Evaluating the Effectiveness of Community Engagement Strategies for Shifting Attitudinal Behaviour Towards Green Stormwater Infrastructure

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Climate change will cause increased frequency extreme weather events with more frequent stormwater runoff and flooding. Therefore it is increasingly critical to understand how to address the increased runoff as well as mitigate and protect against the effects of climate change. Green stormwater infrastructure (GSI) refers to features that can help absorb, collect and redirect increased stormwater runoff. However, GSI and stormwater management (SWM) are alien or overlooked concepts to much of the public. This study aimed to understand how education in the form of a design charrette and brochures impacts residents' views, beliefs, values and actions towards GSI in a flood prone community in Cambridge, Ontario. Pre and post surveys, site visits, interviews, and observation at the charrette and facilitator notes were used to understand the effect of education on changing perceptions and actions among residents. Educational methods were largely not effective at changing residents' attitudes and behaviors towards GSI, except on a few questions related to SWM action and the impact on water bodies. Being impacted by extreme weather, experiencing extreme weather and household income, were significant covariates that influenced residents' responses. The lack of enthusiasm towards installing GSI was driven by cost concerns, perception of higher level of government responsibility, need for government leadership on GSI, and value of current property uses among residents. However, residents appreciated receiving education and desired more education on GSI.

More research is needed to understand how to engage and motivate the public to install GSI. While education did not prompt most participants to install GSI, it created awareness for GSI and SWM, which was not previously considered by many residents. Upon education in GSI, participants were generally supportive of these endeavors. As climate change worsens, it will be increasingly critical to find ways to build the support and engagement needed to install GSI in communities. Researchers and land use practitioners must find ways to fund GSI, galvanize the public to implement it in their properties, show leadership by implementing GSI throughout the community, provide incentives, financial and non-financial, to spur residential implementation, and use risk mapping to prioritize and encourage GSI installation among residents. Practitioners should also encourage smaller non-GSI actions residents can take to improve SWM on their property as these are easier, cheaper and likelier to be done by residents. Practitioners should build on the momentum and support generated by public engagement events to implement GSI and SWM in their neighbourhoods and communities.

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1.0 Introduction

Increasing urbanization is a global phenomenon, with the increased amount of people moving to cities across the past 40 years (UNESCO, n.d.). In combination with intensifying rainfall events due to climate change (NASA, n.d.), growing amounts of impervious surfaces in urban areas are becoming increasingly problematic for stormwater management (SWM). Also the Region of Waterloo, Ontario, has experienced an increase in the amount of impervious surface cover (Region of Waterloo, 2010). For instance, an assessment performed in the City of Kitchener, Ontario, discovered 44,500 large, medium and small single-family residences constituting over 1,100 ha of impervious surface (consisting of roofs, driveways etc.) in which residential properties comprise a substantial quantity (Cote & Wolfe, 2014). The problem of stormwater runoff from impervious surfaces will grow in the future. The Region of Waterloo has undergone much urbanization, around 50% of new residences are constructed outside of already existing urban spaces within the built-up areas in the urban boundary in six of the past eight years and new residential units built external to existing urban areas exceeded those built within existing urban areas in 2012 and 2015 (Region of Waterloo, n.d.).

The Intergovernmental Panel on Climate Change has cautioned that in Canada more frequent and severe storms will occur in the future (Credit Valley Conservation Authority, 2015). These outcomes are already occurring. For example, in August 2016 a severe downpour occurred in a residential suburban Cambridge neighbourhood within the Region of Waterloo. The rainfall event dumped 100 mm of water in some parts of Cambridge and Kitchener, resulting in road and residential basement flooding. The flooding prompted a response from the City of Cambridge who partnered with Reep Green Solutions – a subsidiary of Green Communities Canada – and the University of Waterloo, to investigate approaches for improving community SWM to prevent further incidents given a changing climate. One solution revolved around the use of green stormwater infrastructure (GSI), also referred to as low impact development.

1.1. Research Purpose and Case Study

The research purpose is to explore how GSI education with educational brochures and design charrettes impacts the attitudes, knowledge, beliefs, intentions, and behaviours of residents regarding GSI, in a flood prone community. The partner organizations wanted to use education

to engage the public and implement GSI features in the community. Green Communities Canada developed a pilot model of a design charrette to educate residents about flood resiliency and GSI. Reep Green Solutions decided to deliver this form of charrette in the flood affected Cambridge study community. As this model applied to flood resiliency is a relatively new concept in Canada, research was needed to understand the effectiveness of charrettes on altering residents' views and actions towards GSI. An educational brochure was also used to educate residents about flood resiliency and GSI. Though educational brochures are used sometimes in public education, its effects in GSI education are less well known and Reep Green Solutions was interested in understanding its effectiveness as well. Surveys and interviews as well as site visits and observation were employed with residents in the study neighbourhood to understand the factors surrounding the effects of education on attitudinal change and behavioural shifts.

This research will address the need to investigate the efficacy of education measures to positively impact residents' attitudes, knowledge, beliefs, intentions, and behaviours regarding GSI. It will also address the larger context of public engagement and behavioral and attitudinal change. Behavioral and attitudinal change towards GSI are increasingly important as flooding and extreme storm events intensify in the wake of climate change. To the author's knowledge, this study is the first of its kind in Canada. Ultimately, it is hoped that the results from this research can help inform effective educational approaches that will lead to the implementation of GSI methods on residents' properties.

1.2. Research question

To carry out the investigation of educational means at altering residents' behaviours and attitudes a research question was devised. The current research was performed to answer the main research question: How does education affect residents' views, attitudes, values and behaviours regarding green stormwater infrastructure (GSI)? The four specific research sub-questions will focus on the effects of education on residents': 1) views, 2) attitudes, 3) values and 4) behaviours.

2.0 Literature Review

This literature review will examine the definition, origin and application of GSI. Topics related to the application, benefits and challenges of the use of GSI are examined. The mental and physical health impacts of GSI in relation to the built environment and the ecosystem services offered by GSI are discussed. Means of participation and public engagement, and barriers to GSI are also reviewed. Lastly the outstanding knowledge gaps present in the literatures and areas of contribution for future study as mentioned by the literature highlight the need for this study.

2.1. Urban stormwater management issues and the need for GSI

2.1.1. Foundation: Climate Change

Climate change refers to anthropogenic-caused changes in the atmosphere and concomitant decline of biodiversity and natural systems (Nurse et al., 2010). Climate stability is a significant influencer of sustainable population health. Climate change will create pervasive consequences of population based human health. Water resources have a direct connection to climate change, and water resources management impacts the vulnerability of human health, ecosystems and socio-economic activities (Gibbons, 2016). Furthermore, water management is expected to function as a means of conservation. Climate change is anticipated to result in drastic alterations to the availability of water in Europe, with rising shortages and droughts in southern Europe and floods across the continent. Droughts are connected with the stress of modified diets and disintegrating livelihoods in developed countries as water is vital for food and food production (Coutts, 2010). Climate change is projected to negatively impact water resources, lead to more frequent floods and storm severity, and combined sewer overflows.

Climate fluctuations likely resulted in more than 150,000 deaths globally and are responsible for nearly 90% of the increase in health risks plaguing juveniles (Coutts & Hahn, 2015). Climate change is currently impacting health, which will become increasingly pervasive. GSI at the larger scale can serve as a climate change buffer through increasing the amount of ecological resources and providing areas that can adapt or control extreme climate variations like flooding or drought, which may be done through provisioning areas that allow surplus rainwater to be collected and then dispersed (Mell, 2009). As the severity of extreme weather events increases, large scale GSI is more viable. Such large scale GSI could be a network of areas that enable the flow of water or pollutants to migrate from source points to storage areas, dispersion and release.

In a study in Los Angeles, Belden & Steele (2011) found that retrofitting streets with GSI such as trees that provide shade and can lower temperatures from the urban heat island effect as well as lower greenhouse gas emissions. It has been stated that green space like trees, urban greening initiatives, and pocket parks have reduced or stabilized the surrounding temperature in New York (Mell, 2009).

SWM concerns are some of the most commonly mentioned for climate change. This is because climate change renders a crucial component of urban drainage design insecure as differences will occur between the rainfall amounts the infrastructure was constructed to handle and the amounts it actually has to manage. This will endanger neighbourhoods with flooding, property damage and human safety threats (Moore et al., 2016).

Larger and more frequent storms have resulted in substantial social, environmental and financial consequences. For instance, Hurricane Sandy in 2012 resulted in 30-50 billion USD in stormwater-linked damages (Shandas, 2015). Due to the massive extent of impermeable surface cover combined with predictions of heightened severity, frequency and scale of storm events, local governments increasingly are using GSI such as rain gardens, bio-retention and urban tree canopies to mitigate against climate change and to handle stormwater (Shandas, 2015).

The potential to improve resilience or the capability of the system to act as anticipated in the wake of change to stormwater is important for research. For instance, directing impervious runoff to lawns or stormwater infiltration methods has been estimated to offset climate change sparked flooding (Moore et al., 2016). The possibility for natural vegetation to offset at least some of the projected rises in runoff and flooding from climate changes has been assessed, generating calls to classify GSI as an imperative part of adaptive planning (Moore et al., 2016).

2.1.2. Implications: Urban Heat Island Effect

Urbanised regions have an increasingly different climate in comparison to urban fringe or rural regions due to built-up infrastructure (Mell, 2009). As a result urban areas are expected to have a smaller tolerance to climate change as they are comprised of closed systems (Mell, 2009). The urban heat island effect is a concept that is ascribed to urban areas, which are hotter than the surrounding regions (Taylor & Hochuli, 2015). Extreme heat has adverse impacts on urban dwellers, especially those vulnerable to poor health. Heightened warming in urban regions is

connected to respiratory conditions, asthma, allergies as well as mortality (Taylor & Hochuli, 2015). The urban heat island effect and poorer air quality are a result of impermeable surfaces and reductions in the amount of open space (Dunn, 2010).

Certain climate hazards can be offset by the presence of green spaces (Taylor & Hochuli, 2015). For instance, heatwaves heighten morbidity in urban regions from heat exhaustion and heat stroke, while green spaces lower the impact of heatwaves through lowering heat storage and nocturnal re-radiation. Green space can refer to public and private gardens, street trees, remnant vegetation and urban agriculture. A study performed in the UK found that a substantial reduction in mortality from respiratory conditions occurred in areas with an abundance of green space, amounting to a 25% drop for high amounts of green spaces for deaths and 85% better mental health in self-reported data (Nurse et al., 2010). These results mirrored by another study in the Netherlands that found that residents who reside near greenspace indicate better health than those in the most urban areas (de Vries et al. 2003).

GSI may provide microclimate controls in urbanized places through providing spaces that collect rainfall, absorb radiation from the sun and amplify urban cooling. Modelling done on the effects of blue-green infrastructure in Vienna, Austria, found that reducing building fraction by 10% through GSI initiatives lowered the heat load in 70% of the city area (Žuvela-Aloise et al., 2016). Increasing the vegetation by 20% in combination with reducing building density by 10% and reducing pavement density by 20% yielded cooling to 42% of the city area (Žuvela-Aloise et al., 2016). In their Los Angeles study, Belden & Steele (2011) investigated the effects of GSI and sustainable landscaping added to 24 neighbourhood homes in a neighbourhood. The pre and post study design allowed the authors to assess the impact of GSI, suggesting that as neighbourhood trees grow, shade from canopy cover lowers temperatures from the urban heat island effect and subsequently decreases release of greenhouse gases from air conditioning (Belden & Steele, 2011).

2.1.3. Problem: Urban Flooding

Runoff directed from impervious surfaces into water bodies transports pollutants from the surfaces into the water bodies. This is unlike runoff that is directed toward permeable open area filters that can handle moderate amounts of non-point source pollution and aid groundwater

recharge (Coutts, 2010). Consequently, the conservation of floodplains and and riparian corridors can assist in limiting the adverse impacts of polluted surface waters on water bodies. GSI can assist this process by handling and collecting excess surface water, which is particularly important for areas in flood plains (Coutts, 2010).

For instance, a study by Montalto et al. (2007) in Japan demonstrated that installation of permeable pavement and infiltration pipes in a 16.7 ha study area lowered peak runoff volumes by 15-20%. Another study by Booth and Leavitt (1999) in Washington State found that a 16 h storm with a peak intensity of 0.4 mm per hour produced almost no runoff where permeable pavement was installed, but resulted in 0.5-1mm of runoff in 15 minutes at peak levels where conventional pavement was installed. A study by Moore et al. (2016) in Hiawatha, Minneapolis, United States, found that a 52% reduction in flooding occurred when adding bioinfiltration to 15% of the watershed. Treating at minimum, 10% of a local watershed with bioinfiltration can yield significant reductions to flooding in built out areas like the Hiawatha (Moore et al., 2016). GSI, when applied at a large enough scale across municipal areas, can curtail stressors, which is crucial in terms of ability to control floods, capture stormwater, and recharge groundwater (Mell, 2009).

2.2. The Classification and Application of GSI and its Benefits

2.2.1. Intervention: Green Stormwater Infrastructure

Green stormwater infrastructure (GSI) is an environmentally sustainable method of land use management that keeps runoff nearby to the source by maintaining the natural landscape attributes and increasing permeability (Tredway & Havlick, 2017). GSI was first applied in Prince George's county Maryland in the 1980s when the Associate Director of Environmental resources for the county, Larry Coffman, was charged with handling pollution. To achieve this, Coffman implemented GSI to handle pollution and excess runoff in the region (Low impact development (GSI) technology, 2013). GSI complements conventional stormwater management (SWM) to help manage the inadequacies of volume and pollution treatment infrastructure (Bhaskar et al. 2016). GSI also replicates the functioning of natural systems through retention, infiltration or evapotranspiration of stormwater near to its source (Bhaskar et al., 2016).

Sustainable urban drainage enables effective water resources management and increased control over the water resources (Mell, 2009). It can also be utilized to offset heightened urban flood

risk, diffuse pollution and decrease habitat fragmentation, which are attributed to climate change and increasing urbanization (Mak et al., 2017). Long-term urban stream monitoring studies cited by Gaffield et al. (2003) in Long Island, New York, and in a zero-order catchment has demonstrated that urban developments resulted in higher flood peaks and contributed to rises in yearly runoff volumes at two to four times the rate of earlier rates for suburban regions and fifteen times the rates for highly urbanized zones. Various approaches can be used to limit such flood peaks. For instance, GSI measures that increase infiltration include rain gardens, permeable pavement and grass swales, while measures for water retention include dry wells, bioretention cells and rain barrels, and measures for increased evapotranspiration include sod and green roofs (Bhaskar et al., 2016).

GSI has been found to enhance neighbourhoods in regards to neighbourhood beautification, heightening property values, improving streetscapes, and improving soil quality (Elkin, 2008). In addition, GSI has been found to have positive social and public health effects. For instance, the Rainway project in Vancouver led to increased neighbourhood social cohesion supported by the work on GSI installation and maintenance by neighbourhood residents (Welsh & Mooney, 2014). The installed GSI will develop into a network of vegetation and soil components that supply ecosystem services and provide resilience against disturbances from climate change (Welsh & Mooney, 2014). Another study from the Netherlands showed that, after accounting for socio-economic variables, green space located within 1-3 km heightened self-perception of health especially by people from lower socio-economic backgrounds (Nurse et al., 2010). Low income-status groups, youth and elderly are at the highest risk of poor health in urban areas (Taylor & Hochuli, 2015) and therefore would benefit most from the positive health effects of GSI.

2.2.2. Assessment: Efficacy of GSI Interventions

The efficacy of GSI at reducing stormwater runoff in urban settings has been examined by a variety of authors. For instance, GSI installation in Waterford, Connecticut, reduced water runoff after residential development by 42%, similar to pre-development levels (Ahiablame & Shakya, 2016). GSI use in the District of Columbia and in the Township of North Huron, Ontario, led to 12% and 5% storm runoff capture, respectively (Ahiablame & Shakya, 2016). Bioretention systems are also efficient in infiltration, evapotranspiration, groundwater recharge, pollutant load

reduction and lowering of runoff volumes and peak flows (Ahiablame & Shakya, 2016). Furthermore, a modeling study for the City of Bellevue, Washington, determined that GSI installation could result in a reduction in downstream water detention volume by 30-50% (Atchison, 2008). Other modeling work has shown that with 20% GSI coverage, sewer intake starts to level off (Zellner et al., 2016). It has also been found that 20% GSI coverage would reduce road flooding and 30% GSI coverage would start to relieve the sewer system from working at full capacity and eliminate downstream outflow (Ghimire et al., 2016).

