than retrofitting, or for municipalities with limited budgets for financial incentives (Ngan 2004). One notable example is the City of Tokyo, where green roofs are required for any roof surface larger than 100 square meters (Getter and Rowe 2006).

As shown, there are a number of options for cities looking to encourage the practice of green roofing. Though broad policy analyses are not available on the success rates of different approaches, Carter and Fowler (2008) identified conditions necessary for the implementation of successful green roofs policies. These factors include: environmental concern in developed areas; well-defined standards for qualifying green roofs; identification of target areas, such as areas high in impervious surfaces; local advocacy for a green roofs program; and sufficient institutional support for technical assistance.

Missoula already fits several of these criteria: the community is known for its environmental advocacy; the downtown area has already been identified by the City Council as a target area for improving permeable surfaces (Missoula Air Quality Advisory Council 2011); and there are a number of local actors who may advocate for green roofs (including one City Council member, several area architects and builders, a number of conservation organizations, and myself through this project). Additionally, the Missoula Title 20 Zoning Ordinance calls for promoting green roofing, among other green building and landscaping practices (Missoula Office of Planning and Grants 2010). However, the Missoula Building

Code has few qualifications for green roofs other than roof weight loading requirements, and technical information from City administrators on best green roofing practices is scanty (Steve Miesmer, City of Missoula Construction Plans Examiner, personal communication, April 12, 2011).

Though communities have approached green roof practices and policies in different ways, one pattern that seems to emerge is a process of "easing in"; that is, cities tend to begin with small incremental steps such as feasibility studies, pilot projects, or financial incentives, and adopt more rigorous policies such as mandatory building design standards once the practice is widely accepted in the community. Basel, Switzerland is an example of this approach; once the success of the city's financial incentive program had been established, a requirement that all flat roofs must be greened was soon to follow (Getter and Rowe 2006).

Case Examples – Green Roof Policies in the United States

Before determining what green roof policies are appropriate for the City of Missoula, it may be helpful to examine the policies enacted in other cities to identify what issues they intend to address, examine what policies have been implemented and how, and if possible determine how successful they have been. The case examples below provide an overview of the green roofs policies enacted in five American cities. These case examples are followed by brief overviews of policies enacted in three cities outside of the US.

Case example cities were identified through Greenroofs.com, a leading portal for green roof information, and were chosen to represent a range of program purposes and implemented policy tools. The five cities serving as case examples in the United States

(Chicago, Illinois; Milwaukee, Wisconsin; District of Columbia; Portland, Oregon; and Seattle, Washington) represent all current green roof-specific programs in the U.S. identified through this research, though it should be noted that a number of other cities include green roofs as part of a broader commitment to sustainable building practices. Each case example includes information available through the respective cities' green roof program websites. The discussion of green roof policies in Milwaukee also includes information gathered from an interview with a green roof program administrator in that city, which asked about the challenges and successes of that program and his recommendations for other cities seeking to promote green roofs through policy measures. Attempts to contact green roof program administrators in other cities received no response.

Chicago, Illinois

The City of Chicago is currently North America's leader in green roofing, with over 90,000 square meters (969,000 square feet) of green roofs installed as of summer 2004 (Getter and Rowe 2006). Chicago, recognizing that green roofs improve stormwater management, reduce the urban heat island, improve air temperature and quality, ease cooling loads, prevent roof membrane degradation, and add amenity and aesthetic value to the urban setting, has taken a number of steps to encourage green roofing in the City (Chicago Green Roofs 2011).

In 2003, the City of Chicago Department of Environment (DOE) contracted a study to test green roof performance under controlled conditions; the study found green roofs were effective in controlling stormwater runoff and cooling the test structures, and recommended green roofs as a measure to reduce the urban heat island effect, reduce stormwater runoff, and enhance air quality in the City (Chicago DOE 2004). In 2005, the

Chicago DOE established the Green Roof Grants Program, which helped fund more than 20 green roof projects that year. In 2006 this program was expanded, offering grants to residential and small commercial green roof projects of up to $5,000; the program funded 40 projects that year (Chicago DOE 2011). Though these financial incentives are no longer being offered, Chicago's Department of Housing and Economic Development's (HED) Sustainable Development Division continues to offer several nonmonetary incentives for building owners wishing to install green roofs, including expedited building permits and density bonuses (Chicago HED 2011). Chicago's City Hall features a 20,000 square foot demonstration green roof and rooftop garden as part of the City's Urban Heat Island Initiative, and in 2010 the City hosted a citywide Green Roof Summit to share green roofing knowledge and best practices. Chicago HED also offers technical information and assistance for building owners looking to add or expand a green roof on their building (Chicago HED 2011).

Milwaukee, Wisconsin

As part of an effort by the City of Milwaukee to reduce polluted stormwater runoff into the City's combined sewage system, the Milwaukee Metropolitan Sewerage District (MMSD) established the 2010 Regional Green Roof Initiative Program to assist building owners in the retrofitting of their properties with green roofs and other stormwater control features (Milwaukee Metropolitan Sewerage District 2010). A similar grant program in 2009 provided up to 50% of installation costs and resulted in the installation of nearly 40,000 square feet of green roof atop the Milwaukee Public Library and the MillerCoors brewery (Milwaukee Metropolitan Sewerage District 2009).

Chris Schultz, the MMSD's Water Quality Senior Project Manager, offered his perspective on the goals, limitations and successes of the Regional Green Roof Initiative Program. He says the goals of the program are to promote and seed green roofing technology regionally to demonstrate feasibility across all sectors, acquire quantitative effectiveness data, and increase the total square footage of green roofing to provide stormwater management benefits. He believes the program has been effective of raising the awareness of the technology in Milwaukee and that there is willingness to employ it in the community, though he believes adoption may be slow without some sort of subsidy. He says the major obstacle at the administrative level is that the required implementation time of one year after funding is approved makes it difficult to find appropriate projects. He says he would like to see the program move its focus from demonstration to implementation by paying out a per-square-foot amount for roof replacements, though given the current political situation in Wisconsin he is unsure if the program will be funded beyond this year (Chris Schultz, personal communication, April 18, 2011).

District of Columbia

Since officially recognizing the benefits of green roofs in the early 2000s, the District of Columbia has worked to provide educational and financial support for green roofing through a number of different measures (District of Columbia Department of the Environment 2011). In 2003, the DC Water and Sewer Authority provided $300,000 to the Chesapeake Bay Foundation (CBF) for "design, installation and maintenance of demonstration green roof projects" within the combined sewer area of the Anacostia River. This funding resulted in the installation of eight demonstration extensive green roofs in the District totaling 113,000 square feet between 2004 and 2008. On one of these projects, the

CBF partnered with the grantee to conduct monitoring experiments of stormwater retention and quality performance. The project concluded with recommendations to establish a permanent institutional system to provide either incentives or requirements for widespread adoption of commercial green roofs, and to establish technical requirements and standards for best green roofing practice (Chesapeake Bay Foundation 2008).

Since then, the District has taken additional steps to encourage green roofs to address goals of reducing stormwater runoff, providing urban amenity space and urban agriculture opportunities, and creating opportunities for green collar jobs and training in the District (DC Greenworks 2011). In 2007, the District Department of the Environment began offering financial incentives for green roofing in the form of a $3 per square foot upfront grant for installations under 4,000 square feet; by 2010, that grant had been raised to $5 per square foot with a cap of $20,000. The program will continue in 2011, offering a subsidy of $5 per square foot, with new construction capped at 5,000 square feet and no caps on retrofit projects. The DDOE also provides a list of "showcase" green roofs with technical and contact information, and in 2009 published a "Green Roof Toolkit", a brochure providing information on green roof benefits, the District's permitting process, and site appropriateness (District of Columbia Department of the Environment 2009, 2011).

Portland, Oregon

The City of Portland has been pursuing sustainable development initiatives for most of the last decade, and has focused on green roofs as a means to manage stormwater, save energy, reduce the urban heat island effect, preserve roof membranes, and provide urban amenity and habitat space (City of Portland Bureau of Environmental Services 2011). The Portland Green Building Policy, adopted in 2005, requires all new City-owned facilities,

wherever practical, to include a green roof with at least 70% coverage, with ENERGY STAR-rated roof materials on any non-greened roof area (City of Portland 2005).

In 2008, the Portland Bureau of Environmental Services (BES) established the Portland Ecoroof Program to provide educational materials about green roof practices and technical specifications, and to offer financial and other incentives for green roof installation, with the goal of increasing Portland's greened roof area by 43 acres (1,873,000 square feet) by 2013. In 2011, the Ecoroof Incentive Program will provide upfront cash grants of $5 per square foot of installed green roof to residential, commercial, industrial and mixed-use developments. The Program has provided funds for at least 30 green roof projects since its inception, making for a total of 271 green roof projects across Portland totalling approximately 556,000 square feet (City of Portland BES 2011). Portland home- and building owners with qualifying green roofs are also eligible for discounts on their municipal stormwater fee of up to 35%, and the Central City Floor Area Ratio bonus allows developers installing qualified green roofs to increase their building's floor area by 1 to 3 square feet, based on green roof coverage, for each square foot of green roof installed (City of Portland Bureau of Planning and Sustainability 2011). The Portland BES Ecoroof online portal also provides a wealth of information on the practice of green roofs, from an Ecoroof Handbook with design, construction and maintenance best practices to detailed reports on plant selection and monitoring research (City of Portland BES 2011).

Seattle, Washington

The City of Seattle has recognized green roofs as effective ways to extend roof membrane lifespan, reduce building heating and cooling costs, control stormwater runoff, and provide urban habitat and amenity space (City of Seattle Department of Planning and

Development 2011). In 2007, Seattle Public Utilities commissioned a study to improve modeling of green roof benefits; this study is still in progress (Seattle DPD 2011a). Seattle offers an impervious surface reduction credit that lists green roofs and rooftop gardens as acceptable strategies, and offers density bonuses for buildings achieving LEED Silver standards or higher, which green roofs can help meet (Seattle DPD 2011b). Seattle also offers technical information and assistance through the Department of Planning and Development website (Seattle DPD 2011a). A 2010 Seattle Green Roof Inventory identified 59 green roofs in the greater Seattle metropolitan area totaling approximately 1.85 million square feet (Seattle Public Utilities 2010a), and a survey conducted that year indicated the City's policy measures including technical assistance programs and incentives played a role in this achievement (Seattle Public Utilities 2010b)

International Green Roofs Policies

The United States is not the only nation promoting green roofs through policy. This section offers examples of green roofs policies in Canada, Europe and Asia.

Toronto, Ontario

The City of Toronto has embraced green roofing policies as a key element in the City's Climate Change Action Plan. The City established an "Eco-Roof Incentive Program" in 2009 as part of its goal to reduce greenhouse gas emissions by 80 per cent by 2050. The program offers a direct payment of $50 per square meter up to $100,000 for eligible green roofs projects meeting certain size criteria (LiveGreenToronto 2011). This incentive program compliments the City's 2009 Green Roof Bylaw, which mandates a certain amount of green roofing for every new commercial, institutional and residential development with a roof area of at least 2,000 square meters (City of Toronto 2011).

