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Te Awarua-o-Porirua Harbour

Assessing Awareness of Methods to Improve Water Quality

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TE AWARUA-O-PORIRUA HARBOUR

ASSESSING AWARENESS OF METHODS TO IMPROVE WATER QUALITY

WPI

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ABSTRACT

This project worked with the Greater Wellington Regional Council (GWRC) to investigate the impediments towards the adoption of low-impact design (LID) methods of stormwater treatment in Porirua, New Zealand to improve the water quality of Te Awarua-o-Porirua Harbour and its catchment area. Our team learned about the harbor's needs through background research, on-site observations, interviews with professionals, and a focus group attended by the project's stakeholder members. The results indicated that miscommunication in the development process and a general disregard for the quality of the harbor prohibit LID from expanding in Porirua. We recommended that developers integrate LID into future plans and the GWRC promote community engagement throughout the harbor catchment.

EXECUTIVE SUMMARY

Introduction

New Zealand culture abides by many values including many shared by Maori, the indigenous people of New Zealand. One example of this is the concept that "Water sustains life," a belief a Maori representative expressed during a Te Awarua-o-Porirua Harbour Whaitua[1] Committee meeting in February 2016. Te Awarua-o-Porirua Harbour is a body of water that is greatly treasured by the citizens living and working around it, both Maori and Pakeha[2] alike. However, there is a growing concern that the community value for the harbor and what it provides is not matched in the way the community manages the harbor. In a sense, the community has turned its back on the waterfront. Reflecting this are concerns about the slow rate of the adoption of new technologies and design principles that may potentially improve water quality in the harbor.

Figure 1: Onepoto Arm of Te Awarua-o-Porirua Harbour

[1] In the context of this report a *whaitua* is an area of land encompassing a specific drainage basin. A *whaitua committee* is a designated community group representative of each whaitua in the region.

[2] *"Pakeha"* refers to New Zealanders of European (or non-Maori) descent.

In the past twenty years, low-impact design (LID) methods for stormwater treatment have become more prevalent around the globe, with Australia readily adopting the practice for the Sydney Olympics in 2000 (Sydney, 2014). LID is a concept or philosophy in addition to a new technology. LID sets the environment as a top priority, with the aim of having development be as non-intrusive to the natural landscape as possible.

This project aids the Greater Wellington Regional Council (GWRC) in analyzing the potential impediments to the adoption of low-impact designs (LID) aimed to improve water quality in Te Awarua-o-Porirua Harbour. We achieved our project goal by accomplishing the following objectives: (1) Gaining an on-the-ground perspective of the harbor's pollution status and background information on prior attempts at implementing LID, (2) Examining stakeholder views on decision-making as it relates to the adoption of LID, (3) Assessing stakeholder opinions of LID, (4) Performing an analysis of possible impediments to the implementation of LID solutions, and (5) Providing recommendations on how to best overcome these impediments.

Our team accomplished these steps to answer the single overarching question that encompasses the scope of this project: "Why are low-impact designs not as prevalent in Porirua as they could be?"

Methods

Our team conducted several weeks of background research prior to traveling to New Zealand. Our research encompassed the geography and demographics of Porirua, the city on the shores of Te Awarua-o-Porirua Harbour, along with information on low-impact design and policies currently in action created by various stakeholder groups.

During our time spent in Wellington, our team conducted five interviews with representatives of different stakeholder organizations. Each interviewee had a different role in

water management in the Wellington region: they were policy makers, city planners, engineers, regulators and consultants. Our sponsor liaison at the GWRC specifically identified these professionals to provide the range of thought and decision-making processes among these different positions. The results and information from these interviews shaped the discussion topics in our focus group workshop the following week.

While our interviews centered on the thought and decision-making processes of individuals interviewed, the focus group discussions addressed the specifics of the impediments to low-impact design in the Wellington region. In setting up the focus group we sent out email invitations to 18 professionals working for each of the stakeholder groups and included an open invitation to other professionals who might have interest in attending. A total of 11 guests attended the workshop and represented a cross section of the professionals involved in shaping decision-making around LID. After a brief introduction, we organized the attendees into two groups with two project team members facilitating each. We divided the focus group schedule into three segments: the first was a discussion of general perceptions of LID, the second focused more on the impediments to LID specific to Porirua, and the last segment brought both groups together for an overview of key points discussed and a brief look at potential solutions for Porirua.

Following the conclusion of our interviews and focus group, we were able to investigate our findings. We coded statements from our interview transcripts into common themes based on different aspects of the individuals' decision-making processes and analyzed the notes from our focus group to identify common themes such as communication, cost, planning, community, and regulations.

The methods used have a number of limitations which the team needed to consider when interpreting the results. These limitations included a small sample size without the participation of land developers or major land owners. While these limitations are significant, the breadth of responses around LID decision-making offers a very useful insight into a number of factors influencing the rate of adoption of LID in the greater Wellington region. Based upon the analysis of our data, we made recommendations to our sponsor organization, the Greater Wellington Regional Council.

Findings

After completing our first three project objectives, we discovered many trends that help to explain why low-impact design (LID) has yet to expand in the greater Wellington region. Most of these trends relate to the process an idea goes through before becoming a policy or a normal way of operating. The first project objective of on-site observation was satisfied by travelling to Te Awarua-o-Porirua Harbour, where we observed that its natural features make it susceptible to pollution from surrounding land development. These natural features include shallow waters and a narrow connection to the sea, preventing flushing of materials and contaminants through the harbor. This gave us an initial understanding of how LID could be useful in the area.

A second on-site visit to the city of Porirua and the harbor's catchment area, or whaitua, introduced us to prior unsuccessful attempts at installing LID. One existing design was a grass swale built out of a roadside ditch intended to filter out unwanted pollutants in stormwater runoff over a length of grassy slope before the water reached a regular storm drain. The device was not constructed as designed and did not function as well as the city planners intended, leaving the pre-existing ditch with little improvement. An additional LID method we observed in Porirua

was the use of EnviroPods® in the suburban storm drains. EnviroPods® are textile sacks used to filter out harmful chemicals from stormwater. The maintenance requirement was higher than the Porirua City Council anticipated and the heavy amount of debris trapped in the devices caused the pods to rip upon attempt to clean them annually. The project team learned that although the effort was well-intentioned, a lack of communication during development and consideration for maintenance resulted in the devices being more of a hassle than the intended low-cost benefit for the city.

Figure 2: Swale in Porirua

Through our interview process, we observed that all of the different stakeholders involved have very different roles in moving a project forward. Each step of a project requires consistent communication with all members in order to solve conflicts that develop along the way. We learned that miscommunication between parties, and at times competing goals, can have an impact on the application of LID. Specifically, for environmental technologies, we found that miscommunications between consultant engineers and regulators often result in a lack

of information about the proposal. This miscommunication sometimes occurs late in the approval processes creating large development setbacks. Other interviewees expressed how the responsibility for projects within city boundaries are often contested, which greatly extends a project's duration and complexity.

Our focus group discussed topics aimed to help us better understand the decision-making processes that might apply to the implementation of LID. We provided "table topics" regarding the impediments to LID adoption and had the participants link these thoughts to Te Awarua-o-Porirua Harbour and its catchment area. We observed that there are many issues to consider when trying to implement a new design or technology for environmental protection and sustainability. The focus group identified many obstacles, but there was also a problem disclosed in the interview process that the workshop surprisingly resolved: focus group members were discussing some issues and resolving them through the communication structure provided by this event.

Figure 3: Focus group discussion

Recommendations

The Greater Wellington Regional Council (GWRC) was already brainstorming strategies to hasten the development of low-impact design (LID) in Porirua prior to our team's arrival. However, with the council's guidance, it was our task to provide research and recommendations that they could use to improve their process. After several weeks of research, interviews, and discussion, the team compiled a list of recommendations that the GWRC can use to expedite the task of implementing LID in Porirua. We used the various impediments such as cost and communication that we found in our data analysis to justify why each recommendation is useful.

The most common theme that stood out throughout our data collection phase was communication and management. There were many complications due to miscommunication or a complete lack of communication between the various stakeholder groups. As such, we recommend that the GWRC host regular meetings during projects that may benefit from LID. Participants in these meetings would include the involved city councils, Wellington Water, Ltd., specific whaitua committees or an equivalent community group, and representatives from the contributing engineering firms and land developing companies. Holding these meetings can keep everyone on the same page and reduce trouble with communication, as well as create an environment to solve issues with experts in every area of LID implementation.

Along with developers joining the loop of communication, another recommendation the team provides is to use new tactics of persuasion that will make developers want to implement LID, rather than force them to through new regulations that are likely to alienate essential conversation partners to solving Porirua's problems. Providing incentives such as rate reductions or rewarding land for each project utilizing LID would be the beginning of a

movement to make LID commonplace for developers. Currently, the normal standards that developers use for building work well, but are not friendly to retrofitting LID in existing infrastructure. Incentives to use LID will allow developers to keep a profit-driven motivation, but also encourage them to begin utilizing techniques that benefit the environment, creating a new work standard.

Creating a new normal standard would not be a quick task, which connects to our third recommendation: changing the mindset of the community. Most crucial in this regard is to keep actively engaging the community about the values their harbor holds. Encouraging civic activities around the harbor and creating new industries to promote recreation and consumerism at the waterfront will help to accomplish this goal. A positive effort to increase activities in the harbor will make residents and tourists want to keep the harbor clean, healthy and visually attractive. This atmosphere may be difficult to create in the current generation, but building awareness and emphasizing the importance of a healthy harbor through the education system will help create a better future for new generations. Future generations are the future of the harbor, so having them realize that the harbor is an integral part of the city they live in may lead them to consider implementing low-impact design mechanisms to protect the health of Te-Awarua-o-Porirua Harbour and guarantee its protection in the future.

Conclusions

Our team has made these recommendations with the community of Porirua in mind. Our goal is to spread awareness of low-impact design (LID) and make it more prevalent in the Wellington region. With these recommendations, our project team is confident that the Greater Wellington Regional Council can collaborate with all of the other stakeholders and formulate a

successful plan to standardize LID implementation through cooperative efforts and begin to install LID techniques in the Porirua Harbour catchment area.

ACKNOWLEDGEMENTS

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Our team would like to give the greatest thank you to our two IQP advisors, Professor Robert Kinicki and Professor Bethel Eddy, for all of their guidance over the past 14 weeks. We would also like to thank our ID 2050 instructor, Professor Stephen McCauley for all of his help with our background research on Te Awarua-o-Porirua Harbour.

TABLE OF CONTENTS

TABLE OF FIGURES

1 INTRODUCTION

Te Awarua-o-Porirua Harbour is central to the city of Porirua in the greater Wellington region of New Zealand. The harbor's shores are home to many community events and activities along with parks and walkways; the city's industrial development and commercial sector are further inland. For members of the local Maori tribe, the Ngati Toa, the area was a "natural food basket" before urban development and sprawl (Dominion Post, 2013). Equally, pollution in the harbor and its inlets has been an ongoing concern since European settlement began in the mid-nineteenth century. Boating, swimming, and fishing were common in the harbor until the Porirua City Council recently discouraged these activities through numerous health warnings in 2013 (PCC, 2015). Local groups claim that it may take an entire generation to restore the harbor to its natural state (Dominion Post, 2013).

Currently, the Porirua City Council and our project's sponsor organization, the Greater Wellington Regional Council, are working with several community groups to improve the water quality of Te Awarua-o-Porirua Harbour through a series of action plans. A study by the Ngati Toa aimed to monitor and better understand the pollution in the harbor is currently underway as well. Other stakeholder groups are working to encourage more efficient communication between organizations and to standardize monitoring methods (PCC, 2012). These stakeholders are taking the initiative to improve stormwater management, yet conventional treatment methods remain commonplace in the area.

