

IMPLEMENTATION OF GREEN INFRASTRUCTURE AS STORMWATER  
MANAGEMENT IN PORTLAND, OREGON

by

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A REPORT

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## **Abstract**

Green infrastructure is an emerging concept which utilizes vegetated systems rather than traditional gray infrastructure for stormwater management. Conducting a literature review revealed the effectiveness of incentive based planning, the benefits of green infrastructure, information on bioswales and wetlands, stormwater management, Portland, and planning implementation strategies. Portland, Oregon, was selected as the area of study because of its widespread application of green infrastructure. Seeking to understand the reasoning behind the implementation of this atypical civic infrastructure, existing policies in the city's Comprehensive Plan and the Zoning Code were analyzed. A policy analysis was conducted through itemizing the relevant policies in the Comprehensive Plan and the Zoning Code. Additionally, six in-depth phone interviews were conducted with Portland base planning-related professionals utilizing a snowball sampling technique to qualitatively understand the policies and circumstances that enabled the implementation of the city's bioswales and wetlands. Findings were revealed through using the grounded theory methodology of coding and memoing to analyze the responses from the interviews. According to the policy itemization and phone interviews, the Comprehensive Plan and Zoning Code were not the reasons for Portland's green infrastructure implementation, as hypothesized. Instead, green infrastructure was evident due to a need for compliance with the U.S Environmental Protection Agency's Clean Water Act, and a resulting Stormwater Management Manual created by the city. Additionally, other reasons for implementation included strong leaders, active citizens, and incentives and grants. The city encountered several challenges with implementation including costs, a technical lack of information, and opposition from members against using green infrastructure, which were all ultimately overcome. Lessons learned from this case study of Portland point to four policy recommendations for other cities wanting to implement green infrastructure to help alleviate pollution and flooding: the need for design having a general Comprehensive Plan and detailed Stormwater Management Manual, experimentation to generate and monitor data, collaboration, and funding.

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## **Chapter 1 - Introduction**

An urban planner's work typically entails community development offering better choices for where and how people live by improving welfare through creating "convenient, equitable, healthful, efficient, and attractive places for present and future generations" (APA, 2011). As established cities redevelop and new ones emerge, much focus needs to be placed on infrastructure to ensure health, safety, and welfare of citizens. One such component includes environmental consciousness in which planners and engineers need to consider not only benefits to people, but also the environment. Specifically, a major challenge faced by many cities in the United States, and even some parts of the world, includes stormwater management.

Stormwater management is necessary in urban landscapes because development has altered the ability of natural processes for water to flow and infiltrate naturally. Stormwater runoff is "generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground" (US EPA, 2009). Indeed, water which would have normally flowed and infiltrated into the ground naturally, instead, flows across the city in manmade infrastructure. Stormwater runoff often becomes polluted with sediments, chemicals, and debris, as it passes across pervious surfaces such as roads, and increases the propensity for flooding. Flooding is exacerbated in urban areas because impervious surfaces (such as concrete rather than vegetation), increase stormwater flow velocities. The Environmental Protection Agency has found that as much as 70% of water pollution and contamination is caused by stormwater runoff (SCI, 2011). Other effects of stormwater runoff can include stream bank erosion, increased turbidity from erosion, habitat destruction, changes in stream flow, combined sewer overflows, and infrastructure damage (US EPA, 2009).

Conventional "gray infrastructure" has traditionally been used to guide and manage stormwater. However, stormwater management techniques in urban areas are now experiencing a rise in green infrastructure. Green infrastructure, an "interconnected network of open spaces and natural areas," is favored by cities as this method naturally manages stormwater, reduces the risk of floods, captures pollution, and improves water quality (CNT, 2012). Green infrastructure addresses the core problem of urban runoff by offering environmentally responsible designs which seek to support a more natural hydrology cycle. Stormwater management through green infrastructure has several benefits. According to the EPA, these benefits include: reduced and

delayed stormwater runoff volumes, enhanced groundwater recharge, stormwater pollutant reductions, reduced sewer overflow events, increased carbon sequestration, urban heat island mitigation and reduced energy demands, improved air quality, additional wildlife habitat and recreational space, improved human health, long-term cost savings, and increased land values (US EPA, 2009). Almost all the benefits are stressed in a majority of research articles advocating for this new method of stormwater management, which protects streams and rivers and offers safety while enhancing the urban environment.

Understanding the benefits of green infrastructure as an alternative to stormwater management, however, does not provide convincing evidence for potential action to be taken by cities. What is essential for promoting its application is an understanding for how cities can actually implement the relatively new concept, which promises environmental, economical, and social benefits. Thus, this research, seeks to uncover ways through policy and other incentives for U.S. cities to implement green infrastructure. To do so, Portland, Oregon, considered a pioneer and leader “in the green infrastructure movement,” will be examined to uncover the importance behind its widespread green infrastructure implementation through examining its Zoning Codes alongside its Comprehensive Plan, in conjunction with interviews of the city’s planning professionals. Two types of green infrastructure, bioswales and wetlands, will be discussed because of their potential widespread usage throughout other cities, though other types of green infrastructure such as green roofs and impervious surfaces are present in Portland. It is hoped that by analyzing this city in detail, the question of what are existing incentives for cities to retrofit developments for the use of green stormwater management will be revealed. The generalized success and challenges of implementation will also be discussed serving as lessons for other cities or municipalities in the United States to learn from when considering implementing green infrastructure.

### **Research Question**

The question of interest is: *Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as bioswales and wetlands – as an alternative stormwater management practice? If so, what are the policies that have enabled Portland to implement green infrastructure? If not, what circumstances prompted the city’s bioswales and wetlands?*

The following chapters include the Background chapter including a literature review identifying existing key literature and the Methodology chapter showing the strategy of inquiry for the research. The Findings chapter presents collected data of policies in the Comprehensive Plan and the Zoning Code as well as information collected from interviews. Finally, the Conclusion includes policy recommendations and a discussion of the findings.

## **Chapter 2 - Background**

### **General Background**

This section will provide a list of words and definitions as they are discussed in this paper. Next, a literature review is provided, and organized according to each aspect of the main question. Finally, a literature summary reiterates main points and restates the importance of the question to be analyzed.

### **Operationalization**

The following glossary or list provides definitions of key words related to stormwater:

- ◆ Comprehensive Plan: A long-term document of the city officially stating the city's goals, visions, and policies for desirable future physical development (Stokes, 2011)
- ◆ Zoning Code: Implementation vehicle of the Comprehensive Plan (short-term), including ordinances (Delaware County, Pennsylvania, 2011)
- ◆ Policies: An action or procedure pursued by the government to guide decisions to achieve goals and outcomes (in this study, meaning the Comprehensive Plan and the Zoning Code) (Dictionary.com, 2011)
- ◆ Incentives: Federal, state, and local (municipal, county, or regional) methods to provoke action
- ◆ Stormwater management: Management of the quantity and quality of stormwater runoff through precipitation that flows over land surfaces with gray or green techniques (CWP, 2011).
- ◆ Conventional Stormwater Management: Management of stormwater with the goal of rapidly moving discharge into streams and rivers – usually through concrete channeling (Roy, et.al, 2008)
- ◆ Green infrastructure: Natural systems that capture, cleanse, and reduce stormwater runoff using vegetation, soils, and microbes to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls (CWP, 2011). Types of green infrastructure include green roofs, permeable pavements, filtration devices, rain gardens, rain barrels, urban forestry and tree plantings, as well as other landscape features and green spaces. In this paper, green infrastructure will focus on bioswales and wetlands.

- ◆ Bioswales: “Vegetated systems designed to facilitate the infiltration of stormwater and remove pollutants through infiltration media and/or vegetation uptake” (Jaffe, et.al, 2010, p. 8). Bioswales are also defined as shallow channels lined with vegetation that slow stormwater runoff into water bodies while filtering the water – swales are usually broad and linear, and function by reducing runoff, filtering pollutants, and recharging groundwater (SCI, 2011).
- ◆ Constructed Wetlands: Wetlands are areas where land and water come together to form a diverse, dynamic, and complex ecosystem for plants, animals, and microorganisms (SCI, 2011 and US EPA, 2009). Usually, they are utilized to “intercept runoff, reduce peak flows, decrease runoff volume, and mitigate pollution” (Jaffe, et al., 2010, p. 8). Aside from helping with filtration and infiltrating stormwater or surface runoff, wetlands also improve water quality, cycle nutrients and other materials, are a habitat for fish and wildlife, and enhance the aesthetics of a landscape (US EPA, 2009).

## **Literature Review**

The literature review examines relevant journal articles and books that specifically address the topic of stormwater management through green infrastructure. Literature tables are provided to summarize who conducted the study, the geographic area of focus, specific methods employed for conducting research, topics investigated in the study, and key findings or conclusions from the work. The organization of the literature is as follows:

- Incentive based planning
- Green Infrastructure
- Bioswales and wetlands
- Stormwater Management
- Why Portland?
- Planning implementation

The overarching purpose of the literature review is to demonstrate what research exists and to frame the question posed in this paper. A firm understanding of what has been done is necessary before further studies can be conducted.

### ***Incentive Based Planning***

Incentives are one of the key ways in which planning can achieve certain, favored development in an area. Incentives are used for political reasons and may have some advantages over governmental mandates or regulations, though governmental regulations are necessary as well. Although several articles were examined regarding incentive based planning, none adequately summarized its importance in terms of environmental planning strategies in particular. In “Market-Based Regulatory Approaches: A Comparative Discussion of Environmental and Land Use Techniques in the United States,” Kaydan stated that there is a movement “from command-and-control to market-based regulatory strategies” (Kaydan, 1992, p. 565). Essentially, in the command-and-control strategy, the government places a mandate on achieving a certain level. These mechanisms are effective in achieving goals and standards, but “they often do so at relatively high costs to society” (Hahn & Stavins, 1991, p. 6). However, in market-based strategies, including using incentives, the approach is market-dependent. Land use policy over the last few decades has used the market-driven incentive to supplement or replace command-and-control approaches (Kaydan, 1992, p. 566). Because of the “reliance on market forces to accomplish public objectives...” incentive-based regulations provide more benefits than command-and-control regulations (Kaydan, 1992, p. 569). Thus, instead of completely using governmental powers to mandate green infrastructure, for example, providing incentives would be more effective. The article, “Incentive-Based Environmental Regulation: A New Era from an Old Idea,” concludes by stating that economic-incentive mechanisms will become more prominent in the future.

### ***Green Infrastructure***

As previously mentioned, there are several types or applications of green infrastructure. This report focuses specifically on the use of bioswales and wetlands as alternatives to conventional concrete systems. An image of a bioswale in Portland is shown in Figure 2.1 for visualization of the concept.

**Figure 2.1 Bioswale as Green Infrastructure in Portland, Oregon**



**Source: Author, 2011**

The following articles, shown in Table 2.1, provide a general overview of green infrastructure. The articles mention several positives of green infrastructure including benefits related to human health, advantageous economic impacts, as well as several other benefits.

**Table 2.1 Green Infrastructure Literature**

Who	Where/Area of Focus	Methods	Key Relationships/Problems	Findings
Tzoulas, et al. (2007)	N/A	Interdisciplinary literature review	Association (not causation) between urban green space, ecosystem, and human health	Ecosystem services provided by Green Infrastructure can provide healthy environments and physical/psychological health benefits to residents and improved socio-economic benefits
Adlaja [Land Policy Institute] (2008)	Michigan	1. Valuation of Green Infrastructure: Hillside and Oakdale as case studies with hedonic pricing modeling 2. Impact of parks (RRRA visitor spending data) 3. Comparison on spending patterns of	Natural resource valuation, natural resource impact analysis, and natural resource conservation funding to understand the relationship between green infrastructure assets and economic impacts	Information on the relationship between green infrastructure and the economic impact is crucial for designing and implementing natural resource policies: 1. Green infrastructure assets have significant positive value 2. State parks can have significant economic impacts 3. State conservation funding

		US with Michigan		driven by state socioeconomic and political characteristics
Wise, et al. (2010)	United States	Literature Review and case studies	The valuation of the economic and social benefits produced by green infrastructure in urban settings	Economic valuation/benefits: reduced energy use, benefit to property and recreation values, avoidance of gray infrastructure and construction costs, reduced treatment costs, reduced flood risk/damage, groundwater recharge, noise, and reduction of urban heat island effect
Jaffe, et al. (2010)	Areas of Illinois with local programs; 5 state programs (Maine, Maryland, Minnesota, New Jersey, and Wisconsin)	Review of peer-reviewed scientific reports and articles; economic modeling	Current conventional stormwater systems are inadequate to handle future stormwater management needs	Green infrastructure practices are as effective as conventional on-site detention basins; green infrastructure can save costs and even provide significant indirect economic benefits
Chau (2009)	Los Angeles, California	Case Study	To examine low impact development (LID) for the City of Los Angeles and potential steps for instituting city-wide low impact development programs or projects	The city can increase its water supply, ameliorate climate change issues, and address the pollution in urban runoff by converting its paved areas from gray to green

**Source: Author, 2012**

“Promoting Ecosystem and Human Health in Urban Areas using Green Infrastructure: A Literature Review” by Tzoulas, et al. used an interdisciplinary literature review to address the key relationship or association between urban green space, ecosystem, and human health. After explaining the concept of green infrastructure, the paper provided a relationship between green infrastructure and health of both ecosystems and humans. The study concluded by stating that the benefits of green infrastructure include providing healthy environments, and both physical and psychological health benefits to residents (Tzoulas, et al., 2007, p. 175).

Economic benefits were mentioned by the Land Policy Institute in the “Comprehensive Study on Economic Valuation, Economic Impact Assessment, and State Conservation Funding of Green Infrastructure Assets in Michigan.” The studies formed a broader framework to understand the “relationship between green infrastructure assets and economic impacts” (Adelaja, et al., 2008, p. VI). The study revealed that green infrastructure assets have positive value based on natural amenities, have a substantial effect on local property values, and enhance long-term financial viability of communities. (Adelaja, et al., 2008, p. 57). Additionally,

“Integrating Valuation Methods to Recognize Green Infrastructure’s Multiple Benefits” by Wise et.al., also analyzed the economic and social benefits of managing stormwater through green infrastructure and LID (Low Impact Development) in urban settings – terms used interchangeably throughout their paper. The use of literature review and case studies formed the paper. The economic valuation of green infrastructure benefits was discussed and included positives such as reduced energy use, improved air quality, benefit to property and recreation values, avoidance of gray infrastructure and construction costs, reduced treatment costs, reduced flood risk/damage, groundwater recharge, noise, and reduction of urban heat island effect (Wise, et al., 2010, pp. 2-16). Finally, another article stating economic benefits was “Using Green Infrastructure to Manage Urban Stormwater Quality: A Review of Selected Practices and State Programs” by Jaffe, et al. Essentially, through peer-reviewed scientific reports and articles and applying an economic model, the report found that green infrastructure techniques are as effective as conventional gray infrastructure. Additionally, green infrastructure can result in savings as compared to conventional gray infrastructure techniques, and green infrastructure can provide indirect economic benefits through “increasing the amount of open space, vegetation, habitat and groundwater recharge” (Jaffe, et al., 2010, p. 5).

Other benefits of green infrastructure were mentioned through “Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply through Low Impact Development” by Chau. This article stated that several positives could result from Low Impact Development (LID), synonymous to green infrastructure: increase water supply, ameliorate climate change issues, address pollution from typical runoff, and create new “green-collar” jobs (Chau, 2009, p. 9). Finally, the U.S. Environmental Protection Agency also contains a list of benefits, some mentioned in the aforementioned articles, including: delayed stormwater runoffs, enhanced groundwater recharge, improved air quality, improved human health, and increased land values, among several others (US EPA, 2009).

Although not mentioned in this section, it is essential to note that green infrastructure may also have many negative aspects in terms of maintenance, costs, and aesthetic oppositions. None of the articles examined focused on the negatives of green infrastructure, and thus, criticisms are not provided in this paper. It is still wise to be aware that there may be certain negatives associated with this new technique, including, for example, an ambiguousness of the

term “green infrastructure” itself. This section did not discuss the negative aspects of green infrastructure, although this component will be asked of Portland professionals in the interviews.

### ***Bioswales and Wetlands***

The Infiltration Practices: Rain Gardens, Bioswales, and Constructed Wetlands section in “Integrating Valuation Methods to Recognize Green infrastructure’s Multiple Benefits” noted several benefits of bioswales and wetlands. As a background, bioswales “are typically installed within or next to paved areas like parking lots or along roads and sidewalks,” which allow water to pool and then eventually drain. The most important feature about bioswales is their ability to trap and filter sediment and other pollutants. Constructed wetlands form dynamic ecosystems to intercept and reduce runoff (Jaffe, et al., 2010, p. 8). Constructed wetlands are “the largest infiltration green infrastructure practice in both area and depth” and are filled with “native plants, grasses” and wildlife to “maximize pollutant removal through biological uptake.” Constructed wetlands are the most effective infiltration practice as they most closely replicate natural wetlands. Additionally, secondary positives of wetlands include recreational and aesthetic benefits (Wise, et al., 2010, pp. 9-11).

Table 2.2 demonstrates research conducted on wetlands and bioswales. The studies explain how swales and wetlands can reduce pollutants from runoff water and how these techniques are part of the best management practice.

**Table 2.2 Bioswales and Wetlands**

Who	Where/Area of Focus	Methods	Key Relationships/Problems	Findings
Storey, et al. (2009)	Case studies of US states	1) Examine and synthesize information from literature, manuals, and documents and 2) National survey of state agency using buffers, strips, and swales	Data to demonstrate the proven performance capabilities of vegetative buffers, filter strips, and grass swales in stormwater treatment	Recent research clearly demonstrates that the water quality performance of the roadside components is comparable to other Best Management Practices to reduce pollution constituents
Borst, et al. in Clar (2007)	N/A	Experimental: Construction of three swales with different slopes	Swale performance for stormwater runoff – understanding of how swales operate as a management practice for stormwater runoff	Grassed swales are one of several tools to convey stormwater runoff from impervious surfaces; other benefits include reduced flow velocities and increased infiltration

**Source: Author, 2012**

Swales and wetlands were discussed in “Stormwater Treatment with Vegetated Buffers” by Storey et al. The purpose of the paper was to provide data showing the proven performance capabilities of vegetated buffers, filter strips, and grass swales. The research was conducted through examining and synthesizing available literature along with transportation, environmental, and agency manuals, as well as a national survey of state agencies using buffers, fillers, and swales through case studies. The paper described each of the three treatments and then provided a general chapter regarding performances such as the slope and length, soils, vegetation, climate, and maintenance. The conclusion reached was that state agencies should consider vegetated buffers, filter strips, and grass swales as roadside applications for stormwater treatments as these practices reduce pollutants (Storey, et al., 2009, pp. 53-55). “Swale Performance for Stormwater Runoff” by Borst, et al. in *Low Impact Development: New and Continuing Applications* analyzes swale performance as well. The experimental method of constructing three swales with different slopes resulted in grassed swales having several benefits including reduced flow velocities and increased infiltration. The article stated that the benefits of the EPA’s swales are the ability to change the “design shape, runoff volume, pollutant constituents, and media,” emphasizing flexibility (Clar, 2007, p. 189).

These two studies provide a basic description of bioswales, prove the effectiveness of these green techniques, and show their benefits so that cities can be guaranteed success for implementation.

## *Stormwater Management*

It is important to understand the evolution of stormwater management in order to know why green infrastructure techniques are even considered. The history of stormwater management has occurred in three main stages: no management, “gray” management, and now, “green” management.

The need for stormwater management came about as cities started becoming more urbanized and more impervious. To address the problem of stormwater that resulted from excess precipitation in urban areas, urban stormwater drainage systems began being implemented from the late nineteenth century until the mid-twentieth century through municipal and engineering works. The goal of the projects was to minimize risks such as flooding, transport waste efficiently, and improve runoff conditions (WSTB, 2008, pp. 16-17). Thus, stormwater management was usually considered the successful collection and disposal of increased surface runoff – with solutions such as “roof gutters, downspouts, swales, curbed gutters, sewer inlets, and sewer pipes...” (Seybert, 2006, p. 2). However, through the goal of merely channeling water to streams and rivers, this “traditional technique” was “out of touch with the environmental values” (Brown, 2005, p. 455). In the very beginning, this technique was created, as mentioned, to respond to urbanization and land development (Whipple, et.al., 1983, p. 30). The “new” concrete approach at that time helped with flood control and floodplain management by land use controls, detention/retention runoff, erosion, and drainage (Whipple, et.al., 1983, p. 2). In the 1980s, attention began shifting to pollution problems and environmental concerns. Eventually, from the 1990s to the present, additional issues were recognized such as “erosion and groundwater recharge” caused by these gray systems (Seybert, 2006, pp. 2-3).

Although the engineered “gray” stormwater management system of the 20<sup>th</sup> century worked, it faces major problems today due to aging and increased load demands. Also, due to the increased impervious surfaces in many cities, runoff travels at faster velocities, which impacts streambanks and aquatic habitats by causing erosion (Bitting & Kloss, 2008). Thus, due to greater environmental consciousness and other added benefits, green infrastructure is considered a viable and valuable stormwater management technique, and is advocated for in this paper.

### ***Why Portland?***

Portland, Oregon is selected for this report because it is a pioneer in terms of green infrastructure, meaning that it was one of the first U.S. cities to widely implement green infrastructure.

Portland, Oregon, a city with a population of 539,000 in 2009, has been considered a “leader in the green infrastructure movement” (US EPA, 2009). Portland’s history began with the area originally inhabited by Native American tribes, and then being settled after the Lewis and Clark expedition in 1806. Portland grew during the California Gold Rush, having a population of 821 in 1850. A few years after being incorporated in 1851, the town continued to grow as it was selected as a major trade center. Although the city experienced a catastrophic fire during 1872, it rebuilt and regained prosperity through the first transcontinental railroad in 1883, bringing its population close to 90,000. Portland increased in population in the 1900s, and during World War II, was a ship-building and manufacturing center. During the 1960s and 1970s, Portland’s leaders avoided problems faced by other metropolitan areas through economic diversification, controlled growth, and environmental planning. Early planners, in fact, had already integrated parks and green spaces into the city. Planners also created ordinances to protect scenic views and other environmental concerns. Continuing today, Portland’s local government is still working on several plans for the area to move the city forward (City Data, 2009). In fact, the city has promoted ecologically sensitive development through several green infrastructure projects and programs. Portland has promoted funding and education relating to stormwater management, and its green infrastructure has flourished from several policy decisions promoting sustainable plans and designs (US EPA, 2009).

In the study “Fostering Green Communities Through Civic Engagement,” Shandas and Messer (2008) studied the Community Watershed Stewardship Program (CSWP) in Portland, Oregon. The authors chose this city as a case study because it had won many awards for being the greenest city in the US, and because it resembles other US cities as well. To understand the prerequisites for developing effective community-based environmental management programs, the authors used surveys, interviews, and participant reports. The conclusion was that representing diverse interests in collaborative solutions is important, such as involving citizens once they are aware that they are a part of the natural world, not apart from it. Flexibility is

needed to allow public participation, and partnerships are also essential (Shandas & Messer, 2008).

### *Planning Implementation*

The following articles illustrate the common barriers to implementing green infrastructure. Table 2.3 provides the articles relating to planning implementation.

**Table 2.3 Planning Implementation Literature**

Who	Where/Area of Focus	Methods	Key Relationships/Problems	Findings
Valentine [The Civic Federation for The Center for Neighborhood Technology] (2007)	The cities of Greater Chicago, Chicago, Philadelphia, Seattle, and Milwaukee	Barriers to green infrastructure through analyzing 5 cities	Comparison of green with traditional is not possible; barriers to implementation include lack of performance data, cost, and decentralization; small-scale inefficient; commonality of strong leader	Green infrastructure practices are new and research regarding its effective has “not yet matured”; costly in retrofitting; decentralized nature can be a barrier
Brown (2005)	Metropolitan Sydney, Australia	Institutional theory as an analytic approach (historical); extensive content analysis of local policy and industry literature and over 600 interviews	To scope the administrative impediments to enabling the practice of IUSM (Integrated Urban Stormwater Management)	Barriers: The current institutional framework, intergovernmental relations, entrenched implementation processes, and historical low political profile of urban stormwater
Roy, et al. (2008)	Australia and United States	Synthesis of literature and compilation of authors’ ideas and experiences	Seven major impediments to sustainable urban stormwater management	Need to make changes in managing stormwater – need to overcome institutional discrepancies and formulate integrated approach; need experimental manipulation at watershed scale with adaptive management; securing sufficient funding
Brown, Sharp, & Ashley (2005)	Australia and UK	Comparative analysis of three independent research projects (one in Australia and two in the UK)	Challenges to self-sustaining implementation of sustainable urban water management (highlight sources and drivers of strategic impediments to sustainable urban stormwater management)	Implementation of SUWM techniques is limited because of the technocratic culture and structure of the system including institutions, organizations, and professions

**Source: Author, 2012**

The report of “Managing Urban Stormwater with Green Infrastructure: Case Studies of Five U.S. Local Governments,” prepared by the Civic Federation for The Center for Neighborhood Technology, listed three barriers to infrastructure implementation including a lack of performance data (insufficient quantifiable data or cost effective alternatives), cost (of implementation and maintenance), and decentralization (stating that green infrastructure is a decentralized, flexible process needing a regional approach) (Valentine, 2007, pp. 7-13). To overcome the barriers, the report concluded that costs were generally higher initially but then were minimized in the future, decentralization was addressed through public education campaigns, and strong leaders made the implementation possible (Valentine, 2007, p. 55). The article “Impediments to Integrated Urban Stormwater Management: The Need for Institutional Reform” by Rebekah R. Brown emphasized the third point of Valentine: decentralization. Brown (2005) stated several barriers to implementation such as the institutional framework, intergovernmental relations, the entrenched implementation process, and the history of the studied region having a low political profile of urban stormwater (p. 466).

The essence of an article by Roy et al., “Impediments and Solutions to Sustainable, Watershed-Scale Urban Stormwater Management: Lessons from Australia and the United States,” provided a much broader impediment list. The authors state that there are seven fundamental impediments to sustainable urban stormwater management. The barriers include uncertainties in the performance and cost, insufficient engineering standards and guidelines, fragmented responsibilities, lack of institutional capacity, lack of legislative mandate, lack of sufficient funding and effective market incentives, and resistance to change (Roy, et al., 2008, pp. 347-350). The actions recommended by the authors include to research costs and performance, create a model ordinance, integrate government levels, develop workshops for professionals, promote grassroots organizations, address hurdles in the market, and educate the community (Roy, et. al., 2008, pp. 355-357). The concluding remarks were that drastic changes need to be made in managing stormwater through overcoming institutional discrepancies, creating an integrated approach, experimenting, and securing funding (Roy, et al., 2008, p. 357).

Finally, “Implementation Impediments to Institutionalizing the Practice of Sustainable Urban Water Management” by Brown, Sharp, and Ashley review recently published literature with regard to the challenges of implementing sustainable urban water management such as the socio-political framework. Their study found that political support, commitment to communities,

transdisciplinarity, and institutional capacity are essential. In *Sustainable Sanitary Waste Management across UK* section of the article, it was found that there is a need for champions, flexible systems, understanding of cultural and social factors, and knowledge by organizations. The studies showed that the implementation of sustainable urban stormwater management is limited, especially because of the technocratic culture and structure of the system comprising the institutions, organizations, and professions that support urban stormwater management (Brown, Sharp, & Ashley, 2005).

### ***Summary of the Literature***

This literature review has revealed the question, “*Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as bioswales and wetlands – as an alternative stormwater management practice? If so, what are the policies that have enabled Portland to implement green infrastructure? If not, what circumstances prompted the city’s bioswales and wetlands?*” The incentive based planning articles indicated how incentive-based approaches are becoming more and more important, and set the stage as to why incentive-based approaches are suggested in this paper rather than purely mandatory requirements. Articles about green infrastructure show why green infrastructure is valuable – especially because of the human health factors and beneficial economic and social impacts. Bioswales and constructed wetlands, two types of green infrastructure, show the environmental benefits. A brief history of stormwater management revealed that green infrastructure is a relatively new concept emerging in the past few decades in the United States. Further, a general history of Portland is discussed revealing the city’s forward sustainable thinking. Lastly, the planning implementation section generally contains articles discussing barriers and impediments to implementation, including for example, institutional and political barriers, costs, and lack of available and exiting data to name a few.

Many of the articles (Tzoulas, et al., 2007; Wise et al., 2010; Chau, 2009; Storey, et al., 2009; Roy et al., 2008) used a literature review and/or case studies as basis for the study. Others used surveys and interviews, but only one conducted an actual experiment. The methodology used in this report will be an examination of policy such as the Zoning Code and Comprehensive Plan, along with phone interviews in Portland, Oregon. The advantage of focusing on just one

city is that it can be analyzed in greater depth. Qualitative lessons taken from Portland can then be applied to similar cities in terms of climate and precipitation across the United States.

This literature review has provided a broad array of information. The purpose of this report is to understand existing literature and to fill the gaps of the missing information. Incentive-based planning, green infrastructure, and bioswales and wetlands are beneficial, but how have these worked in the particular case of Portland, and further, how can these principles be extended for including other cities in the United States? It is also important to note that the information provided in the literature review is only a small selection of numerous scholarly articles, journals, books, and many sources on green infrastructure and stormwater management.