London, United Kingdom

The City of London has been a leader in green roof deployment in Europe. The 2008 Mayor's draft replacement London Plan established as goals for the City reducing greenhouse gas emissions, mitigating the effects of global climate change, protecting open spaces, and providing urban habitat and green space (City of London 2011). The United Kingdom Environment Agency advocates for widespread adoption of green roofing (UK Environment Agency 2011), and the Mayor's Climate Change Adaptation Strategy calls for the delivery of 100,000 square meters (1,076,00 square feet) of new green roofs by 2012, requiring green roofs for all major new developments within London's Central Activities Zone (Mayor of London 2010). In addition to creating urban amenity space and addressing the threats of global warming, the UK Green Building Council lauds green roofs as a measure to improve urban habitat, increase London's biodiversity, and serve as return areas for endangered species (Carus 2009). London also played host to the 2010 World Green Roof Congress, which served as a forum to share green roof case study and research information (World Green Roof Congress 2011).

Tokyo, Japan

In response to a significant urban heat island problem and lack of urban green space, the City of Tokyo has aggressively pursued green roofing. In 2001, the "Tokyo Plan 2000" required all new buildings greater than 1,000 square meters (10,763 square feet) to green at least 20% of their roof space. One goal of the Plan is to establish a green area in Tokyo, including roof spaces, of over 4.5 square miles by 2015 (GreenRoofs.com 2011b).

Summary and Conclusions

An examination of these case examples leads to two observations that may be helpful to an effort to promote green roofing in the City of Missoula through policy measures. First, it is clear that cities craft green roof policies around goals specific to their location. Stormwater management is a common goal for green roofs policies in the United States, though several cities also cite goals of improving the urban heat island and urban air quality, reducing building energy demands, extending roof lifespans and creating urban habitat and amenity space. In Toronto and London, climate change mitigation and greenhouse gas emissions reductions are the primary goals, and in Tokyo, green roof mandates were established primarily to help alleviate the urban heat island. In this mode, the City of Missoula would likely benefit from identifying specific green roof benefits that would help meet existing goals, and craft any green roof policies around these benefits. For instance, though stormwater management may not be the pressing issue it is in places like Seattle and Portland, green roof benefits such as energy use reductions, roof membrane preservation, air quality improvements, and creation of urban amenity and habitat space may be effective drivers of local green roof measures.

Second, cities vary widely in the green roof policy measures employed and the intensity of these measures. Incentives, both monetary and nonmonetary, and educational and technical assistance programs seem to be common features of green roof initiatives in the United States, though other tools have been used as well: Chicago's City Hall green roof demonstration project and Portland's "lead by example" policy for City-owned buildings are notable exceptions. Other than Portland, mandatory building design standards seem to be employed more in cities outside of the United States. Whether these different approaches

are due to availability of resources, political will, general knowledge about the practice and benefits of green roofs, or a combination of these and other considerations is not known at this time. However, the City of Missoula should use these criteria when evaluating the different available green roof policy tools to determine how best to approach this issue.

Chapter 3: Stakeholder Analysis

Introduction

Studies have shown that legislators attempting to craft policy rely, second only to their own best judgment, on input from constituents and organized interest groups with a stake in the issue in question (stakeholders) (Richan 1996). Discussions with City of Missoula policymakers throughout the spring and fall of 2010 confirmed that no City action on green roofs was likely without input from a range of Missoula stakeholders. At the same time, experts in environmental organizing have acknowledged the critical importance of community involvement in crafting local solutions to environmental issues (Finnegan and Sexton 1999). Informed by these insights, this project has shared information with and sought feedback from Missoula stakeholders to identify the needs, interests, and preferred outcomes of local actors and interest groups to determine what, if any, green roofs policy may be politically and administratively feasible and practical in Missoula.

In order to offer City decision makers recommendations on how to best approach this issue, this project sought input from a wide range of Missoula-area stakeholders, including City administrators, representatives from the business and building communities, local conservation organizations, and actors within the green roofs industry. Methods used to identify stakeholders are described below.

Methods

Stakeholders were identified through preliminary interviews and discussions with City Council members, City administrators, and Missoula industry and development organizations, in the period between March of 2010 and January 2011, in which they were asked for their thoughts on green roofs, opinions of what kinds of policies may be useful to

promote green roofing in Missoula, and what individuals and organizations should be included in the conversation. These preliminary interviews helped to construct a basic understanding of the primary concerns and questions about green roofs policies among Missoulians. This process also generated a list of stakeholders to be contacted for in-depth interviews. With a few exceptions, these identified stakeholders generally fell into one of three groups: City administrators, architecture and building firms, and conservation organizations.

Potential interviewees were contacted by phone or email for participation. Interested stakeholders were provided with a brief PowerPoint informational presentation giving an overview of green roofing, the benefits offered by green roofs to building owners and the community, and definitions of the different green roofs policies and examples from other communities. Interviews were conducted in person during the first three weeks of April, 2011 and recorded, and ranged in length from fifteen minutes to over one hour per session. Interviewees were asked a series of open-ended questions to gather their thoughts and concerns about the practice of green roofing and the policies used by other communities to promote the practice. Interviewees were asked to what extent they or their organization had been involved in employing or promoting green roofs and whether they would be in favor of the City of Missoula taking measures to encourage green roofs. They were asked for comments on four actions the City might take to promote green roofing (a City-organized pilot green roof project, a "lead by example" policy for all City buildings, incentive programs, and mandatory building design standards) and then asked to rank these options in order of preference and explain their rankings. They were asked to identify other individuals and organizations in Missoula who they thought should be included in the

dialogue. Finally, interviewees were asked to share any other comments on green roofs and green roofs policies that had not been covered in the interview.

This process resulted in a number of interviews from all three stakeholder groups identified in the preliminary interviews: City Administrators (6 individuals), Architecture, Design and Building Community (9 individuals), and Conservation Organizations (4 individuals). Also included were a representative for the Missoula Downtown Association, a local green roof vegetation grower, and a representative from Xero Flor America, a leading green roof system provider. In total, 22 individuals were interviewed in 16 separate interview sessions. Five group interviews were conducted: four interviews with two interviewees each, and one interview with three interviewees. The proposal for these interviews was submitted to the University of Montana Institutional Review Board (IRB), which exempted this research from IRB requirements. The questionnaire used to facilitate these interviews and generate thoughts and comments may be found in Appendix B of this report.

Though this project has sought to include as broad a collection of stakeholder opinions as possible, certain groups may be underrepresented in this analysis. This is most evident in the "Architecture, Design and Building Community" stakeholder group, which is composed primarily of individuals representing firms with strong commitments to sustainable building design. This imbalance is likely due mainly to stakeholder responsiveness: the firms with the most interest in green roofing were the most likely to participate in this research. As such, future study should attempt to include a number of conventional architecture, building design and building firms for a more accurate

representation within those communities. Additionally, a number of other stakeholders and stakeholder groups identified through these interviews were not interviewed due to time and scheduling constraints.

City Administrators

Chase Jones, Grant Administrator, City of Missoula Green Blocks Program – April 8, 2011

The Green Blocks Program, established in 2008, provides energy audits for Missoula residents and provides resources and education to the community on energy conservation measures, insulation, and renewable energy with funding from the U.S. Department of Energy and a partnership with Northwestern Energy (City of Missoula Green Blocks Program 2011). Mr. Jones says that as the Program's focus is primarily residential energy efficiency, education and outreach, it has not been involved with green roofing at all. He does see green roofing education fitting in with the Program's education component, however. He also is familiar with the "Corner" building's green roof, and says it is not only aesthetically pleasing but also makes sense on other levels such as sustainable design and energy efficiency.

Mr. Jones thinks a City demonstration green roof project would be "fantastic", though he wonders how to fund such a project. He says such a project would be valuable to demystify green roofs and encourage wider adoption of the practice. He feels a City "lead by example" policy could make sense, though he notes that cost will be a concern for the City, which keeps essential services as its top priority. He notes the City's budget allows little to no wiggle room, so though he thinks financial incentives for green roofing sound like a good approach, he does not see where the City would find money for such a program. He also

wonders if in the current economic climate financial incentives would be sufficient to prompt widespread adoption of the practice. He likes the idea of some kind of mandatory standards for buildings over a certain size, but doesn't see these as a realistic option due to likely opposition from the business and building communities. He ranks a City demonstration project as his top preference, followed by a City "lead by example" policy, then financial incentives, and finally mandatory building design standards.

Mr. Jones feels that green roofs "make wonderful sense" on many levels, and supports expansion of the practice in Missoula. He thinks educating people on the practice and benefits of green roofs is a necessary first step, and that a demonstration project could fit this need. He would like to see all buildings in Missoula undergo basic energy efficiency improvements first, and that green roofs would be a great addition on top of that effort. Additionally, he wonders if Missoula has the technical expertise to procure and install green roofs.

Steve King, City of Missoula Public Works Director, Steve Miesmer, City of Missoula Construction Plans Examiner, and Don Verrue, City of Missoula Building Official – April 12, 2011

The City of Missoula Public Works Department is responsible for maintenance and upgrades of the City's infrastructure, including engineering, wastewater management, and buildings. The Building Inspection Division within the department administers and enforces City building codes and regulations, issuing building permits and conducting building inspections. These three representatives of the Missoula Public Works Department make clear that their offices do not make policy, but rather fill an administrative role. However, they say that they do often advocate for ideas and practices they think are beneficial to the City.

These representatives are most familiar with the stormwater management benefits of green roofing, which they say are less applicable to the City as much of Missoula sits on highly permeable soils and does not discharge much of its stormwater into surface waterways or central sewer collection. As such, they feel the City does not have the municipal structures in place (such as a stormwater sewer access fee) to create financial incentives for green roofing. They do however mention that Missoula building code requires onsite retention for stormwater, and green roofs may help meet those requirements.

With regards to a City demonstration green roof project, Public Works' primary concern would be added demands for landscape maintenance, which would need to be "highly justified" by other benefits such as energy or resource conservation. They are aware of the prolonged lifespan of waterproof roof membranes with green roofs, so with regards to a City "lead by example" policy they would like to know if the extra costs of installing green roofs on City buildings would made up for by this benefit. They also point out that some City buildings would not be appropriate targets for green roofing (for example, the roof of the new City parking garage is intended to be parked on, and the Parks and Recreation building was designed primarily with economy in mind). As Montana is a maximum/minimum state, where local building requirements can be no more or less restrictive than those set by the State Legislature, any mandatory standards would likely have to be enforced at a State, rather than local, level, though a local mandate may be possible through landscape requirements in the zoning code. However, they do not feel that Missoula has the urban issues that would justify a mandate at this time.

Though these representatives point out that due to its relatively low density Missoula is not faced with some of the urban issues other communities must address, they acknowledge that the Missoula Growth Plan calls for directing growth inward within existing City limits and increased urbanization and densification in the urban core and along arterials and commercial corridors. As this occurs, density issues such as stormwater management, access to amenity and habitat space, landscaping requirements, and the urban heat island will become higher priorities, as well as energy and water conservation.