The traditional stormwater treatment methods currently in place in Porirua are largely incomplete, in terms of achieving long-term contaminant management. An attempt to be more environmentally conscious in 2002 introduced EnviroPods® to the city's suburban streets. The concept behind the EnviroPod® filters was sound—the Porirua City Council placed textile

"pods" into the mouths of storm drains, which caught and filtered all of the entering debris. The drains, however, quickly became too congested and the pods too heavy to remove without ripping. Since this time, the Porirua City Council has tested other low-impact tactics in Porirua, but each have presented challenges. For example, flooding of grass swales filters out little pollution (Calder, Personal Communication, 2016).

Low-impact design was an idea in the early 1980s that came to fruition as an innovative and sustainable approach to stormwater management. Low-impact design, or LID, naturally filters stormwater as opposed to the use of conventional methods which simply redirect, store or dispose of stormwater. LID has many benefits including better land usage and the improvement of the environment and quality of life when compared to conventional methods such as large water treatment plants and detention ponds. In recent years, awareness of LID has increased and the technology is more widely accepted due to its advantages and necessity for many communities (Coffman, 2001).

Low-impact urban design and development has gained widespread recognition in New Zealand. It is not only backed by environmentalists; economists, developers, builders and government officials have also become proponents of natural drainage systems. LID decreases the amount of impervious spaces, which prevents water body pollution instead of treating it, and also contributes to improved property values and aesthetic appeal, all of which would be beneficial for Te Awarua-o-Porirua Harbour and the Porirua community (Sustainable Cities, 2010). This leads to our main project question "why has the city refrained from reforming the stormwater management infrastructure in recent years?" Our goal was to answer this question by identifying the impediments prohibiting the adoption and advancement of LID in Porirua.

The Greater Wellington Regional Council (GWRC) sponsored our project and guided us as we worked and tried to answer our main project question. The team worked closely with members of the environmental policy team to establish the scope of our project, lay out our project objectives, and ultimately achieve these project goals by providing recommendations to the GWRC. The project aimed to accomplish the following objectives: (1) Gaining an on-the-ground perspective of the harbor's pollution status and background information on prior attempts at implementing LID, (2) Examining stakeholder views on decision-making as it relates to the adoption of LID, (3) Assessing stakeholder opinions of LID, (4) Performing an analysis of possible impediments to the implementation of LID solutions, and (5) Providing recommendations on how to best overcome these impediments.

We achieved these project goals by conducting background research, both during our initial 7-week term at Worcester Polytechnic Institute (WPI) and through on-site visits to the Porirua Harbour catchment area during our term spent in Wellington. After the team completed our background research, our group conducted five interviews with professionals from the project's stakeholder organizations, and facilitated a focus group of 11 attendees from the various stakeholders. The stakeholder companies utilized by our project team included the GWRC, the Porirua and Wellington city councils, Wellington Water, Ltd., and Te Awarua-o-Porirua Whaitua Committee. Our team analyzed the discussions in our interviews and focus group and determined that planning in the development process is one of the largest impediments to implementing LID in Porirua. Our results showed us that the process is complex with an insufficient amount of guidelines for installing LID methods in development projects. Our project concluded with a list of six recommendations to the GWRC.

2 BACKGROUND

This chapter informs the reader of the background research completed by our project team over the first seven weeks of our project before arriving in New Zealand. The information comes from online reports and journals and collaboration with our sponsor liaison at the Greater Wellington Regional Council. This research shaped our project proposal and guided our progress throughout our time spent in Wellington. Most of our background research remained relevant to the project objectives, and we have added some information since we initially proposed the project.

2.1 History of Settlement and Progression of Pollution in Porirua

In the fifteenth century, Maori settled around Te Awarua-o-Porirua Harbour due to its abundance of marine life and surrounding beauty. In the early nineteenth century Europeans also began to settle around the harbor. During this time, as modern civilization began to grow, the harbor waters began to degrade. As urban society created infrastructure in the area, relocated sediment began to fall into the harbor. Foreign sediments would drain into the harbor's ecosystem disrupting the environment that previously existed. During this century of development, wildlife began to relocate as their natural habitats were no longer suitable for their survival (Trust, 2013). In the mid-twentieth century, during an era of modern consumption practices, litter and other non-organic pollutants began to contribute to the pollution of the harbor. Aside from everyday waste products and debris, all storm drains emptied unfiltered liquids into the harbor. This led to anything that was previously on the streets accumulating within the harbor. Specific examples of these pollutants are fluids from vehicles, soaps and

cleaning chemicals, sedimentation from construction, litter, and any other inorganic products found in an urban environment that do not belong in aquatic ecosystems (PCC, 2015).

2.2 Geography and Demographics

Porirua City is one of four cities located in the greater Wellington region. Lying on the southwestern coast of the North Island in New Zealand, it completely surrounds a body of water previously known as "Porirua Harbour." As of 2014, the official name of the harbor is "Te Awarua-o-Porirua Harbour." The Porirua City Council modified the name with the intention of acknowledging the Maori roots of the harbor body and its importance to all residents in the region (PCC, 2015). There are two main sections that make up the harbor, the Pauatahanui Inlet to the north and the Onepoto Arm to the south, in addition to an outer harbor section and a catchment area, or whaitua[3], that spans the city of Porirua and into the city of Wellington. Figure 4 depicts a map of the greater Wellington region and the harbor's catchment area.

As of the 2013 New Zealand census, Porirua City has a population of 51,700. Roughly 20% of the population is Maori. In economic terms, the median income in Porirua per individual above the age of fifteen is 31,400 NZD. Additionally, 31% of the total population has an annual income of over 50,000 NZD while 9.3% are unemployed (Census, 2013). Porirua City has urban and rural districts throughout. In general, the urban areas are coastal and located along the harbor, while the rural areas are further inland and dedicated to agriculture and development of future subdivisions.

[3] In the context of this report a *whaitua* is an area of land encompassing a specific drainage basin.

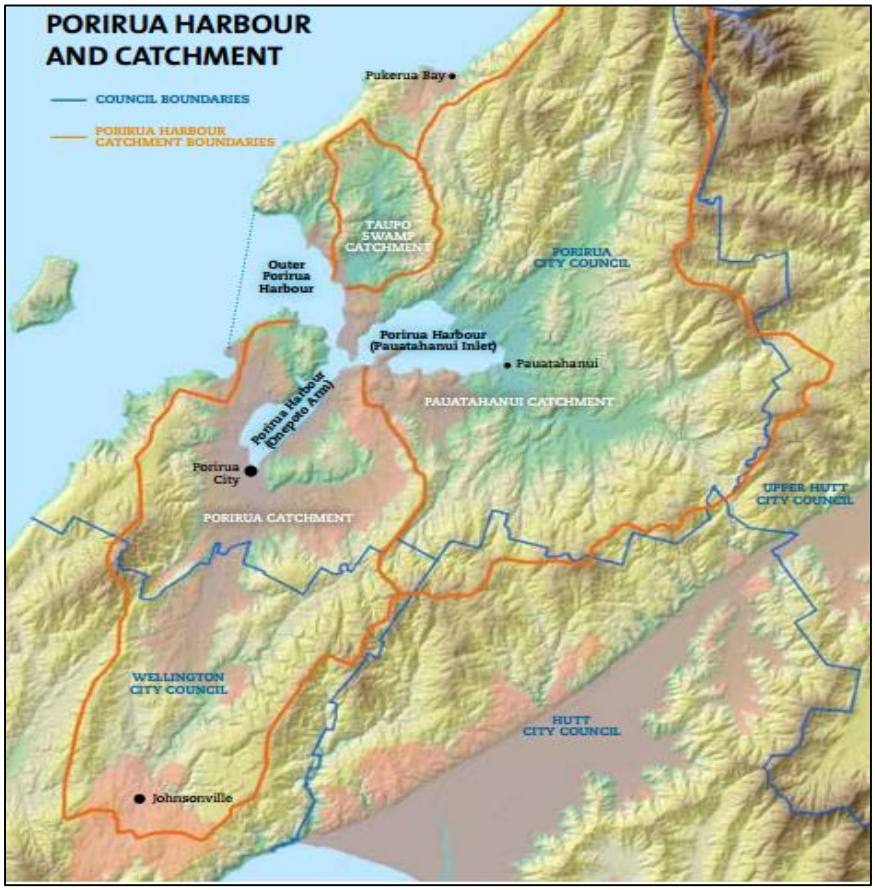

Figure 4: Map of the Greater Wellington Region and Te Awarua-o-Porirua Harbour (PCC, 2012)

2.3 Current Policies and Action Plans

2.3.1 Resource Management Act 1991

The New Zealand Ministry for the Environment first implemented the Resource Management Act in 1991, and has made a series of amendments since. The Resource Management Act designates three different types of councils with set environmental responsibilities. Regional councils manage public resources such as air, land, rivers and coastal areas. District and city councils are responsible for local land. This includes managing rubbish

disposal, subdivision development, and bush clearing as a few examples. Unitary authorities encompass both district and regional council responsibilities. There are only six unitary authorities in New Zealand, compared to 11 regional councils and 67 district/city councils. Councils individually develop district and regional plans to better manage the environment. These plans often require resource consent—authorization given by a regional council for an activity involving natural assets—for potential projects that the district or regional plans do not explicitly permit or deny. The Ministry for the Environment, the New Zealand Environmental Protection Agency, and the Department of Conservation all oversee councils and can adjust the councils' plans by implementing National Policy Statements as they see fit (Ministry, 2015).

2.3.2 National Policy Statement for Freshwater Management 2014

The Ministry for the Environment introduced its National Policy Statement for Freshwater Management (NPSFM) in 2011 with an amendment in 2014. The NPSFM addresses the unsuitable water qualities and water use efficiency throughout the greater Wellington region and the rest of the nation. It suggests implementation ideas to bring the water qualities up to an established standard. The Ministry defines the national bottom line for water quality as water suitable for boating and wading. The national government will provide 12 million NZD to regional councils over the next four years to achieve consistent bottom lines nationwide, and to completely implement the Policy Statement by the year 2025 (Ministry, 2014).

A key element of the NPSFM is to encourage community involvement in improving water management and quality and to attain national bottom lines in every region. The statement requires that each territorial authority formulate their own monitoring plan for strict record keeping of all water entering and exiting each whaitua, declaring values of "ecosystem health"

and “human health,” and prioritizing protection of freshwater species. The regional councils must improve their local water quality and no council objective may be set lower than the established national bottom lines (Ministry, 2014).

2.3.3 Porirua Harbour and Catchment Strategy and Action Plan 2012

The Greater Wellington Regional Council, the Porirua and Wellington city councils, the Ngati Toa Rangatira and a number of other community organizations introduced the Porirua Harbour and Catchment Strategy and Action Plan in March of 2012. Fifteen local agencies have adopted this plan in order to better manage and protect Te Awarua-o-Porirua Harbour and its estuaries and catchments. The plan aims to work with the community to reduce the rates of sedimentation in the harbor by enforcing stricter land management regulations, strengthening inter-agency collaboration through effective leadership and communication, and restoring ecological health to the harbor by reducing pollutant inputs and following through with the steps outlined in the plan (PCC, 2012).

2.4 Stakeholders Involved in Progressing Low-Impact Design

The team identified six major stakeholders for this project: the Greater Wellington Regional Council, Te-Awarua-o-Porirua Whaitua Committee, the Porirua and Wellington City Councils, Wellington Water, Ltd., and the Porirua Harbour and Catchment Community Trust. These stakeholders all hold power over the decisions of whether or not low-impact design (LID) is feasible in Porirua and therefore, are specifically germane to the project investigation.

2.4.1 Greater Wellington Regional Council

The Greater Wellington Regional Council works with the councils of the four major cities on the southern end of the North Island: Wellington, Porirua, Hutt and Upper Hutt to protect the environment and well-being of the community by developing emergency management plans, implementing natural resources protection, and by managing and monitoring regional parks, public transportation and pollution control. The different councils' jurisdictions are defined by the Resource Management Act (see Section 2.3.1). The council also oversees water supply to the region by treating and supplying the water for the area's largest reservoirs for local distribution (GWRC, 2015).