GSI installation in the Sugar Creek Watershed in Normal, McLean County, Central Illinois, has been found to lower the average runoff by 47% from 186 mm to 99 mm, with treatment of parking runoff having greatest efficacy and treatment of rooftop runoff having lowest efficacy (Ahiablame & Shakya, 2016). The installation of bioretention GSI in four multi-family residential zones in Atlanta, Georgia, resulted in a 50% reduction in stormwater in multi-family residential zones for a 100-year storm (Jeong et al., 2016). In another study from Mississauga, Ontario, it was found that GSI was able to increase infiltration of stormwater volume by 50-60% following 30 mm rainfall (Sandink, 2016).

Various GSI types have different abilities to affect peak rainfall intensity and flood levels. For instance, bioswales are superior in early peak intensity storms, while porous pavements do better in middle peak intensity storms and green roofs are superior in late peak intensity storms (Qin et al., 2013). Related to the phenomenon of varying levels of success and performance of GSI is that combining different types of GSI can have benefits. It has been found that using three GSI types (i.e., rain gardens, permeable pavement and stream naturalization) simultaneously resulted in the highest peak flow runoff reductions, varying from 27% for 500-year storms, 42% for 2-year storms (Tredway & Havlick, 2017). The efficacy of combined GSI types can be explained by the variation of benefits and limitations of each GSI type that are offset by combining GSI types. For instance, permeable pavement is very good at flood reduction, but requires much land to install and has low storage capacity, while bioswales have small effects on flood mitigation, but require less land and have high storage capacity (Qin, et al., 2013). For instance, when bioretention units and rainwater harvesting are combined, the amount of land used for GSI declines from 8% to 7% in single family zones and from 17% to 14% in multi-family residential areas (Jeong et al., 2016). Other research has shown that rain gardens have low water detention

capability, but can be used to reroute rainwater from sewers to other sinks (Green et al., 2012). Thus multiple GSI types work better than a singular type for urban flood mitigation across a range of storm types.

Clearly, great variation exists among the findings of GSI studies because many factors contribute to the efficacy and performance of GSI initiatives. The design and function of GSI differs greatly due to variations in precipitation pattern, soil, topography and climate, in addition to the watershed drainage dynamic (Kertesz et al., 2014). Though individual GSI performance varies, the general trends show that GSI can be effective at reducing surface water flows and urban flooding.

2.2.3. GSI and Mental Health

Research has examined the impact that GSI has on mental health and has highlighted that exposure to nature provides a slew of mental health benefits (Coutts, 2010). Being around and feeling connected to natural environments has demonstrated to foster mental health such as stress reduction, forging positive affective states and better cognitive performance (Coutts, 2010). Green infrastructure is beneficial for mental health as the presence of greenness predicts mental health, exclusive of effects on physical fitness and social cohesion (Coutts, 2010). These benefits stems from the intrinsic human preference for aspects of the natural environment and processes that have the capability to replenish and renew reduced functional resources (Coutts, 2010).

Being around green spaces has been linked with numerous public health benefits including reductions in stress and mental fatigue (Kondo et al., 2015). A study in the University of California, Irvine, that evaluated 112 young adults walking in nature-oriented and urban areas found those that walked in nature-oriented areas had reduced anger levels, heightened positive moods, and reduced stress as indicated by blood pressure ratings, relative to those in urban areas (Hartig et al., 2003). Research has demonstrated that access to green spaces is associated with lowered stress levels, and people who report to visits to green spaces more often and spend greater amounts of time there report less stress-related ailments (Coutts, 2010).

The literature outlines a number of effects that GSI has on exposure to nature and the public health benefits obtained by them. A recent review identified that peoples' contact with natural

areas lowered physiological indicators of stress like skin conductance and blood pressure, and increased self-reported mental wellness (Nurse et al., 2010).

Urban stimuli may overwhelm some residents with noise from traffic, congestion, lights and signs but nature exposure has the ability to restore cognition from stimuli overload (Taylor & Hochuli, 2015). It has been asserted that the presence of green space in communities is advantageous for residents regardless of whether they actively utilize it or not (Taylor & Hochuli, 2015). Natural areas are valuable for stress recovery, and gardening has been shown to lower stress (Taylor & Hochuli, 2015). Elderly residents seated in a small garden for an hour had superior measures of concentrations than when they remained in their rooms (Nurse et al., 2010). This is beneficial, as residents who install GSI features in their gardens can derive benefits not just from the presence of them, but also by tending to the features. Green spaces are also important for children. More green spaces in urban areas lead to heightened concentration and self-discipline in juveniles, and more playtime for children (Nurse et al., 2010). Parents also rank the mental health of children participating in green activities as better (Nurse et al., 2010).

Additional advantages of GSI include “green exposure”, which has been demonstrated to lower aggression, violence, vandalism, assaults and generally reduce crime (Kondo et al., 2015). Community building through participation in environmental activities has been demonstrated to boost community pride and enrich urban neighbourhoods (Nurse et al., 2010). Consequently, some bodies, like the European Environment Agency, have recommended that people should have a less than 15 minute walk to a green space, and English Nature, a UK government agency, recommends that urban residents should have a green space access fewer than 300 m away from their homes (Taylor & Hochuli, 2015).

2.2.4. GSI and Pollution Reduction

Humans rely on water for basic life needs and sustenance. But high water quality and quantity depends on the capability of the landscape to replenish groundwater and filter pollutants (Coutts, 2010). Rising amounts of impermeable areas in urban regions modify runoff and drainage cycles, rendering precipitation as transporters for pollutants such as oil, pathogens, toxins, nutrients into local water bodies (Dunn, 2010). Excess water volumes from storms result in negative environmental detriments such as floods and combined sewer overflows (Dunn, 2010). Therefore, GSI’s benefits for water filtration are crucial for sanitation and public safety. Boston’s

greatest combined sewer overload has an abundance of organic pollutants and suspended solids that almost matches the rates of untreated sewage (Montalto et al., 2007). GSI methods dispersed throughout urban watersheds can complement natural hydrologic patterns by directing rainwater through flow paths. Models depict that managing runoff in this way would negate need for sewers and sub-catchments.

The expansion of metropolitan regions has resulted in inferior water quality and local flooding (William et al., 2017). More impermeable areas lead to less infiltration and more runoff which transport pollutants like suspended sediments, polycycratic hydrocarbons, pesticides, fertilizers and heavy metals from rooves, lawns and streets (William et al., 2017). For instance, an 18% increase in urbanization in Indianapolis, Indiana, from 1973-1991 yielded an 80% increase in yearly runoff volume while the average yearly burden for lead, copper and zinc rose by over 50% and rates of fecal coliform bacteria have increased (Gaffield et al., 2003).

GSI has been connected to pollution filtration (Wright, et al., 2016). For instance, a permeable paving parking lot constructed in Athens, Georgia, yielded 93% less runoff than a typical parking lot, as well as runoff reductions in lead, copper, cadmium and zinc (Montalto et al., 2007). A bioretention area can collect runoff from impermeable areas and can permit water to absorb into soil, where pollutants are eliminated by adsorption, vegetation uptake, sedimentation, microbial activity and filtration (Woodward et al., 2009). In a study in North Carolina, nitrogen, suspended solids, copper, lead, phosphorous, and zinc loads have been reduced and runoff captured by the soil (Woodward et al., 2009). Similarly in another study in Humboldt County, California, it was determined that pollutants can be addressed through a variety of GSI methods (Kalt, 2010). For example, heavy metals and petroleum can be handled by permeable paving and bioswales (Kalt, 2010). Nitrogen, pesticides, phosphorous and fecal coliform bacteria from sewer back-ups, pet waste, and septic systems can be reduced through rain gardens or bioswales (Kalt, 2010). Copper from rooves and car exhausts can be mitigated by rain barrels, rain gardens, and cisterns (Kalt, 2010). However, the efficacy of GSI to reduce pollutants is variable. For example, it has been shown that bioswales eliminated metals and total suspended solids, but reductions of nitrates and phosphates were variable (Kalt, 2010).

2.2.5. GSI and Social Integration

GSI has the potential to foster social integration of people (Mell, 2009). GSI can heighten awareness, utilization and ownership of spaces and garner their long-term use (Mell, 2009). This can enable people to feel part of these spaces and make the area safer and more appealing to others (Mell, 2009). Activities such as gardening, environmental volunteering, and walking can boost community resilience and sustainability (Nurse et al., 2010). However, GSI installation can be problematic if GSI is planned in a way that fails to address the variety of community interests and can lead to reduced use and exclusionary areas (Mell, 2009).

Social interaction and cohesion benefit from natural environments. For example, Nurse et al. (2010) observed a 90% rise in individuals in green space relative to non-green space, which resulted in 83% more people being engaged in socialization. Natural features and vegetation can foster play and create diverse activities suitable for different age groups, which have been shown to produce increased concentration and motor skills among people (Nurse et al., 2010).

2.3. Making GSI Happen

2.3.1. GSI and Reverse Auctions

Given the large amounts of privately owned land in urban areas, homeowners' involvement in GSI installation is critical. Many studies have examined various approaches to foster such engagement. For instance, in Shepherd Creek, Cincinnati, Ohio, a reverse auction approach was used to distribute GSI measures to homeowners (Mayer et al., 2012). Bidders that were successful were provided a payment equal to the quantity they bade, a rain garden or a maximum of four rain barrels at no cost, and three years of maintenance for the rain barrels or rain gardens. The reverse auction yielded the implementation of 83 rain gardens and 176 rain barrels, amounting to 30% of the eligible 350 residences (Mayer et al., 2012). Almost 55% of the participants bid $0 for rain barrels, suggesting that no-cost GSI retrofits were required to incentivize many homeowners (Mayer et al., 2012). A reverse auction approach has also been used by Shuster & Rhea (2013) in Shepherd's Creek, Cincinnati, Ohio. Reverse auctions in two years (2007 and 2008) yielded installation of 50 rain gardens and 100 rain barrels in the first year and a further installation of 35 rain gardens and 74 rain barrels in the second year. In total this approach yielded GSI installation in 19% of the 350 eligible residences in the target community (Shuster & Rhea, 2013).

2.3.2. GSI and Community Engagement

Other methods have been used to increase GSI implementation in communities. For instance, GSI projects such as Portland Green Streets and Kansas City's 10,000 Rain Gardens employed resident participation, and resulted in large-scale shifts in view of stormwater as a resource instead of a waste (Shuster et al., 2008). Other studies have used outreach, meetings, workshops, and education to foster resident participation in GSI. A study in King's County Seattle and North Ballard regarding roadside GSI installation had 75 resident attendees for a community GSI planning meeting (Cramer, 2015). While there was initial opposition to the project, small community meetings were successful at turning public opinion to support for the project (Cramer, 2015). Community engagement activities were also performed in San Francisco City and the Wiggle Neighbourhood Green Corridor (Ehsaei et al., 2015). The project's objective was to lower the amount of stormwater going in the combined sewer system and better pedestrian and biking conditions by the "Wiggle" bicycle lane and adjacent community streets. Public engagement in the GSI project resulted in community-based choices for GSI design options (Ehsaei et al., 2015). Community associations and groups have been shown to be useful for garnering participation. For instance, the study of the Bottom Neighborhood Empowerment Association worked with numerous education and GSI retrofit opportunities, such as three educational workshops in the community, and resulted in the installation of 12 rain gardens and dispersal of 24 rain barrels (Wright et al., 2009).

Outreach communications have also been shown to promote GSI engagement. A study in Wilmington, North Carolina, has shown that GSI fliers can grab residents' attention (Wright et al., 2009). A study in Shepherd Creek, Ohio, used various marketing approaches to increase GSI implementation mailed information packages and door hangers (Mayer et al., 2012). Another study in Lincoln, Nebraska, has shown that increased publicity around rain gardens increased the proportion of community members knowing about rain gardens from 34% 41% (Meder & Kouma, 2010). Education and information about the benefits of GSI can also be used to prompt developers to implement GSI. Incentives for developers, such as offering funding and long-term maintenance plans for conserved open areas, as well as modifying the approval process to favour conservation can address some of the large impediments to conservation subdivision implementation (Allen et al., 2012). This study also demonstrated that highlighting the benefits of environmental initiatives can increase public acceptance (Allen et al., 2012).

2.3.3. GSI and Education

Education has been demonstrated as being useful for prompting GSI engagement from residents. For instance a study conducted by North Carolina State University showed that all residents that participated in the project had education on stormwater runoff and water quality (Wright et al., 2009). This was iterated in another study, which found that GSI initiatives that were familiar to participants were favoured. For instance, a study in Rotterdam, Netherlands, found that rain gardens had a higher favourability to residents (48%) than green roofs (37%) or green walls (15%) (Derkzen et al., 2017). In a study in Howard County, Maryland, low awareness of GSI was cited as a challenge to GSI implementation activities (Newburn & Alberini, 2016).

2.3.4. GSI and Financial Incentives

Willingness to pay has been used as a means of assessing engagement in GSI with residents. A survey by Bowman et al. (2012) found that 50% of residents were aware of GSI methods. However participants were unwilling to pay a large amount of money for GSI installation, and most residents said they were willing to pay only between $1-$1,500 for rain gardens and permeable pavement (Bowman et al. 2012). Accordingly, financial incentives have been shown to be an effective motivator to get residents to install GSI on their properties. Incentives can be in various forms including rebates, discounts, tax credits, or grants (Copeland, 2013). For instance, a study by Cote and Wolfe (2014) examined permeable pavement as GSI in Kitchener, Ontario. It examined how incentives, education and other variables influenced residents' perceptions on permeable pavement. Most participants answered that they felt the need to improve stormwater management was at least somewhat important and 77% of participants felt a responsibility to contribute to stormwater reduction management. However, no one was willing to spend more than 50% of the installation cost for permeable surfaces, while 85% indicated that they would be willing to pay more if incentive programs existed. Barriers to GSI installment included awareness and knowledge of stormwater issues, pavement cost and low income (Cote & Wolfe (2014). A study in Howard County, Maryland, found that the proportion of households willing to install a rain garden without financial incentives was only 18% (Newburn & Alberini, 2016). This rate increased over threefold when a 30% rebate was included (Newburn & Alberini, 2016).

2.3.5. GSI and Aesthetics

Aesthetics and visual appeal of GSI can serve as an additional value that has been noted by residents. A study in Wilmington, North Carolina, included a resident survey, which

demonstrated that beautification, in addition to stormwater management, is a significant aspect for residents who consider rain gardens (Wright et al., 2009). In a study in Rotterdam, Netherlands, residents favoured varied and visually appealing GSI initiatives (Derkzen et al., 2017). The visual appeal of GSI has also been noted in other studies. For instance, rain gardens and bioretention areas provide visual appeal next to ecosystem services such as stormwater management and pollinator habitat (Kertesz et al., 2014).

2.3.6. GSI Implementation as a Contagious Process

GSI implementation itself can also help foster participation. Many residents in Wilmington North Carolina's Bottom neighbourhood became involved in installing rain gardens or rain barrels after seeing one on a neighbour's property (Wright et al., 2009). Word of mouth communication was the most significant way of spreading news about GSI projects in this study (Wright et al., 2009). Another study in Lincoln, Nebraska found that residents' interest in rain gardens rose from 10% to 22% over one year (Meder & Kouma, 2010). This may have been driven by the greater number of rain gardens and display flags in the community, which was making rain gardens more familiar in the area (Meder & Kouma, 2010).

2.4. Knowledge Gaps and Knowledge Advancement

The literature review has shown that there is a great body of work on various aspects of GSI. However, there is a need to further increase understanding about the effectiveness of different methods of educating the public about GSI. Specifically, there is a knowledge gap regarding the effectiveness of design charrettes and educational brochures at impacting residents' attitudes and behaviours regarding lot-level GSI implementation.

This study is the first of its kind to investigate the application of design charrettes to encourage residents' implementation of GSI on the individual lot level in response to a recent flooding event. Previous studies have used other engagement approaches for GSI implementation at the parcel level. The current study differs from Allen et al. (2012), whose study was not in response to a flood event and that is different because of its setting in the US context. The purpose of the current study is addressing the above knowledge gaps. Ultimately, answering the previously stated research question will provide the information required to fill these knowledge gaps.

3.0 Methodology

This chapter describes the research methodology applied to the current study. It outlines the philosophical foundations and paradigm, research approach, means used to collect and analyze the data, as well as the rationale why these measures and approaches were taken.

3.1. Research Philosophy

My research was guided by the pragmatism research philosophy. Pragmatism originates from actions, consequences and situations instead of antecedent (Creswell, 2013). It focuses on applications of what is functional and solutions to issues. Rather than concentrating on methods, researchers highlight the research issue and angles to understand the issue. It is a philosophical foundation for mixed methods studies. Pragmatic philosophies possess an ontology that is oriented towards action and efficacy (Seasons, Three Research Approaches, 2017).