Mike Barton, Interim Director, Missoula City-County Office of Planning and Grants – April 13, 2011

The Missoula City-County Office of Planning and Grants was established in 1996 to aid in City and County development planning in such a way as to reflect those communities' "environmental, economic, aesthetic, and social values" (Missoula County 2011). The OPG worked with HomeWORD on the Gold Dust low-income housing development, and has assisted some housing developers with green building practices, but has not been involved with green roofing specifically. Mr. Barton says the OPG is supportive of green building projects and green initiatives, though he points out such projects are often cost-intensive at the front end, and available funding is being reduced due to the current economic and political landscape.

Mr. Barton does not see the City taking a role as an active encourager of green building practices, but as more of an enabler of such practices. He feels Missoula, as a smaller community than other cities encouraging green roofing, has less freedom to offer incentives for green roof installation. He also feels that mandating green roofs in building design standards is likely to meet significant resistance, as anything that adds mandatory

costs to development generally is contentious in the development community. He feels that local government and commercial entities generally take a longer-term view of building investment than private homebuyers, including considerations of long-term energy needs and maintenance. However, with regards to a City project, he sees a green roof as an added front-end cost at a time when governments are seeking to reduce costs across the board. In general, Mr. Barton does not see green roofing as the compelling issue it might be in other communities, and feels the concept will take a long time to become widely accepted in the West. He also sees maintenance issues as being something that would need to be addressed before green roofs were widely adopted.

Bruce Bender, City of Missoula Chief Administrative Officer – April 15, 2011

Mr. Bender says that as far as he knows, green roofing has only been a topic in sidebar discussions in the Mayor's office. Generally, he sees the practice as being more initiated by private interest, and to his knowledge there have been no discussions about promoting the practice through policy. He sees other communities pursuing green roofing for two primary reasons: using rooftops as gardens and amenity space, which he sees as a potential benefit to the City but not necessarily a driver for policy; and stormwater runoff and quality control, neither of which he sees as major priorities as much of the City uses sumps (also known as injection wells, which are catchment pits that allow water to percolate through the ground and recharge the aquifer) to control and purify its stormwater and return it to the aquifer. He notes that new construction in the City is required to separate its stormwater drains from the sanitary sewer system, but mentions that certain older buildings in the downtown area discharge their stormwater into that system, and that

measures such as green roofing to control and retain stormwater on those buildings could be a benefit to the City.

Mr. Bender sees the Missoula Water Quality District, the County office charged with protecting surface water and the aquifer, as a potential proponent of a demonstration green roof project, and thinks that the older downtown buildings that discharge stormwater into the sewer system would be the best targets for such a project. With regards to a City "lead by example" policy, he mentions that the City is already considering LEED standards for new building projects and is concentrating on reducing energy consumption and greenhouse gas emissions. He sees Missoula as having fewer resources than other communities to offer financial incentives for green roofing, though he mentions that wastewater treatment standards have and continue to become more strict, and that incentives may make sense in the future as the effort to reduce roof drain systems becomes more expensive. With regards to mandatory building standards, he feels any such requirement would need to be tied to water quality issues, but does not see these as being pressing enough to require such measures at this time. He feels a pilot project is where an initiative like this should start and ranks it his top preference, followed by a City "lead by example" policy, then incentives, and finally mandatory standards.

Mr. Bender mentions that the areas likely to experience water quality and stormwater control issues are on the urban fringe – the airport district, for instance, sits on soils high in clay and will require central storm drains, and may be a target for measures to reduce stormwater runoff. He sees the rest of the valley's use of sump systems as working

very well, and doesn't anticipate future problems with this practice even as the City becomes more urbanized.

Architecture, Design and Building Community

Steve Loken, Owner and Designer, Loken Builders – April 7, 2011

Loken Builders is a Missoula-based full service design and contracting firm "specializing in energy and resource efficient construction (Loken Builders 2011). The firm has installed three deep-bed green roofs in the past fifteen years, and is entertaining the idea of incorporating green roofing and rooftop gardens for five to seven out of fifteen units in an upcoming townhouse design. Mr. Loken feels that large, flat roofs such as commercial or multifamily residence buildings are the best targets for green roofs, and generally promotes them for aesthetic benefits, though he thinks there is a good case to be made on the merits of reduced cooling load and improved stormwater management. He generally sees green roofs as one solution within a broader context of impermeable surface issues, and sees stormwater control as a growing problem of increasing urbanization. He points to a washed-out storm culvert on the Clark Fork River near Grizzly stadium as an example of the problems stormwater can cause even in Missoula's arid environment. In his words, "If you knew what was going on in a rainstorm, what flushed into the Clark Fork River, it would make you sick. It would make everybody sick."

Mr. Loken feels the City of Missoula should take measures to support green roofing. He thinks the City should find a high-profile building to retrofit for a City demonstration green roof. He recognizes the City is responsible to taxpayers for making the best long-term decisions, and feels that a cost/benefit analysis of roof membrane lifespan improvement could make a good case for a City "lead by example" green roofing policy, as long as roofs

are not replaced prematurely. He feels financial incentives could be useful if they were tied to measurable goals such as stormwater runoff reduction, and though he acknowledges that the current economy makes it difficult for the City to offer incentives at this time, he feels that the long-term reduction in infrastructure costs could make such incentives a win/win situation for the City and building owners. He also points to other incentive models such as reduced landscaping requirements, or easing of building height restrictions for buildings incorporating green roofs. He thinks mandatory building requirements make sense on the surface, but worries that without guidelines on best practices and demonstration and experience within the community, such mandates may cause developers to take steps detrimental to the community to avoid extra requirements. He also thinks such mandates should be directed first toward non-locally-owned big box retail stores, noting the sizeable footprints of these buildings and the financial ability of these companies to comply with such standards. He ranks a City demonstration green roof as his first preference, followed by a City "lead by example" policy, as long as it can be shown to be cost-effective for taxpayers. After these, he prefers financial incentives, with mandatory building standards as his last choice.

Mr. Loken feels that the City of Missoula needs to clearly stipulate its goals with regards to stormwater control, energy consumption, vertical development, and better and smarter housing for its residents. He thinks that once these goals are clearly stated, wider deployment of green roofing will emerge as a natural response. He also feels that Missoula should be moving toward greater urban densification, and sees green roofs becoming more important as the urban core becomes more dense.

Alexander (Zandy) Sievers, Energy Technician, Sustainable Building Systems; Builders' representative, Missoula Greenhouse Gas Energy Conservation Team – April 8, 2011

Sustainable Building Systems is an architectural design and energy certification firm dedicated to "moving buildings toward a more sustainable operations model with a lower carbon footprint." (Sustainable Building Systems 2011) The Missoula Greenhouse Gas Energy Conservation Team educates and communicates with the Missoula community about energy efficiency and greenhouse gas reduction opportunities and initiatives, and provides recommendations to the Missoula City Council on topics including energy efficiency and building efficiency strategies (City of Missoula Greenhouse Gas Energy Conservation Team 2011).

Though Sustainable Building Systems is generally not involved with roofing specifically, the firm advocates for green roofs as part of its holistic building sustainability approach which emphasizes energy, water and resource efficiency and overall sustainability and durability. Mr. Sievers recognizes the stormwater control, energy efficiency, and heat island benefits of green roofing, as well as aesthetic benefits, and recommends green roofs wherever applicable.

Mr. Sievers is "absolutely in favor" of the City of Missoula promoting green roofing, noting also that such a move would create opportunities for his firm. He would support a City demonstration project, though he points out it may be easier and cheaper for the City to partner with the owner of an existing green roof to conduct monitoring and data collection. With regards to a City "lead by example" policy, he feels green roofs should be part of a broader list of sustainable building practices, but thinks such a policy may not be as effective as other options. He feels that financial incentives or fee reductions for sustainable

and mindful building practices are progressive ways for the City to promote such practices, though he recognizes that the current economy and City budget may make such financial incentives impossible at this time. With regards to mandatory building design standards, he feels this is a difficult time to require extra costs for developers and builders due to the current political landscape and slow pace in the building industry. He agrees that requiring green roofs for buildings with large footprints makes sense from the perspective of stormwater control and the heat island effect, but predicts such a move would generate significant opposition and potentially waste valuable time and political capital. He sees mandatory standards as the final step in a progression of education, demonstration, and wider adoption. He ranks a City demonstration project as his top preference, followed by a "lead by example" policy, then financial incentives, and finally mandatory standards.

Mr. Sievers feels that the City of Missoula should take a more aggressive position on sustainable building design, including requirements for green space. On that topic he hopes the City will recognize green roofs as permeable surfacing in the building code. He also feels there needs to be more education about green roofs, particularly about load requirements for targeted buildings. He also notes that green roofing in Missoula's arid climate could pose issues, and that green roofs need to be designed to be drought-tolerant.

Kent Bray, Director of Regional Operations, and Jeff Crouch, Senior Project Manager, CTA Architects Engineers – April 12, 2011

CTA Architects Engineers is an architecture and engineering design firm with a strong commitment to integrated and sustainable design (CTA Group 2011). CTA has had some experience with green roofing: CTA's Billings office roof is greened, and the firm has proposed green roofs for three projects in Missoula and encourages the practice wherever

appropriate, primarily from a standpoint of amenity space benefits. However, the firm has not installed any green roofs in Missoula as of yet, and cite increased costs (generally $11-12 per square foot) as the most common reason green roofs are removed from building plans.

These representatives for CTA are generally in favor of the City of Missoula encouraging wider green roof deployment through policy measures. They favor a City demonstration green roof project, and think a green roof should be considered for a large upcoming City building project. They like the idea of a demonstration project adding amenity space to Missoula's urban setting; they also identify schools as a good target for such a project, noting the large footprint of these buildings and the opportunity to educate and raise interest among Missoula schoolchildren. When asked for thoughts on a City building "lead by example" policy, these representatives stated that education on green roofs and demonstration projects should be a higher priority. However, they point out that Missoula County has already enacted a policy to build new buildings to LEED standards, and would like to see the City of Missoula take similar measures by including green roofs as an element of a broader commitment to sustainable building design. They see incentives as having a chance to be an effective driver of the practice, especially when coupled with monitoring and data collection to prove the concept in a local setting. They propose that the City should look to other entities such as Northwestern Energy for possible partnerships on any financial incentive program. With regards to mandatory building design standards, they are leery of mandating any practice before it is certain that the practice is the best approach for local building. Rather than mandating one particular practice such as green roofing, which they point out will not be appropriate for all buildings, they would prefer to see an

adoption of LEED standards for new construction, with green roofs as one in a toolbox of different sustainable building practices. They rank a pilot project as a top option, followed by a City building policy and incentive programs, and rank mandatory standards last.

These representatives for CTA note a need for established best green roofing practices, such as crafting plant and soil types to local conditions, and would like to see more information gathering to determine the most effective practices for Missoula's climate. They see greywater recycling as a good tie-in to green roofing, and a potentially easy and inexpensive way to irrigate, especially when coupled with rainwater capture and reuse.

