SPUR

GREENER AND BETTER ROOFS

A ROADMAP FOR SAN FRANCISCO

SPUR MEMORANDUM

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This memo reflects the diverse views of these stakeholders. Affiliations are listed for identification purposes only.

Introduction: The Benefits of Green Roofs

The hard, grey, uninteresting rooftops that cover as much as 30 percent of San Francisco's land area[1] are underutilized spaces that could be more beneficial to the city and to the environment. More productive and sustainable uses of rooftops include solar panels, solar hot water, wind turbines, green stormwater infrastructure, urban agriculture, publicly accessible open space and areas landscaped for recreation or natural habitat — or a combination of these uses. However, such better uses are generally more expensive for building owners and developers to install and maintain than their more basic and ubiquitous roof counterparts. There are often barriers that prevent better uses from being easily implemented. And upgrading or retrofitting the roofs of existing buildings to handle solar, green, or "blue" (for water detention) improvements may be even more challenging than building them that way the first time around.

Despite potentially significant cost and code-based hurdles, the benefits of greener rooftops are known and documented (Figure 1).[2] Green roofs benefit building owners and occupants as well as the public, by making the city more resilient. Some studies indicate that public or shared benefits may supersede private/building-specific benefits by a factor of 10, with public benefits of green roofs estimated at $30 per square foot compared to unused black roofs.[3]

Figure 1. Potential Benefits of Green Roofs
Benefits of green roofs vary by how they are designed and where they are located.[4]

Public Benefits of Green Roofs	Private Benefits of Green Roofs
Reduced quantity of stormwater runoff and improved water quality of the runoff	Reduced stormwater runoff (cost savings in cities where building owners pay stormwater fee separate from sewer fee)
Reduction of the urban heat island effect	Building energy efficiency/energy savings
Green/open space for passive recreation (when the roof is accessible)	Increased property value based on views/aesthetics and/or provision of open space
Food production (community gardens, etc.)	Food production (for use in building or for sale)
Aesthetic improvement, views from neighboring buildings	Improved performance of photovoltaics
Improved air quality	Noise reduction
Increase in habitat that promotes biodiversity	Extended life of the roof

[1] The amount of roof space as a percentage of the total area of a city typically ranges from 5-30 percent, depending on the density of buildings. Steven W. Peck, *The Rise of Living Architecture*, 2012, Green Roofs for Healthy Cities, www.greenroofs.org, p. 8.

[2] SPUR has previously written about the benefits of green roofs in our 2006 report, *Integrated Stormwater Management*, http://www.spur.org/publications/library/report/integratedstormwatermanagement_110706

[3] U.S. General Services Administration (GSA), The Benefits and Challenges of Green Roofs on Public and Commercial Buildings, May 2011, accessed at http://www.gsa.gov/portal/mediaId/158783/fileName/The_Benefits_and_Challenges_of_Green_Roofs_on_Public_and_Commercial_Buildings

[4] Ibid; and DC Greenworks, *Green Roof Incentives: A 2010 Resource Guide*, February 2010, 5-7, accessed at: http://dcgreenworks.org/wp-content/uploads/2012/07/dc-greenworks-2010-survey-of-green-roof-incentive-policies.pdf; and *The Rise of Living Architecture,* 16-17*,* see note 1.

In recognition of the public and private benefits of green roofs, many cities around the world have incentives and even regulations requiring them in new construction. Several cities in Europe — such as Stuttgart and Berlin in Germany, and Basel and Zurich in Switzerland — have had requirements in place and mature green roof industries for more than 10 years: As of 2013, Stuttgart alone has 21 million square feet of green roof. Over the past decade in North America, green roofs have certainly been on the rise, growing from about 1 million square feet in 2002 to more than 16 million square feet as of 2011.[5] But green roofs are still seen as somewhat exotic and niche in San Francisco. San Francisco lags substantially behind other cities such as Portland, New York, Chicago and Toronto in both green roof-specific policy and in on-the-roof implementation.

The SPUR Green Roof Task Force

The SPUR Green Roof Task Force was convened around the question of what could be done to support the development and broader implementation of green roofs in San Francisco. Inspired by the CitiesAlive conference coming to San Francisco in October 2013; a recent increased interest in urban agriculture, biodiversity and green roof policy; and a study trip to Switzerland attended by numerous San Francisco stakeholders, SPUR convened a task force in August 2013 that included members representing various city departments and the local construction and development industry. The group met over the course of six weeks to consider existing policies that support green roofs and to devise a policy roadmap for how to move forward on green roofs in the coming months and years.

The task force recognized that green roof policy overlaps considerably with broader green infrastructure policy, and with all the many ways to better utilize roofs, including producing renewable energy, collecting rainwater and creating publicly accessible open space. As well, we recognize that green walls and other forms of living architecture provide many of the same public and private benefits: beautification, air quality improvement, urban heat island reduction and more. However, we limited our scope to greening roofs based on the recognition that this type of improvement to the built environment has a specific set of challenges and opportunities. Our recommendations focus on ways to reduce barriers, create incentives, educate the building and development industry, and study opportunities to regulate green roofs someday in the future. Some of these recommendations also apply to creating more usable or better roofs overall, and/or to living walls.

