Using Visual Preference Surveys to Inform Planting Design in Stormwater Planters

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APPROVAL

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ABSTRACT

Urban green stormwater infrastructure facilities come in many forms, which include variation in the number and types of plant species. How plant diversity in stormwater facilities is perceived and valued by the public, stormwater professionals, and designers remains in question.

This project investigates whether plant diversity in small scale urban sites (curbside stormwater planters) is preferred by local residents and designers, how this preference might be related to overall attitudes about water management issues, and how the preferences of current and future designers differ from local residents. This study consists of two survey tests: a visual preference test, and an awareness and attitudes test. There are three participant groups from Eugene, OR: residents living close to a stormwater planter, stormwater professionals, and landscape architecture students at the University of Oregon. The results reveal the respondents' visual preference for plant diversity, understanding of stormwater planter function, and their awareness of watershed issues.

Survey results were then used to inform proposed planting designs for a stormwater planter in Eugene. I explore how designers can approach stormwater facility planting design in ways that are responsive to both professional and public preferences.

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This project could not have been possible without the following people:

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INTRODUCTION

1.1 PROJECT INTRODUCTION

There is a wide variety of designs for urban green stormwater management facilities, which include variation in the number and types of plant species. Simple stormwater facility designs can include as few as one or two plant species. In Eugene, OR, these mainstay plants are the Common Rush (*Juncus patens*) and Slough Sedge (*Carex obnupta*), but a greater diversity of plant species can be incorporated, depending on available funding, suitable conditions, and public acceptance. Stormwater planters (a subset of stormwater facilities) serve many functions including reducing peak stormwater flow and filtering debris and pollutants. Facilities with greater plant diversity and structural heterogeneity may provide some habitat benefits and support local biodiversity (Kazemi et al. 2011). But questions remain about how plant diversity in stormwater facilities is perceived and valued by the public and by stormwater professionals and designers.

There is much literature in the fields of conservation biology and landscape architecture about the benefits people receive from urban biodiversity, including benefits of ecosystem services and psychological well-being. Furthermore, the argument has been made that exposure to urban biodiversity will give people a greater understanding of the environment, leading to an inspiration of an ecological ethic and a willingness to act to protect local natural resources. Conservation planners, natural resource managers, and landscape architects often claim that exposure to nature and green spaces can be an environmental education tool. If this is to be successful, it is vital to establish a link between people's experience of urban biodiversity and their knowledge of natural systems in urban environments. How residents and landscape designers (both currently practicing and students) prefer stormwater planters to look, how they view connections between stormwater planters and the broader hydrological context, and how visual preference and knowledge and attitudes about natural systems are linked, are all important to understand if the design of stormwater planters is to be used to better educate urban dwellers about their surrounding watershed.

1.2 LITERATURE REVIEW

Factors currently contributing to design of stormwater planters in Eugene, OR

Design of stormwater management facilities in Eugene, OR is dominated largely by technical and legal concerns and constraints. Managing stormwater is part of the city's goal of protecting water resources and maintaining compliance with the National Pollutant Discharge Elimination System (NPDES) municipal separate stormwater sewer system (MS4) permit. The City of Eugene's Stormwater Management Manual specifies all technical aspects of stormwater facility design (City of Eugene 2014).

The main purpose of stormwater facilities in Eugene, OR is to act as flood control to reduce property and infrastructure flooding hazards, thus maintaining capacity for the city's stormwater conveyance system, and to mitigate water quality risks (chemical and organic pollutants, heavy metals, bacteria and viruses, floatable debris and thermal load) from entering downstream waterways. Stormwater facilities are sized according to a theoretical Water Quality Design Storm to ensure they will perform their functions under most reasonably predictable rain events (City of Eugene 2014).

Stormwater planters are a specific type of stormwater facility, comprised of hardscape walls (structural concrete or segmented retaining wall block) and flat-bottomed vegetated reservoirs which collect and treat runoff from impervious surfaces (Figure 1.1). The design of stormwater planters is similar to stormwater swales (Figure 1.2), which have sloped vegetated sides, and the two designs often occur on roadsides. The City requires the basin area of stormwater planters maintain 90% vegetation coverage when plants are mature. Plant selection must conform with the approved planting list for the City of Eugene, and planters occurring in the public right-of-way are further restricted in plant species selection (having to, for example, be less than 2' high at maturity to maintain safe sight-lines for vehicles). Furthermore, there are environmental constraints on the selection of plants for public stormwater planters. A limited number of plants can tolerate the conditions of roadside planters in Oregon, consisting of droughts in summers, inundation in the winters, and roadside pollution. Last, planters must be maintained by busy staff at the Department of Parks and Open Space and worker-hours are limited, so plant maintenance requirements need to be minimal (City of Eugene 2014).

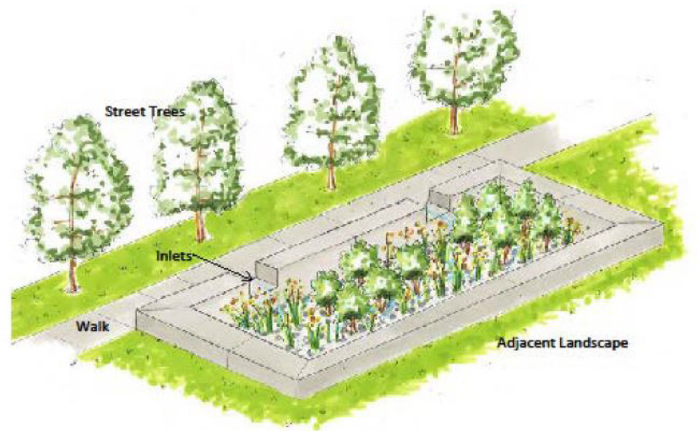


Figure 1.1 Example of stormwater planter (City of Eugene 2014)

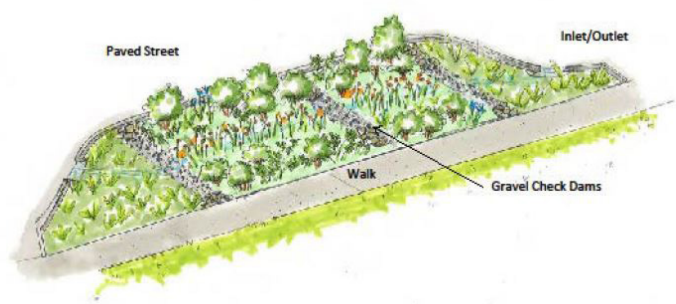


Figure 1.2 Example of stormwater swale (City of Eugene 2014)

Public preference for the appearance of plant diversity

How people respond to the visual appearance of biodiversity, including naturalistic plantings in general, is a rich field of research. The literature shows that the public has a complex, at times contradictory, set of understandings and attitudes toward the appearance of plant diversity in an urban setting. Nassauer (1995) discusses how acceptance of the appearance of naturalistic "messiness" increased with visual cues to human care, which has implications for how novel urban ecosystems can be designed to increase both ecological function and public acceptance. Preference for plant diversity can be highly contextual (e.g. partially vegetated spaces are preferable in parks), and dependent on the presence of human interventions (Qiu et al. 2013). There is evidence that visual preference is correlated with perceived naturalness, and both factors rise with increasing vegetative cover in the context of an urban streambank (Ho et al. 2014). Hoyle et al. (2017) found that "naturalistic" plantings are perceived to have high restorative mental health effects, but it is colorful flower cover specifically that garners the highest aesthetic value. Surveys of Swiss gardeners found that "natural and species-rich" home gardens were rated the most aesthetically pleasing, whereas conventional, species-poor gardens were thought to be "boring and normal" (Lindemann-Matthies and Marty 2013). While it is difficult for members of the public to grasp the details of the concept of biodiversity, they can nevertheless express high interest and positive value toward conserving it (Lindemann-Matthies and Bose 2008).

Also emerging in recent research is the value of "informal" public spaces as sources of connection to biodiversity. Botzat et al. (2016), in their review of articles about public perception and valuation of biodiversity, found that the study of smaller, less traditional urban greenspaces (like medians where many stormwater planters are found) are understudied compared to large urban parks. They also found that smaller biodiversity scales (i.e. community scale, species, traits, genes) were less popular than studying large scale biodiversity at the ecosystem or landscape scale. Both results lead me to believe that researching biodiversity perception and valuation at the scale of plant communities within urban stormwater planters would be filling a gap in the general body of research.

Link between species richness and people's awareness of natural systems

Many articles about urban biodiversity begin with discussions of how people are more disconnected from the environment than ever before, driven by the increasing urbanization of populations around the world, and how urban nature is vital to maintaining that connection (Shwartz et al., 2014, Hoyle et al., 2017, Bettigole et al. 2013, Dearborn and Kark, 2009). Indeed, "connecting people with nature and providing environmental education" is one of seven key motivations for conserving urban biodiversity, as outlined by Dearborn and Kark (2009).

The link between connection to urban nature and educational outcomes is not always clear. While biodiversity may be considered desirable, it is difficult for members of the public to notice on their own, and so may not be conveying any messages by simply existing (Shwartz et al. 2014). Biodiversity has been shown to have a positive impact on greenspace users' well-being measurements, such as cognitive restoration, positive emotional bonds and sense of identity (Fuller et al. 2007). Contrary to Shwartz et al., the 2007 study by Fuller et al. shows that green space users *can* reliably perceive plant species richness, and that number of distinct habitats can "cue" perceptions of biodiversity as well as trigger psychological benefits. Giacalone et al. (2010) show how gaps in public knowledge of stormwater facilities indicate a need for more targeted educational and promotional outreach, again demonstrating that stormwater facilities may not stand alone as educational installations. If conservation planners, landscape architects and natural resource managers are claiming to use exposure to biodiversity as an environmental education tool, it is vital to establish a link between people's experience of urban biodiversity and their knowledge of natural systems in urban environments.

Previous applications of visual preferences testing and questionnaires

The most commonly used method for determining visual perception of the landscape is some form of questionnaire surveys (Ho et al. 2014) though the specific technique of the survey can vary. In-person surveys are used at a specific site so that respondents are a self-selected group of site users (Kalivoda et al 2014, Fuller et al. 2007) or when participation in a study requires more action than answering survey questions (such as taking site photographs, as in Qiu et al. 2013). Telephone interviews are employed when detailed or nuanced discussion is required about participants' underlying knowledge and opinions, and the participants are geographically diverse (Lindemann-Matties and Bose 2008, Giacalone et al. 2008). Photo questionnaires are often used when assessing visual preference (Lindemann-Matthies and Marty 2013, Howley 2011, Polat and Akay 2015, Kalivoda et al. 2014, Ho et al. 2014). Using a limited array of pre-selected images has the advantage of restricting potential answers to maintain ease of quantifying and statistically analyzing responses.

What is known about potential differences between respondent groups

Bridging what professional designers consider to be indicators of landscape visual quality (derived from what are thought to be universal design concepts like unity, harmony, balance etc.) and a perception based approach which prioritizes sensory-perceptual processes (such as legibility, prospect-refuge etc.) is a long-standing challenge for the design world, and a clear way to connect the two approaches has not been well articulated (Daniel 2001). Perception-based assessments of responses of human viewers are more commonly conducted by academics for research purposes, and landscape management practice is more likely to be informed by expert-based assessments (Daniel 2001). Polat and Akay (2015) combined both expert-based and perception-based assessments by enlisting landscape designers to select and categorize the set of photographs that the user group was shown, but the landscape architects themselves were not surveyed on their own visual preferences. It was implied though, that designers would be more likely to prefer a landscape that clearly adhered to the principles of design (Polat and Akay 2015).

1.3 PROJECT SCOPE AND GOALS

The knowledge gaps this project aims to fill are whether plant diversity in small scale urban sites (curbside stormwater planters) is preferred by local residents and designers, how this preference might be related to overall attitudes about water management issues, if the preferences of current and future designers differ from local residents, and if so, how? By filling these gaps in knowledge, I hope to explore how designers can approach stormwater facility planting design in ways that are both responsive to both professional and public preferences.

The assumed link between individual perception of biodiversity and public knowledge of natural systems is especially vital in stormwater green infrastructure design. Popularity of stormwater planters, swales, rain gardens, green roofs etc. as a means of managing stormwater overflow and pollution control has risen in recent years, and few studies exist about how they contribute to public knowledge of stormwater issues or serve as a community benefit. It is similarly unclear what planting design approach to stormwater planters is most preferred by the members of communities, or even the landscape designers creating planting plan for stormwater planters. Designers of stormwater planters face a delicate balance between designing for function of stormwater facilities, keeping maintenance time and costs low, and the desire for a diverse plant palette to increase local biodiversity. Practically speaking, plant diversity is not necessary for the basic functional benefits of stormwater planters, a simple *Juncus* and *Carex* palette often is sufficient. If designers of stormwater planters want to make a stronger case on which to base their designs, they need to know what the public acceptance level is for plant diversity and whether or not species rich designs are achieving the educational goals at which many designers are aiming.

Furthermore, performing a perception-based assessment that encompasses both observers of a site (nearby residents) and current and potential designers will shed light on where commonalities and divergences occur in visual preference. Surveying both groups for attitudes about watershed issues will help inform how the groups vary.

This project explores how plant species diversity in stormwater facilities is perceived by the nearby residents, and whether people express a preference for the appearance of increased plant diversity in stormwater planters and swales. It also investigates whether the type of stormwater planting preferred by a resident or designer correlates to awareness of the larger purposes of stormwater green infrastructure and attitudes toward watershed issues in general.

I also pose this visual preference question to stormwater professionals (designers and maintenance staff) who work in Eugene, OR, and landscape architecture students at the University of Oregon. Comparison of the professional and student preferences to the residents of Eugene is conducted and discussed.

1.4 RESEARCH QUESTIONS

There are 5 primary research questions for this study.

Question #1: Are minimal or diverse plantings more visually appealing to residents, stormwater professionals, and landscape architecture students in Eugene, OR?

Question #2: What do the respondent groups think are the primary uses for stormwater planters? Do these attitudes vary between the groups?

Question #3: Do residents observe habitat value or seasonal change in stormwater planters? Are students and professionals supportive of designing for habitat value or seasonal change in stormwater planters?

Question #4: For residents, do their visual preferences and awareness vary by the type of planting in the stormwater facilities near them?

Question #5: Does visual preference for plant diversity correlate to awareness of local water systems and stormwater planters?

1.5 RESEARCH DESIGN

Research design and process is summarized in Figure 1.3. This study consists of two separate survey tests: a visual preference test, and a watershed attitudes test. There are three respondent groups: residents of Eugene, OR living within a half mile radius of a stormwater planter, stormwater professionals in Eugene OR, and landscape architecture students at the University of Oregon.

The visual preference test gauges what appearance of stormwater facility is preferred by the respondents. Respondents were given computer generated images of generic stormwater planters with both a low level of species diversity (only one plant species), and a high level (many plant species, structural heterogeneity apparent) and asked which they prefer. They were also asked to list their reasons for their choice.

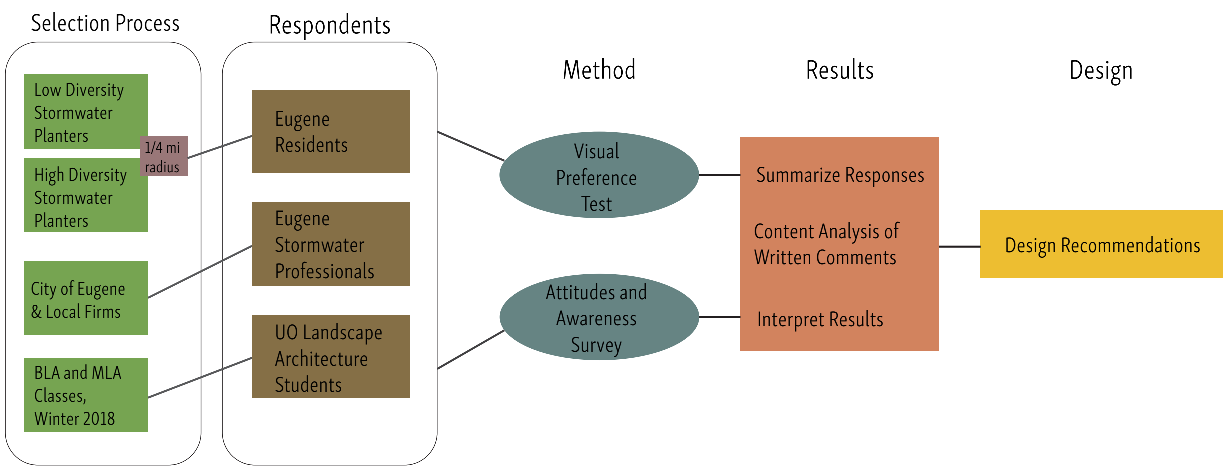


Figure 1.3 Research process diagram for study methods, analysis, and expected outcomes

The watershed attitudes assessment questions target awareness of watershed issues, and whether that awareness correlates with the planting design strategy of the nearest stormwater facility or with respondent's preference for or against a diverse planting strategy.

Respondents were asked a short list of questions regarding their knowledge and awareness of the stormwater facilities and the overall water systems. After the survey results were analyzed, they were used to inform a series of planting designs for several stormwater planters in Eugene. These design proposals are based on visual preferences of residents, stormwater designers and maintenance staff.

METHODS

2.1 RESEARCH METHODS OVERVIEW

The process for conducting the research method for this project consisted of identifying and recruiting participant groups followed by developing and distributing the survey materials.

Subsequent chapters of this document will describe how the data from the survey were processed and analyzed (Survey Results chapter), and how the survey results were brought to bear in a series of projective stormwater planter planting designs (Design chapter).

2.2 STRATEGY OF INQUIRY

The scope of this project employs both deductive and inductive knowledge creation strategies. Using the definitions of Deming and Swaffield (2011) deduction is a way of knowing that involves experimentation and evaluation, while induction builds upon an understanding of human experience and empirical evidence. The deductive survey method of this projects collects quantifiable data with which to test a set of hypotheses on how various groups of people in Eugene, OR view stormwater planters and watershed issues. The results of the survey are used to inductively produce alternative design techniques for stormwater planters in Eugene, OR that take into account the views of the participants of this study (covered in Chapter 4).

This project employs a quantitative method to gather information on the very subjective questions by using a mailed survey to poll people's preferences and attitudes regarding plants in stormwater facilities. The data gathered from the chosen participant groups will provide meaning and context regarding how plants are viewed in stormwater planters, and are used to empirically inform proposed designs. As such, this project is what Deming and Swaffield (2011) consider a social construction approach to knowledge, by constructing an understanding of the world built upon an understanding of people's experiences.

An assumption of this project is that knowing and attending to the preferences and attitudes of both design professionals and the general public will provide a more nuanced approach to the design of stormwater facilities. Furthermore, having quantifiable data on which to claim knowledge of the preferences and attitudes of those groups creates a more informed argument on which to base design decisions. To this end, the results of the survey methods are used to inform alternative planting design strategies that attend to the varied goals and attitudes of surveyed people in Eugene, OR.

2.3 FROM RESEARCH QUESTIONS TO METHODS

As described in the previous chapter, this project has 5 main research questions. The research questions address the topics of visual preference, attitudes and awareness of stormwater issues, and the relationship between designer values and user observations (Table 2.1). As shown in Table 2.1, each question is framed to compare a "controlled" variable (i.e. the independent variable) which can be selected by the researcher, and a "measured" variable (i.e. the dependent variable) which is revealed with the experimental data.

	Controlled variable	Measured variable
Question #1 Are minimal or diverse plantings more visually appealing to residents, stormwater professionals, and landscape architecture students in Eugene, OR?	Participant Group	Visual preference
Question #2 What do the respondent groups think are the primary uses for stormwater planters? Do these attitudes vary between the groups?	Participant Group	Awareness of stormwater planter use
Question #3 Do residents observe habitat value or seasonal change in stormwater planters? Are students and professionals supportive of designing for habitat value or seasonal change in stormwater planters?	Participant Group	Design values
Question #4 For residents, do their visual preferences and awareness vary by the type of planting in the stormwater facilities near them?	Appearance of nearest planter	Visual preference, Attitudes and awareness, Design values
Question #5 Does visual preference for plant diversity correlate to awareness of local water systems and stormwater planters?	Visual Preference	Attitudes and awareness, Design values

Table 2.1 Research questions, their controlled and measured variables

These research questions can only be adequately answered using information gathered by asking people about their thoughts and opinions. Therefore, data on the participants' visual preference for the appearance of stormwater planters, their attitudes and awareness of stormwater planters and watershed issues, and design values and observations were gathered using a mail survey method. A visual preference question offered a choice between two pictures, while the attitudes and awareness survey questions were posed as Likert scale (on a 1-5 range from "strongly agree" to "strongly disagree") or yes/no questions. These types of "closed" survey questions allow for straightforward data analysis. Responses can be aggregated in spreadsheets and analyzed for statistical patterns or correlations. Each question on the survey allowed additional space for people to explain their answer in a sentence or two. The written responses were coded and summarized prior to analysis. This approach is qualitative, rather than quantitative, but can still provide significant insight and context to the responses gathered by Likert scale or binary questions.