## **Chapter 3 - Methodology**

### **Prologue**

The following section will describe the methodology, or strategy of inquiry, for the research question, and will outline a plan of action to complete the report. The following chapter will state the research design including specific methods used and their significance.

Essentially, to answer the research question (*Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as bioswales and wetlands – as an alternative stormwater management practice? If so, what are the policies that have enabled Portland to implement green infrastructure? If not, what circumstances prompted the city’s bioswales and wetlands?*), two main methods will be used: a policy analysis (an examination of the Comprehensive Plan and Zoning Code) and phone interviews with planners and other related professionals in the city.

The following chapter will begin with a description of the sample and the reasons of choosing Portland, discuss the measurement and strategy used (particularly, aspects regarding data collection/sample strategy and data analysis), the anticipated findings/hypothesis, and finally, project planning and scheduling.

### **Description of the Sample**

The focus of the study is on Portland, Oregon, located in the northwest part of the United States, as shown in Figure 3.1. Focusing on one city will allow information to be formulated at greater depth, rather than, for example, two or more cities.

**Figure 3.1 Location of Portland, Oregon**



**Source: Author, 2011**

Portland was chosen for two main reasons. The first reason being that the author of this report had visited Portland as part of an Infrastructure Planning and Financing class field trip at Kansas State University in March 2011. It was through visual inspection that green infrastructure was noted as obviously existing in the city. The observed green infrastructure gave a unique character to the city, and thus generated interest and prompted several questions. Green infrastructure does have several benefits, as were discussed earlier, but how and why green infrastructure was widely evident in Portland was not understood. Was it through the political and planning process, or some other reason such as possibly individual private effort or developer attitudes? The other reason Portland was selected is because it is a leading example and a “pilot” city (one of the firsts) on forming innovative strategies to address stormwater management. As was stated in the Literature Review section, Portland, Oregon, has been considered a “leader in the green infrastructure movement” (U.S EPA, 2009). Drawing

generalizations and lessons from a “model,” successful, and well-known city implementing green infrastructure will be beneficial for other cities in the United States.

## **Measurement and Strategy**

The two main methods for the study include a policy analysis or examination of the Comprehensive Plan and Zoning Code, and phone interviews with planners and other relevant professionals in the city. The following section will include details on the data collection and sample strategy as well as the data analysis.

### ***Policy Analysis (Governmental Documents)***

The first part of the data collection was the policy analysis through secondary data, specifically, governmental documents. The Portland Comprehensive Plan is available and accessible online at <http://www.portlandonline.com/bps/index.cfm?c=34249> through the City of Portland’s Bureau of Department Services. The intent of the city’s Comprehensive Plan, including goals, policies, and objectives, is to guide the future growth and development of the city (City of Portland, Oregon, 2011). Portland’s Zoning Code (specifically the Title 33 Planning and Zoning Code, a subcategory under the City’s Code and Charter) is also available online at <http://www.portlandonline.com/auditor/index.cfm?c=28148>. The intent of these codes are to implement Portland’s Comprehensive Plan and land use plans while protecting the health, safety, and welfare of the citizens of Portland. The code is published by the Bureau of Planning, administered by Land Use Services, and includes regulations as proposed by the Bureau of Planning and as adopted by the City Council through the public legislative process (City of Portland, Oregon, 2011). These codes can be derived from the city’s Auditor’s office. Several other documents could have also been analyzed such as, for example, the Stormwater Management Plan (SWMP) available at the Portland Bureau of Environmental Services website (<http://www.portlandonline.com/bes/index.cfm?c=37842&a=126117>). However, for the purposes of this report, other plans such as this were not analyzed. The goal of this paper is to be able to generalize or apply the basic principles from Portland to cities where the climate and precipitation causes stormwater runoff problems in the United States. Comprehensive Plans and Zoning Codes are general to all cities. Thus, the focus will remain only on these policies.

This “policy analysis” method was conducted through reading both the Comprehensive Plan and the Zoning Code. The result was creating a list or an itemization of the discussion of stormwater management, particularly urbanized bioswales and wetlands, extracted from the policies in two separate tables. This first step, then, was used to set the background of Portland’s policies and answer the first part of the question: *Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as bioswales and wetlands – as an alternative stormwater management practice?* The answer, either a “yes” or “no,” prompted the next few questions of the report, mainly for which the second method of interviewing was used.

### ***Phone Interviews***

The second technique was a semi-structured phone interview using the snowball sampling technique, producing mainly qualitative, but also some quantitative results to answer both the first, but more specifically, the second part of the research question. The second part of the question states: *If so, what are the policies that have enabled Portland to implement green infrastructure? If not, what circumstances prompted the city’s bioswales and wetlands?*

Several possible approaches could have been taken for this survey research including observations, field experiments, mail questionnaires, personal interviews, and telephone interviews. The telephone interview strategy was chosen because of its advantages in cost (no travel costs), speed in terms of reaching the target interviewees in a short time, a high response rate, and high quality data. Some of the disadvantages of telephone interviews could be a reluctance to discuss sensitive topics (specific information of particular projects, especially information of costs over the phone) and the ability to terminate the interview before its completion due to time constraints (Frankfort-Nachmias & Nachmias, 2008, p. 223). Both these negatives are acknowledged, but this method is still chosen for its positive aspects. Emails with the interview questions as an attachment were sent in advance to respective professionals for their convenience and anticipation of questions which were asked. The cover letter of the attachment stated the author’s introduction and intent, a description of the project, references, time estimate of interview, and permission to record and be published in this report. It was hoped

that the interviews, recorded for a personal archive, would last at least approximately 30 minutes. The length of each interview varied – many exceeded thirty minutes.

This particular method did not describe specific people to interview, and there was no set “sample” other than professionals associated with green infrastructure and stormwater management, particularly working for the city. Thus, a snowball sampling method was used, as is often employed with a population not easily identifiable, and when investigation is necessary. The first contact of the snowball sampling process started with Marie Johnson at the Bureau of Environmental Services, a contact from the Portland class trip in March 2011. She was first contacted through email and then through phone. It was hoped that she would provide information on planners for the city (public sector) and other developers or consultants (in the private sector) associated with green infrastructure projects in the city. Johnson was very helpful and provided contacts such as Renee Loveland (Gerding Edlen), Emily Hauth (Sustainable Stormwater Program), and Roberta Jortner (Bureau of Planning and Sustainability). Other professionals interviewed were Dawn Uchiyama (Stormwater Management Manual) and Alisa Kane (Bureau of Planning and Sustainability) referred to by others. The phone interview was conducted so that both mainly qualitative and some quantitative data could be obtained, not only to answer the second part of the research question (successful policy), but also to uncover the answers to basic questions not found through analyzing the Comprehensive Plan and Zoning Code. Essentially, the phone interview was the main methodology employed in this research. The amount conducted and the stopping procedure was not specifically noted because of the snowball sampling technique. However, it was hoped that at least six in-depth interviews would be sufficient to answer the questions. The interview questions and a sample cover letter are attached in Appendix A.

### **Anticipated Findings/Hypothesis**

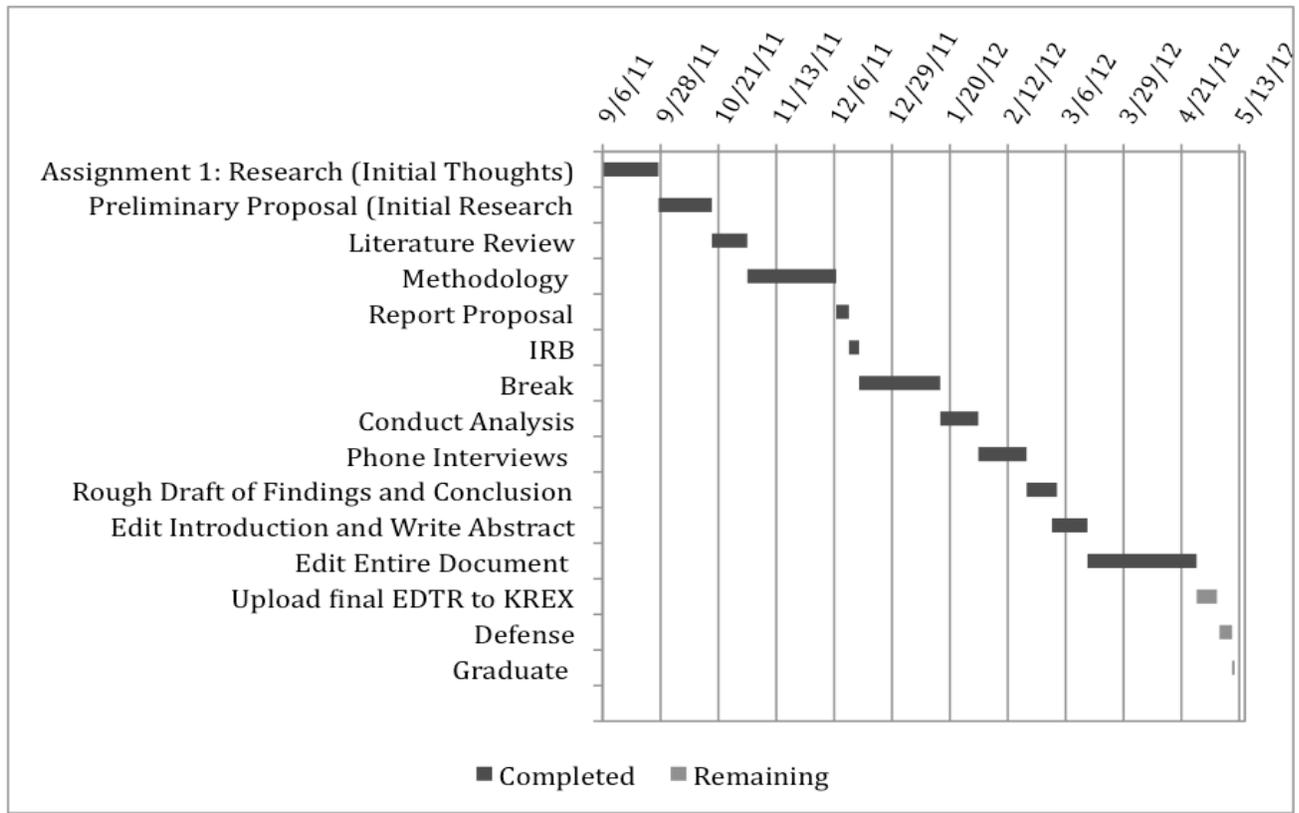
The first part of the question, “*Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as bioswales and wetlands – as an alternative stormwater management practice?*” was thought to prompt a “yes” or “no” answer. It was believed that there are, indeed, existing policies set forth in the Comprehensive Plan and the Zoning Code which encourage

retrofitting development of green infrastructure projects for stormwater management. The Comprehensive Plan and the Zoning Code may contain information which facilitates or encourages such development. The specific text from these policies regarding green infrastructure (particularly urbanized bioswales and wetlands) were eventually extracted in tables for an organized view. Policies making the city successful were thought to be the mere inclusion of such techniques in the Comprehensive Plan and Zoning Code, which would indicate that cities across the United States need to focus on these core policies to implement green infrastructure. On the other hand, if no such policies existed in the Comprehensive Plan and the Zoning Code of Portland, then the question became focused on how the creation of existing urbanized bioswales and wetlands projects came about, through *“If so, what are the policies that have enabled Portland to implement green infrastructure? If not, what circumstances prompted the city’s bioswales and wetlands?”* Additionally, perhaps besides the policies, other factors such as strong leaders and planning department, active citizens, concerned developers caring about environmental impacts, and other techniques such as grants, subsidies, and loans were thought to be more important. These answers were definitely revealed mainly from the interviews with Portland planners, developers, and consultants.

### **Project Planning and Scheduling**

Table 3.1 below shows the project planning and scheduling for the 2011-2012 academic year in order to finish the report. The dates for Fall 2011 were known as they were given in the PLAN 897: Proposal Writing class. Approximate dates in 2012 are provided in the table below. Specific dates for Spring 2012 became more concrete closer to graduation from the Graduate School.

**Table 3.1 Planning and Scheduling**



Source: Author, 2011

## Chapter 4 - Findings

Many important findings were generated after using both policy analysis and phone interviews. This chapter will provide the information gathered from the itemization of Portland's Comprehensive Plan and Zoning Code on green infrastructure as well as from the six interviews conducted of the professionals from Portland. The interview responses were recorded in an audio recorder and later transcribed. Grounded theory was then applied on the transcribed interviews by using the coding and memoing technique. The following section is thus the basic outcome of the grounded theory process.

As mentioned, six interviews were conducted. The methods included itemizing the policies from the Comprehensive Plan and the Zoning Code. However, it was also important to gain qualitative, first-hand information from planning-related professionals in Portland to understand their perspectives on the Comprehensive Plan, Code, and Portland's successful implementation of green infrastructure. Intensive interviewing provided for an in-depth exploration of the interviewee's perceptions, attitudes, and their construction of reality (Charmaz, 2006, pp. 25, 27). Recording the interviews of the professionals allowed for gathering exact, rich data. In order to create meaningful analyses of the data, grounded theory was used. Applying grounded theory allowed to "separate, sort, and synthesize [qualitative] data" (Charmaz, 2006, p. 3). Two steps are included in grounded theory – coding and memoing. Qualitative coding is categorizing segments of the data with labels. "Grounded theory coding generates the bones of [the] analysis... coding is more than a beginning; it shapes an analytic frame from which [to] build the analysis." Codes help to organize large amounts of data and give meaning to the information collected. Thus, the recorded interviews were transcribed into a document and coded question-by-question. Ultimately, coding provides "a focused way of viewing data. Through coding... discoveries and gain[ing] a deeper understanding of the empirical world" is possible (Charmaz, 2006, pp. 45-70). The codes, then, were listed out per question in an excel sheet for an easier view. The step after coding is memoing. Memoing is applied after the data organization but before drafts of papers. Memoing allows for analyzing data and the codes created earlier in the research process. Memos are informal. The purpose is to synthesize data and to allow for exploring or comparing trends or patterns between each of the interviews. Being aware of these patterns can evoke the most important points or issues

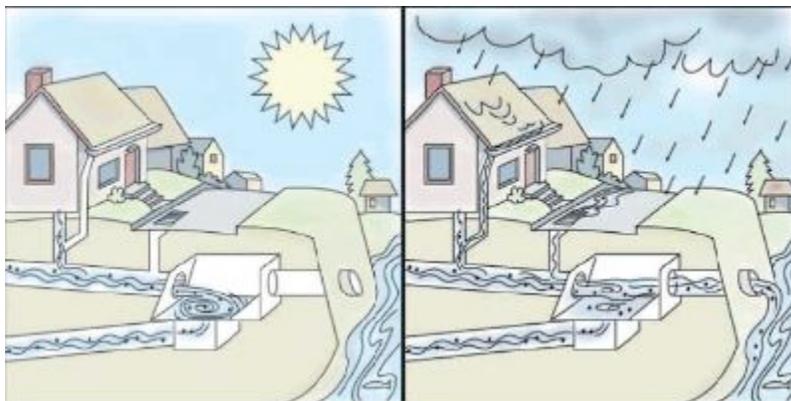
discussed by all the participants (Charmaz, 2006, pp. 72-84). The coding of the interviews is attached in Appendix B, and the memos are in Appendix C for a detailed view of the interview responses and the process.

The interview questions and a sample cover letter are attached in Appendix A. The process of the snowball sampling technique is attached in Appendix D. The names highlighted (in blue) are interviewed individuals. The other references and names were suggested, but were either not contacted or unavailable. The first person contacted was Marie Johnson from the Bureau of Environmental Services. Johnson's role was pivotal because not only did she provide invaluable knowledge, but she also suggested other professionals who were very beneficial in terms of answering the interview questions. After Johnson, the next interview was with Renee Loveland from the Gerding Edlen Development Company. Loveland also invited Clark Brockman from SERA Architects. Both of these individuals were resourceful because of their unique developer perspective rather than being governmental professionals. The third interview was with Emily Hauth and Henry Stevens from the Sustainable Stormwater Program, followed by Roberta Jortner and Shannon Buono of the Bureau of Planning and Sustainability. Dawn Uchiyama was the next individual interviewed. Uchiyama represented the Stormwater Management Manual, the most influential policy document in the city. Finally, the last person interviewed was Alisa Kane from the Bureau of Planning and Sustainability; Kane was referred to the author by both Loveland and Brockman.

The questions asked were to answer the specific research question in addition to addressing the concerns other cities might have when wanting to implement or being hesitant about green stormwater systems. The interview began by asking if the Comprehensive Plan and Zoning Code specifically mentioned anything about retrofitting developments. If it did not, then what were the reasons for the presence of urban bioswales and wetlands in the city? Through this question, the answer to the first part of the research question was quickly answered. These answers also paralleled with the information found through itemizing the policies from the Comprehensive Plan and Zoning Code. Information from a majority of the interviews revealed that both the Comprehensive Plan and Zoning Codes are lagging in terms of providing information about green infrastructure. Many also revealed that the Plan is a few decades old and is currently in the process of being updated. Although the Comprehensive Plan and Code do have some policies on stormwater management, they are very general policies and appear only a few

times in the two documents. Instead, the biggest reason for the existence of urban bioswales and green infrastructure are twofold: governmental regulations and the consequent Stormwater Management Manual. Johnson (and almost all) stated that the manual emerged because the city was in trouble with the Federal Government for violating the Clean Water Act for discharging pollution in the Willamette River. Hauth and Stevens specified that the city violated the National Pollutant Discharge Elimination System (NPDES) section of the act. Indeed, according to the U.S. Environmental Protection Agency, the NPDES is a permit program through the Clean Water Act, “which controls water pollution by regulating point sources (such as pipes or man-made ditches) that discharge pollutants into waters of the United States” (EPA, 2009). Because of Portland’s combined sewer system, which includes both sanitary and sewer water, the city would get overflows during heavy rains. The combined sewer system was mentioned by almost all the interviews, and thus, was further researched. According to a website by the Bureau of Environmental Services, it is stated that many of the older neighborhoods in Portland have this particular system that “mixes untreated sewage and stormwater runoff in a single pipe. During very heavy rain storms, runoff from buildings, streets, and other hard surfaces can fill these combined sewers to capacity and cause them to overflow” (BES, 2012). The website also provided the diagram shown in Figure 4.1, illustrating the combined sewer system overflow.

**Figure 4.1 Combined Sewer System Overflow in Portland, Oregon**



**Source: BES, 2012**

When the pipe caused pollution in the river and was not following the government’s guidelines, something different had to be done. Since the pipe system was not working, Brockman stated “clearly what we need was a different system other than building bigger pipes.”

As mentioned, the Stormwater Management Manual was referred to by all the interviewees as well. The manual provides several requirements that developers have to follow. Hauth and Stevens among many others stated that an advisory board created the manual in 1999, targeted towards more green infrastructure developments. The green system was preferred according to Stevens because “it’s cheaper for us to do the green thing than to do the pipe replacement that would have achieved the same result as far as reducing combined sewer overflows.” Johnson also stated that building green and planting trees is usually more cost effective than pipes, and favored especially because both have the same benefits. As for the Comprehensive Plan, almost everybody stated that the plan included some information on green infrastructure and was “old.” The Comprehensive Plan was adopted on October 16, 1980 “to guide future development and redevelopment of the city.” The plan includes amendments effective through July 2006 (City of Portland, Oregon, 2011). The Portland Zoning Code was adopted by Ordinance #163608 and began effectiveness as of January 1, 1991 (City of Portland, Oregon, 2011). The two planners, Jortner and Buono, said that the Plan and Code refer to some green infrastructure policies. Both said that the Zoning Code refers to the Stormwater Management Manual for specific requirements. Indeed, this information fits with the itemization of the Comprehensive Plan and Zoning Code conducted. The two tables in Table 4.1 and Appendix E display this information. The Comprehensive Plan was searched for items associated with green infrastructure, sustainability, or with bioswales and wetlands – anything that related to and closely identified with some green policies.

**Table 4.1 Portland Comprehensive Plan Itemization**

Section	Key Word	Description
8.7	Stormwater	Maintain coordination of land use planning and capital improvement to insure the most efficient use of the city’s sanitary and stormwater run-off facilities.
8.14E	Natural Resources	Protect natural resources where appropriate from sediment and other forms of pollution through the use of vegetation, erosion control measures during construction, settling ponds, and other structural and non-structural means.
8.15B	Stormwater and Wetlands	Maintain and improve the water quality of significant wetlands and water bodies through design of stormwater drainage facilities.
8.15C	Stormwater and Wetlands	Conserve stormwater conveyance and flood control functions and values of significant riparian areas within identified floodplains, water bodies, and wetlands.
8.15	Wetlands	Conserve significant wetlands, riparian areas, and water bodies which have significant functions and values related to flood protection, sediment and erosion control, water quality, groundwater recharge and discharge, education, vegetation, and fish and wildlife habitat. Regulate development within significant water bodies, riparian areas, and wetlands

		to retain their important functions and values.
8.15A	Wetlands	Conserve significant riparian, wetland, and water body natural resources through the designation and protection of transition areas between the resource and other urban development and activities. Restrict non-water dependent or non-water related development within the riparian area.
8.16A	Wetlands	Provide protection to significant wetland and water body natural resources through designation of significant upland areas as a buffer between the resource and other urban development and activities.
11.21	Stormwater	Integrate master planning for stormwater management with other city activities to achieve adequate drainage and to minimize pollution and erosion problems.
11.22	Stormwater	Where necessary, limit the increase of Portland’s impervious surfaces without unduly limiting development in accordance with the Comprehensive Plan.

**Source: Author, 2012**

The table above reflects the comments from the interviews. The Comprehensive Plan has some general information mainly in Chapters 8 (“Environment”) and 11 (“Public Facilities”). The Comprehensive Plan mentions wanting an effective stormwater facility, protecting natural resources from pollution, improving the quality of and conserving wetlands and waterbodies through the design of stormwater systems, minimizing pollution and erosion problems, and limiting the increase of impervious surfaces. There is not much information specifically on green infrastructure. Johnson had mentioned the “Portland Plan” as some of the ideas that may be incorporated in the upcoming, updated Comprehensive Plan. Some relevant information from this plan is extracted in Appendix F.

Policies in the Zoning Code are attached in Appendix E. The information is derived from Title 33 of the City Charter under “Planning and Zoning.” Some of the information is also from Section 17, “Drainage and Water Quality.” According to this table, most of the policy from Chapter 33 states the general importance of open space and landscaping features on stormwater because these features intercept the stormwater by providing a non-permeable surface. The city acknowledges and recognizes the ecological value of landscaping which is beneficial to reducing stormwater runoff pollution and flow. Many times in the code, it is stated that stormwater must be treated according to the standards set by the Bureau of Environmental Services. Striving to reduce impervious surfaces was mentioned several times in the Code. Stormwater swales were referenced to just a few times. Numerous times, the Code cites the Stormwater Management Manual. This is evident especially in Chapter 17 of the manual. Essentially, this entire section mentions the manual repeatedly.

Not surprisingly, the most important policy, then, comes from the ever-popular Stormwater Management Manual. In the manual, vegetated surfaces to treat and infiltrate stormwater are emphasized. The manual applies to all development and redevelopment public or private projects. There are four chapters in the manual: “Requirements and Policies,” “Facility Design,” “Operation and Maintenance,” and “Source Controls.” The Appendix also stores valuable information including retrofitting design, several guides, plant lists and templates, construction detail, and so on (City of Portland, Oregon, 2011). Because of such detail, the manual is a key policy that shapes the green infrastructure of the city. Johnson pointed out that sometimes, the manual does conflict with the zoning code, at which time, the code overrules the manual – this conflict can be problematic and needs to be resolved.

Another interview question, the inquiry about specific requirements for implementing stormwater management, thought to be things such as physical space (specific physical space requirements/constraints), minimum level of precipitation or climate required, or size (population or density of the city), were all directed to the manual. Uchiyama described the manual: it is “an administrative rule [with] policy in it and there’s also design guidelines in it. It’s a funky arrangement. It’s not typical. We have policy and design guidelines/standards all in one place.” She provided a brief history of how the manual began. Several professionals including engineers, scientists, and individuals from various disciplines formed a committee and came up with specific numbers through information derived from pilot projects and personal knowledge. The final numbers were not only technical, but also realistic. The number known to most all the interviewees was “500 square feet.” Essentially, Portland’s guidelines require green infrastructure if development is greater than 500 square feet. Another specific number stated by Uchiyama was “6%.” 6% is the space required to be set aside for the amount of impervious area created. She emphasized, however, that the number will vary depending on the soil quality. More pervious soils will need a smaller amount than soils that are poorer. Jortner and Buono stated that the general applications of the manual depend on the design storm and frequency, and Hauth and Stevens stated that specific requirements will vary by different areas. The specific soil and amount of rainfall, for example, will determine what a particular city will need. Brockman’s private sector background recognized that the city’s codes are more stringent than the requirements necessary for LEED (Leadership in Energy and Environmental Design) certification. Thus, a beneficial starting point for a city to produce a region-specific policy would

be to analyze and use some of LEED's requirements for stormwater management. After researching "LEED for New Construction and Major Renovations" by the United States Green Building Council, it was found that a starting point for more information on LEED stormwater requirements are in section 6.1 and 6.2 in "LEED for New Construction & Major Renovations" found at <http://www.usgbc.org/ShowFile.aspx?DocumentID=1095>. Additionally, another take-home message for cities would be to analyze Portland's stormwater management requirements and the process undertaken, and apply the formulas and approaches of the calculations wisely to specific areas.

After learning that the Comprehensive Plan and Zoning Code do not have much information on green stormwater management, but rather that the requirements are found in the city's Stormwater Management Manual (which specifies detailed information), it is logical to wonder whether a new approval system was created to allow for these green projects to emerge in the city. The replies from the interviews to this question broadly stated that although a completely new process was not created, it was certainly slowly altered or built upon to accommodate for this new green infrastructure strategy. This change did not occur overnight – Hauth and Stevens and Jortner and Buono stressed that permitting changes happened slowly and incrementally and still continue to occur. Johnson stated that the green systems are approved after going through the review of the Bureau of Developmental Services, planning regulations, and the Bureau of Environmental services review regarding the Stormwater Management Manual. Of course, there were concerns to this system, especially by engineers. Hauth and Stevens and Jortner and Buono stated that there was a cultural change for this profession to accept the concept of green on the same grounds as the traditional pipe development. Private developers, however, embraced this change. According to Loveland and Brockman, it was beneficial that the city's permitting process presumed that different developments and designs would be unique. He suggested that the system was even more effective when developers negotiated and worked with the city early in the design stages of the project because, ultimately, there is risk when creating a green infrastructure project. The city helps developers through a built-in incentive on permitting. According to Jortner and Buono, a simpler permitting process is a reward for developers using green facilities.

Of course, aside from the policy documents such as the Plan, Code, and Stormwater Management Manual, other factors made Portland's development of green infrastructure possible

as well. Strong leaders, active citizens, concerned developers, and grants were methods suggested in one of the interview questions, to which all agreed. Johnson and Loveland and Brockman cited the culture of the north-west region. All the interviewees mentioned that the citizens are very active in this area of the country in terms of their participation and volunteerism. Additionally, one of the biggest responses seemed to be the nature of the leadership. The leaders of the city learned the importance of stormwater management because of the overflows and untreated sewage. The pollution problem became readily apparent, and the city knew that a new method for handling stormwater had to be devised. For Kane, the regulations created were so strong that they have helped shape the vegetative character of the city. The supportive leadership of the city encouraged experimentation and testing of new concepts. This open attitude, especially through leaders who advocated for this system such as the progressive policies of the Bureau of Environmental Planning (in creating the Stormwater Management Manual) and some councilmembers and the mayor, made possible for several test projects. Brockman pointed out that a city needs density to be innovative. He cited Portland's enforcement of the Urban Growth Boundary earlier in the city's history, which allowed the city to become denser, and thus, lead to the innovative character of the present. Leadership and citizens, to Jortner, was fundamental as well – she stated that “the leadership and the community usually come ahead of the policies.” Incentives were another major reason behind the existing green infrastructure. For the two private developers, Loveland and Brockman, it was important for the city to be helpful in terms of charge reductions for developments. Brockman emphasized the concept of the SDC, or System Development Charge. This policy instrument is favored by developers (who are also cited as another reason for making green infrastructure possible in the city) because it reduces their initial finances rather than reward them at the end of the development process. Other incentives and grants mentioned were the “1% for Green,” community grants, federal funding such as EPA grants, and the eco-roof incentives. Uchiyama believed that the most important catalyst for green infrastructure to begin was help from the Environmental Protection Agency, which provided grant money for starting early projects in the city. Another reason besides policies that allowed for the achievement of green infrastructure according to Hauth and Stevens was the ability to work together with the internal bureaus as well as external partners to achieve the multi-objectives of green infrastructure.