In this memo, we describe the current policy landscape for green roofs in San Francisco, briefly describe the green roof policy development process that has been successful in other cities, along with a few case studies, and lay out a road map with near-term and long-term recommendations about what San Francisco can do to create a more favorable environment for greening rooftops in the future.

[5] Peck, Steven, supra note 2.

San Francisco's Current Green Roof Policy Landscape

San Francisco has a number of existing policies and funding mechanisms that are supportive of the development of green roofs:

1. **The Stormwater Management Ordinance**
   Perhaps the most influential policy putting green roofs in the construction pipeline today is this 2010 city legislation that requires any development or redevelopment project that disturbs more than 5,000 square feet of ground space to meet specific stormwater management standards outlined by the San Francisco Public Utilities Commission (SFPUC). Project developers can use a variety of tools — such as cisterns, bioretention planters, permeable pavement and green roofs — to manage their project's stormwater.[6] According to the SFPUC, as of fall 2013, this ordinance has led 18 of the 78 projects under review to include a green roof in their permit and project construction documents, totaling 139,000 square feet of new traditional green roof construction. While the stormwater management ordinance is a powerful tool that incentivizes the use of green roofs, it is only applicable to new construction and redevelopment projects. The policy does not affect the retrofitting of existing buildings to add green roofs.

2. **Financing for green roof retrofits through GreenFinanceSF Program**
   San Francisco's Property Assessed Clean Energy (PACE) program includes green roofs as one of the project types eligible for this property-secured financing program. PACE programs allow building owners to borrow money for energy and water efficiency projects with potentially lower rates and longer payback periods than they would receive from a traditionally structured loan.[7] Though green roofs are eligible for this financing, no project has yet applied to use their loan for this purpose.

3. **Neighborhood and specific plans that include support for green roofs**
   The city's Urban Forest Master Plan and several neighborhood plans and specific plans include green roofs as a desirable component. For example, the Recreation and Open Space Element of the General Plan states that rooftop greening can help "meet a number of the city's open space goals" and calls for buildings to be constructed with a roof structurally able to support minimum depths for planting. The Fisherman's Wharf Public Realm Plan encourages green roofs on all parcels to improve the visual quality of roofs from surrounding hillsides.

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[6] San Francisco Board of Supervisors, "Stormwater Management Ordinance" (Ordinance 83-10, 2010). Accessed at: http://www.sfbos.org/ftp/uploadedfiles/bdsupvrs/ordinances10/o0083-10.pdf. See also, San Francisco Public Works Code, Article 4.2, Sections 147-147.6. San Francisco Public Utilities Commission and Port of San Francisco, *Stormwater Management Guidelines: November 2009 Version*. Accessed at: http://www.sfwater.org/Modules/ShowDocument.aspx?documentID=2779

[7] GreenFinanceSF Commercial Program, *Eligible Measures List*, March 15, 2012. Accessed at: https://content.renewfund.com/production/san_francisco_county_ca_commercial/gfsf_eligible_measures.en.pdf. See also: San Francisco Department of the Environment, "Green Finance SF: Commercial PACE Program." Accessed on October 5, 2013 at: http://www.sfenvironment.org/article/financing/greenfinancesf-commercial-pace-program

4. **Audit of city-owned buildings with rooftops suitable for urban agriculture**
   Following passage of the urban agriculture ordinance in 2012, the San Francisco Real Estate Division began the process of reviewing all city-owned buildings to determine which had roofs that would be suitable for urban agriculture. In 2013, the division reported that it had made some progress reviewing the basic characteristics of more than 500 buildings, but that more in-depth investigation, which the division plans to do, is necessary to make more informed determinations.[8] The audit was specifically focused on roofs that could support vegetable farming.

Figure 2: Types of Green Roofs
The three types of green roofs are defined by their depth and the type of growing media they use.

Extensive	Semi-intensive	Intensive
3 to 6 inches deep	**6 to 12 inches deep**	**8 to 24+ inches deep**
Lightweight substrate, simple plant pallet or seeded. Usually low maintenance.	Lightweight substrates, varied topography, perennials and varied plant material. More maintenance required.	Varied topography and substrate depth. Applications include urban agriculture, garden roofs, sky park, traditional landscape, trees, and ornamental shrubs. Higher maintenance required.

Image source: Brenneisen, S. Space for Urban Wildlife: Designing Green Roofs as Habitats in Switzerland. *2006. University of Applied Sciences Wadenswil.*

[8] Office of the City Administrator, Memorandum to The Honorable David Chiu, President of the Board of Supervisors, "Urban Agriculture Recommendation," April 19, 2013, pages 17-18. Accessible at: http://www.spur.org/files/posts/Urban_Ag_Strategic_Plan_Final.pdf

Green Roofs, White Roofs and Blue Roofs

There are several types of infrastructure that can make roofs perform better. What's the difference between them, and which one should San Francisco focus on?