The five main research questions are designed to be testable with the results of the data from the survey. The survey can also provide additional information or show patterns not anticipated by the researcher, but which may prove to be useful in the design implications discussed in further chapters of this report.

2.4 RESPONDENT GROUP SELECTION

This project surveys three participant groups: residents of Eugene, OR living within a quarter mile radius of a stormwater planter stormwater professionals in Eugene, and landscape architecture students at the University of Oregon. The residents of Eugene may be considered post-occupancy users of the stormwater planters, given the close proximity of the planters to their homes, and the assumption that they see them almost every day. The stormwater professionals are the group with experience with design and maintenance of, if not the stormwater planters specifically referenced in this study, stormwater facilities around Eugene. The landscape architecture students are future designers, whose knowledge base is likely to be based on theory and their education, rather than field experience.

Selection of Stormwater Planters

Stormwater planters were selected based on planting design, four lower in visible number of species and structural complexity (Figure 2.1) and four higher in these measures of diversity (Figure 2.2). The final eight stormwater planters (Figure 2.3) were chosen using both my own knowledge gained from my experience working on the stormwater maintenance team for the City of Eugene in the summer of 2017, and consultation with the staff of that team.

Lathen Way and Country Haven Dr.

Amazon Pkwy and E. 29th Ave.

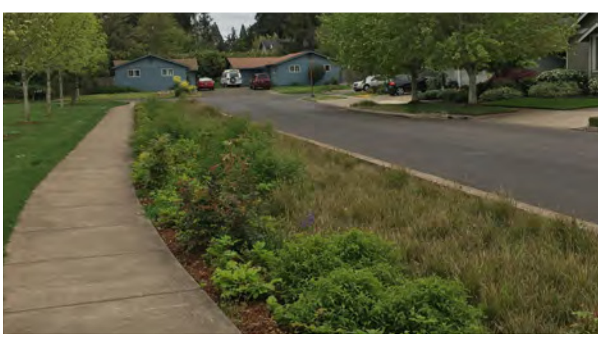
Wedgewood Dr. and River Loop 1

Roosevelt Blvd. between N. Terry St. and Danebo Ave.

Figure 2.1 Photos of lower diversity stormwater planters

W. 13th St. between Bailey Hill Rd. and Dani St.

Lakeview Dr. between County Farm Rd. and Devon Ave.



Manzana St. between Garth Ln. and Benjamin St.

Hilyard St. between E. 26th Ave. and E. 27th Ave.

Figure 2.2 Photos of higher diversity stormwater swales

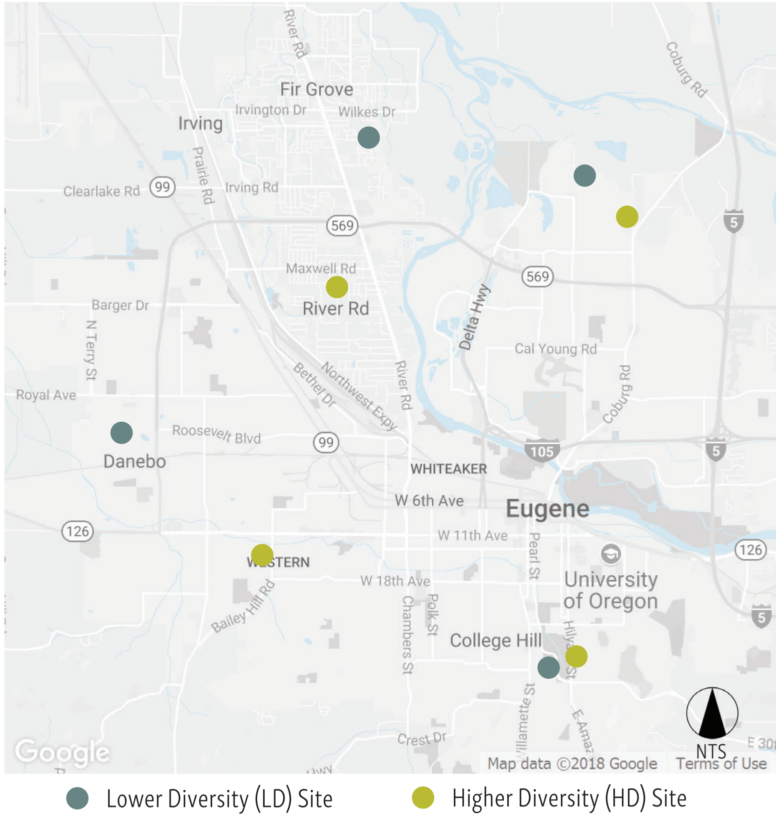


Figure 2.3 Map of stormwater facilities

Recruitment of Eugene Residents

The selection of residents of Eugene, OR was based on proximity to the selected stormwater planters. Using a combination of publicly available information from both Google Maps and the online Whitepages, addresses were found for residences surrounding each stormwater planter. Fifteen addresses near each of the eight stormwater planters were selected as survey recipients, for a total of 120 residents.

Recruitment of Stormwater Professionals

Names and contact information for local stormwater professionals came from my own professional network as a former seasonal employee of the City of Eugene Parks and Open Space department, on the Stormwater Infrastructure Maintenance (SWiM) team. I also asked professionals that I knew to refer me to other professional in their network who they believed would be qualified to participate in this survey, with a final total of seven invited stormwater professionals participants.

Recruitment of UO Landscape Architecture Students

University of Oregon landscape architecture students enrolled in studio classes in the Winter 2018 term were recruited for participation in this project. Undergraduate students in their 3rd, 4th, and 5th years of the landscape architecture program and first professional graduate students in their 1st, 2nd, and 3rd years of study were invited to participate. I visited studios personally to recruit participation, with a total of 67 invited student participants.

2.5 SURVEY METHODOLOGY

Surveys were mailed (along with project description, informed consent form, and a pre-addressed and stamped return envelope) to seven stormwater professionals and 120 residents of Eugene, OR. Surveys for 67 students were handed out before studio classes, and students were instructed to return their survey (in the envelope in which it came) either to me directly, at a drop box on my studio desk, or in my university mailbox in Lawrence Hall.

Visual Preference Test

The first page of the survey was the visual preference test question. The visual preference test gauges what appearance of stormwater facility is preferred by the respondents. Respondents were given two different color images of generic stormwater planters, identical except for the plants shown. One photo had a low level of species diversity (only one species), and one had a high level (many species, structural complexity apparent) and respondents were asked to choose which they would prefer. They were also asked to briefly describe their reasons for their choice.

Attitudes and Awareness Questionnaire

The attitudes and awareness survey contained questions on the following topics:

1) stormwater planter use and function, particularly for flood and pollution control.

2) local watershed issues, particularly water quality and the role of plants in the watershed.

3) observations of stormwater planters (for residents) or preferred design intentions (for professionals and students), pertaining to habitat value and seasonal visual interest.

There were eight questions in total. Six questions asked for respondents to select their answer on a Likert scale of 1-5, with an option to select "don't know/unsure," and two questions were "yes" or "no" questions, also with a "don't know/unsure" option. Survey materials are provided in Appendix A.

SURVEY RESULTS

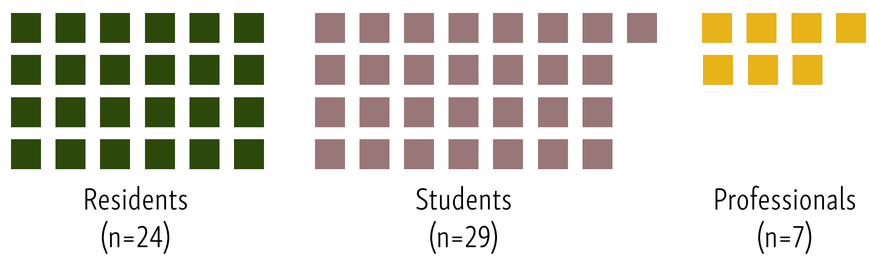


Figure 3.1 Respondent groups

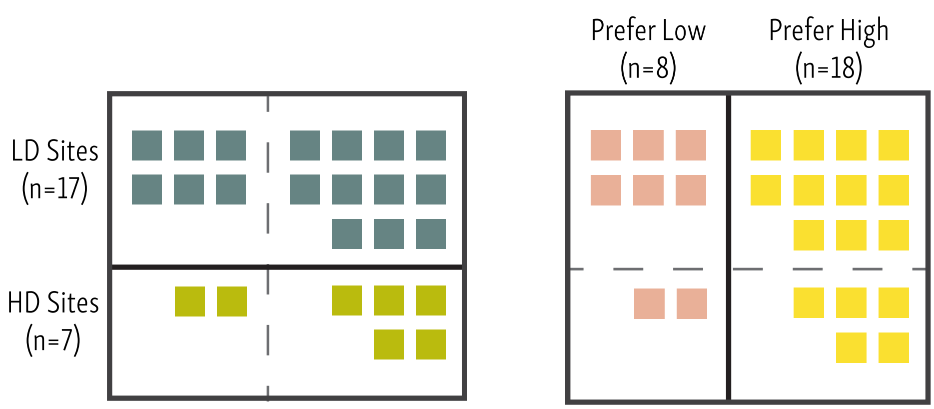


Figure 3.2 Subdivisions of resident group

3.1 OVERVIEW OF SURVEY RESPONSES

Survey responses were received from 24 Eugene residents out of 120 distributed, for a 20% response rate. Students returned 29 surveys out of 67 distributed, for a 43% response rate. Seven professionals agreed to participate, all of whom returned a survey, for a 100% response rate (Figure 3.1).

Likert scale question responses were aggregated and summarized. To aid in analysis, responses on the low end of the Likert scale (numbers 1 and 2) were added together to form a category of "disagree" responses, and responses of 4 and 5 on the scale were added to form an "agree" category.

Investigating some of the research questions required sub-dividing the residents' responses based on the controlled variables of the research question (Figure 3.2). Residents were either separated by the plant diversity in the stormwater planter nearest them (low diversity planters are referred to as "LD sites" and diverse planters are "HD sites), or by their answer to the visual preference question on the survey (either "prefer low" or "prefer high").

Each Likert scale question gave respondents the opportunity to write in the main reasons for their answer. A content analysis approach was used to identify common themes from the written responses and tally how many respondents mentioned each theme.

In this chapter, data have been arranged by the research question they are addressing. Each group's numeric responses, and the themes that arose in the written responses have been summarized. The charts show a general synthesis of the attitudes of the respondent groups. The majority response for each group is labelled with its percent value. A comprehensive summary of survey data is in Appendix B.

It is very important to note that the sample size of respondents in this survey is too small to draw any wider conclusions about residents, students, or professionals in Eugene, OR. Limitations and opportunities for further research are discussed in chapter 5.

3.2 SURVEY RESULTS BY RESEARCH QUESTION

Research Question 1: Are minimal or diverse plantings more visually appealing to residents, stormwater professionals, and landscape architecture students in Eugene, OR?

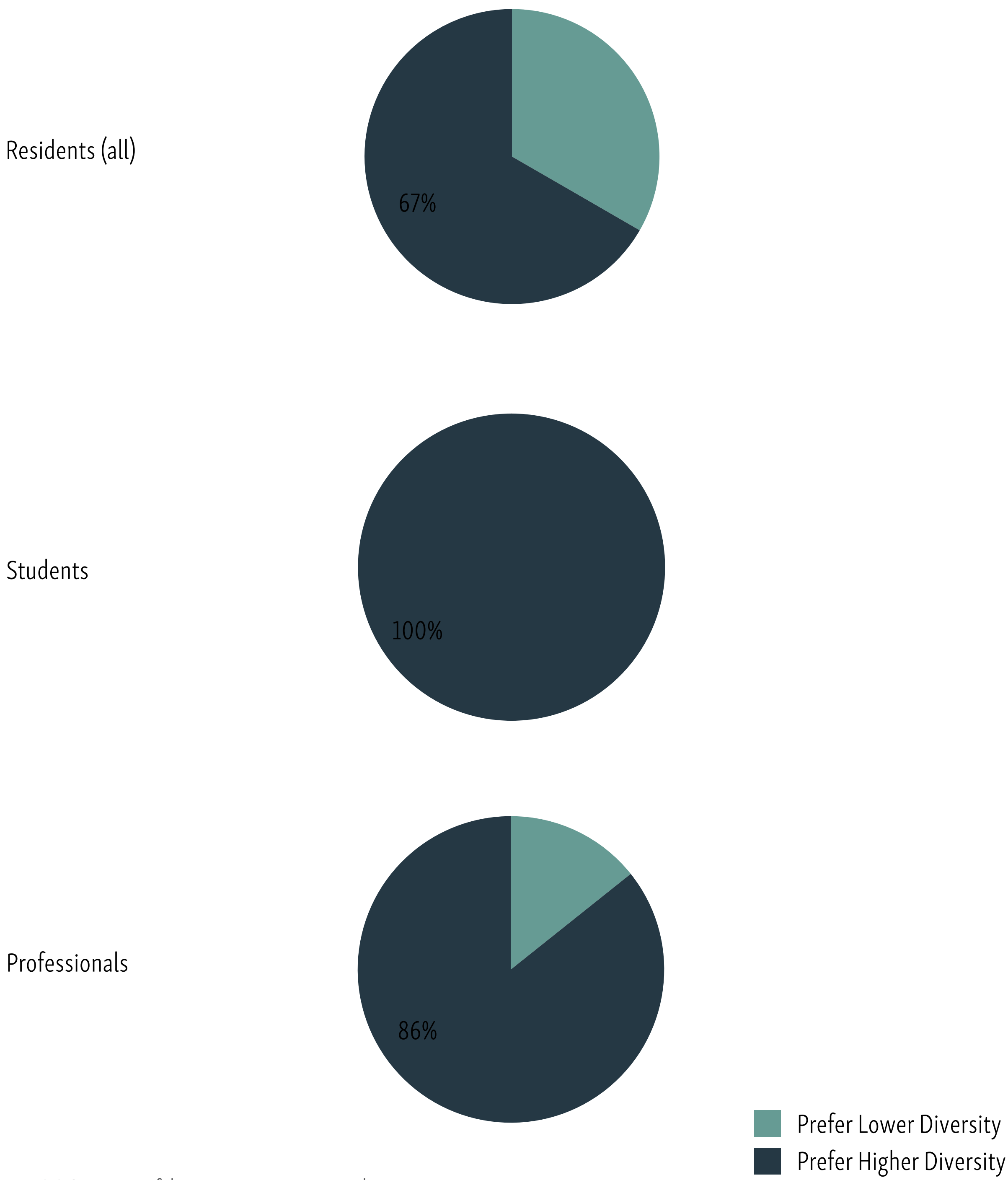


Figure 3.3 Summary of data pertaining to research question #1

Figure 3.3 shows that when posed the choice between an image of a low diversity stormwater planter and one that showed greater plant diversity, a majority of each respondent group preferred the diverse planting.

The narrowest majority occurred in the resident group, where 67% of the respondents preferred the higher diversity planter. Among the people who selected this choice, their written responses indicate that the diversity (often phrased as "variety" by respondents) of plants was a determining factor for almost all of them. Most of the group wrote that they preferred the appearance of the diverse planter, or disliked the look of the more uniform planter.

Written responses of the people who preferred lower diversity revealed a few themes. Most of the residents who preferred the low diversity planter wrote that they like its clean and simple appearance. Cost concern accompanying maintenance was brought up by only one person, who seemingly would have preferred the appearance of the higher diversity planter. No one in this group wrote that plant diversity (or lack thereof) had any bearing on their choice.

Students were unanimous in their preference for the diverse planter. The most common reason for this choice was the diversity or variety of plants. A little more that half of the students mentioned the appearance as contributing to their preference. About 40% wrote that they thought the diverse planter would be more likely to provide a habitat benefit.

Only one out of seven professionals preferred the low diversity planter, and this individual wrote that although they liked the appearance of the high diversity planter, that the low diversity planter had a simpler design that would function better in the long term.

Safety concerns were brought up by a small minority of residents, mentioning that taller plants would create traffic hazards. Maintenance or cost concerns were mentioned by a fair number of group HD residents (those living near a diverse planter) and by a majority of professionals

Functionality of the planters was mentioned by some students and a majority of professionals. Students tended to say they thought a diverse plant palette would function better, or saying that they assumed the diverse planter was fully functional in addition to being diverse. Professionals were split, with some saying the less diverse plant palette would provide more treatment, and some who thought the diversity would add greater function in pollutant uptake.

Design Implications: The majority of surveyed residents of Eugene, OR find stormwater planters with diverse plant palettes to be visually appealing. Landscape architecture students and professionals also prefer more diverse plantings, and so are in agreement with most of the residents surveyed. While there are many concerns when designing diverse stormwater planters, defying the visual preferences of residents need not necessarily be one of them.

Research Question 2: What do the respondent groups think are the primary uses for stormwater planters? Do these attitudes vary between the groups?

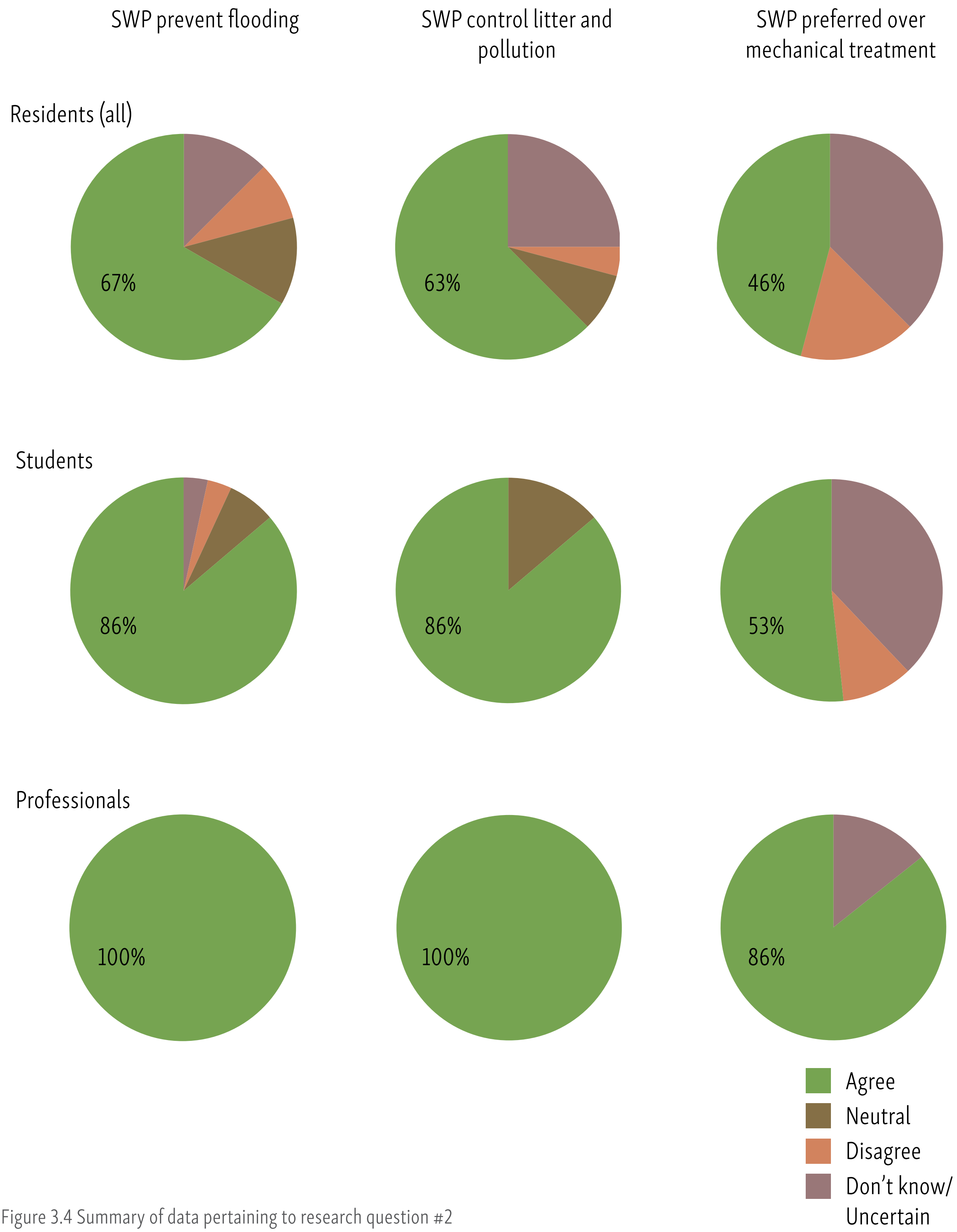


Figure 3.4 Summary of data pertaining to research question #2

Figure 3.4 shows that overall, there is an understanding of the uses of stormwater planters in each group who responded to the survey. Not surprisingly, landscape architecture students and professionals were in stronger agreement about the uses and benefits of stormwater planters than residents were, though a majority of residents also seemed to understand their uses.