Lucas Dupuis, Owner and Designer, Sustainable Building Design – April 13, 2011

Sustainable Building Design offers full service residential design services specializing in sustainable building practices. Energy efficiency, resource efficiency and healthy building materials are an integral part of every project (Sustainable Building Design 2011). As Sustainable Building Design's primary focus is residential development, opportunities to employ green roofs have been limited. However, SBD has installed one green roof on a local deck, and has been trying to incorporate green roofing into various projects. Mr. Dupuis feels green roofing is not being promoted in Missoula the way it is in other communities.

Mr. Dupuis feels that the City should "definitely" take steps to encourage green roofing, especially in urban areas where the benefits of the practice are most important. He feels a City demonstration project could be inserted into a new municipal project, and points to the new emergency communications center as one possible opportunity, especially if that project can leverage state or federal funding. He feels a City "lead by

example" policy makes sense for appropriate buildings due for reroofing, and is generally supportive of policies encouraging forward thinking. He thinks financial incentives could be helpful for attracting private sector investment, and would help the case for wider adoption of green roofing and other sustainable building practices. He also points out that ongoing interest in and upkeep of green roofs could be better secured with ongoing incentives such as a recurring sewerage or water fee rebate. With regards to mandatory building standards, he is in favor of increasing requirements for sustainable building design and would like to see green roofing as one in a toolbox of options for building sustainability. He ranks incentives as his first preference, followed by a City demonstration project and "lead by example" policy, with mandatory requirements last.

Mr. Dupuis feels that the building industry adopts ideas slowly, and that the best way to change common practices is to demonstrate the concept. He feels that emphasizing lifecycle payback and providing ongoing incentives is the best way to build interest in green roofing and keep the practice going.

Don MacArthur, Principal Architect, and Colin Lane, Associate Architect, MacArthur Means and Wells Architects – April 13, 2011

MacArthur, Means and Wells is a locally-based architecture firm with a commitment to "contributing positively to the built environment, with minimal effect on the natural environment." (MacArthur Means and Wells Architects 2011) The firm has completed a couple of projects incorporating green roofs or rooftop gardens, including the Gold Dust rooftop gardens and a grass roof on a house on Flathead Lake. They have looked at green roofs for larger projects including multifamily residences, though due to cost (they estimate green roofs to be around twice as expensive as conventional materials) have not executed

any of these plans. The firm is dedicated to on-site stormwater retention and management and sees green roofs as helping to meet these goals. Mr. MacArthur and Mr. Lane also see turning roof space into useable amenity space as a good driver of the practice, and see green roofs as a way to preserve habitat and residents' access to plants, animals, and the land.

These representatives are interested in the practice of green roofing and feel they definitely have a place. With regards to the City promoting the practice through policy, they note that Missoula may not face the same challenges as other communities where green roofs are being promoted. They point out that Missoula is not as urban as other communities with a serious heat island problem, and does not have the same stormwater management issues as other cities. However, they note that pollution of the aquifer would be a serious problem, and that treating stormwater and keeping it out of streams, rivers and the aquifer is important. Though they generally do not see municipalities leading the way on this kind of idea, they think a "catalytic leadership project" like a City demonstration green roof could be a great way to demonstrate the concept, offer community amenity space, and raise awareness and excitement for the practice. They suggest finding a high-visibility building such as the new public safety facility for such a project and coupling it with data collection to measure its effects. With regards to a City "lead by example" policy, they feel green roofs should be one element in a broader sustainable building policy. They point to Missoula County's Green Building Policy, and would like to see the City take similar steps and demonstrate a serious commitment to sustainability in building practices. Rather than requiring green roofs for all appropriate City buildings, they would prefer a requirement for each City building project to evaluate a green roof as an option along with a suite of other

sustainable building practices. With regard to incentives, they feel that in terms of payback green roofs are not a “low-hanging fruit”; however, if money is available then financial incentives make sense, especially in conjunction with a suite of other water control methods. They point out that incentives for green roofs only would have a smaller water conservation benefit than incentives for other water-efficiency measures such as low-flow toilets and location-appropriate landscaping. They feel mandatory building standards would come after a longer process of education, demonstration and wider adoption, as with greywater recycling. They rank a demonstration project as part of a suite of sustainable building practices and a “lead by example” green building policy as their first preferences, followed by financial incentives, with mandatory design standards their last choice.

Mr. MacArthur and Mr. Lane see implementation and long-term maintenance and performance as important considerations with green roofing. They note that the technology is not well-known in Missoula, and wonder if there is enough local knowhow to do quality green roof installation at a fair price. They see proper installation and care as essential to long-term performance and prevention of premature damage.

These representatives also note the importance of habitat preservation and recreational land access to the Montana lifestyle, and see these becoming bigger priorities as Missoula continues to urbanize. They feel green roofs can play a role in allowing us to live more densely while still allowing us to grow food and access plant and wildlife habitat. They see the urban amenity benefits of green roofs becoming more important under the City’s plan to urbanize and increase density, and think this could be a major selling point for green roofs in Missoula.

Pat Suplee, Owner and Principal Architect, Studio Modera – April 15, 2011

Studio Modera is a Missoula-based boutique-style architecture and design firm emphasizing a "more sustainable modernism that is site sensitive as well as environmentally respectful." (Studio Modera 2011) Ms. Suplee is the owner of an extensive green roof atop her private Missoula residence, which she installed not only for environmental, aesthetic and amenity reasons, but also as a fire control measure. Two projects designed by her firm have portions of their roofs greened, and she cites aesthetics as the major driver for clients interested in green roofing.

Ms. Suplee feels that encouraging green roofing would be a good step for the City of Missoula, and in addition to stormwater control and alleviation of the heat island effect, thinks that green roofing is a great way to encourage inhabitant use of roof space. She thinks a City demonstration green roof "would be fantastic", and feels that a City "lead by example" policy makes sense and would be a great way to promote the practice. She agrees that deferring costs through incentives would be helpful in making green roofing more appealing to the general public, though she acknowledges that due to the current state of the economy it is a difficult time to raise funds, especially through raising taxes or permit fees. She notes that the City may have success seeking funding partnerships with green building advocates. With regards to mandatory building design standards, she feels requirements for commercial buildings over a certain size "could make a lot of sense". She ranks a City demonstration project as her top preference, followed by mandatory standards, with incentives and a "lead by example" policy as her last choices.

Due to her experience with her own green roof, Ms. Suplee has useful insight into some of the practical concerns surrounding green roofs. Her green roof cost around $10 per

square foot, though she notes that this cost did not include the waterproof membrane already installed on her residence. She feels that this extra cost is most likely to pay itself off through membrane preservation on flat roofs, where installation costs are lower than on canted roofs. With regards to irrigation, she says the first-year establishment period did require regular irrigation, but that since the vegetation has established itself she only irrigates during the hottest periods of the summer when no rain has fallen for two to three weeks. She also says that the established roof (comprised of fourteen species of sedums grown in the Bitterroot) is generally thick enough to keep out invasive weeds.

John Freer, President and Owner, Riverworks Inc.; Chairman, Missoula Building Industry Association Green Building Program – April 20, 2011

Riverworks, Inc. is mainly a residential construction firm, and though Mr. Freer has explored green roofing for a number of projects he has not installed any green roofs in Missoula. He would support green roofing and education about the concept as part of a larger, holistic green building agenda, noting the connectivity between green roofing and other thoughtful building sustainability practices such as greywater recycling.

Mr. Freer feels a City demonstration green roof could be very educational and beneficial. He notes that the benefits of green roofs (energy use, building climate footprint, stormwater runoff reductions) scale up non-linearly with increasing building size, and that a demonstration project would make more sense on a large building than in a residential setting. He thinks a City "lead by example" green building policy including green roofs could be a "great way" to introduce the concept of green roofing to the Missoula market and educate consumers and the building industry on their purpose and best practices. He prefers nonmonetary incentives, such as density or height bonuses (allowances for

developers to increase the number of units or floors in a new residential project, for example), to financial incentives; he points out that anything earmarking funds solely for green roofs would draw support away from other funding needs. However, he would be more supportive of financial incentives for green roofs if they were offered as part of a broader building sustainability incentive program. He sees mandatory building standards as a "fairly onerous" approach to the issue, and worries that requirements above and beyond the norm could have the effect of preventing new businesses from coming to Missoula. He ranks a demonstration project and a "lead by example" policy as his top preferences, followed by nonmonetary incentives for green roofing, then financial incentives, and finally mandatory standards.

Mr. Freer mentions a few challenges to widespread adoption of green roofing in Missoula. He points out that there is a high degree of unfamiliarity with the practice in Missoula, and that costs can be prohibitive even among those familiar with green roofing. He also points out that due to ongoing maintenance requirements, mainstream adoption in residential developments will be hard to achieve, since green roofs are not "install and forget" projects like conventional roofs.

Conservation Organizations

Brianna Randall, Water Policy Director, and Jill Alban, Communications Manager, Clark Fork Coalition – April 7, 2011

The Clark Fork Coalition is a 26-year-old nonprofit conservation organization dedicated to protecting and restoring the Clark Fork River basin (Clark Fork Coalition 2011). The CFC originally planned a rooftop garden for their new Missoula office building in 2007, but did not install it due to cost. The CFC works to model efforts to improve the watershed,

improve water quality and reduce stormwater runoff into the Clark Fork River, including better building design and the incorporation of permeable surfaces. These representatives see green roofing in Missoula as a good next step after the 2009 State of Montana adoption of greywater reuse standards, and feel that the greywater reclamation tax rebate legislation recently considered in the State Legislature could be a good model for incentivizing green roofs.

The Clark Fork Coalition is in favor of the City of Missoula promoting green roofing through policy. They feel a demonstration project makes sense for the City, especially when coupled with a feasibility study to prove the concept in Missoula. They see the upcoming City Climate Action Plan as a possible opportunity to incorporate such a project, and also point to a need for educational materials on best green roofing practices and what kind of buildings are appropriate for retrofits. They acknowledge that City buildings represent a significant portion of the City's greenhouse gas emissions – approximately 20% in 2008 according to Missoula's recent greenhouse gas emissions inventory (Saha et al. 2010) – and think a "lead by example" green roofing policy for City buildings may be a useful option for addressing this, though they wonder how many City buildings may be appropriate targets for the practice. They feel incentives for green roofing would be a good approach, but recognize that the City budget may not be able to accommodate financial incentives at this time. They rank a City demonstration project and incentives as their first preferences, followed by a "lead by example" policy and finally mandatory building standards.

As a watershed conservation organization, the Clark Fork Coalition can offer important insight into stormwater runoff issues in Missoula and how they relate to the

health of the Clark Fork River. They say their office regularly receives calls during rain events in Missoula from concerned citizens alerting them to questionable runoff being discharged into the river – "We'll get a call that someone's at Brennan's wave and they see black water dumping into the Clark Fork," says Ms. Randall. They see a top-down approach – addressing the source of runoff – as a more cost-effective means to tackle this problem than retrofitting Missoula's stormwater system, pointing out that it is much less expensive to reduce the stormwater entering the system than to try and treat what comes out.