Green roofs (also known as living roofs, vegetated roofs, planted roofs, or eco-roofs) use plants as an extension of a roof to improve its performance across multiple applications (see Figure 1). By additionally protecting the waterproofing membrane with a layer of thermal insulation, green roofs make membranes last longer.[9] Green roof systems include waterproofing, root barriers, water retention and drainage systems, filter cloth, growing medium (substrate) and plants. They can have soil as shallow as three inches or as deep as several feet, supporting a range of plant types and usage profiles. Our SPUR task force liked the idea of the term "golden roofs" to describe those that are designed with drought-tolerant plants to thrive in the Bay Area's Mediterranean climate. Like many of the region's areas, in the dry season, grasses on such roofs would turn a golden color, offering many of the benefits of a "green" roof but with less need for irrigation.

Blue roofs[10] temporarily store and gradually drain rainwater off a building's rooftop. These systems detain stormwater for a determined period of time to slow the rate of stormwater release into sewer systems. A blue roof system requires a secondary waterproofing membrane and uses small openings, placed inside inlets of roof drains, to capture rainwater then slowly release it.

White or cool roofs use roofing materials that absorb less sunlight than traditional materials. By absorbing less heat, they conduct less heat into the building and save energy. Compared to a traditional roof, white roofs can reduce cooling loads or maintain lower inside air temperature if the building is not cooled. Though low-slope cool roofs are white, colored materials are used for steeply sloped roofs that are visible from the ground.[11] In California's 2013 Energy Standards, cool roofs are a prescriptive requirement for all new non-residential and new high-rise multifamily projects, as well as for reroofing projects, whether low-slope or steep-slope.[12] A project may forego the cool roof by upgrading the efficiency of other aspects of the building to save at least as much energy.

Solar roofs, i.e. photovoltaic and solar thermal systems, harness sunlight for productive use. California's 2013 Energy Standards require all new buildings (residential and non-residential) to have at least 250 square feet of shade-free and penetration-free roof space for future installation of solar energy systems.[13]

How do these different roof types stack up against each other? Green roofs are unique in their capacity to host biodiversity and connect wildlife corridors.[14] White roofs have the lowest cost in comparison of these three better-roof strategies, but they can increase reflective glare onto surrounding buildings. Blue roofs tend to cost more than white roofs and less than green roofs, but they do not provide additional benefits beyond stormwater retention or possibly non-potable applications.

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[9] Green Roofs for Healthy Cities "About Green Roofs". Accessed October 11, 2013 at: http://www.greenroofs.org/index.php/about/aboutgreenroofs

[10] NYC Environmental Protection, "Rooftop Detention". Accessed October 10, 2013 at: http://www.nyc.gov/html/dep/pdf/rooftop_detention.pdf

[11] Cool Roof Rating Council, "At Home with Cool-Colored Roofs" Public Interest Energy Research Technical Brief (2003), Accessed October 21, 2013 at: http://coolroofs.org/documents/CoolColoredRoofs_000.pdf

[12] California Energy Commission, "2013 Nonresidential Compliance Manual" Tables 3-11 and 3-12. AccessedOctober 21, 2013 http://energy.ca.gov/2013publications/CEC-400-2013-002/CEC-400-2013-002-CMF.pdf

[13] California Energy Commission, 2013 Nonresidential Compliance Manual" and corresponding residential manual. Accessed October 21, 2013 http://energy.ca.gov/2013publications/CEC-400-2013-002/CEC-400-2013-002-CMF.pdf

[14] National Audubon Society Conservation, "Pacific Flyway". Accessed October 11, 2013 at: http://conservation.audubon.org/pacific-flyway

Green Roof Policy Development in Other Cities

Effective municipal green roof policy typically develops by certain steps, or phases, on a pathway to broader acceptance and installation of green roofs:[15]

1. **Confirming or estimating anticipated benefits.** This phase investigates the expected impact of widespread green roof installation at the city scale.
2. **Raising awareness through demonstration projects and identifying champions.** Examples of such demonstration projects include Chicago's City Hall and the California Academy of Sciences in Golden Gate Park.
3. **Community engagement through promotion and public education.** This helps create a culture and demand for green roofs. Actions taken during this phase may include hosting forums/round tables, creating stakeholder advisory boards and launching public information campaigns.
4. **Action plan development and implementation.** This phase results in an action plan with concrete goals and time frames to track progress; it may also involve creating incentive programs such as tax credits, grants, stormwater utility fees and more to support green roof installations on more typical commercial building roofs.
5. **Technical research.** This may be ongoing alongside other phases; it involves understanding the particulars of the urban environment in which policies are being developed to best tailor design guidelines, plant palettes, watering regimes, etc. to be most effective and efficient.
6. **Program and policy development to institutionalize green roofs.** This step synthesizes the technical research and stakeholder outreach/community education to produce a policy framework. It may involve both regulatory and financial measures.
7. **Continuous improvement.** In this most mature phase of green roof policy, efficacy of new programs and policies can be monitored and improved as green roof implementation becomes standard.