Not everything was easy for this city – many implementation barriers had to be overcome. The literature review suggested cities have trouble with the cost of implementation, long-term maintenance, lack of technical information, right of way issues, and of course differing opinions by key stakeholders and political leaders. Portland handled all of its hurdles successfully. To overcome the cost issue, of both implementation and maintenance, a method was devised in which the city and private developers divided payment. Johnson, Uchiyama, and Kane stated that for the city, the Capital Improvement Program (CIP) helped with funding costs. The city is required to put in 1% of a project budget into green infrastructure treatment. Private developers, on the other hand, are responsible for their own developments. Costs were also overcome by several incentives. Jornter and Buono listed some incentives including disconnecting downspout payments, FAR (Floor-Area-Ratio) bonuses, and rebates on planting trees. As mentioned, Uchiyama stressed the importance of EPA funding and redirecting funding from the city. A unique way of helping with green infrastructure implementation was planners allowing lots to cluster in development to allow for more space for green infrastructure systems or facilities. Maintenance costs may be somewhat higher for green infrastructure than pipes which have a longer life-cycle and do not need much maintenance as they are underground. Almost everybody stated that the responsibility of maintenance is largely unknown, although many believe it is the responsibility of the Bureau of Environmental Services on public property and developers or owners on private property. The lack of knowledge or information on the new green infrastructure topic was overcome through allowing freedom to experiment. The city trusted the professionals to try new, unconventional approaches or methods. Having a comfortable environment in the city where experimentation and testing was allowed fostered a data-driven method to prove green infrastructure's effectiveness to the city leaders and skeptical city engineers. Hauth and Stevens stressed the idea of information gathered through small demonstration projects from which data could be monitored, collected, and analyzed before broad scale applications could be implemented. Stevens clearly stated “we aren't just carpeting the city with these things – it's in targeted areas which have a need for them... there's a sophisticated nuisance analysis about where they go. Sometimes people think we're putting them everywhere in the city, and that's not true.” Right-of-way issues were not a big concern. Green infrastructure was placed where there was adequate space. In order to avoid some space issues, Uchiyama, Loveland and Brockman, as well as Jortner and Buono suggest that other cities

remember that the process is a lot easier to do before the community develops. Another hurdle was political support. Of course, not everybody will agree on everything, and some people may be skeptical about green infrastructure. Conflicting opinions also occurred in Portland. Engineers, especially, held to a traditional way of thinking. This thinking was eventually resolved through presenting data on the effectiveness and multiple benefits of green infrastructure. Portland also overcame the hurdle of the differing opinions of key leaders and councilmembers through a data-driven approach and showing examples of the effectiveness of the green method. Kane suggested that not all projects will be successful. “You have to be prepared to succeed and fail, and when you fail, you have to be prepared to tell people why it failed and how it [can] be fixed.”

Another hurdle to Portland’s implementation of green infrastructure might be some negatives or drawbacks of the strategy, which were asked about in a separate question. The most severe challenge according to all the individuals was maintenance and the question of whose responsibility it is to maintain the public green infrastructure. Hauth and Stevens stated that it is impossible to predict how much money will be needed down the line. To Uchiyama, however, the concern of maintenance, no matter the cost, is more about stewardship and caring for the land. Green infrastructure also has the drawback because it is competing for money with several other pressing issues a city may have. Green infrastructure in some areas may not have as high a priority as other areas. Other concerns were different per interview. Johnson pointed out a negative can be the “one size fits all” mentality. Thus, it is vital to recognize that what works in one area may not work in another. Another potential drawback identified by Johnson and even by Loveland and Brockman is reasoning. Green infrastructure is not being implemented because of its moral reasoning, but because it is practical. Both believed that it is necessary to think about hydrology and soil rather than thinking about this new method as “cool” or trendy. To Johnson, another issue can also be not bringing multiple disciplines together. Loveland and Brockman briefly discussed mismanaged politics, which can be especially vocal from the conservative side of politics. Another consideration for implementing green infrastructure is to be aware of the learning curve and response time needed for overcoming issues to green infrastructure. Other negatives stated were public perception (who may see this type of infrastructure as imposing on private property) and perception in terms of geographical expectations (some areas may be accustomed to vegetation in urban areas whereas other cities may not be as open). A major

drawback stated by Kane was in terms of design. Sometimes design is not thoughtful and hinders users as swales may encroach on sidewalks or force bikers onto traffic because of curb designs, problems which have happened in Portland.

Overcoming many barriers and negatives of green infrastructure, several projects were successful in Portland. Johnson discussed three projects: Clay Street, Montgomery Street, and the Johnson Creek project. Briefly, Clay Street was an area where green infrastructure not only handled stormwater, but also provided a green route to the Willamette River. Montgomery Street, running through Portland State University, was another successful project. Although opposed by some, Johnson concluded that green must be a strong movement if some feel threatened by its presence. Finally, another project was Johnson Creek. Johnson was very proud of the fact that for the first time in several years, this area did not flood. A project in Portland explained by Kane was one where there was success in having a green street as well as bike improvements. The lessons from these projects were to collaborate between both the gray and green infrastructure individuals. Working together is the solution for implementing these projects in the city.

Ultimately, Portland learned its lessons through polluting their major river (Willamette) and successfully came a long way through implementing the green infrastructure strategy. The question was asked about what advice the city would like to convey to other cities or municipalities wanting to implement green infrastructure strategies as stormwater management. The following bullets show the suggestions and advice given by the professionals:

- ◆ Foster an atmosphere of testing ideas to generate good design (Johnson)
- ◆ Bring people together – internal and external partners; collaborate (Johnson, Hauth and Stevens, Uchiyama)
- ◆ Learning from others is important through tours, brownbags, and background research from other cities (Johnson, Jortner and Buono, Uchiyama, Kane)
- ◆ Start small rather than city-wide with demonstration projects (Johnson, Hauth and Stevens, Kane)
- ◆ Have positive press and marketing once in the process (Johnson)
- ◆ Consider capital and having access to money (Johnson, Hauth and Stevens)
- ◆ Highlight the multiple uses, functions, or city objectives of implementing this one solution (Loveland and Brockman, Hauth and Stevens, Uchiyama)

- ◆ Consider a broad scale and work with a region instead of separate cities (Loveland and Brockman)
- ◆ Provide incentives, such as System Development Charges and other incentives to provide some certainty for developers (Loveland and Brockman, Jortner and Buono)
- ◆ Understand that new development is easier than retrofitting developments (Loveland and Brockman)
- ◆ Acquire and monitor data (Hauth and Stevens)
- ◆ Work slowly and have patience (Hauth and Stevens, Uchiyama)
- ◆ Have community outreach and education (Hauth and Stevens)
- ◆ Cultivate political leaders and active citizens (Jortner and Buono)
- ◆ Invite top-notch developers to provide an example to start the trend and foster constructive competition (Jortner and Buono, Johnson)
- ◆ Remember that the end goal is to mimic nature (Jortner and Buono)
- ◆ Apply green infrastructure to the right places (Hauth and Stevens, Jortner and Buono, Uchiyama, Kane)

Specifically, after admitting the Comprehensive Plan and Zoning Code of Portland do not provide much information as both are dated, many professionals stated it is essential to have at least some broad goals in the Plan and Code. Jortner suggested having broad objectives related to green stormwater management, and Johnson recommended a strong connection specifically between stormwater and land use. The plan, according to Jortner, should also have policy that meets multiple objectives (a concept stated by both Loveland and Brockman as well as Hauth and Stevens) and which form the basis of sustainability. Land use tools can also be included in the code in order to ensure adequate space for green infrastructure. Specifically, the foundation for the Comprehensive Plan can come from a Stormwater Management Manual that can state explicit expectations and rules. Thus, almost all agreed that a stormwater manual of some sort is essential to help with the implementation component of green infrastructure. Uchiyama suggested that to come up with design guidelines and standards of a manual, it is vital to have a wide range of stakeholders including members from the private sector in an advisory committee. Starting with simple manuals can eliminate stress and frustrations. Finally, another advice by most was to explore information from the code and policies of other cities. Uchiyama stated a very good point – “no one has to reinvent the wheels at this point. There’s a lot of good material

out there.” She warned, however, that although it is helpful to borrow from similar cities, it is essential to not borrow carelessly. What applies in one area may not be the same in another.

The responses from the interviews were extremely helpful. The answers to the questions asked and the advice given from Portland is useful for other similar cities to learn from Portland in order to implement green infrastructure as stormwater management.

## **Chapter 5 - Policy Recommendations and Conclusion**

Policy recommendations will be discussed in this chapter, elaborating on the general concepts discussed in the interviews. Four policy recommendations are provided as guide for other cities seeking to implement green infrastructure. Finally, the conclusion summarizes the report's significant findings and discusses future research opportunities.

### **Policy Recommendations**

Four policy recommendations are suggested for implementing green infrastructure:

1. **General Comprehensive Plan and Detailed Stormwater Management Manual**

Portland is an exceptional case where green infrastructure resulted after the city violated the Environmental Planning Agency's Clean Water Act by polluting the Willamette River. However, it is better to approach a potential problem earlier than after it is too late. In terms of policy, starting broadly and then becoming more specific can be helpful. Broad green infrastructure principles should be incorporated into the Comprehensive Plan and Zoning Codes to begin valuing the general importance of green infrastructure. Following the general policies, a more specific and detailed stormwater management manual should be created. The manual can be modeled off Portland or any other successful city, but data should be relied upon local conditions through citywide and neighborhood-level experimental projects. Additionally, several stakeholders should be present when forming a manual so that technical advice from all parties can make the manual stronger and acceptable by the consensus of a large, professional and technical group.

2. **Experiment and Generate Data**

Professionals in Portland repeatedly highlighted the fact that because of experimentation, data could be generated and used as evidence of a working system. It is essential for government leaders and planners to promote an open environment, fostering the growth of innovative ideas. By allowing people to experiment in a small setting, local data can be gathered about the effectiveness or improvements needed in a green infrastructure system. Setting up small swales and monitoring the soil and rainfall, for example, can be a start to a larger project. Neighborhood level projects can also be beneficial to begin. Additionally, learning from the data of others and

being aware of drawbacks can promote realistic approaches to a green infrastructure system. This idea can become policy through specifically stating that experimentation is encouraged in the Comprehensive Plan or a Stormwater Management Manual. Additionally, editing and revising rigid zoning requirements or land use codes to become more flexible can allow for testing green infrastructure.

### 3. Collaborate

Collaboration is necessary between several groups. First, leaders have to collaborate and jointly promote a safe environment allowing the development of new ideas. Second, it is essential for there to be a component of community outreach and education. Involving the public at an earlier stage in this emerging green process can allow people to explore the benefits of green infrastructure and understand why a city would want such a system. In terms of policy, mandating community meetings should be a section added in a potential Stormwater Management Manual to ensure community participation and involvement. Identifying and involving the local citizens can lower or diminish their concerns and allow for support when these systems are proposed. Education can include community classes and lectures, handing out pamphlets, displaying posters, newspaper articles, and so on, to reach the public. Additionally, it is necessary to collaborate with other jurisdictions and professionals. By visiting other locations, listening to lectures and seminars, and understanding how others worked can help develop a local system. Policy mandating training or having educational components for city employees associated with environmental planning can be incorporated into the Stormwater Management Manual to promote research and continue gaining innovative knowledge. Finally, collaborating with internal and external partners is also key. Having a consensus and unity among several departments can allow for multiple benefits to be explored. Once it is realized that different areas of a government (for example, Parks and Recreation, Transportation, and so on) benefit, the final gain can become cumulative and positive for all. Policy can require bi-weekly or monthly meetings for various departments involved in a green stormwater management project.

### 4. Funding

The last policy recommendation is incentives. Money, or lack of money, is usually what either promotes or prohibits a project. Several cities may already know that green infrastructure is a progressive, beneficial way of thinking. However, a lack of funding could be hindering implementation. At these times, it is necessary to seek grants – such as the Environmental

Protection Agency grant that really helped Portland. Rethinking priorities and redirecting existing funds can also help. Many times, it is not realistic to expect money from state or federal agencies. At that point, perhaps just reshuffling city finances can facilitate a step towards implementing green infrastructure. Portland did the same – the city used existing money to help green infrastructure. Policy can redesign a city’s financial plan to require money to be redirected to a green stormwater management fund. Finally, providing some incentives, especially for the private sector can help encourage developers and designers. Many private developers are thinking green and want to be sustainable. However, a city can hinder that creative and environmental thinking by rigid zoning codes or not allowing room for creative solutions. Policy can change zoning codes to be more flexible or waive certain aspects of codes to encourage green developments. Incentives offered to developers such as rebates or cost reductions on projects implementing green infrastructure can show its value and channel development in the way a city prioritizes its goals. Policy can specifically be integrated into a separate section in the Stormwater Management Manual to list several possible incentives, which would vary year to year depending on the city’s financial situation. The incentives of a particular year could then be cataloged on the city’s website for updated information.

## **Conclusion**

### ***Concluding Thoughts***

The question of interest was sufficiently addressed though the hypothesis was proven incorrect. It was believed that there would be policies in the Comprehensive Plan and the Zoning Code which encouraged retrofitting development projects for stormwater management with green infrastructure. There are, however, very few existing policies in these documents. Rather, Portland’s unique circumstance of violating the Clean Water Act and the formation of a successful Stormwater Management Manual were the key drivers. Additionally, several other factors such as strong leaders fostering an open learning environment, active citizens, and incentives, played an important role in the implementation of green stormwater management. Of course, Portland had to overcome several barriers prior to the implementation, including negative opinions of this strategy. Portland, however, is still learning and will continue to learn over time as new knowledge and research emerges.

The information for this report was gathered through first exploring background information through a literature review. Then, conducting an inventory of the policies in the Comprehensive Plan and Zoning Code as well as gaining qualitative data through the snowball sampling technique from phone interviews also revealed some interesting information. The data from the interviews was coded and memoed with final results presented in the “Findings” chapter.

To conclude, this study was conducted because planners want to provide their communities with places and developments that value health, safety, and the general welfare. A major challenge faced by several cities throughout the United States includes stormwater runoff, prevalent because of increased impervious surfaces in urban areas. Runoff from precipitation becomes polluted and can cause severe flooding as it attempts to enter manmade, concrete constructions. A solution to this outdated infrastructure system is green stormwater management, which increases pervious surfaces and allows water to be maintained by natural, ecological systems, thereby reducing pollution and flooding issues. Along with solving these basic problems, green infrastructure also has several other positive qualities such as improving health and economically benefitting cities. This new concept promises environmental, economical, and social benefits.

Cities which have pollution or flooding problems should seriously consider retrofitting their gray infrastructure into green infrastructure. To help implement the strategy, this paper provides qualitative data from Portland, Oregon, which provides a great example of using this green method of stormwater management. It is hoped that with time, more and more places facing urban runoff problems consider this strategy as opposed to the pipe system this country has been accustomed to. It is time not only to think environmentally, but also practically and innovatively.

### ***Generalizability***

Generalizability, or external validity, is the extent to which the research findings are applicable to larger populations and to different settings (Frankfort-Nachmias & Nachmias, 2008, p. 520). The main reason this particular study was conducted is for this very purpose. Although Portland will have many unique features and circumstances, the goal was ultimately to

draw out basic characteristics from the city which can then be applied to essentially all relevant cities and municipalities in the United States. Thus, it was assumed that a theoretical generalization would be to apply the lessons from Portland to cities facing similar urban runoff problems in the United States. Even though some lessons may not be applicable to certain cities, the overall lessons can be applied to cities which face a similar runoff, flooding, and pollution problem.

### *Limitations*

The study faced a few barriers or challenges acknowledged below.

#### Limitation 1: Time Constraints

One major problem was thought to occur in the second part of the methodology, the telephone interviews. The planners at Portland are already busy with daily duties in the city. Additionally, since the city is an innovative pilot city, other students and researchers might also be interested and ask questions to planners. In order to overcome this barrier, the research was conducted in advance to give ample time for interviews to occur. Time constraints were noted, and time was managed efficiently to finish the report in a timely manner. This preconceived problem was not a big hurdle. Essentially, all the interviews were conducted in three weeks. The professionals contacted scheduled an interview shortly after the initial contact, allowing a smooth data gathering experience.

#### Limitation 2: Methodology

The second concern was in terms of the actual methodology itself. Several different methods could have been used for the same question posed, and different results could be generated according to those methods. For example, if time and money were not an issue, then a trip to Portland would have been helpful. Perhaps visiting the offices and having personal, one-on-one conversations or interviews with planners and professionals would have been more beneficial as positives with this strategy are flexibility in the questioning process, control of the interview situation, a higher response rate, and obtaining fuller information (Frankfort-Nachmias & Nachmias, 2008, p. 219). Additionally, the snowball sampling technique could have also been circular or ineffective if the person interviewed did not refer to a new person. If this were the case, more research would have had to be conducted to select another interviewees to restart the

snowball sampling technique or begin to pick “random” relevant people who may be helpful. Fortunately, neither the methods nor the snowball sampling technique was a problem. A personal visit with the professionals could have been beneficial, but the phone interviews were very informative and flexible. Additionally, the snowball sampling technique was not an issue because of the many references provided especially by Marie Johnson and several other interviewed professionals.

### ***Future Research***

Further research can be conducted to build upon this study. First, because of time and scope limitations and the unavailability of some participants, more interviews could not be conducted even when the snowball sampling technique yielded several potential interviews. Perhaps these potentials can be contacted to gain further information. For example, it would have been very beneficial to learn about green infrastructure from the perspective or point of view of the Bureau of Transportation. Additionally, if the scope of the research were not only on Portland, then other areas could have been targeted as well – Seattle, areas in California, and Philadelphia were mentioned through the interviews as also having great implementation for green infrastructure. Focusing on multiple cities and comparing and contrasting the strategies rather than just concentrating on Portland would definitely produce a different, and perhaps a more broad, analysis.

Additionally, perhaps the next step to this analysis would be to study the Stormwater Management Manual in detail as this is the driving force behind the existing green infrastructure in the city. Extracting some valuable, general numbers from Portland’s manual would have helped cities gain a starting point. Researching if other cities also have beneficial green infrastructure related stormwater manuals would also be a helpful compilation.

Finally, although qualitative data is helpful, having quantitative data would have produced a different, valuable study. Having specific numbers are usually concrete evidence some cities seek in order to become persuaded. Perhaps the qualitative advice given by Portland will not be adequate for some cities to consider this strategy.

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## **Appendix A: Interview Questions and Sample Cover Letter**

The following questions were asked during the phone interviews:

1. Do the comprehensive Plans and Zoning Code specifically mention anything about retrofitting developments? If not, why are there existing urban bioswales and wetlands? Discuss.
2. Are there other factors besides policies (or in addition to policies) that make Portland's development of green infrastructure possible? (Roles of strong leaders and planning department, active citizens, concerned developers caring about environmental impacts and other techniques such as grants, subsidies, and loans?)
3. What is the approval process for green infrastructure? Did a new system have to be created to allow for these projects in Portland?
4. How did Portland overcome the following:
  - a. Costs of implementation if there were any major costs (Funds? Financial incentives?)
  - b. Costs of long-term maintenance of bioswales and wetlands
  - c. Lack of information on a relatively new concept
  - d. Right of Ways and public/private property issues if there were any
  - e. [Differing] opinions of all key players/stakeholders (City council, other planners, Mayor, community/local members, and private property owners) in the political process
5. Are there specific requirements for implementing stormwater management such as: physical space (specific physical space requirements/constraints), minimum level of precipitation or climate, or size (population or density of the city)?

6. Can you describe some recent retrofitted projects? What made them successful? Were there characteristics only applicable [uniquely] to Portland?
7. What advice do you have for other cities wanting to implement green infrastructure strategies for stormwater management, particularly urbanized bioswales and wetlands?
8. Several benefits of green infrastructure are known through many articles and studies conducted. What do you believe are some negatives or drawbacks of this strategy?
9. What are the first few steps you would recommend a city to take to implement this strategy, specifically in terms of the Comprehensive Plan and Land Use Codes or ordinances? What other advice do you have for other cities in terms of the retrofitting process?
10. Other information obtained through a flexible discussion.

January 30, 2012

Marie Johnson, Bureau of Environmental Services

City of Portland, Oregon

Hello. I am sending you a request to be interviewed because I was one of the Regional and Community Planning students in the Portland fieldtrip Kansas State University had in March 2011, led by Huston Gibson, Associate Professor of Landscape Architecture and Regional and Community Planning. Your participation is voluntary and will be greatly appreciated.

My name is Madhuri Kulkarni, and I am a second year graduate student in the Regional and Community Planning program in the College of Architecture, Planning, and Design at Kansas State University.

As part of our final year in the program, we are required to develop a master's report addressing issues in planning. I have always been interested in Environmental Planning, and after visiting Portland, Oregon, for our Infrastructure Planning and Financing class fieldtrip in March, 2011, I was greatly influenced by the stormwater management through green infrastructure in the city. Thus, the focus of my master's report became the "Implementation of Stormwater Management as Green Infrastructure in Portland, Oregon." My hopes are to use Portland, Oregon, as an example to show how other cities in the United States can retrofit existing development to this sustainable process, specifically by implementing the strategies through the Comprehensive Plan and the Zoning Code.

The main question of my report is: *"Are there existing policies in the Comprehensive Plan and the Zoning Code of Portland, Oregon, for encouraging retrofitting development with green infrastructure – such as urbanized bioswales and wetlands – for stormwater management projects? If so, what are the policies that made this city successful? If not, what circumstances prompted the creation of the existing urbanized bioswales and wetlands projects?"*

My methodology is two part – 1) Analyzing Portland's Comprehensive Plan and Zoning Codes and itemizing "green infrastructure" strategies 2) Research using phone interviews using the snowball sampling technique to help answer the question. The phone interviews will ask 10 questions, with the expected duration of approximately 30 minutes. The interview questions are attached to this letter for convenience and anticipation of questions which will be asked.

Permission has already been acquired from the Kansas State Institutional Review Board (IRB) for conducting the interviews. I am also asking permission for including your name in the report. Additionally, I am also asking permission for recording the interview for my personal archive to correctly and accurately document your responses. If you wish to remain anonymous or do not want to be recorded, I will respect and ensure your confidentiality.

I understand that you, as a professional, are very busy with work and that you may also be getting several requests by students similar to me asking for your time. I would really appreciate your help, insight, and knowledge so that I can further my own knowledge and master's report. You are a valuable expert in the city of Portland, and your help will greatly affect me and my report. I hope that the report can ultimately influence several cities to follow Portland as an example.

Thank you in advance for your willingness to help.

Madhuri Kulkarni

Kansas State University

Graduate Student in Regional and Community Planning

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## Appendix B: Interview Codes

Interview 1: Marie Johnson  
Bureau of Environmental Services  
February 03, 2012, 11:15 am-12:39 pm

**Pre-Interview:** A number of these questions, other people might be better qualified to answer – will give best understanding. In terms of implementation, our comprehensive plan is lagging, and much of the implementation is happening through codes, but not the zoning code... other cities are also doing interesting things if you want to find out how other cities have adapted

Madhuri 4/25/12 1:20 PM

**Comment:** Comprehensive Plan is lagging

**Q1: Do the Comprehensive Plans and Zoning Codes specifically mention anything about retrofitting developments? And if not, why?**

**A1:** Comp Plan: It doesn't talk about green infrastructure, it talks about streams of drainage ways (utility function, and doesn't acknowledge natural function). The Comp Plan written in 1980 and been updated several times, but does not reflect the BES guiding policy document, which is the Portland Watershed Management Plan. That was adopted in '95, but not binding policy like the Comp Plan. When city council adopted it, they said that when the Comp Plan was updated, it was to incorporate the goals/policies of the Watershed Management Plan. The Zoning Code – central city and other plan districts, there are incentives for eco roofs and other incentives for green infrastructure, but I don't know the code well enough to say for sure. There are provisions in one part of the city – the Johnson Creek Watershed – that require impervious limitations with limits on coverage, understanding that there needs to be an opportunity for stormwater to infiltrate into the ground. There are code provisions – there's the Stormwater Management Manual – can't remember when it was adopted, but it is used in development review and direct developers – not to retrofit, but if they are doing new development or redevelopment that they need to manage as much stormwater as possible. That was done for a couple of reasons: in about a third of our city, our stormwater is handled through the combined system (stormwater and sanitary sewers), and we were in trouble with the Feds because, as is typical with other cities, the system would get overloaded and then it would discharge into the Willamette River. And it would happen all winter long. We would have sewer going into the river. So green stormwater management practices reduce the amount of stormwater going into the combined system, which reduces the demand for the demand for the combined system, which in turn reduces the likelihood of overflow. So there was that need. In part of the city, stormwater goes into what goes into UIC – ground Injection Controls. Some places the stormwater goes into private pipes – own challenges: harder to regulate water quality, flashy conditions because of impervious conditions makes it hard on streams. Some places, there isn't a stormwater management system. A lot of the city, we are asking the soil to be our stormwater management system. So the stormwater management manual is basically to get infiltration in places where we don't have a good way to handle stormwater and to reduce the demand on the built facilities. In terms of stormwater, that's a big deal. On private property, you're more likely to see swales in the highly urban areas, eco roofs, landscaped planters – partly because they have to do it. You know, the stormwater management manual requires it. And then partly, I think, in the more urban areas, like in South Water Front, there wasn't a good stormwater management system to begin with, so it would have been more extensive to do a traditional piped system. There was an incentive to

Madhuri 3/5/12 3:14 PM

**Comment:** Comp Plan does not talk about green infrastructure

Madhuri 3/5/12 3:16 PM

**Comment:** Code provision: Stormwater Management Manual – used in development review

Madhuri 3/5/12 3:17 PM

**Comment:** Trouble with Feds for discharge in river

Madhuri 3/5/12 3:17 PM

**Comment:** Green stormwater management likelihood of overflow

Madhuri 3/5/12 3:18 PM

**Comment:** Challenges to private pipes

Madhuri 3/5/12 3:19 PM

**Comment:** Lack of stormwater management

Madhuri 3/5/12 3:19 PM

**Comment:** Soil is stormwater management

Madhuri 3/5/12 3:20 PM

**Comment:** Swales on private property required by manual

create a distinctive urban district, and that green element really created a sense of identity, so developers were attracted to that area, who were comfortable with those kind of practices and have found that building green can actually be profitable. So in terms of private development, that's what has triggered it. The city has a Green Streets policy that says that all city funded development must meet stormwater management requirements with green street facilities (contention between BES and Bureau of Transportation). They're not philosophically opposed to, but strapped for money, so it's kind of a problem for them. Also have a Sustainable stormwater program – do retrofits where we identify areas where the existing system isn't adequate – lots of impervious areas. Invest in retrofit there. Taber to the River program: big part of southeast Portland where there are problems with the sanitary sewer backing into people's basements – not popular! The environmental services planning folks and their engineering folks got together to figure out how to deal with that problem. Did analysis of the approaches, and found that the most cost effective approach was to do a pipe upgrade with significant investment in tree planting, green streets, private stormwater facilities, and so on. Taber to the river: in that area to the river, there are incentives for private property owners to do green stormwater management and then we're doing our own retrofit program because it's cheaper than making bigger pipes. Combined: changes in regulations, changes in policies, and changes in analysis about effective way to meet needs. What's interesting is that this isn't coming out of the Planning bureau, it's coming out of the sewer bureau, basically. I should say that some of the motivation was that we were not in compliance with the Clean Water Act. We had to do something. We also invested \$1.4 billion in a giant pipe. If we don't do green infrastructure and development increases in the city, the pipes won't be enough. It would be sad if people spent tons of money into pipe systems and then it ran out of capacity in 20 years. It's a combination. Then there's the ethic too. But there's regulatory drivers, financial drivers, and some policy stuff as well.

Madhuri 3/5/12 3:22 PM

**Comment:** Sense of identity and cheap for developers to have green

Madhuri 3/5/12 3:23 PM

**Comment:** City has to meet stormwater requirements

Madhuri 3/5/12 3:24 PM

**Comment:** Retrofits in inadequate and impervious areas

Madhuri 3/5/12 3:25 PM

**Comment:** Sanitary problems, solution of pipe and green upgrades

Madhuri 3/5/12 3:26 PM

**Comment:** Cheaper to retrofit than make pipes

Madhuri 3/5/12 3:26 PM

**Comment:** Not in compliance with Clean Water Act

Madhuri 3/5/12 3:27 PM

**Comment:** Pipes inadequate

**Q1a: You referred to the Stormwater Management Manual, the Green Streets, and the Sustainable Stormwater Program – are those the reasons why there are bioswales and wetlands?**

**A1a:** Yeah, so there's the Stormwater Management Manual which requires more use of those facilities on private property and private development. The sustainable stormwater program provides some incentives for private property owners and does some retrofits and demonstration projects. The Greenstreet policies requires green streets – somewhat controversial. Bureau is doing infrastructure improvements to get most capacity for investment. So a \$20 million pipe program could help 2 neighborhoods. Now we spend \$15 million, but get the same benefit because it's cheaper to plant trees. So we're doing those kinds of things. Somewhat there's a community ethic too. There's a nonprofit called DePave – encouraging people to take out their drive ways and put in a garden or stormwater management. We've done demonstration projects with churches and schools. If there's an area with not enough capacity (combined system), we would have agreements with a church to take out 4 parking spots and put in a raingarden or a swale. Or a school district to do extensive stormwater gardens to handle the runoff from parking lots, playgrounds, and roofs. It's pretty significant. Same acreage in residential would have more pervious area than school sites. Sort of a combination of demonstration projects. Base of this, there was a shift to access funds for city retrofits. We could fund them using capital dollars. So

Madhuri 3/5/12 3:28 PM

**Comment:** Tree plantings cheaper than pipes with same benefits

Madhuri 3/5/12 3:28 PM

**Comment:** Community ethic (nonprofits)

Madhuri 3/5/12 3:29 PM

**Comment:** Projects with schools and churches

we can borrow money against future sewer rates. Funded the same way as upgrading pipes. A lot more is possible. Does that make sense? It's very complicated.