3.2. Research Approach

There are three types of research approaches: quantitative, qualitative and mixed methods. The current study followed a mixed methods approach. A mixed methods approach uses both qualitative and quantitative information, combining the two types of data and utilizing unique designs that might be inclusive of philosophical assumptions and theoretical frameworks of both qualitative and quantitative approaches (Creswell, 2013). The goal of this research approach is to combine the strengths of a quantitative approach, such as generalizability, with the strengths of a qualitative approach, such as comprehensive detail (Creswell & Plano, 2007). The mixed methods approach allows a researcher to mix quantitative statistical data with qualitative findings or confirm quantitative information with qualitative data to draw comparisons or contrasts. The central assumption of the mixed methods approach is that using a combination of both qualitative and quantitative approaches allows a more comprehensive understanding of a phenomenon than using either a singular qualitative or quantitative research approach allows.

The mixed methods research approach applied to the current study used quantitative research based on surveys and qualitative research in the form of interviews. It also applied qualitative measures collected through site visits with residents and participant observation at a GSI design charrette. The design charrette also introduces elements of participatory action planning to the current research. Participatory action research was developed in organizational behaviour from research that concentrated on the active involvement of practitioners, participants and researchers

in the research process. It concentrates on performing research for and with those who will benefit from it (Howard & Somerville, 2014). Participatory action research utilizes exploration, action and reflection to produce knowledge in participants (Sutton & Kemp, 2006).

3.3. Study Design

This study follows a general pre-post design with control group. A treatment is applied in the form of education through educational GSI brochures distributed to residents door-to-door (Appendix H) and a GSI design charrette. Changes in participants' views, attitudes, values and behaviours regarding GSI as caused by the educational treatments are inferred from survey observations and interviews before and after the educational treatments, and in comparison to survey observations of a control group that did not receive educational treatments.

3.3.1. Educational brochures

Educational brochures about urban stormwater and GSI (Appendix H) were one of the two forms of educational treatment and were distributed to 125 residences in the target neighbourhood. The brochures were distributed on only one side of each street to minimize those receiving the brochures sharing the information with neighbours in the control group on the other side of each street. Streets were chosen to avoid those who signed up for the design charrette and those who received a rain home visit to avoid overlap of educational treatments. This was done because overlap of educational methods might fail to educate some residents while repeating the educational treatment amongst those who already received some form of education.

3.3.2. Design charrette

A GSI design charrette was the second form of educational treatment. Residents were invited and notified about the design charrette via an invitation letter that was sent by the City of Cambridge to the approximately 800 households in the study area. Posters advertising the workshop were also posted throughout the community. The design charrette timing and location were also included on the back of the educational brochures distributed to residents.

The GSI design charrette was held to allowed participants to obtain greater understanding of notable neighbourhood features and the issue of decreased permeability accompanying an increase in urbanization and hardscaping in their neighbourhood. In addition, participants were educated about the concept and application of GSI as well as neighbourhood stormwater management. This provided participants more comprehensive and detailed information about

urban stormwater and GSI than offered by the educational brochures. Following initial presentations regarding urban stormwater and GSI issues, design charrette participants were asked to participate in guided activities prompting them to envision, plan and map GSI opportunities for their properties and neighbourhood. The charrette activities were guided by facilitators.

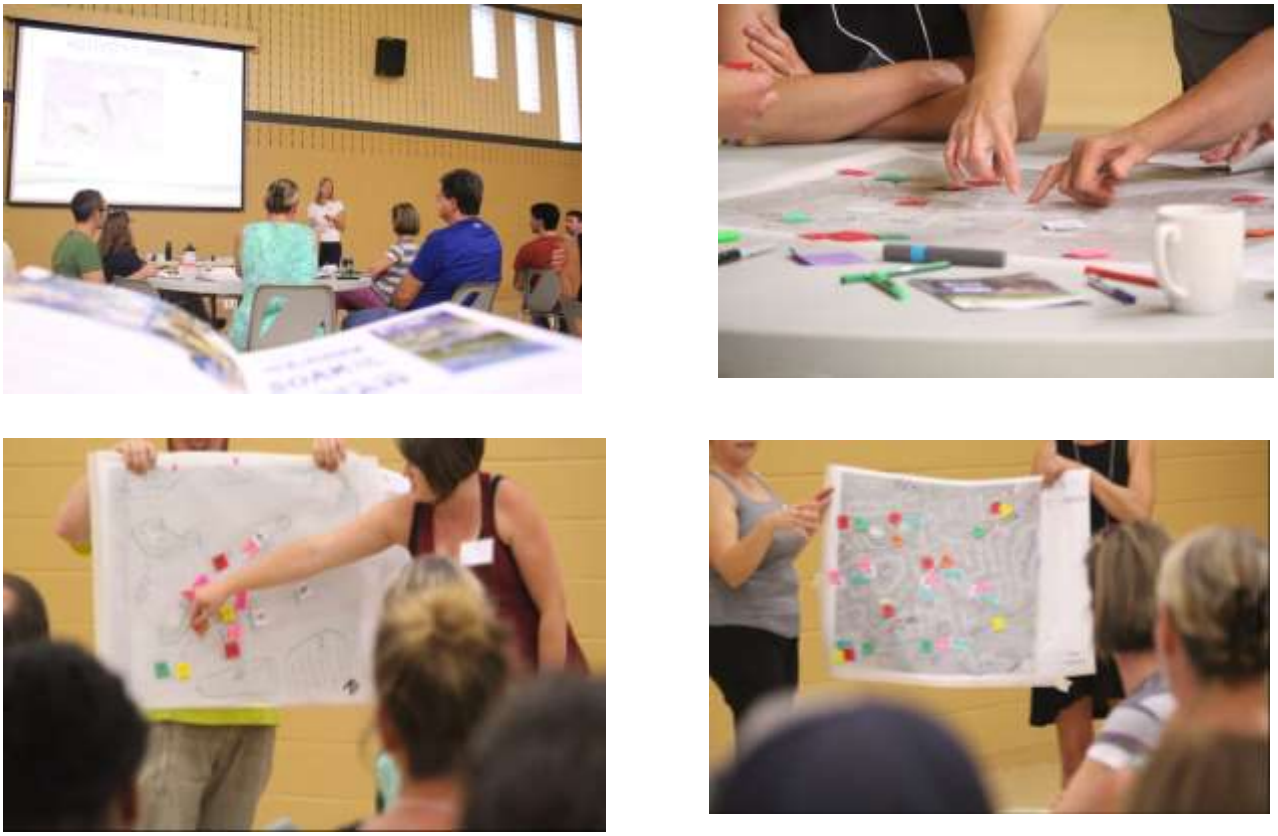

Figure 1. Photos of the September 2017 design charrette. Images show residents learning about GSI and stormwater management from the landscape architect (top left panel), designing and presenting their ideas of areas of relevance for stormwater management (top right and bottom left panel, respectively) and GSI solutions in the neighbourhood (bottom right panel).

The design charrette was held on a Wednesday evening in late September, 2017, at a local church. This location and time were chosen to minimize barriers for participation and maximize attendance. The charrette lasted for approximately two hours. Seventeen residents from twelve households attended. The workshop began with an introductory note by the City Engineer on city

stormwater management initiatives. A landscape architect then gave a presentation on the community background and problems posed by impermeable surfaces and increased runoff and the effect on flooding. The presentation then discussed various stormwater strategies and GSI features.

The second portion of the workshop had participants engage to map their community features, attributes and issues as well as identify opportunities for GSI. The first activity was a Community Mapping Activity. Participants located areas classified as opportunity areas, notable community strengths, areas that would benefit from GSI (e.g., a community park or other feature that could positively showcase or would be enhanced by GSI), issue areas unrelated to stormwater management (e.g., an underutilized area, unsafe areas or unsightly areas) and areas that are affected by poor stormwater management (e.g., poor drainage or area where water pools and cannot percolate) and areas that had localized flooding. At the end of the exercise, maps were transferred to other tables to give participants the opportunity to agree or disagree with these classifications. The second activity, had participants identify GSI features that could be incorporated in the areas identified in the first exercise.

Lastly, a third activity had residents prioritize GSI projects that could be done within the short term (i.e., within one year), within the medium term, and within the long term (i.e., two years or longer). For this purpose, residents placed GSI projects along a timeline. Seventeen residents attended the workshop, including those from the flooding affected street and other parts of the community. Some residents were previously educated on GSI through RAIN Home Visits or the brochure prior to the charrette. In addition, the charrette was also attended by four facilitators, a local municipal counsellor and staff from Reep Green Solutions, University of Waterloo, and the City of Cambridge.

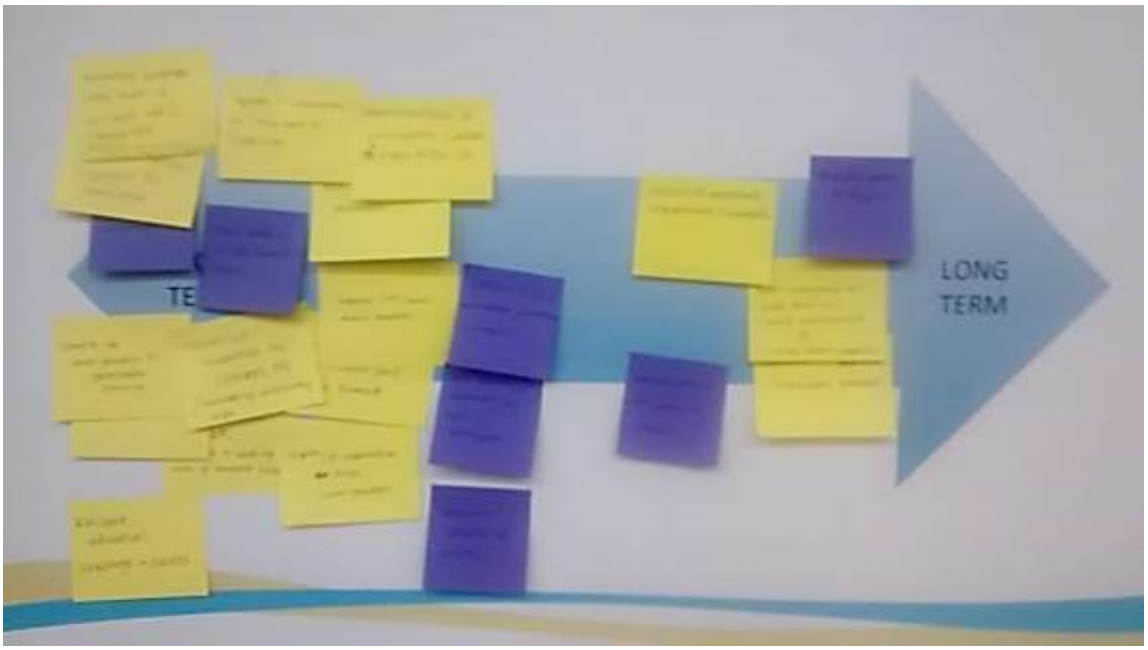

Figure 2. Timeline Activity: shows the Timeline Activity where residents placed projects developed during the charrette on a timeline spanning from short term to long term projects to prioritize GSI initiatives developed during the charrette.

Participants were allocated to four tables in groups of four to five to achieve demographic diversity with a variety of age groups and genders at each table and geographic representation among the neighbourhood, with the exception of one table which only had residents from the flood-affected street. This was done to minimize deviation from the charrette's GSI development objective by upset residents and monopolization of grievance airing by depriving other residents of the opportunity to contribute their ideas.

3.4. Data Collection

3.4.1. Pre- and post-treatment surveys

Pre- and post-treatment paper questionnaires were distributed door-to-door in July (pre-treatment) and in September-October (post-treatment) of 2017 to residents on 12 streets in a residential neighbourhood of Cambridge, Ontario. Streets were initially selected to be representative of the larger neighbourhood (e.g., housing type, proximity to neighbourhood features and services, income level, and proximity to the street affected by the August 2016 flooding incident). More streets were added throughout the distribution process, as households rejected the questionnaire during the initial distribution. The door-to-door surveys enabled the researcher to interact with potential participants to explain the study, address any potential

questions and build rapport, which aids in increasing likelihoods of residents' participation. Questionnaires were also handed out to residents that signed up for a rain home visit as well as those who registered for the design charrette.

Paper questionnaires were assigned an anonymous code that allowed individual-level data entry and analysis to protect participant privacy. An anonymized online questionnaire option was also available. Both paper and online questionnaire options were provided to allow participants to choose their preferred response method and thus increase the response rate and representativeness.

Pre-treatment paper questionnaires were collected from participants in July-September, 2017, and post-treatment paper questionnaires were collected in October-November, 2017. The collection period for the post-treatment survey was longer because a period of severe rain and thunderstorms prevented the researcher from collecting paper questionnaires during much of October.

The surveys consisted of distribution of paper questionnaires to 250 residences in the target neighbourhood (125 who received an education treatment and 125 who did not) and distribution of project invitation letters to 700 residences (includes the 250 paper questionnaires). The invitation letters included a link to the online version of the questionnaire. To prompt survey participation, an incentive of a chance to win a RAIN CAN (a watering can branded with the Green Communities Canada stormwater program logo) was offered to residents who completed the pre-education questionnaire.

Despite best efforts, the researcher succeeded only in collecting 47 pairs of pre- and post-treatment questionnaires. Limited responses to surveys are a common occurrence for this kind of research. However, an additional reason for the limited responses may have been the severe weather that prevented the researcher from survey collection for extended periods of time. This might have led residents to discard the questionnaires.

The questionnaire collection challenges arising from poor weather were addressed using a staggered pickup for questionnaires in the latter stages of the pre-education survey and during the post-education survey. In addition, during the post-education survey, pre-addressed postage-paid envelopes were left with residents who failed to complete the questionnaire at the initial

collection time. This enabled more responses to be received. Online surveys also led to more responses, as flyers with the link to the online survey were left when residents forgot to complete the paper questionnaire, or were not home during questionnaire collection. To further increase response rates, incentives were added such as two-dollars attached to survey reminders and the chance to win one of five Tim Horton's Gift cards in a raffle.

3.4.2. Questionnaires

The questionnaires were based on the Green Stormwater Infrastructure (GSI) Questionnaire developed by Sarah Sinasc in her study of communities in Dundas, Ontario (Sinasac, 2017). The pre-treatment questionnaire consisted of 43 questions separated into thematic sections (Appendix B). These thematic sections covered questions about residents' believes regarding: GSI knowledge and education, general and personal GSI effectiveness, responsibility for GSI, GSI capability, likelihood and intentions to install GSI, and previously installed GSI.

Many of the questions are thematically linked with social-psychological constructs formulated with Theory of Planned Behaviour (Ajzen, 1991). The theory explains if a person is inclined to partake in a specific behaviour (Ajzen, 1991). The relevant social-psychological constructs include behavioural attitude (i.e., the extent a person has a positive or negative view of a certain behaviour), subjective norm (i.e., the social pressure a person feels to engage or not in a certain action), and perceived behavioural control (i.e., a person's appraisal of how easy or challenging an activity is to perform) (Ajzen, 1991). Usually, the more positive the person's attitude and subjective norm and the more a person feels they have a greater extent of behavioural control, the greater the intention the person has towards engaging in the behaviour.

Additional questions asked about residents' experience with GSI charrettes and workshops, demographics (e.g., age, income), housing type and experience with extreme weather events. Most question items were of a 5-point Likert scale type with answer options ranging from 'strongly disagree' (1) to 'disagree' (2), 'neutral' (3), 'agree' (4) and 'strongly agree' (5). A 'do not know' answer option was also provided, which was excluded from the subsequent statistical analysis A few question items provided short text, multiple choice, and yes/no answer options. Participants could skip any questions they did not want to answer. The statistical analysis focuses on the Likert scale question items.

The post-treatment questionnaire was very similar to the pre-treatment questionnaire but also included sections specific to individual GSI education experiences (e.g., GSI design charrette, Reep Green Solutions RAIN Home Visit) (Appendix C). The additional sections asked questions about the usefulness of these educational experiences.

The questionnaire design was a point of strength of the current study. For example, the questionnaires included both positively and negatively phrased questions. This accounted for selection bias such as participants just choosing one response to all questions after experiencing survey fatigue (Ben-Nun, 2011). The open-ended questions in the questionnaire allowed the researcher to gain information that was not anticipated. The inclusion of a picture dictionary, consisting of a picture and description of each GSI feature, allowed participants to grasp what GSI beyond a simple written definition.

3.4.3. Interviews

Just as in the case of the surveys, interviews were conducted before and after the educational treatments. Interviews were semi-structured ensuring that metrics could be used to examine participants' views and actions towards GSI, but also to explore other themes that might arise during the conversation and which could contribute valuable insights into participants' underlying views and beliefs. The interviews provide more information on participants' attitudes and perceptions regarding GSI, including unanticipated information that could not be collected with the surveys. All interviews were recorded by the interviewer in abbreviated longhand writing, allowing capture of all participant answers. Interviews were on average 30 minutes long and conducted over the phone or at the participants' residences.