Cities around the world are in various stages of green roof policy development. The most mature programs and policies are in Europe. Germany has had a green roof industry for 40 years. 70 cities in Germany offer direct financial incentives for green roof installations; such direct incentives include a program in Berlin that reimbursed 50 percent of construction costs (through 1997) and programs in other cities subsidized green roofs on a square-foot basis. Over 200 cities in Germany offer stormwater fee credits for green roof installation, while nearly 150 cities require green roofs on new construction: fee credits and requirements can go hand-in-hand. In Switzerland, where green roof policy primarily seeks to address energy efficiency, particularly for cooling in the summer, cities like Basel first created new standards for roof insulation and used utility fees to create subsidy programs for green roofs prior to establishing mandates for new construction. In Toronto, a pilot incentive program subsidizes around $2 per installed square foot of green roof was the first step to creating a requirement in 2009 for new large flat roofs to install green roofs, with coverage requirements dependent on the size of the building.

[15] According to Green Roofs for Healthy Cities, a nonprofit industry association dedicated to green roof industry development in the U.S. and Canada. www.greenroofs.org. Also described by DC Greenworks, "Green Roof Incentives: A 2010 Resource Guide", Feb. 2010, page 10. http://dcgreenworks.org/wp-content/uploads/2012/07/dc-greenworks-2010-survey-of-green-roof-incentive-policies.pdf

As of 2009, there were more than 90 green roof incentive programs in the United States.[16] These programs include incentives such as tax credits, grants, loans, permit fee reductions, stormwater fee credits, density bonuses and expedited permitting. For example, Chicago established a grant program for three years of $5,000 per project that aimed to address urban heat island effect. Portland, seeking to address stormwater issues, provides $5 per square foot of subsidy and, in certain parts of the city, provides floor area ratio bonuses for green roofs. Portland funds its green roof subsidy program with $5 million annually. In Minneapolis, property owners may reduce their stormwater utility fees by up to 50 percent by reducing their site's impervious area, and may qualify for up to 100 percent fee reductions for using green roofs. New York City had a one-time property tax abatement of $4.50 per square foot of green roof, but participating in the abatement program was so cumbersome for building owners that the program was scarcely used.[17] Incentives and other green roof programs must be designed carefully to ensure impact and efficacy.

Roadmap for San Francisco Green Roof Policy

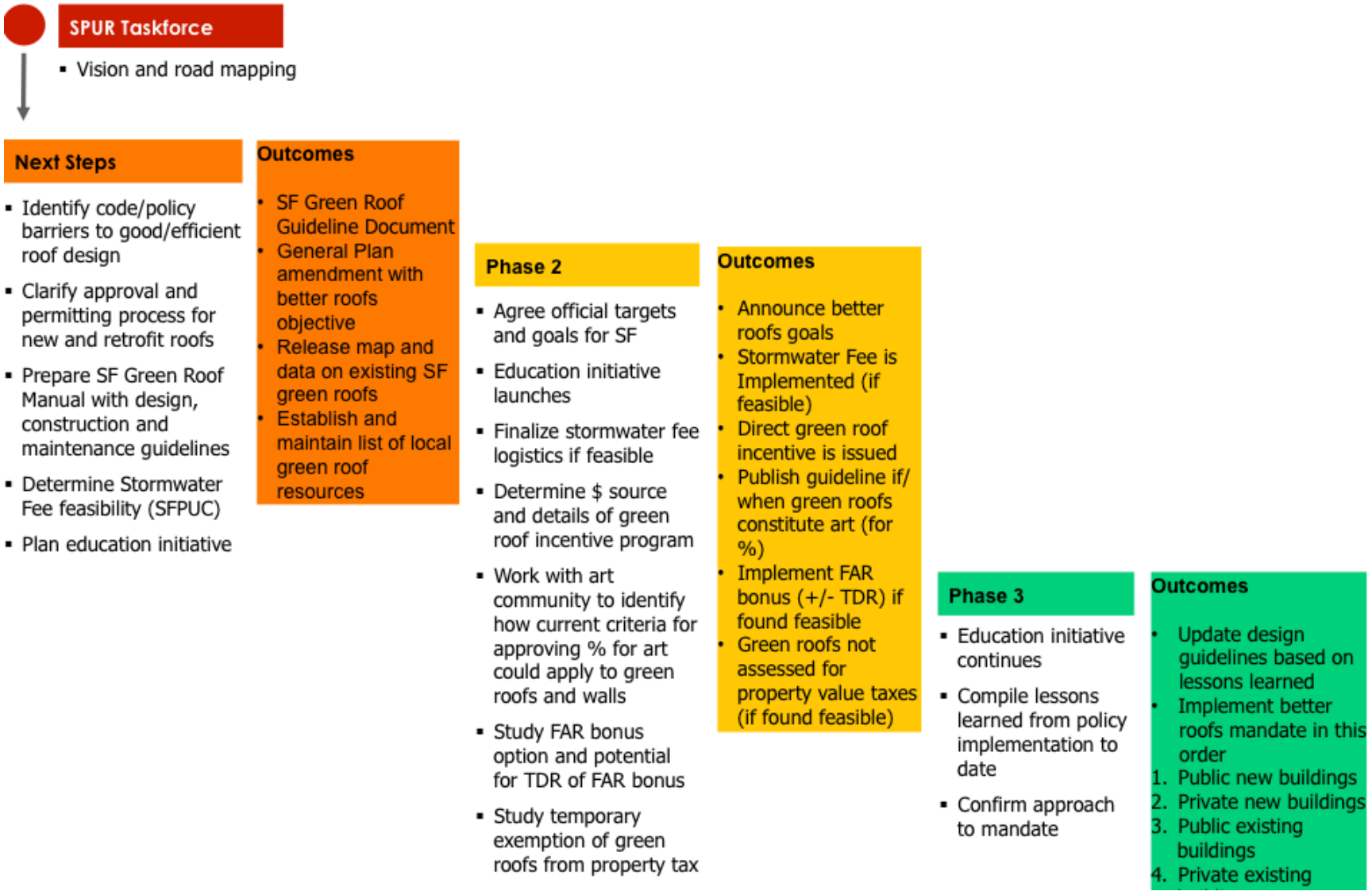
In studying green roof policy, policy development and how green roofs have proliferated in other cities, our task force arrived at four principal conclusions for San Francisco:

- We need to address barriers and confusion surrounding permitting and design for green roofs in San Francisco.
- We need the design, building and development industry to get up to speed with green roofs, and particularly to experiment with lower-cost designs.
- We have almost no incentives available to help reduce the high private cost of green roof installation, which could eventually mature the industry and bring costs down in the future.
- The public benefits of green roofs, which grow exponentially with the proliferation of green roofs, may even exceed their private benefits, thus there is a role for public subsidies to address costs.

Our green roof policy roadmap includes two categories of recommendations: ones that can launch today, and ones that are promising but not ready for implementation without preliminary actions and/or future study. We recommend the appropriate sequence of implementation in Figure 3.

[16] DC Greenworks, 2010, supra note 7, page 18.
[17] Crauderueff, R. et al. *The New York City Green Roof Tax Abatement: Policy Lessons*, 2012, http://swimmablenyc.info/wp-content/uploads/2013/01/SWIM-Green-Roof-Assessment_paper.pdf

Figure 3. Proposed Green Roof Policy Road Map for San Francisco



Recommendations Ready to Launch Today

1. **Clarify the permitting process for green roofs.** Living roofs have a number of building elements that may or may not trigger the need for a building permit and Planning Department approval. In the current system, permit applicants are expected to know which permits are required from the Department of Building Inspection (DBI). In some cases, codes that were intended for a wide range of uses, such as plumbing and fire codes, are not clear in their application to living roofs. This lack of clarity can result in delays in the permit process, changes to designs and even hesitation by designers and contractors to proceed with desirable features like living roofs. Confusion regarding the potential additional height rooftop landscaping may add to a project has also been cited as a reason project sponsors do not choose green roofs to comply with the Stormwater Management Ordinance — even though all conforming buildings are allowed to access a four foot height exemption for landscaping. DBI, working with the Planning Department, the Fire Department and green roof professionals, should develop a list of common living roof features and their definitions, identify the permits and documentation required and the document review process for each feature. This could result in a process diagram clearly explaining which types of roofs trigger which permits and inspections, whether different permits apply to residential and commercial buildings, and under what thresholds the requirements may be different.

2. **Create an interdepartmental green and/or better roof manual, containing design guidelines and policies and clarifying the permitting process for both new and retrofit roofs.** Best practices in green and/or better roofs with regard to common green roof types, plant selection, substrate, design, irrigation frequency, habitat provision, benefits, concerns related to waterproofing and more, have not yet been proposed for San Francisco. Such a manual could explain how to pair and permit solar or renewable energy installations with green roofs — a practice that can make the solar systems more productive (as plants help cool the equipment) and the green roofs more diverse/less water intensive. It would also include the permit process diagram recommended above. It should explain as well the structural engineering requirements for both new and retrofit roofs, to ensure that green roofs do not exacerbate seismic risk. The manual should be developed as a collaborative project between DBI, the Planning Department, SF Environment, the Office of Real Estate, and the SFPUC, possibly coordinated by the Mayor's Office, with the final product available on all the above-referenced departments' websites.