Generally, residents understood the uses of stormwater planters (SWP) to prevent flooding and control litter and pollution, with about two thirds of residents agreeing that those were the benefits. Professionals were in unanimous agreement that SWP help prevent flooding and keep litter and pollution out of the local river. Students also strongly agreed with these statements, although roughly one third of students qualified their agreement by saying that SWP could help reduce flooding but not prevent it entirely. Residents were less likely to be able to explain the reasoning behind their assertions, and were the most likely of any group to leave the written portion blank.

Only about 20% of all surveyed residents cited their own observations of SWP preventing floods in their written response, while a little less than 40% wrote that they understood the theoretical function of SWP in absorbing flood water.

A majority of residents agreed with the statement that SWP control litter and pollution. There was a significant difference between the residents and the students and professionals. About 30% of residents understood that trash gets caught in the planters, and so is prevented from getting to the river. About 40% of students and 70% of professionals mentioned this benefit.

Less than 20% of residents mentioned the benefit of water filtration as reason in their explanation. Roughly half of students, and a strong majority of professionals mentioned that SWP provide a water filtration benefit.

A little less than half of residents thought that mechanical treatment was not a better option, almost as many reported being unsure. Students had a very similar reaction to residents, being only very slightly more likely to reject mechanical treatment as an option. A large majority of professionals thought mechanical treatment was not a better option, a small number were unsure, and none agreed. Roughly 30% of all groups (residents compared both ways) worried that mechanical treatment would be too costly. Professionals were the most likely to propose a combination of green and mechanical treatment options (43%). Students and residents proposed this idea at similarly low rates (17% for both).

Design Implications: Residents are generally aware of the uses that SWP serve for water quality control, though not to the same extent as students and professionals. If awareness exists for their uses and benefits, designers may be able to add additional visual interest or ecological value to increase public understanding and acceptance further.

Research Question 2: What do the respondent groups think are the primary uses for stormwater planters? Do these attitudes vary between the groups?

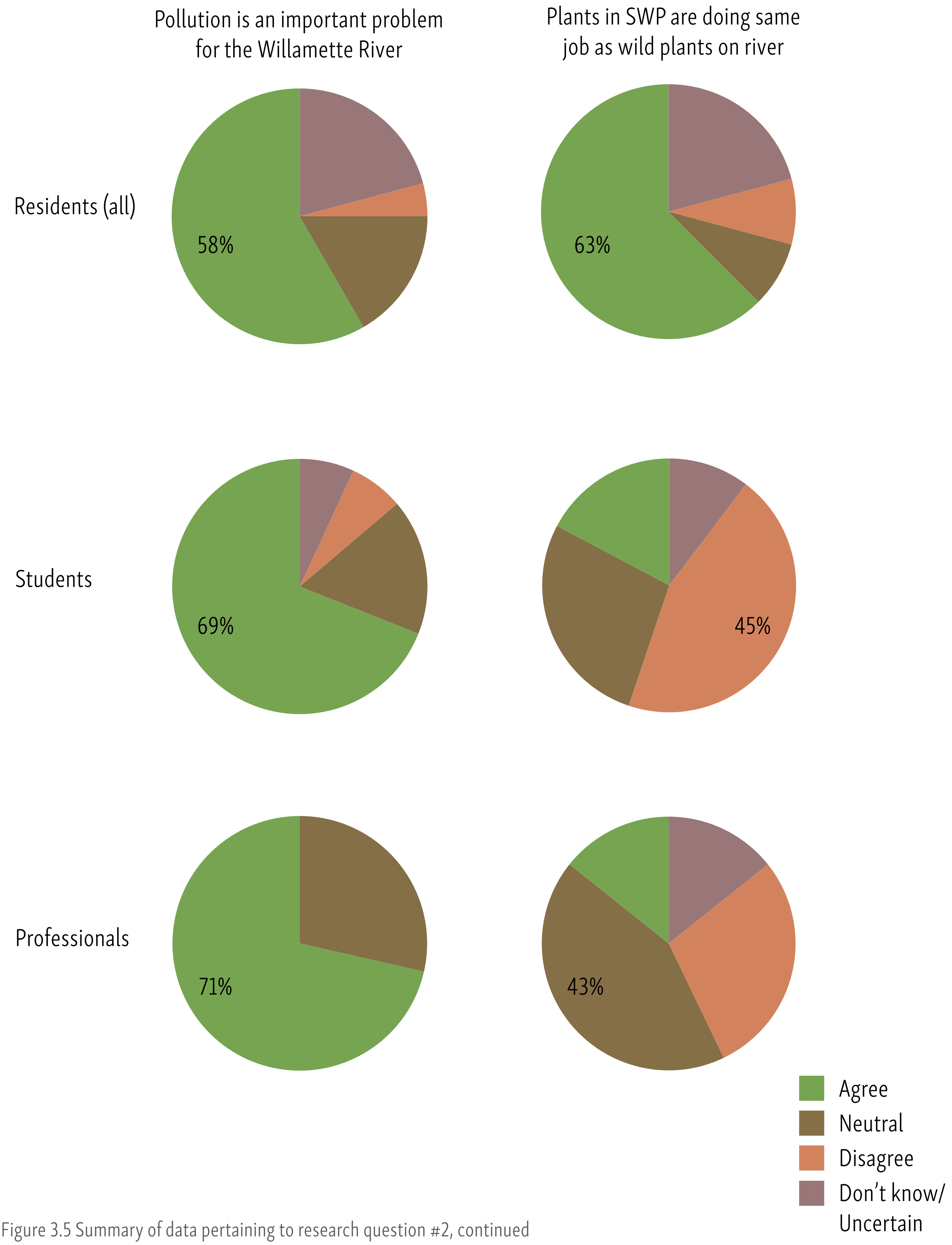


Figure 3.5 Summary of data pertaining to research question #2, continued

Figure 3.5 shows that a slight majority (58%) of residents agreed that pollution is an important problem facing the Willamette River, although many were neutral or undecided. No common theme emerged in the resident written responses.

Students and professionals had higher majorities in agreement, especially professionals, who only responded with 3 or higher on the Likert scale.

Not surprisingly, professionals were much more likely to cite their own work or observations in supporting their choice, something less than 10% of students or residents did.

A third of students wrote that Eugene is no worse than any other city in terms of pollution, or that Eugene's issues with pollution weren't unique. Students were more likely than the other groups to say that agriculture and industry were bigger problems for the river than pollution from the city (17% vs. 4% and 0%)

When asked whether they thought plants in stormwater planters were doing the same job as plants along rivers, there was a strong difference between the groups. Residents were most likely to agree that stormwater plants were doing the same job as wild plants (63%). Students were most skeptical of this statement, with the largest group being the 45% who disagreed, followed by 28% who were neutral. Professionals were also skeptical, with most saying they were neutral or disagreed.

Residents weren't entirely comfortable explaining their answer, one third gave general assertions that the statement was true, and another third left the written portion blank. The most repeated response was water filtration function, but even that was only 17%.

Students most commonly listed retaining water (24%) as a similarity. A larger portion pointed out that they thought that wild plants prevented erosion and that stormwater planters did not (I believe this is debatable). The most common student response was that the contexts of river banks and SWP were too different to make comparisons.

Professionals also most often wrote that the contexts of river banks and SWP were too different to make comparisons (71%). But professionals also mentioned absorbing water (29%) and filtration (29%) as similarities.

Design Implications: The majority of respondents are aware of the problems of water quality in the local waterway, though education may be needed to raise awareness. Residents are also fairly likely to see SWP as proxies or extensions of the plants on a river bank, and so may understand SWP to be important factors in keeping the river clean.

Research Question 3: Do residents observe habitat value or seasonal change in stormwater planters? Are students and professionals supportive of designing for habitat value or seasonal change in stormwater planters?

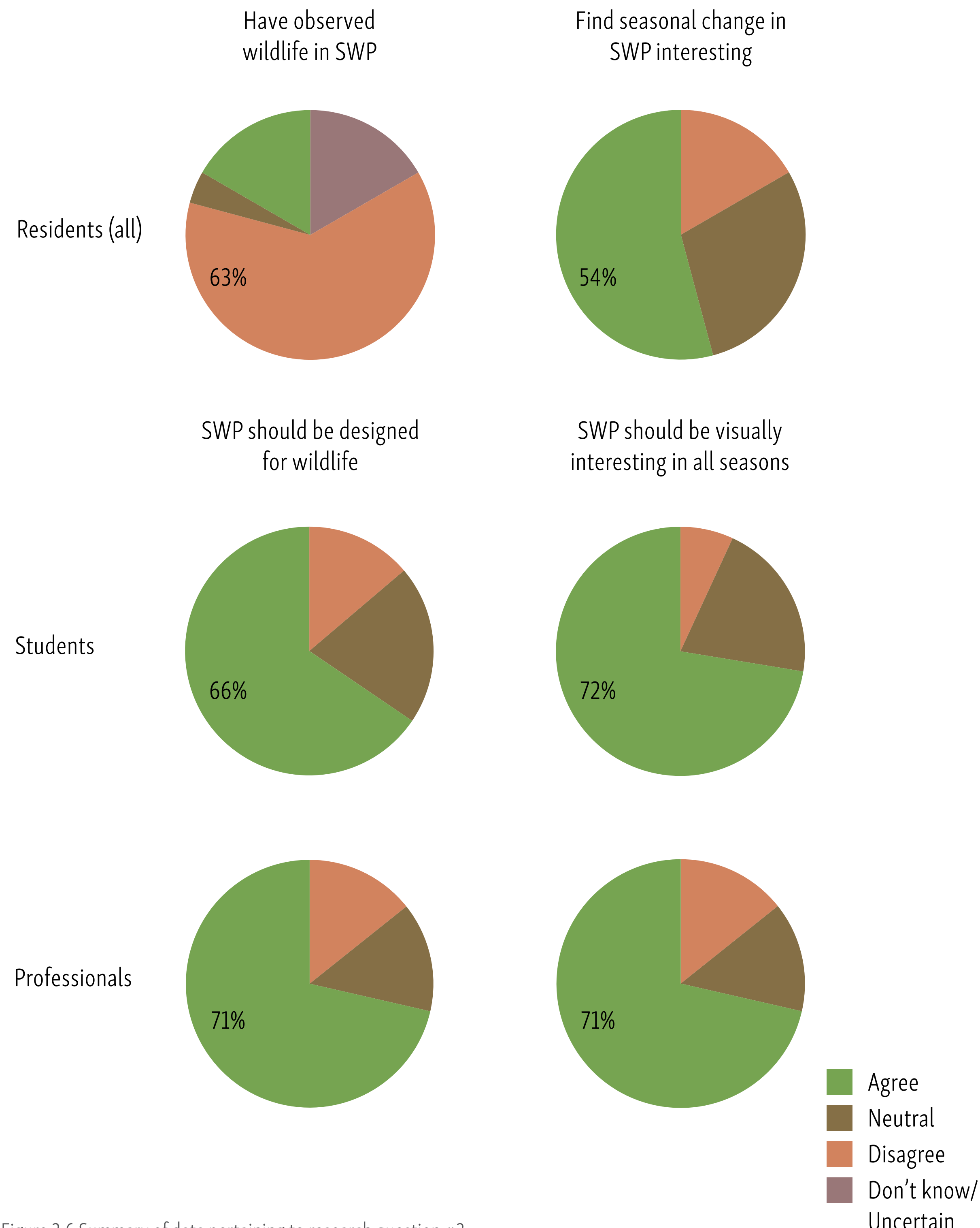


Figure 3.6 Summary of data pertaining to research question #3

Figure 3.6 shows that for this research question, the respondent groups were given different survey questions to see how they respond to the topic of certain ecological processes in stormwater planters. The ecological processes were habitat provision and seasonal change. Residents were asked if they had observed these ecological processes, while students and professionals were asked if they would design for them in an ideal situation.

Residents mostly had not observed wildlife in planters. Those who had mostly reported seeing birds (21% of all residents). On the other hand, students and professionals were mostly in favor of designing for wildlife (66% and 71%, respectively). Only 14% of the students and professionals disagreed with the statement.

Students and professionals did express concerns about some aspects of designing SWP to provide wildlife habitat. 43% of professionals and 28% of students questioned attracting wildlife to SWP, some concerned with taking space away from filtration plants, some with the minimal benefit such habitat would provide. 29% of professionals (and no students) brought up concerns about adding to maintenance time and cost.

When asked what kind of wildlife they would design for, students were most likely to propose designing for pollinators (34%), insects (24%) and birds (24%). Professionals were more in favor of birds (43%), and insects (29%), but less so with pollinators (14%). Both students and professionals brought up the notion that multi-functionality was a positive design goal for SWP, and habitat would be one of those functions (21 and 29%, respectively).

About half (53%) of residents agreed that they found seasonal change in SWP to be interesting, with a significant portion being neutral.

Students and professionals, while in general agreement with this statement, did raise some skepticism. 31% of students and 43% of professionals pointed out that aesthetic value is not the main function of SWP, and that function should always be prioritized. About a quarter of students and professionals did say that seasonal change contributed to the beauty of the stormwater planters. About 30% of each group said that having attractive SWP can increase public acceptance of them.

Design Implications: Stormwater planters are not providing habitat for wildlife, at least not visibly so for surveyed residents. Professionals and students are generally in favor of designing SWP to attract some kinds of wildlife. Where opportunities arise, designing for certain kinds of wildlife may lead more of the public to observe SWP in their local landscape and to see their benefits. Residents are more observant of seasonal change, and as with wildlife, professionals and students are in favor of designing for year-round visual interest. Again, it seems that increasing seasonal interest will catch the eye of more residents, which may help them see how the planters are functioning in the landscape.

Research Question 4: For residents, do their visual preferences and awareness vary by the type of planting in the stormwater facilities near them?

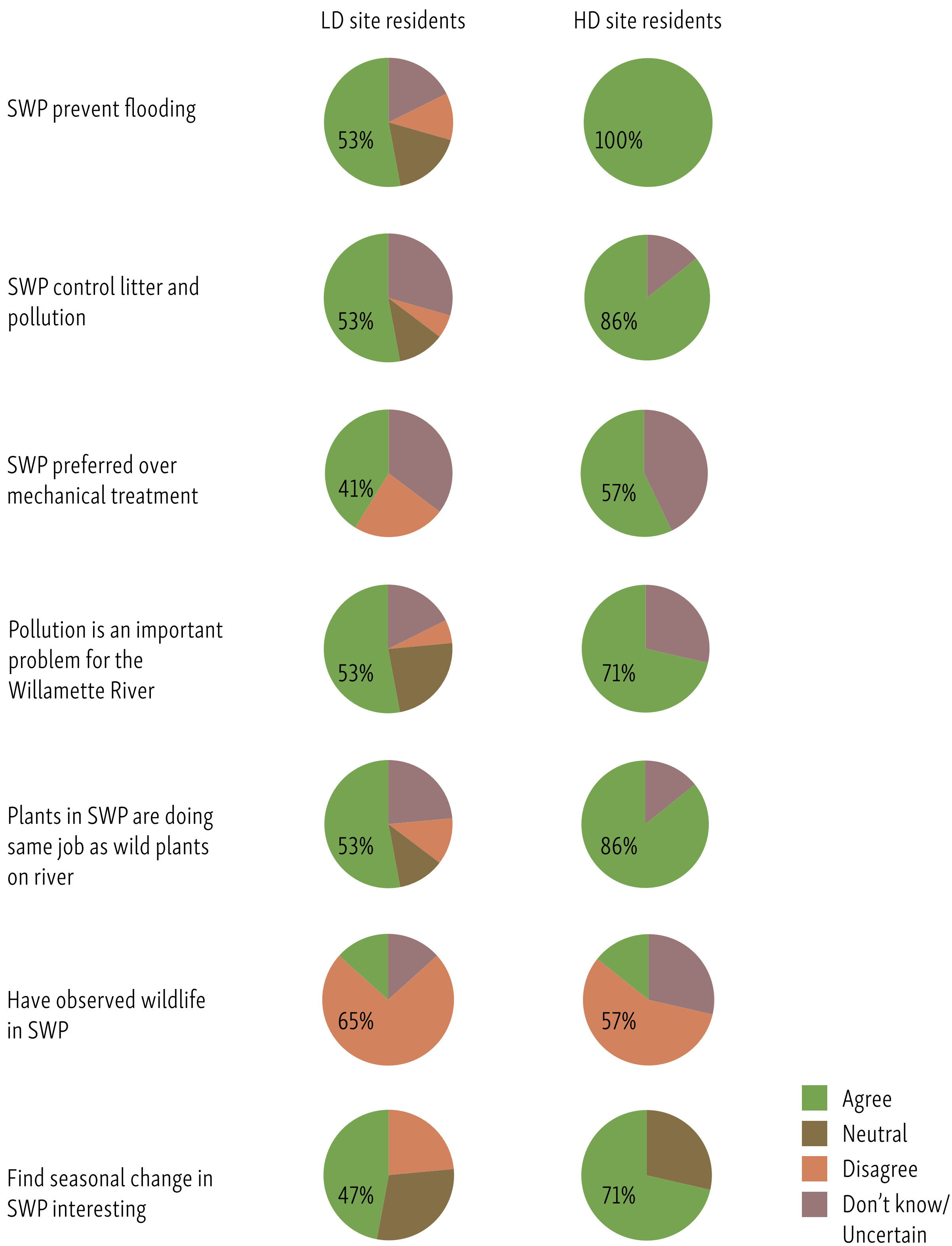


Figure 3.7 Summary of data pertaining to research question #4

Figure 3.7 shows that there was no difference in visual preference between residents living near low diversity planters (LD site residents) and those living near higher diversity planters (HD site residents), but there were some differences in how they explained their preference. Group HD was more likely to mention diversity, variety, or differences in plants as the reason for their choice.

Across all questions asked in this survey HD site residents were more likely to express agreement with the benefits of SWP and their role in the landscape of Eugene, OR. Group HD were more likely to agree that SWP helped prevent flooding, indeed they had 100% positive response. Slightly more than half of group LD agreed. Furthermore, a large portion of group HD used a correct explanation of how SWP prevent flooding in their reasoning for their answer (e.g. “SWP absorb water into the ground, so the storm drains don’t back up”), compared to less than a quarter of group LD.

Regarding whether SWP help keep litter and pollution from reaching a Willamette River, residents in group LD were less likely to agree, only about half, while large majority of group HD agreed. Written responses indicate that there was a similar understanding that SWP trap trash before it enters storm drains. Group HD residents were more than twice as likely as group LD to say they thought there was a water filtration benefit to SWP (29% and 12% respectively).

Group HD was slightly more likely than group LD to prefer SWP over mechanical treatment options for stormwater. While almost a quarter of group LD would prefer the mechanical treatment option, none in group HD preferred that option. Group HD was more likely to explain their stance with the assertion that “natural solutions” are always preferable. A similar proportion of each group worried that mechanical treatment would be too costly. This may indicate a more positive view of green infrastructure solutions to stormwater in residents with plant diverse stormwater planters nearby.

People in group HD were more likely to agree that pollution is an important problem for the Willamette River and that SWP plants are performing the same function as wild river bank plants. In fact, none in group HD disagreed or were neutral. However, no commonalities or trends were evident in the written responses, so there are few clues to why this might be.

Whether the residents observed wildlife in SWP did not change much depending on the design of nearest stormwater planter. Group HD was more likely to find seasonal change in SWP to be interesting. All those who disagreed with this were from group LD. Nearly a quarter of group LD wrote that they find the SWP plants to look bad at some point of the year, while group HD was somewhat more likely to say that seasonal change was beautiful.

Design Implications: Taken together, these trends may suggest that more diverse planters are a better vehicle for demonstrating SWP functions and benefits.

Research Question 5: Does visual preference for plant diversity correlate to awareness of local water systems and stormwater planters?