Tim Skufca, Redevelopment Committee chair, Missoula Urban Demonstration Project (MUD) – April 5, 2011

The Missoula Urban Demonstration Project (MUD) is a local nonprofit and volunteer-driven conservation organization promoting urban sustainable living "through education, demonstration, and celebration in the Missoula community." (Missoula Urban Demonstration Project 2011) Mr. Skufca says that, in general, MUD is "completely on board" with promoting the practice of green roofing in Missoula, stating that MUD's purpose is to demonstrate and promote all aspects of innovative building and design techniques. He says that MUD's preference would be to promote a harvestable product such as rooftop container gardens, and says MUD plans to include a food-producing green roof on an upcoming project.

MUD generally would be in favor of a City policy to encourage green roofing, though the organization is currently engaged in pushing greywater recycling and composting toilets as top priorities for City action. Mr. Skufca sees a City demonstration project as a good way to raise awareness of the project. He stresses the need to make sure such a project is designed and installed correctly, pointing out that proper roof performance will be primary

to demonstrating other green roof benefits such as stormwater control and energy efficiency. With regards to a City "lead by example" policy, he is "extremely excited" about the use of green roofs as one element of a broader commitment to sustainable design for City buildings. He feels that financial incentives are not the best option, as they may take away from funds that could be used for other MUD priority projects such as solar and wind energy, greywater recycling, and building insulation retrofits. He ranks a City pilot project as his first preference, followed by a City "lead by example" policy, with financial incentives and mandatory building design standards as his last choices.

Mr. Skufca has two concerns about green roofing in Missoula, both water-based. He prefers stormwater collection for gardening purposes and sees green roofs as potentially taking away from that goal. He also is concerned about irrigation needs to keep green roofs healthy over the hot summer months. However, he is more comfortable with climate-appropriate green roofing practices such as utilizing drought-tolerant local species.

Matt Hisel, Co-director and Administrative Coordinator, Home ReSource – April 13, 2011

Home ReSource is a non-profit building materials reuse center that works "to reduce waste, build healthier communities, and promote a more vibrant and sustainable local economy." (Home ReSource 2011). Mr. Hisel says that the people behind Home ReSource are "big advocates" for the practice of green roofing, and plan to install a green roof for the Home ReSource entry awning utilizing deep beds and native plants.

Home ReSource is fully in support of the City of Missoula taking steps to promote green roofing, and Mr. Hisel feels that education and demonstration of the practice should be the first steps. Mr. Hisel thinks the City "definitely should" pursue a demonstration green

roof project – he says that not installing one on the Currents Aquatic Center was a missed opportunity, but adds that the new emergency communications center could be a good target. He thinks a City "lead by example" policy could be more feasible than requiring green roofs in the private sector, and feels that City buildings are a good place to demonstrate sustainable building practices. He would like to see financial incentives offered to encourage green roofing, possibly through tax credits. With regards to mandatory design standards, he feels it is difficult to require building standards above and beyond the norm, and worries about extra mandatory costs for local businesses and nonprofits already running thin margins. However, he sees non-locally-owned companies (such as big box retail stores) as a potential target for such standards, pointing out that these companies have the finances to be able to comply with extra requirements for sustainable building. In his words, "hit the big guys, don't hit me with it." He ranks a City demonstration project and incentives as his top preferences, followed by a City "lead by example" policy and finally mandatory building standards.

Other Interviews

Linda McCarthy, Executive Director, Missoula Downtown Association – April 20, 2011

The MDA is a nonprofit member-based organization dedicated to "promoting, supporting and enhancing the vitality of downtown Missoula." The organization is made up of over 400 businesses and individual members, and coordinates downtown events including Out to Lunch and the River City Roots Festival (Missoula Downtown Association 2011). The Missoula Downtown Association has not been involved in promoting or utilizing green roofs, but sustainability increasingly has been part of MDA's discussions in the past five years, including recycling, composting and alternative energy sources for downtown events.

Renovation and preservation of downtown buildings, which Ms. McCarthy notes are generally built to more sustainable standards in terms of materials, falls in line with sustainability initiatives. As examples of other sustainability measures supported by the MDA, she notes the installation of solar parking meters, the establishment of bike lanes in the downtown area, and the MDA's bus pass program.

Ms. McCarthy thinks policies to incentivize green roofs in Missoula could be a good idea, though she feels mandates that would impose additional costs on small businesses would be problematic. She feels a City demonstration green roof would be a good opportunity to showcase the concept and set a tone of leadership on the part of the City. She thinks the downtown area would be a good place for such a demonstration project, especially given the ongoing renovation and investment in downtown development. She also feels such a project would have greater benefits in the downtown area than in a residential setting. With regards to a City "lead by example" policy, she points to the Missoula Percent for Art initiative as a similar example of the City leading the way on policies that serve the public and work to meet City goals. She wonders how financial incentives would be funded, and she thinks an incentive program would be more feasible if funds could be procured through tourist dollars (such as a Montana sales tax) rather than additional fees for Missoula businesses and property owners. With regards to mandatory building design standards, she would prefer a broader policy of overall building sustainability, with green roofs as one of many options in a sustainability toolbox. Even then, she worries any mandatory standards would be overturned at the State level. Regardless, she believes such a mandate would come after a process of education, demonstration, and offering incentives.

Ms. McCarthy feels that Missoula is in the process of learning the importance of having access to green space and food-growing areas in an urban setting. She thinks rooftop gardens could become extremely valuable as Missoula's urban core becomes denser. She suggests that an anchor store downtown with residential space above could be a good target for a rooftop garden, saying it "could be a really cool thing to have downtown and fits very well with the moniker of the Garden City".

Nate Lengacher, independent local green roof vegetation grower, and Brian Mosley, West US Operations Director, Xero Flor America – April 16, 2011

Nate Lengacher is an independent grower with a farm in the Bitterroot valley who contracts with Xero Flor America, a leading North American green roof provider. Xero Flor America "utilizes extensive academic research and proven German technologies to produce a variety of green roof systems tailored to individual project design goals and regional North American climates" (Xero Flor America 2011). Both Mr. Lengacher and Mr. Mosley would love to see more green roofs deployed in Missoula, especially for University and municipal buildings. They acknowledge that Missoula does not have the stormwater control issues other communities face (though several storm drains in the downtown area drain to the Clark Fork River), but point to the downtown area's pronounced heat island effect in the hot summer months, green roofs' insulative properties, enhanced roof membrane lifespan, and Missoula's desire for aesthetically-pleasing amenity space and preserved habitat all as areas where Missoula could benefit from promoting green roofing. Mr. Lengacher and Mr. Mosley have a number of suggestions for how Missoula could best go about this.

These green roof industry representatives feel a City demonstration green roof would be a great way to raise awareness among consumers, vendors and designers by

serving as a reference project, and to create education and data collection opportunities as well as offering valuable amenity space to the community. They recommend a municipal building for such a project, particularly due to the City's long ownership horizon for its buildings – they believe extensive green roofs really pay for themselves around the 20-year mark when a conventional roof would need replacing, so installing one on a City building would be an economically wise choice and provide other benefits. They recommend locating a flat roof with high solar exposure to truly reap the cooling benefits of the roof, either on a new building or one which is already due to be reroofed. Additionally, the demonstration roof should be either accessible to citizens or visible from above, and rather than a test strip should be a total roof installation which would allow for studies of the interior effects of the green roof. Finally, they recommend such a project be clear and honest about the project's costs and benefits, to protect providers, suppliers and installers from unrealistic expectations among interested consumers. In addition, they suggest the City make an official statement in favor of the practice of green roofing to further encourage their use.

Mr. Lengacher and Mr. Mosley also have a number of recommendations regarding incentives for green roofing. They feel that if financial incentives are available, they should be as straightforward as possible; they point to Portland's direct $5 per square foot Ecoroof grant program as a good example of this. They also point to incentives that may be made available without impacting the City's budget, including qualifying green roofs as permeable surfaces and so freeing them up as an option for developers trying to meet permeable surface requirements, and offering developers the ability to increase their project's planned density (housing units/area) by building further upward if they incorporate a green roof.

These representatives feel there is a good deal of confusion and bad information in circulation about green roofs and the benefits they may offer. Regarding irrigation and maintenance, they assert that green roofs can be designed to regional climates, resulting in healthy, weed-resistant roofs requiring minimal maintenance. They note that the insulative qualities of green roofs are misunderstood; rather than increasing a building's envelope, green roofs actually reduce cooling load in summer months through a combination of thermal mass and reflectivity. They compare these benefits to white reflective roofs, which they point out must be cleaned and repainted every few years to maintain reflectivity, do not help retain stormwater, and do not protect themselves from solar radiation damage or daily heat cycling leading to eventual membrane breakdown (green roofs, on the other hand, prevent 77% or more of daily expansion and contraction due to heat). Finally, with regards to fire risk, they point out that properly designed green roofs have been vetted and found acceptable by Missoula's Fire Marshal, and when installed with irrigation systems in place can actually act as a fire control measure. They note that the Xero Flor system has been granted the German Certificate Against the Spread of Flame after passing stringent fire safety testing measures.

Stakeholder Analysis

The stakeholder interview portion of this project was successful in generating a wide variety of opinions from a range of Missoula stakeholders. This section will analyze each stakeholder group separately to identify the primary thoughts and concerns of the "City Administrators", "Architecture, Building and Design Community", and "Conservation Organizations" groups, as well as evaluating each of the four policy options included in the stakeholder interviews based on the collected interview responses for each group. Due to

the limited number of interviews in the "Other Interviews" group, and the distinctly different roles of the interviewees grouped there, that category has not been included in this group breakdown. However, these "Other Interviews" are included in the overall analysis.

City Administrators

The City administrators interviewed for this project share a certain degree of familiarity with green roofing, mainly from its reputation as a stormwater control measure. In addition to stormwater benefits, amenity space benefits were recognized by two out of six interviewees in this category, and prolonged lifespan of roofing membranes and energy benefits were recognized by one interviewee each. Only one of this group expressed interest in the City of Missoula taking steps to encourage the practice through policy steps.

Unsurprisingly, the main concern among City administrators regarding green roofs and green roof policies was expense to the City. Availability of funding or other resources for green roofing initiatives was a topic touched on by each of the six interviewees in this category, who are all intimately familiar with the tight City budget. These concerns were largely related to the City's ability to offer financial incentives, though two interviewees felt that expending monetary and labor resources for a City demonstration green roof could be a concern. Three out of six wanted to make sure that a City "lead by example" policy would make financial sense for the City before voicing an opinion for or against.

Another primary topic of concern in this group was the absence of a pressing stormwater management issue in Missoula, which most (four out of six) in this group see as the primary driver for green roofing initiatives in other communities. For this reason, five

out of six of the interviewees in this group do not see green roofs as offering solutions to any pressing City issues at this time, though three out of six feel green roofs may become more valuable to the City as it continues to urbanize and become more dense.

Due to the nature of some of these interviewees' positions within the City administration, preference rankings for the four policy options discussed were provided by only two out of six interviewees in this group. However, both of those ranked a demonstration green roof first, a City "lead by example" policy second, financial incentives third, and mandatory building design standards last.