3. **Provide monetary incentives for green roofs.** Cost is cited as perhaps the greatest barrier to green roof installation. Typical green roof installation costs in San Francisco currently run between $20 to $30+ per square foot, which is significantly higher than average prices in cities that have had policies supporting green roofs in place for several years (e.g. Portland, where the average cost is between $15 and $20 per square foot). A temporary incentive can be an effective way to encourage more green roof installations, drive market growth and reduce prices permanently due to increased experience, awareness and local economies of scale. California solar incentives have been highly

effective in this regard and use a ratcheting incentive model with a decreasing incentive rate, illustrated in Figure 4 below. This model is particularly effective at encouraging early adoption. The proportion of total cost covered can remain high as amount drops because base price will tend to drop as the local industry matures and demand rises.

Figure 4: Potential Green Roof Incentive Structure

Step	Incentive Rate	Available Up To	Percent of Cost Covered (assumes base cost drops as local industry progresses)	Funding Needed
1	$6/sf	First 200,000 sf contracted	~25%	$ 1.2 million
2	$4.50/sf	Next 250,000 sf contracted	~20%	$ 1.125 million
3	$3/sf	Next 300,000 sf contracted	~15%	$ 900,000
4	$1.50/sf	Next 350,000 sf contracted	~10%	$ 525,000
	Total area	1.1 million sf	Full incentive cost	$ 3.75 million

The city should begin offering a direct financial incentive to new and existing buildings that install green roofs, and choose a single department to administer the program. The city should require qualifying roofs to meet the Water Efficient Landscape ordinance, boost incentive levels for desired attributes (e.g. raise incentive 10 percent for projects that offer accessible open space and another 10 percent for those that promote biodiversity, etc.) and consider offering funds for compliance installations that go "above and beyond" regulatory requirements. This could help projects get over the much higher cost hurdle of using a green roof rather than other infrastructure — which may not carry as many public benefits — to meet the current requirements under the Stormwater Management Ordinance.

Funds could possibly be made available for the incentive program through the SFPUC, or possibly through the General Fund or other funds available to support open space, biodiversity, carbon mitigation, etc.

4. **Implement a stormwater fee.** Many cities nationwide (and worldwide) have a stormwater fee. It would be one of the most effective policies San Francisco could implement to encourage green roof adoption — as well as increase use of other green infrastructure. Property owners in San Francisco currently pay water and wastewater rates based upon the size of their water meter and level of water consumption. There is no economic mechanism or incentive for private properties to reduce or treat stormwater effluent. As SPUR has highlighted in previous reports,[18] by reallocating a portion of the wastewater rate to reflect stormwater flows coming off a parcel, the SFPUC could create

[18] Such as *Integrated Stormwater Management* (2006) available at http://www.spur.org/publications/library/report/integratedstormwatermanagement_110706 and more recently, *Stormwater Fees: The Equitable Path to a Sustainable Wastewater Future* (2012), available at http://www.spur.org/publications/library/report/stormwater-fees .

a more equitable rate structure in which ratepayers were responsible for the impact of their properties on sewer infrastructure and the environment. Allowing property owners to reduce their sewer fees by building green infrastructure (ecology-based solutions that retain or detain stormwater on site) the city would create an economic incentive for property owners to build more green infrastructure, including green roofs. Green roofs could become one of the most desirable types of green infrastructure for properties that do not have much ground-level site area, or those that that cannot remove impervious site surfaces. A stormwater fee would also improve equity in the rate structure between existing buildings, which currently do not have any stormwater management requirements, and new buildings, which are subject to the Stormwater Management Ordinance. The SFPUC is currently in the middle of a study that would propose a rate structure to fund its Sewer System Improvement Program sometime beginning in 2014. In 2014, the SFPUC should reallocate wastewater rates to include a stormwater fee, that could be based upon factors such as parcel size, impervious surface and/or land use, and that property owners could petition to reduce upon installing qualifying green infrastructure.

5. **Amend the city's General Plan to include an overall vision for green roofs, making clear the case for a city-scale approach to green roof implementation.** As noted above, a number of citywide, specific and neighborhood plans refer to green roofs but inconsistently articulate how and where they should be implemented. A vision within the General Plan would be useful for reference in future area plans and design guidelines to ensure consistent policy language. The General Plan update could refer to the green and/or better roof manual and design guidelines (recommended above), so that green roofs called for in specific plans may be more readily implementable.

6. **Allow green and/or better roof improvements to be exempt from tax assessment for a limited number of years.** Under state law, installation of an extensive green roof on a new or existing building would not likely be considered assessable new construction, as roof replacement and repairs are considered normal maintenance practices.[19] However, more intensive green roofs — those that provide space for urban agriculture, public open space or other mixed better-roof uses — could be considered "substantial physical rehabilitation" and not just "roof coverings," triggering reassessment of the property's value. As a provision of state law, solar energy systems are currently excluded from property tax assessments until 2016. This exemption was originally provided to improve incentives for solar installations when they were less common and more expensive than they are today, a condition similar to where green roofs are now. State law also provides for an exemption from reassessment for seismic upgrades, which are also improvements to building stock that provide both public and private benefits. The State Board of Equalization should allow the value of a new green and/or better roof to be excluded from property tax assessments for a limited number of years. Although the added value of a green roof will vary on a case by case basis, excluding upgrades and improvements from reassessment will encourage experimentation with green, solar, food-growing and mixed-use roofs.