Pre-treatment interviews (Appendix D) were performed with two participants in the GSI design charrette as well as with one participant in the Rain Home Visits. One of the interview participants resided on the flood-affected street, while the remaining participants resided elsewhere in the neighbourhood. The pre-treatment interview script asked participants questions related to their knowledge, attitudes, and actions on GSI. Questions surrounding their expectations of the GSI design charrette as well as experiences with extreme weather and flooding were also posed.

Post-treatment interviews (Appendix E) were performed with GSI design charrette participants. In addition to the pre-treatment interview participants, two more post-treatment interview participants were recruited. Post-treatment interviews focused on the experience the participants had at the design charrette, the efficacy of the design charrette as well as concerns with GSI or the design charrette. The researcher also asked participants whether their knowledge, support, responsibility, attitudes and intentions to install GSI, or to modify their property, changed after attending the design charrette. Interviews were done over the phone with of three participants, while the other two participants were done in person at the interviewee's home.

One of the challenges in conducting interviews is building trust and rapport with residents, which is essential for yielding better quality interview responses (Bryman et al., 2012). However, the researcher was able to build trust and rapport with residents as indicated by honest answers given by interview participants, who revealed dissatisfactions and frustrations. This trust and rapport was created through recurring meetings with the interview participants during site visits and meetings at the design charrette.

3.4.4. Site visits

Site visits were conducted as a complement to RAIN Home Visits. RAIN Home Visits are consultations by experts trained in residential drainage and stormwater management and can be ordered by residents in the areas of Lake Simcoe, Waterloo Region and Hamilton (Rain Community Solutions, n.d.). In the context of the current study, 12 free RAIN Home Visits were offered to residents in the City of Cambridge. After registering for the Rain Home Visit, residents were asked if they would provide permission for a researcher to accompany the RAIN Home guide and observe the visit. Site visits were performed during six RAIN Home Visits. The researcher observed the RAIN Home guide on the walk-around of the property and during explanation of modifications that could be done to better handle stormwater and areas where features could be installed such as a rain gardens. When given permission, the RAIN Home guide and researcher also observed basements for stormwater related issues. In addition to the RAIN Home Visits, one site visit was performed with a design charrette participant and another site visit with a survey participant.

During site visits, the researcher collected a standard set of observations describing the area of the neighbourhood and the property type (Appendix A). The researcher asked the resident

questions aligned with the RAIN Home Visit, which related to issues such as paved areas, eaves, downspouts, drainage and infiltration. Furthermore, the researcher asked questions regarding views, attitudes, values and experiences with stormwater issues. Finally, the researchers asked questions regarding residents' interest in GSI as well as motivators and barriers to GSI installation and experiences with extreme weather. In addition to the observations, the researcher photographed property and neighbourhood features noted by the RAIN Home guide.

Site visits served as an additional qualitative data source that complemented the quantitative data sources. This approach is useful for revealing overall patterns of GSI perceptions and the impact the educational treatments had on changing these perceptions. It is also useful for examining in-depth drivers behind the perceptions, attitudes and ideals held by study participants that could not be anticipated or derived with the results of the quantitative survey questionnaire. This is particularly important for case studies such as this that focus on producing in-depth understandings of a certain phenomenon in a specific geographic location.

One challenges for the site visits was recruiting participants. However, the ability of the researcher to join the RAIN Home Visits helped addressing this challenge. Another challenge was building rapport with participants. During the RAIN Home Visits, this rapport was provided by the Rain Home guide. However, the researcher also was able to build rapport herself as indicated by the two site visits that were conducted independently from the RAIN Home Visits. Nevertheless, when conducting site visits, the researcher may have missed information. Some of this information was accessible later through obtaining RAIN Home Visit Reports from the RAIN Home guide.

3.4.5. Design charrette participant observations

Two University of Waterloo researchers attended the design charrette and took observation notes of participants' behaviours and dialogue content. These observations included areas of participants' agreement and disagreement about residential stormwater issues, knowledge of the neighbourhood, GSI opportunities and issues, and areas of flooding concern. Observations began after the stormwater and GSI presentations, which were delivered by the city engineer and a landscape architect. 17 participants attended the design charrette and were seated at four tables. The activities at each table were guided by one facilitator. The two researchers were assigned

responsibility for two tables each, which was rotated half way through each charrette activity or when the information died down.

The design charrette observations were focused on understanding the effectiveness of the educational intervention and how it shaped participants' views and actions. Observations noted the timing of comments and behaviours, either at the beginning, middle or end of the design charrette. This allowed assessment of how participants' views shifted from exposure to initial information, participation in design charrette activities, and discussions with other participants.

The presence of two researchers, instead of just one, observing the charrette enriched the amount of information that was recorded. It also improved the quality of data collected as researchers can interpret things differently, and the alternate field of view from the second researcher compensated for the shortcoming of a singular view (Morrison et al., 2012). Furthermore, the notes completed by the design charrette facilitators also enhanced the richness of the data, as the facilitators could completely focus on the events at their respective participant table.

Using observations from the design charrette – instead just the data from the interviews – allowed the researcher to obtain data from another interesting perspective. This is because interview participants might be affected by social desirability bias and be inclined to report their views and actions a certain way when talking to the researcher directly. The design charrette observations permit the researcher to observe the participants while they are interacting with peers possibly reducing the social desirability bias (Salkind, 2010).

A challenge for the design charrette was obtaining enough participants. This issue might have been amplified because there were only resources to hold one design charrette workshop. The occurrence of only one possible time for the design charrette limited the number of attendees for the event as not everyone was available at this time. This was expressed by some participants at the design charrette registration as well as by residents who spoke to the researcher at other occasions.

3.4.6. Design charrette facilitator notes

In addition to the observations made by the researchers during the design charrette, table facilitators also made notes of their observations, which they shared with the researcher after the

event. This was done to fill in potential observation gaps of the two university researchers who rotated between the tables. The facilitator notes included information on the design charrette participants (e.g., number and types of attendees) and addressed interactions among participants, including what kind of information was exchanged, the engagement style of participants, and the content of ideas expressed.

3.5. Data Analysis

3.5.1. Quantitative data analysis

IBM SPSS was used to perform the quantitative data analysis in this study. Several forms of statistical analysis were used to analyze the survey data. This included t-tests to investigate differences in survey responses between participants who received or did not receive education. ANCOVAs were also used to investigate whether there were any effects of educational treatments on participants' survey responses, while compensating for confounding variables. In addition, linear regressions were used to investigate whether educational treatments affected survey responses positively or negatively. Closed-ended survey questions where participants ranked their response on a one to five point Likert scale were analyzed to determine their effect and statistical significance.

T-test

T-tests can be used to investigate whether there are differences in the means of two groups. This test does not account for the possible effects of confounding variables. In the current study different groupings were used: 1. before versus after the educational treatment, and 2. having received education versus not-having received education.

ANCOVA

ANCOVAs (Analysis of Covariance) can be used to assess if there are significant effects of categorical independent variables on a dependent (normally continuous) variable, while accounting for the possible effects of confounding variables (i.e., covariates) (Fan, 2012). Unlike ANVOAs, which simply examine differences in group averages, ANVOCAs assess differences in means adjusted for the effects of covariates. Consequently, this means any variable that is measureable and could have a statistical link to the dependent variable could be considered a covariate, which means covariates can affect the dependent variable. They are considered

bothersome as they can obscure the relationships among the independent and dependent variables, thus they need to be controlled in analysis.

In this study, the demographic data collected in the survey, e.g. age, gender, length of time at residence, in addition to participants' experience with extreme weather and flooding were the covariates in the analysis. This approach was used as the researcher wanted to understand if other attributes were influencing responses of participants over the educational treatment delivered to participants.

A stepwise backward elimination was performed with the ANCOVAs. All demographics were included in each question. At the end, if there were any significant covariates, the ANCOVA was performed again on the same question with only the significant covariates. This was repeated until only significant covariates were left. If no covariates were significant, then the questions were run without any covariates. This is used to identify the best equation; backwards elimination variables are chosen and removed from the analysis until none remain that fit the criteria for elimination (Vogt, 2011). This was done in order to determine if other attributes were influencing responses of participants over the educational treatment delivered to participants.

Linear Regression

Linear regressions were used to understand the direction of the change in the dependent variables. Linear regression is a statistical method that permits the prediction of values of a continuous dependent variable according to values of categorical or continuous independent variables (Shaikh, 2018). This means the amount of variance in a dependent variable can be predicted by the independent variable. This relationship can be positive, meaning both the dependent and independent variables increase together, it can be negative, meaning that when the independent variable increases the dependent variable decreases, or it can be zero when the two variables are unrelated.

The means in which the surveys were analyzed was a point of strength of this study. The use of ANCOVAs enabled the researcher to account for constraining variables that might have been influencing the responses such as gender, income, education level, and experiences with stormwater and extreme weather and prior experience with charrettes. Linear regressions allowed the researcher to account for the direction of change.

3.5.2. Qualitative data analysis

All qualitative data (i.e., interviews, site visits, charrette observations, charrette facilitator notes) were analyzed during primary coding using descriptive-based coding, as explained in Saldaña's *The Coding Manual for Qualitative Researchers* (2009). In descriptive coding, the researcher summarizes the data in the form a single word or short phrases (Saldaña, 2009). This technique it is suitable for all qualitative studies and is especially useful for beginners (Saldaña, 2009).

Attention was paid to incorporate aspects of value-based coding. This type of coding applies the participant's values, beliefs and attitudes displaying their worldview (Saldaña, 2009). Value based coding is suitable for almost all qualitative kinds of research, especially those that investigate the cultural, interpersonal and intrapersonal experiences and behaviours within case studies (Saldaña, 2009). Attitudes refer to how we think or feel about an object, person, oneself or an idea. They comprise a lasting mechanism of appraisal affective based reactions based on assessing the value laden beliefs and ideas which have been learned. A belief encompasses attitudes and values but is also inclusive of individual "knowledge, experiences, opinions, prejudices, morals and other to interpretive perceptions of the world.

Secondary coding was also utilized for qualitative data analysis. Secondary coding is pattern-based coding and its aim is to devise categories, themes, concepts or theory-based organizations from the set of primary codes developed (Saldaña, 2009). During this process, primary codes are reclassified to produce a smaller more limited range of codes. Pattern-based coding is "explanatory or inferential [coding] that [identifies] an emergent theme, configuration or explanation" (Saldaña, 2009, p. 152). Pattern-based coding brings the material together in a significant aspect for evaluation and is a means of collectivizing the summaries into smaller themes, classifications or subgroups.

The researcher looked for beliefs, attitudes and values within the qualitative data and summarized these in a word or short phrase. After secondary coding was concluded the researcher developed a list of top codes which encompassed the most frequently coded themes. These themes were used to inform the research findings. All coding was done by one researcher. Therefore any biases in the interpretation were consistent.

3.5.3. Triangulation

Triangulation is the use of multiple methods in pursuit of a research question and is a widespread approach applied in mixed methods research (Creswell & Plano, 2007). Triangulation aims to produce different but complementary data on the same subject to best understand the research issue. A single-phase triangular design occurs when researchers perform qualitative and quantitative research simultaneously and assign equal weight to all research methods. The researcher interprets all forms of data together during analysis to merge the forms of data.

The combination of qualitative and quantitative data collection methods used in this the current study allows triangulation of the study findings. While the quantitative data from the survey provide generalizable information, the qualitative data (i.e., from the interviews, site visits, charrette observations, charrette facilitator notes) provide more in-depth and contextual information that can explain the patterns observed from the quantitative data. Using several data collection methods is also useful for assessing consistency in responses among participants.

3.6. Study Area

The study site for this project was a suburban neighbourhood in the City of Cambridge, Ontario. The community for the census tract the study neighbourhood falls under has a population of around 7,830 as of 2016 (Statistics Canada, 2017). The top age cohorts (above age 19) are: 50-54 - 790 residents, 55-59 - 675 residents, 20-24 - 635 residents, 45-49 - 600 residents, and 40-44 - 510 residents.

The average total household income is 138,998 as of 2015 (Statistics Canada, 2018). The neighbourhood is largely comprised of single detached homes: 1,795 single detached homes, 70 semi-detached homes, and 390 row houses comprised the census tract as of 2016 (Statistics Canada, 2017). Notable neighbourhood features include a community centre (with a large amount of green space), parks, and schools. The neighbourhood is also adjacent to a conservation area. Many residents have lived in the community for a substantial period of time. The amount of movers for a 5-year period comprised 1,930 versus 5,460 non-movers (Statistics Canada, 2018).

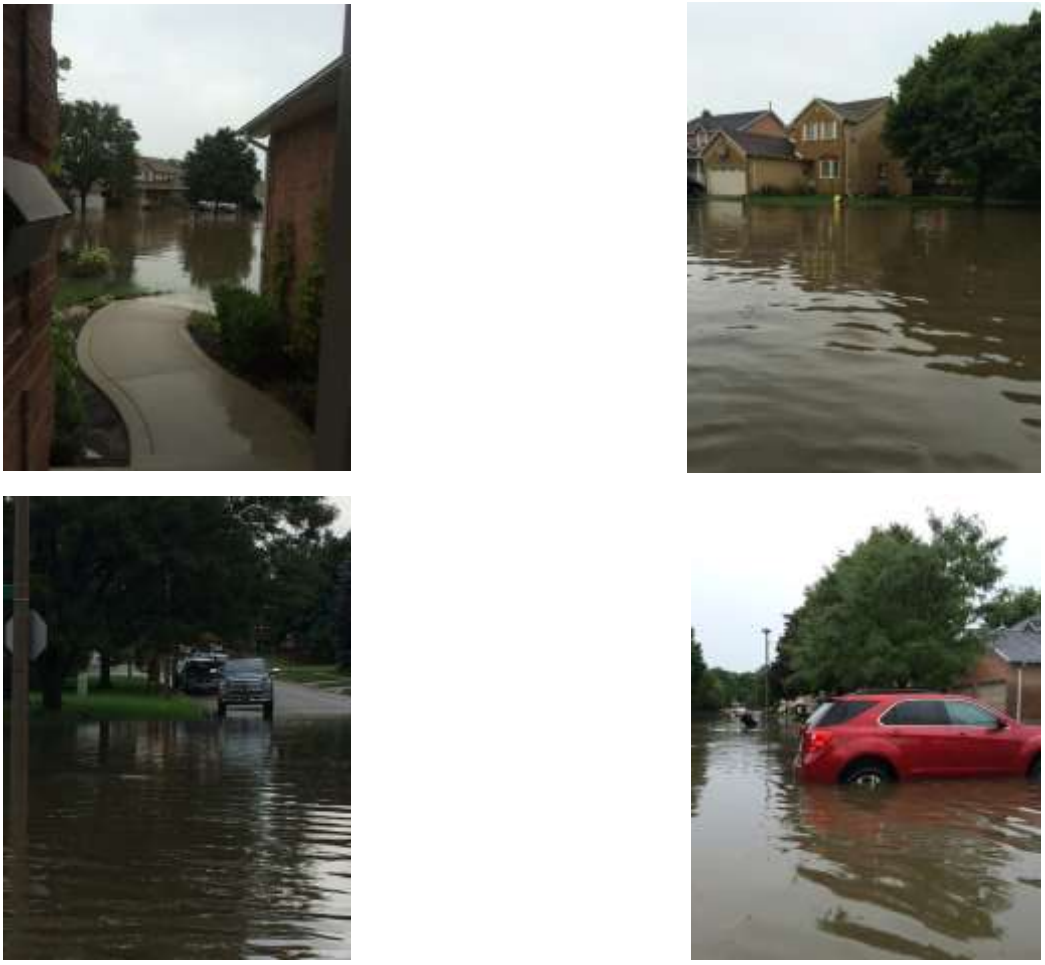

Figure 3. Photos depicting flooding after storm in study community.

The neighbourhood was chosen as it is community with a history of flooding and has experienced issues with stormwater management. A flood occurred most recently in August 2016 after a severe downpour storm event. This flood sparked initiatives between Reep Green Solutions, the City of Cambridge and the University of Waterloo to address this issue at the community scale. One street in the study neighbourhood experienced flooding in this event. This street backs onto a neighbourhood stormwater management pond, which was unable to handle the excess downpour.

4.0 Results

The following section examines the key findings within the quantitative (surveys) and qualitative (interviews, site visits, charrette facilitator notes, and charrette observations) data in response to the main research question. Demographics of the study neighbourhood and the participants are also presented. Key findings were those determined to be overarching and repeatedly found across multiple forms of research collection methods found in a research findings matrix. Findings that occurred across two or more forms of data collection methods were included. The data collection forms and other research materials used to conduct the study such as the site visit script, survey questions, interview script, design charrette observation form and design charrette facilitator notes form can be found in Appendixes A, B, C, D, E, and F respectively.