Madhuri 3/5/12 3:30 PM

**Comment:** Shift in funds, same way as upgrading pipes

**Q1b: Why is the stormwater management manual important? Why do people follow that? Is it a policy?**

**A1b:** They have to. On private property, they have to unless they can demonstrate it's not possible. There are places where there are problems or conflicts between what the zoning code requires and the manual. Because the manual is not part of the zoning code. I think the manual IS a land use tool, but hasn't been ruled that. There are situations where the zoning code and the stormwater management manual conflict (intensity, street pattern, block pattern, etc.). Some places, the soil doesn't soak up water very well. Usually the land use wins out. You would have to meet the stormwater management manual requirements.

Madhuri 3/5/12 3:31 PM

**Comment:** Conflict between manual and code

Madhuri 3/5/12 3:31 PM

**Comment:** Required to meet manual

**Q1c: Did you say the manual would overrule the zoning code?**

**Q1c:** No, usually the zoning code rules the manual. Which, I think, is problematic. We're actually in the process of a Comp Plan update, and we're trying to introduce to planners the idea that our land has a carrying capacity. It can only handle so much water, and that in the places where the carrying capacity is poor, we should not be requiring for a lot of development. So that's kind of a shift in thinking.

Madhuri 3/5/12 3:32 PM

**Comment:** Code overrules manual; problematic

Madhuri 3/5/12 10:06 PM

**Comment:** Need shift in thinking: carrying capacity and development

**Q1d: Not all cities would have a stormwater management manual, right?**

**A1d:** I don't think so. I'm not an expert on that, but I don't think so.

**Q1e: How exactly did the manual come about? Was it just because of the river polluting?**

**A1e:** I'm not absolutely sure. Check the history online. But my guess is that we were in violation of the Clean Water Act because we weren't handling our stormwater appropriately, and we needed to take action. And that was one of the actions. Let's not make the problem worse! And that's a cost issue. We don't talk about that a lot, but that's a fundamental challenge in planning. Who pays the cost of new development?

Madhuri 3/5/12 3:33 PM

**Comment:** Violation of Clean Water Act prompted action and manual

**Q2: Other factors besides policies that makes green infrastructure possible? You talked about the active citizens and the neighborhood group.**

**A2:** What's the role of local culture? There is that ethic. The DePave group is a nonprofit that's doing stuff. Friends of Trees are doing tree planting – trees are part of our green infrastructure. They've been in operation for 20+, maybe 25, years. We had developers who were receptive to these ideas and saw the cost benefit, especially in this economy. In terms of what kinds of support is there, we have some money to help property owners (technical assistance or grant funds for eco roofs) and 1% for green funds (green street facilities), but I'm not super knowledgeable about that. There is that ethic part. The strong leadership has happened in a quieter way. Our bureau director is not heavily into promotion, but what we does do is that he allows an atmosphere of experimentation. Our green roof program was through a staff member. That was the beginning of that program! There is a place for trying new things, and testing new things, seeing if they are effective and piloting them. In our bureau, that happens. In Planning and Sustainability, they've had neighborhood programs and plans that have policies which are adopted into the Comp Plan. Green elements into land use zoning, infrastructure improvements – part of policy. The South Waterfront Plan has policies about green infrastructure. Sometimes it's

Madhuri 3/5/12 3:33 PM

**Comment:** Local culture/ethic – nonprofits and developers

Madhuri 3/5/12 3:34 PM

**Comment:** Money (funds) to help developers

Madhuri 3/5/12 3:35 PM

**Comment:** Strong (but quiet) leadership

Madhuri 3/5/12 3:35 PM

**Comment:** Atmosphere of experimentation and testing

Madhuri 3/5/12 3:36 PM

**Comment:** Neighborhood plans can be adopted into Comp Plan

hard to do something city wide, but there might be a community where there's an interest or need. In South Waterfront, there was a need because there was an absence of infrastructure and had tested some approaches and found them satisfied. And there were interested developers. And it was along a river. Bring all those together and there's enough energy to incorporate policies, codes, design guidelines that all reinforce this idea of green infrastructure. And when you go now, you can see them. It's well played out. Have BES's policy guides, but not Comp Plan policy guidance. Calls attention to that. That's absolutely going to happen. At this point, it's as much about Planners thinking about this as the community because what happened is that this environmental planning function is separated between the Planning bureau and the Environmental Services (infrastructure). We do our projects, have our money and spend it, and have a stormwater management manual, but in terms of providing a broader framework to shape communities that integrate green infrastructure, we haven't done that. So long-range planners don't think about it. It's invisible to them. They think about streets and parks and houses. And sometimes they think about natural areas. But they don't think about infrastructure. They don't think about what happens to runoff. I feel like if planners are not drawn from the landscape architecture tradition, it's a serious problem. It's my personal opinion.

Madhuri 3/5/12 3:37 PM  
**Comment:** Easy to do community than city project if there's necessity

**Q3: What is the approval process for green infrastructure?**

**A3:** I talked about the stormwater management manual. If somebody comes in to build a development, they're going to our Bureau of Development Services (do land use reviews and building code reviews). They get reviewed for consistency with the planning regulations. And BES also has folks who do development review to look at the adequacy of infrastructure and to implement the Stormwater Management Manual. They're housed with our Development Services folks, and from a public perspective, it should read as a fairly seamless process, but the green infrastructure stuff is permitted through us. It's probably both. Current planning and environmental services.

Madhuri 3/5/12 3:39 PM  
**Comment:** Disconnect in Planners' and BES's way of thinking in infrastructure

**Q3a: So the development services and the current planners would see if it matches and if it gets approved?**

**A1a:** Yeah. You would go the Bureau of Development Services who would review it for land use and transportation. And our folks would review it for Stormwater Management Manual.

Madhuri 3/5/12 3:40 PM  
**Comment:** Approval through Developmental Services, planning regulations, and BES review

**Q3b: Random question: Other cities won't have a special bureau like your bureau. They would just have planners.**

**A3b:** Different cities manage cities differently, but who is the sewer bureau? We're a sewer bureau who is also responsible for water quality regulations. We also got involved in endangered species act regulations and develop the environmental restoration program, and so on. But I don't know in other cities is the sewer bureau it's own bureau? Is sewer monitored together? Is there an infrastructure bureau? Those are implementation and maintenance. There would be variations. In Portland, we have a commission form of government with 5 commissions and each is responsible for different bureaus. Commissioners usually advocate for different geographies. Here they advocate for different functions. That's part of it. Our commission in charge was an environmental engineer at the time, so he was into this stuff. He was a strong advocate. Because of the political system, some functions aren't as integrated in a city that had a city manager. Maybe in another city, planners would focus on different things and would be in the same bureau. I'm not sure. Even here, we forget. Our soil is part of our infrastructure. If we're putting

Madhuri 3/5/12 3:42 PM  
**Comment:** Different management by city (Sewer/infrastructure bureau would be in charge)

Madhuri 3/5/12 3:42 PM  
**Comment:** Commissioner's role vary - geography vs functions

Madhuri 3/5/12 3:43 PM  
**Comment:** Commissioner as advocate

water into the soil to manage stormwater, our job is to manage stormwater. Then the soil is part of our infrastructure. The trees are part of our infrastructure.

Madhuri 3/5/12 3:43 PM  
**Comment:** Soil and trees are part of infrastructure

**Q3c: So you think that’s the ethical part of it? It’s also part of policy, so you think it’s more ethic and culture?**

**A3c:** One of my frustrations in the Planning bureau (where I came from) is that we thought about land use and transportation and that connection and growth and what cities should look like, but we didn’t think about infrastructure and sewer capacity and the basic natural conditions. Is this really the best place to put development? Can the soil and streams handle it? And what happens is when we don’t think about that, we create big problems. It would be nice if Planners had more of an understanding about how the natural systems affect development positively and negatively. And there are limitations. There’s a limit on how steep a slope you can practically develop on. That doesn’t mean it’s a good idea. There isn’t that kind of thinking. There isn’t that kind of thinking about areas and depth for water. We need to have 20,000 new households? We need to think about what that means for groundwater, how to design a building, and so on. Our planners are not accustomed to thinking that way. We approach planning as more of an urban design exercise and flow of people. That’s important, but where I’m coming from is an evening listening to Ian McHarg. Maybe there’s a starting point before that. We have done plans that have done that, but we have a long way to go. Planners and some of our folks don’t get that. We plant trees and that will help soak up water. It frustrates me! It’s necessary to understand basic functions of hydrology and soil characteristic. That’s not true for all. Some people have told me that surely you wont plant trees on all the streets. Well, yeah, we will. And people have asked me, then what about urban areas? So trees somehow are not urban. I said it’s practical! It’ll get hotter. Don’t you need shade? Isn’t that cheaper than air-conditioning? They’re not accustomed to thinking that way. To them, green is an aesthetic. It’s a design feature. We have a urban design guy here who said “Keep your fucking leaves away from our fountain!” – because we were doing green streets near a foundation, which is a historically significant area. But he finds the green streets facilities not attractive. So yeah, some are not as attractive. So it’s not all perfect here. More people are pro-green. But it comes back to – do people think we’re doing green because it’s “cool”, or do they really understand the practical reasons why. Central city people talk about urban plazas for design. I’m not against urban plazas. But if that stormwater goes into the pipes, you may overflow the basements of the hotels. They just haven’t thought about that.

Madhuri 3/5/12 3:44 PM  
**Comment:** Lack of infrastructure and basic natural condition knowledge in Planning

Madhuri 3/5/12 3:45 PM  
**Comment:** Planners not accustomed to thinking about environmental systems and limits

Madhuri 3/5/12 3:46 PM  
**Comment:** Step before urban design

Madhuri 3/5/12 3:46 PM  
**Comment:** Basic functions of hydrology and soil necessary

Madhuri 3/5/12 3:47 PM  
**Comment:** Different way of thinking; trees not urban – need to be practical

Madhuri 3/5/12 3:47 PM  
**Comment:** Green to some is just aesthetic

Madhuri 3/5/12 3:47 PM  
**Comment:** Some find green not attractive

Madhuri 3/5/12 3:48 PM  
**Comment:** Green as practical rather than “cool”

**Q4-1: How did Portland overcome the cost of implementation if there are major costs?**

**A4-1:** Private property = owners responsibilities. On public property = we can fund it through the Capital Improvement program so we get access to that funding, so that’s good. Parts of the city need streets to be improved. We’re still deciding with the office of Transportation over who pays for those stormwater facilities when the streets get improved. We need to work it out. We need new leadership. They want to build new streets, but they need to put stormwater facilities there and those are expensive. Either they can’t afford to or are angry at us because they’re saying why should we pay? We say, well, you are the ones who paved all this area. We’re both right. We need to figure that out.

Madhuri 3/5/12 3:48 PM  
**Comment:** Private developers responsible and city through CIP for funding costs

**Q4-2: Long-term maintenance?**

**A4-2:** Technically, we’re responsible, but it’s not figured out. On school districts, that’s an issue. Because they don’t have money. Maintenance is the big issue.

Madhuri 3/5/12 3:49 PM  
**Comment:** Conflict in payment between BES and Transportation

Madhuri 3/5/12 3:49 PM  
**Comment:** Maintenance is a big issue

**Q4-2a: So your bureau is in charge of that then [maintenance]?**

**A4-2a:** We're in charge of maintaining the public facilities.

**Q4-2b: And the private developers would obviously have to do their own?**

**A4-2b:** Exactly. And there's some talk about some talk in the residential areas where the community might help with maintenance. But it's a challenge. The bigger the streets, the less the individual would feel a sense of ownership of that. If I were in a residential community and I had a green street facility outside my house, I wouldn't mind weeding it. But if I were in an apartment on a 5-lane highway with a green street facility next to a bus stop. Is that my responsibility? Or if I own a convenience store next to it? Probably not.

Madhuri 3/5/12 3:51 PM  
**Comment:** BES: public facilities and developers: private for maintenance

Madhuri 3/5/12 3:51 PM  
**Comment:** Ownership and maintenance depends on size

**Q4-3: How did Portland overcome the lack of information on a relatively new concept?**

**A4-3:** I think I talked about that – with piloting it. Working with people who are receptive to that idea. People wanted them. We tested them. We do a lot of public information.

Madhuri 3/5/12 3:51 PM  
**Comment:** Piloting and testing to overcome lack of information

**Q4-4: Rights-of-way and private property issues?**

**A4-4:** There are some places where people don't want green streets because it could interfere with their parking. We try to work that out through conversations. I don't know if we move forward if there are objections. I don't know for sure. In some areas, we have some planting pallets where people can make choices about what can go into the green facilities. More in the residential areas.

Madhuri 3/5/12 3:52 PM  
**Comment:** Conflict resolved through conversation and by presenting options

**Q4-5: Differing opinions of key stakeholders?**

**A4-5:** Well, we have our own money, so it's not an issue because of that. When we were doing the South Waterfront Plan to incorporate green infrastructure – well, years of negotiation. I don't think there was a simple answer to that. Discussing issues with the developers, the leadership from the bureaus, and the city council.

Madhuri 3/5/12 3:52 PM  
**Comment:** Negotiation to overcome differing opinions

**Q5: Are there specific requirements for implementing stormwater management?**

**A5:** I don't know the exact requirements. My sense is that they have to be designed to handle a specific rain event. I don't know what that rain event is.

Madhuri 3/5/12 3:52 PM  
**Comment:** Rain event for specific requirements

**Q6: Do some projects have characteristics only applicable to Portland?**

**A6:** In terms of retrofit projects, there are 3 visible ones with information online. Clay Street Project which is from a residential area through an industrial area and down to the Willamette. There's a sense that the industrial area feels a barrier. Green street handles stormwater but also gives a visual queue of a route to the river. Montgomery Street is another good one. Portland State University down to the river. Some of them are paved streets and some are right of ways for ped and bike only. That's the one Randy said "Keep your fucking leaves off." I think it's hilarious. It's so funny because it showed without him realizing, that he felt threatened by the green streets. Which means it's a pretty strong movement. The Taber to the River is a big area working with residents and public property – a good example of a neighborhood using green infrastructure. We do have plans on Johnson creek. It handles a lot of stormwater, so Phase 1 is complete. Middle of an urban renewal and industrial site. The major road there floods every other year. We got a grant to pay for a part of it. We had a big flood in January, and for the first time in recent history, the road didn't flood as a result. That's pretty cool. Taber to the River, which was about the engineers and the stormwater folks, rethought infrastructure priorities. It's

Madhuri 3/5/12 3:53 PM  
**Comment:** Clay Street: green provides route to river and handles stormwater

Madhuri 3/5/12 3:54 PM  
**Comment:** Green is a strong movement if some feel threatened (along Montgomery St)

Madhuri 3/5/12 3:54 PM  
**Comment:** Johnson Creek didn't flood for first time

pretty innovative. Getting the green folks and the gray folks together to problem-solve is challenging, but really gratifying when it works. Floodplain restoration project: habitat improvement, property protection, stormwater, and economic development project. Maybe not unique to Portland, but demonstrates interest in working together.

Madhuri 3/5/12 3:55 PM  
**Comment:** Collaboration between gray and green to problem-solve  
Madhuri 3/5/12 3:55 PM  
**Comment:** Working together

#### Q7: Advice for other cities.

A7: I think starting small with a new idea and testing it. Having good design is important. Bringing together the folks to analyze technical performance and financial payback is really helpful because it's gotta make sense and be practical. And then finding a way to get capital for public projects. We're using capital dollars to get land. There's a lawsuit against that. We might lose.

Madhuri 3/5/12 3:56 PM  
**Comment:** Test new ideas, have good designs, bring people together, and consider capital

#### Q7a: So the access to capital, is that the Capital Improvement program?

A7a: Yeah, using sewer dollars. There's limitations to what you can use that money for. That money needs to benefit certain things. We've been able to make the case that green infrastructure is benefitting the system, so it makes sense to spend that money. So we have access to capital. Green infrastructure get into the queue along with gray infrastructure projects and have access to the same money. If you don't have money to build it, you're not going to get very far.

Madhuri 3/5/12 3:57 PM  
**Comment:** Access to capital  
Madhuri 3/5/12 3:57 PM  
**Comment:** Green and gray have same access to money

#### Q8: Some of the drawbacks.

A8: Well, maintenance is a challenge. It's not as hard to maintain a sidewalk as it is to maintain a swale. Sometimes there's a tendency to think that the solution worked here so we should apply it somewhere else. But that doesn't always work. Seattle's had problems. We've had problems where the green street facilities doesn't work if the groundwater is too high. Can't assume "one size fits all." These approaches are cost effective, but people don't believe us. Which is sad. Sometimes people think we're doing it for moral reasons instead of practical reasons. I totally believe the moral reasons, but I think we should communicate it in terms of practical benefits. Look, this will keep the water out of the sewer. Keep it simple. Often it isn't more expensive. Oh and then, who's responsible? Also there are design issues. I can understand that good design is important in central cities. Some are great, some don't fit in the urban context. Planners, urban designers, architects – need to bring disciplines together in some ways.

Madhuri 3/5/12 3:58 PM  
**Comment:** Drawback: maintenance

Madhuri 3/5/12 3:58 PM  
**Comment:** Drawback: One size fits all mentality

Madhuri 3/5/12 3:59 PM  
**Comment:** Drawback: Not just moral, but also practical reasons

Madhuri 3/5/12 3:59 PM  
**Comment:** Drawback: who's responsible?

Madhuri 3/5/12 3:59 PM  
**Comment:** Drawback: Need to bring together disciplines

#### Q9: First steps in terms of comp plan or land use codes and ordinances

A9: I touched on the facilities side. But learning from others' piloting and testing. In terms of policies and codes, it might be easier to try new policies in particular areas where there are challenges rather than starting it city-wide. That's probably culture specific. I was in San Antonio for a conference. The downtown riverwalk is a stormwater facility! They built it because they get flash floods. In a city like that, maybe people would want to see it as a city-wide. But start small. We did do incentives early on in terms of codes – Floor Area Ratio or Development bonuses for eco-roofs. That's another way to introduce it. And also positive press. Marketing it and getting people excited. BES's document is not binding to anybody to us. But it's kinda funny that we are updating our Comprehensive Plan to catch up with what already is existing practice. That's maybe not what you want.

Madhuri 3/5/12 4:03 PM  
**Comment:** Learn from others

Madhuri 3/5/12 4:03 PM  
**Comment:** Start small rather than city-wide

Madhuri 3/5/12 4:04 PM  
**Comment:** Early incentives

Madhuri 3/5/12 4:04 PM  
**Comment:** Positive press and marketing

#### Q9a: So if cities were to update their Comprehensive Plan, you think something like the Stormwater Management Manual could be incorporated into the plan itself?

**A9a:** Maybe not, but you could use language in the Comp Plan that acknowledges the role of trees and soil to handle stormwater and to offset impact of development. The link between stormwater practice and land use practice needs to be made by the Comp Plan. The Comp Plan has a section about utilities and basic services saying you should operate services safely. Well, that's not helpful. We have to do that. Here, we know how to provide stormwater services. And planning knows land use. But we need to have policy that says "how should we think about the relationship between land use and stormwater" – practical and design. Use stormwater as an amenity to celebrate water as artistic. So the Comp Plan could have language that makes a connection between land use and stormwater without saying what you have to do, unless the jurisdiction is ready for it.

Madhuri 3/5/12 4:06 PM

**Comment:** Comp Plan: make link/relationship/connection between stormwater and land use

**Q9b: So you think a separate manual would still be a good idea?**

**A9b:** I think it could be. Every jurisdiction structure is different. Seattle picked some parts of the city have a green factor area where they are required to do some green infrastructure – they pick from a weighted pallet. It's hard to say without knowing the specifics of the community. And we have lots of guest lecturers and brown bags, so that helps for policy makers to introduce new ideas. We've gone on tours and host tours for other cities to get bureaucrats and policy-makers introduced to new ideas and getting them excited. That's key. Richard Daley started his eco-roof program because he went to another city and wanted a better one in his city. Not the most sophisticated, but a little competition works sometimes. There's that political side of it. In terms of the code, I think it depends on how big the problem is. Starting with incentives is a good thing. Then area plans. Right now, cities can't afford to pay the impact of other people's actions, but they also don't want to make development costs high.

Madhuri 3/5/12 4:06 PM

**Comment:** Separate manual might be good idea

Madhuri 3/5/12 4:08 PM

**Comment:** Lecturers and brownbags helps introduce new ideas

Madhuri 3/5/12 4:08 PM

**Comment:** Competition can be helpful

**OTHER:** Reference to other people with different perspective. Sustainable stormwater, stormwater management manual, and somebody from Planning. Perspective from private developer (Gerding- Edlen). Will email.

I didn't talk about the Portland Plan.

**Should I look through the Comp Plan and zoning ordinance? Will that help?**

I have the Comp Plan in front of me. Under the infrastructure section. Under the environmental section... it might be important to say that citywide policies aren't that great. Some area plans do a better job. There's a few references, but it's really dated. The Portland Plan is like a warm-up to the Comp Plan, but some of those policies might be moved forward. That does have policy language around green infrastructure.

Madhuri 3/5/12 10:15 PM

**Comment:** Portland Comp Plan: policies not that great and dated

**When is the updating process being started?**

We have started. We're just planning for it. The Portland plan goals will move into the Comp Plan. It's a preview of where we're going.

**Interview 2: Renee Loveland and Clark Brockman**  
**Gerding-Edlen Development Company LLC and SERA Architects**  
**February 13, 2012, 10:30 am-11 am**

**Q1: Do the Comprehensive Plans and Zoning Codes specifically mention anything about retrofitting developments? And if it doesn't, then why do you think the urban bioswales**

**and wetlands are evident in Portland?**

**A1: C** – Don't know if it is in the Comp Plan or Zoning code, but there are many city policies that have brought it about. Some of it has been controversial. For example, the mayor moved money from sewer budgets into bicycling budgets and that's why those swales worked out. It was hard for the mayor to show how it made sense, but it did all make sense. It was interesting to see the political challenges.

Madhuri 3/5/12 4:10 PM  
**Comment:** City policies made bioswales/wetlands evident – some controversial politics

**R** – We have benefitted from Portland's incentives from this infrastructure, mostly for green roofs. There's FAR bonuses for projects. That was a big deal for some of our projects in the early 2000s. don't know if they're still applicable

Madhuri 3/5/12 4:11 PM  
**Comment:** Incentives for infrastructure

**C:** They still are. We're taking advantage of them in one our projects right now. They still are applicable.

**R:** There's a stormwater reduction charge from the city for projects or buildings that have green infrastructure and area dealing with the infrastructure on site and not go into the city system. That's a tangible benefit. There's also a gray-to-green program that the city has that incentivizes projects to add green roofs and retrofit. There are city driven policies, but I'm not sure what the code requires. At the street-scape, it seems that most urban projects are doing some swale treatment. I see that a lot.

Madhuri 3/5/12 4:11 PM  
**Comment:** Incentives (reduction charges and programs for benefits)

**C:** I believe there are System Development Charge, or SDC reduction, as well. SDC reduction is worth nothing. It's a policy instrument that other cities can adopt. This is interesting because Portland has come to it accidentally because of Renee's firm because they were working on projects that could demonstrate that showed potable and stormwater – didn't make sense to charge full system. Initially they were one project at a time, but other projects would borrow out of Gerdling-Edlen's book for other green buildings. This starts to total up in the 100s of 1,000s of dollars. It's an effective policy – by reducing a system development charge, you're reducing a permit cost, which is shown in the beginning of a project, which means it goes to a developer's bottom line instead of incentives that come out after the project is capitalized. Then the incentive money is more a reward, but doesn't affect the developer's initial financial package, where an SDC reduces the capital cost.

Madhuri 3/5/12 4:13 PM  
**Comment:** System Development Charge (SDC): effective policy instrument to reduce developer's initial finances

**R:** That's the big deal.

**C:** Portland calls it a Systems Development Charge, but different cities will have different names. Basically, it's the charges a city assesses based on impacts to the city infrastructure. Transportation, Sewer, Stormwater SDCs, but that's a Portland term.

**Q2: Are there factors besides these policies that make the green infrastructure possible, like strong leaders or citizens?**

**A2: R** – Absolutely, there's a culture in the Pacific Northwest where there's a lot of support for trying to do things differently and lighten the environmental footprint. From my perspective, it's been very important to us to include some design component that speaks to this and we've done rainwater capture/reuse, wastewater, greenroofs, stormwater filtration on site. There's been an emphasis. The city has driven the biodiversity of the fact that they have said how important it is to manage our stormwater effectively. We've had a combined sewer stormwater system for a long time, and the city would get overflows when it would rain heavily. We would have untreated sewage going into the river. They've redone that infrastructure and it was a huge cost to the city. That helped people connect the dots between distributed treatments of stormwater versus investing billions of dollars into infrastructure that needs to be maintained. There has been

Madhuri 3/5/12 4:13 PM  
**Comment:** Culture of Pacific Northwest to do things differently

Madhuri 3/5/12 4:14 PM  
**Comment:** City stresses importance of stormwater management

Madhuri 3/5/12 4:15 PM  
**Comment:** Combined sewer overflows and untreated sewage: huge cost to city

a real push to decentralize stormwater treatments. And the BES has been very supportive of projects that are trying to do things. We got a system development charge reduction on a project in rainwater capture/reuse for toilet flushes, and they agreed to provide us with a reduction. That hasn't become commonplace because they feel they have invested money in the infrastructure.

**C:** It's interesting to see the big pipe develop because it might go down into a big public expenditure of the 90s in Portland, and it was seen as a billion dollar investment, and yet Civil Engineers see the system will be nominally maxed out as early as 2013 or 2014. And it's taken almost 10 years to build. Clearly what we need is a different system other than building bigger pipes. We can't keep building bigger freeways. BES is a very progressive public agency and they do that with a lot of latitude from council. We are blessed with a fairly progressive set of policies that date back to 30 years. What is it in Portland that has allowed us to experiment? It goes back to the land use laws 30 some years ago when we created an Urban Growth Boundaries. Other cities ask what do we need to have that's happening in Portland. You gotta start with that urban density piece. Even if it's going to take 30 years, that means you've gotta start today. And you can trace policies all the way back to stormwater management and green building policies and they date back to that. The density forces a city to become innovative.

Madhuri 3/5/12 4:15 PM  
**Comment:** BES is supportive with charge reductions

Madhuri 3/5/12 4:16 PM  
**Comment:** Need different system than building bigger pipes

Madhuri 3/5/12 4:18 PM  
**Comment:** BES and policies are progressive

Madhuri 3/5/12 4:18 PM  
**Comment:** Portland allows experimentation

Madhuri 3/5/12 4:18 PM  
**Comment:** Density forces city to become innovative (Portland's UGB)

**Q3: What was the approval process for getting green infrastructure? For any projects that you've worked on?**

**A3: C** – Well the city has a permitting process that presumes that different projects will do different things, and not just go by the books. The pre-application process asks what the project is planning even in design development. A lot of it is negotiated while the projects are still being designed.

**R:** Yeah, that happens early in the process. We've done large redevelopment projects over several blocks and in the South Waterfront Area (brownfield redevelopment with city's partnership and other developer from the town). There's 10-15 block parcels and they designed it so the district is disconnected from the city storm system, so the water is either infiltrated or treated/cleaned before going to the river or a component of green stormwater with the building. It's a great example of working with the city early on. That approval process starting back in 2000-2001. We had to work with the city to get comfortable with it. Not just the city, but other engineering firms as well who were excited to try new things, but might have been perceived as having risk. Things have changed quickly. It's progressive. These strategies work and the introduction of the green space in the urban environment. It's a visual amenity to the area and the introduction to nature in the urban environment adds the "livability" of the project.

Madhuri 3/5/12 4:19 PM  
**Comment:** Negotiation while project is being designed

**C:** You can see many small bioswales in the street corners, and those serve multiple uses. They shorten the travel distance for pedestrians across the street, which is a safety feature – a natural traffic calming features, which is slowing the traffic – another safety feature, which helps bicycles as well while reducing system impacts on the stormwater system. I would encourage jurisdictions to look for policies which have multiple uses in one solution.

Madhuri 3/5/12 4:19 PM  
**Comment:** Work with city early on – early in process

Madhuri 3/5/12 4:20 PM  
**Comment:** There is risk, but need to be progressive

Madhuri 3/5/12 4:20 PM  
**Comment:** Green: visual amenity and livability

**C:** You can see many small bioswales in the street corners, and those serve multiple uses. They shorten the travel distance for pedestrians across the street, which is a safety feature – a natural traffic calming features, which is slowing the traffic – another safety feature, which helps bicycles as well while reducing system impacts on the stormwater system. I would encourage jurisdictions to look for policies which have multiple uses in one solution.