[19] State Board of Equalization, Property Tax Rules, Rule 463 (b)(4) http://www.boe.ca.gov/proptaxes/pdf/r463.pdf

7. **Host a series of green roof tours targeted to design, development, architecture, landscape and construction industry professionals to increase their familiarity with the performance of green roofs and SF-appropriate design.** Organizations devoted to professional education and inspiration such as the American Institute of Architects, American Planning Association, US Green Building Council, Green Roofs for Healthy Cities, the American Society of Landscape Architects and others should conduct tours and provide credit or continuing education units for green roof programs and technical training. Such entities could also collaborate on hosting and adjudicating green roof design competitions or awards for students and/or professionals. If the San Francisco building and construction industry could become more aware of green roof benefits and design opportunities, it could lead to more buildings successfully incorporating low-cost, climate appropriate technologies and reduce the sense that green roofs are exotic and expensive building features.

8. **Allocate at least $1 million from the Sewer System Improvement Program for a series of green roof demonstration projects on municipal facilities that would be monitored to provide performance metrics.** Analysis of these facilities' performance would inform design guidelines for inclusion in the SF green roof manual recommended above. The SFPUC is currently in the process of upgrading the city's sewer system with a $4.6 billion dollar investment. Currently, $400 million of this retrofit and rehabilitation program is slated for "green infrastructure," including demonstration or pilot projects. While the full scope of the green infrastructure component of the Sewer System Improvement Program (SSIP) has not yet been determined, green roofs should be one of the types of projects explicitly eligible for funding both in the pilot-project phase and upon full implementation of the SSIP.[20] More information gained from monitoring these demonstration roofs could provide more San Francisco-specific data for a variety of green roof types, including stormwater and energy performance, success of low-cost roof technologies and best plant palettes by microclimate (survivability in drought, salt, fog, wind, etc.). The SFPUC could run a competitive grant/challenge process to solicit teams, including academic or other qualified researchers, to conduct green roof research and build demonstration roofs that could be visited by tour groups and serve as educational opportunities.

[20] San Francisco Public Utilities Commission, "Green Infrastructure Projects". Accessed October 5, 2103 at: http://sfwater.org/index.aspx?page=614.

Recommendations for the Future, and Those That Need Further Study

Three ideas are described below that the SPUR Green Roof Task Force considered but believed to be premature to recommend for now, given the state of the industry, current costs, lack of incentives and uncertainty around best practices in design. But given the experience of other cities, we determined that these three policy options — often found at the most mature phase of green roof policy development — deserve more in-depth study and are likely to be recommended for implementation after the city has put into place some of the recommendations listed above. These options are in Phase 2 and 3 of the road map shown in Figure 3.

9. **Provide a floor area ratio (FAR) bonus for buildings covered by green roofs.** An FAR bonus for green roofs could afford an increase in floor area allowable for a facility that meets certain threshold requirements. Such a program has been highly successful in Portland. Such thresholds would likely include:
   - A minimum area (square footage) dedicated to a green roof.
   - Design meeting certain parameters defined in a manual to be written.
   - A post-occupancy review and inspection of the design.
   - A covenant ensuring the facility would be maintained in perpetuity.

   Floor area bonuses are typically calibrated to anticipate the cost of the amenity and be sufficient to constitute a genuine incentive. Study of this option might entail consideration of FAR bonus for other desirable components, such as solar panels, water reuse or provision of public open space. The study could also examine the potential of establishing a transfer of development rights program to allow buildings that are already at their zoned height limits to sell FAR bonuses offsite as a benefit of installing a green roof.

10. **Study the potential of using the Art Enrichment Ordinance and Planning Code-based public art provisions to fund artistically enhanced green roofs or walls.** The city's Art Enrichment Ordinance requires 2 percent of the gross construction cost of public buildings and transportation improvement projects to be allocated for public art. Artwork acquired by the city through this program must be permanently exhibited; "works of art" on public display and architectural objects do not count. In addition, the 1985 Downtown Plan established the 1 Percent Art Program which requires 1 percent of the construction cost of new buildings or additions of 25,000 square feet or more to provide public art. In 2012, the plan was expanded to include South of Market and parts of the Eastern Neighborhoods. Around the world, living walls and beyond-utilitarian green roofs are often considered works of art that evolve over time and serve as a reflective, living urban respite. The SFPUC should work with the city's Arts Commission and with the Planning Department, which administers the 1 Percent program, to determine what types of living installations or functional "art" could possibly qualify to be funded, partially or fully, by this often-substantial funding stream.