The results of the analysis showed that the educational treatments were largely ineffective at changing participants' views and actions towards GSI except in regards to a small number of questions connected to specific GSI beliefs and actions. Thus the hypothesis that education influences participants' views, attitudes, values and behaviours to be more positively inclined towards GSI and to taking action to implement GSI is not supported by the results.

4.1. Participant Sample

4.1.1. Quantitative

Description of survey participants

Fifty participants responded to both the pre- and post-education survey (Table 1). There was a greater number of male (n=24) than female (n=18) participants. Most participants were over the age of 46 years. The mode of the age distribution fell in the age class of 51-54 years. Participants tended to have advanced levels of education, with 50% of participants having an undergraduate degree or higher. Participants tended to have a high income, with most (75%) household incomes being larger than the regional average of $77, 000 per year. The majority of participants have lived in the community for more than ten years and the most common residence period was longer than 20 years. The vast majority of participants (98%) own their homes. Most participants (93%) live in single-detached homes, semi-detached homes comprise four percent of homes and two percent live in some other housing form. Sixty-four percent of participants have experienced home flooding during their lifetime. However, only 33% of participants reported experiences of

extreme weather, while 58% of participants reported that they were impacted by extreme weather.

Three residents participated in the pre-charrette interviews. Of these participants, two were female and one was male. Participant age ranged from the reported age of 36-40 years to 60-64 years. Five residents participated in the post-charrette interviews. Of these participants, three were identical with the pre-charrette interviewees. Of the two new participants, one was female and one was male. In the pre-charrette interviews all three participants had experience with stormwater management issues such as flooding, water seepage in their basements, or excess water ponding in their yards on their property. However, neither of the two additional post-charrette interview participants had stormwater management issues such as flooding or water pooling in their basements or yards on their current property. One of the residents who participated in both the pre and post-charrette interviews resided on the street that was affected by the August 2016 flooding in the City of Cambridge.

Description of site visit participants

Of the eight site visits, three visits were conducted with individual male participants, four visits were conducted with individual female participants, and one visit was conducted with a couple consisting of one female and one male. The age of site visit participants ranged from 18-25 years to over 65 years. One of the site visit participants resided on the street that was affected by the August 2016 flooding in the City of Cambridge.

Description of charrette participants

Sixteen residents from 14 households attended the charrette. The participants' genders included eight women and eight men. The attendees' age ranged from 18-25 years to 60-64. Five of the participants resided on the street affected by the August 2016 flooding.

Table 1. Demographic information of the survey participants.

Demographic Variable	Number of Responses	Percent of Responses (%)
Gender	42	
Male	24	57
Female	18	43
Age Group	44	
18-25	1	2
26-30	2	5
31-35	0	0
36-40	3	7
41-45	5	11
46-50	6	14
51-54	8	18
55-59	7	16
60-64	7	16
65+	5	11
Educational Background	43	
High School diploma	1	2
College diploma	6	14
Undergraduate Degree	14	33
Graduate Degree	9	21
PhD	13	30
Other	0	0

Table 1. Continued.

Demographic Variable	Number of Responses	Percent of Responses (%)
Household Income	34	-
Less than $19,999	1	3%
$20,000 - $39,999	0	0%
$40,000 - $59,999	4	12%
$60,000 - $79,999	4	12%
$80,000 - $99,999	7	21%
$100,000 - $119,999	5	15%
$120,000 - $139,999	4	12%
$140,000 - $159,999	1	3%
$160,000 - $180,000	3	9%
More than $180,000	5	15%
Length of time at current residence	43	-
Less than a year	2	5%
1-5 years	7	16%
6-10 years	9	21%
11-15 years	5	12%
16-20 years	8	19%
More than 20 years	12	28%
Rent or own residence	43	
Own	34	-
Rent	1	3%
Other	0	0%

Table 1. Continued.

Demographic Variable	Number of Responses	Percent of Responses (%)
Dwelling Type	45	
Single detached house	42	93%
Semi-detached house	2	4%
Other	1	2%
Experienced home flooding before	44	
Yes	29	66%
No	15	34%
Experienced extreme weather	45	
Yes	15	33%
No	30	67%
Impacted by extreme weather	43	
Yes	25	58%
No	18	42%

4.1.2. Qualitative

Description of site visit participants' properties

During site visits, the researcher talked with study participants and observed the various landscaping features and uses in participants' yards. The yard of Participant 8B boasted lots of vegetation and contained a Gogi berry bush as pointed out by the participant (Figure 4.).

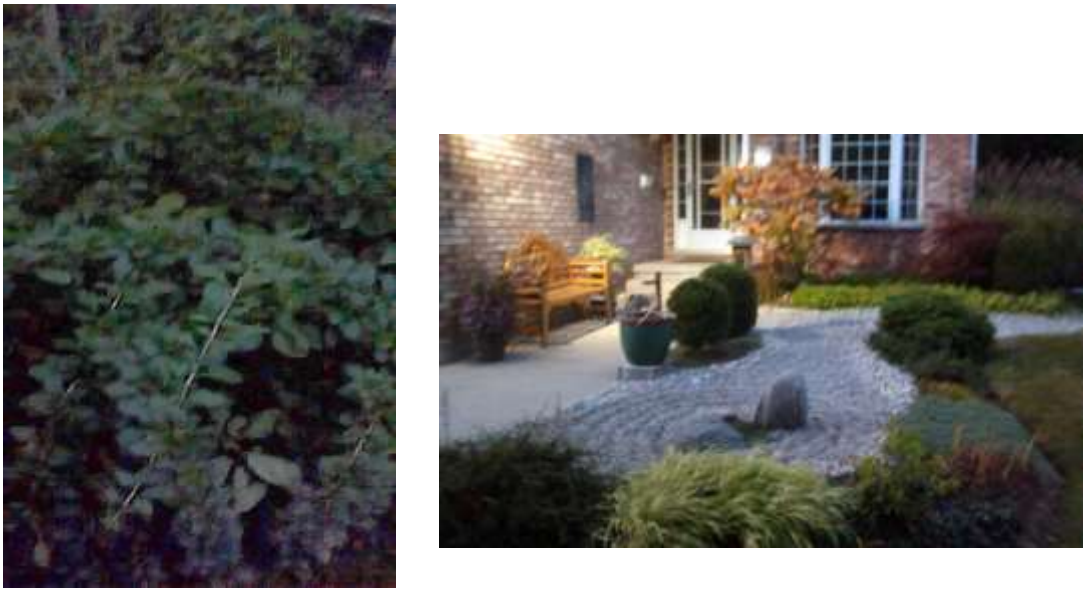

Figure 4. The yard of Participant 8B planted with a variety of vegetation, the left panel includes the Gogi berry bush, while the right panel depicts the vegetation and rock garden in the front yard.

Also the yard of Participant 5B contained a great amount of plants, many of which attracted bees during the site visit (Figure 5).

Figure 5. The yard of Participant 5B contained many plants that attracted bees.

The site visit to the yard of participant 2B allowed the researcher to observe many native plants including asters, wildflowers and perennials (Figure 4). Only one site visit participant did not

have landscaping features on their yard and narrated a negative experience with plantings in the past. Participant 3AB shared "[We] used to have a veggie garden, but bacteria would grow." when asked about reason for the lack of plantings in their yard.

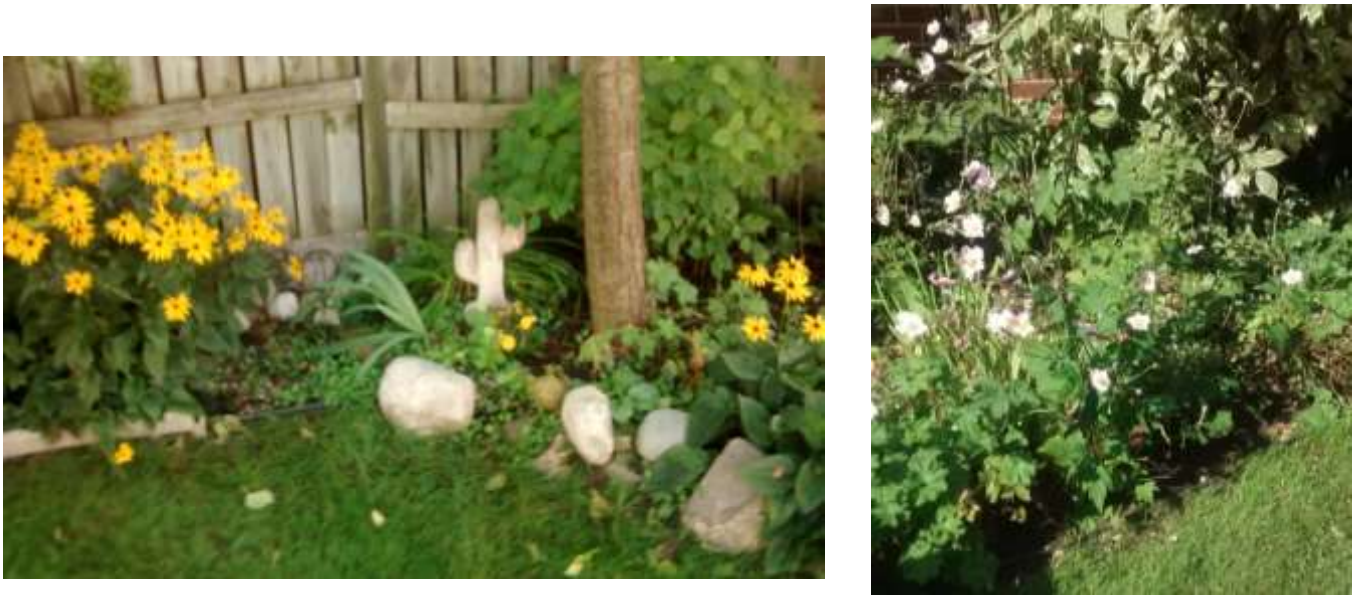

Figure 6. The left panel shows the native black-eyed susans and the right panel depicts the purple asters planted in Participant 2B's yard.

In addition to decorative landscaping, participants used their yards for other valued purposes. Four site visit participants used their yards for compositing of organic materials. Many participants also listed a number of valued functions of their properties such as relaxation and recreation (Figure 7).

Figure 7. Landscaping and relaxation features of Participant 2A's yard. The left panel shows the vegetation and walkway that leads to the backyards while the right panel shows the landscaping features adjacent to the back patio area in the backyard.

Seven site visit participants agreed that they value the recreation or relaxation aspects of their yards. Participant 2A commented [that] they value the privacy offered by their yard, which is afforded by the various plantings and landscaping features of their garden "I sit here, at the side. [You] can't see in my yard, [it provides privacy]." Six site visit participants agreed that beautifying their property or neighbourhood motivates them to install GSI.

4.2. Risk Perceptions regarding Urban Stormwater and Floods

4.2.1. Quantitative

Survey participants were ambivalent regarding the risk of their basement being flooded and education did not change this perception

Participants overall neither agreed nor disagreed with the statement that their basement might be at risk of flooding over the next five years, and this perception did not change from before to after the educational treatment ($t = 0.739$, $p = 0.462$, Table 2). The t-tests suggest that the educational treatment did not affect the perceived risk of basement flooding, which stayed the

same for both the control (t = 0.798, p = 0.429) and treatment groups (t = 0.288, p = 0.775) (Table 3). Also the ANCOVA and linear regression suggest that the educational treatment did not affect participants' perception of the risk of their basement being flooded in the next five years (F = 1.681, B = -0.337, t = -1.296, p = 0.202) (Table 4).

Table 2. Results from a t-test (before versus after) of participants' perceptions of risk of their basement being flooded in the next five years. Tested are perceptions of risk for all participants combined. Lower and higher scores (1-5) represent lower and higher risk perceptions, respectively.

	Treatment			
Question item	Before	After	t	p
Chance of flooding	3.44	3.28	0.739	0.462

Table 3. Results from a t-test of participants' perceptions of risk of their basement being flooded in the next five years. Tested are perceptions of risk for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher risk perceptions, respectively.

	Control group				Treatment group			
Question item	Before	After	t	p	Before	After	t	p
Chance of flooding	3.52	3.27	0.798	0.429	3.38	3.28	0.288	0.775

Table 4. Results from an ANCOVA and a linear regression of the effects of educational treatment on participants' perceptions of risk of their basement being flooded in the next five years. Lower and higher scores (1-5) represent lower and higher risk perceptions, respectively.

	ANCOVA		Regression			
Question item	F	p	B	R^2	t	p
Chance of flooding	1.681	0.202	-0.377	0.04	-1.296	0.202

4.2. 2. Qualitative

GSI workshop participants showed concerns around stormwater prone areas in their neighbourhood and generated plans to address these

Facilitators logged charrette participants' concerns of stormwater prone areas. These concerns were apparent in worries about flood-affected areas noted by participants at Table 1 who

developed GSI strategies such as rain gardens along streetscapes and better conveyance in issue areas (weakness areas in the community unrelated to stormwater management, e.g. an underutilized area, unsafe areas, or is unsightly). Charrette participants at Table 3 commented that they had concerns with the neighbourhood stormwater management pond that is adjacent to the street that was flooded in August 2016. Furthermore, charrette participants at Table 4 also discussed concerns with the stormwater management pond as well as the flood-affected street (Figure 8).

Figure 8. Map produced by design charrette participants from Table 4 showing areas of concern for stormwater management in the community.

In addition to noting participants' concerns about flooding, Table 4's facilitator commented that the charrette participants had developed complete strategies in areas of concern in residential areas. Participants at this table had experienced flooding from the recent stormwater event in August 2016. However, charrette participants at this table did not develop GSI in municipally owned, public areas of concern. Table 1's facilitator also recorded that their participant group developed GSI projects in areas of concern in residential areas, while Table 2's facilitator noted the partial development of plans for residential scale GSI.

4.3. Knowledge and Education about Green Stormwater Infrastructure

4.3. 1. Quantitative

Survey participants did not feel they have been educated about GSI and education did not affect this perception

Overall, survey participants disagreed with the statement that they have received formal education on green stormwater infrastructure. However, they neither agreed nor disagreed with the statement that they have received informal education regarding this issue. These perceptions did not change from before to after the educational treatment (formal education: $t = -0.242$, $p = 0.809$; informal education: $t = -0.287$, $p = 0.775$, Table 5). The t-tests suggest that educational treatment did not affect perceptions of having received education, which stayed the same for both the control (formal education: $t = 0.177$, $p = 0.861$; informal education: $t = 0.891$, $p = 0.378$) and treatment groups (formal education: $t = 0.446$, $p = 0.658$; informal education: $t = 0.379$, $p = 0.706$) (Table 6). The ANCOVA suggests that the educational treatment did not affect participants' perception of having received formal or informal education (formal and informal: $F \leq 0.325$, $p \geq 0.140$) (Table 7).

Survey participants were ambivalent about attending a neighbourhood GSI workshop and education did not affect this inclination

Participants overall neither agreed nor disagreed with the statement that they would try attend a neighborhood GSI workshop if one was offered, and this inclination did not change from before or after the educational intervention ($t = 0.300$, $p = 0.765$, Table 5). The t-tests suggest that the educational treatment did not affect participants' intention to attend a neighborhood GSI workshop, which stayed the same for the control ($t = -0.109$, $p = 0.914$) and the treatment groups ($t = 0.526$, $p = 0.601$) (Table 6). The ANCOVA and regression analysis suggest that the educational treatment did not affect participants' intent to attend a GSI workshop ($F = 0.137$, $B = 0.091$, $t = 0.370$, $p = 0.713$, Table 7).

Table 5 Results from a t-test (before versus after) of participants' perceptions of having received formal or informal education about green stormwater infrastructure. Tested are perceptions for all participants combined. Lower and higher scores (1-5) represent lower and higher perceptions of education, respectively.

	Treatment			
Question item	Before	After	t	p
Formal education	2.16	2.22	-0.242	0.809
Informal education	2.98	3.04	-0.287	0.775
GSI workshop	3.40	3.34	0.300	0.765

Table 6. Results from a t-test of participants' perceptions of having received formal or informal education about green stormwater infrastructure. Tested are perceptions for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher perceptions of education, respectively.

	Control group				Treatment group			
Question item	Before	After	t	p	Before	After	t	p
Formal education	2.35	2.29	0.177	0.861	2.00	2.16	0.446	0.658
Informal education	2.86	3.14	0.891	0.378	3.08	2.96	0.379	0.706
GSI workshop	3.29	3.32	-0.109	0.914	3.52	3.36	0.526	0.601

Table 7. Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' perceptions of having received formal or informal education about green stormwater infrastructure. Lower and higher scores (1-5) represent lower and higher perceptions of education, respectively.