*Table 1: Summary of Green Roof Policy Preferences of City Administrators**

Rank	Demonstration Project	Lead by Example Policy	Financial Incentives	Mandatory Policy	Education/ Information
1st	2				
2nd		2			
3rd			2		
4th				2	
Other	1†	2±	1±	2±	2†

* Values shown indicate the number of administrators giving 1st through 4th rankings for various green roof policies
† Supported or gave qualified support, but not ranked
± Mentioned but not ranked

Architecture, Building and Design Community

The Missoula architecture, building and design community, having a good deal of experience with green roofs, were more aware of the range of benefits green roofs can offer to building owners and the greater community. Stormwater management benefits were mentioned in six out of seven interviews, followed closely by aesthetic and amenity benefits (five out of seven). Three interviewees touched on the topic of energy efficiency, two on alleviation of the urban heat island, and one each on the topics of prolonged roof

membrane lifespan, habitat preservation, opportunities for growing food, and fire protection.

The primary concern of this group regarding green roofs is the need for more demonstration and education about best green roofing practices, topics which were brought up in six out of seven interviews. Six out of seven interviewees gave feedback in favor of the City committing more strongly to green building practices in general, with green roofing as one method in a toolbox of available sustainable building techniques. Four interviewees touched on the cost of green roofing as a potential obstacle to widespread adoption. Other less prevalent concerns or comments brought up in these interviews were: the need for maintenance beyond what a conventional roof requires; the performance of green roofs in Missoula's arid climate; green roofs as a method to deal with increasing Missoula urbanization; the need for the City of Missoula to officially recognize green roofs as permeable surfacing. Each of these concerns was expressed by 2 out of 7 interviewees in this group. One interviewee mentioned: the potential for green roofs to help protect the aquifer from pollution; and the opportunities to tie green roofing into greywater recycling systems.

The architecture, green building and design stakeholders interviewed were generally supportive of the City of Missoula taking steps to encourage green roofing, with five out of seven interviewees expressing full support for the idea, while the other two expressed conditional support. Six out of seven interviewees were quite enthusiastic about a City demonstration green roof project and ranked it as their top preference (see Table 2). Six out of seven ranked mandatory building design standards as the least preferred option. Five out

of seven interviewees ranked a City "lead by example" policy as their second choice, though four of these would prefer such a policy to treat green roofs as one of many options in a toolbox for sustainable City building practices. Although four of these interviewees were supportive of incentive programs, three of these acknowledged the difficulty of providing funds for green roofing given the current state of the economy and City budget constraints. Two out of seven interviewees also offered ideas for nonmonetary incentives such as reduced landscape requirements or density bonuses for projects incorporating green roofs, indicating they had given a good deal of thought to green roofs. Indeed, four out of the seven architects and green builders had professional or personal experience installing green roofs.

*Table 2: Summary of Green Roof Policy Preferences of Architecture, Building and Design Community**

Rank	Demonstration Project	Lead by Example Policy	Financial Incentives	Mandatory Policy	Education/ Information
1st	6		1		
2nd	1	5		1	
3rd	1		6		
4th		1		6	
Other					5†

* Values shown indicate the number of administrators giving 1st through 4th rankings for various green roof policies
† Supported but not ranked
± Mentioned but not ranked

Conservation Organizations

The Missoula conservation community, represented in this project by three high-profile Missoula conservation organizations, is generally aware and supportive of the practice of green roofing. These groups' primary interests in the practice revolve around stormwater management benefits and increased energy efficiency (both were noted in two

out of three interviews), though creating space to raise food in Missoula's urban environment was a major interest for one interviewee. The primary concern regarding green roofing in this group, reflected in all three interviews, is the need for more demonstration and education to raise awareness in the community and help Missoulians become more comfortable with the practice. Other concerns mentioned in these interviews by one person (not necessarily the same person) were: the cost of green roofing beyond that of conventional roofs; the performance of green roofs in Missoula's arid climate; and the need to identify best installation and maintenance practices.

Each of these three organizations is in favor of the City of Missoula adopting measures to support green roofing. All three interviewees enthusiastically ranked a City demonstration green roof as the top preferred option, followed by a City "lead by example" policy in second place. Two out of three felt financial incentives would be a good way to promote the practice, though not without acknowledging the difficulty of diverting funds to green roofs given the current economy and City budgetary constraints; the other felt financial incentives may draw funds away from other priority issues. Representatives of all three organizations ranked mandatory building design standards as their least preferred option.

*Table 3: Summary of Green Roof Policy Preferences of the Conservation Community**

Rank	Demonstration Project	Lead by Example Policy	Financial Incentives	Mandatory Policy	Education/ Information
1st	3				
2nd		2	1		
3rd		1	2		
4th				3	
Other					3†

* Values shown indicate the number of administrators giving 1st through 4th rankings for various green roof policies
† Supported but not ranked
± Mentioned but not ranked

Overall Analysis

An analysis of all stakeholder interviews taken together gives a good deal of insight into community support for City leadership on green roofing, and stakeholders' preferred methods for promoting green roofing through policy tools. Twelve out of sixteen interviews resulted in responses in support of the City taking official action to promote green roofing in Missoula, primarily from the "Architecture, Design and Building", "Conservation", and "Other" stakeholder groups. With a few exceptions, policy options were ranked in the following order of preference: a City-led demonstration green roof project was the first ranked preference, a City "lead by example" policy was second, financial incentives were third, and mandatory building design standards were ranked as the least preferred option (see Table 4). Twelve interviewees also supported a City effort toward education on green roof benefits and best practices for Missoula's climate, seeing the dissemination of this information as an essential step toward widespread green roof adoption.

*Table 4: Summary of Green Roof Preferences for All Stakeholder Groups**

Rank	Demonstration Project	Lead by Example Policy	Financial Incentives	Mandatory Policy	Education/ Information
1st	12		1		
2nd	1	10	2	1	
3rd	1	1	11		
4th				12	
Other	1†	2±	1±	2±	12†

* Values shown indicate the number of interviewees giving 1st through 4th rankings for various green roof policies

† Supported or gave qualified support, but not ranked

± Mentioned but not ranked

Chapter 5: Recommendations and Conclusion

As discussed previously, community involvement is essential to successfully crafting local solutions to environmental issues (Finnegan and Sexton 1999), and policymakers must rely on stakeholder input when considering how best to address policy issues (Richan 1996). An analysis of stakeholder policy preferences and views gathered in this report makes it possible to draw conclusions regarding the opportunities to promote green roofing in the City of Missoula and offer recommendations for crafting such promotions to local conditions. Keeping in mind City budget limitations, Missoula's small size relative to some of the other cities promoting green roofing through policy measures, the deep importance to Missoula residents of preserving landscape and environmental quality, and the strong convergence of recommendations among interviewed stakeholder groups (see Table 4) to begin with education, demonstration and awareness-raising, this research project has generated six recommendations as to how the City could best promote green roofing and encourage more widespread adoption in the community:

- educating citizens about green roofing benefits and best practices;
- establishing a City-led demonstration green roof project;
- better defining green roofs within the City Building Code;
- passing a nonbinding resolution in support of green roofing in Missoula;
- adopting a strong sustainable building policy for the City of Missoula; and
- offering nonmonetary incentives for building owners looking to install green roofs.

This chapter explains each of these recommendations.

Recommendations

Education

From an analysis of the conducted stakeholder interviews, it is clear that the first step toward promoting green roofs in Missoula should be to educate residents and building owners about the practice and the benefits it may offer to the community. Though all of the interviewees had some degree of familiarity with green roofing, most, especially City administrators, knew of them primarily for their benefits to stormwater management. Though this feature of green roofs may offer some benefit to Missoula, especially in the downtown area and west of Reserve Street, there are others that may be of more importance to the City, particularly building energy use reductions during the hot summer months, protection of roof membranes from degradation, opportunities to create urban amenity and food growing space, and habitat creation and restoration. These last two will be of particular importance as Missoula continues to urbanize and become denser within City limits. This research also found that certain concerns regarding green roofs – especially maintenance and irrigation demands and fire concerns – may be somewhat overstated, as they can be readily mitigated with proper design to local conditions. The City of Missoula Greenhouse Gas Energy Conservation Team could address these knowledge gaps by providing information on best green roofing practices with an emphasis on location-appropriate design; such an effort could be aided by partnerships with other actors such as the Missoula Water Quality District, the Clark Fork Coalition, the Missoula Urban Demonstration Project, and members (especially architects and builders) of the Missoula Sustainable Business Council. Those leading this educational effort may look to Portland, Los Angeles and Minneapolis-St. Paul for examples on how best to present this information (see

Appendix 1), and should utilize the City's "Green Initiatives" webpage[1] to reach a wide audience in the community (the City of Portland's online Ecoroof portal is one excellent example of a thorough, well-organized and attractive presentation of such information – see Appendix 1).

City-led Demonstration Green Roof

The City has the opportunity to raise awareness of green roofs and provide information on best practices in a more dramatic way through the development of a City demonstration green roof project. Among the eleven (out of fourteen) stakeholder interviews generating responses in support of the City taking steps to encourage green roofs, all felt that a City demonstration project would be among the best first steps. A City-created green roof project makes sense on a number of levels: it would serve to demonstrate the concept and feasibility of green roofing in Missoula's local conditions, climatic and otherwise; it would provide opportunities for data collection and research; it could help achieve goals set by the City's upcoming Climate Action Plan; it would be an opportunity to create a valuable community green space; and it would serve to raise the City's environmental profile. Such a project may also be in the City's best financial interest due to the ability of green roofs to preserve waterproof roofing membranes, particularly if the project could be accounted for with life-cycle pricing rather than simple upfront costs[2].

This research has generated a number of recommendations regarding how such a demonstration project should best be conducted for maximum benefits and exposure.

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[1] Available at http://www.ci.missoula.mt.us/index.aspx?NID=956.

[2] Lifecycle comparisons between conventional and green roofs are becoming more standard with increased adoption of the practice, and have demonstrated that green roofs have saved building owners money over the lifetime of the roof (U.S. EPA 2010).

Specifically, it should be placed on a flat roof with high solar exposure; it should be placed on a new construction project, or otherwise a building that is due for reroofing; it should be a total, rather than partial, installation to maximize its energy and membrane protection benefits; and it should be either accessible to visitors or placed in an area where it would be visible from above to showcase aesthetic appeal (both the Missoula Mercantile building at 110 North Higgins Street, and the upcoming emergency communications center were mentioned in stakeholder interviews as potential high-visibility target locations).

The City may find opportunities for private and public partnerships or grant funding to help shoulder the upfront costs of such project. One such partner may be the Missoula Water Quality District, as that office previously has been involved in assisting with the costs of other best management practices, especially at the demonstration level (Jon Harvala, Environmental Health Specialist, Missoula Water Quality District, personal communication, April 29, 2011). A City energy efficiency loan fund, if established as has been occasionally discussed (e.g. Energy Block Grants Work! 2010), may also serve as a source for demonstration project funding. City policymakers and advisers, particularly the Missoula Greenhouse Gas Energy Conservation Team, may look to the District of Columbia's partnership with the Chesapeake Bay Foundation as an example of a successful public/private partnership effort to establish, maintain, and share information about demonstration green roof projects, and may follow that city's lead in incorporating energy and performance monitoring to generate feedback about best practices and effectiveness. However such a project is funded, project costs should be presented in such a way as to set realistic expectations in the community; for example, anything that reduces the overall cost

of the project such as donated materials and labor should be acknowledged as unique to the project and not the standard for green roof installation.