2.4.2 Te-Awarua-o-Porirua Whaitua Committee

The Te-Awarua-o-Porirua Whaitua Committee is an advisory body for the Greater Wellington Regional Council. The committee serves as a liaison between the communities in the designated whaitua and the regional council. Their objective is to improve local land and water quality through implementation of the National Policy Statement for Freshwater Management (see Section 2.3.2) and to create a Whaitua Implementation Plan (WIP) detailing a plan of action to help communities with future land and water management issues. The Te-Awarua-o-Porirua Whaitua Committee consists of members from the National Resource Committee, local officials, and any resident in the whaitua with interest and knowledge related to water management (GWRC, 2015).

Te-Awarua-o-Porirua Whaitua Committee's plan is to spend more time in the field learning about and discussing the policies and regulations relevant to the issues: health monitoring resources, historical data, current hydrology and water use, and local ecology and biology. The committee plans to spread awareness of these issues throughout the community

and to get the local residents involved in their plan of action. They hold regular meetings open to the public to discuss progress and request input. The committee is currently focused on recognizing the issues at hand, aligning their values with those of the community, and establishing the WIP which they aim to finish by February of 2016 (GWRC, 2015).

2.4.3 Porirua and Wellington City Councils

The Porirua and Wellington city councils are local authorities made of elected officials in their respective cities. A city council is responsible for forming the city's vision and implementing programs to better the economy, environment and the overall well-being of its residents. Currently the city of Wellington is focusing on increasing its global appeal and improving its services (WCC, 2015), while the city of Porirua is working towards upgrading its infrastructure and allocating funds towards a variety of programs including recycling and business development (PCC, 2014). The state of Te-Awarua-o-Porirua Harbour is a direct concern of the Porirua City Council but also indirectly involves the Wellington City Council as some Wellington City residents live within the harbor's catchment boundaries (PCC, 2012), which Figure 4 depicts.

2.4.4 Wellington Water, Ltd.

Wellington Water, created in September of 2014, is the organization that oversees the drinking water operations for the greater Wellington region. Formed by a merger of Capacity Infrastructure Services and the Greater Wellington Regional Council's water supply and distribution company, it is now jointly owned by the Greater Wellington Regional Council and the Hutt and Upper Hutt, Porirua, and Wellington city councils. The company is currently working with whaitua committees to develop consistent water monitoring methods and to meet

the requirements of the National Policy Statement for Freshwater Management (see Section 2.3.2). Wellington Water is also focused on increasing community awareness and education on the water quality issues in the region (Wellington Water, 2015).

2.4.5 Porirua Harbour and Catchment Community Trust

In March of 2011, the Porirua City Council, the Greater Wellington Regional Council, the Wellington City Council and the Ngati Toa Rangatira established The Porirua Harbour and Catchment Community Trust as a means to include the concern of both arms of Te-Awarua-o-Porirua Harbour in one active organization. The list of trustees includes a representative from each of the four founding groups, along with several community members with environmental professions or concern for the harbor. The purpose of the trust is to promote sustainable management of the entire harbor and its estuaries and catchments. The trust works closely with the Porirua City Council but is an independent advocate for the harbor. The trust also aims to spread community awareness and increase education on both the ecological and environmental issues concerning the harbor, and contributes to other local groups seeking to revive and protect the harbor (Trust, 2013).

The trust publishes annual "scorecards" that measure progress in improving the harbor and the current status of pollution. Trust representatives on the review panel synthesize information from the Porirua and Wellington city councils and from the trust's own surveys and projects. The trust releases an annual report every February (Trust, 2013).

2.5 Low-Impact Design

The United States Environmental Protection Agency defines low-impact design or development (LID) as practices that manage stormwater by minimizing impervious cover using

natural or man-made systems to filter and return stormwater into the ground (EPA, 2009). The goal of LID is to reduce runoff and mimic a site's predevelopment hydrology. This is generally accomplished by treating stormwater runoff close to its source, rather than treating the water in costly end-of-pipe facilities (UDT, 2015). LID practices shown in Figure 5 include preserving pervious space and utilizing methods like rain gardens, green roofs, porous pavement, and bio-filtration. Implementation of LID decreases pollution by naturally filtering stormwater runoff and can also reduce the risk of flooding during heavy rainfall.

Despite all of these benefits, one of the primary concerns about the implementation of LID is the issue of cost, with a common misconception that these methods are prohibitively expensive. However, the EPA conducted a study in 2009 of 17 LID projects in the United States and compared the cost to the estimated cost of conventional development. Of the 17 projects in the survey only one showed an increase in overall cost with the other 16 demonstrating a 15-40% decrease in costs (EPA, 2009), thus demonstrating the feasibility of LID.

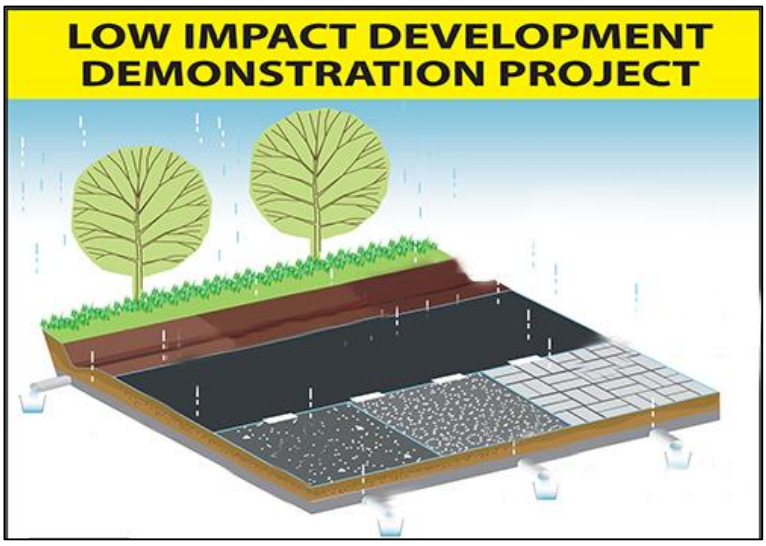

Figure 5: Examples of low-impact development (YCW)

2.6 Diffusion of Technology

2.6.1 Diffusion of Innovation

Implementation of new technologies is a long process that involves direct cooperation from the people who will use the technology. The process of diffusion best describes how innovation starts as a new concept tested in real life application, and evolves into something that has become a part of everyday life. As shown in Figure 6 along the yellow line, new technology introduced into society typically begins with a slow adoption rate. The adoption of the technology will eventually grow exponentially as it increases from 25% to 75% of the population. A new technology is generally considered a societal norm by the time 75% of the population is using it. The adoption of the technology throughout the remaining population becomes asymptotic as the technology approaches 100% acceptance by the people. The cause for the asymptotic increase is due to the assumption that not everyone would completely adapt to the new technology. The blue line in Figure 6 illustrates the distribution of the people who contribute to the diffusion of new innovation, which creates a bell curve. The figure essentially illustrates that there is a slow start to the diffusion process, but if implemented correctly, the adoption process will take off and usher the technology into everyday life.

There are several impediments involved when a technology is diffusing into society. One possible obstacle could be the particularities of the culture in which the technological diffusion is taking place, which is variable around the world. A cultural norm is an idea, concept, or physical thing that most people of any society believe to be standard (Sieck, 2012). Culture can greatly affect how quickly a social group adopts new technology, depending upon the technology's relevance to its society's values and structural characteristics. For example, a materialistic technology such as television or personal computers will have a much faster diffusion process

and become a cultural norm in a society that generally revolves around material objects, such as in a number of first-world countries, whereas the same technology may not be as accepted by a society that is less dependent on consumer goods, such as many third-world countries (Dubois, 1972).

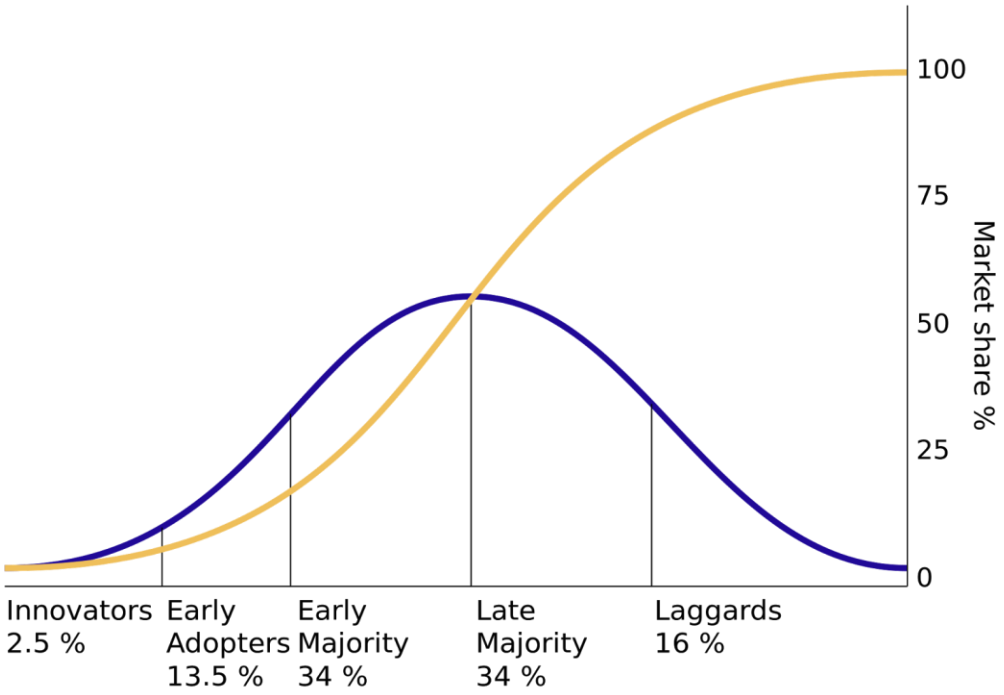

Figure 6: Diffusion of ideas (Everett, 2012)

Another cultural restraint that affects innovation diffusion is the culture's willingness to change and adapt to new circumstances. As an example, American society is one that tends to implement new standards in a fast and accepting manner. However, many European societies revere their traditions and are therefore less accepting of a change in standards that would affect traditional norms. If a culture mostly consists of individuals who are less willing to try new things, the diffusion of a new innovation will be a substantially slower process, if it were to succeed at all (Dubois, 1972).

2.6.2 Personal Bias in Decision-Making

Personal bias is something that everyone has, and when making decisions, will always factor into the process, whether as a strong presence or a small one. These biases form from past experiences and beliefs carried over from things such as education, traditions, and past work experiences. These personal biases determine where on the diffusion of technology spectrum a person lies (see Figure 6). If an individual is more open to new ideas and is willing to try new technologies, then that person would likely fall under the category of an early adopter on the graph. The more traditionally-minded people, on the other hand, might belong in the later adoption group or even the laggards. In addition to this, people who are untrusting of this new technology may also be in the later adoption group due to reasons such as bad past experiences with the technology or that they are inherent skeptics of new ideas. All in all, personal bias can either be a boon or an impediment to the diffusion of technology.

2.7 Focus Groups

Focus groups are a research method used to start discussion as a means for feedback on ideas, products, and concepts. In a focus group, a variety of pre-determined guests meet, and with the help of a facilitator, begin a discussion about a specific topic. From these discussions, researchers can learn more about their topic and also discover potential problems that they may have overlooked. In marketing, analysts generally use focus groups to roughly gauge whether or not a product will be successful or not, depending on the population's opinions. A small group of people generally participate, so the entire targeted population may not always be correctly represented. By selecting a wide range of guests, from community members to professionals in our case, researchers achieve a more accurate representation.

3 METHODOLOGY

This project aids the Greater Wellington Regional Council (GWRC) in analyzing the potential impediments to the adoption of low-impact designs (LID) aimed to improve water quality in Te Awarua-o-Porirua Harbour. We achieved our project goal by accomplishing the following objectives: (1) Gaining an on-the-ground perspective of the harbor's pollution status and background information on prior attempts at implementing LID, (2) Examining stakeholder views on decision-making as it relates to the adoption of LID, (3) Assessing stakeholder opinions of LID, (4) Performing an analysis of possible impediments to the implementation of LID solutions, and (5) Providing recommendations on how to best overcome these impediments.