	ANCOVA		Regression			
Question item	F	p	B	R^2	t	p
Formal education	0.008	0.930	-0.038	0.00	-0.089	0.930
Informal education	2.251	0.140	0.550	0.05	1.500	0.140
GSI workshop	0.137	0.713	0.091	0.00	0.370	0.713

4.3.2. Qualitative

GSI workshop and site visit participants expressed interest in education on GSI and stormwater management

During the pre-charrette interviews, all three interview participants shared that they hoped to gain increased education, knowledge, and understanding or awareness about GSI and stormwater management from attending the charrette. Participant 3A remarked "I'm also interested [to] see and learn about [green stormwater infrastructure], I do not know much about municipal planning."

An interest in education on GSI could also be seen during the charrette. For the charrette design activity, many of the participant groups conceived GSI demonstration projects they would like to see installed in their neighbourhood (Figures 8 and 9).

Figure 9. Map produced by design charrette participants depicting opportunities for GSI demonstration sites.

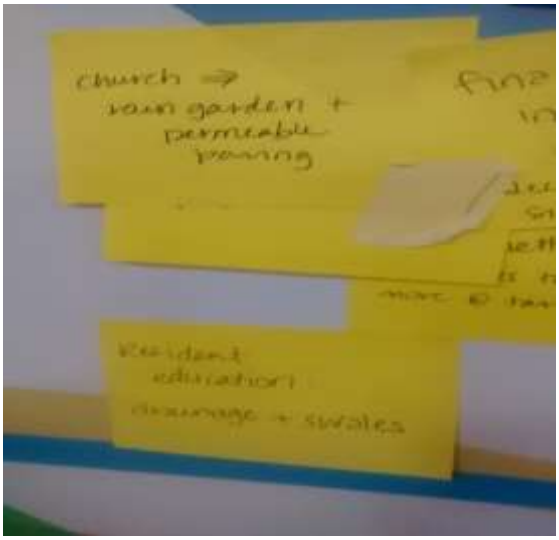

Figure 10. Post-it notes written by design charrette participants depicting timelines for possible GSI demonstration projects.

The researchers observing the design charrette noted that some participants had an interest in education. One researcher documented how participants at Table 1 developed a plan for a rain garden demonstration project at the local conservation area. However, the Table 1 facilitator documented that participants felt they would benefit from support from a professional for better planning. The researcher also documented the desire of participants at Table 1 for residential education on bioswales, changing landscaping for enhanced drainage, and the effects of homeowners' property management on stormwater management. Furthermore, Table 1 participants discussed their interest in having a rain barrel sale and GSI information session in the community to educate residents.

One of the researchers recorded participants' conception of a GSI demonstration site at the local community centre with the purpose of educating residents about stormwater conveyance and educating children on GSI and stormwater as part of the school curriculum. The charrette facilitators commented on the participants' desire for education on GSI and interest in additional resources that would better equip the participants with the ability to install GSI.

A desire for more knowledge about GSI and stormwater management was also prevalent during the site visits. Six of nine site visit participants agreed that having knowledge on GSI would facilitate or motivate them to implement it. Site visit Participant 1 commented on how the only information he had on GSI was from the study survey he had received previously.

GSI workshop participants felt the workshop increased their knowledge of GSI and stormwater management

A strong theme arising from the post-charrette interviews was that participants felt attending the charrette helped improve their knowledge of GSI and stormwater management. This was explicitly expressed by four of the interviewed charrette participants. For example, interview participant 2A expressed surprise about the knowledge he was able to acquire at the charrette "Yes. I didn't realize so many ways to deal with my runoff. I was more focused on making [the] runoff not coming in [the] basement, more focused on that, [than the] notion[of] it [the water going to] go to waste [by] not using it ...".

The charrette served as exposure to the ideas of GSI and stormwater management, as some charrette participants had no prior knowledge or understanding of these topics. One participant remarked

> Yes, [I did] not know [it] existed before. [I] had no idea what [the stormwater management] ponds were for. [I did] not know houses [on flood-affected street were] being flooded. Huge storms [leave huge amounts of] water running down [the] street. [I] never considered how [it was] affecting other people. (Interview Participant 5A)

Interview participant 5A also commented on stormwater runoff when asked about their experience with stormwater issues. The researcher asked the interviewee if they had experience with heavy amounts of runoff after storms, to which the interviewee replied "Runoff, … often yes. [There is a] lot of water rushing down [the] street on [street name], behind [the] school yard, behind the fence." Importantly, before the charrette some charrette participants were aware of stormwater management ponds or excessive amounts of runoff, but had failed to connect these features to the issues of stormwater management and flooding. The post-charrette interviews revealed that the charrette served to introduce the concept of GSI to some of the participants who had never heard of GSI or considered stormwater management before.

4.4. Attitudes regarding Green Stormwater Infrastructure

4.4.1. Quantitative

Survey participants had mostly positive attitudes toward GSI but education did not affect their attitudes toward GSI

Survey participants overall did not agree nor disagree with the statements that GSI lowers chances of their basement being flooded and that it does not reduce polluted runoff entering streams and rivers (both: before 2.69 – 3.44, after 2.81 – 3.28, Table 8). However, survey participants overall tended to disagree that GSI does not improve the quality of local drinking water and disagreed that GSI is a waste of time and money (both: before 2.39 – 2.43, after 2.36 – 2.49, Table 8). Survey participants overall further tended to disagree that installing a rain garden would be unpleasant (before 2.20, after 2.33, Table 8) but agreed that GSI would benefit their property and neighborhood (before 3.54, after 3.67, Table 8). None of these sentiments changed from before to after the educational treatment (all: $|t| \leq 0.750$, $p \geq 0.455$, Table 8). The t-tests also suggest that the educational treatment did not affect any of these sentiments (control all: $|t| \leq 1.042$, $p \geq 0.305$; treatment all: $|t| \leq 1.169$, $p \geq 0.249$; Table 9). Finally, also the ANCOVA analyses suggest that educational treatment had no effect on the above sentiments (all: $F \leq 2.051$, $p \geq 0.159$, Table 10).

Table 8. Results from a t-test (before versus after) of participants' attitudes regarding GSI. Tested are attitudes for all participants combined. Lower and higher scores (1-5) represent lower and higher agreement with attitudinal statements, respectively.

	Treatment			
Question item	Before	After	t	P
Lowers chance of flooding	3.44	3.28	0.739	0.462
Does not reduce polluted runoff	2.69	2.81	-0.560	0.550
Does not improve water quality	2.43	2.36	0.418	0.677
Is waste of time & money	2.39	2.49	-0.505	0.615
Rain garden is unpleasant	2.20	2.33	-0.750	0.455
Benefits property & neighbourhood	3.54	3.57	-0.165	0.869

Table 9. Results from a t-test of participants' attitudes regarding GSI. Tested are attitudes for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher agreement with attitudinal statements, respectively.

	Control group				Treatment group			
Question item	Before	After	t	P	Before	After	t	p
Lowers chance of flooding	3.52	3.27	0.798	0.429	3.38	3.28	0.288	0.775
Does not reduce polluted runoff	2.83	3.14	-1.018	0.314	2.52	2.52	0.006	0.995
Does not improve water quality	2.52	2.68	-0.680	0.500	2.35	2.08	1.169	0.249
Is waste of time & money	2.48	2.77	-1.042	0.305	2.30	2.24	0.226	0.822
Rain garden is unpleasant	2.38	2.38	0.000	1.000	2.04	2.28	-1.012	0.317
Benefits property & neighbourhood	3.50	3.41	0.331	0.742	3.58	3.72	-0.527	0.601

Table 10. Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' attitudes regarding GSI. Lower and higher scores (1-5) represent lower and higher agreement with attitudinal statements, respectively.

	ANCOVA		Regression			
Question item	F	P	B	R^2	t	p
Lowers chance of flooding	0.325	0.571	-0.175	0.01	-0.570	0.571
Does not reduce polluted runoff	0.389	0.536	-0.234	0.01	-0.624	0.536
Does not improve water quality	1.865	0.179	-0.368	0.04	-1.366	0.179
Is waste of time & money	2.051	0.159	0.449	0.04	1.432	0.159
Rain garden is unpleasant	0.017	0.898	-0.035	0.00	-0.129	0.898
Benefits property & neighbourhood	1.441	0.236	-0.285	0.03	-1.201	0.236

4.4.2. Qualitative

GSI workshop participants had positive attitudes toward GSI

Participants in the charrette had a positive of impression of GSI, both before and after participating in the charrette. Three participants stated during the pre-charrette and post-charrette interviews they agreed that GSI is a positive thing. For instance, one participant marveled

> If there wasn't any [GSI] [my] house would be floating. When [my house] was new [there was a] lot of water [reaching my house] in spring melt [from the] park. [My property is] lower than the neighbours, significantly, [by] 2 feet lower than [my neighbours and the] park. Runoff [reached a] lot of places, [the] houses [here] used to have [a] pond on [the] property. (Participant 2A)

Another participant was asked if they felt GSI is beneficial for handling stormwater management in the community. The participant responded during the pre-interview

> Yes, for sure. I guess, [that GSI is also useful] as well as [for] preventing flooding, [it is] better for end [of the flow stormwater management], [to] divert [water] off roads …, [GSI is also beneficial for the] general conservation of [the] environment. People should do [it, install GSI] and people don't [install any features to deal with stormwater management]". (Participant 3A)

During an interview following the charrette, Participant 4A, who was not familiar with GSI prior to the charrette, was asked if the community mapping activity affected their ability to identify areas where action could be taken to improve stormwater management. The participant stated "[the mapping activity] highlighted areas [I had] not appreciated before. I live on [a] hill, [I am] not affected. My activities benefit people at the bottom of the hill. [The activity had us] look at landscape where water flows, impact helpful."

4.5. Normative Beliefs regarding Green Stormwater Infrastructure

4.5.1. Quantitative

Survey participants were mostly ambivalent about their responsibility for managing stormwater and education did not affect their beliefs

Survey participants overall neither agreed or disagreed with the statement that they would take pride in a rain garden (before 3.36, after 3.33, Table 11). Similarly, survey participants neither agreed or disagreed that they have a responsibility to help the city manage stormwater or that the municipality should be solely responsible for stormwater management (both: before 2.98 – 3.23, after 2.76 – 3.26, Table 11). However, overall survey participants tended to agree that they felt an obligation towards preserving features that help manage rain in their neighborhood (before 3.57, after 3.52, Table 11). None of these beliefs changed after the educational treatment (all: $|t| \leq 0.979$, $p \geq 0.330$, Table 11). The t-tests results further suggest that the educational treatment did not affect any of these beliefs (control all: $|t| \leq 1.363$, $p \geq 0.180$; treatment all: $|t| \leq 0.904$, $p \geq 0.372$; Table 12). In addition, the ANCOVA analyses suggest that the educational treatment did not affect survey participants' normative beliefs (all: $F \leq 1.370$, $p \geq 0.111$, Table 13).

Table 11. Results from a t-test (before versus after) of participants' agreement with normative beliefs regarding GSI. Tested are agreements with normative beliefs for all participants combined. Lower and higher scores (1-5) represent lower and higher agreement with normative beliefs, respectively.

	Treatment			
Question item	Before	After	T	p
Would take pride in rain garden	3.36	3.33	-0.348	0.730
Have responsibility to help city	3.23	3.26	-0.107	0.915
Feel obliged to preserve rain features	3.57	3.52	0.279	0.781
Believe municipality's sole responsibility	2.98	2.76	0.979	0.330

Table 12. Results from a t-test of participants' agreement with normative beliefs regarding GSI. Tested are agreements with normative beliefs for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher agreement with normative beliefs, respectively.

	Control group				Treatment group			
Question item	Before	After	T	p	Before	After	t	p
Would take pride in rain garden	3.19	3.29	-0.348	0.730	3.50	3.36	0.499	0.621
Have responsibility to help city	3.29	3.05	0.748	0.459	3.18	3.44	-0.904	0.372
Feel obliged to preserve rain features	3.40	3.45	-0.189	0.851	3.27	3.58	0.661	0.512
Believe municipality's sole responsibility	3.32	2.86	1.363	0.180	2.65	2.67	-0.051	0.959

Table 13. . Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' agreement with normative beliefs regarding GSI. Lower and higher scores (1-5) represent lower and higher agreement with normative beliefs, respectively.

	ANCOVA		Regression			
Question item	F	P	B	R^2	t	p
Would take pride in rain garden	0.150	0.701	0.111	0.00	0.387	0.701
Have responsibility to help city	2.005	0.164	-0.393	0.05	-1.416	0.164
Feel obliged to preserve rain features	1.086	0.303	0.267	0.03	1.042	0.303
Believe municipality's sole responsibility	1.370	0.248	-0.360	0.03	-1.171	0.248

4.5.2. Qualitative

GSI workshop participants' beliefs varied as to who is responsible for stormwater management

Prior to the charrette, participants' opinions varied as to who was responsible for stormwater management. Participant 1A shared "[We] all play a part". This participant also felt that it was the responsibility of residents to maintain stormwater management features after development.

> After [development has occurred the government's responsibility for GSI] is preventative [they are responsible for installing stormwater management features that prevent stormwater issues like flooding from occurring], it is our responsibility to maintain, [and] enhance [stormwater management features that the government installed]. [It also] depends on the scale and size [of the neighbourhood stormwater feature]. If [the initial stormwater management in the residential development by the government is] done properly, [then the] maintenance [of stormwater management systems for residents is] not as bad. (Participant 1A)

Participant 3A felt responsibility for stormwater management should be shared between the government and developers: "[It should] definitely [be the] government [that should] be planning [and] installing these kinds of system, we get more weird storms with global warming. [The] government should create [an] underground system [to deal with the water], [the government] put house plots [on areas with] water [issues], water flows away from [the] house to lakes. [The government should] work with [the] developer, [make the] developer have [an] incentive with [installing GSI on properties, for example this could be] stones [infiltration gallery] and [also include having a] rain barrel attached to house."

Participant 2A felt that in the case of new development, the source of the water determined who was responsible for the management of the stormwater Participant 2A: "Consider where water comes from. In my case city, developers and landowner"... Participant 3A asserted residents should be responsible with government support "When it comes to saving water, people [residents it is] their responsibility, like [the] government [could] provide free or cheap rain barrels, [and] information [on how to] do it [install GSI]." In the pre-workshop interview, Participant 3A commented "Said [the] government [is] being negligent, [they are not properly] maintaining [the stormwater management] pond, but also [stormwater management is a] thing

[that should be done by the government as the government is] morally obligated [to deal with stormwater management]..." There is also the perception that the government has failed at handling stormwater management for the community. Two participants, Participants 3 and 4, commented on how the government inadequately handled stormwater management for the community. Participant 3A shared "… [It is] kind of annoying [that the] government [did] not maintain [the] pond, [this] let [the] flooding happen. [The flooding was] beyond residents control. [The government did] not maintain things…"

Workshop participants considered government to have primary responsibility for GSI and residential stormwater management

During post education interviews, several participants revealed they felt the government has a higher level of responsibility than residents for GSI and stormwater management. For example, with regard to the question if they feel stormwater management through GSI was only residents' responsibility, one participant responded

> No, the city has [a] huge responsibility when [they] plan new development, [they should do so to] get more benefit [for stormwater management]. If [they, the government] have [a] high density subdivision planned, [they] build [should be] somewhat restricted. [The government should] put [a] footprint down, can put stuff [stormwater features] around [the] edges [of the residential development], [the flooding would] not have [had the] impact [it did] had it [GSI] been done at the beginning. (Participant 4A)

When asked what the allocation of responsibility should be, Participant 4A said: "Well in terms of percentage, it's a 80-20 situation. Residents will deal with [what they have been given] they [residents do] not design [the] spaces [they] move into, [residents] are dealing with what [the city and developers have] given [them]". The interviewer inquired further into whose responsibility the remaining 80% would be. Participant 4A replied "city planning, municipal planning, whoever authorizes builders to do this, [should say] here's your guidelines or limits".

However, another participant remarked on responsibility for stormwater management shared between government and residents.

> Depends on the situation. It's kind of annoying the government does not maintain the pond, let's flooding happen. [The flooding was] beyond [the]

> residents' control. [The government did] not maintain things. But neighbours should maintain property in case extreme things occur. Is 50-50 [responsibility for GSI between the government and residents], extreme situations aside? (Participant 3A)

The participant elaborated when asked about the division of responsibility

> Depends on the situation, for example [with the stormwater management] pond, [if it had] worked properly, [but there was still a] flood, [then it would not be solely about attributing responsibility to the] government [then I could] see why [responsibility between the City and residents would be shared]. [The] City [did] not maintain [the pond for] 20 years, but [the division of responsibility would be] 50-50 e.g. [if there was a] tonne of rain, [and the] government [was] not [at] fault, [however the] government [would] still need to help out [residents]. [I] question why [we] pay taxes for some times [things], [yet we do] not pay taxes in case of floods. (Participant 3A)

During the charrette, facilitators also noted attendees' perception of government responsibility for GSI. The Table 4 facilitator commented that participants were generally supportive of GSI but were not looking to spend their own money on GSI. Table 4's facilitator also documented participants' opinion that the City should promote GSI on residential properties, such as rain gardens and rain barrels. Table 4's facilitator recorded "In general, my group was in support of GSI but they still remain of the mind that the city should take the bulk of the social, economic, and financial responsibility." Also during the charrette, one of the researchers recorded that residents and the facilitator at Table 3 discussed the city financing GSI through grants for stormwater management maintenance and funding for volunteers to handle GSI.