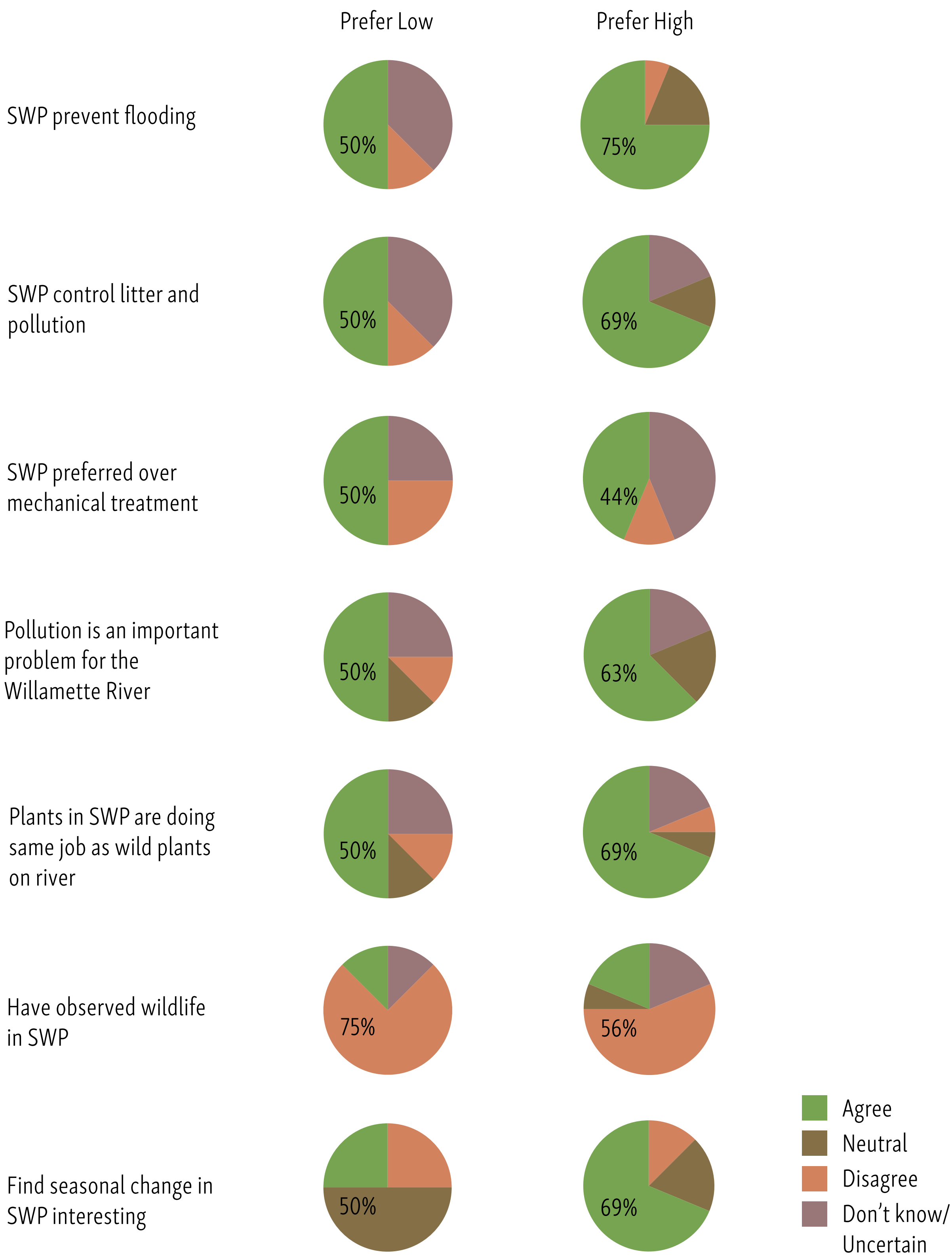


Figure 3.8 Summary of data pertaining to research question #5

Figure 3.8 shows that when the residents were sorted by their visual preference choice for plant diversity (“prefer low” and “prefer high”) it is possible to see different patterns. Differences were not very dramatic, but generally those who prefer the higher diversity planters had a higher level of agreement regarding benefits of SWP and their role in the landscape of Eugene, OR.

Those who prefer higher plant diversity were more likely to think SWP prevent flooding than those who prefer low diversity (75% and 50%, respectively). This was a statistically significant difference according to a Fisher’s exact test calculation. Those in the higher preference group were also more likely to demonstrate that they knew that the purpose of SWP was to absorb water into the ground before it got to a storm drain (44% vs. 25%, respectively).

Similarly, those who preferred higher plant diversity also were more likely to agree that SWP keep litter and pollution out of the local river. Only about half of those who preferred low diversity agreed that SWP control litter and pollution. Additionally, 44% of those who prefer high diversity said that they knew that trash gets trapped before it enters the storm drains, while none in the “prefer low” group expressed that understanding.

People who prefer higher diversity were more likely to agree that pollution was an important problem and to believe that SWP plants were performing the same function as wild plants on a river bank. The margin for this difference was slight, however, and no trends were apparent in the written responses.

Those who prefer higher diversity planters were slightly more likely to have observed wildlife in stormwater planters, or to be neutral or unsure. The group preferring high diversity were much more likely to agree that the seasonal change in SWP was interesting, and the low diversity preference group was more likely to be neutral or disagree. A quarter of the high preference group wrote that seeing seasonal change makes a SWP or the neighborhood more beautiful (this was not said by any in the lower preference group).

Design Implications: It may be useful for designers and maintainers of SWP to have a better understanding of attitudes of people who express different visual preferences, so as to tailor educational or outreach communications to residents to increase public knowledge, awareness and acceptance.

DESIGN

4.1 FROM SURVEY RESULTS TO DESIGN QUESTION

This survey may be considered a pilot study to examine respondent group's attitudes toward the appearance and use of stormwater planters. The sample size of respondents was too small to be statistically representative of the resident, student, or professional populations in Eugene, OR. If, however, a similar study was undertaken, and the trends found in this study held true, there would be several interesting takeaways regarding the design of stormwater planters.

Residents of Eugene are also mostly in agreement with landscape architecture students and stormwater professionals regarding the beneficial uses of stormwater planters. Furthermore, most surveyed residents of Eugene prefer the appearance of greater plant diversity in stormwater planters near them. If the visual appearance of plant diversity is one of the factors that increases public acceptance of these facilities, it may increase willingness to care for (or at least not litter in) stormwater facilities, or willingness to have public funds pay for more throughout the city. Landscape architecture students and local stormwater professionals were also in favor of designing with a more diverse plant list, so should be empowered to explore ways to do so, without worry that the public prefers a more minimal approach. These findings lead to an interesting new design challenge: given that the appearance of plant diversity is preferred by both residents and designers, how would stormwater planter design be approached with plant diversity as a primary goal?

4.2 OVERVIEW OF SITE

The location chosen to model an example of a diverse stormwater planter is a newly constructed retrofitted intersection at the corner of W. 12th Ave. and Jefferson St. in Eugene, OR (Figure 4.1). This intersection in Eugene is in a residential area, but is quite heavily travelled, as this stretch of Jefferson St. originates as the off ramp from the I-105 expressway, and terminates in an entrance to the Lane Events Center.

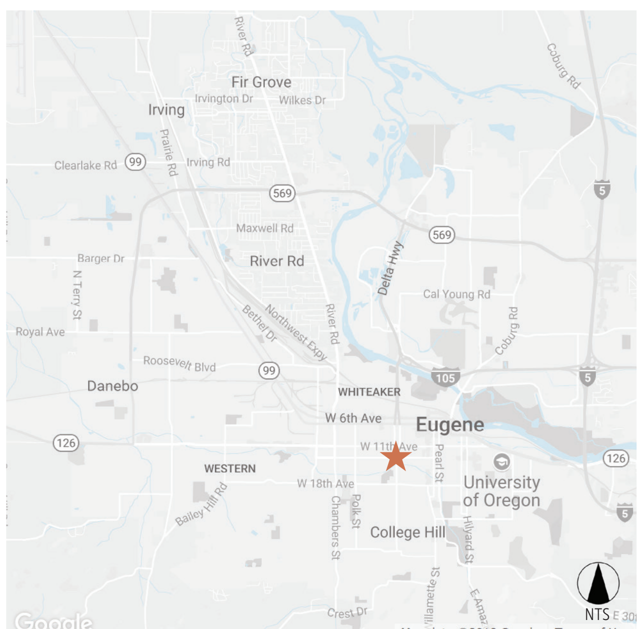


Figure 4.1 Context map of site location in Eugene, OR

Curb extensions were added to this corner in 2017 (Figure 4.2). These designs are also known as "bump outs," which capture runoff in stormwater

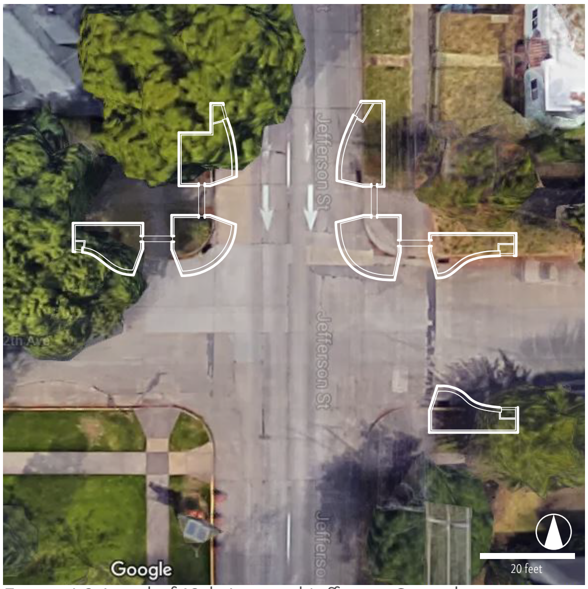


Figure 4.2 Aerial of 12th Ave. and Jefferson St. curb extensions

planters, as well as increase pedestrian safety and calm traffic speeds. According to the Portland Stormwater Manual (2016), curb extension stormwater facilities can either be constructed as swales (which have sloped sides and no concrete walls) or as stormwater planters (having flat bottoms and concrete walls), however the Eugene Stormwater Manual (2014) does not have a separate category for curb extensions. At the corner of 12th and Jefferson, the curb extensions are constructed as planters, flat bottomed facilities with concrete walls on all sides.

The newly constructed stormwater planters comprise 7 separate facilities, capturing water in the northwest, northeast, and southeast corners (Figure 4.3). The northeast and northwest corners each comprise 3 planters connected under the sidewalks with grate covered channels, while the southeast corner has a single planter. Each group of planters and the single planter have an outlet in the form of a beehive (domed) stormwater drain located at the soil level, which prevent the water level in the planters from rising too high. The inlets of the facilities are gaps in the curb, topped with a metal plank. Each inlet deposits runoff into a splash pad, which is a concrete pan a few inches deep with notched sides, that allows sediment in the runoff to settle out and the water to enter the planter more widely dispersed and with reduced speed. Flat bottomed splash pads also greatly reduce staff time and effort for inlet maintenance, as accumulated sediment can be more easily shoveled out compared to gravel or rock splash pads that require hand tools to remove sediment.


Figure 4.3 Site photo looking east showing NW corner planters

4.3 DESIGN RECOMMENDATIONS

Working on the assumption that more plant diversity in stormwater planters will increase public enjoyment and acceptance of them, the recommendations in this chapter explore strategies for introducing more plant diversity into stormwater planters in Eugene, OR.

Design challenges for stormwater planters

Stormwater planters offer a unique challenge for planting design, especially those occurring in the right-of-way areas on city streets. Stormwater planters have flat bottoms and concrete sides to contain soil and vegetation, which differentiates them from stormwater swales that have vegetated side slopes. The stormwater manuals of both Eugene and Portland define the bottom of stormwater facilities as "Zone A," while the dryer side slopes are referred to as "Zone B" (Figure 4.4 and 4.5). Having a flat bottom means that runoff entering SWP floods the facility evenly, and so the entire planter is Zone A. This limits the number of suitable plants for these facilities, as every plant in Zone A needs to withstand occasional to persistent inundation throughout the Oregon winter.

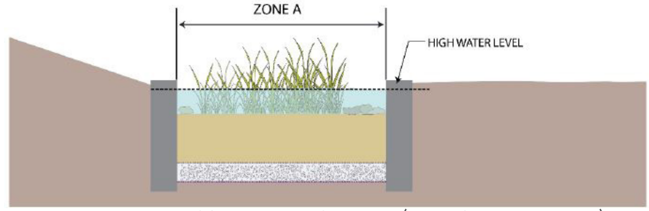


Figure 4.4 Diagram of flat-bottom facilities (City of Portland 2016)

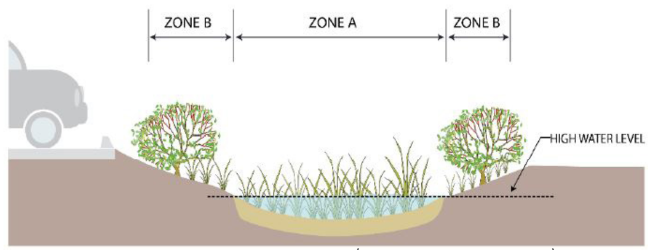


Figure 4.5 Diagram of sloped facilities (City of Portland 2016)

Plants in stormwater planters in Eugene not only have to contend with extended flooding in the winter, but also hot temperatures and drought in summers. The physical features of stormwater planters can cause stress to plants, further restricting the number of species that can survive in such facilities. In summer, the concrete sides of planters heat up and reflect sunlight, which on warm summer days can overheat the plants they contain. This radiant heat is compounded by the use of pea gravel to mulch many stormwater planters (Figure 4.6). The design requirements for stormwater planters in the Eugene stormwater manual specify that "washed pea gravel, river run rock or other non-floating mulch" be used to cover soil at a depth of 2-3 inches (City of Eugene 2014). While pea gravel is useful for weed suppression and can help trap moisture in the soil, the surface of the gravel layer can get hot in the sun and reflect heat to the base and undersides of plants in stormwater planters.

The locations of public stormwater planters can further constrain the number of suitable plant species. Many SWP occur in the right-of-way areas between streets and sidewalks and even, as is the case with the 12^{th} and Jefferson site, as curb extensions at intersections. It is vital for vehicle and pedestrian safety that plants in these facilities do not block visibility between the streets and sidewalks. Therefore, potential mature plant height is an important limiting factor for plants used in SWP.

Proposed strategies to address challenges and allow for more plant diversity

Clearly, there are several factors that make adding a diverse range of plant species in pubic stormwater planters a difficult endeavor. The growing conditions are harsh and maintenance is minimal, meaning that a limited number of plant species are up to the job. But I argue that some strategies can be employed to increase plant diversity, and these strategies are worth testing based on the high rate of preference for higher plant diversity found in the survey results shown in Chapter 3.

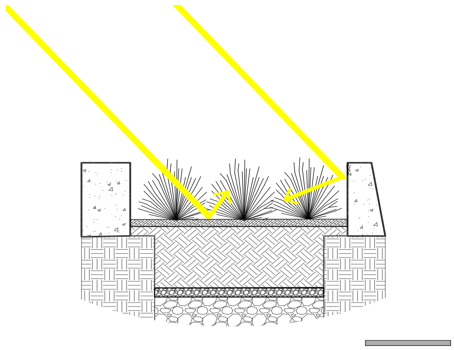


Figure 4.6 Reflected heat reflects off concrete planter sides and pea gravel

First, strategies can be undertaken to reduce the harsh summer conditions occurring in stormwater planters. Occasional summer irrigation by stormwater maintenance staff may be implemented to both cool and hydrate the plants in the long summer droughts, but this technique is time intensive for staff and cannot be relied upon to ensure the survival of vulnerable plants. A more long-term solution may be strategically planting shrubs or larger herbaceous plants along any south or west facing inner walls of planters, to shade these walls and reduce the intensity of reflected sunlight (Figure 4.7).

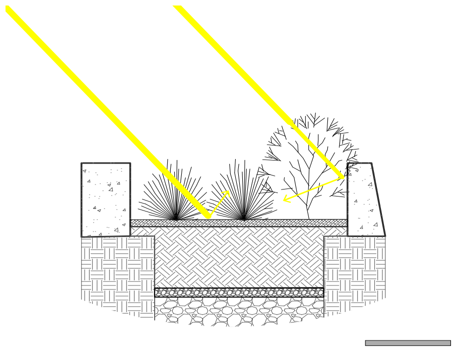


Figure 4.7 Shrubs and mulch reduce reflected heat

By replacing the practice of mulching the planters with pea gravel, with coarse wood and bark mulch, soil and plants can be kept cooler, as gravel mulch has been shown to increase soil temperature whereas organic mulch will reduce soil temperature and narrow the temperature fluctuation range (Jordán et al. 2014). Careful attention should be given to ensure that wood mulch does not escape the facility through the storm drain outlet. For example, the drains could be surrounded by a layer of river rock planted with sedges that would trap mulch that might float into the drain, as shown in the planting plans to follow (Figure 4.8, details in Figures 4.17 and 4.18 on page 52).

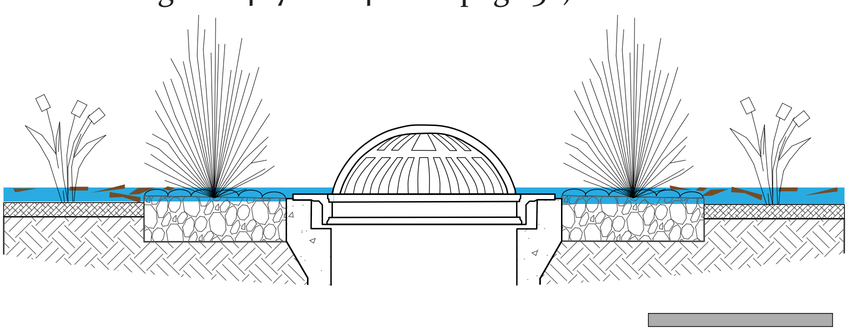


Figure 4.8 River rock and plants block mulch from floating down outlet drain

The most immediate impediment to the number and types of species in stormwater planters are the restrictive lists of species approved of by the City of Eugene for use in stormwater planters in right-of-way zones. Ideally, plants are selected that can survive the level of moisture, pollution, maintenance and disturbance they might encounter in the public realm, as well as accounting for height restrictions or other safety concerns. However, it warrants exploration of these lists to ensure that all possible species are considered. New species could be experimentally placed in field conditions to test their inclusion on the approved plant list. The first place to start with this expansion of the plant list would be to compare it to the approved plant lists outlined in stormwater management manuals of other cities in western Oregon. Any plant species that meets the height requirement for safety and can survive the moisture conditions of a stormwater plant should be considered eligible to be included in the plant list approved by the city of Eugene.

In examining the lists of plants approved for use in the City of Eugene and the City of Portland there is considerable opportunity to diversify the types and numbers of species used in stormwater planters. For example, it is recommended that either 0, 4 or 12 small shrubs can be added to every 100 square feet of planting area, with the rest of the area being filled with herbaceous plants, mostly *Juncus* and *Carex* species (City of Eugene 2014). The reasoning for this is most likely to maximize the so-called "treatment area" of the planter, the area of plant species considered to be the most efficient at treating pollution in stormwater runoff. However, the trade-off is plant diversity, and it is at the cost of the preferred appearance of the majority of surveyed residents, stormwater professionals, and landscape architecture students of Eugene, as well as the other added benefits of plant diversity outlined by professionals in the survey results. I recommend loosening the required number of shrubs per 100 square feet, allowing more flexibility in planting design. Furthermore, because the planters at the 12th and Jefferson site are on the curbside of an intersection, there needs to be a height limitation. The Eugene Stormwater Manual requires that no plant in the right-of-way should be over 24" in height when fully grown, but I would suggest a mature height of 36" which still excludes trees and large shrubs. Because the soil level of the planters on 12th and Jefferson are 18" below ground level, a plant with a height of 36" will not create a traffic hazard. Allowing for a little extra height opens up many additional species on the plant list for use in the 12th and Jefferson planters (Figure 4.9).