Our team worked with our sponsor liaison at the GWRC to modify our existing mission statement to reflect the change in our project from a feasibility study of LID to a report on the impediments of implementing LID. While our correspondence with our sponsor liaison helped shape the background and scope of our project, the most helpful information for our recommendations came from our interviews, focus group, and general discussions with stakeholder representatives. These face-to-face meetings enabled us to finalize our project's focus and direction.

3.1 Understanding the Pollution Issue

3.1.1 A Visual Understanding of Harbor Issues

Before speaking with stakeholders and discovering the reasons why the city of Porirua has not widely used low-impact designs (LID), we observed Te Awarua-o-Porirua Harbour and its catchment area to gain a better perspective on the current water treatment methods and to take

an initial look at the potential impediments of LID. This entailed touring the city and its suburbs and visually identifying impediments of LID such as the availability of green spaces and the positioning of existing stormwater management infrastructure. It also provided us familiarity with the spatiality of the catchment area, which is valuable when developing recommendations for the Greater Wellington Regional Council (GWRC). Our sponsor liaison at the GWRC, as well as a representative from Porirua City Council, showed us around the area and informed us about the LID options that the councils have already explored over the years.

3.1.2 Determination of Interviewees

During this project we analyzed the opinions and suggestions of several stakeholder groups and external sources. In our initial research we worked with our sponsor liaison at the Greater Wellington Regional Council (GWRC) to determine which departments the council plans to involve in the implementation of future environmental technologies in Porirua. The team first aimed to select a representative from each of the major stakeholder groups. This included the GWRC, Porirua City Council, Wellington City Council, Wellington Water, Ltd., Te Awarua-o-Porirua Harbour Whaitua Committee, and a recommended consulting engineer.

It is important to note that we did not interview all stakeholder groups involved in the planning and process of development. Important omissions include local iwi, the wider community and developers or major land owners these omissions were due to a lack of availability or the time constraints of the project. While these limitations are significant, the breadth of responses around LID decision-making offers a useful insight into a number of factors influencing the rate of adoption of LID in the greater Wellington region.

The second task was to interview professionals involved in the development process: policy, regulation, planning, and engineering. Our GWRC sponsor provided a list of possible

interviewees with their respective occupation and organization and we worked together to generate a diverse list of five interviewees to satisfy our needs (see Table 1). For the sake of confidentiality, the team omitted the interviewee's name and the organization. Prior to conducting each interview, we gained consent from the interviewee to make an audio recording of the interview for transcription purposes. The results of the interviews provided data from most of the stakeholder groups, as well as the departments involved in completing the overall goal of implementing low-impact designs in Porirua.

Label	Position
Interviewee A	Policy
Interviewee B	Policy
Interviewee C	Planner
Interviewee D	Consulting Engineer
Interviewee E	Regulator

Table 1: Interviewee labels

3.2 Interviewing Stakeholders and Facilitating a Focus Group

Our team decided to create a two-step data collection process in order to address these factors and gain as much information as possible as to why Porirua has not used LID

more. Interviewing the stakeholders about their decision-making processes was the first step in completing our second and third project objectives (see Section 3 Introduction). The team designed several questions (see Appendix A) aimed to learn more about the personality of the professional and the process they go through along with everything they take into consideration in order to complete an assignment. Our second step was to use the information learned from our interviews to develop topics for a focus group involving stakeholders from different organizations and disciplines. Some of the stakeholder members the team invited to the focus group also participated in the prior series of interviews. The focus group linked together the responses on decision-making with topics specific to LID. This information allowed the team to further analyze the impediments of implementing LID in the hopes of one day accelerating the diffusion process of LID in Porirua and perhaps, New Zealand.

3.2.1 Interviews on Decision-Making

Our team wrote the interview questions to determine the characteristics of selected stakeholders and to learn how they made influential decisions in their line of work. We designed the interview questions to be broad and unrelated to LID to provide our team with general personality information that would affect a project involving utilizing a new technology, such as LID. As mentioned in the background chapter (see Section 2.6), with the process of diffusion of technology there is a large cultural aspect as to why a new technology may or may not diffuse into society. The interviews consisted of "how" and "why" questions (see Appendix A) regarding decision-making, as well as questions about company policies or biases that either target project decisions that involve conventional concepts or new concepts. Our team determined interviewees from a list of willing candidates provided by the team's sponsor liaison

at the Greater Wellington Regional Council. These people were from our various stakeholder organizations and of different occupations and roles in their respective organizations.

3.2.2 Planning the Focus Group

After coding and organizing the interview responses from stakeholder members using transcripts of the recorded interviews (see Appendices E-I), we identified the most common themes that appeared in these discussions. We used our coding process to identify answers to the binary questions we asked interviewees, as well as to highlight instances where the team could simplify an answer into a themed code. Examples of these codes were conversations related to finances, communication, and influences on decision-making. The recognized codes contributed to our focus group guidelines (see Section 3.2.3) to further produce opinions on the topics. As the focus group was our main source of data, our intended discussion topics needed to be as specific as possible in order to get the most valuable data from our responses. Due to this, the incorporation of interview data into our focus group questions and discussion topics (see Appendix D) was an essential part of our data gathering process.

Our project team met with the community engagement team at the Greater Wellington Regional Council (GWRC) three times to discuss our plan for the focus group we were to facilitate. The team members helped our project team to understand the intent of a focus group and to set specific goals for our focus group. Using the information learned in our interviews, our goal for the focus group was to expand on this information and learn more about the entire developmental process in the greater Wellington region. Our focus group was to have broad discussions of past and present projects, but to narrow in on the impediments of LID in Porirua.

Our team brainstormed the best ways to facilitate our focus group to maximize the amount of relevant information. We developed pre- and post-workshop questionnaires (see

Appendices B-C) to gather demographic and professional information on our guests. Using our interview results, we came up with eight "table topics" to discuss during the workshop. The purposefully vague topics included cost, communication, stormwater, low-impact design, Porirua, infrastructure, regulation/policy and priorities. We planned the schedule for the focus group which we discuss further in Section 3.2.3. We also organized catering for the event and gathered all of the needed materials for the focus group, such as whiteboards, notepads and pens.

3.2.3 Focus Group

Following the interviews, our team held a focus group on February 10, 2016 at the Greater Wellington Regional Council (GWRC). In planning this three-hour workshop, we sent out email invitations to 18 professionals working for each of our stakeholder groups and included open invitations to other professionals who might have interest in attending. Of the professionals invited, 11 attended including representatives from all of our stakeholder groups and three from various consulting engineering firms. We began the workshop with a questionnaire (see Appendix B) to determine demographic information and the individuals' experiences with LID. Following a brief description of Te Awarua-o-Porirua Harbour and how LID implementation could improve its water quality we began the discussion portion of the workshop. We divided the discussion into three distinct segments. For the first two segments the team split the participants into two groups: five in one group and six in the other. A team member facilitated each group discussion while another one took notes. The purpose of this split was for the stakeholders to take part in a smaller-sized discussion of LID where the team could hear everyone's voices. The discussion topics and questions (see Appendix D) were partially influenced by the results of our coded interview transcripts (see Section 4.2). The first focus group segment was a general talk on the impediments of LID while the second segment focused

specifically on Porirua. These discussions were loosely-structured with the predetermined questions only used to keep the conversation on topic; the team left the details and specific points discussed to the discretion of the participants. We did this to allow the conversation to flow naturally, which would aid in the analysis of our focus group discussions. The analysis gauged the frequency of specific topics mentioned in the free-form conversations by coding the notated statements and phrases recorded by a team member (see Appendix J).

Following these two segments we combined the two discussion groups for a final closing segment. In closing, we reviewed the two groups' main points and brainstormed potential strategies to address the impediments that we had identified in the previous sections. In analyzing the workshop, we organized the notes taken into a narrative form. Each statement was then put into a spreadsheet and sorted for common themes (see Appendix J). The frequency with which each theme appeared would indicate their relative importance to the focus group participants. Based on the results of our focus group analysis we identified the top impediments (see Section 4.3.2) the environmental policy department of the GWRC would need to address in order to begin implementing LID in Porirua.

3.3 Analysis of Possible Impediments of Low-Impact Design Solutions

Our team conducted an analysis on the impediments of low-impact design (LID) implementation in order to find and recommend potential solutions that the Greater Wellington Regional Council can use to make LID more widespread throughout New Zealand. Using our coded transcripts, we were able to identify personal, cultural or practical biases that the interviewed stakeholders may hold when making important workplace decisions. Using this information, we then tried to identify any of the biases of these stakeholder members, as well as

the different constraints placed on them by their work. We also determined how all of these factors applied to the decision-making process. This information on how engineers and planners made important decisions was key to finding the main impediments to the implementation of LID technologies. Additionally, the team used our interviews to get a better understanding of the process of development, where an idea for environmental protection becomes a formal policy or furthermore a physical design implementation (see Figure 9). This process would help the team notice any areas where LID could fit in the process if it was not already and highlight areas in the process that contribute to impediments of LID implementation.

The focus group results played a large role in helping to determine what may be potential obstacles to the usage of LID. While the interviews focused more on the decision-making process of the individuals, we tailored the focus group to lean more towards LID implementation, specifically the stakeholders' perceptions of the matter. Coupled together with the personal interviews, our team was then able to pinpoint where these differing perceptions originated and why a bias may be present in the first place.

This analysis of our two-step interview/focus group process (see Section 4) narrowed down the reasons the city of Porirua has yet to implement LID solutions in its harbor catchment area and aided the team in compiling recommendations (see Section 5.1) on how to popularize these strategies.

4 RESULTS AND ANALYSIS

Through numerous conversations and background research, the team formulated several ideas and opinions about the potential obstacles limiting the acceptance of low-impact design (LID) in the Porirua community. However, in order to find more definite solutions, simple conjecture was inappropriate. By taking the information collected in our interviews and focus group and interpreting it through various means of coding and analysis, we were able to uncover data that highlighted some possible impediments to the more wide spread use of LID in the greater Wellington region.

4.1 Site Visits

Our team visited Porirua on three occasions. We travelled by foot around the central business district (CBD) and the Onepoto Arm and its main inlet during our second week working at the Greater Wellington Regional Council (GWRC). This initial visit was later followed up by a three-hour guided tour of the Porirua Harbour catchment by Keith Calder, a Porirua City Council representative, accompanied by three members of the GWRC environmental policy team. During these visits, our team photographed various important sites including Porirua Stream and sites of earthworks development, examples of low-impact design (LID) methods, and current methods of conventional stormwater treatment including detention ponds and motorway storm drains.

Our third visit to Porirua was to attend the Te Awarua-o-Porirua Whaitua Committee meeting on February 11, 2016 in northern Porirua. At this meeting, committee members discussed the committee's values regarding the harbor and catchment. In addition, they attempted to align their values to the views of the catchment community, which they have

analyzed through a variety of surveys. The drive to the meeting also allowed our team to view the Pauatahanui Catchment for the first time. This large rural area surrounds the Pauatahanui Inlet and is the site for future suburban development. At the Te Awarua-o-Porirua Whaitua Committee meeting we learned that this proposed new development has engendered community concern about the potential increase in sedimentation in the inlet.

4.1.1 On-Site Observations

During our visits to Porirua, the team made several observations regarding the state of the Onepoto Arm and the different subdivisions around its catchment area. While walking around the Onepoto Arm we noticed a lack of commercial development along the waterfront. The various businesses located on the shore faced away from the harbor psychologically separating the community from the harbor. We also observed little development of walkways and public space along the arm, further outlining a detachment of the city from its harbor. After discussing with council staff and community members, it was clear that policy makers were aware of this potential issue and were working to address it, but changing the layout of the city center would take time.