Participants felt that residents held less responsibility for GSI than government since residents lacked awareness of stormwater management issues

Some participants mentioned the government has a higher level of responsibility than residents because the public is unaware of issues around stormwater management. When asked what the level of responsibility should be among actors, one participant shared

> Only since [the] general population [did] not know [about stormwater management], [I would] place [a] higher [level of] responsibility on the city, provincial and federal

> government. [The government is an] agent to find ways to bring [stormwater management] to people. [The government] could force developers [to handle stormwater management] [they could] make [developers] do things [install GSI]. (Participant 2A)

Participant 5A shared "[Responsibility] should be equal if [the] municipality educates the people [about stormwater management]. More [responsibility for the] municipality if they don't educate people [about stormwater management]."

Participants thought government should show leadership on GSI

Participants also shared that the government needs to show responsibility and leadership on GSI. One participant explained:

> What did the city do? [The city did not add much [to the charrette], one [participant was] interested in [discussing the stormwater management] pond. The City guy [City Engineer did] not put stop to it when [he] could have [the City Engineer] allowed this topic to be a focal point for too long]. [I am] not sure what [the] city would've expected more [in terms of initiative on GSI from residents]. What [I want to] know [is] where they've [the City government] instituted any of this [installed any GSI in the city], where [is the city] planning [on installing GSI]. [What about] next door, [where] the park [is], why haven't they done anything [installed any GSI]? [The] City built [a] pavilion [in the park], [yet they did] not put in [a] cistern. [The park] was [the] prime place for it [GSI], if encouraged it [the government was to encourage GSI installation]. Why not do it [install GSI]? I've lived here [for] 24 years. There is a well next door. [I] feel City [does] not do much [in terms of GSI]. [They] have lots of areas [where they] could do something. The park is a hub for the community. [Residents] might be encouraged to try something [if they see GSI in the park]. [This is a] huge missed opportunity. (Participant 3A)

Participant 3A explained the frustration they felt surrounding the City's lack of initiative and contribution to GSI implementation, including at the charrette, particularly towards the deviation from the charrette's focus on identifying ways of installing GSI in the neighbourhood. Participant 3A also revealed that the City has failed to implement and GSI in the neighbourhood, despite the ample existence of suitable locations. The

participant added that showing leadership by implementing GSI could serve to motivate residents to install GSI.

During the post-education interview, Participant 3A shared "In your neighbourhood? Yes, let me know what options there would be for the neighbourhood. If government actually got it started, people would do it." Another participant also shared the sentiment that the government should initiate GSI installation,

> [The government] could force developers [to handle stormwater management] [they could] make [developers] do things [install GSI]. If [people] see things [GSI they] will think [about] what it is, [they will see it and think] I should do this. What [residents] do [install GSI] on [their] own property, people not see [notice it], understand [its stormwater management purpose], [there is] no sign [explaining the use of a residential] rain barrel [on people's properties]. (Participant 2A)

4.6. Control Beliefs regarding Green Stormwater Infrastructure

4.6. 1. Quantitative

Survey participants believed they had space but not time or money to install GSI, and these beliefs were not affected by education

Overall, survey participants neither agreed nor disagreed with statements that described their ability to spend the required money and time on GSI in general or specifically on rain gardens (all: before 2.52 – 2.84, after 2.78 – 2.96, Table 14). However, survey participants tended to disagree with the statement that they do not have space in their yard for any type of GSI (before 2.32, after 2.55, Table 14). None of these beliefs changed from before to after the educational treatment (all: $|t| \leq 1.563$, $p \geq 0.122$, Table 14). The t-test results suggest that educational treatment did not have an effect on these control beliefs, which stayed the same for both the control group (all: $|t| \leq 1.518$, $p \geq 0.137$, Table 15) and the treatment group (all: $|t| \leq 1.411$, $p \geq 0.166$, Table 15). Finally, also the ANCOVA analyses suggest that the educational treatment did not affect survey participants' control beliefs (all: $F \leq 1.500$, $p \geq 0.227$, Table 16).

Table 14. Results from a t-test (before versus after) of participants' agreement with control beliefs regarding GSI. Tested are agreements with control beliefs for all participants combined. Lower and higher scores (1-5) represent lower and higher agreement with control beliefs, respectively.

	Treatment			
Question item	Before	After	T	P
Able to spend money for GSI	2.52	2.85	-1.563	0.122
Able to spend time for GSI	2.84	2.96	-0.514	0.608
Do not have time for rain garden	2.79	2.78	-0.007	0.994
Do not have space for GSI	2.32	2.55	-1.185	0.240

Table 15. Results from a t-test of participants' agreement with control beliefs regarding GSI. Tested are agreements with control beliefs for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher agreement with control beliefs, respectively.

	Control group				Treatment group			
Question item	Before	After	T	P	Before	After	t	p
Able to spend money for GSI	2.38	2.82	-1.518	0.137	2.67	2.88	-0.702	0.486
Able to spend time for GSI	2.68	2.95	-0.815	0.420	3.00	2.96	0.138	0.891
Do not have time for rain garden	3.05	2.86	0.547	0.587	2.52	2.72	-0.734	0.467
Do not have space for GSI	2.43	2.50	-0.242	0.810	2.22	2.60	-1.411	0.166

Table 16. Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' agreement with control beliefs regarding GSI. Lower and higher scores (1-5) represent lower and higher agreement with control beliefs, respectively.

	ANCOVA		Regression			
Question item	F	P	B	R^2	t	p
Able to spend money for GSI	0.852	0.361	0.294	0.02	0.923	0.361
Able to spend time for GSI	1.500	0.227	0.433	0.03	1.225	0.227
Do not have time for rain garden	1.342	0.253	0.424	0.03	1.158	0.253
Do not have space for GSI	0.299	0.587	-0.137	0.01	-0.547	0.587

4.6.2. Qualitative

GSI workshop and site visit participants had cost concerns about GSI

The qualitative data revealed participants' concerns about the cost of GSI. Two of the five post-charrette interviewees revealed that their charrette attendance had not influenced their decision to install GSI. When asked why they were reluctant to install GSI, participants replied that they had cost concerns and lack of direct personal benefit that would be derived from installing GSI on their property. One participant commented

> I think it is important [helping the neighbourhood with stormwater management], but retrofits are costly. My driveway has hard paving. Replacing it would cost a fortune. I do not need to replace it. If I could do something, and it would fit, but [doing something] today would be cost prohibitive. (Participant 4A)

Participant 3A remarked "[I] Feel fuzzy [on] how do it [implement GSI]… [I] don't know where put it [GSI]. [The] government [would] say [it would] break [a] bylaw. [The] timing too [is another issue, it is] fall, [I} would look into in [the] spring. Cost [is another concern]."

Participant 4A's sentiment was reiterated by three other participants who commented that it would be easier to install GSI when a property is first developed, or when moving into a property, rather than installing GSI retroactively. Installing GSI retroactively is more difficult for property owners because it is costlier and requires more effort to remove the current landscaping features. The desire for rebates or incentives was also mentioned during site visits. Six of the site visit participants agreed financial incentives would be a motivator or facilitator towards installing GSI on their properties. Site visit recipients also agreed that being able to cover the costs of GSI would be a motivator for installing GSI. Seven of the site visit participants agreed that having the ability to finance GSI would be a motivator for installing it. Participant 1A added that "[I would have] some concern, e.g. if [GSI cost] $1000, if [a GSI is] $10, [I would have] no concern [about costs." In addition, facilitators at the charrette also recorded that the participants expressed a desire for funding or rebates.

Participants might install GSI if it is to their financial benefit

After the charrette, the interviewer asked Participant 4A about their intentions to install GSI and the cost barrier to implementation. The participant shared that they did not have any intentions to install GSI.

> [I am] probably not going to look at [GSI], [it would be] too costly. [I do] not get [a] personal benefit [from installing GSI]. [In] my situation [where I am not experiencing stormwater issues, there is] not [an] incentive [for me to install GSI]. (Participant 4A)

The Interviewer inquired further, and asked if the barriers to implementing GSI would be lessened if the participant obtained benefits in terms of improved stormwater management, reduced taxation or money savings from using less water. Participant 4A replied "I am not going to tear up my driveway if [I do] not need to or [if there] is no benefit [for me]. It boils down to cost. I am not affected." The Interviewer inquired further if the participant would be interested in implementing GSI if they could find lower cost forms of GSI. The participant replied

> Yes, if I saw some benefit for me, I would be more likely than not [to install GSI]. [The] cost threshold [of]… [needed to] install [GSI would] probably [be a] few hundred dollars. Beyond that, [there is] no incentive [for me] to do [it] unless [I] get [a] long term benefit. (Participant 4A)

The interviewer asked to clarify if the benefit the participant referred to was in terms of stormwater management or finance. The respondent explained that they meant a financial benefit

> Some [kind of] insurance benefit would provide [enough of a] benefit [for me], [if I could] save $100 a year in insurance, [it] might be worth it, [I would need a] cost benefit, again. It's what's in it for me [which] come[s] to the forefront, no matter what you're dealing with. (Participant 4A)

Participant 3A also shared during their post-charrette interview that:

[in terms of the GSI implementation] cost- resident should do it [pay the initial costs], but [the] government substitute [supplement to costs of GSI implementation] or subsidize [it]. [This could be] like energy star appliances, caulking [where the] government gave [residents a] tax break [for installing them]. If [residents] could prove

saving water [that they are], diverting water [from runoff], [then the government should] give [those residents a] tax break. People need incentives to do things. I bought a rain barrel, [because I] thought [it was] important. If [the] government [would] say [that there is] something in it, for you, other than [the] environment [in terms of incentives]."

Participants' lack of available yard space limited their willingness to install GSI

Many participants listed space constraints, and concerns on modifying their property as the reasoning behind why they were reluctant to install GSI. Participant 2A remarked "[there is] no room. [I would] have to tear up [my yard], [I am] not prepared [to do that]." Space limitations were also a concern during site visits. In the pre-charrette interview, another participant remarked in response to being asked which GSI features they were interested in

> Similar stuff [as the RAIN Home] guide recorded, [such as suggestions on locations for GSI and stormwater management on their property]. If had lot of [space on my] property [I] would do all of the above [all of the GSI features suggested by the RAIN Home guide]. (Participant 1A)

Participants also held particular values and uses for their properties, which conflicted with GSI installation. Participants felt they were unable to install GSI because they felt they lacked the space needed to accommodate GSI along with the existing activities and uses on their properties. One participant shared

> One [reason I am] not sure [GSI] makes sense for us, [is that we] want to put in a pool [in our yard]. [I] hope [I could] use [a] rain barrel method to save with costs of the pool. An infiltration gallery … we don't need it, [when] storms happen [we do] not get new water [coming onto our property]. Also [with a] pool [it would] not work. (Participant 3A)

During post-charrette interviews, another participant expressed an interest in GSI but revealed they would not install GSI right now. The reasoning behind the reluctance to install GSI was revealed when the interviewer asked if the charrette activities influenced the participant's decision to install GSI. The participant shared

> Yes, [the charrette activities did influence my decision to install GSI]. [I] just don't have [the] space to do it. [The] main barrier [is that my] landscaping [is] set

> in [an] area [where I] can't change anything. [I] know [I] shouldn't make [stormwater management] worse. [What I] would not have [done] though [is to] install more cement or concrete. [I] Can explain to neighbours why [installing more hard surface would] not [be a] good idea. (Participant 5A)

In the post-charrette interviews, four participants also said they had limited room, but they would consider installing a rain garden. A response by Participant 3A, who had revealed that they felt they had a limited amount of space on their property for GSI, points toward delayed action on installing GSI

> [I] feel fuzzy [on] how [to] do it [having the right level of] preparedness. Sure, [I could do] research online [to find information out about a] rain garden. [But, I] don't know where [to] put it. The government [would] say [that I would] break [a] bylaw. [The] timing, too, [is another concern. It is] fall. [I] would look into [installing a rain garden] in [the] spring. (Participant 3A)

The concern about limited space for GSI was a common constraint felt by residents towards installing GSI. Site visits were performed on two of the interview participants' properties and were done on homes throughout the neighbourhood. The space requirements needed to accommodate GSI vary by design and by GSI type. The smallest GSI method would be a rain barrel, which range from 20 gallon to 150 gallon sizes (Lake Superior Duluth Streams, n.d.). The average holds 220 L of water (Rain Barrel.ca, n.d.). Rain gardens take up more spaces and are design dependent, they area is sized at a 1:5 ratio from rain garden size to stormwater drainage area (Credit Valley Conservation Authority, 2014). Rain gardens are an average depth of 85 cm (Toronto and Region Conservation Authority, 2018). The largest form of GSI that is typically done on residential properties is infiltration galleries. They can range from a few meters to several kilometers (World Health Organization, n.d.). Permeable pavement would not require additional space to implement as the amount of space needed to fit permeable pavement would match the current paving surfaced on the property. Lot size of site participants are mostly characterized as medium sized (up to ¾ acres) with one small (less than ¾ acres). This would fit with most of the homes in the community which were medium sized single detached homes. Given the background on the average lot size of homes in the study

community and the amount of space needed to implement GSI features, the average lot size would be sufficient to able to physically accommodate GSI. However, as mentioned earlier current property uses in addition to other factors inhibited residents from wanting to install GSI.

Residents assert GSI should be done proactively on new developments or when first moving in

Participants also shared that they felt installing GSI proactively, when initially designing or landscaping a new property, would be better than retrofitting existing properties. One of the participant commented during the post charrette interview that:

> This is why new developments [is] critical [for GSI], [it is] more cost effective [to install it beforehand on new properties]. [There is a] proposed development, [on the] golf course, [this is an] example [where GSI should be incorporated into land redevelopment]. [The] example [is] to get [GSI] in early [so it] will have more of a lasting [impact to] build on. (Participant 4A)

Apart from new residential developments, another favoured time for implementation of GSI was a move to a new residence. One participant shared that they would consider GSI if they moved

> I wish [I] knew [about] this when [I] first moved in. I liked things [at the Greening Your Neighbourhood Workshop], [the GSI] pictures shown [at the charrette]. [I will] Keep [GSI] in mind if [I] move. [I] like [the] dry river-bed rocks [conveyance]. [I] kind of like [the] cistern. (Participant 2A)

Participants want Government Support and Leadership on GSI Implementation

Charette facilitators marked down that participants were uncertain about installing GSI on their properties. This was observed by facilitators at Tables 2 and 4. Table 4's facilitator expressed that it seemed like participants wanted government support to implement GSI on their properties. Table 2's facilitator commented that it was uncertain if participants felt capable of installing GSI on their properties. Table 1's facilitator recorded that participants felt they would need a professional to install GSI.

At the charrette, the researchers observed that no residential-scale GSI projects on personal residential properties were developed. The projects that participants developed were larger

community-scale or municipal-scale GSI. Projects devised at the charrette also included demonstration sites or GSI features in parks, or neighbourhood amenities such as at the local community centre and conservation area. The projects developed in the residential neighbourhood were situated on public lands like streets or in right of ways, not on private properties.

4.7. Intentions regarding Implementation of Green Stormwater Infrastructure

4.7. 1. Quantitative

Education did not affect participants' unwillingness to install GSI because they were not interested or willing to change their property

Overall, survey participants were ambivalent about their intentions to install GSI on their properties, no matter what the type of GSI or the benefits derived from it (all: before 2.48 – 3.23, after 2.55 – 3.38, Table 17). Exceptions to this trend might be survey participants' overall agreement with the statement that they are likely to install permeable pavement (before 2.45, after 2.45, Table 17) and their disagreement with the statement that they were willing to manage their property for a positive effect on nearby water bodies (before 3.66, after 3.40, Table 17). None of these intentions changed from before to after the educational treatment (all: $|t| \leq 1.481$, $p \geq 0.234$, Table 17). The t-test results suggest that educational treatment did not affect these intentions, which stated unchanged levels of intentions for the control group (all: $|t| \leq 1.860$, $p \geq 0.070$, Table 18) and the treatment group (all: $|t| \leq 1.426$, $p \geq 0.161$, Table 18). However, the ANCOVA and linear regression results suggest that the educational treatment has increased the likelihood that survey participants might install an infiltration gallery ($F = 6.817$, $B = 0.908$, $R^2 = 0.15$, $t = 2.611$, $p = 0.013$, Table 19). All other intentions to install any form of GSI remained unaffected by the educational treatment (all: $F \leq 2.490$, $p \geq 0.122$, Table 19).