Green Roof Standards in Building Code

Given the near-absence of any mention of green roofing in the Missoula Building Code, one important step the City could take to facilitate green roof deployment would be to set official standards for green roofs through the Public Works Department. Such standards in other cities generally include guidelines on media depth, vegetation employed, best available waterproof membranes, and plant irrigation and roof drainage (National Institute of Building Sciences 2010). An effort to create green roof standards in the Missoula Building Code would serve as an opportunity to define best practices, and may serve to help future green roof initiatives, such as incentive measures, identify qualifying green roof projects.

Additionally, the City should determine if green roofs qualify as measures to meet landscaping requirements. Currently, all lots to be developed in the City of Missoula are required to have at least 15% of their total area landscaped, unless 15% is unavailable for landscaping due to the existence of structures and paving (in which case the developer must provide the maximum amount of landscaping possible) (Missoula City Zoning Ordinance §19.77.040(A), §19.77.045(A)). As the stated goals of these landscaping requirements include “creating an aesthetically pleasing and functional living environment “, “improving the air quality of the community”, “protecting water quality by providing vegetated areas that minimize and filter storm water run-off”, “moderating heat by providing shade”, and “buffering incompatible land uses and generally enhancing the quality and appearance of the entire site of the project” (Missoula City Zoning Ordinance §19.77.010), green roofs may

serve as acceptable substitutes for ground-level landscaping, but this must be clarified in the Missoula City Zoning Ordinance. City administrators may look to building codes in Chicago and Portland for examples of thoughtful green roof standards[3].

Nonbinding Resolution in Support of Green Roofs

Should they determine that promoting green roofs in Missoula is worth pursuing, one step the City Council could take, recommended by one stakeholder, would be to pass a nonbinding resolution in support of the practice. Even if no other actions are politically or practically feasible, nonbinding resolutions can serve to express a deliberative body's approval of something they cannot pass into law (Holland 2007). Such a resolution would serve to highlight the issue in the community and set a tone of leadership on environmental stewardship and sustainable building design, though the effect the resolution would have on increased green roof deployment would certainly be more effective when used in conjunction with the other recommendations presented here rather than on its own.

Commitment to Sustainable Building

One recommendation that has emerged from this research project concerns not green roofs specifically, but rather the practice of green building in a more general sense. Nine out of twelve interviews (this count excludes City Administrator interviews) generated statements in support of the City of Missoula following Missoula County's lead by establishing an official, progressive commitment to sustainable building practices (see Appendix 2 for Missoula County's Green Building Policy). These stakeholders felt that green

[3] The City of Chicago Department of Environment provides recommendations for green roof composition through its "Green Roof Systems Layers" page, available at http://www.cityofchicago.org/city/en/depts/doe/supp_info/green_roof_systemslayers.html, and these criteria are used in Chapter 17-4, "Downtown Districts", in the Municipal Code of Chicago, available through the American Legal Publishing Corporation at http://www.amlegal.com/library/il/chicago.shtml.

roofing should be included as one practice in a toolbox of sustainable building techniques, and that the City Council should lead the way by enacting policies to require some level of sustainable design in all municipal projects. While it is true that the City of Missoula has acknowledged sustainable building practices through the 2007 enactment of Resolution Number 7241, this Resolution requires only that new construction or major remodels include an analysis of available energy savings versus energy use at minimum code requirements (City of Missoula 2007), rather than setting a minimum level of sustainable design such as (for instance) acquiring a certain level of LEED certification. The Missoula City Council may look to other cities such as Portland, Oregon and San Jose, California[4] for examples of cities requiring a minimum LEED standard for municipal buildings. Should this prove impractical at this time, the City should at least follow Missoula County's lead in committing to "incorporate or support" LEED methods and techniques, including green roofs as one in a suite of available techniques.

Incentives

Though the City budget may not allow for the establishment of a green roof financial incentive program (a point acknowledged by nearly every stakeholder interviewed), the City Council should consider offering other nonmonetary incentives for promoting the practice. One option for such a nonmonetary incentive would be allowing green roofs to qualify for landscaping requirements, offering developers more freedom in how each site is developed. Even if the City decides green roofs only qualify for a percentage of the established landscaped area requirements, qualifying green roofs on something other than a 1:1 ratio

[4] The City of San Jose adopted a policy in 2001 requiring LEED certification for all municipal buildings; by 2007 the requirement had been raised to LEED Silver for all municipal and Redevelopment Agency buildings. See "San Jose's Green Building Policies" at http://www.sanjoseca.gov/esd/greenbuilding/policies.asp.

(for example, 2 or 3 square feet of green roof qualifying as one square foot of ground-level landscaping) may still function as an effective incentive for developers while meeting the various objectives of the landscaping requirements. Additionally, the City should consider height bonuses for projects incorporating green roofs as in Chicago, Portland and Seattle, where developers are allowed to add extra floors to new developments in exchange for installing a green roof, and expedited building permit review for projects incorporating green roofs. These incentives would serve to promote the deployment of green roofs in Missoula without impacting the City budget or drawing funds away from other worthwhile projects.

Opportunities for Further Research

This project has identified three areas that present opportunities for further research, including two specific to green roofing in Missoula and one for the broader study of green roof policies.

First, as mentioned in Chapter 3, conventional (as opposed to green) builders may be underrepresented in the stakeholder analysis conducted for this project, probably due to simple responsiveness. That is, the architecture, design and building firms already involved in green building were more likely to be interested in participating in this project; firms without such prior involvement did not respond to requests for interviews. In order to ensure a fair representation of the views of the architecture, design and building community in Missoula, future studies should strive to include both green and conventional builders. However, the participation and input of Mr. John Freer (a representative of the Missoula Building Industry Association as well as a green builder) should help to mitigate this imbalance for the purposes of this project.

Second, though this project found that "a number" of older buildings in the downtown area drain into central sewerage rather than injection wells or sumps, it is unclear exactly how many buildings this encompasses and what the total roof area of such buildings is. As these buildings may offer greater stormwater management benefit opportunities from green roofing, an inventory of exactly how many and which buildings drain to central sewerage would offer an opportunity to better understand the amount of stormwater runoff contributed by roofs in the downtown area and its impact on the sewer system.

Finally, though existing literature on green roof policies tends to identify only the six policy tools identified in Chapter 3, this project has identified two other existing green roof policy types: educational campaigns, as in Chicago; and nonmonetary incentives such as expedited permitting, allowances for permeable surface or landscape requirements, and density or height bonuses for developers incorporating green roofs, as in Portland and Seattle. An update of the literature to include all the existing policy types would be helpful for green roof advocates and cities looking to consider all the different options for promoting green roofing through policy.

Conclusion

The recommendations provided in this report draw from the experiences of other cities with green roof policies and the feedback gathered through interviews with Missoula stakeholders. In this author's opinion, education on green roof benefits and design to local conditions should be the first step taken if the City makes a determination to promote green roofing, and establishing standards for green roofs in the Missoula Building Code and the City Council passing a nonbinding resolution to raise the profile of the practice should

follow. Once this educational, technical and political foundation is in place, the City should consider the other recommended actions (a City-led green roof demonstration project, a City commitment to sustainable building practices, and nonmonetary incentives for green roof installation). Of these, nonmonetary incentives may be the most practical next step. Qualifying green roofs to meet landscape area requirements, providing building height bonuses, and expedited permitting could be enacted with minimal budget impact and minor updates to the Missoula Zoning Ordinance and building permitting procedures.

As mentioned previously, if it were accounted for or budgeted with lifecycle pricing, a City-led demonstration green roof project may also prove to be financially feasible as a next step, and would enjoy the support of many of the stakeholders interviewed for this project. Given the City's tight budget, a stronger City commitment to sustainable building practices (which also enjoys significant public and private support) may prove difficult at this time, but should be seriously considered by City policymakers in the future, especially during the drafting of Missoula's Climate Action Plan.

This research has shown that Missoula stands to reap many benefits from widespread adoption of green roofing, and that community stakeholders are generally enthusiastic about measures the City could adopt to encourage the practice. Though this research project is only the first step in what will likely be a long process of education, demonstration, and wider adoption, it hopefully may serve as a stepping stone for green roofing efforts, and function as a source of information for City officials and green roofing advocates in their efforts to green the Garden City.

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Appendix 1: Educational Materials

In addition to promoting green roofs through such policies as financial incentives or mandatory building design standards, a number of cities provide technical and educational materials to provide information about green roof benefits and best practices and supply technical information for those looking to install or retrofit green roofs on their building. This Appendix includes examples of such educational efforts and provides links to online information.

Portland, Oregon

The City of Portland's Ecoroof web portal provides a wealth of information regarding green roofs, including basic information about green roofing, technical information, green roof research, and guides for project managers and others wishing to install green roofs. The Ecoroof portal is available online at http://www.portlandonline.com/bes/index.cfm?c=44422 .

Los Angeles

"Green Roofs – Cooling Los Angeles" is a 64-page handbook produced by the Los Angeles Environmental Affairs Department which includes detailed information on green roofing, particularly technical considerations and local permitting guidelines. The handbook is available online at http://www.fypower.org/pdf/LA_GreenRoofsResourceGuide.pdf .

Minneapolis-St. Paul

The Urban Small Sites Best Management Practice Manual is a resource guide provided by the Minneapolis-St. Paul Metropolitan Council that provides 40 best management practices aimed at managing stormwater runoff and pollution. The "Green Rooftops" chapter of the Manual provides design requirements and other technical information on green roofs as a stormwater control measure, and may be accessed online at http://www.metrocouncil.org/environment/Watershed/BMP/CH3_RPPImpGreenRoof.pdf .

United States Environmental Protection Agency

The U.S. EPA provides definitions and discussions of green roof benefits and costs through its website, and provides links to additional information including the Green Roofs Chapter from its publication "Reducing Urban Heat Islands: Compendium of Strategies" along with other related informational links. The "Green Roofs" page may be accessed online at http://www.epa.gov/heatisld/mitigation/greenroofs.htm .

United Kingdom Environment Agency

The U.K. Environment Agency, in keeping with the Greater London Authority's Living Roofs policy, provides extensive information on green roofs through its website. The site includes discussions of green roof benefits and challenges, frames green roofs within a context of U.K. and London policies, and provides guidance on site selection, design, and technical evaluation. It also provides a list of other resources in print and on the Web. The "Green Roof Toolkit" site is available online at http://www.environment-agency.gov.uk/business/sectors/91967.aspx .