Additionally, a substantial amount of litter was in the waters of the catchment itself, and during low tide this rubbish was especially visible. Our observations of the Onepoto Arm also demonstrated that the harbor is a low-energy system, meaning that unlike Wellington Harbour, which is deep and has unobstructed access to the ocean, Te Awarua-o-Porirua Harbour has a narrow junction providing limited access to the open ocean. Consequently, sedimentation and other pollutants do not naturally filter out of Porirua Harbour as easily as they do in the Wellington Harbour. This causes sedimentation buildup which leads to a very noticeable decrease in water depth over time (see Figure 7).

Figure 7: Onepoto Arm at low tide, showing sedimentation build-up

It is clear that a number of attempts at LID in the Porirua catchment have faced challenges. During our second visit to Porirua we toured the residential subdivisions in the Porirua catchment. There we saw a few attempts at low-impact stormwater treatment such as EnviroPods® installed in storm drains, and artificial wetlands at the base of the hills close to the harbor. The purpose of EnviroPods® is to filter out chemical contaminants and debris in storm drains through a textile sack, or "pod." However, construction sites near some of the pods produced sediment buildup which led to problems in the effective removal of the pods during their scheduled annual maintenance. The debris made the pods too heavy to remove without tearing apart. Many of the pods needed replacement after the first round of maintenance. In the case of the artificial wetlands, the city constructed them in such a manner that water and any

pollutants that collect have no way to filter into the harbor. This created stagnant ponds which potentially cause health problems with algal blooms during the summer months.

The steep geography of the surrounding land area may also make traditional LID solutions more difficult to correctly install. We saw a prototype of a grass swale (see Figure 8) created by the Porirua City Council along the side of a sloped street. As in the cases of the EnviroPods® and artificial wetlands, improper construction and placement of the swale hampers its ability to effectively control and treat stormwater. In this instance, the angle of the swale walls was too steep and stormwater would flow through at high speeds, preventing the water to naturally seep into the pervious surface and limiting the amount of water that it could effectively filter. To compound this problem, the placement of the swale makes it susceptible to collecting rubbish that is subsequently carried down the hill by stormwater, thus requiring regular cleanings to stay functional.

Figure 8: Swale in Porirua

4.2 Interviews

4.2.1 Interview Summaries

Our team interviewed five professionals from our stakeholder groups in the greater Wellington region. These professionals gave us insight into their daily tasks and the influences behind their decision-making processes. For the sake of anonymity, the team excluded interviewees' names and companies from our summaries. We refer to the interviewees as Interviewee A, Interviewee B, Interviewee C, Interviewee D, and Interviewee E in order of the date the interviews took place.

Interview A: February 1, 2016

Interviewee A ("A") was a policy advisor who gave us a lot of information on the workings of Te Awarua-o-Porirua Whaitua Committee and the Resource Management Act. The whaitua committee handles community outreach and the Resource Management Act creates rules and regulations regarding interactions between people and the environment. "A" discussed the lack of regulations regarding the implementations of low-impact development (LID). There is no standard code of practice for LID, so "A" felt that oftentimes councils implement development projects involving LID in an inconsistent and costly manner.

Interview B: February 2, 2016

Interviewee B ("B") provided useful insight into the workings and decision-making procedures of local government. Through our interview we learned about the long-term planning process around the creation of rules and laws, specifically regarding land and road development. We also gained insight into the specifics of the law creation process, beginning with initial drafts, edits by stakeholders to fit their needs, public hearings, and finalizing with a

formal document. This includes the community outreach efforts to get citizens involved in decision-making. Interviewee B also discussed that the Building Act of 1991 is an important factor in the shape and design of dwellings. This act defines a policy where developers can either use pre-approved construction designs or new designs as long as they perform at the same standards. While the Building Act does allow for the introduction of new designs and practices, "B" mentioned that developers tend to stick to the pre-approved designs rather than experimenting with new ideas due to the predetermined knowledge of costs, timelines and risks. While this is the most economical method, there is currently no incentive for developers to innovate and pursue low-impact designs (LID), as doing so would incur further review of plans and increase costs. It also will take more time for implementation, ultimately leaving no real incentive for developers to innovate and pursue LID. There is room for LID innovation in the current policy, but developers have no incentive for this innovation and tend to choose the current economical methods.

Interview C: February 9, 2016

Interviewee C ("C") was a planner who was not associated with any of the important regulatory and resource consent decisions made by the councils. "C" provided a clear idea of the policies and regulations that constrain these decisions, such as required consents from various authorities or a lack of standard development plans. Through the interview, we learned that the ideals of policy and regulations drive "C's" decisions when connecting development projects to the water system.

Interviewee C was very pragmatic and in some cases skeptical of the practicality of the concept of low-impact design (LID), which was a notable difference from the other interviewees. This was due to "C's" belief that since developers are profit-driven, it is very unlikely that they

would voluntarily implement any LID projects as the implementation would be too costly. "C" also believed that the public's common misconceptions of LID, including high costs and a general lack of awareness, deter from its feasibility. Consequently, property rates would go up, which could cause dissent among the residents of the area.

Interview D: February 9, 2016

Interviewee D ("D") was an ecological engineer. Through this interview we gained valuable insight on how engineers attempt to deal with stormwater pollution throughout the development process. Developers, according to the interviewee, tend to bring in consultants at the end of a project rather than at the beginning where their advice could be more useful. Additionally, we discovered a communication issue between designers and builders. The designers who have a better knowledge of low-impact design (LID) are not in constant communication with builders, who lack experience with LID. Builders often revert to traditional designs during LID construction without consultation with the designer, which decreases the effectiveness and efficiency of the final product. "D" also stated a belief that Australia is decades ahead of New Zealand in terms of stormwater management policies but did not specify any singular reasons for this belief.

Interview E: February 10, 2016

Interviewee E ("E") described the consent and compliance process from an environmental regulation standpoint. "E's" role in projects includes upholding the Resource Management Act and ensuring that developers follow proper policies and rules. "E" evaluates a client's applications and assesses the necessary steps to approval. "E" also touched on the responsibilities of city and regional councils in terms of environmental consents, such as how they determine the level of impact development would have on the environment and whether or

not to approve specific projects. City and regional councils differ in that city councils are in charge of land development in the city while regional councils' main concerns are the effect of development on the environment and natural resources. According to "E," the councils in Wellington have been making strides to work more closely together by increasing communication with each other. "E" explained how regulations are critical in resource preservation and how cities need to monitor sites of earthworks development in order to minimize sediment erosion and runoff. "E" explained that regulations are critical in resource preservation and cities need to monitor sites of earthworks development in order to minimize sediment erosion and runoff.

4.2.2 Analysis of Interviews

Most of the data collected from our interviews was qualitative and designed to provide insight into the tendencies and customs of those involved in decision-making. We selected our interviewees due to their different roles in the stages of the development process in or around city property (see Section 3.1.2). These interviews depicted the many factors an individual may encounter when making decisions, generally in regards to their personality, job position, and organization. Through coding the interview transcripts, the team was able to additionally identify important themes that would be relevant to our low-impact design (LID) focus group. These themes became our "table topics" in the first half of the workshop and consisted of cost, communication, stormwater, and LID.

From our interviews, the team developed a road map showing the process a new design or regulation would have to go through prior to its implementation (see Figure 9). The first stage is the policy development stage, where an idea framework becomes a formal document of regulatory policies. Interviewee B stated (see Appendix F) that the process can be very long

depending on how many people the design ultimately affects and how many stakeholders the project would involve. This interviewee further elaborated on how a project or policy may require a series of hearings and appeals in order to satisfy all parties involved with its inner workings. Due to this process, it can take years to get the framework of any policy in place.

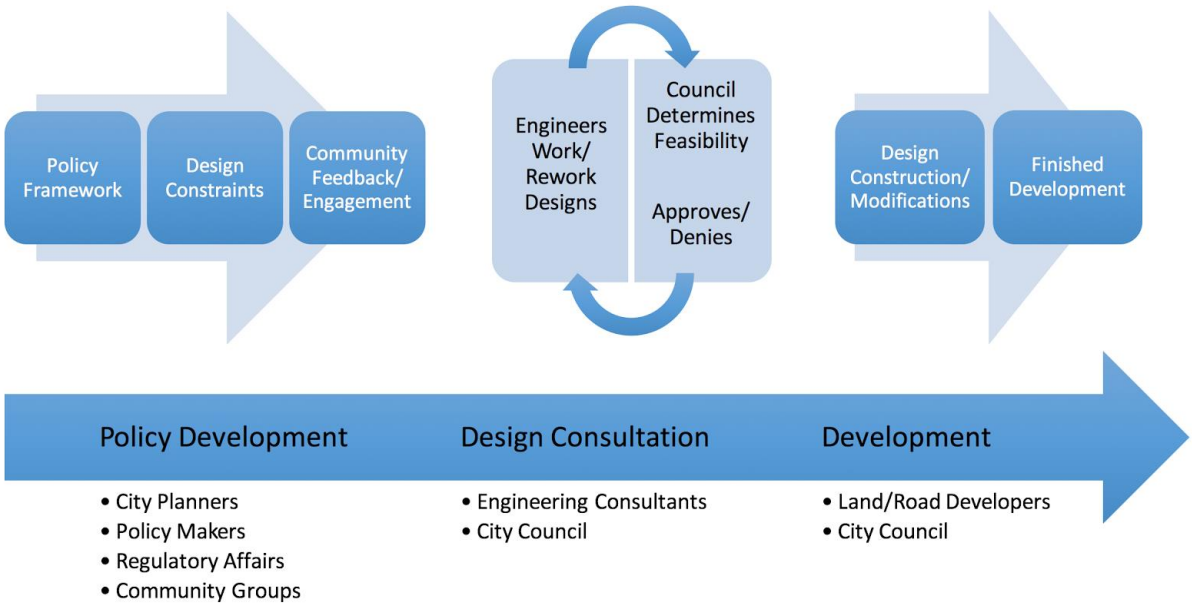

Figure 9: Process of technology implementation

In addition to this, Interviewee E also explained (see Appendix I) that different councils have different jurisdictions, and in cases poor communication between the councils can add even more complexities to future land development. For example, while city councils have the power to decide how to use land, they have to comply with environmental guidelines established by regional councils. A lack of communication between these different jurisdictions can inhibit the progress of innovative development. However, we understand that the councils are working to resolve the inherent tensions between different jurisdictional roles.

The second and third stages in design implementation (see Figure 9) includes the engineering consultation of the design where the engineers create the blueprints and the development of the physical design that land developers or owners will construct on city property. Interviewee D elaborated (see Appendix H) on how the city council consults an engineer to design the most appropriate structure for the development. The council discusses the feasibility of the design, often "behind closed doors," and will consult with the engineer if they need to make changes prior to implementation. Once the process is able to move on to the actual development stage, the process does not always include the engineer (see Figure 9). Developers will often modify designs without consulting the designer.

Some of the important information from our interviews were personal opinions on how the interviewees believed they could achieve progress. Two examples of these opinions in particular were the individual's willingness to embrace change and if they prefer regulatory policies or physical design solutions when it comes to solving issues within the community. The interviewees tended to make statements relating to both answers of these questions, suggesting that a mixed model involving regulatory and design solutions is likely to be considered as a way of driving changes.

To determine an interviewee's willingness to embrace change, we asked the question, "Do you think people prefer conventional methods when new ones are available? Why? What is your stance?" (see Appendix A). New methods could consist of low-impact designs such as rain gardens and green roofs, and conventional methods would include devices like unfiltered storm drains and detention ponds. Our results (see Figure 10) show that policy workers could prefer either option. From the context of their interviews, the two policy workers preferred the most efficient methods, regardless of whether they were conventional or something new. The

interviewee who worked in planning (Interviewee C) favored conventional methods, and emphasized the role of new technologies, specifically LID, although noting that these may well increase property rates. However, Interviewees C and D disagreed with each other; Interviewee D believed that logical methods, new or old, should take precedence over any expense. Interviewee E only mentioned a preference in method when prompted, which explains a 100% preference to new methods (see Figure 10). Due to this instance, it is important to note the number of times the interviewee mentioned the topic. The team used this as an indicator to how sensitive the interviewee was to the topic in regards to their work.