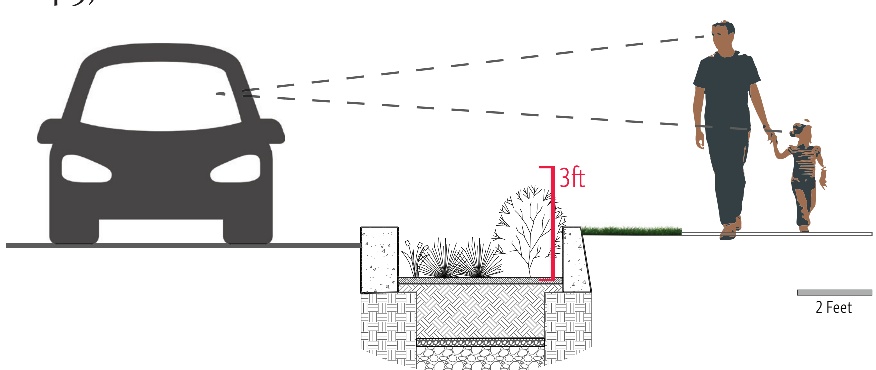


Figure 4.9 Plants up to a mature height of 3' do not present a visibility barrier when planted below ground level

4.4 PLANT LIST RECOMMENDATIONS

Proposed Planting Strategy: "Diversify Zone A"

My first proposed planting plan involves using a wider variety of plants classified under the "Zone A" designation of the stormwater manual of the City of Eugene, those that can withstand frequent inundation and wet soils. This planting strategy prioritizes selecting plant species that range in growth habit (selecting forbs and small shrubs) to join the sedges and rushes usually used.

To build a potential plant palette for this plan, I looked at the approved stormwater plant lists of both the City of Eugene and the City of Portland. All plants on the following lists appear on one or both of those city's plant lists, are a maximum of 36" in height, and are recommended for use in "Zone A" of a swale or a planter. The list of plants approved in Eugene for use in the public right-of-way is quite limited: only 9 species of the sedges/rushes plant type, and 1 small shrub (see Table 4.1).

Latin Name	Common Name	Plant Type
Carex densa	Dense Sedge	Sedge/Rush
Carex obnupta	Slough Sedge	Sedge/Rush
Carex stipata	Sawbeak Sedge	Sedge/Rush
Carex tumulicola	Foothill Sedge	Sedge/Rush
Cornus sericea 'Kelseyi'	Kelsey's dwarf red-twig Dogwood	Shrub
Juncus acuminatus	Tapertip Rush	Sedge/Rush
Juncus effusus var. gracilis	Common Rush	Sedge/Rush
Juncus effusus var. pacificus	Soft Rush	Sedge/Rush
Juncus ensifolius	Dagger-leaf Rush	Sedge/Rush
Juncus patens	Spreading Rush	Sedge/Rush

Table 4.1 Zone A plants approved for use in public projects in Eugene, specifically in the public right-of-way (City of Eugene 2014)

The list expands when it includes plants that are approved for public use in Eugene (see Table 4.2), plants that are approved for public stormwater planters and swales in Portland (see Table 4.3), and plants that are approved for use in private stormwater swales and planters in Portland (Table 4.4).

Latin Name	Common Name	Plant Type
Agrostis exarata	Spike Bentgrass	Grass
Allium amplectens	Slim leaf Onion	Forb
Beckmannia syzigachne	American Slough Grass	Grass
Blechnum spicant	Deer Fern	Fern
Bromus carinatus	California Brome Grass	Grass
Bromus sitchensis	Alaska Brome	Grass
Bromus vulgaris	Columbia Brome Grass	Grass
Camassia quamash	Common Camas	Forb
Carex deweyanna	Dewey Sedge	Sedge/Rush
Danthonia californica	California Oatgrass	Grass
Deschampsia cespitosa	Tufted Hair Grass	Grass
Deschampsia elongata	Slender Hairgrass	Grass
Dichelostemma congestum (congesta)	Ookow (Northern Saitas)	Forb
Downingia elegans	Calico Flower	Forb
Eleocharis acicularis	Needle Spike Rush	Sedge/Rush
Eleocharis ovata (obtusa)	Ovate Spike Rush	Sedge/Rush
Eleocharis palustris	Creeping Spike Rush	Sedge/Rush
Elymus glaucus	Blue Wild Rye	Grass
Epilobium densiflora	Dense Spike Primrose	Forb
Eriophyllum lanatum	Oregon Sunshine (Wooly Sunflower)	Forb
Festuca occidentalis	Western Fescue Grass	Grass
Festuca roemeri var. roemeri	Roemer's Fescue	Grass
Glyceria occidentalis	Western Manna Grass (NW Mannagrass)	Grass
Juncus oxymeris	Pointed Rush	Sedge/Rush
Juncus tenuis	Slender Rush	Sedge/Rush
Juncus unilateralis	One-sided Rush	Sedge/Rush
Lupinus polyphyllus	Large-leaved Lupine	Forb
Polystichum munitum	Sword Fern	Fern
Scirpus americanus	American Bulrush	Sedge/Rush
Scripus microcarpus	Small Fruited Bulrush	Sedge/Rush
Spirea betulifolia	Shiny-leaf Spirea	Shrub

Table 4.2 Zone A plants approved for use in any stormwater facilities in Eugene (City of Eugene 2014)

Latin Name	Common Name	Plant Type
Lavandula angustifolia 'Hidcote Blue'	Hidcote Blue English	Shrub
Liriope muscari 'Big Blue'	Big Blue Lilyturf	Grass-like
Nandina domestica 'Moon Bay'	Moon Bay heavenly bamboo	Shrub
Spiraea japonica 'Goldmound'	Gold mound Japanese spirea	Shrub
Spiraea japonica 'Walbuma'	Magic Carpet Japanese spirea	Shrub

Table 4.3 Zone A plants approved for use in public stormwater facilities in Portland (City of Portland 2016)

Latin Name	Common Name	Plant Type
Carex rupestris	Curly Sedge	Sedge/Rush
Carex testacea	New Zealand Orange Sedge	Sedge/Rush
Carex vesicaria	Inflated Sedge	Sedge/Rush
Cistus spp.	Various rock rose species	Shrub
Iris sibirica	Siberian Iris	Forb
Juncus balticus	Baltic Rush	Sedge/Rush
Schoenoplectus americanus	American Bulrush	Sedge/Rush
Sisyrinchium californicum	Yellow-eyed Grass	Forb
Spirea densiflora	Sub-Alpine Spirea	Shrub
Spirea x bumalda	Bumald Spirea	Shrub
Thuja plicata dwarf and semi-dwarf spp.	Semi-dwarf Western Red Cedar	Shrub
Vaccinium ovatum	Evergreen Huckleberry	Shrub
Veronica liwanensis	Speedwell	Forb
Viburnum davidii	David Viburnum	Shrub

Table 4.4 Zone A plants approved for use in private stormwater facilities in Portland (City of Portland 2016)

Proposed Planting Strategy: "Add Zone B"

The number of approved plants grows substantially when it is expanded to include plants that can withstand the conditions in "Zone B," the higher ground found on the side slopes of a stormwater facility where soils are rarely inundated and less frequently wet. These Zone B plants vary in growth habit, size, color, bloom time and more. However, all of these species are precluded from being planted in stormwater planters, which are not designed with side slopes. My plan for addressing this involved using straw wattles to created raised planter beds within the stormwater planters, thus creating space for Zone B plants to thrive. Straw wattles are nylon mesh tubes (about 8" in diameter and usually 20-25' long) filled with straw primarily used for slope support and erosion control. Their permeability allows water to percolate through, which means they should not drastically impede the water flow through a stormwater planter, especially one where the flow is slowed and distributed by a splash pad as is the case at 12th and Jefferson.

Building a potential plant palette for this plan used the same process as in the previous planting strategy. Again, I looked at the approved stormwater plant lists of both the City of Eugene and the City of Portland. All plants on the following lists appear on one or both of those city's plant lists, are a maximum of 36" in height, and are recommended for use in "Zone B" of a swale. The list of plants approved in Eugene for use in the public right-of-way is quite limited: only 9 species of the sedges/rushes plant type, and 1 small shrub (see Table 4.5).

The list expands when it includes plants that are approved for public stormwater planters and swales in Portland (see Table 4.6), plants that are approved for public use in Eugene (see Table 4.7), and plants that are approved for use in private stormwater swales and planters in Portland (Table 4.8).

Latin Name	Common Name	Plant Type
Arctostaphylos uva-ursi	Kinnickinnick	Shrub
Cornus sericea 'Kelseyi'	Kelsey's dwarf red-twig dogwood	Shrub
Daffodil sp.	Daffodil	Forb
Fragaria chiloensis	Coastal Strawberry	Forb
Iris douglasiana	Douglas Iris	Forb
Iris tenax	Oregon Iris	Forb
Mahonia nervosa	Dull Oregon Grape	Shrub
Mahonia repens	Creeping Oregon Grape	Shrub
Nandina domestica ('Nana' in Portland)	Dwarf heavenly bamboo	Shrub
Polystichum munitum	Sword Fern	Fern
Rubus calcynoides	Creeping Bramble	Shrub
Rubus pentalobus	Creeping Rubus	Shrub
Spirea sp.	Dwarf Spirea	Shrub

Table 4.5 Zone B plants approved for use in public projects in Eugene, specifically in the public right-of-way (City of Eugene 2014)

Latin Name	Common Name	Plant Type
Carex morrowii 'Ice Dance'	Ice Dance Japanese Sedge	Sedge/Rush
Lavandula angustifolia 'Hidcote Blue'	Hidcote Blue English	Shrub
Liriope muscari 'Big Blue'	Big Blue Lilyturf	Grass-like
Nandina domestica 'Moon Bay'	Moon Bay heavenly bamboo	Shrub
Spiraea japonica 'Goldmound'	Gold mound Japanese spirea	Shrub
Spiraea japonica 'Walbuma'	Magic Carpet Japanese spirea	Shrub

Table 4.6 Zone B plants approved for use in public stormwater facilities in Portland (City of Portland 2016)

Latin Name	Common Name	Plant Type
Aster hallii	Hall's Aster	Forb
Aster subspicatus	Douglas' Aster	Forb
Athyrium felix-femina	Lady Fern	Fern
Camassia quamash	Common Camas	Forb
Collomia grandiflora	Large Leaf Collomia	Forb
Deschampsia cespitosa	Tufted Hair Grass	Grass
Festuca rubra	Red Fescue	Grass
Fragaria vesca	Woodland Strawberry	Forb
Fragaria virginiana	Wild Strawberry	Forb
Gaultheria shallon	Salal	Shrub
Helictotrichon sempervirens	Blue Oat Grass	Grass
Lupinus micranthus	Small Flowered Lupine	Forb
Lupinus polyphyllus	Large-leaved Lupine	Forb
Mahonia aquifolium	Tall Oregon Grape	Shrub
Potentilla gracilis var. gracilis	Graceful (Slender) Cinquefoil	Forb
Prunella vulgaris var. vulgaris	Heal All	Forb
Pteridium aquilinum	Bracken Fern	Fern
Rosa gymnocarpa	Baldhip Rose	Shrub
Sedum oreganum	Oregon Stonecrop	Forb
Spirea betulifolia	Shiny-leaf Spirea	Shrub

Table 4.7 Zone B plants approved for use in any stormwater facilities in Eugene (City of Eugene 2014)

Latin Name	Common Name	Plant Type
Baccaris pilularis 'Dwarf'	Dwarf Coyote Bush	Shrub
Cistus spp.	Various rock rose species	Shrub
Hebe spp.	Various hebe species	Shrub
Lavendula spp.	Lavender species	Shrub
Lupinus bicolor	Bicolor Lupine	Forb
Paxistima myrsinites	Oregon boxwood	Shrub
Sisyrinchium californicum	Yellow-eyed Grass	Forb
Spirea densiflora	Sub-Alpine Spirea	Shrub
Spirea x bumalda	Bumald Spirea	Shrub
Symphyotrichum subspicatum	Douglas' Aster	Forb
Thuja plicata dwarf and semi-dwarf spp.	Semi-dwarf Western Red Cedar	Shrub
Vaccinium ovatum	Evergreen Huckleberry	Shrub
Viburnum davidii	David Viburnum	Shrub

Table 4.8 Zone B plants approved for use in private stormwater facilities in Portland (City of Portland 2016)

Each of these plans represent a considerable expansion of the number of species available to stormwater facility designers (Figure 4.10). The first strategy, "Diversify Zone A," allows an additional 50 species to be considered for Zone A. The second strategy, "Add Zone B," contains 35 species that can be used in the Zone B area created by the raised terraces.

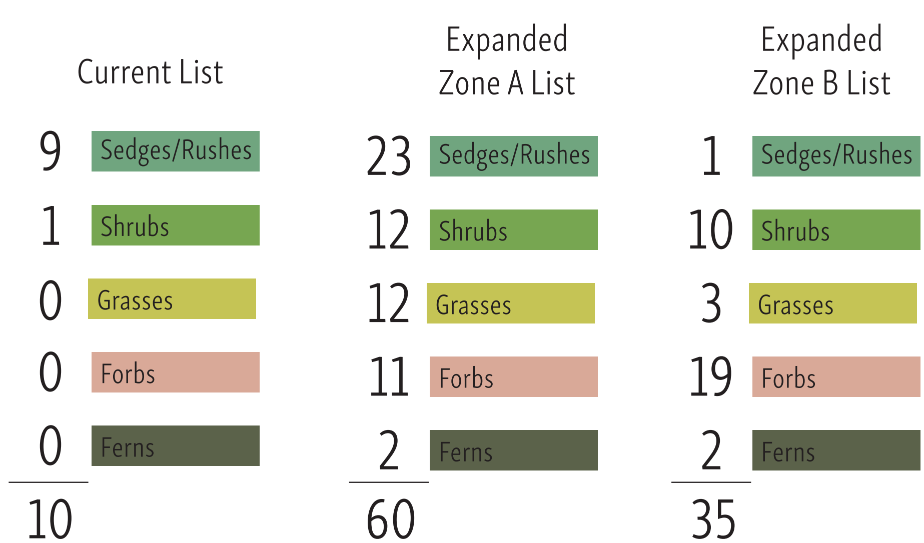


Figure 4.10 Comparison of currently approved plants for use in Eugene right-of-way stormwater facilities and new proposed plant lists for each planting zone

4.5 PROPOSED DESIGNS

Proposed Planting Strategy: "Diversify Zone A"

To demonstrate how the expanded planting list may be employed, I created a planting plan for the planters on 12th and Jefferson using the "Diversify Zone A" strategy. Two small shrub species, 3 sedges or rushes, and 3 forbs were chosen for the plant palette (Figure 4.11). I've provided a diverse planting plan for the northwest and northeast corners (Figures 4.11-4.13) of the intersection.

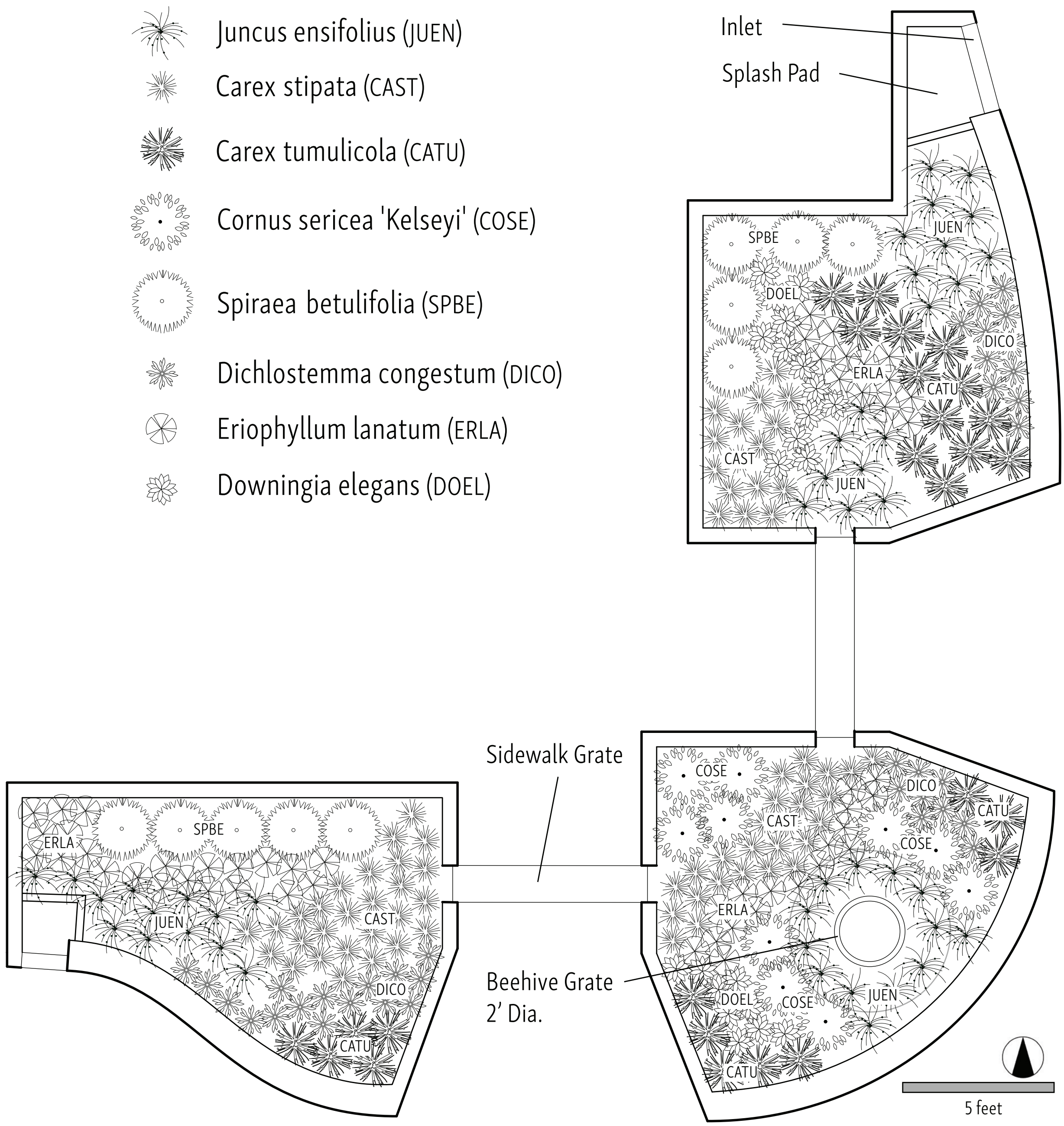


Figure 4.11 Strategy "Diversify Zone A" planting plan, NW corner

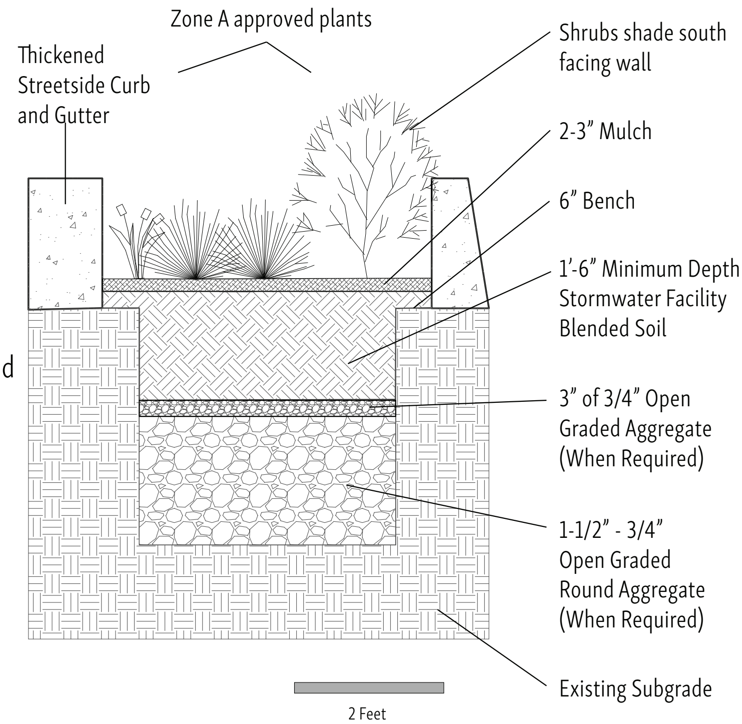


Figure 4.12 Strategy "Diversify Zone A" Section

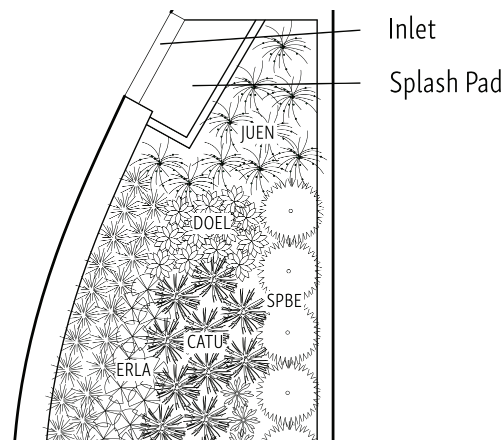
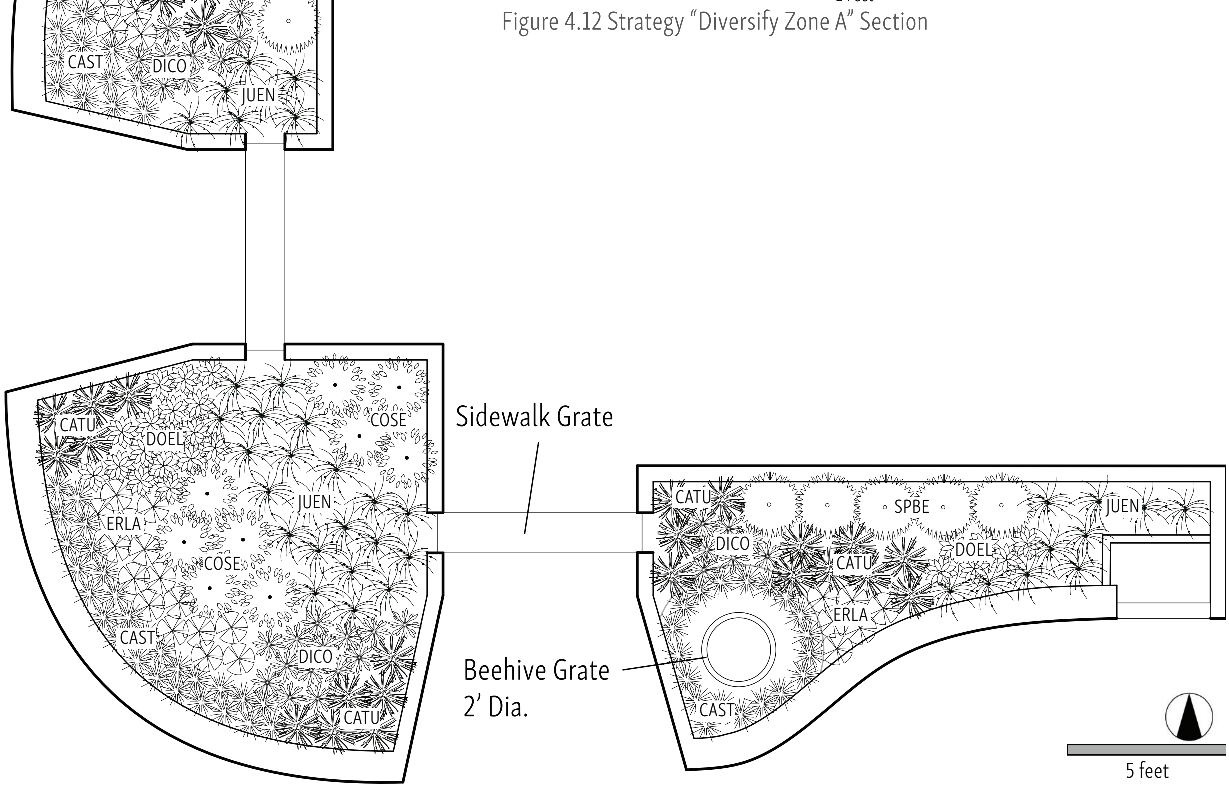