Madhuri 3/5/12 4:21 PM  
**Comment:** Multiple functions of swales: travel distance and traffic (safety) – multiple uses in one solution

**Q4: What are some specific requirements for implementing stormwater management – does any of that matter?**

**A4: R** – Don't know, but city wants projects to be what can be done. It's more on the developer side to do what they can afford and can fit. The city would be open.

**C** – LEED requirements for stormwater management on site are less than the city of Portland's

requirements. So the city of Portland's basic code requirements are more stringent than LEED's. Any city of Portland project that goes after LEED certification gets stormwater points just by building to code. You could at least without knowing what the exact metric is, it's more stringent than the LEED credits. Other than that, I can't tell you the exact amounts.

Madhuri 3/5/12 4:21 PM

**Comment:** City's codes are more stringent than LEED

**Q4a: So if a city doesn't have specific requirements, do you think the first steps would be to look at LEED and to have those as a starting point?**

**A3a:** Absolutely. To ease into it, a city could have STC reductions for stormwater performance that meets or exceeds LEED requirements - that would be a fast way for a city to write a policy. And it would give due diligence around what is specific to their region, because it varies by the physical and political climate, but that would be easy for a city to incentivize and to craft a region-specific policy.

Madhuri 3/5/12 4:22 PM

**Comment:** Fast way to write region-specific policy: LEED requirements

**Q5: There's been so many good things about green infrastructure, so what are some negatives or drawbacks to the strategy?**

**A5: C-** Mismanaged political management on the mayor's part because he was progressive (move money within city budget), but he got unbelievable crap for it from conservative voters who didn't want to see infrastructure spent on anything else.

Madhuri 3/5/12 4:22 PM

**Comment:** Negative: mismanaged politics

**R:** There was a learning curve to make sure it was done efficiently in the project. And then design and engineering community responded quickly to that. We had some interesting developments on green roofs in the early 2000s from an ongoing operation standpoint, making sure they looked and functioned well. We had to redo a roof at quite an expense. The soil mixture was not right and we all learned from - the designer, landscaper, and ourselves. We had to overcome that hurdle. And the cost associated with stormwater storage and reuse is difficult and challenging because you need to have a large volume of tank area to hold all the water so you can have it when you need to use it. That strategy is costly and not easy to integrate into a project, but if you not focus on capturing all the water (be realistic). We were able to make a dent in our water reduction.

Madhuri 3/5/12 4:23 PM

**Comment:** Negative: Learning curve and response

Madhuri 3/5/12 4:23 PM

**Comment:** Be realistic

**Q6: What are the first few steps you would recommend a different city to implement the strategy? What advice do you have?**

**A6: C -** I've given you a few around land use policies and to look for twofers and threefers, and using STC incentives. If you have multiple cities close together in a regional government, then have them think bigger than stormwater just by itself. I'm thinking of the South Bay area and their municipal purple pipe for nonpotable water that covers Palo Alto, Mountain View, San Jose, and Sunnyvale, and they treat wastewater to a nonpotable standard, which is more affordable. And some stormwater - they put it in a purple pipe and sell it at a lower cost than potable water. Cities in a regional government should think about doing things like that while working on stormwater reductions.

Madhuri 3/5/12 4:23 PM

**Comment:** Use twofers and threefers and use STC

**R:** I read about San Diego and their system. I would also be careful about thinking about retrofits versus new building. It's more complicated to retrofit a green roof or system into an existing building that you're not demolishing. I noticed you used "retrofitting" a few times in your descriptions, and I want you to realize that new buildings is easier, and that's been our experience rather than retrofit which might be more cosmetic.

Madhuri 3/5/12 4:24 PM

**Comment:** Think about region instead of separate cities

Madhuri 3/5/12 4:24 PM

**Comment:** New development is easier than retrofitting

**OTHER: C-** Contact green building person at BES - Alisa Kane. Maybe call Palo Alto

Wastewater treatment system about their municipal purple pipe. It's a pretty amazing policy achievement.

**R:** Contact of engineer or landscape architect.

**Interview 3: Emily Hauth and Henry Stevens**  
**Sustainable Stormwater Management Division**  
**February 13, 2012, 3:00 pm – 3:51 pm**

**Q1: Do the Comprehensive Plans and Zoning Codes specifically mention anything about retrofitting developments? And if it doesn't, then why do you think the urban bioswales and wetlands exist in the city?**

**A1: E-** We do have the stormwater management manual and those are our stormwater management requirements for new and redevelopment, so that drives private development, and anyone creating impervious surface over 500 square feet will have to manage stormwater from that and show how, but in terms of some of retrofitting for green streets, there are many influences there. It is in our stormwater management manual as well as part of the code, but we have our private and public sides for the retrofitting.

**H:** We work under the stormwater management requirements for the city. Not too much the planning. [The comprehensive plans] generally talk about greening the city, improving watershed health, and mention green stormwater management approaches, but we generally do that for specific reasons to protect our sewer system or watershed areas as far as retrofits go. It's not a global requirement – its generally more targeted. Our average material is talked to with the public. New and redevelopments have to do it, retrofits are usually more complicated and expensive, and putting these in new or redevelopments are more specific and targeted.

Madhuri 3/5/12 4:29 PM

**Comment:** Stormwater Management Manual

Madhuri 3/5/12 4:30 PM

**Comment:** Manual is more targeted

**Q1a: So the comprehensive plan and code don't really mention anything about it and it's from the stormwater management manual, do you know how that came about or who started the manual?**

**A1a: E –** Yeah, it goes way back to the requirements of the National Pollution Discharge Elimination systems permit, and that says we have to manage stormwater from our watersheds and keep sediment from going into our rivers. That started way back when. It was 1999 that we had our first manual, and that was developed from a lot of professionals in the area of landscape design, architecture, policy makers/regulators all got together in this advisory board and pushed the city to develop some policies around managing stormwater and to come up with this manual. That's how the manual came about. Then we also have our combined sewer overflow issue simultaneously really, that we were required by the federal government to manage our CSOs, clean up the river. That was a 20-year project that just completed. In addressing the CSOs, we were required to keep stormwater out of the pipes using these green facilities. We started with small demonstration projects to see what might work – anywhere from rain gardens to down south disconnection was a big approach putting rain gardens on property, disconnecting their downspout. That was a popular program that just ended after 18 years.

Madhuri 3/5/12 4:30 PM

**Comment:** Manual came about because of pollution in river

Madhuri 3/5/12 4:31 PM

**Comment:** Manual made in 1999 by advisory board

Madhuri 3/5/12 4:32 PM

**Comment:** Federal government required cleaning river

Madhuri 3/5/12 4:32 PM

**Comment:** Began with demonstration projects

**H:** A lot of retrofits completed in recent years are CSO related and the stormwater manual came about because of NPDS requirements. Do you know about the NPDS permit program? Smaller communities didn't have to develop stormwater management plans early on the way we did, but that's why our stormwater manual came out in the 90s. But retrofits have been driven by the CSO programs where it's more cost effective to build/maintain green streets than to do the

Madhuri 3/5/12 4:33 PM

**Comment:** Manual needed because of NPDS requirements

equivalent amount of work underground replacing pipes. It's cheaper for us to do the green thing than to do the pipe replacement that would have achieved the same result as far as reducing combined sewer overflows. We're going to see other cities that are weighing pros/cons and have CSO problems to see how much pipe work they have to do versus green, and in retrospect, we were the early cases. We couldn't build pipes big enough to manage all the problems. It would have been unbelievably expensive. And these green retrofits allowed us to do it less expensively. So we're not just doing stormwater management for watershed benefits, we are doing the infrastructure projects related to the combined sewer.

Madhuri 3/5/12 4:33 PM

**Comment:** Cheaper to be green than replace pipes

**Q2: Are there factors besides these policies or this manual that make Portland's development of green infrastructure possible, like leaders or citizens?**

**A2: E** – Yes, I would say all of the above. It started from having a strong supportive leadership giving us the go-ahead to try these innovative green approaches, and then it trickled down. It takes active citizens too. We have different incentives to provide people to get engaged, and they'll apply to grants and incentives to develop stormwater management projects, one being the community watershed stewardship grant program, and they provide up to \$10,000 for any project that includes community and manages stormwater or improves the health of watershed. Then we also have 1% for green incentives that helps implement green streets. Citizens can apply for that, but other bureaus or professionals do. Then we have an eco-roof incentive program. Anyone in the community can apply and get \$5 per square foot to implement an eco-roof. And then some of our developers are pushing the envelope too and pushing us to try different approaches, and we can monitor how those might work and then eventually they might make their way into our stormwater management requirements as well. We work closely with our other bureau partners – Portland transportation and planning – more recent, within the last 4-5 years. We are working more closely with internal partners to get a multi-objectives approach of the stormwater management techniques. We work with our Bureau of transportation for street improvements or safety, so they'll integrate a green street into their project because it does provide both stormwater and other pedestrian and bicycle safety features. We're working with the Bureau of planning to get at some of the green corridors that connect neighborhoods and business and catalyze development in areas to improve the neighborhood and to implement green streets. Also, we work with our economic development entity to catalyze development. If we work together with our bureaus and with strong leadership, we achieve multi-objectives. And we're in the midst of updating the city's 35 year comprehensive plan and green is a big piece of it too. There's a need to integrate more green into our urban environment. It is making its way into these big comprehensive plans.

Madhuri 3/5/12 4:35 PM

**Comment:** Supportive leadership

Madhuri 3/5/12 4:36 PM

**Comment:** Active citizens

Madhuri 3/5/12 4:37 PM

**Comment:** Incentives and grants (Community grant, 1% green, eco-roofs)

Madhuri 3/5/12 4:37 PM

**Comment:** Developers with different approaches

Madhuri 3/5/12 4:38 PM

**Comment:** Achieve multi-objects by working with other bureaus (internal partners)

**Q2a: Do you get the grants from the state or where do you apply for them?**

**A2a: E** - We have a number of grants. We did receive some funding from the federal government. The innovative wet weather program and we were able to implement about 25 different projects (eco roofs, green streets, to private property facilities). We're a utility rate based bureau, so much of our funding comes from people paying for their waste/stormwater managed, so we use that funding to put towards grants. The ecoroof incentive was part of our gray-to-green initiative. That's a 5 year program. Our leaders decided it was important to accelerate implementation to these green approaches, and that includes green streets, eco roofs, cleaning invasive weeds – its' not just stormwater related. Our leaders put in \$15 million for this

program.

**H:** I don't know how much we've gotten from the federal government.

**E:** At least over a million dollars [from the federal government]

**H:** The city of Portland has grant programs to move this whole thing along to demonstrate new technologies and to be innovative.

**E:** [The private developers usually go beyond the manual too because Portland wants to be recognized as a green city. They see the value in doing it for business.]

Madhuri 3/5/12 4:39 PM  
**Comment:** Funding from federal government and from city leaders

Madhuri 3/5/12 4:39 PM  
**Comment:** Developers see value in green city

**Q2b: Do you think the ideas from the stormwater manual will be implemented in the updated Comprehensive Plan?**

**A2b: E –** [That is just for stormwater management, so it's a separate requirement. The comprehensive plan is more prescriptive. It recognizes a lot of different policies that are out there. And just how we want to grow our city. So it's not

**H:** [The stormwater management manual is very, very detailed. It has cross-sections, detailed languages for storm-sizes. It's a typical manual.]

Madhuri 3/5/12 4:40 PM  
**Comment:** Comp Plan is prescriptive

Madhuri 3/5/12 4:40 PM  
**Comment:** Manual is detailed

**Q3: Do you know what the approval process is for green infrastructure? Did a new system have to be created to allow for these new projects that happened in Portland?**

**A3: H-** Yes, lots and lots of changes happened in the permit world, and it's taken years. There's a lot of behind the scenes work to allow these projects to move forward. Lots of work on permit. When cities come and visit they think we've got it all figured out, but permitting gets addressed incrementally over the years. [There's been lots of changes to move forward the stormwater management issue because it's secondary in development. If you design a site without it, you leave it to the end and you don't have room for it. One of the changes is to make people think about stormwater management up front and incorporate it into landscape areas that might not otherwise be multi-function. That's a huge issue. Lots of work done internally that's invisible to the outside world. it was very hard to implement some of the first projects. It has mostly gotten easier, but still needs tweaks. Like codes for parking lots layout – screening requirements, vegetation requirements, and so on, so the code is changed slowly but surely to make those overlap. So you get credit for choosing plants for screening and stormwater management. It sounds like a no-brainer.]

Madhuri 3/5/12 4:40 PM  
**Comment:** Lots of permitting changes and still continuing incrementally

Madhuri 3/5/12 4:41 PM  
**Comment:** Work [permitting] still needs tweaks

Madhuri 3/5/12 4:42 PM  
**Comment:** Codes and requirements change slowly but surely

**Q4-1: How Portland overcame the cost of implementing green infrastructure?**

**A4-1: H –** [It's a big issue. The first few projects were test projects and that's how we started. Then it's more of a standard practice now in some parts of town. To be frank, replacing the sewer system is so expensive that green streets (more expensive than swales) was still cheap, compared to the alternative of replacing pipe systems. In a combined sewer area, it would be expensive. We benefitted from efficiency – we package up to 70 green streets in single contracts. This is in the combined sewer area. Cost is definitely a consideration. There will be some areas where the pipe-work will be cheaper so we'll do pipes there. **We aren't just carpeting the city with these things – it's in targeted areas which have a need for them.** We're doing it for multiple benefits now – we're upgrading intersections so they're more pedestrian friendly. [There are utility lines and those become expensive to work around. Avoid certain locations to reduce cost. The challenge is to put the green street where the stormwater goes – near a low spot in an inlet. Dealing with existing infrastructure can make things costlier.]

Madhuri 3/5/12 4:42 PM  
**Comment:** Tests, then standard

Madhuri 3/5/12 4:43 PM  
**Comment:** Green cheaper than pipe replacement

Madhuri 3/5/12 4:43 PM  
**Comment:** Targeted areas have green

Madhuri 3/5/12 4:44 PM  
**Comment:** Multiple benefits

Madhuri 3/5/12 4:45 PM  
**Comment:** Avoid certain areas for cost

Madhuri 3/5/12 4:45 PM  
**Comment:** Put green where necessary

**Q4-2: Were there differing opinions of any city council members or mayors? Did some people not favor it?**

**A4-2: E** – There wasn't any roadblock in terms of the political support, which is why we've achieved what we have.

**H:** They're trusting us to do it where it makes sense and not do it where it doesn't make sense.

**E:** There was a lot in the beginning on the CSO issue. There was a lot of freedom to try different things that were looking at cost-effective approaches. They trusted us to see what might be possible. Green-streets were so new (8 years ago), and our own engineering folks were not on board – they were skeptical for obvious reasons because it was new. What we did was just try it. That was our approach. Monitor it to see if it is working – looking at function, infiltration, and design of facility. Through the monitoring, we came up with the numbers and evidence that they are effective and working, and so 8 years later, that's how we're doing business. We start with small demonstration projects and added more to the palette and went more broad scale. It's part of how we address our pipe systems. We've shown it's cost effective. In our Taber to the River program, we're putting in 70 greenstreets at a time, so that's major. **We didn't get there overnight.**

Madhuri 3/5/12 4:46 PM  
**Comment:** Trust from city and freedom to try new things

Madhuri 3/5/12 4:47 PM  
**Comment:** Engineers skeptical of new approach

Madhuri 3/5/12 4:47 PM  
**Comment:** Proof of effectiveness through monitoring

**H:** The first facility was put in 8 years ago. And there's a legitimate question about long-term maintenance. And what inputs they will need over time. We're active about getting data. We have a large maintenance budget – it's between \$4-500,000 a year. It's important to bring home data. **We look at the life-cycle cost for the pipe and green systems. Sometimes it works out in favor of the green systems and sometimes the pipes are cheaper. There's a big life-cycle cost analysis being done. We're not carpeting the city – we're targeting areas which make sense cost-wise. And they have to do the job adequately.** Sometimes we'll plan for green streets and put them in our computer models, which don't sometimes fix the problem. **There's a sophisticated nuisance analysis about where they go. Sometimes people think we're putting them everywhere in the city, and that's not true.**

Madhuri 3/5/12 4:48 PM  
**Comment:** Started small demonstrated projects and then broad scale

Madhuri 3/5/12 4:48 PM  
**Comment:** Important to get data

**Q5: Are there specific requirements for implementing stormwater management? – Physical space, size of city, and so on. Do you have numbers? Thresholds?**

**A5: E-** Yes – that's spelled out in the stormwater management manual. So there's a big calculation that uses a design storm event particular to Portland and depending on the storm event and the size of the drainage area, and what type of technique you're using, will determine what size stormwater facility you put in. For example, if you wanted to put in a swale for runoff from a parking lot, then it would be like 9% of the drainage area. And that's for a swale. For a planter with a flat bottom (more area), then it would be 6% of the sizing area. Then it also depends on soil infiltration. We have in our manual this sizing calculation. You plug in some numbers and the soil infiltration rate. That is the guidance for how much area you need.

**H:** It's very city to city – specific to different locations and their rainfall regimes and type of soil.

**E:** For us, we have small storm events. Others might get big rainfall at a time, so they might have different sizing requirements. Ours is particular to our area.

Madhuri 3/5/12 4:49 PM  
**Comment:** Life-cycle cost analysis for green infrastructure to place in appropriate areas

Madhuri 3/5/12 4:51 PM  
**Comment:** Manual shows specific calculations and formulas

Madhuri 3/5/12 4:52 PM  
**Comment:** Areas will have different calculations (soil, rainfall)

**Q6: I've only read about good things in using green infrastructure. Can you tell me some negatives or drawbacks of the strategies?**

**A6: E** – First thing that comes to mind is for our green streets. Perception. Sometimes the public may not perceive them as a good thing. When you're putting them in front of their home and it's

going to take away a parking space, they see it as a tradeoff that they're not supportive of. Usually we place them at cornerlots so these homes still have ample parking. You can't please everybody, but people are supportive for the most part. I have a list of over 200 people calling and asking about green streets. It's indicative that people like it.

**H:** The east side of the city have good soils, but not the west. The west have a liner – fabric or concrete, and these areas have a pervious pipe at the bottom. It's like a big green sponge. We get what we need to control peaks of storms – sock absorbers. They're expansive and we get fewer benefits from this side than the other where there are better soils. So cost becomes an issue if you have to line them. Maintenance is still being learned. It's a work in progress. What will they look like in 10-20 years? What will be needed? We assume we might need to replace parts of soil and plants in 30 years because of the acumination of pollutants, debris, and sediment. We're building that in our projections. All jurisdictions are strapped for maintenance dollars. Even if it works, we've shown it's cheaper in the long run. But do we have the money 5 years down the road? We have lots of maintenance work to do, but adding it right now is a tough sell.

**E:** Inviting the public to participate in the care of green streets might help reduce some cost and time for the facilities.... When we can show that you can save money by using green over gray, then it's a good selling point which is why more developers are adopting it.

**H:** They'll do what we do – look at options. Sometimes the green is clearly less expensive, and sometimes it's not.

### **Q6: What advice do you have for other cities that want to implement green infrastructure strategies?**

**A6: E –** Start out small. Get a demonstration project or two and monitor them. See how they're working their particular area and then move up and expand on that. Perhaps it's possible to combine it with some other street projects to get the “bang for the buck.” Also, you need to work with your partners, internal and external. We put a lot of effort into our community outreach and education for the public, so that's why we were successful as well, particularly for our first green streets. We worked with the adjacent neighbors to make sure they were supportive. And we went as far as to say if it doesn't work, we can repave it. It's important to tell them what's going on and share all the benefits of this. Answer their question or concerns.

**H:** We've seen other cities stumble with that. We were allowed to spend more resources on the outreach necessary. We've seen other cities have trouble with it with the public not react as well to implement green streets. We have strong neighborhood organizations here. The outreach is important. And permitting.

**E:** We have some policies to get the support – our mayor and government signed off on the policy and approved it and said this is important to us. Start out small, monitor them, combine with other projects if possible, and expanding from there.

**H:** We didn't do this over night. We did not jump into it. We stepped into it slowly. Don't do large contacts without testing the idea. There's a lot of things to consider and learn. We had to refine how we tested the soil, inlets and outlets – the whole design has been updated over the years.

**E:** Some jurisdiction don't have a separate jurisdiction for stormwater, so that could be more difficult to get everyone on board.

**H:** We have a flow of incoming revenue that's directed specifically towards these kinds of

Madhuri 3/5/12 4:52 PM

**Comment:** Negative: Perception

Madhuri 3/5/12 4:53 PM

**Comment:** Negative: Cost and maintenance

Madhuri 3/5/12 4:54 PM

**Comment:** Look at options: sometimes green is less expensive

Madhuri 3/5/12 4:54 PM

**Comment:** Start small (monitor demonstration project)

Madhuri 3/5/12 4:54 PM

**Comment:** Combine with other projects

Madhuri 3/5/12 4:55 PM

**Comment:** Work with internal and external partners

Madhuri 3/5/12 4:55 PM

**Comment:** Community outreach/education

Madhuri 3/5/12 4:55 PM

**Comment:** Some struggle, but outreach is really important with strong neighborhood organizations

Madhuri 3/5/12 4:56 PM

**Comment:** Start small and expand

Madhuri 3/5/12 4:56 PM

**Comment:** Did not do it overnight – work slowly

activities as opposed to the general fund where you compete from the same pot. We were ahead of the game by having separate utilities.

Madhuri 3/5/12 4:56 PM  
**Comment:** Direct flow of revenue for this specific activity

**Q6a: So would a separate department be beneficial to different cities?**

**A6a: H** – Generally there are separate Public Works departments, but we’re saying that if you don’t have a stormwater utility, it could be difficult to get these kinds of programs going.

**A6a E:** That would be interesting to find out if you talk to other jurisdictions that don’t have a separate stormwater utility – are they having difficulty because of that?

**Other:** Plenty of cities are doing this kind of work.

**Interview 4: Roberta Jortner and Shannon Buono  
Bureau of Planning and Sustainability  
February 15, 2012, 5:00 pm – 5:54 pm**

**Q1: Do the Comprehensive Plans and Zoning Codes mention anything about retrofitting developments? And if not, then why are there existing bioswales and wetlands in the city?**

**A1: R** – What do you mean by wetlands? Natural wetlands? Constructed wetlands or both? Green infrastructure here, for context, is natural systems as a whole. If you think about streams, wetlands, and trees and ecoroofs and bioswales and constructed facilities that there’s a continuum there. There may be policies and codes for some parts of the green infrastructure system and not others. My take is that the Comprehensive Plan at this time doesn’t specifically refer to green infrastructure. Our comprehensive plan is 20+ years old and we’re updating it right now to update policies to address green infrastructure. In terms of the zoning codes, all developments that trigger stormwater more than 500 square feet is subject to the city’s stormwater management manual, which promotes bioswales – easier to get through system if you have certain facilities. So while the zoning code doesn’t specifically lay out stormwater requirements, the specifications of those are required.

Madhuri 3/5/12 4:58 PM  
**Comment:** Old Comp Plan doesn’t refer to green infrastructure

**S:** In terms of the zoning code and retrofitting, we have a chapter that deals with upgrading development that is currently not conforming with zoning code requirements – such as stormwater management in parking lots. The development needs to meet the stormwater management manual. Land divisions – if you are dividing the land for subdivision, you have to meet the stormwater management manual for the whole site – more for new developments not retrofitting.

Madhuri 3/5/12 4:58 PM  
**Comment:** Zoning code – manual for requirements

**Q1a: So the land divisions is for the new developments?**

**A1a: S**-Well, people are typically dividing land for houses, although there could be an oversized lots. But all the street systems would have to have stormwater facilities and the management manual promotes green infrastructure.

Madhuri 3/5/12 4:59 PM  
**Comment:** Upgraded developments and land divisions need to meet manual requirements

**Q1b: Is the manual referred to in the Comprehensive Plan or the code?**

**A1b: S**- It’s referred to in land division regulations in the zoning code. You have to meet all the requirements, and it directs you to show with your application that you are meeting the requirements for the stormwater and sanitary system and the rights of way. I don’t think the stormwater management manual is referred to in the comprehensive plan, but is in the nonconforming upgrade chapter. It might be in the environmental chapter for sure. So yeah, the zoning code refers to it.

Madhuri 3/5/12 5:26 PM  
**Comment:** Zoning code refers to manual

**R:** It's easier to institute these facilities in new developments than to retrofit old developments where it wasn't designed to have bioswales. So how you retrofit a city that's already mature is a good thing to think about. In the environmental zoning chapter in the zoning code, we did make some changes a few years ago to address development on already developed sites where there's expansion or redevelopment. Those already disturbed sites have a streamlined process for developments that did certain things to improve conditions on their site. The applicants could choose from a menu and one of the items included removing impervious areas and to improve environmental conditions. That was specifically geared towards enhancing existing sites. Other options were to remove invasive plants and such. We called that our site enhancement option or standards.

Madhuri 3/5/12 5:27 PM

**Comment:** Easier for new development that retrofit

**S:** When you say retrofitting developments, are you thinking about private development? Some of what happens is retrofitting rights of ways with stormwater, but they are not regulated by the zoning code or the comprehensive plan, but they do have to meet the stormwater management manual when they are fixing a street, and often doing it with green infrastructure is what happens.

Madhuri 3/5/12 5:29 PM

**Comment:** Development on pre-developed sites to enhance site

**Q1c: What are the rights of ways regulated by?**

**A1c: S** – By the bureau of transportation.

**R:** There are some parts of the city where rights of ways make up 40-50% of the land, so the city is investing a tremendous amount of resources and effort to install green street facilities to pick up the runoff from streets and adjacent properties. That's our biggest initiative and it's not regulated by the zoning code at all.

Madhuri 3/5/12 5:29 PM

**Comment:** Right of ways are not regulated by code or Com Plan, but do have to meet manual requirements

**Q1d: Can you talk more about the green streets initiatives?**

**A1d: R** – BES is responsible for the stormwater management program and they're a capital bureau who develop and maintain these projects. The facilities typically are like swales in the streets and they build out from the curb and they are designed to take drainage from the streets and filter/clean it to either infiltrate it into ground or into some other facility. Some of them have trees, some don't. The relationship to the adjacent property owner, neighborhood support, do they help take care of it? Adopt a swale? It's all under discussion. It's an opportunity and challenge how the city would work with the neighborhood because it's right in front of people's property. It can serve other purposes like traffic calming. Some people like them some people don't.

Madhuri 3/5/12 5:30 PM

**Comment:** City invests lots of resources in rights of ways

Madhuri 3/5/12 5:31 PM

**Comment:** BES maintains stormwater programs

**Q1e: When the comprehensive plan will be updated, will there be anything that talks about bioswales or wetlands or anything green infrastructure related?**

**A1e: S** – Yes, I don't think there would be anything about bioswales particularly, but there will be policies related to green infrastructure, and not just keeping it specific to stormwater management, but also ecoroofs and green walls and designing buildings with green infrastructure. Design with nature. And stormwater management is integral. The policy won't be focused only on stormwater management.

Madhuri 3/5/12 5:31 PM

**Comment:** Question about who takes care of swales is under discussion

**R:** Specify wetlands for constructed or stormwater wetlands. Oregon law requires inventory on wetlands and protecting them. I think of the wetland systems as watershed health. there aren't that many constructed wetlands here, frankly. Some help with hydrology. There's detention ponds and some have wetland-like characteristics. There's some wetlands that are partially constructed. Just define wetlands. In terms of green infrastructure initiatives, there will be more attention on

Madhuri 3/5/12 5:32 PM

**Comment:** Updated comprehensive plan will have general green infrastructure policies

Madhuri 3/5/12 5:33 PM

**Comment:** Define wetlands

bioswales, ecoroofs, and greenstreets than there are on wetlands – they take a lot of maintenance and a lot of room. There may be other places that do more wetland construction.

Madhuri 3/5/12 5:33 PM

**Comment:** Focus not much on wetlands, but on swales, ecoroofs, and greenstreets

**Q2: Are there factors besides policies that make the green infrastructure possible? Maybe such as strong leaders or active citizens?**

**A2: R** – The answer is definitely yes. The leadership and the community usually come ahead of the policies. And the technology does too, sometimes. We have in the last 10-15 years, some strong leadership and push towards green infrastructure, partly by a combined sewer overflow. We have an old sewer system that was sending sanitary waste in the Willamette River, and we were in a state order to fix the system. It was expensive to go to the big pipes, so we thought what other things can we do? What are the ways to do that that also makes neighborhoods prettier and is more green in the system and might be more cheaper to maintain? We had a couple of city councilmembers who have been active and our mayor who went behind a 5 year initiative to invest a lot in a lot of areas, including green infrastructure. Generally, the community tends to support features that add vegetation and greenery to their neighborhoods.

Madhuri 3/5/12 5:34 PM

**Comment:** Leadership and community are even important than policies

**S** – Some of the creek watersheds in Portland (TMDLs: Total Mass on Daily Loads) also played a role. In the same way we were regulated in the Willamette River and the quality of the water, it was also the major creeks and cleaning the water before it gets there in a way that doesn't require a lot of gray infrastructure.