Appendix 2: Missoula County Green Building Policy

RESOLUTION NUMBER 2010-070

RESOLUTION ESTABLISHING THE MISSOULA COUNTY GREEN BUILDING POLICY

WHEREAS, Missoula County encourages and promotes the use of green building practices in the design, construction, renovation, remodeling, and operation of all County-owned facilities; and,

WHEREAS, Green building practices, as defined by the U.S. Green Building Council LEED™ Program, are practices that conserve resources, use recycled content materials, maximize energy efficiency, and otherwise consider environmental, economic, and social benefits in the design and construction of a building project. Leadership in Energy and Environmental Design (LEED™) is a voluntary, consensus-based national standard for developing high-performance, sustainable buildings, and,

WHEREAS, the LEED™ rating system is a nationally recognized system for rating the performance of buildings and to guide project design. The LEED rating system components include: sustainable site deign; water efficiency; energy and atmosphere; indoor air quality; materials and resources; and innovation in design. The LEED rating system calls for buildings to be constructed in ways that have been proven to reduce the consumption of energy and other natural resources, enhance recycling and re-use of building materials, minimize disposal of construction and demolition debris, and improve building performance, cost efficiency, and building longevity, and,

WHEREAS, The United States Green Building Council (USGBC) is an organization that serves as the nation's foremost coalition of leaders from across the building industry. USGBC works to promote buildings that are environmentally responsible, profitable, and healthy places to live and work, and

WHEREAS, Missoula County intends to promote green building practices in all capital projects that the County plans, designs, constructs, remodels, renovates and operates as long as certain financial requirements are met, and,

WHEREAS, the intent of these practices is to provide environmental benefits, create local jobs, improve employee health, productivity and the quality of workspace, enhance asset value, and achieve the highest, most cost-effective environmental performance possible over the life of County projects, and,

WHEREAS, Missoula County develops, owns and operates a variety of facilities that require ongoing operation and maintenance. Ensuring that County facilities are designed, operated and maintained using green and sustainable practices may reduce long-term operating and maintenance costs borne by County taxpayers, conserve energy, reduce greenhouse gas emissions, improve indoor air quality, and enhance worker productivity.

NOW THEREFORE BE IT RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA establish the Missoula County Green Building Policy, incorporating environmentally responsible guidelines into all buildings the County plans, designs, builds, renovates, remodels and operates. Taking direction from LEED™ methods and techniques, and garnering support from the Green Building Team, Missoula County will implement this policy in order to mitigate carbon emissions, air and water pollution, and human health hazards caused by building construction and operation, and to reduce energy consumption and long-term operating and maintenance costs.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA directs offices and departments to incorporate or support the use of Leadership in Energy and Environmental Design (LEED™) methods and techniques, whenever possible, as follows:

New Construction and Major Renovation - For all new construction and major renovation, departments are required to apply LEED™ criteria in the pre-design and design phase of projects, whenever applicable, and are encouraged to seek the highest LEED™ certification level achievable that is cost-effective based on long-term costs and limits of available funding. New Construction is any new building or structure. The types of projects where LEED™ standards could apply include - but are not limited to - office buildings, storage facilities, transfer stations, wastewater treatment facilities and pump stations, maintenance facilities and recreational facilities. Projects qualifying for LEED certification shall be registered thr90 ' the U.S. Green Building Council.

For all new projects where the scope of the project or type of structure limits the ability to achieve LEED™ standards - such as restroom facilities, park shelters, and parking lots - departments are encouraged to incorporate green building practices whenever possible using LEED™ criteria as a guideline for incorporating such practices, based on life cycle costs and limits of available funding. The scope of all renovation projects shall be evaluated to determine whether LEED Certification is merited.

Remodels and Minor Renovations - For all remodels and minor renovations, departments are encouraged to incorporate green building practices whenever possible and to use the LEED™ criteria as a guideline for incorporating such practices. Remodel is to add on to or alter the structure of an existing building or structure. Renovate is to improve, repair, or upgrade the condition of a building or structure.

Tenant Improvements and Leased Spaces - For all leased spaces and rentals leased by or from the County, departments and lessees are encouraged to incorporate green building practices whenever possible and to use the LEED™ criteria as a guideline for incorporating such practices, including the LEED™ criteria for Commercial Interiors and the LEED™ criteria for Core and Shell. Departments and lessees are encouraged to negotiate improvements to the leased or rented facilities with the owner to meet the Core and Shell criteria in order to reduce energy and water consumption, and operating costs for the facilities.

Existing Buildings - Departments are encouraged to incorporate green building practices in existing buildings, and to use the LEED™ criteria for Existing Buildings: Operation and Maintenance as a guideline for incorporating such practices.

LEED™ for new construction and major renovations is a rating system for building that was designed to guide and distinguish high performance buildings that have less impact on the environment, are healthier for those who work and/or live in the building, and are more profitable than their conventional counterparts.

LEED™ for Core and Shell is a green building system designed to provide a set of performance criteria for certifying the sustainable design and construction of speculative developments and core and shell buildings. Broadly defined, core and shell construction covers base building elements, such as the structure, envelope, and building-level systems, such as central HVAC, etc.

LEED™ for Commercial Interiors is a certification program developed by the U.S. Green Building Council that addresses the specifics of tenant spaces primarily in office, retail, and institutional buildings. Tenants who lease their space or do not occupy the entire building can LEED™ certify their space as a green interior.

LEED™ for Existing Buildings: Operations and Maintenance is the tool for the ongoing operation and maintenance of existing commercial and institutional buildings. The system identifies and rewards current best practices and provides an outline for buildings to use less energy, water and natural resources; improve the indoor environment; and uncover operating inefficiencies.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA will finance projects at a level suitable to meet the Policy requirements. Use of green building practices should be accomplished within traditional project budgets. If additional funds are sought for up-front costs, an analysis of the project should be completed by the department to estimate the life cycle costs and benefits of using green building practices If the analysis reveals that higher up-front costs yield long-term benefits (such as lower operations and maintenance costs), or there are other compelling reasons for the additional up-front costs, the department may request executive consideration of additional budget expenditures.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA require that each Department is responsible for incorporating the Green Building Policy into capital improvements, purchasing practices, and training staff.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA that a Green Building Team shall be created. The Green Building Team will provide support and education services to offices and department and serve as the technical resource on implementation of these policies. The Green Building Team will coordinate communication among

Departments and evaluate implementation of this policy. The Green Building Team will consist of a minimum of the Facilities Services Director, Public Works Director, Health Officer, Office of Planning and Grants Director, and the Chief Financial Officer, or their designees. Contract architects, landscape architects, engineers and those with other skills may be part of the team, as needed.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA that all architecture, engineering and construction service bids and requests for proposals/qualifications will reflect the Green Building Policy goals and requirements.

NOW THEREFORE BE IT FURTHER RESOLVED THAT THE BOARD OF COUNTY COMMISSIONERS OF THE COUNTY OF MISSOULA that all appropriate project managers, maintenance, and operations staff will be responsible for pursuing green building training. The County will offer training for all interested employees on LEED™ standards. The Green Building Team may facilitate training for County employees.

APPROVED AND SIGNED THIS 10th DAY OF JUNE, 2010

ATTEST:

Vickie M Zeier
Vickie Zeier, Clerk and Recorder

BOARD OF COUNTY COMMISSIONERS
MISSOULA COUNTY

Michele Landquist
Michele Landquist, Chair

Bill Carey
Bill Carey, Commissioner

Jean Curtiss
Jean Curtiss, Commissioner

APPROVED AS TO FORM
AND CONTENT:

Martha McClain
Chief Civil Deputy County Attorney

Appendix 3: City of Missoula Resolution Number 7241

RESOLUTION NUMBER 7241

A RESOLUTION OF THE MISSOULA CITY COUNCIL TO ADOPT AN ENERGY EFFICIENCY AND GREENHOUSE GAS REDUCTION POLICY FOR MUNICIPAL BUILDING PROJECTS INCLUDING NEW BUILDINGS, BUILDING ADDITIONS AND MAJOR REMODELS.

WHEREAS, energy efficient building techniques can pay for themselves and will save taxpayer money over time; and

WHEREAS, fossil fuels are finite, pollute the air we breathe and contribute to climate change when burned; and

WHEREAS, on June 17th 1996 the City of Missoula passed resolution number 5890 expressing support and agreement in joining the international Cities Climate Protection Campaign resolving to take a leadership role in reducing greenhouse gas emissions and to develop a local action plan to increase energy efficiency and reduce greenhouse gas emissions throughout the community; and

WHEREAS, on May 3rd 2007 the Mayor of the City of Missoula signed a resolution of support for the US Conference of Mayors Climate Protection Agreement; and

WHEREAS, on May 10th 2004 the City of Missoula adopted a Greenhouse Gas-Energy Efficiency plan that called for the formation of a Greenhouse Gas Energy Conservation Team; and

WHEREAS, the Missoula Greenhouse Gas Energy Conservation Team has been charged to advise the Missoula City Council on ways to reduce greenhouse gas emissions and constructing efficient buildings with reduced fossil fuel use is one way to reduce greenhouse gas emissions; and

WHEREAS, the best time to incorporate features that reduce fossil fuel use and promote energy efficiency in buildings is at the planning and design stages.

NOW THEREFORE BE IT RESOLVED that the City of Missoula adopts an Energy Efficiency and Greenhouse Gas Reduction Policy for new municipal construction and major remodels of municipal buildings. The term major remodels is meant to encompass projects that meet one or more of the following criteria: 1) projects affecting over 2,500 square feet of a buildings floor plan with a reasonable potential for energy efficiency upgrades, 2) replacing 75% or more of building heating system, 3) replacing 75% or more of building cooling system, 4) replacing over 50% of the building lighting, 5) involving removal of over 50% of a buildings roof, or 6) involving work on over 50% of a buildings exterior walls. The term major remodels is not meant to cover cosmetic remodels, emergency repairs or regular maintenance. The Energy Efficiency and Greenhouse Gas Reduction Policy for city initiated projects requires:

1.) Project Invitation for Bids or Requests For Proposals for new municipal buildings and major remodels will state the high priority of energy efficiency and greenhouse gas reduction for the initial 20 year operation of the building project. The request for proposal shall specify the energy rates to be used in the energy cost estimates required in item 2.) below.

2.) Licensed professionals providing services for a project will be required to include an energy analysis that:

a. estimates the energy consumption and long-term operating costs of the building if built to minimum code requirements.
b. proposes energy efficiency measures based on current technology and site location.
c. estimates the energy consumption and long-term operating costs from the scenarios proposed in 2.) b. above.

d. provides an economic analysis of the costs and benefits of proposed measures based on the initial 20 year period.

3.) Licensed professionals providing services for a project will be required to demonstrate capability and experience with energy analysis, or hire consultants with the necessary expertise.

4.) For the purpose of educating the public on the benefits of energy efficiency and greenhouse gas reduction:

a. results of the energy analysis shall be documented and available via the city website.
b. the energy efficiency and greenhouse gas reduction features incorporated into the project shall be publicized through educational displays during construction and in the completed building.
c. after the building contract is awarded, a press release may be issued that summarizes the energy analysis and energy features chosen for the project.

PASSED AND ADOPTED this 2nd day of July, 2007.

ATTEST:

/s/ Martha L. Rehbein
Martha L. Rehbein
City Clerk

APPROVED:

/s/ John Engen
John Engen
Mayor

(SEAL)