Figure Figure 4.13 Strategy "Diversify Zone A" planting plan, NE corner

Proposed Planting Strategy: "Add Zone B"

To demonstrate how the expanded planting list may be employed, I created a planting plan for the planters on 12th and Jefferson using the "Add Zone B" strategy. One small shrub species, 3 sedges or rushes, and 3 forbs were chosen for the plant palette (Figure 4.14). I've provided a diverse planting plan for the northwest and northeast corners (Figures 4.14-4.16) of the intersection.

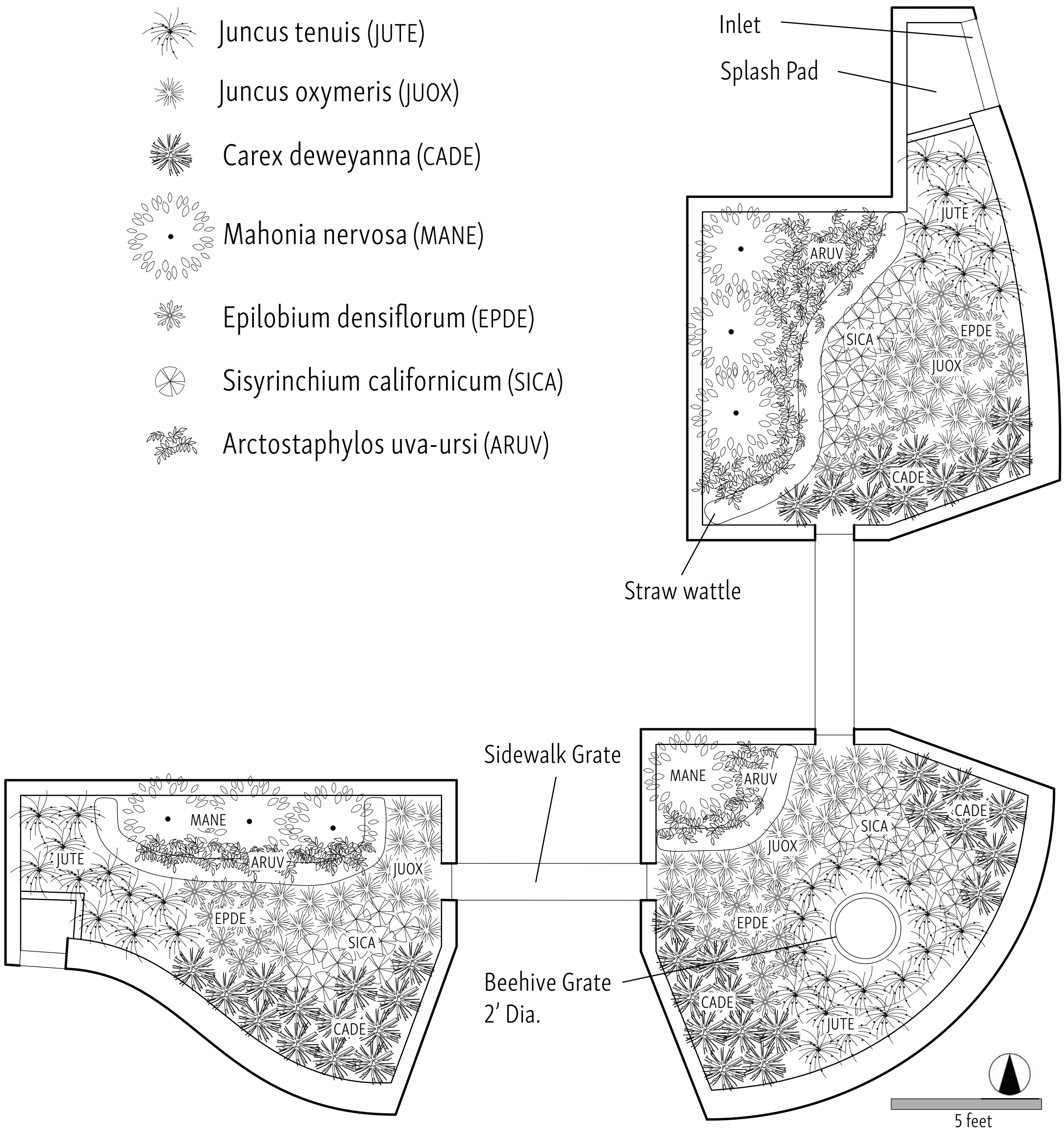


Figure 4.14 Strategy "Add Zone B" planting plan, NW corner

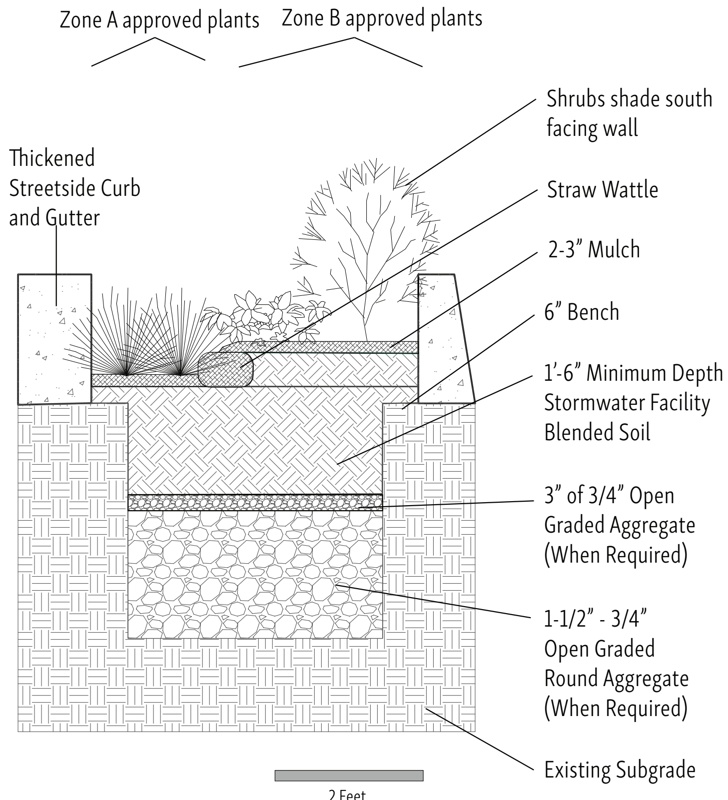


Figure 4.15 Strategy "Add Zone B" Section

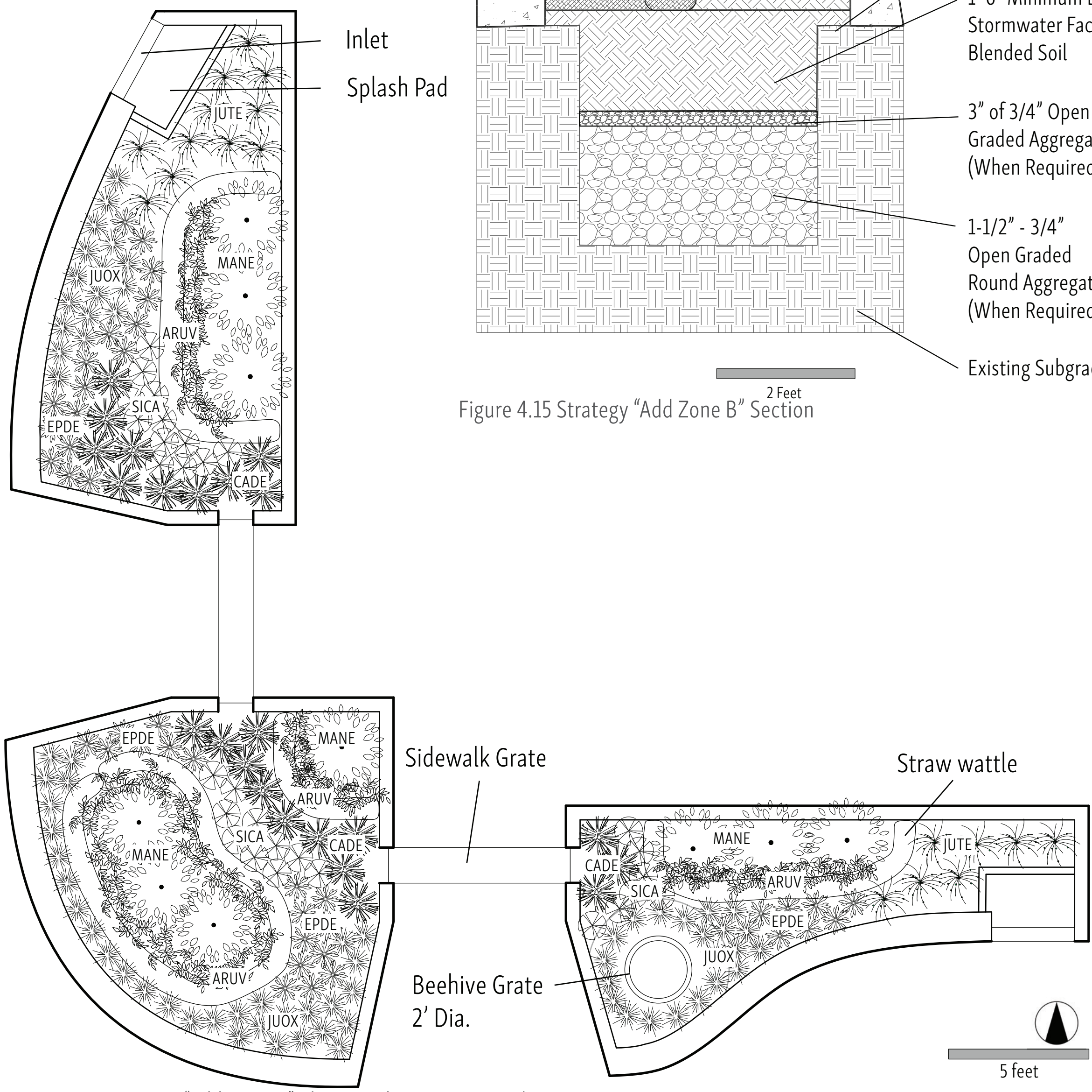


Figure 4.16 Strategy "Add Zone B" planting plan, NE corner plan

Outlet details

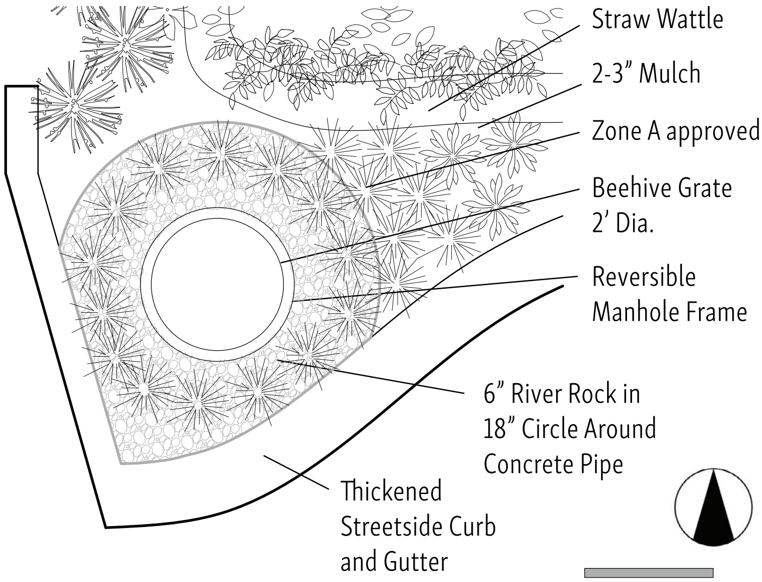


Figure 4.17 Outlet detail plan, showing river rock placement

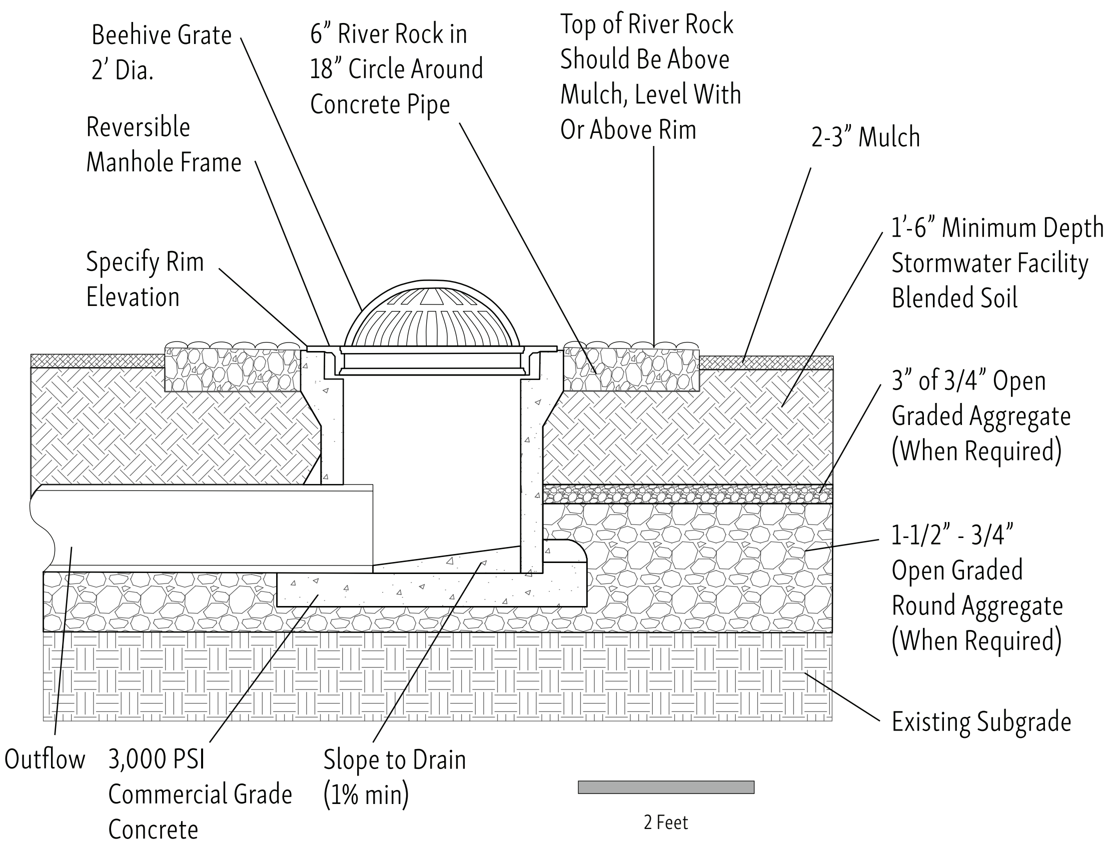


Figure 4.18 Outlet detail section, showing river rock placement

4.6 MONITORING RECOMMENDATIONS

One of the great advantages of these proposed planting designs is that they can be adjusted to test different species, or even reversed if they are deemed unsuccessful, with no damage to the stormwater planter. The plants that do not thrive can be replaced with different species that staff want to test or replace with proven survivors (the hardy *Juncus* and *Carex* species). The mulch and the wattles proposed in the "Add Zone B" strategy can be removed and replaced with more conventional pea gravel with only a loss of staff time and the cost of the mulch.

To judge whether the proposed plans are successful and worth maintaining or installing in subsequent stormwater planter designs, a dedicated monitoring plan should be undertaken. Plants should be checked by City of Eugene stormwater maintenance staff regularly, monthly if possible, during the first year after planting to monitor and record their condition for future reference. Plants that are newly added to the approved planting list should be especially carefully monitored. The condition of the mulch and wattles should be checked more frequency in the winter, especially after large storm events to make sure the mulch is staying in its designated area and that the wattles, if used, are not impeding the flow or infiltration of flood waters. If the planter on the southeast corner of the 12th and Jefferson intersection is planted as a control to compare to the chosen strategy employed in the other corners (Figure 4.19), it should be included in the monthly inspections to provide a record of the success of its plants.

To test each strategy simultaneously to see which performs better under the similar conditions, it would be interesting to plant one corner using the "Diversify Zone A" strategy and one corner using the "Add Zone B" strategy, keeping the southeast corner as a minimally planted control. Success of a diverse planting strategy for the stormwater planters at 12th and Jefferson would be judged based on plant survival and growth over the first year after planting.

It is possible that recruiting residents living near stormwater planters to "adopt a planter" could help increase the survival of a more diverse range of species. Residents can be trained to identify the plants in the planters near them and be givn the responsibility of weeding, removing trash, and keeping an eye on the condition of the mulch and straw wattles (if used), with instructions to report any anomalies or problems to City of Eugene stormwater staff.

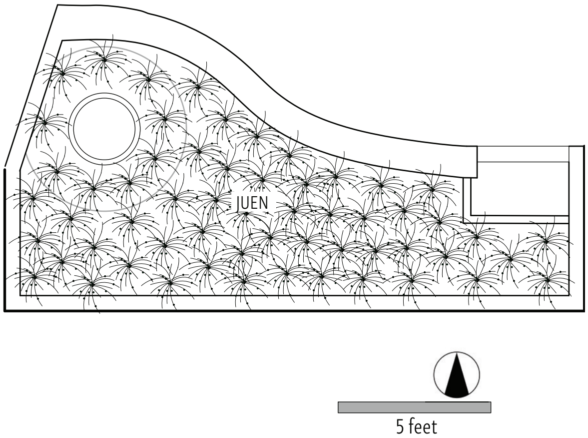


Figure 4.19 Minimal planting plan on SE corner plan to be a control for possible planting experimentation

CONCLUSIONS

5.1 PROJECT EVALUATION AND LIMITATIONS

The goal of this study was to begin to investigate the preferences and attitudes of the residents of Eugene, OR who live near stormwater planters, students, and professionals. As a small pilot study, this project was successful in demonstrating potential trends in the surveyed populations, as well as how results of community surveys can be used as a motivating factor in a design.