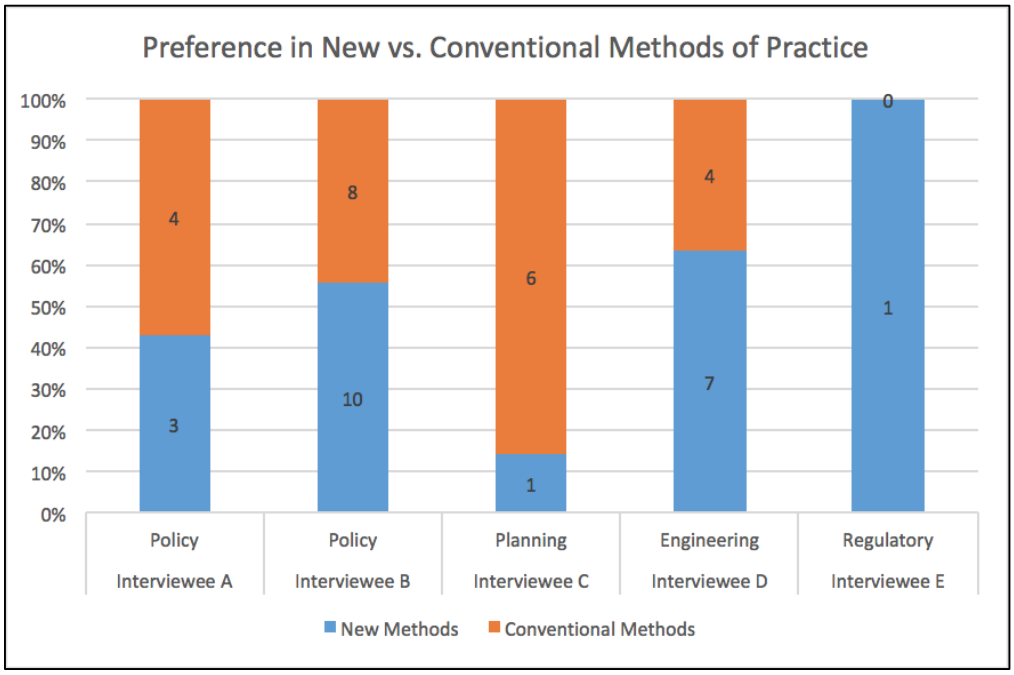

Figure 10: Preference in New vs. Conventional Methods of Practice

When asking the question "What are your views on regulation vs. design solutions?" (see Appendix A), the team interpreted the results to find that the general consensus among the interviewees was that there needs to be a mix of the two, with three interviewees preferring regulation having dominance over a design implementation (see Figure 11). Aside from one

interview, the interviews all included one count of a discussion about design solutions and at least one discussion of regulatory actions (see Figure 11). Most interviewees explained that councils need to put policies in place as new design solutions become more prevalent. Currently, New Zealand offers little guidance for implementing new designs such as LID. In reference to Figure 9, stakeholders discuss LID implementation during inconsistent stages of development if discussed at all, which may partially explain the widespread failures of its installation. In order to successfully implement such design solutions, it seems appropriate to have a set of rules that will guide these development processes. This would require a standard process where stakeholders put LID into consideration during the early development stages.

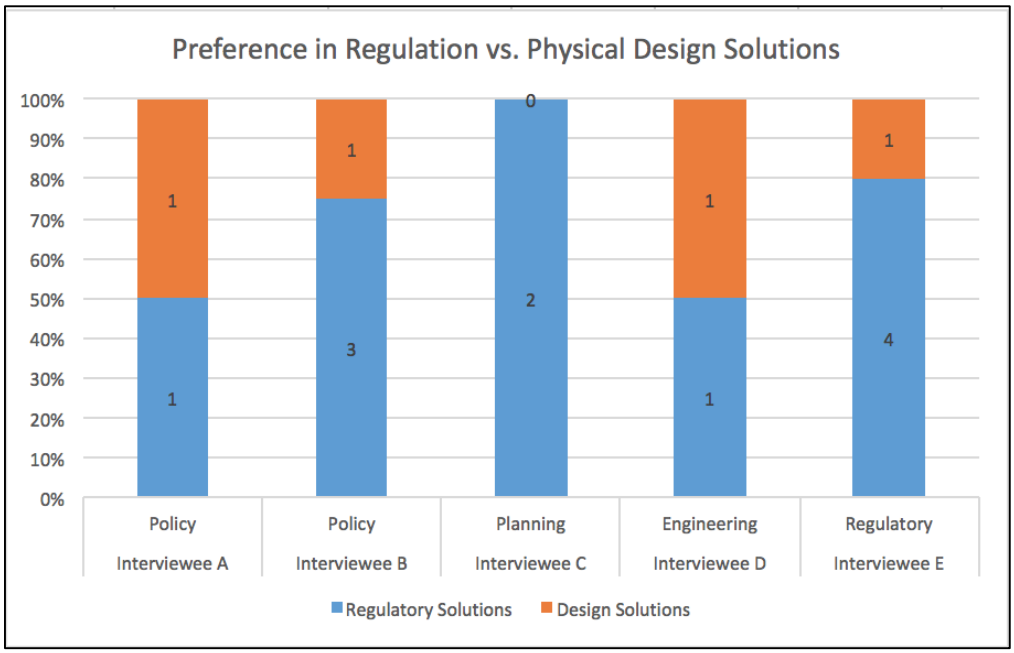

Figure 11: Preference in Regulation vs. Physical Design Solutions

4.3 Focus Group

We conducted a focus group on February 10, 2016 at the Greater Wellington Regional Council. The purpose of this group event was to have members from stakeholder organizations

of different occupations collaborate and share opinions on the problems and obstacles delaying the implementation of low-impact design (LID) in Porirua. There were 11 focus group attendees that we split further into smaller groups of six and five. Two team members facilitated each group. Figures 12 and 13 below show the two groups sharing opinions about the impediments guided by the designated focus group "table topics" (see Appendix D) placed on note cards in the center of the table. Figure 14 shows these impediments discussed. "Table topics" in our focus group consisted of pieces of paper with the words stormwater, LID, cost, and communication. For the second half of the session, we had the group focus their conversations on Porirua using the table topics labeled Te Awarua-o-Porirua Harbour, infrastructure, priorities, and regulation/policy. The facilitators ran the focus group in an open forum manner in which there was as little prompting from the facilitator as possible. This style of facilitation led to the attendees talking about the table topics freely, allowing the team to gather data that set questions would not have been able to target. While the team had prepared questions beforehand, they were mostly unused as the team only resorted to them when either the natural flow of the discussion had ceased, or when the attendees had gone off topic in their free discussion.

4.3.1 Focus Group Summary

During the early stages of the focus group conversation, our team recognized several underlying themes that quickly came into play. We will write these themes in bold throughout the following section. The first theme was the **misconception that low-impact design (LID) is strictly a form of technology**. Focus group attendees from one of the groups vocalized the idea that LID is more a philosophy than a technology, and can simply be a concept taught through education. This was an important topic that tied into another theme regarding the quality of the environment for future generations and how they will value the nature around them.

Figure 12: Focus group facilitated by Michael and Jon

The **lack of regulations for development** also became the topic of discussion in one of the two groups, where three engineers talked about the trials and tribulations that they faced when dealing with construction companies. To them, developers were profit-driven, and since they were effectively losing building space and money by implementing LID, there was no real incentive for developers to implement LID in their overall construction plan. The other discussion group strongly focused on the regulatory policies in place. Different regulations involved in every step of the development process currently shape the progression of development. A number of stakeholders within the community view any regulations related to the environment as more of a negative obstacle rather than as a positive impact on the future of such development. This conversation transitioned into the idea that preserving the environment needs to be a norm amongst all parties involved in land development in order to produce a positive long-term impact in the future. "What kind of place do [New Zealanders] want to live in?" was one question a particular attendee asked that helped to shape the discussion in this focus group.

The **lack of knowledge of LID amongst developers, political leaders, and the community** was another important reason the concept has not been successful in New Zealand's past. According to a focus group participant, even when the country uses LID, it is often poorly implemented with consultants generally called in to evaluate the design only after the construction of the developer's completion of the design. If the developers incorrectly or poorly constructed the design, the consultant cannot give any useful input, as there is nothing they can do at that stage. Additionally, as pointed out by a separate focus group participant, most politicians are unaware of the concept of LID, and do not know what there is to consider or what to expect if they were to recommend an LID technique.

The **maintenance of the implemented LID** solutions was another problem outlined in both of the focus groups. The planners and the engineers came together to agree that when dealing with LID, councils often did not seem to determine the maintenance responsibility until after the implementation of the design or the development. Understandably, according to the focus group participants, this led to several problems. They noted confusion between the councils about who is responsible for the design's maintenance, with concerns among parties as to who would pay for it. This addressed a further accountability issue. One example of this is the EnviroPods® installed by the Porirua City Council in 2002. There was no designated party responsible for the maintenance which led to the large removal of the EnviroPods® when maintenance costs ended up being higher than anticipated.

Figure 13: Focus group facilitated by Alex and Julia

Towards the end of the workshop, the group began to talk about different techniques for implementing LID. One idea that seemed to gain traction was the idea of having developers install rainwater tanks into all of the new buildings that they constructed. This would alleviate the problem at the source, as the definition of the stormwater problem had two main factors: the treatment of stormwater and the creation of it. By having developers install inexpensive rainwater tanks in every house, the community can reduce the amount of stormwater created. Another idea that was popular was incentivizing the implementation of LID. One example discussed in the focus group was the idea that for every LID a developer created, they could build another house on the property. These kinds of incentives would nudge the developers in the right direction, which would receive a better response than simply enacting dozens of new regulations limiting developers which could potentially cause resentment.

4.3.2 Data from Focus Group

Two team members took notes for the duration of the focus group. These notes consisted of table topic discussions and direct quotes from focus group members. The notes were later synthesized into a narrative form. A team member entered each statement from the new narratives into a spreadsheet and searched the statements for common themes. If the team member noted a recognized theme in a sentence, they tallied it. A total of 376 statements yielded 672 instances of recognized themes, for an average of approximately two themes per statement. Nine statements did not include relevant themes, so we did not include them in the results (see Appendix J). The recognized themes were Finance, Communication, LID, Stormwater Management, Porirua/Community, Infrastructure, Regulation/Policy, Priorities, Development, and Other. The three most common "other" discussion topics were Planning/Objectives, Perception, and Education/Awareness (see Figure 14).

The data shows that Porirua/Community was the most common topic of discussion for the focus group at 15.2%. This skew of our data may be due largely to the fact that it is a very broad theme, encompassing everything from the physical landscape of the Porirua Harbour catchment area to engaging the community in harbor involvement. The low-impact design (LID) theme may be one of the least prevalent themes at 5.8%, however we can consider the LID and Stormwater Management counts as one tally because LID is a sub-discipline of stormwater management. This brings the combined count up to 14%.