Madhuri 3/5/12 5:35 PM

**Comment:** Strong, active leadership from city councilmembers and mayor

Madhuri 3/5/12 5:35 PM

**Comment:** Community support for vegetation

**Q3: What is the approval process for green infrastructure? Did a new system have to be created for these newer projects?**

**A3: R** – The BES has to sign off on land use reviews and development permits for the projects to make sure they meet requirements. But the stormwater management manual has evolved. This is a cultural change for the engineers in the city who had to educate themselves and other financing issues. Putting a pipe in the ground is typical with 30 year bonds, but once vegetation is introduced, it's different. The city recently decided it could include trees that are in the greenstreet facilities and we could use capital dollars or bond money for trees. That's a new thing. So in some ways, there are new components. Sometimes changed and somethings didn't. But culturally it's a different way of looking at how to manage water running off the landscape.

Madhuri 3/5/12 5:37 PM

**Comment:** BES reviews permits to ensure meeting requirement

**S** – But they didn't have to create a new approval system, per say, from scratch for approval. They became part of a development plan or a land use review that went through an existing process.

Madhuri 3/5/12 5:37 PM

**Comment:** Cultural change for engineers of green versus pipes

**R** – The stormwater management manual has a process that rewards people who uses these facilities by having a simpler permitting approach.

Madhuri 3/5/12 5:38 PM

**Comment:** No new approval system – added part of system

Madhuri 3/5/12 5:38 PM

**Comment:** Simper permitting as reward for green facilities

**Q4-1: How did Portland overcome the cost of implementation if there were major costs?**

**Q4-1: R** – Talk to BES about the cost issue for sure. They're the ones dealing with the cost. I think cost is always an issue, and there are issues with this too as other infrastructure. In terms of encouraging people to use these, the city has some incentives such as disconnecting downspouts so they don't go into the streets and the sewer system. Instead, the water from the roofs would go onto the lawn and infiltrate. The city essentially paid people to do that as part of the combined sewer overflow saga. There are bonuses - Floor Area Bonuses. There's a rebate on your stormwater bill if you plant trees. It's a temporary program, but it's called "Treebate" to encourage people to plant trees which are also part of stormwater green infrastructure.

Madhuri 3/5/12 5:39 PM

**Comment:** Cost is always an issue

**S:** In terms of land divisions, one of the ways to make it feasible to incorporate detention ponds

Madhuri 3/5/12 5:40 PM

**Comment:** Incentives: disconnecting downspouts payments, FAR bonuses, rebates on planting trees

or other green stormwater systems is to allow people to cluster their lots in a smaller – make the lots smaller to not lose density. You do your stormwater swale, but you still get the same number of lots to sell. It's called clustering the developments, and that's once incentive we have provided to not make it more costly.

Madhuri 3/5/12 5:41 PM  
**Comment:** Clustering lots in developments to allow for green systems

**Q4-2: What about costs of long term maintenance?**

**A4-2: R-** Talk to BES and ask about what the city would incur relative to other facilities and what they know about private maintenance costs for developers.

**A4-2: S-** Anecdotally, it is not uncommon that the land divisions have a bioswales, so people are not choosing gray sewer systems for their stormwater management. I'm assuming it can't be more costly because everybody does it.

**R-** City's stormwater requirements address quantity and quality. So people have to figure out how to regulate what runs off the site, but they also have to have facilities that clean the water too. There's a difference in residential and commercial areas because they both need to consider the manual requirements. Eco roofs and planters are becoming common for people to put water so they can meet landscaping requirements which can regulate flow can clean the water. Cities need to work with the fact that there have to be different approaches in different places. You can't do the same thing in a wet, hilly area versus another part of the city. There has to be flexibility in how we use these things.

Madhuri 3/5/12 5:42 PM  
**Comment:** Stormwater requirements address quantity and quality

Madhuri 3/5/12 5:43 PM  
**Comment:** Flexibility on location

**Q4-3: Were there any rights of way issues or private property issues that the city had to overcome?**

**Q4-3: S-** Green streets initiatives is a joint effort between environmental services and transportation. There are issues now with the idea of bioswales and planters and designing streets that way. Engineers were very traditional in their thinking and didn't want to make the lanes narrower or lose parking spaces. It didn't fit into their thinking. But with political leadership and some amount of a regulatory requirement in the case of our combined sewer overflow and TMDLs, they combined to pressure the traditional thinking in that bureau to overcome that. The more often a street got built with that and it worked, you eroded that hesitation of holding on to traditional "brick and mortar" type design and engineering.

Madhuri 3/5/12 5:44 PM  
**Comment:** Engineers had traditional thinking

Madhuri 3/7/12 5:33 PM  
**Comment:** Political leadership and requirement forced change in traditional thinking

**R:** There's still an issue. There's still resistance within the city. There are pros and cons. None of these things are issues. You talked about maintenance. The biggest challenge for all infrastructure is maintenance and how do you maintain over time. the bureaus who are facing budget cuts are hesitant to take on anything new because there's a learning curve and because the maintenance might be different, so it's still evolving.

Madhuri 3/5/12 5:45 PM  
**Comment:** Working results challenged traditional thinking

**S:** Sometimes time is the issue.

Madhuri 3/5/12 5:45 PM  
**Comment:** Maintenance is an issue

**R:** The more examples you have of things that work, then things tip and things become more mainstream.

Madhuri 3/5/12 5:45 PM  
**Comment:** Time is an issue

**S:** It didn't happen organically, I think. It did require leadership.

Madhuri 3/5/12 5:45 PM  
**Comment:** Examples and leadership can help

**Q4-3a: If there's a city that want to do green infrastructure and stormwater management but they have problems with their budget, is there anything they can do or would they have to wait for experiments?**

**Q4-3a: R-** Things don't happen overnight unless it's forced. Cities that are heading in this direction likely will have to take the time for people to get comfortable with it. People have to adapt. Things aren't necessarily applicable in all situations. All cities are facing budget cuts, but I

would show cost effective examples to make changes and it won't cost more. You might have to learn to do things in a slightly different way. Show examples and cultivate advocates. Once it's out there, then people can see it's interesting.

Madhuri 3/5/12 5:46 PM  
**Comment:** Show examples and allow people to adapt

**Q5: Are there any specific requirements for implementing stormwater management? Like maybe physical space or climate or amount of precipitation. Is it in the manual?**

**A5: R-** There are formulas in there about impervious areas, slopes, receding water bodies. And there's also requirements relating to the design storm, so it's a storm frequency. So you're building a swale or pipe that would take a certain intensity or duration into account. Our storm patterns may change because of climate change. More specifics are in the manual.

Madhuri 3/5/12 5:47 PM  
**Comment:** Specific requirements in manual (design storm and frequency)

**Q6: What advice do you have for other cities that want to implement these strategies?**

**A6: S-** Cultivate a political leader and maybe even citizen activists that will pressure on the leaders, and if there is a receptive leader who can champion that cause.

Madhuri 3/5/12 5:48 PM  
**Comment:** Cultivate political leaders and active citizens

**R:** Along with that is developers. If you can have one or two top notch developers who are willing to do a development or two as a showcase, it can make a big difference. They would be like a kick-off. People always watch their competitors, and if they are doing well and are cost-effective and good press, then others will want to do it too.

Madhuri 3/5/12 5:48 PM  
**Comment:** Top-notch developers to do showcase

**S:** This often happens around transit, but take your city on tours and talk to the people there that have made it work, and figure out how they did it. We can't tell you all the tools right now, but take the leaders on a field-trip to see and hear about how things started.

Madhuri 3/5/12 5:48 PM  
**Comment:** Take city on tours/field-trips

**R:** On the policy end, recognize the impact of impervious area on watershed health and the cost of dealing with stormwater and human health impact (flooding), and the policies that call for urban design and site design that mimic natural processes. **It costs less with trees than pipes to create a landscape that behaves more like an undeveloped landscaped.** Nature does a good job of keeping things clean and not flooding more than they are supposed to. The other thing is incentives. Even small financial incentives can make a big difference sometimes. From the development end, the biggest concern is certainty. Developers want certainty and don't want to spend too much time, and if you can tell people that they can go through permitting fast doing these types of things, then if reviews go more quickly, it can be a powerful tool.

Madhuri 3/5/12 5:49 PM  
**Comment:** Mimic nature

**S:** Public outreach to introduce people and neighborhoods to the green infrastructure in a way that they can comprehend them. We're not asking you to maintain them, but it's super easy. It got everybody thinking.

Madhuri 3/5/12 5:50 PM  
**Comment:** Incentives – providing certainty to developers

Madhuri 3/5/12 5:50 PM  
**Comment:** Public outreach

**Q7: Portland is unique in terms of the fact that the city HAD to do this, but other cities won't have specific stormwater manuals, so what would you recommend for a city like that in terms of the comprehensive plans and codes to encourage green infrastructure?**

**A7: R-** Policies that elevate the importance of clean water, clean ground water, and design that supports dealing with stormwater as close to the source as possible. That's important. Ultimately, the clean water act requires cities to have a stormwater management plan. And they do differ. But ultimately, most cities have to have some plan to manage their stormwater. Usually they will have specifications even if not a specific manual. You can use land use tools to look at how sites are designed and to make sure there's room for stuff like setbacks and limits on building coverage limits, so in the Comp Plan, we will look at if it's sufficient. Should we look for other coverage limits? We want to look at land use and zoning and policies to get to cleaner, better

Madhuri 3/5/12 5:51 PM  
**Comment:** Policies should elevate importance of clean water close to source

management of stormwater. Ultimately, you need to have something like a stormwater management manual because people have to know what they are expected to build.

Madhuri 3/5/12 5:52 PM  
**Comment:** Use land use tools to have adequate room for green  
Madhuri 3/5/12 5:52 PM  
**Comment:** Need manual for expectations

**Q7a: I agree that a manual is needed. But that's referred to in the comprehensive plans too, right?**

**A7a: R-** Our Comprehensive Plan focuses on broad policies and objectives and doesn't get into specific implementing tools. It wouldn't tell people you have to do green infrastructure, but more like what's the objective? The objective is to manage stormwater in a way that protects rivers and streams, that keeps them clean, and protects public health, and here's the biggy: one of the policies that we need to put into the Comprehensive Plan that we don't have now is that stormwater should be managed in a manner that meets multiple objectives. In other words, if you put water into a pipe, that doesn't improve your neighborhood livability, it doesn't provide shade like a tree. If we're looking at stormwater that meets multiple objectives, it provides habitats. Then you look at facilities that are green because they do meet multiple objectives. One of the policies we should look at is mimicking natural processes and meeting multiple objectives for social, economic, and environmental - triple bottom line for sustainability.

Madhuri 3/5/12 5:53 PM  
**Comment:** Have broad objectives in Comprehensive Plan for stormwater management

**Other:** Innovative street design with stormwater as part of a holistic main street site by Jay Sugnet. You have a good cross-section of folks. Do you think there's an angle you're missing? Transportation? It would be illuminating to get the transportation perspective. Her name is Courtney Duke. Have you spoken to the Bureau of Developmental Services? That might be an interesting discussion.

Madhuri 3/5/12 5:54 PM  
**Comment:** Have policy that meets multiple objectives

**Interview 5: Dawn Uchiyama**  
**Stormwater Management Manual**  
**February 17, 2012, 3:30 pm – 4:10 pm**

**Q1: Do the Comprehensive Plans and Zoning Codes specifically mention anything about retrofitting developments? And if it doesn't, then why are there existing urban bioswales and wetlands?**

**A1:** When you say wetlands, you mean a stormwater facility. So, Portland's comprehensive plan is really old. I believe it was last updated in 1989 or in the early 90s, so our Comp Plan does not talk about retrofitting. It is going through an update process and we anticipate it will say some things about retrofitting, but currently it does not at all. The zoning code is relatively silent on it as well, but our stormwater manual is an administrative rule that supports the zoning code, so our manual is part of the zoning code and is implemented as a result of that, but it just says that the BES is responsible for managing stormwater, and ensuring that private property and public right of way adhere to the requirements of the "slim." We refer to the manual as the "slim." So there is one other reference I know of - the nonconforming use in Title 33 where existing land uses are forced to make some mandatory upgrades, and there's a list of things they can do and stormwater retrofits are one of the things they can do. Other than the manual, which is an administrative rule, the zoning code really does not talk much about retrofitting. And the term retrofitting is worth defining. Our manual applies to the threshold of 500 sq. ft of new impervious area. So if you had a building and you tore it down and put a parking lot there, we consider that redevelopment. The manual would apply. Even though it was impervious before, if you build new impervious, the

Madhuri 3/5/12 5:54 PM  
**Comment:** Comp Plan is old and doesn't mention retrofitting

Madhuri 3/5/12 5:55 PM  
**Comment:** Manual is part of zoning code

manual does apply. So anytime you put new structure or new pavement over 500 sq. feet, you have to use the stormwater manual.

Madhuri 3/5/12 5:56 PM  
**Comment:** Manual needed with over 500 sq ft development

**Q1a: So the manual only applies to new developments? Not retrofits?**

**A1a:** We consider new development the same as retrofit. You might call it retrofit, we call it redevelopment. When someone comes in to redevelop a site that's already developed, we will apply the manual. If there's just doing it on their own to change the site and not creating new impervious area, then we wouldn't require it.

**Q2: Are there factors besides policies that makes the green infrastructure possible? Like strong leaders, citizens, or grants?**

**A2:** It's definitely strong leaders and planning department, absolutely. Our city government has roles and responsibilities divided among several bureaus – we have a transportation bureau, planning bureau, and so forth. Environmental services is responsible for sanitary and stormwater and within our bureau we have planning and so on. We've had very strong leaders in our bureau who have advocated for this and made the case for city council and leaders above our own bureau. Portland is also amazing in terms of citizen activism and volunteerism and environmentalism. It's a hub of activity and concern and people really pride themselves on doing things differently in Portland. It's not like citizens came to the table and said "we want stormwater management, but they did say "I love the green space and I want them protected, and when you build I want them enhanced" and those kinds of things. So the citizens were definitely an active part of the conversation. I have not run into too many concerned developers although we have a few, but it's not a driver. And then we did get a grant from the EPA probably close to 17 years ago that allowed us to do ten or a dozen pilot projects where we looked at managing stormwater on site. We retrofitted parking lots and explored some ideas. That grant money from the EPA was a very important catalyst. But it was a long time ago. It was close to 20 years ago.

Madhuri 3/5/12 5:56 PM  
**Comment:** Strong leaders and department advocacy

Madhuri 3/5/12 5:57 PM  
**Comment:** Active citizens

Madhuri 3/5/12 5:57 PM  
**Comment:** Some concerned developers, but not a driver

Madhuri 3/5/12 5:57 PM  
**Comment:** EPA grant money: catalyst

**Q3: What is the approval process for green infrastructure? Did a new system have to be created?**

**A3:** Yeah, definitely. So before when you developed, you had to have a conveyance system to carry the water away – you didn't have to treat it in any way at all. The approval process before the manual was to show a catchbase in order to implement what you're referring to the green infrastructure. We had to create the stormwater manual, so we had to tell people what to design and come up with standards for water quality treatment and then we had to create groups that would do that review for those reviews in land use and building permit and the public right of way. So there are three different groups that review for these green pieces of infrastructure. So yes, a whole new system had to be created. It was basically added on because there was always something that made sure that the water was put away somewhere safely. We always did that. But to treat it before it was discharged was the new part.

Madhuri 3/5/12 10:42 PM  
**Comment:** New system created for treated discharge

**Q3a: I've heard of the manual several times through different people I've spoken to. Who exactly created the manual and how did they know what the different requirements are?**

**A3a:** The first manual was adopted in 1999 and we had a stormwater advisory committee and there were many, many, many people involved. BES staff, engineers in the private sector, and stakeholders from the park bureau, the water bureau, and the transportation bureau. So it was by committee that the first manual was put together. And it's been updated now 4 times. We're

Madhuri 3/5/12 10:42 PM  
**Comment:** Manual created in 1999 with advisory committee

using the 2008 version which is the 4<sup>th</sup> revision. I'm the program manager for that. The last revision was also with a team of people. So every time we've updated, it's with a team of people. A rather large team of people. It's been in place for over a decade and we're on our 4<sup>th</sup> version. And we basically had to make it up as we went. There really weren't any reference points for us. We were blazing new ground. So it was painful. There were a lot of lessons learned, and there still are, for that matter.

Madhuri 3/5/12 5:59 PM

**Comment:** Committee included large team of people

**Q4: So the specific numbers in the manual – detailed physical requirements and levels of perception – so how did those numbers start? Is that where the experiments come in?**

**A4:** Yeah, we had our pilot projects to refer to, but we borrowed from a lot of different disciplines and different sources. We had some experience with dry wells, so we knew putting water into the ground was not a new idea. We had people who had experience in engineering ponds and more traditional stormwater devices, so there was information there. There was some preliminary information about water moving through a grassy swales (the first facilities), so engineers and scientists came and agreed on how much treatment the water received and how much time it needed to be in the swale to get the treatment. Just teams of people with different backgrounds coming together to agree. And when all said and done with the technical people, there's the "is this going to work?" question. If the technical requirements seem bigger than realistic goals, then you have to taper them back so they can be realistic. So there was some give and take before the final numbers were agreed to. But it is based on engineering and science that was available to us at the time.

Madhuri 3/5/12 6:00 PM

**Comment:** Specific numbers from pilot projects and different disciplines

Madhuri 3/5/12 6:00 PM

**Comment:** Be technical, but realistic

Madhuri 3/5/12 6:00 PM

**Comment:** Numbers from engineering and science

**Q4-1: How did Portland overcome cost of implementation? Were there any financial incentives?**

**A4-1:** Because it's a requirement, there was a cost for us to put the manual together, but really in terms of building swales and planters and basins and other facilities, it happens with new and redevelopment, so it's not like we had to pay for that. It's people who are developing that have to pay. Although we've had the combined sewer system where sanitary and sewer waters are comingled, and we had a regulatory requirement because when it rained, we would overflow the combined sewage into the river. So we had a regulatory requirement that dictated us to stop those combined sewer overflows. So for the past twenty years, our bureau has been building pipes and interceptors and doing huge public infrastructure projects to stop those overflows. With that, we've had to get as much stormwater out of the system as possible, so we were very motivated to find other places for the stormwater to go because we didn't have enough room in our pipes to capture everything. So I would say the combined sewer system was definitely a regulatory driver. It forced us to look at things differently. We've certainly had other EPA funding and there weren't any huge incentive. I think we're just redirecting funds. A couple of years ago, we did something called gray to green and city council gave us one time money to invest in green infrastructure and mostly it was property acquisition and other things. That was probably the only – it was our money to begin with – but it was just redirected to focus on green infrastructure.

Madhuri 3/5/12 6:01 PM

**Comment:** Developers pay for implementation

Madhuri 3/5/12 6:01 PM

**Comment:** Combined sewer system was a regulatory driver that forced change

Madhuri 3/5/12 6:02 PM

**Comment:** EPA funding and redirecting funds

**Q4-2: How did Portland overcome long-term maintenance costs?**

**A4-2:** Well, we haven't. We haven't. It's still a problem. We're still limping along. We do the best we can with the resources we have, but it's definitely been more challenging. We've kind of jumped off the cliff and had them all built and we knew maintenance was going to be a problem

but we wanted this to happen so badly we didn't really want to think about it until we got there. And now we're here, and we have 600-800 green streets now and it's very challenging to keep them maintained. So I don't think we've overcome that, and there's many questions about maintaining stormwater facilities. We are working with our state transportation agency, city transportation agency, the park bureau, and we go round and round on it – who's going to pay for this? So it's not easy, but it hasn't stopped us.

Madhuri 3/5/12 6:02 PM

**Comment:** Have not figured out maintenance costs

**Q4-2a: Even though it would cost money to maintain green infrastructure, it would still cost money to maintain gray pipes, right?**

Madhuri 3/5/12 6:03 PM

**Comment:** Discussions with other agencies about who will pay

**A4-2a:** Well, the pipe costs are less because they're underground and they have a certain lifecycle. They're not going to fail. You don't need to do anything with them for 20, 40, 50 years. But it's the damage to the environment that's costly. We have an endangered species act issue here with the salmon, and the stormwater that goes into the pipe goes into surface water where fish are impacted or habitat is impacted, so there are no maintenance for the pipe, but there are environmental costs that have costs.

Madhuri 3/5/12 6:03 PM

**Comment:** Pipe costs are less because they're underground and their lifecycle

Madhuri 3/5/12 6:03 PM

**Comment:** Costly environmental damage because of pipes

**Q4-3: How did Portland overcome lack of information on a new topic? The answer to that would be experimentation, but is there anything else?**

**A4-3:** It's a decade of hard work. it really was. We learned a lot of lessons. I think there were also some good examples of some good design, and those good design were often referenced that we could make it better or we could make this work or make it simpler. So I think it's important to get some successes and it requires good design and having good designers. And we still struggle with that. But good design is the answer to that. You build something that people might not even know as a stormwater facility; they just know that they love it and it makes the place look great and they're happy with it regardless of how it functions.

Madhuri 3/5/12 6:04 PM

**Comment:** Hard work and learning lessons along the way

Madhuri 3/5/12 6:04 PM

**Comment:** Good design is essential

**Q4-4: Did the city have to overcome right-of-way issues?**

**A4-4:** Absolutely. Both right of way and public property. It really comes down to a real state issue. We're asking people to set aside land for stormwater. In parts of Portland, the right of way is very limited. On paper it might be wide enough, but the topography is such that it's difficult to fit a swale or planter. So limited land is always an issue, and on private property it's the same thing.

Madhuri 3/5/12 6:05 PM

**Comment:** Right of way issue is real estate issue

**Q4-4a: So how is it overcome? Because a lot of bioswales are still on the roadside, right?**

**A4-4a:** Yeah, but when they don't fit, we're at an impasse. So it works where we can fit it in, which is maybe 50% of the time or something. But where we can't fit it in, we wrangle until we can find a solution for everyone. It can sometimes be complicated. So it's harder when you're in a community that's already built out. Portland has an urban growth boundary, and within that contained growth, most of the land has already been built on. So to go back and find spaces to find is really difficult. If it hasn't already been preserved it's hard to get it now. This is common sense, but it's easier and best to do it before a community develops.

Madhuri 3/5/12 6:05 PM

**Comment:** Swales work when they fit

Madhuri 3/5/12 6:06 PM

**Comment:** Hard to find solution when land is already built

Madhuri 3/5/12 6:06 PM

**Comment:** Easier process before community develops

**Q4-5: Were there any differing opinions of key players or stakeholders? I know that the leaders agreed that green infrastructure was a good idea, but were there some people that didn't like that idea?**

**A4-5:** Sure, yeah. And we battle it out over time and there's still people who disagree and don't

agree with it, but they're the minority. So we've just overcome those concerns. I think it's gotten easier because we've proved that we can do it. In the beginning, it was really, really hard. So definitely a range of opinions.

Madhuri 3/5/12 6:07 PM

**Comment:** Easier to overcome differing opinions because method is proven

**Q5: The next question is probably more in the manual, but do you know if there's any specific requirements that stormwater management needs like minimum level of precipitation?**

**A5:** This is all in the manual. If you create over 500 square feet of impervious area, you have to build a stormwater management facility that is addressing both pollution prevention (water) and then it has to address the flow or the volume or detention. So we have two main requirements for our facilities. And in general, it's about 6% of your impervious area (building, parking lot, or lot). However much impervious area you create, you should plan on setting aside about 6% of your land to treat stormwater. And if you have good soils, if the water can soak up more, it could be slightly smaller, and if you have poor soils that don't soak up the water, it could be larger.

Madhuri 3/5/12 6:07 PM

**Comment:** Details in manual, but generally need green if area over 500 sq. ft.

Madhuri 3/5/12 6:07 PM

**Comment:** General rule: 6% green for built, but depends on soils

**Q6: Can you describe some recently retrofitted projects and what makes them successful?**

**A6:** "Retrofitted" happens every day with private property owners who are building or redeveloping – they have to retrofit the site. That's how we do business. So it's happening all the time. We have a project called "Taber to the River" and it's a whole drainage basin – like a pipe shed – it's a relatively big area. It was connected to our combined sewer program and there was interest in taking stormwater out of the combined sewer, so BES made a huge capital improvement to take the stormwater out of the combined sewer pipes and put them into green streets, so it's huge sections of towns that have green streets in residential areas. We had never done it at that scale before. So we do it every day. One lot at a time. Just chipping away at it. It's still pretty slow going. So this Taber to the River project was one of the first times that we looked at a whole drainage basin and said how much water do we need to get out of the combined sewer, and we did that with swales and planters and curb expansions. So that's pretty exciting.

Madhuri 3/5/12 6:09 PM

**Comment:** Taber to River: Large scale green street program

**Q7: In the many articles I went through it always talked about the benefits of green infrastructure and how it's so good. Only a few touched on some negatives. Can you expand on what you think are some negatives or drawbacks? Like maintenance?**

**A7:** Definitely. Maintenance was going to be my first one. I'm a landscape architect by training and my husband is too. And he works at a Japanese garden in Portland, and they invest a lot of money in maintaining it. And we care a lot about that place. I think there are just lessons to be learned. We say that maintenance is a problem, but when you really value something and you really care about it, it's a stewardship issue. And you just have to ask yourself where can you spend the money. What's my priority? So although maintenance is a problem now, in the long term, I hope it's something we overcome because these places are really valuable and they provide other benefits. I hope this is a short-term problem in figuring out how to do it. Portland is at tail-end of figuring out how to do it. I hope it's not a long-term setback or a negative. The only other thing, reverse of this maintenance issue – and not a drawback, is that we have limited dollars and aging infrastructure. We know there are other priorities that need to be funded. So it's often really hard to say to build new infrastructure when our gray infrastructure is falling apart. Even though we know that the green will do some of the gray's work and pick up some of the services that we need to provide. There are some compelling projects that we need to do that

Madhuri 3/5/12 10:46 PM

**Comment:** Maintenance is a big issue

Madhuri 3/5/12 6:09 PM

**Comment:** Maintenance is a stewardship issue; care for land is more important

compete with the green infrastructure dollars. Again, it's where you spend your money and what your priorities are. I wouldn't necessarily call that a drawback, but there are competing interests for the money, and it sometimes can make the conversation very difficult to move forward if you look at all your priorities and issues. Building green infrastructure might not come to the top. We're really lucky in Portland because our climate is mild and we get a lot of rain and it's heavily vegetated. People are used to a lot of vegetation and kind of expect it. I'm from Chicago, and it's completely different. People hate trees. They're messy and leave things in my car and driveway. People are funny about vegetation. Where in Oregon and west coast, nature is so much more dominant. People expect it to be green. So we have a little bit of an advantage. I mean other parts of the country do too (North Carolina and south). It's hard to identify the negatives!

Madhuri 3/7/12 6:23 PM  
**Comment:** Competing interests for spending money/priorities

Madhuri 3/5/12 6:11 PM  
**Comment:** Expectation of vegetation depends on US region

**Q8: What advice do you have for other cities that also want to implement green infrastructure strategies like bioswales and wetlands?**

**A8:** It's more universal advice, but these kinds of changes need to be done collaboratively and you need to build partners and it takes time. You have to be patient. You can't just snap your fingers and have it all come together. If you start an initiative like this, you have to be prepared for the long haul and you have to be able to work collaboratively. You can't force these things down anyone's throat. You need a lot of partners. That would be my biggest advice. I think now if I were at a community that wanted to do this, there's so many more examples. Do you homework and visit those other communities. Do your background research and do as much outreach and sharing that information as possible so people have an idea of what you're taking about.

Madhuri 3/5/12 6:11 PM  
**Comment:** Collaboration and necessity of partners

Madhuri 3/5/12 6:11 PM  
**Comment:** Be patient

Madhuri 3/5/12 6:11 PM  
**Comment:** Do background research and share information

**Q9: In terms of policy, maybe the Comp Plan and land use codes or ordinances, do you think would be helpful? Because Portland's a unique case where nothing's really stated in the Comprehensive Plan or the codes. It was forced in Portland because of the Clean Water Act, but other places wouldn't have that. How would they begin to put that in their codes so that gets built?**

**A9:** Planning is starting the comprehensive plan revision process and we're finding that our green infrastructure just has so many other city objectives, so planners want to piggyback and show the correlation between what we're doing and community livability and getting people out of their cars, exercising, and good transportation systems, and those kinds of things. It's important to see how different systems interact and in particular, the transportation system. You really need some strong allies on the transportation system. It's crucial. Because you're overlaying that green system on top of the transportation system or side-by-side. They need to be included in the planning. Parks is also another important piece of that. Parks and transportation need to work closely with the stormwater or infrastructure bureaus. That's the Comprehensive plan – where you bring all the layers together into one document/effort. In terms of land use codes and ordinance, there are model ordinances and model land use codes. It's amazing what we've accomplished because our land use codes are also very old and in different pieces. It's complicated. Our zoning code is huge. It takes someone a whole career to understand the ins and outs of it. So Portland doesn't really offer a model for that, and we bypassed it because of the manual that the code refers to. It was like avoiding hard work to get it into code.