The primary result of this project was the finding that a two-thirds majority of residents of Eugene, OR and an even larger majority of professionals and landscape architecture students prefer the visual appearance of plant diversity in curbside planters. This result surprised me somewhat, as I was assuming residents might prefer a more stark, cleaner appearance for stormwater planters given their functional use and their locations on curbsides. I also wondered if stormwater professionals opt for the minimal plant palette in order to prioritize ease of maintenance and hardiness over the visual appearance of diversity. While maintenance and functionality were very important to surveyed professionals, they seemed open to exploring ways to increase plant diversity while still maintaining function.

It was also encouraging to find that a majority of surveyed residents understood the uses for stormwater planters as a solution for the flooding and pollution issues facing the local watershed. This suggests to me that the public might be supportive of using stormwater planters (and other facilities) to protect local water quality and habitats.

When it comes to designing for added benefits like habitat value and year-round visual interest, landscape architecture students and professionals were generally supportive of designing for these qualities, but residents were not currently seeing these qualities. This suggests that there is room to explore possibilities of layering added functions onto stormwater planters that provide benefits beyond water storage and filtration.

The results of the survey did show some difference in residents' attitudes and preferences based on the level of plant diversity in the stormwater planter nearest them, but this trend will need further study to clarify the driving factors behind it. That such trends may exist is an interesting opportunity to create diverse stormwater planters as a vehicle for demonstrating the functions and benefits of stormwater planters, and even the function of the local watershed as a whole. Results also seemed to show that people who had different visual preferences also had varying attitudes toward the functions and benefits of stormwater planters. The correlation and relationship between these factors needs to be understood more thoroughly, but it might show that designers need to be attentive to a wide range of perspectives about the appearance and perceived benefits of plants in stormwater planters.

I believe that this project also demonstrates the opportunities that come with making plant diversity a primary goal of stormwater planting design. There already exists a high level of plant diversity on the lists of approved stormwater plants for the cities of Eugene and Portland, OR. Landscape architects and stormwater professionals should be empowered to explore ways of introducing plant diversity into their designs, especially if the support of the community for the appearance of diversity is clearly demonstrated.

There were several limitations to this study that influenced the outcomes. Reaching participants with a mailed study may have decreased potential response rate, compared to phone or in person interviews, because of the lack of opportunity for follow-up attempts to contact people. The survey materials themselves presented another constraint. Likert scale questions can be limiting and constrain people's answers, while the written portion of the survey may have reduced the number of people willing to fill it out. Analyzing the results of such limited survey answers is also a challenge. It was clear in reading some of the responses that the respondent had misinterpreted the meaning of the question, or had circled a Likert scale number that didn't match the sentiments in their written answer.

5.2 FURTHER RESEARCH

Given a small sample size, especially among Eugene residents and stormwater professionals, it is impossible to make broad claims about the visual preferences or attitudes investigated in this survey. However, I believe that the results are interesting enough to warrant a follow-up survey that investigates visual preference and attitudes toward stormwater planters in Eugene, and even other cities that are interested in creating community benefit from their stormwater planters. The relationships between visual preference, awareness of natural systems, and attitudes toward intervention strategies require deeper, more detailed study. Such research should be undertaken not only by landscape architecture students and academics, but also by cities and practicing professionals in order to improve the community benefit of stormwater planters and other facilities. It is important for designers to keep in touch with the attitudes and preferences of the public, especially those in close proximity to public works projects.

If this line of inquiry is to be continued in Eugene, I believe a larger, statistically significant version of this survey should be conducted. Door-to-door in person interviews conducted by someone familiar with Eugene's stormwater practices might yield more nuanced answers to visual preference and attitude questions. A greater number of stormwater professionals (at least 10-20) should also be consulted about constraints and opportunities of designing for greater plant diversity in stormwater facilities, in both Eugene and in other Pacific Northwest cities tackling stormwater challenges. Having a statistically representative pool of respondents will help bolster any claims derived from the research, and so will better inform any proposed changes to City codes or maintenance practices.

Research should also be conducted about whether members of the public are willing to contribute their time to help monitor and maintain plants in stormwater planters, and if that willingness is tied to more visually diverse planting strategies. Additionally residents of Eugene, OR should be polled to investigate whether they are willing to pay more in taxes to fund the construction, maintenance, and monitoring of new and existing stormwater planters, and how that willingness is linked to diversity of the planting plan of the planters.

Installing diverse planting plans like those demonstrated in chapter 4 is another opportunity for further research. As mentioned in section 4.6, designers and maintenance staff will have to closely monitor which plants in any new planting strategy are surviving well, and any maintenance adjustments that may be needed. Using a new diverse plant palette in a stormwater facilities presents an opportunity to repeat a community visual preference survey to gauge how the nearby residents react to it. Residents living near a newly planted SWP can be surveyed on their attitudes toward the appearance of the new plants, as well as their observations of the stormwater planters as flood prevention, habitat value, seasonal interest and so on. If stormwater professionals with the City of Eugene want to involve the community further in the design of stormwater planters, it would be interesting to survey the visual preference of residents before the construction of a new SWP and incorporating their preferences when selecting the new plant palette (a process I demonstrated by using the results of my survey to inform the new design proposals). Taken pre- and post-planting resident surveys would provide useful insight into the attitudes that residents have about stormwater plants.

APPENDIX A

Group ID Code#

Below are two pictures of a typical green stormwater facility. The only difference is the types and number of plant species. Which would you design if you had the choice?

Circle one: **Picture 1** **Picture 2**

What is the main reason for your choice?

____

____

____

____

____

Please rate how much you agree with the following statements on a scale from 1 to 5, with 1 being completely disagree and 5 being completely agree. You may also answer that you are undecided or don't know.

1) Stormwater planters are useful for preventing flooding.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

2) Stormwater planters are an effective way of keeping litter and pollution out of the Willamette River.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

3) Pollution from the City of Eugene is a very important problem facing the Willamette River.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

4) Ideally, stormwater planters would be designed to provide food and shelter for wildlife.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What kinds of wildlife would you design for?

____

____

____

Please rate how much you agree with the following statements on a scale from 1 to 5, with 1 being completely disagree and 5 being completely agree. You may also answer that you are undecided or don't know.

5) The plants in stormwater planters should be visually interesting or appealing in all seasons.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

___
___
___

6) Plants in stormwater planters are doing the same job as wild plants would on a river bank.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

___
___
___

Do you believe that stormwater is treated before it enters the Amazon Creek, or the Willamette River?

Yes   No   Undecided/ Don't Know

What is the main reason you feel this way?

___
___
___

Do you believe that mechanical or engineered techniques to remove pollutants would be a better way to prevent pollution to the Willamette River than stormwater planters?

Yes   No   Undecided/ Don't Know

What is the main reason you feel this way?

___
___
___

Thank you so much for your participation! Please mail this survey back as soon as you can, in the envelope provided, along with your signed consent form. I look forward to hearing from you.

--Brittany

Group ID Code#

Below are two pictures of a typical green stormwater facility. The only difference is the types and number of plant species. Which would you prefer to have on a street in your neighborhood?

Circle one: **Picture 1** **Picture 2**

What is the main reason for your choice?

____

Please rate how much you agree with the following statements on a scale from 1 to 5, with 1 being completely disagree and 5 being completely agree. You may also answer that you are undecided or don't know.

1) Stormwater planters are useful for preventing flooding.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

2) Stormwater planters are an effective way of keeping litter and pollution out of the Willamette River.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

3) Pollution from the City of Eugene is a very important problem facing the Willamette River.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

____

____

____

4) I have seen stormwater planters providing food and shelter for wildlife.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What kinds of wildlife have you seen?

____

____

____

Please rate how much you agree with the following statements on a scale from 1 to 5, with 1 being completely disagree and 5 being completely agree. You may also answer that you are undecided or don't know.

5) It is interesting to see how the plants in the stormwater planters change with the seasons.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

___

___

___

6) Plants in stormwater planters are doing the same job as wild plants would on a river bank.

Completely Disagree		Neutral		Completely Agree	
1	2	3	4	5	Undecided/ Don't Know

What is the main reason you feel this way?

___

___

___

Do you believe that stormwater is treated before it enters the Amazon Creek, or the Willamette River?

Yes No Undecided/ Don't Know

What is the main reason you feel this way?

___

___

___

Do you believe that mechanical or engineered techniques to remove pollutants would be a better way to prevent pollution to the Willamette River than stormwater planters?

Yes No Undecided/ Don't Know

What is the main reason you feel this way?

___

___

___

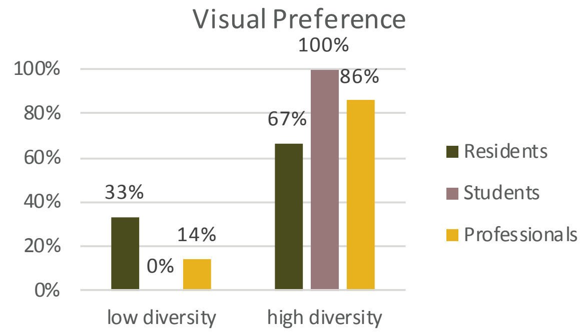
Thank you so much for your participation! Please mail this survey back as soon as you can, in the envelope provided, along with your signed consent form. I look forward to hearing from you.

--Brittany

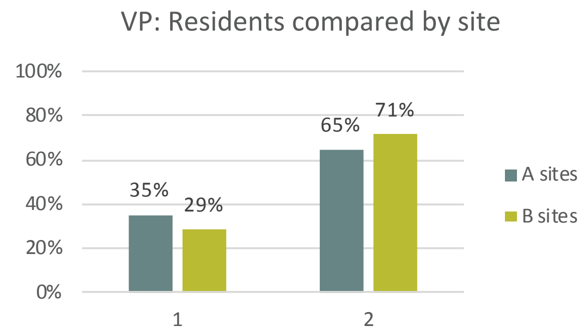
APPENDIX B

SUMMARY OF SURVEY RESULTS, BY SURVEY QUESTION

Visual Preference Question: Which [of the following images] would you prefer to have on a street in your neighborhood?



	average	median	mode
All Residents	1.7	2	2
UO Students	2.0	2	2
Professionals	1.9	2	2



	average	median	mode
A sites	1.6	2	2
B sites	1.7	2	2

Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is a significant difference between the residents as a whole and the students and professionals combined. The Fisher value for this comparison was .002, p=.05.

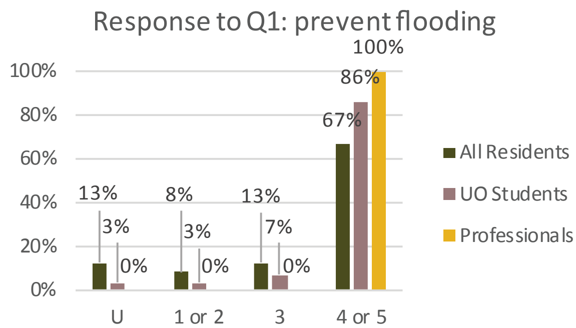
	reference diversity/ variety/ differences	positive aesthetics pretty/ nice/ attractive	wildlife/ habitat	safety concerns	maintenance/ cost concerns	reference clean/ simplicity/ consistancy	functionality
All Residents	54%	38%	4%	8%	13%	17%	0%
UO Students	83%	55%	38%	0%	0%	0%	38%
Professionals	71%	71%	43%	14%	71%	14%	71%

	reference diversity/ variety/ differences	positive aesthetics pretty/ nice/ attractive	wildlife/ habitat	safety concerns	maintenance/ cost concerns	reference clean/ simplicity/ consistancy	functionality
A Residents	47%	41%	6%	12%	6%	12%	0%
B Residents	71%	29%	0%	0%	29%	29%	0%

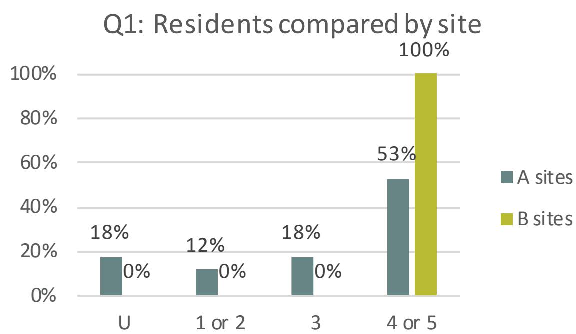
	reference diversity/ variety/ differences	positive aesthetics pretty/ nice/ attractive	wildlife/ habitat	safety concerns	maintenance/ cost concerns	reference clean/ simplicity/ consistance	functionality
Prefer Low	0%	38%	0%	25%	13%	50%	0%
Prefer High	81%	38%	6%	0%	13%	0%	0%

Note: "A sites" refer to low diversity planter sites (LD sites in document) and "B sites" refer to higher diversity sites (HD sites)

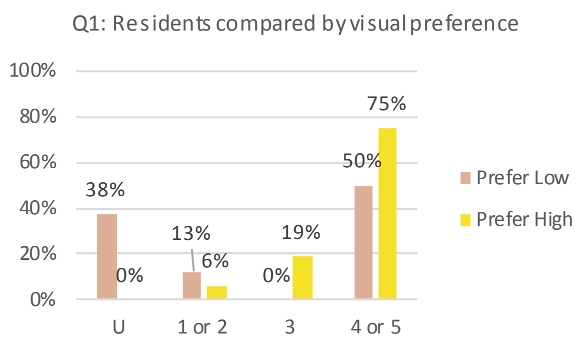
Question 1: Stormwater planters are useful for preventing flooding.



	average	median	mode
All Residents	4.1	5	5
UO Students	4.2	4	4
Professionals	4.4	4	4



	average	median	mode
A sites	3.9	4.5	5
B sites	4.7	5	5



	average	median	mode
Prefer Low	4.0	5	5
Prefer High	4.2	5	5

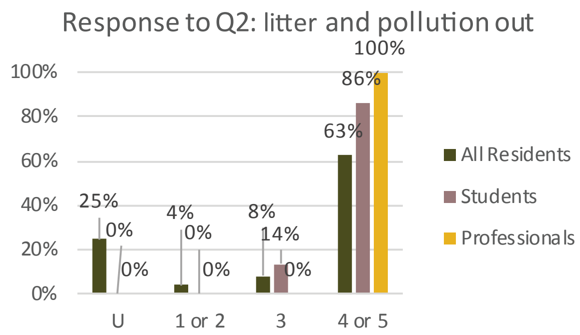
Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is a significant difference between the "Prefer Low" and the "Prefer High" groups. The Fisher value for this comparison was ..03, p=.05.

	based on personal observation	articulate the logic (room for/ absorb/ slow water)	help, but don't prevent	hedging (not sure, it depends, no experience)	conditioned on proper maintenance	No answer
All Residents	21%	38%	0%	17%	0%	25%
UO Students	0%	79%	34%	14%	7%	0%
Professionals	14%	100%	0%	0%	43%	0%

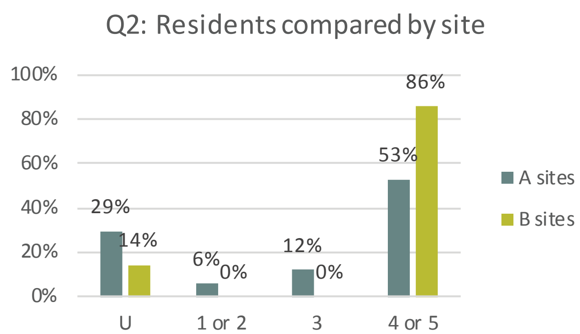
	based on personal observation	articulate the logic (room for/ absorb/ slow water)	help, but don't prevent	Not sure, it depends, no experience	conditioned on proper maintenance	No answer
A Sites	18%	24%	0%	24%	0%	35%
B Sites	29%	71%	0%	0%	0%	0%

	based on personal observation	articulate the logic (room for/ absorb/ slow water)	help, but don't prevent	hedging (not sure, it depends, no experience)	conditioned on proper maintenance	No answer
Prefer low	13%	25%	0%	13%	0%	50%
Prefer high	25%	44%	0%	19%	0%	13%

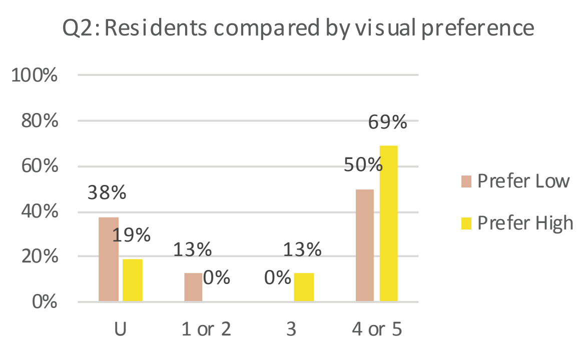
Question 2: Stormwater planters are an effective way of keeping litter and pollution out of the Willamette River



	average	median	mode
All Residents	4.2	4.5	5
UO Students	4.1	4	4
Professionals	4.1	4	4



	average	median	mode
A sites	4.2	5	5
B sites	4.3	4	4



	average	median	mode
Prefer Low	3.8	4	5
Prefer High	4.4	5	5

Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is a significant difference between the residents as a whole and the students and professionals combined. The Fisher value for this comparison was .003, p=.05.

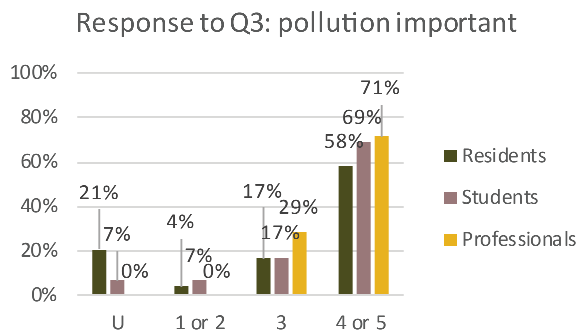
	personal experience/ observation	helps, but don't solve entirely	Helps with litter, trash winds up in planter	Water filtration benefit	conditioned on proper maintenance	No known evidence/ no data	No answer
All Residents	4%	4%	29%	17%	13%	13%	25%
UO Students	3%	10%	38%	48%	10%	0%	0%
Professionals	0%	14%	71%	86%	29%	14%	0%

	personal experience/ observation	helps, but don't solve entirely	Helps with litter, trash winds up in planter	Water filtration benefit	conditioned on proper maintenance	No known evidence/ no data	No answer
A Sites	0%	0%	29%	12%	12%	18%	24%
B Sites	14%	14%	29%	29%	14%	0%	29%

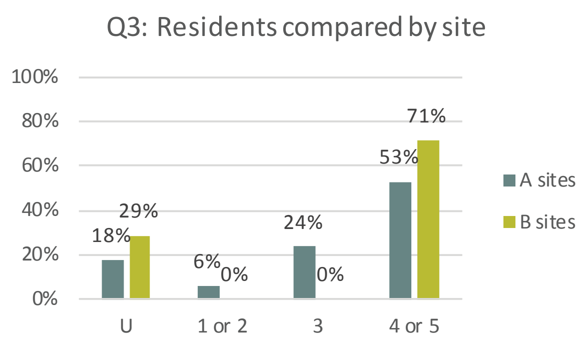
	personal experience/ observation	helps, but don't solve entirely	Helps with litter, trash winds up in planter	Water filtration benefit	conditioned on proper maintenance	No known evidence/ no data	No answer
Prefer low	13%	13%	0%	13%	0%	25%	25%
Prefer high	0%	0%	44%	19%	19%	6%	25%

Note: "A sites" refer to low diversity planter sites (LD sites in document) and "B sites" refer to higher diversity sites (HD sites)

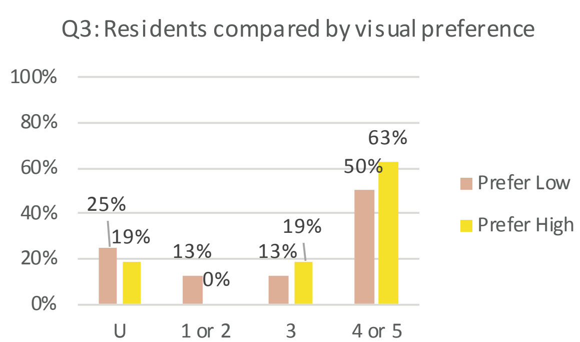
Question 3: Pollution from the City of Eugene is a very important problem facing the Willamette River



	average	median	mode
All Residents	4.1	4	5
UO Students	4.0	4	5
Professionals	4.3	5	5



	average	median	mode
A sites	3.9	4	5
B sites	4.6	5	5



	average	median	mode
Prefer Low	3.7	4	4
Prefer High	4.3	5	5

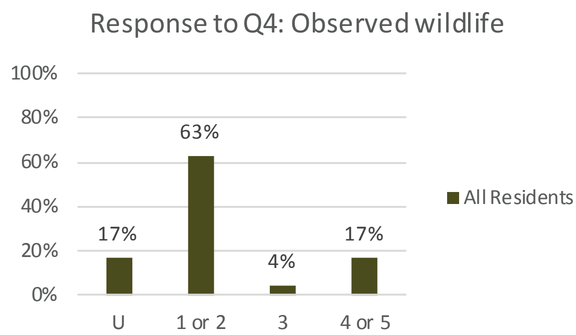
Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is no significant difference between any of these groups.