11. **Require green roofs for new development and on public buildings.** For new development, Planning Code-based requirements could be put in place to require a

portion of all flat or modestly sloped roofs[21] to incorporate green roof facilities (per the manual to be created). Requirements would likely include a specified minimum area and/or other performance standards. Thresholds could include projects or roofs of certain sizes and types, or within certain zones and/or districts. Consideration could also be given to visibility. (Areas with lower-rise building visible from key viewpoints or taller surrounding development might be maximized.) Such regulations should be considered in tandem with related requirements or programs manifested through other ordinances, programs and agencies. More specific and inclusive mandates should be crafted specifically for public buildings.

Regulations applicable to existing development (re-roofing projects) could require a portion of all new roofs to incorporate green roof elements. Exemptions could include structural loading restrictions, or roofs with a nominal percentage of utilizable area. Requirements could also include necessary structural upgrades to accommodate loads. Structural upgrades otherwise being provided could be an additional trigger.

Conclusion

Green roofs have an amplifying effect: The more there are, the more benefits we all receive in the form of urban cooling, beautification, open space, stormwater management, noise reduction, air quality improvement and more. San Francisco, which often claims to be America's "greenest" city, could do much more to improve the policy landscape for green roofs, green walls and better utilization of rooftops in general. Implementation of our roadmap will help.

San Francisco has a couple of its own models to follow here. In the policy development process for both solar energy installations and green buildings, the city has slowly moved from doing publicly financed demonstration projects to clarifying the permitting process and providing incentives for incorporating these better uses into the built environment. We are optimistic that a similar story for green roofs can unfold over the next several years.

[21] A reasonable maximum roof slope to study is a rise of less than three feet in twelve feet, or 3:12.

Appendix 1: Considerations for Green Roofs in Our Summer-Dry Climate

San Francisco has a sympathetic climate for growing plants due to its coastal fog and lack of frost. However, our summer dry climate calls for adaptive strategies and expectation management. Green roofs should respond to surrounding hillsides when possible, which sometimes means that plants will be golden rather than green. Phases of growth should also be accounted for in living systems: Seeding sections of a roof involves a waiting period for growth and the visibility of plants. Spring ephemerals will flower and fade with the season. Variations in the aesthetic appearance of roofs should be addressed with education.

Due to low annual rainfall water, designing for water efficiency is key, addressing plant selection, growing media and supplemental irrigation requirements. Supplemental irrigation can be provided without the use of potable water by incorporating fog catchers, capturing and utilizing rainwater and condensation from HVAC systems. In the case of new designs, structurally incorporating rainwater catchment cisterns into perimeter structures can feed rather than compete with plants on roof surfaces.

The vegetative layer should be considered for climate and microclimate conditions, which often means considering plants that are native to the region, or semi-arid areas of similar climates, and tend to require less water. Some native plants such as succulents retain high water content, preventing the spread of fire. Grasses that dry out seasonally need not be dangerous if they are reasonably maintained and placed with appropriate fire breaks.[22] Green roof design should comply with local fire codes, which may need to be examined for green roof applications.

Ideal plant characteristics include:

- Lasting, thriving or active through the year and through the seasons or through many years (perennial plants)
- Lateral and adaptable root system (fibrous or woody root system, without a deep tap root)
- Low nutritional requirements
- Low maintenance
- Light weight at maturity
- Drought resistant in both cold, dry winters and hot, dry summers
- Wind resistant
- Non invasive
- Low, compact, spreading growth habit
- Low dry matter content to alleviate fire safety concerns

Source: Tolderlund, L. *Design Guidelines and Maintenance Manual for Green Roofs in the Semi-Arid and Arid West, 2010*

[22] Tolderlund, L. *Design Guidelines and Maintenance Manual for Green Roofs in the Semi-Arid and Arid West, 2010*. University of Colorado Denver. http://www2.epa.gov/sites/production/files/documents/GreenRoofsSemiAridAridWest.pdf

Appendix 2: Lowering the Cost of Green Roofs

Material, installation and maintenance costs have factored highly into the difficulty of green roof adoption in San Francisco. Experiments with lower technology and/or more local material sources provide one way to address this. Low-depth "extensive" roofs (see Figure 2) tend to weigh less, cost less and require less maintenance. These options should be demonstrated and monitored with findings reported and shared to develop best practices for local microclimates.

While there are cost advantages to shallow green roofs, systems with less than four inches of substrate are not recommended, as they do not sustain well over time. Sedum mat systems that work well in other climates are challenged in dry systems and tend to die out. It is also difficult to achieve plant diversity with uniformly shallow systems, though some low-cost modular, continuous and loose-laid systems have successfully held diversity of plant species. Demonstration sites should test low-cost systems and seek opportunities to incorporate light-weight components to vary the landscape, such as hay, recycled fibers or repurposed Styrofoam blocks.