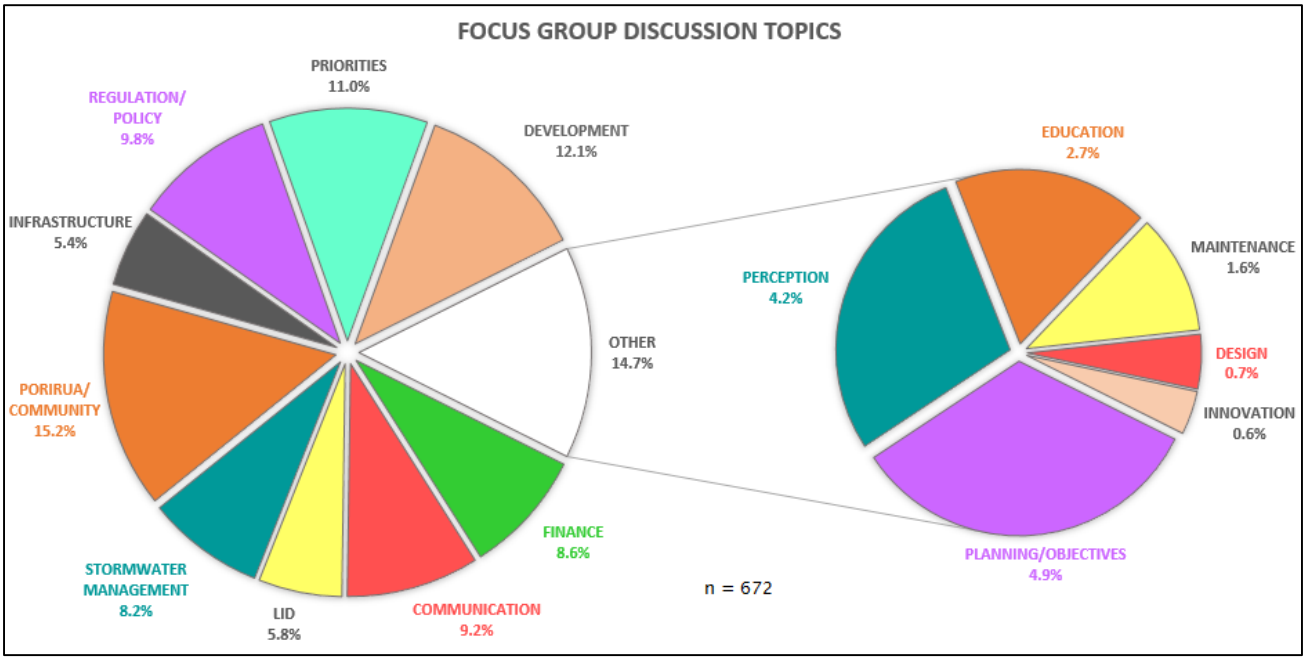

Figure 14: Focus Group Discussion Topics

The team member defined each "other" tally as either Perception, Planning, Objectives, Education/Awareness, Maintenance, Design or Innovation. As our process allowed for counting more than one theme per statement, the "other" count became very high. For comparison purposes, we grouped Planning and Objectives together as one tally, as these are similar themes.

The analysis of our data allowed us to see how often attendees discussed certain themes with little prompting from focus group facilitators. These themes reflect the impediments preventing LID from expanding in Porirua. Once we gauged the importance of our prescribed themes by noting the most prevalent theme within our analysis, we took the appropriate steps to tailor our recommendations to be solutions for the identified impediments for the Greater Wellington Regional Council.

4.4 Te Awarua-o-Porirua Whaitua Committee Meeting

4.4.1 Meeting Observations

On February 11, 2016 our team visited the Te-Awarua-o-Porirua Whaitua Committee meeting as guests. The whaitua committee meets as a whole in Porirua approximately every five to six weeks. This meeting consisted of a set agenda of topics for the committee to discuss. We learned that the committee is only allowed to make decisions during the committee meetings. However, smaller "working groups" focus on a variety of tasks and report back to the full committee at the regular meetings. A member of the environmental policy team at the Greater Wellington Regional Council presided over the meeting and acted as a liaison between the council and the committee. The general public is welcome to attend the meetings and often members of both the Porirua City Council and Wellington City Council attend, though at this meeting only a representative of the Porirua City Council was present.

The committee works to engage the local community and spread awareness of the issues in the harbor catchment. At this meeting the committee discussed the numerous surveys they conducted that gauged which attributes of the harbor the community values the most. From the survey results, the committee worked to align the committee values with the community values. The committee meeting concluded with a written list of harbor attributes valued by both the community and committee including ecological health, access for recreation, sustainable development, and traditional Maori values. We were able to observe a productive meeting, even though the full committee was not in attendance.

4.5 Summary of Impediments

This section discusses the potential obstacles currently prohibiting the implementation of low-impact design (LID) methods in the city of Porirua and the Te Awarua-o-Porirua Harbour catchment area. We concluded this list of obstacles by synthesizing our background and on-site research in combination with the results and analysis of our conducted interviews and focus group with the stakeholders of Te Awarua-o-Porirua Harbour.

4.5.1 Ineffective Communication and Unclear Accountability Between Stakeholders

During our time spent working with the Greater Wellington Regional Council (GWRC) we have learned that the local government structure is complex in terms of overlapping responsibilities and jurisdictions. Under the Resource Management Act (see Section 2.3.1), regional councils have responsibilities for managing public resources including air, land, water, and sea, while city councils, in addition to numerous daily tasks, are in charge of local land use and management. City councils oversee subdivision development, but large earthworks projects also require resource consent from regional councils. This division of jurisdiction regarding land use has created some confusion over exactly who is responsible for maintaining environmental management systems as shown with the example of the EnviroPods®. This leads to the question: If Porirua was to implement low-impact design (LID) practices, who would be in charge of the new infrastructure? Which party is technically responsible for the maintenance of the new designs? Ineffective communication and accountability between stakeholder groups may be limiting the potential of LID in Porirua.

4.5.2 Negative Perception of Porirua

Due to the state of the current infrastructure as well as the fact that Porirua is a low socioeconomic area, the local media often negatively portrays Porirua. Though these negative perceptions have decreased in the past decade, Porirua is still "looked down upon" by some in the greater Wellington region. This perception does not help drive improvements for the water quality in Te Awarua-o-Porirua Harbour. As stated by a focus group member "[The people of Porirua] think that if it looks like [a dump], it must be [a dump], so they can treat it like [a dump]." Ideally, communities want to take care of a resource that they cherish, but with the negative perception as well as the current state of the harbor, it becomes hard to value something that few others do. A negative perception of Porirua may be prohibiting new ideas, such as low-impact designs, from flourishing and altering this perception.

4.5.3 Disconnect Between Porirua Community and Te Awarua-o-Porirua Harbour

During our time spent in Porirua, our team noticed the distinct separation of the central business district and the waterfront of the Onepoto Arm in Te Awarua-o-Porirua Harbour. All of the shops and restaurants face inward and the majority of the construction on the shore are industrial buildings or car parks. This configuration creates a psychological separation between the community and the harbor waters. With such a major break between the people and harbor, it becomes easier for people to ignore the harbor. With all of the major businesses facing away, shoppers can go about their business without interacting or even seeing the harbor at all. This creates a detachment between the community and the harbor which inhibits innovation and the desire to implement new technologies to potentially reconnect the two entities and clean up the harbor.

4.5.4 Lack of Standardized Regulations and Incentives for Low-Impact Design

Currently there are no nationalized or regionalized regulations dealing with stormwater management in New Zealand, therefore there are no guidelines for developers implementing low-impact design (LID). This, combined with a lack of incentives by city and regional councils, has given developers no reason to integrate LID methods in their construction projects. Several members of the focus group stated that developers would need to be either forced through regulations or enticed by economic incentives to begin utilizing LID techniques.

4.5.5 A Lack of Experience with Low-Impact Design

As noted in both our interviews and focus group there have been prior attempts at implementing low-impact design (LID) methods in Porirua. However, these attempts failed due to poor design and implementation. Using the example of the artificial wetlands and swale we observed in Porirua (see Section 4.1) it is clear that the contractors who constructed them did not have experience with LID and changed aspects of the design, hampering the effectiveness of the final product. Interviewee D mentioned to us that on one project he worked on, the construction developer had modified the design "D" created not realizing that by doing so they had restricted the product from performing its function. This and similar incidents have led to many people feeling LID is more trouble than it is worth, making them reluctant to make further attempts at using LID.

4.5.6 Unawareness of Low-Impact Design

The professionals that participated in our focus group were largely aware of low-impact design (LID), as shown in Figure 15. However, they expressed concerns that the general

population of the greater Wellington region is largely unaware of the concept. This unfamiliarity may be a source of hesitation and the community's unwillingness to adopt and pay for new technologies. The community may also be unaware that LID depends just as much on perceptions and philosophies as it does on physical designs, meaning that a simple mindset change can have an impact on the environment.

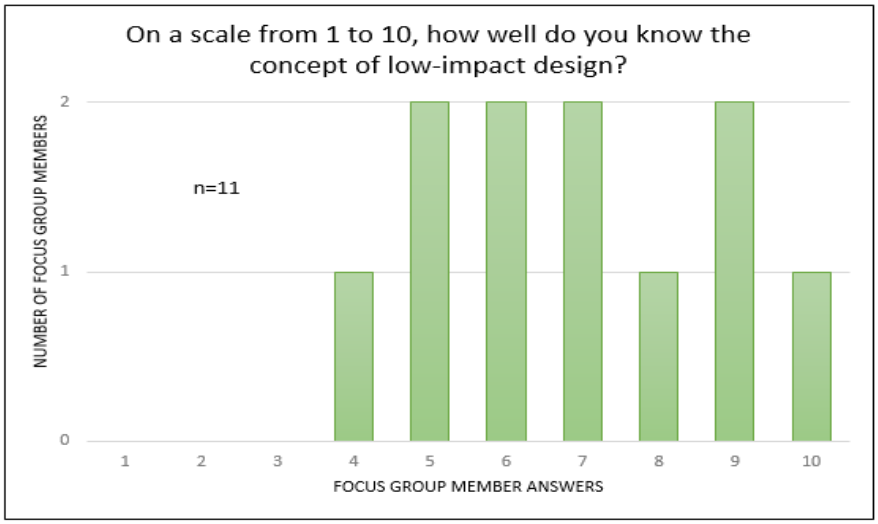

Figure 15: Pre-Workshop Questionnaire results for focus group members' knowledge of LID

5 RECOMMENDATIONS AND CONCLUSIONS

5.1 Recommendations

The intent of this section is to supply the Greater Wellington Regional Council (GWRC) with a set of recommendations drawn from our conclusions concerning the impediments to the implementation of low-impact design (LID) in the city of Porirua and Te Awarua-o-Porirua Harbour catchment area (see Section 4.6). While our team was only able to utilize a small sample size for our research, we are confident that these are ideas worth exploring over the next several years in order to improve the water quality in Te Awarua-o-Porirua Harbour through the use of LID.

5.1.1 Organize Regularly-Scheduled Meetings with All Involved Stakeholders

Our initial intentions when hosting our focus group were to collect data to discover the impediments of implementing low-impact design (LID) in Porirua. However, the focus group identified, as well as previewed, a solution for the communication issue that the process of LID implementation reflects. With a representative from all of the stakeholders present, conversation disclosed instances of poor implementation, clarification, and resolution of LID problems. Disclosing these factors led to clearing up some of the miscommunication between these stakeholders. After seeing some of this progress in the focus group regarding how LID can work in Porirua, the team recommends that the Greater Wellington Regional Council organizes similar workshops on a regular basis. Stakeholders can hold these meetings as often as desired depending on a project's timeline. An example could be semi-annual or annual meetings with

several stakeholders for a large project such as large-scale earthworks development in Porirua. Essentially, if all stakeholders were to come together before moving to the next step of a project and rectify any issues or concerns, we feel that the process will be faster and more efficient with the satisfaction of most, if not all parties involved.

5.1.2 Promote a Positive Image of Porirua

In order to address negative perceptions around Porirua Harbour (see Section 4.5.2), our team suggests that the Greater Wellington Regional Council (GWRC) and the Porirua City Council continue with their efforts to promote a positive image of Porirua City and its harbor. The local whaitua committee is also taking steps to address this by raising community awareness through attending festivals near the harbor and going to school events. However, in order to fully change people's perspectives of the harbor, this effort would need to rise to an even larger level.

5.1.3 Revitalize Porirua City Centre

One way that Porirua could encourage an integration of the harbor and the community would be a revitalization of the city center. As it stands, the central business district of Porirua faces away from the water. By revitalizing the city center and bringing businesses closer to the harbor, foot traffic will become more common along the harbor front. This would aid tremendously in connecting the citizenry to the harbor, because when people are interacting and facing the water every day, the water eventually becomes a part of who they are and they become more likely to take care of it. We are aware that the city is considering how this might be achieved and that any change is a long-term objective.