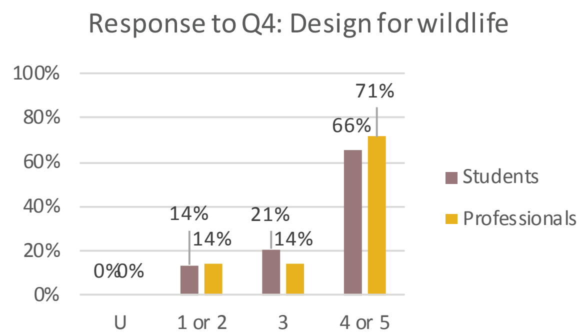
	Personal observation	Water from city goes straight to river	Cite outside source	Any city is a polluter, Eugene not unique	Eugene is not the only/ worst offender on Willamette	Agriculture and industry are bigger contributors	Potential loss of an asset (recreation, beauty)	River/ natural system is vulnerable/ delicate	Downstream effects	Not enough evidence	No answer
All Residents	8%	4%	8%	4%	13%	4%	4%	8%	4%	17%	25%
Students	3%	7%	0%	34%	14%	17%	14%	0%	14%	10%	0%
Professionals	43%	14%	0%	14%	0%	0%	0%	0%	0%	0%	0%

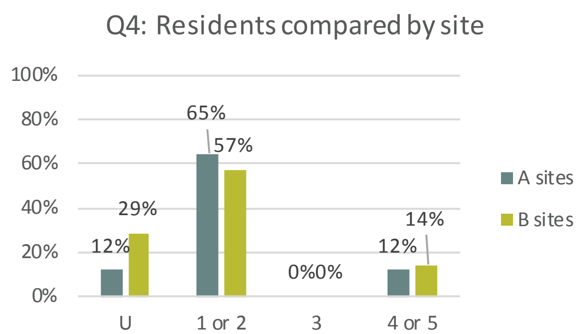
	Personal observation	Water from city goes straight to river	Cite outside source	Any city is a polluter, Eugene not unique	Eugene is not the only/ worst offender on Willamette	Agriculture and industry are bigger contributors	Potential loss of an asset (recreation, beauty)	River/ natural system is vulnerable/ delicate	Downstream effects	Not enough evidence	No answer
A Sites	12%	6%	12%	0%	12%	6%	0%	12%	0%	12%	29%
B Sites	0%	0%	0%	14%	14%	0%	14%	0%	14%	29%	14%

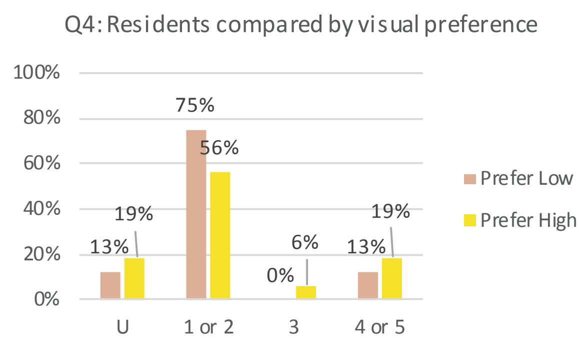
	Personal observation	Water from city goes straight to river	Cite outside source	Any city is a polluter, Eugene not unique	Eugene is not the only/ worst offender on Willamette	Agriculture and industry are bigger contributors	Potential loss of an asset (recreation, beauty)	River/ natural system is vulnerable/ delicate	Downstream effects	Not enough evidence	No answer
Prefer low	13%	13%	13%	13%	13%	13%	0%	13%	0%	13%	25%
Prefer high	6%	0%	6%	0%	13%	0%	6%	6%	6%	19%	25%

Question 4: I have seen stormwater planters providing food and shelter for wildlife









	average	median	mode
All Residents	2.0	1	1
UO Students	3.9	4	5
Professionals	3.6	4	4

	average	median	mode
A sites	2.0	1	1
B sites	1.8	1	1

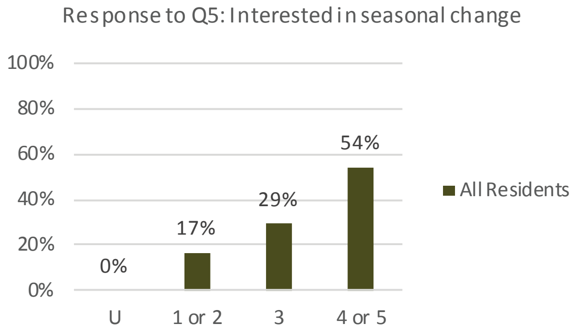
	average	median	mode
Prefer Low	1.2	1	1
Prefer High	2.2	1	1

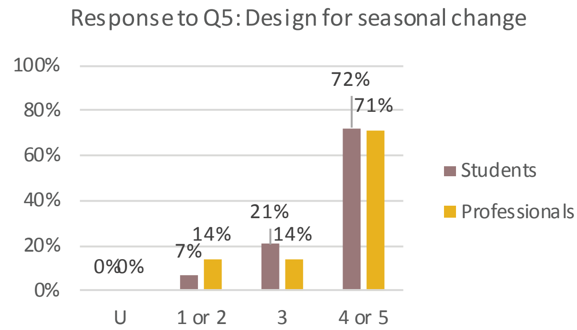
Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is no significant difference between any of these groups.

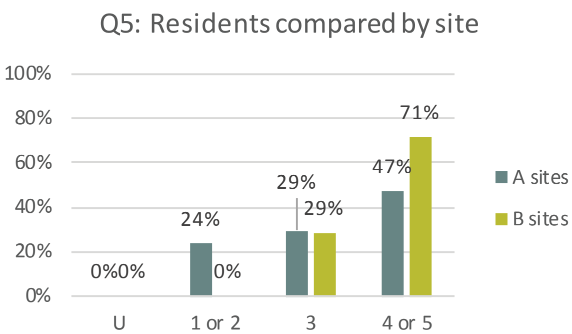
	birds	insects, generally	pollinators	small mammals	amphibians	benefits of multi functionality	Not the function of SWF, treatment is priority	Question having wildlife in SW planter	Concerns about maintenance	Have not observed	No answer
All Residents	21%	4%	0%	8%	4%	0%	0%	0%	0%	58%	21%
UO Students	24%	24%	34%	7%	10%	21%	14%	28%	0%	0%	0%
Professionals	43%	29%	14%	0%	14%	29%	14%	43%	29%	0%	0%
	birds	insects, generally	pollinators	small mammals	amphibians	benefits of multi functionality	Not the function of SWF, treatment is priority	Question having wildlife in SW planter	Concerns about maintenance	Have not observed	No answer
A Sites	24%	6%	0%	12%	0%	0%	0%	0%	0%	59%	18%
B Sites	14%	0%	0%	0%	14%	0%	0%	0%	0%	57%	29%
	birds	insects, generally	pollinators	small mammals	amphibians	benefits of multi functionality	Not the function of SWF, treatment is priority	Question having wildlife in SW planter	Concerns about maintenance	Have not observed	No answer
Prefer low	13%	0%	0%	0%	13%	0%	0%	0%	0%	75%	13%
Prefer high	25%	6%	0%	13%	0%	0%	0%	0%	0%	50%	25%

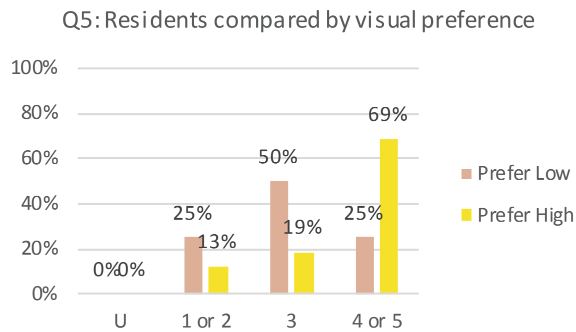
Note: "A sites" refer to low diversity planter sites (LD sites in document) and "B sites" refer to higher diversity sites (HD sites)

Question 5: It is interesting to see how the plants in the stormwater planters change with the seasons









	average	median	mode
All Residents	3.8	4	5
UO Students	3.9	4	4
Professionals	3.7	4	4

	average	median	mode
A sites	3.6	3	5
B sites	4.3	5	5

	average	median	mode
Prefer Low	3.3	3	3
Prefer High	4.1	5	5

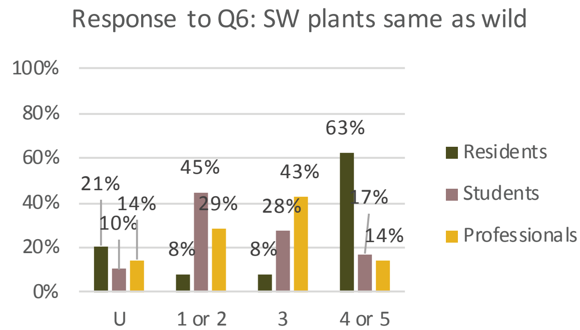
Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is no significant difference between any of these groups.

	Have not observed	Have not observed, but would like to see	Have observed, enjoyed	Have seen, but look bad	Seasonal change makes SWF/ area beautiful	Not the function of SWF, treatment is priority	Increase public acceptance	Cost or maintenance concerns	No answer
All Residents	21%	8%	17%	17%	17%	0%	0%	0%	29%
UO Students	0%	0%	0%	0%	24%	31%	31%	3%	0%
Professionals	0%	0%	0%	0%	29%	43%	29%	14%	0%

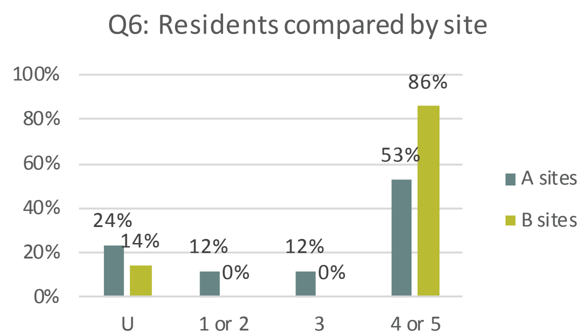
	Have not observed	Have not observed, but would like to see	Have observed, enjoyed	Have seen, but look bad	Seasonal change makes SWF/ area beautiful	Not the function of SWF, treatment is priority	Increase public acceptance	Cost or maintenance concerns	No answer
A Sites	18%	12%	12%	24%	12%	0%	0%	0%	29%
B Sites	29%	0%	29%	0%	29%	0%	0%	0%	29%

	Have not observed	Have not observed, but would like to see	Have observed, enjoyed	Have seen, but look bad	Seasonal change makes SWF/ area beautiful	Not the function of SWF, treatment is priority	Increase public acceptance	Cost or maintenance concerns	No answer
Prefer low	25%	0%	0%	13%	0%	0%	0%	0%	63%
Prefer high	19%	13%	25%	19%	25%	0%	0%	0%	13%

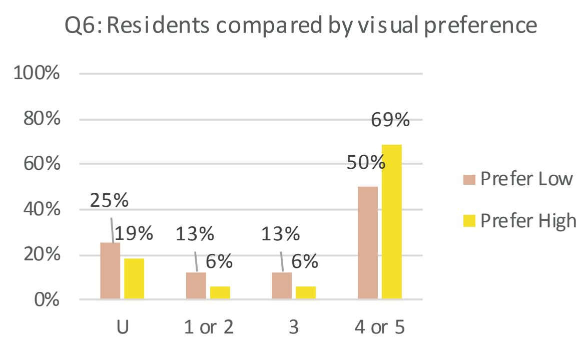
Question 6: Plants in stormwater planters are doing the same job as wild plants would on a river bank



	average	median	mode
All Residents	4.1	4.5	5
UO Students	2.6	2.5	2
Professionals	3.0	3	3



	average	median	mode
A sites	3.9	4	5
B sites	4.5	4.5	4



	average	median	mode
Prefer Low	4.0	4.5	5
Prefer High	4.2	4	5

Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is a significant difference between the residents as a whole and the students and professionals combined. The Fisher value for this comparison was .0002, p=.05.

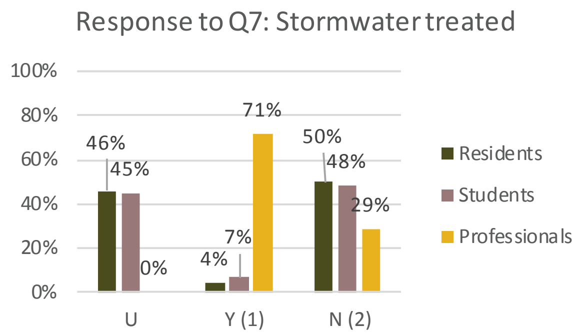
	yes, but no specifics	retain/ absorb water	Hold soil	Wild plants prevent erosion, SW doesn't	yes, habitat	yes, Filtration	Context too different	Not enough information /it depends	No answer
All Residents	33%	4%	4%	4%	4%	17%	0%	17%	33%
UO Students	7%	24%	10%	24%	3%	7%	38%	14%	7%
Professionals	0%	29%	14%	14%	14%	29%	71%	14%	0%

	yes, but no specifics	retain/ absorb water	Hold soil	Wild plants prevent erosion, SW doesn't	yes, habitat	yes, Filtration	Context too different	Not enough information /it depends	No answer
A Sites	35%	0%	0%	6%	6%	18%	0%	24%	29%
B Sites	29%	14%	14%	0%	0%	14%	0%	0%	43%

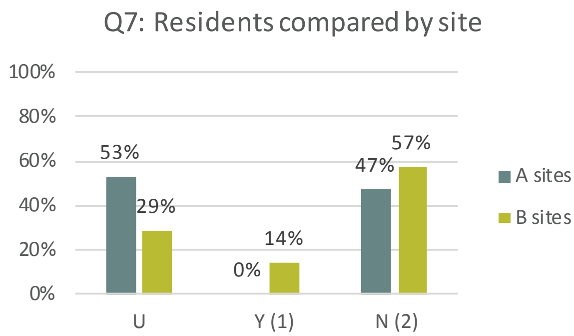
	yes, but no specifics	retain/ absorb water	Hold soil	Wild plants prevent erosion, SW doesn't	yes, habitat	yes, Filtration	Context too different	Not enough information /it depends	No answer
Prefer low	13%	13%	0%	0%	0%	13%	0%	25%	50%
Prefer high	44%	0%	6%	6%	6%	19%	0%	13%	25%

Note: "A sites" refer to low diversity planter sites (LD sites in document) and "B sites" refer to higher diversity sites (HD sites)

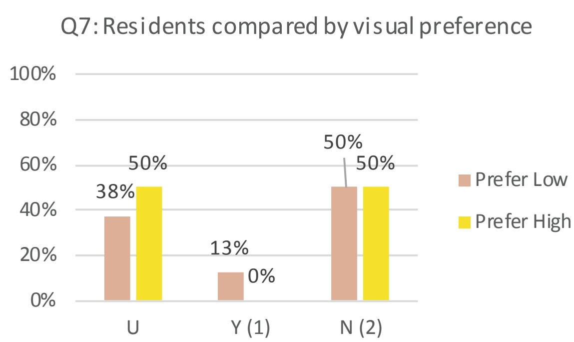
Question 7: Do you believe that stormwater is treated before it enters the Amazon Creek, or the Willametter River?



	average	median	mode
All Residents	1.9	2	2
UO Students	1.9	2	2
Professionals	1.3	1	1



	average	median	mode
A sites	2.0	2	2
B sites	1.8	2	2

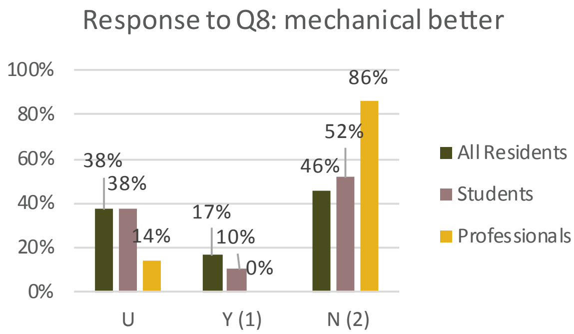


	average	median	mode
Prefer Low	1.8	2	2
Prefer High	2.0	2	2

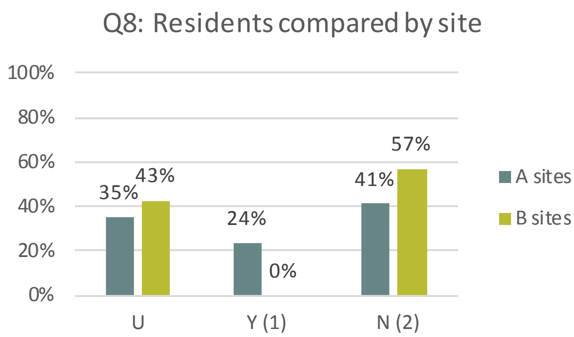
	Storm drain label	**Treatment only through SWF**	**Personal observation**	**Water from city goes straight to river**	**Not enough information /it depends**	**No answer**
All Residents	8%	8%	4%	0%	17%	33%
UO Students	3%	7%	14%	14%	31%	10%
Professionals	0%	71%	0%	0%	0%	0%
	Storm drain label	**Treatment only through SWF**	**Personal observation**	**Water from city goes straight to river**	**Not enough information /it depends**	**No answer**
A Sites	6%	12%	6%	0%	18%	29%
B Sites	14%	0%	0%	0%	14%	43%
	Storm drain label	**Treatment only through SWF**	**Personal observation**	**Water from city goes straight to river**	**Not enough information /it depends**	**No answer**
Prefer low	0%	13%	0%	0%	13%	38%
Prefer high	13%	6%	6%	0%	13%	31%

Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is a significant difference between the professionals and the residents (.0004, p=.05) and between the professionals and the students (.0007, p=.05)

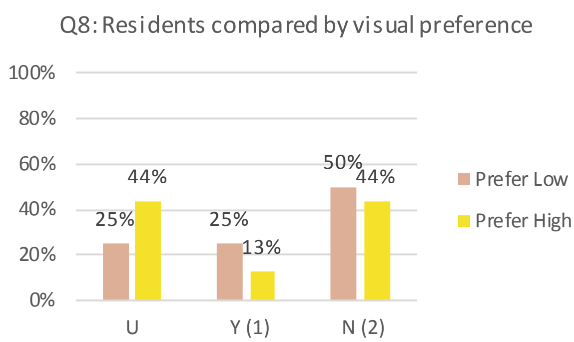
Question 8: Do you believe that mechanical or engineered techniques to remove pollutants would be a better way to prevent pollution to the Willamette River than stormwater planters?



	average	median	mode
All Residents	1.7	2	2
UO Students	1.8	2	2
Professionals	2	2	2



	average	median	mode
A sites	1.6	2	2
B sites	2.0	2	2



	average	median	mode
Prefer Low	1.7	2	2
Prefer High	1.8	2	2

Note: According to Fisher's Exact Test (used to compare statistical differences between groups with small sample size) there is no significant difference between any of these groups.

	Natural is better	**Mechanical would be more effective**	**Mechanical treatment too expensive**	**Mechanical treatment might have detrimental effects**	**Favor a combination**	**Not enough information**	**No answer**
All Residents	29%	13%	29%	4%	17%	21%	21%
UO Students	24%	7%	31%	7%	17%	17%	7%
Professionals	57%	29%	29%	0%	43%	0%	0%

	Natural is better	**Mechanical would be more effective**	**Mechanical treatment too expensive**	**Mechanical treatment might have detrimental effects**	**Favor a combination**	**Not enough information**	**No answer**
A Sites	24%	18%	29%	6%	12%	29%	18%
B Sites	43%	0%	29%	0%	29%	0%	29%

	Natural is better	**Mechanical would be more effective**	**Mechanical treatment too expensive**	**Mechanical treatment might have detrimental effects**	**Favor a combination**	**Not enough information**	**No answer**
Prefer low	25%	25%	25%	13%	25%	13%	25%
Prefer high	31%	6%	31%	0%	13%	25%	19%

Note: "A sites" refer to low diversity planter sites (LD sites in document) and "B sites" refer to higher diversity sites (HD sites)

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