Madhuri 3/7/12 6:30 PM  
**Comment:** Multiple city objectives

Madhuri 3/5/12 6:13 PM  
**Comment:** Parks, transportation, and infrastructure should work together

Madhuri 3/5/12 6:14 PM  
**Comment:** Bring everything together in Comp Plan

Madhuri 3/5/12 6:14 PM  
**Comment:** Use model codes and ordinances (Not Portland's)

**Q9a: Is the manual a policy or regulation?**

**A9a:** It's an administrative rule and there is policy in it and there's also design guidelines in it.

It's a funky arrangement. It's not typical. We have policy and design guidelines/standards all in one place. And we have a sewer design manual (technical document that compliments the manual). It's just the way Portland evolved that we do it this way. Other jurisdictions have stronger language in their codes and ordinances. We just didn't have to do it that way. Portland has strong landscape standards with screening requirements and landscaping. It would be good in Portland if we could integrate that with our stormwater requirements. So that's another place to see what's in the existing code (trees, buffering, screening). Lots of times those landscape requirements can be partnered with the stormwater requirements. Again, it becomes a matter of real estate. So any real estate that can be saved or set aside for this – the more the better. It's always tug of war and going back and forth on what the land will be used for.

Madhuri 3/5/12 6:15 PM

**Comment:** Manual is an administrative rule with design guidelines/standards

Madhuri 3/5/12 6:16 PM

**Comment:** Combine landscaping and stormwater requirements

**Q9b: How would a city make a good manual? Would they just all have to get together? It seems more effective to have a manual than the Comprehensive Plan and ordinances to actually make the stuff work. How would you begin the process of having a manual?**

**A9b:** Well you need an advisory committee with a wide range of stakeholders. Transportation, park people, plant people, soil people, geology, land use- wide range of people to weigh in. And on the private side, you need engineers, landscape architects to look at how it would fit in to existing development codes. It would need to fit in. There must be a couple of dozen stormwater manuals already. People call all the time and borrow Portland's stuff. We have an open policy to let people take whatever they want – photos, drawings, text. We always tell them if you make improvements, let us know so we can do it too. There are a lot of resources out there now. Consultants call me and want to build their manuals based on successful cities and what they've done. It's fairly common for people to put a manual together. In Oregon, Salem is our capital and Eugene is where the University of Oregon is – two fairly large cities right behind Portland in terms of development, and when they first launched their manual, they basically just took Portland's. They didn't even do anything - which I don't recommend because every place is different. And Eugene had some real problems as a result of just taking ours and not trying to fit it to their own needs. So I think you would need to look at jurisdictions or cities that are very similar to your own in terms of climate and development patterns and get some other example and go off of that. **No one has to reinvent the wheels at this point. There's a lot of good material out there.** And even Portland's manual is pretty big – it's thick. It's a lot of information, and I think it can be streamlined. I think that's one advice I would give to jurisdictions. The simpler the better. You can always make it more complicated as you go on, but when you're launching it, it's better to keep it simple. Because if people get frustrated with the process being too complicated, they're going to give you a hard time and undermine the efforts. So start out simple and refer to as much existing information as possible because there's a lot out there.

Madhuri 3/5/12 6:17 PM

**Comment:** Have wide range of stakeholders including private sector in advisory committee to make manual

Madhuri 3/5/12 6:17 PM

**Comment:** Borrow stormwater manuals

Madhuri 3/5/12 6:18 PM

**Comment:** Look at similar cities and don't borrow carelessly

Madhuri 3/5/12 6:19 PM

**Comment:** The simpler the better, to begin with

**Other:** Take a look at the manual. Chapters 1 (policy) and 2 (facilities and description) are the most important. Chapters 3 and 4 are about source control policy which is kind of complicated, and our maintenance. There's just tons of information in the appendices which not many people look at. There is a section on retrofitting which is in appendix A-5, and it talks about voluntary retrofitting, not what you're required to do. Our website is amazing. There's a workgroup called sustainable stormwater, who did the first pilots. Those projects are in factsheets, what they cost, pros and cons. It's almost overwhelming how much is on our website.

**Interview 6: Alisa Kane**  
**Bureau of Planning and Sustainability**  
**February 23, 2012, 4:00 pm - 4:20 pm**

**Q1: Do the Comprehensive Plans and Zoning Codes specifically mention anything about new or retrofitting developments? And if it doesn't, then why do you think the urban bioswales and wetlands are present in Portland?**

**A1:** So it's mentioned in the Comp Plan which is currently being updated quite extensively. But it's mentioned as overall goals, so there's objectives around managing the stormwater. And so it does exist there and I imagine it will continue to exist because it's a fairly important part of our natural resources section in the comprehensive plan. In the zoning code there are some requirements around meeting the current the stormwater guidelines, but they're not particularly specific, because there is the stormwater management manual which supersedes and is the overarching guidelines to all this. Certain type of development triggers certain type of activity then you have to follow that code.

Madhuri 3/5/12 9:42 PM  
**Comment:** Mentioned as overall goals in Comp Plan

Madhuri 3/5/12 9:43 PM  
**Comment:** Some requirements in code, but mostly from manual

**Q1a: So in the Comprehensive Plan, do you know exactly what chapter that is? Was it the Natural Resources section?**

**A1a:** I believe so. Maybe also the environment section. I would look in there.

**Q2: Are there factors besides policies that make green infrastructure possible? (strong leaders, active citizens, or grants/loans)**

**A2:** Yes, the whole answer is yes. I would say specifically to green infrastructure when we're talking about bioswales – it's been a perfect storm of all those. Certainly the city took a strong leadership role in promoting and requiring a certain level of management and greening of the infrastructure. That has increased over time. So you used to have to do modest things to parking lots or to streets and over time they really increased efforts to get that and the regulations around it. A lot of it has to do with our river and our combined sewer, which means that rainwater and sewer water all go together, and when they overflow, they all go to the river. Have you heard the story before? It's one of the reasons why we have such strong regulations around it. Because we're required to. On top of that, we have a savvy development community, and because of our strong regulations, the way the city looks is starting to appear different. There's a lot of vegetation, focus on bringing nature back into the city. Lot of times you go to a city and it's just filled with concrete. Here you have plenty of concrete but a lot of other things going on, including bioswales that manage stormwater especially important pieces that links the whole system together. And then there's been grants over the years. Less so now, but in the beginning, there were hundreds of thousands of dollars to do stormwater projects. There's now an ecoroof grants (\$5/square foot) – that's the only remaining real grant available, and the rest is just required by standard course of development.

Madhuri 3/5/12 9:44 PM  
**Comment:** City's strong leadership role

Madhuri 3/5/12 9:45 PM  
**Comment:** Strong regulations because of combined sewer overflow

Madhuri 3/5/12 9:45 PM  
**Comment:** Savvy development community

Madhuri 3/5/12 9:45 PM  
**Comment:** Strong regulations shape vegetative character of city

Madhuri 3/5/12 9:45 PM  
**Comment:** Grants and standard development

**Q3: Do you know much about the approval process and permitting for green infrastructure?**

**A3:** A little bit, from general observation.

**Q3a: Do you think that's changed since green infrastructure started becoming more prevalent?**

**A3a:** Yes, and they probably had to add staff to review that portion of the permit. And our permitting functions are somewhat spread out throughout the city depending on the topic area, so there's people who do the transportation side of the permits, people who do the health safety side, and people who look at the natural systems, so over time they have to either change and learn more and/or hired new staff.

Madhuri 3/5/12 9:46 PM

**Comment:** New staff or learning of old staff for permitting

**Q4-1: How did Portland overcome the cost of implementation of green infrastructure?**

**A4-1:** Some of it was because it was heavily subsidized in its early years so grants and the city took on a fair amount of the infrastructure improvement itself, and that's just mostly to the facilities we own – thousands of miles of right of way. So anytime we do a project there, we're either required to do a green treatment to it or we pay into a fund. Did people talk to you about the 1% for green streets?

Madhuri 3/5/12 9:47 PM

**Comment:** Heavily subsidized in early years through grants

**Q4-1a: Can you tell me more about it again?**

**A4-1a:** So if a city is repairing a street, then they would be required to put 1% of the project budget into green infrastructure treatment for the area, and if they don't do that, they put their money into a fund that gets dispersed into the community for other projects. So it's a way to capitalize installations. Look up the 1% for green streets program, and that's for city projects. In terms of private sector projects, they have to meet the requirements and earlier they had some incentives, but now it's something they have to do, so it has to be capitalized by the private developer.

**Q4-1b: So every time a private developer builds something, the city has to pay?**

**A4-1b:** No, those are two distinct things. Anytime the city does something, it's required to do some green infrastructure improvements, and if they don't do it, they pay into the funds. On the private side, they're just required to do certain amount of green infrastructure. And they have to pay for it themselves.

Madhuri 3/5/12 9:47 PM

**Comment:** City is required to put 1% of project budget into green; developers required to do it

**Q4-2: Well, I guess this question was answered that long-term maintenance still hasn't been overcome. So my question is how is maintaining green infrastructure different from maintaining concrete structures?**

**A4-2:** There is definitely the challenge of that. You go to some poorly maintained bioswale, for example, and you'll see trash, cigarette buds, and it prevents the proper drainage and, so who's responsible for picking that up? Sometimes it rests with the owner of the building, sometimes it rests with the city, sometimes there are long-term maintenance agreements that are created. But it's definitely not been figured out. It's not a routine course of practice although it needs to be because maintenance is just as important as installing the facility.

Madhuri 3/5/12 9:48 PM

**Comment:** Question about maintenance

**Q4-3: How did Portland overcome the lack of information? Other cities don't really know much about green infrastructure. So how can that city get over the new information it hasn't tried before? How do you get over that?**

**A4-3:** It's all about education, and that's where the city and specifically the Bureau of Environmental Services shines – they are very active in getting out and educating people on the benefits, what it looks like, how to do it. They provide a lot of literature online. They produced stormwater management tours, they developed seminars, they go to big conferences and tell people about it. It's something you have to spend as much time and energy on the education

piece as you do on changing the regulations. Because you can change the regulation and nobody will know how to do it and it won't work without the education.

Madhuri 3/5/12 9:49 PM  
**Comment:** Education is important (tours, seminars)

**Q4-4: How did Portland overcome differing opinions of key stakeholders? Were there some people that didn't really agree to green infrastructure as a good method? Some people wouldn't believe it. How do you get over different opinions?**

**A4-4:** You have to show them that it works, that it's less expensive for development, show them that it's not going to ruin their buildings or basements, and it's just a matter of having projects that work. And certainly over time, there will be projects that don't work. Those get the most news, of course. **You have to be prepared to succeed and fail, and when you fail, you have to be prepared to tell people why it failed and how it got be fixed.** There's a story in Seattle where they installed some bioswales and it really didn't work at all, and it was becoming a health hazard because of stagnant water and filling up with garbage, and it's something the city forced on the community, and there was interesting backlash against it.

Madhuri 3/5/12 9:50 PM  
**Comment:** Show projects work

Madhuri 3/5/12 9:50 PM  
**Comment:** Some projects may fail, but explain why

**Q4-4a: I didn't know about that. Do you know what part of the city that was in of if it was a development project?**

**A4-4a:** It was in an existing part of the city that had issues around stormwater in a neighborhood. It was fairly recent. In the last 6 months is when it happened.

**Q5: Can you describe a recently retrofitted project and what made it successful or what didn't make it successful? Like neighborhood level or city wide?**

**A5:** One of the things that's been somewhat successful but equally contentious is the pairing of green street improvements with bikeway improvements. And a successful example is in the Culley Neighborhood, and there are articles about that. And it basically did a lot to improve a very large arterial street. They added a bike way (cycle track) which is a segregated cycle lane, but they also added green street improvements that deal with the runoff of the street, and at the very least, the development project sounded like the community was happy because they got a much more improved street and the green street piece helped to beautify what was a pretty downtrodden area.

Madhuri 3/5/12 9:52 PM  
**Comment:** Success of green streets and bike improvements (two in one)

**Q5: Of the research I've done so far, I've only seen the good things about green infrastructure, so can you tell me what some of the negatives or drawbacks are? You kind of mentioned that in the Seattle example.**

**A5:** The maintenance issue is one, certainly. But on top of that, from a user perspective, there are some challenges in the way that bioswales get installed in Portland. As a cyclist, I noticed that sometimes, there will suddenly be a bioswale in the area that will force you into the traffic, so they use bump outs and different ways to direct streets, but because they've added this green infrastructure, it's been more difficult for cycling. In addition, there are some challenges to the early projects in curb distance. Imagine you open up your car door and there's nowhere for you to get out because the sidewalk has been removed to make bioswales and suddenly we're hearing stories of people twisting their ankles and stepping in big mud piles because of the bioswale. And some of that can be fixed with more thoughtful design or design with a section for people to stand on that isn't vegetated. Design is a big part of how it can succeed to see the best design standards and try to mimic those.

Madhuri 3/5/12 9:52 PM  
**Comment:** Issue: Maintenance

Madhuri 3/5/12 9:53 PM  
**Comment:** Issue: User difficulty in biking and forced out in traffic

Madhuri 3/5/12 9:53 PM  
**Comment:** Issue: curb design

Madhuri 3/5/12 9:53 PM  
**Comment:** Fix curb problems with thoughtful design standards

**Q5a: So usually if there's a bioswale on the road, there's no sidewalks there? Is it in place of sidewalks?**

**A5a:** No, it just encroaches on the sidewalk so there'll be less sidewalk, so half of the sidewalk is bulldozed and then they put in a swale.

Madhuri 3/5/12 9:54 PM  
**Comment:** Swales encroach on sidewalks

**Q6: What advice do you have for other cities that want to implement the green infrastructure strategies and what would you recommend in terms of the Comprehensive Plan and ordinances?**

**A6:** I would say start with a demonstration project and really try to make it a showcase so that it speaks for itself. I also think it has to be something that responds to urban conditions, so certainly in Portland it makes sense. Will this make sense in Arizona? Probably not. There's other things you'd want to be focusing on. So apply it to the right place, don't apply it just for the sake of applying it. I would also encourage anyone who would be ultimately responsible for enacting a policy to do just what you're doing and call around, visit, and actually go to cities that have done this. And just take the best management practices and incorporate them into what you do.

Madhuri 3/5/12 9:55 PM  
**Comment:** Start with demonstration project as showcase

Madhuri 3/5/12 9:55 PM  
**Comment:** Apply it to the right places

Madhuri 3/5/12 9:55 PM  
**Comment:** Research other areas for best practices

**Q6a: Ok, anything about the Comprehensive Plan or the land use ordinances? I know that the Comprehensive Plan is more general, so the stormwater manual will more specifically talk about it, but do you think anything can be said more in the plan?**

**A6a:** Possibly. I'd have to look. Since the one we have is so old, it's not even a good place to start from. I do think there's a place for in the Comprehensive Plan, and maybe it is fairly overarching in general. Stormwater will be treated as an asset and managed appropriately eliminating the impact on the natural environment. Something like that. Something broad, and then the management plan or manual becomes the implementation mechanism. One other thing that happened in the zoning code was that we had Floor Area bonuses for installing ecoroofs. That was another incentive, but that stayed in the zoning code.

Madhuri 3/5/12 9:57 PM  
**Comment:** Have something broad in general Comp Plan and use manual as implementation

## **Appendix C: Interview Memoing**

### **Interview 1: Marie Johnson (Johnson) – Bureau of Environmental Services**

After speaking extensively with Marie Johnson from the Bureau of Environmental Services, clearer ideas about how the City of Portland operated when using green infrastructure emerged. Johnson began by stating that both the Comprehensive Plan and Zoning Codes are lagging in terms of providing information about green infrastructure. Instead, the Stormwater Management Manual plays a bigger role. The manual came about because the city was in trouble with the Federal Government for violating the Clean Water Act for discharging pollution to the Willamette River. As per the manual, both the city and developers have to meet certain requirements for stormwater management. Indeed, the benefits of green infrastructure are not just that it complies with the requirements of the Federal Government, but that it is also more cost effective as tree plantings are cheaper than pipes, usually with the same benefits. One negative about the manual is that it does, at times, conflict with the zoning code. At those instances, the code overrules the manual, which can be very problematic.

Other than the very few and broad statements from the Comprehensive Plan and Zoning Codes and the specific manual, several other factors besides these policies also make green infrastructure possible. Johnson stated that the local culture is very important for the city. Both nonprofit organizations and developers possess the green ethic. Additionally, developers are further inclined to use green infrastructure strategies because they are given funds. In terms of leadership, the director of the bureau [Bureau of Environmental Services] has been strong but quiet. Indeed, with the attitude of experimentation and testing, several projects were possible. It was stressed by Johnson that it is easier to begin green infrastructure projects at a community or neighborhood level rather than at the city level. Ultimately, those specific lessons from the smaller area, then, can be generalized into the Comprehensive Plan at a later stage.

In terms of approving green infrastructure projects, the process of approval goes through the review of the Bureau of Developmental Services, planning regulations, and the Bureau of Environmental services review regarding the Stormwater Management Manual. Of course, this process would vary by state depending on the individual city management and hierarchy. The way the government is set up in Portland is really effective because the city commissioners do

not have roles divided according to geography. Rather, their roles are divided according to bureaus. Thus, it really helped that a few commissioners also advocated for green infrastructure.

Johnson's informative informal ideas included her take on green infrastructure and what can be done to improve. She mentioned how trees and soil are part of green infrastructure, and sometimes it is difficult for Planners or others dealing with green infrastructure to acknowledge the basic natural conditions and knowledge of infrastructure. Some may not be accustomed to thinking about environmental systems and limits. Johnson stressed that there is a crucial step before urban design – to really think about the functions of hydrology and soil. Her final thoughts were about “green” infrastructure. She advocates for this type of infrastructure not because it is a “cool” trend or is aesthetically pleasing, but because it really is practical.

Portland did have to overcome some obstacles before implementing green infrastructure in the city. Costs of implementation was one. However, as Johnson pointed out, this was overcome by dividing what the city and private developers had to pay. For the city, the Capital Improvement Program (CIP) helped with funding costs. Private developers, on the other hand, were responsible for their own developments. Maintenance is a big issue as well. Again, private developers are on their own for maintenance. On the other hand, it is still being figured out in the city, although the Bureau of Environmental Services will probably be responsible. Another concern, the lack of knowledge on this relatively new concept, was overcome in Portland with, as mentioned before, a comfortable environment where experimentation and testing was encouraged. Ultimately, any differing opinions or conflicts were resolved through presenting several options, conversation, and negotiation.

Three projects in Portland were revealed by Johnson. Clay Street was an area where green infrastructure not only handled stormwater, but also provided a green route to the Willamette River. Montgomery Street, running through Portland State University, was another successful project. Although opposed by some, Johnson concluded that green must be a strong movement if some feel threatened by its presence. Finally, another project was Johnson Creek. Johnson was very proud of the fact that for the first time, this area did not flood. The lessons from these projects were to collaborate between both the gray and green infrastructure individuals. Working together is ultimately the solution for implementing these projects in the city.

Although green infrastructure is beneficial in many ways, some negatives were pointed out by Johnson as well. The most severe challenge is maintenance. This negative also relates to a similar issue, responsibility and whose responsibility it is to maintain the green infrastructure. Another drawback can be the “one size fits all” mentality. What works in one area may not work in another. Another potential drawback identified by Johnson is reasoning. Green infrastructure is not being implemented because of its moral reasoning, but also because it is practical. She stressed that the practical side of the issue needs to be conveyed. Finally, another issue can be not bringing multiple disciplines together.

Johnson had invaluable advice for other cities wanting to implement green infrastructure. The first response was fostering an atmosphere of testing ideas. With good design, offering early incentives, and bringing people together, green infrastructure can be possible. These ideas can be extracted from other cities – learning from others is important. Another consideration is capital. It is necessary to have access to capital and it might be helpful to have the same stream of or access to money for both gray and green projects. As was mentioned in the earlier part of this interview, starting small rather than city-wide can be beneficial. Once in the process of implementation, positive press and marketing is key.

In terms of the Comprehensive Plan and Zoning Code, Johnson stated that there needs to be a strong connection between stormwater and land use. This relationship needs to be acknowledged. Johnson said that a separate manual might be a good idea. Finally, she suggested that planners and officials who want to implement green infrastructure principles should attend lectures and brownbags to get introduced to new ideas. Understanding what others can do can provoke a sense of competition, which can be quite helpful. Portland’s Comprehensive Plan is dated and the policies are not very great. Thus, it might be helpful to look at the Plans and Codes of other cities.

## **Interview 2: Renee Loveland and Clark Brockman (Loveland and Brockman) – Gerding-Edlen and SERA**

The short, but informational, interview from the perspective of two private developers – Renee Loveland of the Gerding Edlen Development Company and Clark Brockman of SERA Architects – helped tremendously. They stated that it was the result of city policies, some

controversial, that made the bioswales and wetlands evident in the city. Another reason why bioswales and wetlands exist are because of incentives for this type of infrastructure. Incentives stated by Brockman were reduction charges and other city-driven programs. One effective incentive for developers stressed by Brockman was the SDC, or System Development Charge. This policy instrument is favored by developers because it reduces developers' initial finances rather than reward them at the end of the development process.

Many factors besides policies make Portland's green infrastructure possible. Similar to Johnson, Loveland and Brockman stated that it is the culture of the Pacific Northwest to do things differently. This culture is promoted by the city because it stresses the importance of stormwater management, which the city learned through the high costs it had to incur because of the combined sewage overflows and untreated sewage. The two developers also stated that the Bureau of Environmental Services is very supportive and helpful in terms of charge reductions for developers. Both the private sector interviewees shared the same view – that a different system was necessary rather than just simply building bigger pipes. Because of BES's progressive policies and because of the culture of Portland that allows for experimentation, the alternative green strategies were developed. A unique point mentioned by Brockman was the connection between density and innovation. He stated that greater density in a city allows it to become more innovative. He backed this statement with the fact that Portland was allowed to become denser after enforcing its Urban Growth Boundary.

The approval process for green infrastructure in Portland stemmed from the fact that the city's permitting process presumes that different developments and designs will be different. Developers need to negotiate with the city while the project is being designed early in the process. Ultimately, there is risk when creating a green infrastructure project, but it is essential to be progressive. "Green," eventually, does not just become a visual amenity and an additional factor to livability, but it also provides multiple other benefits. Swales, for example, reduce travel distance and increase traffic safety. It is thus beneficial to have multiple uses in one solution.

In terms of specific requirements for implementing stormwater management, Brockman stated that the city's codes are more stringent than the requirements necessary for LEED (Leadership in Energy and Environmental Design) certification. Thus, a beneficial starting point for city to produce a region-specific policy would be to analyze and use some of LEED'S requirements for stormwater management. (A starting point to researching about LEED

stormwater requirements are found in section 6.1 and 6.2 in “LEED for New Construction & Major Renovations” found at <http://www.usgbc.org/ShowFile.aspx?DocumentID=1095>.

The negatives about green infrastructure by Loveland and Brockman were different than the ones stated by Johnson. Loveland and Brockman discussed briefly mismanaged politics, which can be especially vocal from the conservative side of politics. Another consideration for implementing green infrastructure is to be aware of the learning curve and response time needed for overcoming issues to green infrastructure. Finally, the last potential negative could be not being realistic. It is important to be practical when considering green infrastructure strategies.

Four pieces of advice were given by the private developers. The first was to use “twofers” and “threefers” when developing. This point relates to earlier in the interview: multiple uses or functions in one solution can be very beneficial. The second advice was to create and use STC (System Development Charges), which are very helpful tools for developers. The third advice regarded scale. Depending on the location, it might be beneficial to think of the entire region instead of separate cities. Having multiple areas can help with a green infrastructure project. Finally, the last piece of advice was to understand that new development is easier than retrofitting developments. It is easier to incorporate green infrastructure principles in a new project rather than altering existing projects.

### **Interview 3: Emily Hauth and Henry Stevens (Hauth and Stevens) – Sustainable Stormwater Program**

Emily Hauth and Henry Stevens from the Sustainable Stormwater Program also provided excellent information regarding the green infrastructure in the city. Urban bioswales and wetlands are evident in the city not necessarily because of the Comprehensive Plan and Zoning Code. As with the previous two interviews, the Stormwater Management Manual was the reason. The manual was instigated, again, because of the pollution in the river which the Federal government oversaw. The two interviewees mentioned the failure of the city to meet the Clean Water Act, specifically the National Pollutant Discharge Elimination System (NPDES) section. As a result of this problem, an advisory board created the manual in 1999 and is targeted more towards green infrastructure developments. In order to ensure the green facilities worked, the city began with small demonstration projects. Additionally, this green system was preferred

because it was cheaper to be green rather than replace pipes, a statement echoing Johnson's comments.

Factors besides policies included the leadership, citizens, incentives and grants, and developer attitudes. Strong, supportive leadership which allowed trying innovative approaches was beneficial. Additionally, the city had active citizens who were excited to be engaged in the projects. Incentives and grants were also other factors besides policies which made the green infrastructure possible. Community grants, programs such as the "1% for Green," and eco-roof incentives helped carry the idea forward. Thus, funding from the federal government as well as city leaders helped achieve the green infrastructure goal. Green infrastructure was also pushed for by developers, who played a vital role in making it possible because they saw a value in having a green city. A significant reasoning behind this achievement was, however, because of the ability to work together. Multi-objectives were achieved through working with other bureaus and internal partners. The important concept of having multiple objectives or functions and working with internal and external partners was also stated by Loveland and Brockman. Green infrastructure was possible further because of the manual. Indeed, the Comprehensive Plan is more general and includes many policies, but the Stormwater Management Manual is more detailed.

In terms of the approval process for green infrastructure, Hauth and Stevens stated that many modifications were made to the permitting process. Indeed, there were several permitting changes and changes continue to happen incrementally. Both admitted that the approval process still needs some tweaking. The final word on permitting was that codes and requirements definitely change, but that change can be slow and accumulative.

Portland overcame several hurdles quite successfully. Although costs of implementation can be high, the city conducted many tests before coming up with a standard for green infrastructure. It also helped that green infrastructure is cheaper and has multiple benefits than pipe replacement. Additionally, one point highly stressed by Stevens was that green areas are not carpeted in the city. Rather, specific areas are targeted in locations where it is necessary. Targeting areas is also beneficial because some areas might have a higher cost to do green infrastructure than pipe replacements. Overcoming differing opinions from key stakeholders and key players can also be a fear. In Portland, the city trusted and gave freedom to its professionals to try new things. Even though the city's own engineers were skeptical of the new approach, the

effectiveness of green infrastructure was proven through monitoring data. Again, only after experimenting with small demonstration projects could more broad scale applications be implemented. Gathering data was stressed by Hauth and Stevens. Specifically, conducting a life-cycle cost analysis for green infrastructure was recommended by Stevens. Only through gathering and analyzing data can either green or gray infrastructure be placed in appropriate areas.

The manual includes several specific requirements for green stormwater management. It includes specific calculations and formulas. It is important to remember that different areas will have different calculations. The specific soil and amount of rainfall, for example, will determine what a particular city will need.

Negatives of this approach were also highlighted by Hauth and Stevens. Maintenance was brought up as a negative because it is impossible to predict how much money will be needed years down the line when this becomes important. A unique concern stated by Hauth was perception. How the public perceives the green infrastructure is important – some may see it as imposing structures on their properties. Finally, another drawback may be not looking at options. Sometimes green is clearly less expensive than gray infrastructure. Other times, it may not be.

Hauth and Stevens had lots of beneficial advice. The first point, similar to Johnson's, was to start small. It is essential to monitor small demonstration projects and acquire data before expanding the scope. This advice also relates to the next one: work slowly. It is imperative to have patience and realize that things cannot be done overnight. Combining green infrastructure with other projects was something which Loveland and Brockman also stated – think about “twofers” and “threefers.” Working with internal and external partners was also stressed. One of the most important advice was the concept of community outreach and education. Both professionals stated that many cities struggle with this component, but outreach is really important, especially with strong neighborhood organizations. Finally, a unique piece of information was to ensure a direct flow of revenue especially for green infrastructure activities. This decreases competition for other projects also seeking funds.

#### **Interview 4: Roberta Jortner and Shannon Buono (Jortner and Buono) – Bureau of Planning and Sustainability**

Speaking with Roberta Jortner and Shannon Buono from the Bureau of Planning and Sustainability also aided in forming conceptualizations of green infrastructure in Portland. The two planners stated that the Comprehensive Plan was very old and is amidst the process of being updated. Thus, the Comprehensive Plan does not really refer to green infrastructure. They did state, however, that the Comprehensive Plan does have a section in which it discusses development which occurs on pre-developed sites to enhance the site for green infrastructure. The updated Comprehensive Plan will have more general green infrastructure policies. The Zoning Code does not specifically refer to green infrastructure information, but does refer to the Stormwater Management Manual for specific requirements. Thus, any upgraded developments and land divisions need to meet the manual requirements. The two planners also mentioned other ideas. They stated that it is usually easier for new development to include green infrastructure rather than retrofitting development. They also mentioned rights-of-ways, which are not regulated by the Comprehensive Plan or the Code. However, these areas do have to meet manual requirements. The city invests lots of resources in rights-of-way. Although BES maintains stormwater programs, there is still a major question about who takes care of swales and other green infrastructure components. Finally, Jortner and Buono also stated that there is not much focus on the wetlands aspect of green infrastructure. Portland is more interested in swales, ecoroofs, and greenstreets.