5.1.4 Regionalize Rules and Regulations

Currently, New Zealand does not have any standardized regulations for the creation of low-impact designs (LID). This essentially means that every time developers implement LID, they need to design it from the ground up, and developers are generally not in charge of the design phase (see Figure 9). This is a problem as it leads to many of the miscommunication errors between the developers and the planners that came to light during our data analysis (see Section 4.2). By having a standardized way of building these designs, there would be no need to continuously "reinvent the wheel" every time a council wanted to install LID. By having regionalized regulations for the implementation of LID, developers would have a base to work off of and would in theory cut down the cases of poorly-built LID solutions.

5.1.5 Integrate Low-Impact Design in Initial Plans for Development

One of the main impediments that we observed was developers' reluctance to implement low-impact design (LID). Our team proposes that there should be a movement towards the incentivization of LID implementation. These incentives could involve rewarding successful implementation of LID with extra development allowance or rate decreases. A consideration or a discussion of LID amongst all stakeholders during the early stages of a development project can increase the effectiveness of LID while minimizing the cost. The team believes that this would be the best way to ease developers into the LID mindset, because developers may resist too many new regulations.

5.1.6 Encourage Low-Impact Design in Education System

As emphasized in our focus group and some of the interviews, changing the community's perception of Te Awarua-o-Porirua Harbour is essential to keeping the harbor safe, clean and iconic. In order to promote this perception, the team suggests that the Greater Wellington Regional Council (GWRC) team with the Porirua City Council (PCC) and Te Awarua-o-Porirua Whaitua Committee to educate the community on the harbor and low-impact design (LID). This education may include the harbor's history, geography and reasons it is susceptible to pollution, and preventative tactics both people and technology (including LID) can use to keep the harbor in a safe and aesthetically-pleasing condition.

One option is that the council build this education component into a curriculum within the local school system so that future generations grow to be avidly attentive of the health of their harbor and of potential methods to help improve its water quality. Other means of education within the community can include published documents and fliers with brief information on how one person's actions can positively and negatively impact the harbor. This educational program should not feel forced upon the community, and instead should engage people and encourage them to love and appreciate the heart of their city.

In addition to this education plan, developers are also a part of the community, both in the sense that their work directly affects the community, and that they may be community members themselves. Because of this, community values shape developers' decisions, as if they aim to make a profit in the community, developers would need to cater to the community ideals. By instilling a sense of preservation and sustainability for the environment into the community, these values will appear in future development, hopefully with an increase in implementation of LID.

5.2 Conclusion

In conclusion, the project team found that the major obstacle to the implementation of low-impact design (LID) in Te Awarua-o-Porirua Harbour lies in the developmental process that policies and designs go through before construction (see Figure 9). If the developmental process changed so that stakeholders considered LID at every stage, our team believes that LID can one day be successfully implemented in Te Awarua-o-Porirua Harbour. The harbor is the focal point of the city of Porirua so we believe the community should look at and treat the harbor as if it is the most important part of the city. With these recommendations, we aspire to give the Greater Wellington Regional Council the tools necessary to achieve the goal of a cleaner and more sustainable Te-Awarua-o-Porirua Harbour.

5.2.1 Lessons Learned

At the conclusion of our project, our team realized a number of things that we could have done differently. For example, ensuring that local Maori and developers themselves participated in our research. Our stakeholder selection focused on the public authorities involved in stormwater management in the Porirua Harbour catchment area and largely neglected the private sector. We received a lot of opinions regarding the development process from the councils, which may have presented us with biased results. Analyzing the opinions of developers and construction companies would have allowed us to formulate more comprehensive recommendations to the Greater Wellington Regional Council.

We also learned that we should have spent more time preparing for our interviews and focus group. Since our interviews split our project team into pairs, these pairs should have discussed and developed an exact plan for these interviews for the sake of consistency. Identical interview structures would have allowed for an ease of analysis and more thorough results. Most

of our team members had little to no experience facilitating or attending a focus group, so we did not exactly know what to expect. Looking back, our team could have had clearer communication with each other, and made sure our individual expectations were consistent with each other.

5.2.2 Future Work

As a first-year project, our team anticipates that future groups can accomplish a lot of work in following academic years that will improve upon our initial findings. We have provided the Greater Wellington Regional Council with a list of recommendations that may help spread the awareness of low-impact design and its implementation in the Porirua Harbour catchment area. In order to improve the water quality of Te-Awarua-o-Porirua Harbour, the council should implement these recommendations, or adaptations of these recommendations, over the next several years. Future project teams may continue to work with the Greater Wellington Regional Council in order to take the necessary steps towards completing these recommendations by incorporating all stakeholders in future plans and discussions.

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Figure Sources

Figure 4. Map of Porirua City and Te Awarua-o-Porirua Harbour. Retrieved December 13, 2015, from http://www.pcc.govt.nz/DownloadFile/Publications/Harbour-Management/Porirua-Harbour-and-Catchment-Strategy-and-Action-Plan-March-2012

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APPENDIX

Appendix A: Professional Interview Questions

Te Awarua-o-Porirua Harbour:
Assessing Awareness of Methods to Improve Water Quality

Interview for Key Stakeholders

Date/Time: Location:

Interviewer: Interviewee:
Secretary: Job Title:
Gender/Age:

Acknowledgement and Confidentiality Notice:

Thank you for participating in our interview. My name is _____ and I represent the group of students from Worcester Polytechnic Institute in the United States that are working with the improvements of Te Awarua-o-Porirua Harbour. Our main objective is to identify the different impediments involved in introducing low impact designs to prevent further harbor pollution. This interview specifically focuses on the process of any project and the decisions involved. Your input in the following interview will provide us with very important information that we can use to accomplish this goal. The interview may last anywhere between one half hour and one hour. The information you provide including answers and personal information will remain anonymous unless otherwise noted. Once again we thank you for taking the time to speak with us.

1. What is the most important decision you've made in your work?
2. What do you consider an important decision?
3. How often is your company faced with these important decisions?

4. What is your thought process when making decisions? What drives you to make a decision?
5. What are the different constraints that you face when making a decision? How do they influence or affect your decision making? How do you prioritize these constraints
6. What are some projects you have worked on or are currently working on?
7. What was your role in these projects?
8. What is the first thing you address when starting a new project?
9. What were some of the important decisions made in these projects? Why were they made? When and how were they made and by whom?
10. How does a policy go from an idea to an enacted regulation?
11. What are your views on regulation vs. design solution?
12. What shapes your decision behind implementing new technologies?
13. Do you think people prefer conventional methods when new ones are available? Why? What is your stance?

Additional Questions

Would you like to be informed with the progress of our project? Y/N

May we follow up with you after this interview if needed? Y/N

Do you wish to be recognized/ thanked in our final report? Y/N
(By default you will remain anonymous)

Space for Additional Notes:

Again we thank you for your time participating in our research. Your input will guide us towards what we hope to be very successful results in restoring Te Awarua-o-Porirua Harbour!

Appendix B: Pre-Workshop Questionnaire

Te Awarua-o-Porirua Harbour:

Assessing Awareness of Methods to Improve Water Quality

Acknowledgement and Confidentiality Notice:

Thank you for participating in our focus group. We represent the group of students from Worcester Polytechnic Institute in the United States that are working to improve water quality in Te Awarua-o-Porirua Harbour. Our main objective is to identify the different impediments involved in introducing low-impact designs to prevent further harbour pollution. Your input in the following survey will provide us with very important information that we can use to accomplish this goal. The survey should take less than five minutes to complete. The information you provide including answers is purely for statistics and personal information will remain anonymous unless otherwise noted. Once again we thank you for taking the time to speak with us.

Survey Questions:

Name: _____

Gender

☐ Male
☐ Female

Ethnic background

☐ Pakeha
☐ Maori
☐ Other: _____
☐ Unspecified

Age Group

☐ 0-12
☐ 13-17
☐ 18-21
☐ 22-35

☐ 36-50
☐ 51-65
☐ 65+
☐ Unspecified

Job Title: _____

Company: _____

Years in Position:
☐ 0-3
☐ 4-6
☐ 7-9
☐ 10-15
☐ 15+
☐ Unspecified

On a scale of 1 - 10 (10 being the most knowledge) how well do you know the concept of low-impact design: _____

Have you worked with low-impact design before?

Again we thank you for your time participating in our research. Your input will guide us towards what we hope to be very successful results in improving Te Awarua-o-Porirua Harbour!

Appendix C: Post-Workshop Questionnaire

Te Awarua-o-Porirua Harbour:

Assessing Awareness of Methods to Improve Water Quality

Acknowledgement and Confidentiality Notice:

Thank you for participating in our focus group. We represent the group of students from Worcester Polytechnic Institute in the United States that are working to improve water quality in Te Awarua-o-Porirua Harbour. Our main objective is to identify the different impediments involved in introducing low-impact designs to prevent further harbour pollution. Your input in the following survey will provide us with very important information that we can use to accomplish this goal. The survey should take less than five minutes to complete. The information you provide including answers is purely for statistics and personal information will remain anonymous. Once again we thank you for taking the time to speak with us.

Name: _____

1. Is there any information not covered today that you feel would be useful for our project?

2. Would you like to be kept informed of our project (i.e. sent the final report)?

   ☐ Yes
   ☐ No thanks

Thank you very much for taking the time to participate in our research and providing us with valuable information. You have been a great help!

Appendix D: Focus Group Discussion Topics

- **Barriers to Low-Impact Design**

Table Topics	Additional Questions Per Topic
Stormwater	1. What are your preferences when it comes to stormwater treatment methods? 2. What stormwater treatment methods do you typically see or use in the Wellington Region? 3. Are these methods effective? How would you make them more so?
Low-Impact Design	4. In what ways is LID is useful and appropriate? 5. What do you think are the impediments or limitations of LID in New Zealand, or in the Wellington Region? 6. Are institutional, educational or professional practices limits to adopting LID? If yes, what might these be? 7. Are there any political or commercial motivations impacting the implementation of LID? 8. What might lead to accelerating LID adoption/use?
Cost	9. In what ways is cost a limiting factor of implementing LID? 10. How would LID save money in the long term?
Communication	11. What lines of communication exist between city planners and developers, and utility companies? 12. To what extent are there communications between land and road developers and environmentalists?

- **Porirua Specific Questions**

Table Topics	Additional Questions Per Topic
Te Awarua-o-Porirua Harbour	1. What is Te Awarua-o-Porirua Harbour's role in the city of Porirua? 2. What is your perception of Porirua?
Infrastructure	3. What changes have been made to the infrastructure of Porirua in recent decades? 4. What measures are currently in place to improve the water quality of the harbour and its inlets? 5. What types of low-impact designs (LID), if any, are currently in place in Porirua? 6. We've heard of prototype LID solutions such as swales and EnviroPods® in Porirua, what has prevented them from being expanded on? 7. Which LID method or methods may be appropriate for Porirua? 8. How do you think the Porirua community would react to supporting a high initial cost of LID if it were to save money in the long term?
Priorities	9. What do you think is the priority of the community? 10. Where does Te Awarua-o-Porirua Harbour rank in importance to your council at the moment? 11. (If applicable) How is the money allotted towards Porirua being used? Who oversees this?
Regulations/ Policies	12. What is your opinion of the car wash ban? 13. Do regulations like this tend to work? If no, why are they implemented instead of taking action? How can they be improved? If yes, how is the decision to introduce these regulations reached?

- **Solutions**

  Groups rejoin, full discussion on potential solutions

1. Based on our previous discussions, what do you think some potential solutions look like?
2. What might lead to accelerating LID adoption/use?
3. In what ways can Porirua implement LID?

Appendix E: Interview A Transcript

This information is confidential and property of the

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Appendix F: Interview B Transcript

This information is confidential and property of the

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Appendix G: Interview C Transcript

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Appendix H: Interview D Transcript

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Appendix I: Interview E Transcript

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Appendix J: Focus Group Data Analysis

Please see the attached Microsoft Excel Sheet titled “Appendix J Focus Group Data Analysis.”

Appendix K: Entrance Survey Results

Please see the attached Microsoft Excel Sheet titled “Appendix K Entrance Survey Results.”