Many other components besides policies play a role in the development of green infrastructure. Leadership and the community, as stressed by Jortner, are even more important than policies. Indeed, in Portland, strong, active leadership was given by the city councilmembers and the mayor. Additionally, the community was also in support of vegetation as a consequence of green infrastructure. Another vital factor making green infrastructure possible was the poor quality of both the watersheds and the Willamette River. Because the pollution problem in the river became apparent, a new method of handling stormwater management had to be developed by the city.

The approval process for green infrastructure was not necessarily added. As Hauth and Stevens pointed out, Jortner and Buono also stated that the permitting changed incrementally. Thus, the new approval system added and became a part of the existing system. Additionally,

what benefitted developers the most was the incentive with the permitting system. Simpler permitting was a reward for developers using green facilities. In accordance with Johnson, Jortner and Buono also referred to the BES as reviewing the permit to ensure that it meets requirements, specifically as stated in the Stormwater Management Manual. A response paralleling to that of Hauth and Stevens was regarding engineers. Jortner and Buono also stated that engineers were concerned with the new system. Indeed, it was a cultural change for this profession to accept the concept of green on the same grounds as traditional pipe development.

Many barriers were overcome by Portland. Costs of implementation were a big concern, but Jortner and Buono pointed out that cost is always an issue. Many incentives were provided for green infrastructure to occur. These included disconnecting downspout payments, FAR (Floor-Area-Ratio) bonuses, and rebates on planting trees. A unique way of helping with green infrastructure implementation was city planners allowing clustering development. Indeed, clustering lots in a development would allow for more space for green infrastructure systems or facilities. It is vital when dealing with green infrastructure requirements, to be aware that both quantity and quality are a concern. Additionally, there should be a flexibility on location when implementing this type of stormwater management. The planners stated that there needs to be flexibility in where the green infrastructure approach will work, paralleling with the ideas of Hauth and Stevens that the aim is not to carpet the city with this facility, but to place it in targeted areas. Another issue pointed out by Jortner and Buono is the issue in thinking of Engineers, who jointly worked with BES. Engineers, as was also stated by Hauth and Stevens, had a traditional way of thinking. Fortunately, this traditional way of thinking was overcome through political leadership and regulatory requirements. Additionally, working results also challenged the traditional thinking. Thus, leadership and examples can help. Providing examples can also allow people to slowly adapt to changes, such as a change from traditional to green infrastructure. Another challenge is maintenance, which can be overcome only with time.

Jortner and Buono provided many pieces of advice for other cities wanting to implement green infrastructure strategies. First, they stated that it is vital to cultivate political leaders. One way suggested to cultivate leaders and provoke ideas to professionals in the city would be to take the city on tours or field-trips to areas where green infrastructure has worked. Second, having active citizens is necessary. In order to get active citizens, it is necessary to have some sort of public outreach component. Developers can also be an effective way to begin green

infrastructure strategies. Having a few top-notch developers showcase a project can not only spur new ideas, but may also foster constructive competition. In order to invite developers to begin this project, then, incentives must be given to developers to provide some sort of certainty and confidence in their proposed project. Finally, a unique piece of advice by Jortner was to remember the end goal of green infrastructure: to mimic nature.

In terms of advice related to policies, specifically regarding the Comprehensive Plan and Zoning Ordinance, the suggestion was to have policies that elevate the importance of clean water close to the source. In the Comprehensive Plan, Jortner suggested having broad objectives related to green stormwater management. Additionally, she suggested having policy that met multiple objectives and forms the basis of sustainability, a concept stated both by Loveland and Brockman as well as Hauth and Stevens. Land use tools can also be included in the code in order to ensure adequate room for green infrastructure. Specifically, the foundation for this can come from a stormwater manual which can have explicit expectations.

### **Interview 5: Dawn Uchiyama (Uchiyama) – Stormwater Management Manual**

The Stormwater Management Manual expert, Dawn Uchiyama, provided outstanding information regarding green stormwater management. She began by acknowledging that the Comprehensive Plan is quite old and that it does not mention anything about retrofitting. In terms of the Stormwater Management Manual, she said it was part of the Zoning Code. According to the manual, areas which are over 500 square feet in development need to follow requirements in the manual.

Uchiyama stated four factors besides policy that make Portland's green infrastructure possible. Strong leaders and department advocacy is certainly important. Leaders who advocate for the green stormwater management system are helpful to its ultimate implementation. Second, active citizens are also important. Getting citizens to participate and volunteer and making them a crucial part of the decision-making process is important. The third player, but not necessarily a major driver, is concerned developers. Finally, the most important catalyst for green infrastructure to begin was help from the Environmental Protection Agency, which provided grant money for starting early projects in the city.

A new system had to be created for treating discharge in the approval process. A new system was devised when the manual was created by an advisory committee in 1999. The committee included a large team of people from various disciplines. They were brought together to begin the discussions on and subsequently create new versions of the manual.

Portland had to overcome many barriers. First, the driving force that compelled Portland to change its traditional stormwater management was the problem in its combined sewer system. Ultimately, costs were split. Developers had to pay for their implementation and the city had to pay for public projects. EPA funding and redirecting funding helped the city. Maintenance costs are a big issue which has not yet been figured out by the city. Discussions occur among the agencies to decide who will pay. Sometimes pipes cost less to maintain because they are underground and because of their long lifecycle. However, the cost of environmental damage has to be considered as well. Much damage is done because of the traditional pipe system to handle stormwater. Thus, although green infrastructure maintenance is an issue, Portland will definitely find a solution with time. Overcoming the lack of information on this new concept of green infrastructure was through hard work and learning lessons along the way. It is imperative to remember that good design is essential. Rights of ways were definitely an issue as well in the city because ultimately, rights of way issue are a real estate issue. Swales can only be put where they fit, and sometimes it is hard to find a swale placement solution because the land is already built. To overcome this barrier, it is important for other cities to remember that the process is a lot easier to do before the community develops, advice also given by Loveland and Brockman as well as Jortner and Buono. Addressing differing opinions of key players and stakeholders is easy, especially when the method is proven. Thus, data is essential, as was also said by Hauth and Stevens.

Specific requirements for implementing stormwater management were derived essentially from pilot projects as well as different disciplines. It is vital to not only be technical, but also realistic when coming up with specific numbers for the stormwater manual. In Portland's case, specific numbers were derived from engineering, science, and a multitude of other disciplines in the advisory committee. Specifically, Portland designated the requirement of green infrastructure if development is greater than 500 square feet. Another general number used is 6%. 6% is the amount of space required to be set aside for the amount of impervious area created. This depends

on soil quality - if soils in some area are more pervious, the amount can be decreased, and if soils are poorer in another area, the requirement can be increased.

Negatives to green infrastructure were also outlined by Uchiyama. Maintenance is the biggest issue. However, Uchiyama stated that maintenance is a stewardship issue and caring for the land is more important than worrying about maintenance money. Additionally, another negative can be competing interests for money. Money is limited and competing for it for green infrastructure can be difficult. Priorities vary city by city, and green infrastructure may not be the most important priority if there are other, more pressing issues or problems. Finally, another negative can be people's expectation of vegetation which varies with different parts of the countries. Some areas may be more used to or prefer vegetation while other areas may not be as open to seeing vegetation in cities.

Uchiyama had four pieces of advice for other cities wanting to implement green infrastructure strategies. First, she said that collaboration is essential. It is necessary to have many partners when going forth with green infrastructure. She stressed the collaboration especially between parks, transportation, and infrastructure. Second, patience is required. Nothing happens overnight and implementing green infrastructure is a long process. Uchiyama also suggested doing background research from other cities and sharing information. Finally, she suggested it was essential to highlight the multiple city objectives as a consequence of green infrastructure. This same idea was resonated also by Loveland and Brockman, Hauth and Stevens, and Jortner and Buono.

In terms of the Comprehensive Plan and Zoning Codes, Uchiyama suggested bringing all different layers and players together in the Comprehensive Plan. She also suggested using model codes, ordinances, and borrowing stormwater manuals of cities successful with green infrastructure. Her caution to this statement was not to borrow from similar cities and not to borrow carelessly. What applies in one area may not be the same in another. To come up with the administrative rule, design guidelines and standards of the manual, it is vital to have a wide range of stakeholders including members from the private sector in an advisory committee. Uchiyama suggested combing landscaping and stormwater requirements and starting simple. Over time, the manual can become more and more complex if really necessary, but simpler manuals can eliminate stress and frustrations.

## **Interview 6: Alisa Kane (Kane) – Bureau of Planning and Sustainability**

Alysa Kane from the Bureau of Planning and Sustainability echoed ideas similar to everybody in terms of the Comprehensive Plan and Zoning Code. She stated that some overall goals are mentioned in the Comprehensive Plan, and there are not many requirements in the Code. Instead, most of the requirements are derived from the Stormwater Management Manual.

Kane's response to factors besides policies making the green infrastructure possible in Portland was the strong leadership role undertaken by the city. She also stated that strong regulations were important. These regulations were created because of the combined sewer overflow. Ultimately, the regulations were so strong that Kane believes they have shaped the vegetative character of the city. She also mentioned a savvy development company as making green infrastructure possible in the city. Finally, she stated that grants and ultimately the city standards have also been influential.

Costs of implementation were overcome by Portland because the city was heavily subsidized in its early years through grants. Another way Portland overcame this barrier was by splitting the responsibility of the city and developers, supporting the ideas of Johnson. The city is required to put in 1% of a project budget into green infrastructure treatment. The private developers have to set aside green infrastructure as it is required. Kane also briefly mentioned that maintenance is a problem and has not yet been figured out. To overcome the lack of knowledge on a new concept, she stressed the importance of education. Kane said that professionals should go on tours or seminars in areas where green infrastructure has been successfully implemented. Finally, for overcoming differing opinions of stakeholders, Kane suggested it is important to show that projects work. Some projects may certainly fail, but it is important to explain why. Showing proof and results of experimentation as a method of overcoming this barrier was stated by all interviewees.

A project in Portland explained by Kane was one where there was success in having a green street as well as bike improvements. Again, pairing or combining multiple objectives was essential to almost all of the interviewees.

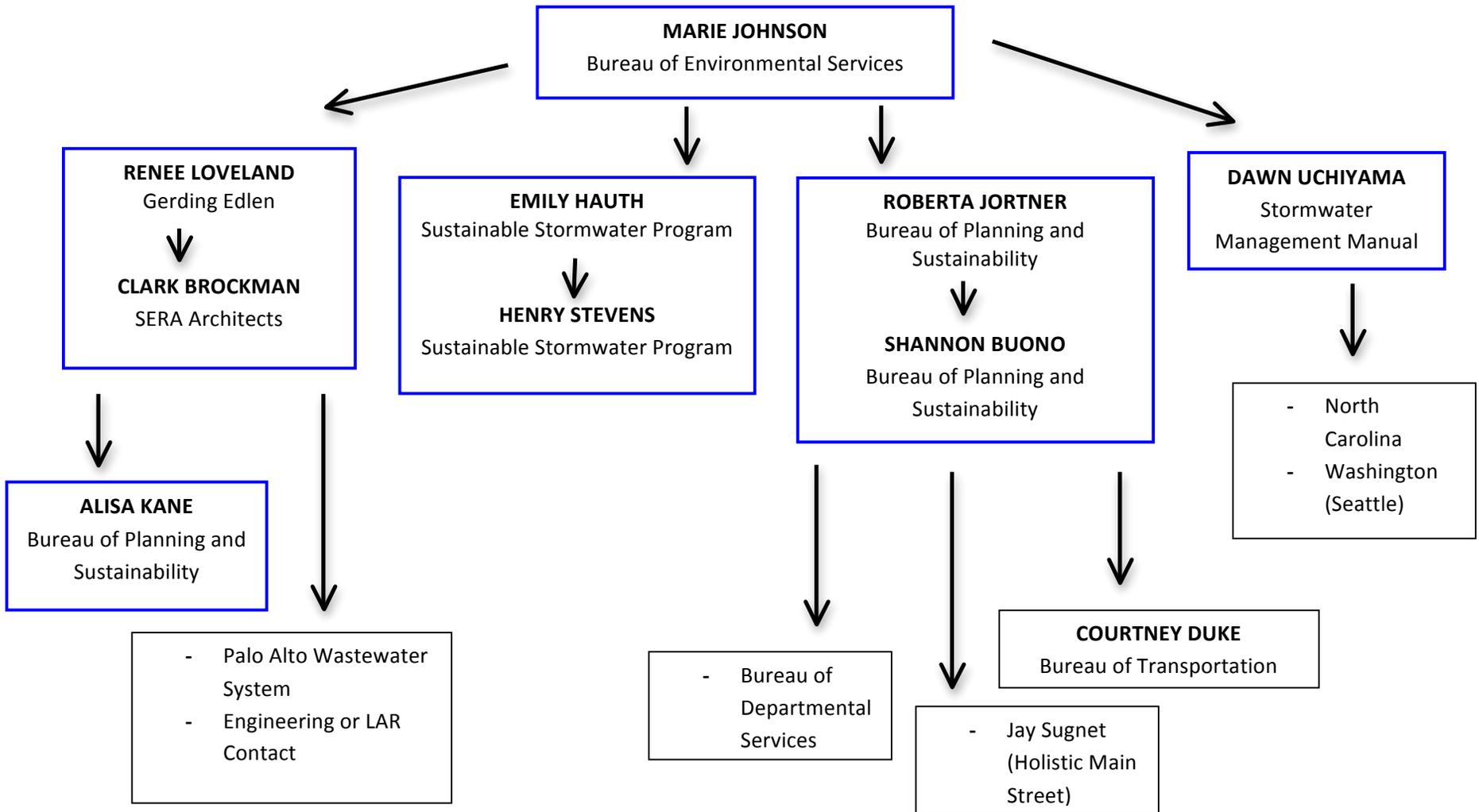
Three negatives or drawbacks were mentioned to green infrastructure strategies. Maintenance was cited again as the biggest drawback. Another drawback discussed by Kane was curb design. She said how from a user perspective, there are difficulties in biking and being forced out into the traffic because of the way the curbs are designed. A third issue she stated was

swales encroaching on sidewalks and reducing sidewalk space for pedestrians. Both of these problems can be solved with more thoughtful design.

Advice given by Kane to other cities was to start small, ideas reflected in the interviews of Johnson and Hauth and Stevens to start small rather than city-wide. Kane suggested starting with demonstration projects which can be showcases for future green projects. Another advice was applying green infrastructure to the right places – again, targeted locations as mentioned by Hauth and Stevens, Jortner and Buono, and Uchiyama. Kane also suggested researching other areas for best practices. Finally, she ended with stating that the something broad should be included in the Comprehensive Plan, and using a manual would help with implementation.

## Appendix D: Snowball Sampling Technique

Snowball Sampling Technique Diagram (Interviews)  
 "Implementation of Stormwater Management as Green Infrastructure in Portland, Oregon"



Source: Author, 2012

## Appendix E: Portland Zoning Code

Chapter	Key Word(s)	Date	Description
33.100	Open Space	07/01/11	Open space functions... Preserving the capacity and water quality of the stormwater drainage system
33.110, 33.120, 33.130	Trees	11/26/10, 07/01/11, 07/01/11	The purpose of trees... to reduce stormwater run-off by intercepting and transpiring precipitation
33.120, 33.130, 33.140	Multi-Dwelling Zones, Commercial Zones, Employment and Industrial Zones	07/01/11, 07/01/11, 07/01/11	Landscaped areas... intercept rainfall and reduce stormwater run-off by providing a non-paved permeable surface
33.248	Landscaping and Screening	07/01/11	The City recognizes the aesthetic, ecological, and economic value of landscaping and requires its use to... Reduce stormwater runoff pollution, temperature, and rate and volume of flow
33.248	Landscaping and Screening	07/01/11	The P1 standard is a landscape treatment which uses a combination of trees, shrubs, and ground cover to provide shade, stormwater management, aesthetic benefits, and screening to soften the impacts of large expanses of pavement and vehicle movement.
33.248	Landscaping and Screening	07/01/10	All required landscaping must be in-ground, except when in raised planters that are used to meet minimum Bureau of Environmental Services stormwater management requirements.
33.254	Mining and Waste-Related Uses	12/14/02	The use, if other than a sewage treatment facility, must provide pretreatment of any liquids being discharged into the City's stormwater or sanitary disposal system. The pretreatment must meet the standards of the Bureau of Environmental Services.
33.258	Nonconforming Situations	02/01/12	2. Nonconforming development with an existing nonconforming use, allowed use, limited use, or conditional use. Nonconforming development associated with an existing nonconforming use, an allowed use, a limited use, or a conditional use, must meet the requirements stated below... (4) Improvements to on-site stormwater management facilities in conformance with Chapter 17.38, Drainage and Water Quality, and the Stormwater Management Manual...
33.266	Parking and Loading	04/24/10	... the vehicle area restrictions for sites on transit streets and in Pedestrian Districts: The parking area layout standards are intended to promote safe circulation within the parking area, provide for the effective management of stormwater runoff from vehicle areas... Reduce the amount and rate of stormwater runoff from vehicle areas... Reduce pollution and temperature of stormwater runoff from vehicle areas; and Decrease airborne and waterborne pollution.
33.266	Parking and Loading	04/24/10	Curbs separating landscaped areas from parking areas may allow stormwater runoff to pass through them.

33.266	Parking and Loading	04/24/10	Stormwater runoff from parking lots is regulated by the Bureau of Environmental Services. See Chapter 17.38, Drainage and Water Quality, and the City's Stormwater Management Manual, which contain requirements for managing stormwater in parking lot landscaping.
33.430	Environmental Zones	11/18/11	<p>Minimum Site Enhancement Options, Option 2 – Impervious Surface Reduction: Remove impervious surface to improve stormwater management, and replant the area with native plants at the following minimum planting density: 10 plants per 50 square feet at a ratio of one tree, two shrubs, and 7 groundcover plants. Trees must be at least one inch in diameter, shrubs must be at least 2 gallons, and groundcover plants must be a minimum pot size of 4 inches. The remaining area may be seeded with native grass seed.</p> <p>Option 3 – Parking Lot Retrofit: Replace existing interior parking lot landscaping with a vegetated infiltration basin using native plants. The minimum planting ratio for this option is one tree and two shrubs for every 50 square feet of planting area, and groundcover plants to cover the remaining area, planted on 12-inch centers. Trees must be at least one inch in diameter, shrubs must be at least 2 gallons, and groundcover plants a minimum pot size of 4 inches. Enhancements must be approved by the Bureau of Environmental Services as meeting the Stormwater Management Manual, and must also comply with parking lot landscape requirements of this Title.</p>
33.430	Environmental Zones	07/01/10	Planted areas, including stormwater swales, must be planted with native plants from the <i>Portland Plant List</i>
33.430	Environmental Zones	07/01/10	When constructed open channels or vegetated swales are proposed, the slope between the stormwater source and the waterbody does not exceed 15 percent at any point
33.510	Central City Plan District	04/24/10	Eco-roof bonus option. Eco-roofs are encouraged in the Central City because they reduce stormwater run-off, counter the increased heat of urban areas, and provide habitat for birds. An eco-roof is a rooftop stormwater facility that has been certified by the Bureau of Environmental Services (BES). Proposals that include eco-roofs receive bonus floor area. A proposal may earn bonus floor area for both the eco-roof option and the rooftop gardens option.
33.510	Central City Plan District	03/05/10	The applicant must submit with the application for a land use review a letter from the Bureau of Environmental Services stating that the landscaping meets the guidelines of the Stormwater Management Manual.
33.510	Central City Plan District	02/01/12	Required South Waterfront Greenway Improvements – Improvements to on-site stormwater management facilities in conformance with Chapter 17.38, Drainage and Water Quality, and the Stormwater Management Manual
33.515	Columbia South Shore Plan District	07/01/10	Stormwater treatment swales: Stormwater treatment swales may be placed within the 15-foot private setback, provided the tree pattern is maintained and any

			nonvegetated swales are visually screened from Airport Way.
33.526	Gateway Plan District	01/16/09	Eco-roofs are encouraged in the Gateway Regional Center because they reduce stormwater run-off... An eco-roof is a rooftop stormwater facility that has been certified by the Bureau of Environmental Services (BES).
33.537	Johnson Creek Basin Plan District	07/01/11	In addition, restrictions are placed on all new land uses and activities to reduce stormwater runoff, provide groundwater recharge, reduce erosion, enhance water quality, and retain and enhance native vegetation throughout the plan district.
33.537	Johnson Creek Basin Plan District	07/01/11	Storm water retention and detention: All storm water originating on the site must be managed to ensure that development on the site does not contribute to flooding. Stormwater collection systems must be designed so that the post development stormwater flow rate off the site is no greater than the pre-development flow rate off the site.
33.537	Johnson Creek Basin Plan District	07/01/11	<p>These regulations mitigate the negative impacts that may result from the development of areas where flooding and landslides are common. The impermeable clay soils of the steep-sided Boring Lava hills to the south of the creek contribute to rapid stormwater runoff in the winter, and contribute to flooding. Unlike the flatter</p> <p>areas north of the creek, in the South subdistrict there are numerous small streams that can quickly carry stormwater runoff to Johnson Creek. The extensive tree canopy on these hillsides helps to slow stormwater runoff. Limitations on development density, tree removal, and impervious surface area reduce stormwater runoff, provide groundwater recharge, reduce erosion, protect water quality, and retain native vegetation. These regulations work together to protect watershed health while allowing the safe and efficient development of unconstrained lands... The regulations of this section manage development in the floodplain in order to protect the quality and natural functions of the floodplain and reduce the loss of property in areas where flooding is common. Together, these regulations help reduce stormwater runoff, provide groundwater recharge, reduce erosion,</p> <p>retain and enhance native vegetation, and enhance water quality</p>
33.563	Northwest Hills Plan District	05/26/06	Stormwater runoff: Post-development stormwater flows from a site must not exceed pre-development stormwater flows from that site. Stormwater systems shall meet Bureau of Environmental Services and BDS design and construction standards.
33.566	Portland International Raceway Plan District	06/13/05	Stormwater Management: Stormwater must be managed on site and have no negative impact on nearby sloughs, wetlands, or groundwater. Primary treatment for water quantity and quality including temperature must occur prior to stormwater entering existing wetlands or sloughs. The PIR Master Plan must include provisions to manage stormwater quality and quantity for each improvement made to the site.

33.630	Tree Preservation	07/01/11	The preservation of trees on a land division site also will: Filter stormwater and reduce stormwater runoff;
33.653	Stormwater Management	09/03/04	These regulations provide for the efficient and flexible placement of stormwater facilities serving a variety of development configurations. The standards and criteria of this chapter  recognize that on-site stormwater facilities may be land intensive and site specific, consequently affecting the arrangement of lots and streets. These regulations ensure that the land division site has an adequate area and an appropriate location for stormwater  facilities. The approval criteria ensure that it is feasible to develop a stormwater system that will have adequate capacity for the developed site.... The Bureau of Environmental Services has preliminarily approved the capacity, type, location, feasibility and land area required of the proposed stormwater management system and stormwater disposal facilities as well as any connection  to off-site facilities. The approval is based on the Sewer Design Manual and the Stormwater Management Manual
33.730	Quasi-Judicial Procedures	11/26/10	Preliminary Stormwater Plan that meets the requirements of the  Stormwater Management Manual and the BES Sewer Design  Manual. This plan must show the capacity, type, and location, as  well as the land area required, of the stormwater management  system and stormwater disposal facilities proposed. The plan  must also provide information on the feasibility of the stormwater  management system being proposed
33.851	South Waterfront Greenway Review	03/05/10	The proposal will mitigate for any reductions in vegetative cover through the use of methods including near shore and bank restoration work, bioengineering, or green building technologies, including innovative stormwater management, on the site... or The proposal will better support the water quality goals of the City's <i>Stormwater Management Manual</i>
N/A	Definition	N/A	Stormwater Facility: A facility designed to improve the quality and manage the quantity of stormwater runoff. Stormwater facilities include vegetated and sand filters, wet or dry ponds, marshes, infiltration facilities, and structural storm sewer devices. Stormwater facilities do not include conveyance systems that are meant only for conveying the stormwater from one place to another and do not affect the quality or quantity of the stormwater.
17.38	Drainage and Water Quality	06/04/99	(Amended by Ordinance No. 182144, effective September 26, 2008.) The intent of this Chapter is to provide for the effective management of stormwater, groundwater, and drainage, and to maintain and improve

			water quality in the Watercourses and Water Bodies within the City of Portland as described in Section 17.38.035.
“	“	“	The Stormwater Management Manual shall be the main administrative rule used to implement this Title.
“	“	“	Stormwater shall be managed in as close proximity to the development site as is practicable, and stormwater management shall avoid a net negative impact on nearby streams, wetlands, groundwater, and other water bodies.

**Source: City of Portland, Oregon, 2011 and Author, 2012**

## Appendix F: Portland Plan

<p>Portland Watershed Management Plan 2005  <a href="http://www.portlandonline.com/bes/index.cfm?a=107808&amp;c=38965">http://www.portlandonline.com/bes/index.cfm?a=107808&amp;c=38965</a></p>
<p>The breadth of these regulations demonstrates stormwater management is a significant watershed health issue. The quantity and quality of stormwater runoff generated by development is one of Portland’s greatest environmental challenges. One of the most effective ways to address this challenge is to incorporate stormwater into urban development as a resource that adds water quality benefits and improves livability, rather than considering it a waste that is costly to manage and dispose of.</p>
<p>In 1998, BES prepared the Integrated Watershed Plan and in 2000, published the Clean River Plan, which proposed implementing ten actions for healthy rivers and comprehensive stormwater management. Designed to supplement Portland’s combined sewer overflow (CSO) abatement effort, the Clean River Plan contains many innovative techniques to reduce stormwater runoff, reduce pollutant levels, restore floodplains and foster environmental education and stewardship bringing about noticeable improvements in watershed health.</p>
<p>The Watershed Plan promotes techniques that incorporate the benefits of natural systems into urban areas. Stormwater runoff can soak into the ground instead of flowing into sewer pipes. Native plants can help remove pollutants and provide habitat, and other innovative technologies can help prevent the rapid flow of stormwater off roofs and parking lots. Retrofitting existing development with landscape facilities that infiltrate stormwater into the ground helps protect Portland streams and terrestrial habitats. This holistic approach integrates the work of various city bureaus, private citizens, business and local non-profit organizations to improve watershed health. This approach will restore more natural watershed and stream functions. It has the most potential to protect and improve water quality while meeting state and federal regulatory requirements in the process. Rather than regulatory requirements defining City actions, ecological principles and watershed conditions will set the course. The result will be net environmental improvements over time.</p>
<p>History: Portland’s first sewers were made of wood and drained the City’s muddy streets directly into the Willamette River. As indoor plumbing became more common, sanitary waste was directed into existing sewers. For nearly a century, these combined sewers carried stormwater runoff and sanitary sewage directly into the Willamette and Columbia Slough. By the 1920s, the river and slough were badly polluted. In the late 1940s, the City began building large diameter interceptor sewers paralleling the river and slough to carry dry weather flows to a new sewage treatment plant in north Portland. The Columbia Boulevard Wastewater Treatment Plant opened in 1952. But during wet weather, stormwater filled combined sewers to capacity and some of the sewage and stormwater mixture overflowed to the Willamette River and Columbia Slough. Combined sewer overflow (CSO) abatement projects controlled CSOs to the slough in 2000. The City will complete projects to control CSOs to the river in 2011.</p>
<p>Definition: COMBINED SEWER areas carry both sanitary sewage and stormwater in the same pipes. When it rains, stormwater overwhelms the capacity of the pipe and overflows to the Willamette River in a combined sewer overflow (CSO). CSOs are regulated by the Clean Water Act, and Portland has additional directives through legal action and DEQ called the Amended Stipulated Final Order to nearly eliminate CSOs by 2011.</p>
<p>Johnson Creek: Johnson Creek has flooded 37 times since 1942, and at least seven floods caused major property damage in the last 35 years.</p>
<p>South Waterfront: Redevelopment in the South Waterfront District will reflect the ability of new development to improve riverbank conditions and provide sustainable stormwater management</p>
<p>Stormwater Management Strategy: Stormwater management is fundamental to improving hydrologic function and watershed health. Development creates streets, rooftops and other impervious surfaces that can increase the volume and velocity of stormwater runoff. Proper stormwater management controls runoff flow and protects property, infrastructure, and natural resources. Site design or retrofits of existing development that reduce impervious area also reduce the amount of stormwater runoff. Ponds, oversized pipes, ecoroofs and swales can all reduce runoff. Properly designed swales, planters, ecoroofs, and other vegetated facilities also filter stormwater pollutants, protect water quality and provide habitat.</p>
<p>Stormwater management policies that reduce impervious areas will also reduce stormwater volume and velocity, which protects streams and aquatic habitat.</p>
<p>Stormwater Management: Implementing the stormwater actions (e.g., increasing infiltration and treating stormwater pollutants) will benefit watershed function in most parts of the City. The stormwater strategy was not applied to undeveloped areas like Forest Park. Rain in these areas is captured by vegetation or infiltrates the soil, making these areas less of a priority</p>

for stormwater strategies than more developed parts of the City

Development and redevelopment provide opportunities to improve watershed function. New development can be designed to minimize impervious surface and to infiltrate as much stormwater as possible. Redevelopment can decrease impervious surfaces and increase the quantity and quality of onsite vegetation.

**Source: City of Portland, Oregon, 2011 and Author, 2012**