Table 17. Results from a t-test (before versus after) of participants' agreement with statements of intentions and actions regarding GSI. Tested are agreements with statements of intentions and actions for all participants combined. Lower and higher scores (1-5) represent lower and higher agreement with statements of intentions and actions, respectively.

	Treatment			
Question item	Before	After	T	p
Not interested in changing property	2.59	2.76	-0.758	0.450
Likely to install rain garden	2.49	2.68	-0.957	0.341
Likely to install rain barrel	3.23	3.38	-0.595	0.553
Likely to install infiltration gallery	2.49	2.55	-0.317	0.752
Likely to install permeable paving	2.45	2.45	0.028	0.978
Planning to install GSI	2.48	2.57	-0.485	0.629
Willing to manage property for positive effect on water bodies	3.66	3.40	1.481	0.234
Intending to control stormwater	3.16	3.00	0.797	0.428

Table 18. Results from a t-test of participants' agreement with statements of intentions and actions regarding GSI. Tested are agreements with statements of intentions and actions for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher agreement with statements of intentions and actions, respectively.

	Control group				Treatment group			
Question item	Before	After	T	p	Before	After	t	p
Not interested in changing property	2.62	3.05	-1.320	0.194	2.57	2.50	0.212	0.833
Likely to install rain garden	2.10	2.50	-1.478	0.147	2.86	2.84	0.062	0.951
Likely to install rain barrel	3.10	3.59	-1.289	0.205	3.36	3.20	0.491	0.626
Likely to install infiltration gallery	2.05	2.59	-1.860	0.070	2.90	2.52	1.426	0.161
Likely to install permeable paving	2.35	2.50	-0.477	0.636	2.55	2.40	0.563	0.576
Planning to install GSI	2.30	2.45	-0.540	0.593	2.65	2.68	-0.101	0.920
Willing to manage property for positive effect on water bodies	3.48	3.18	1.208	0.234	3.83	3.60	0.964	0.341
Intending to control stormwater	3.19	2.82	1.268	0.212	3.14	3.16	-0.082	0.935

Table 19. Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' agreement with statements of intentions and actions regarding GSI. Lower and higher scores (1-5) represent lower and higher agreement with control beliefs, respectively.

	ANCOVA		Regression			
Question item	F	P	B	R^2	t	P
Not interested in changing property	2.490	0.122	0.571	0.06	1.578	0.122
Likely to install rain garden	2.065	0.159	0.488	0.05	1.437	0.159
Likely to install rain barrel	1.661	0.204	0.470	0.04	0.289	0.204
Likely to install infiltration gallery	6.817	0.013	0.908	0.15	2.611	0.013
Likely to install permeable paving	0.152	0.698	0.125	0.00	0.390	0.698
Planning to install GSI	0.096	0.759	0.100	0.00	0.309	0.759
Willing to manage property for positive effect on water bodies	0.281	0.599	-0.141	0.01	-0.530	0.599
Intending to control stormwater	1.336	0.254	-0.345	0.03	-1.156	0.254

4.7.2. Qualitative

While participants' perspective on GSI changed, they were not currently willing to change their landscaping to install GSI

A key finding of this research is that participants place much value on their properties, and their current features and uses. This explains at least partially why participants show limited willingness to modify their land and install GSI on their property. During interviews, participants commented that they did not want to modify their properties at the present time. For example, during the post-charrette interview, the researcher asked Participant 2A if they had any concerns regarding GSI. The participant explained "GSI [would take up my] own property, time, [and require] maintenance. Now [my property is] all landscaped." Similarly, when an interview participant was asked where the reluctance to install GSI stems from, they stated their perspective on GSI had changed but they could not act on it.

"Yes, [I] learned [there are] other ways to do things. Had I known before I would have done things differently. No room now." (Participant 2A)

Some participants indicated they might modify their properties in minor and conventional ways for stormwater management

During site visits, two participants agreed that they would be less likely to engage in activities that were detrimental to GSI. For instance, Participant 1A remarked "What [I am] thinking of

doing [is putting in an] additional downspout, changing all three ways [water is] exhausted [the] off roof. Area thinking getting concrete [added to], [I will] probably do [it in a] different way."

During post-charrette interviews, three participants shared that they felt limited in the types of GSI that they could implement. They stated that they might institute only minor property modifications to support their own and their neighbourhood's stormwater management, instead of implementing GSI. This included installing window wells, planting vegetation, and planting trees. Participant 4A shared "Planting a number of trees, evergreens and others throughout [my] property, [as well as planting] gardens, [and] grass. Nothing like GSIs presented [at the charrette], [like the] pond or [permeable] driveways." Participant 5A was asked if they intended to install GSI after attending the charrette and responded "I am considering getting rain barrels." When the interviewer inquired why they were interested in rain barrels, the respondent answered "[it is the] only thing [I] could do that would be useful. [I] can't change [the] landscape, environmentally rain barrels make a lot of sense for me." Participant 2A also shared the same sentiment of feeling that the only form of GSI that they could implement would be a rain barrel due to landscaping constraints on their property.

Participants indicated they would consider GSI in future moves

A number of participants said they would consider GSI in future moves to a new residence. In the post-charrette interview, a participant shared they would consider GSI

> I wish I knew this when [I] first moved in. I liked things [at the Greening Your Neighbourhood Workshop], [such as the GSI] pictures shown [at the charrette]. [I would] keep [GSI] in mind if [I] move. [I] like the dry river-bed rocks [infiltration gallery], kind of like cistern. (Participant 2A)

Participant 2A also said "If [I were to] start over, I would consider installing it [GSI]." Also during the post-charrette interview, Participant 4A commented on how they would do GSI proactively rather than retroactively because they want to keep their property the way it is currently: "I still say retrofitting after [the property is already landscaped] is expensive and difficult to do. Being mindful [of incorporating GSI] at the beginning [would] lead to a better outcome."

4.8. Actions regarding Implementation of Green Stormwater Infrastructure

4.8.1. Quantitative

Survey participants have not taken action yet on GSI and education clarified this to them

Survey participants did neither agree nor disagree with statements that indicated whether they had already installed GSI or changed their landscaping to manage stormwater runoff (all: before 2.74 – 2.93, after 2.77 – 2.98, Table 20). These perceptions did not change from before to after the educational treatment (all: $|t| \leq 0.171$, $p \geq 0.865$, Table 20). The t-tests suggest that educational treatment did not affect these perceptions, which remained unchanged for the control groups (all: $|t| \leq 1.097$, $p \geq 0.279$, Table 21) as well as for the treatment group (all: $|t| \leq 1.178$, $p \geq 0.143$, Table 21). However, the ANCOVA and linear regression results suggest that the educational treatment decreased participants' perceptions of having installed GSI on their property ($F = 9.747$, $B = -0.855$, $R^2 = 0.18$, $t = -3.122$, $p = 0.003$, Table 21). Educational treatment had no effect on participants' perceptions of having changed their landscaping to prevent stormwater runoff ($F = 0.801$, $p = 0.376$, Table 21).

Table 20. Results from a t-test (before versus after) of participants' agreement with statements of intentions and actions regarding GSI. Tested are agreements with statements of intentions and actions for all participants combined. Lower and higher scores (1-5) represent lower and higher agreement with statements of intentions and actions, respectively.

	Treatment			
Question item	Before	After	t	P
Have installed GSI on property	2.93	2.98	-0.171	0.865
Have changed landscape to prevent runoff	2.74	2.77	-0.089	0.929

Table 21. Results from a t-test of participants' agreement with statements of intentions and actions regarding GSI. Tested are agreements with statements of intentions and actions for the control and treatment groups separately. Lower and higher scores (1-5) represent lower and higher agreement with statements of intentions and actions, respectively.

	Control group				Treatment group			
Question item	Before	After	t	p	Before	After	t	P
Have installed GSI on property	3.14	2.68	1.097	0.279	2.74	3.24	-1.178	0.143
Have changed landscape to prevent runoff	2.90	2.64	0.736	0.466	2.59	2.88	-0.879	0.384

Table 22. Results from an ANCOVA and a linear regression of the effects of educational treatment (yes versus no) on participants' agreement with statements of intentions and actions regarding GSI. Lower and higher scores (1-5) represent lower and higher agreement with statements of intentions and actions, respectively.

	ANCOVA		Regression			
Question item	F	P	B	R^2	t	P
Have installed GSI on property	9.747	0.003	-0.855	0.18	-3.122	0.003
Have changed landscape to prevent runoff	0.801	0.376	-0.315	0.02	-0.895	0.376

4.9. Results in the context of Theory of Planned Behaviour

Participants had overall positive attitudes toward GSI. However, it also appeared that participants' limited subjective norms and control beliefs constrain GSI implementation on private property. Participants' subjective norms around GSI responsibility are evident as they asserted their belief that the government has the main responsibility to install GSI rather than the private residents. Participants believe the government should show leadership by implementing GSI first, such as on new properties and throughout the community including in important community features. Participants' behavioural control beliefs are demonstrated through their belief that they lack the space to implement GSI and their desire for funding and for further education on GSI. In line with these findings, participants overall also expressed that they did not intend to install GSI on their properties. Therefore, participants are less inclined to implement GSI because they feel: 1. the responsibility for GSI implementation lies with the government, and 2. they lack the necessary resources in form of space, finances and knowledge to install GSI.

The general pattern observed among participants was that educational treatments did not affect participants' behavioral norms and behavioral control beliefs expressed through their views and actions towards GSI. This was indicated by the lack of statistically significant differences in responses from before to after the educational treatments. When asked about responsibility for GSI and stormwater management and why they were reluctant to install GSI, participants frequently repeated the explanation that the government should have more responsibility and show leadership on GSI. Participants also frequently expressed their desire for more resources to install GSI in the form of non-financial enablers of installation such as additional education as well as financial-based enablers like rebates and incentives. These perceptions remained unaffected by the educational treatments overall.

4.10. Highlights of Findings

This study integrated both quantitative and qualitative data to understand participants' perceptions, intentions and actions surrounding GSI and how educational treatments might influence these. Both quantitative and qualitative results suggest that the educational treatments were largely ineffective at altering participants' intended actions. In the majority of survey questions, participants' responses did not change from before to after exposure to the educational treatments. However, a few exceptions existed, as certain post-education survey responses produced statistically significant differences from the pre-education responses. This occurred in the case of questions that assessed participants' intentions to install an infiltration gallery, and on the level of agreement towards statements that indicate that they have installed GSI on their property as seen in Appendix I.

The lack of change in responses from the pre-education to the post-education survey aligns with the participants' responses in the qualitative research methods: During interviews, participants indicated that they were willing to make only small, conventional property modifications to better handle stormwater management on their property, such as installing a rain barrel, see Appendix I..

While education was largely ineffective at changing participants' views on taking action on GSI, exposure to GSI education did have some effect on influencing participants' attitudes. Participants did state that after the education treatment (i.e., the design charrette), they viewed past landscaping decisions differently and would have implemented more pervious surfaces to protect their properties and that of their neighbours from stormwater management issues.

A number of overarching themes appeared across the multiple qualitative data collection methods. This included participants' expectations for economic return on investment from GSI and opinions about government responsibility, obligation and leadership around stormwater management. In addition, participants value the layout and designs of their yards, as well as landscaping and current property uses as indicated in Appendix J.. These aforementioned values were shown to limit GSI implementation among participants. Although educational treatments did not spark the desire to install GSI on participants' properties, residents were receptive to the educational activities, see Appendix J. This was evident from participants' assertions that they did want additional GSI education and resources that would allow them to install GSI on their

properties. In keeping with participants' emphasis of government responsibility, they mainly suggested GSI projects on public lands, see Appendix I.

5.0 Discussion, Recommendations and Research Needs

This chapter is a discussion of the study's new and important contributions to the field of planning within the context of the academic literature.

The research was designed to understand how education affected residents' views, attitudes, values and actions towards GSI. The hypothesis was that education would be effective at changing these thoughts and behaviours on GSI. However, the assessment indicated that education was not effective at imparting change in residents. This was demonstrated by the lack of statistically significant quantitative data and by the responses in the qualitative data.

5.1. Connections to Environmental and Planning Literature

The results of this study suggest that residents were largely not motivated to install GSI, even after receiving education about urban stormwater and GSI. Many of the factors that limited residents' motivation to install GSI where discussed elsewhere throughout the literature. The following section explains the dynamics behind the residents' lack of interest and reluctance in the adoption of GSI on their properties.

5.1.1. Cost and other financial concerns regarding GSI limit installation

A key finding of the current study was related to residents' cost concerns regarding GSI. This was a common reason for the reluctance of residents to implement GSI. This finding parallels those of other studies such as the one by Brown et al. (2016) in the Mt. Evelyn neighbourhood of Melbourne, Victoria, Australia, which found that most residents were interested in the financial benefits offered by a GSI program, though for some residents environmental concern was a motivating factor for an interest in GSI. Also other studies found that residents had financial concerns surrounding the use of GSI (e.g., Cote and Wolfe, 2014; Newburn & Alberini, 2016).

The current study confirmed this phenomenon as demonstrated by participants' concerns about the cost of GSI and their desire for funding, other financial incentives or compensation for the installation of GSI. Participants in the current study also indicated a willingness to install GSI if it was inexpensive or to perform less costly alternative forms of stormwater management on their property (e.g., rain barrels). Paralleling these results, Brown et al. (2016) found that participants were largely motivated by monetary incentives, while Bowman et al. (2012) found that

participants were willing to fund GSI if it was inexpensive. Overall, previous research has shown that residents are likelier to install GSI if they have incentives or financial benefits such as tax credits, rebates or grants, which cover GSI installation costs or maintenance expenses (Copeland et al., 2013; Green et al., 2012; Newburn & Alberini, 2016).

Recommendation 1

This study showed that cost concerns are a principle factor behind residents' reluctance to install GSI on their properties. To address these concerns, researchers and municipalities should calculate and publish the costs for the installation of different kinds of GSI and should highlight inexpensive forms of GSI. In addition, municipalities should promote knowledge of the residential costs savings from using captured rainwater for gardening and of public costs savings from decreasing strains on the conventional stormwater management system.

To address GSI cost concerns, municipalities should provide incentives and funding such as rebates, tax rebates and other financial benefits. Municipalities like Kitchener, Ontario, and Waterloo, Ontario, encourage residential stormwater management by providing rebates and stormwater credits where residents obtain financial incentives for installing GSI features. However, an important factor is the amount of the financial incentives. Given the substantial capital cost of some GSI features and the cost aversion of residents, financial incentives have to be large enough to offset a considerable portion of the GSI instalment costs.

Furthermore, municipalities should explore options for assembling stormwater cooperatives to fund community-scale GSI. For example, the Seattle Neighborhoods Actively Prepare (SNAP) Program helps groups of neighbours agree to cooperate following a major disaster. Some communities in this program have detailed plans and responsibilities assigned to specific community members, while others are less formal (City of Seattle, n.d.). Other municipalities could follow this example and create programs that engage residents and fund GSI installation by collecting and investing marginal contributions from residents into a large fund to implement GSI. Such cooperatives would fund GSI, organize implementation and ensure adequate and expansive implementation across the community. An organized body to implement GSI like a cooperative might increase residents' motivation to participate because they would be assured

mass-scale installation throughout their neighbourhood instead of individual, marginal efforts that can come with high personal costs.

5.1.2. Education did not spark residents' desire to install GSI on their own property

The current study showed that education was mostly ineffective at increasing intentions to install GSI on residents' properties. However, upon receiving education, participants did have positive views of certain GSI features, which was demonstrated by increased intentions to install a rain garden or infiltration gallery. During the design charrette's design activity, participants also readily placed GSI features throughout the community and in demonstration sites. The occurrence of increased positive views of certain GSI features among participants corresponds with Brown et al.'s (2016) findings that residents had positive views of GSI features.

However, other studies have differed from the current findings. Education has been shown to influence participants' engagement and installation of GSI (Wright et al., 2009; Green et al., 2012; Mayer et al., 2012; Meder & Kouma, 2010). Education has also been shown to increase participation levels and interest in both engagement with outreach activities and GSI installation (Green et al., 2012; Wright et al., 2009; Mayer et al., 2012; Meder & Kouma, 2010). However, in these cases increases in GSI installation commonly were accompanied by financial incentives and other forms of benefits. As before, these finding emphasize that financial incentives can serve as a facilitator of GSI installation. This is because financial incentives offset the costs from GSI installation and maintenance borne by residents who incur personal costs when adding GSI features on their property.

Recommendation 2

Municipalities should educate the public about the personal benefits that homeowners can obtain from both GSI and non-GSI property level stormwater management. Previous studies have shown that residents are motivated to install GSI features for personal benefits, like watering their gardens, and to make their properties more attractive to purchasers when selling homes.

Planning professionals should inform residents that there are smaller-scale actions and property modifications that can be made to help with stormwater management besides large-scale GSI. This includes actions such as redirecting downspouts to pervious areas, avoiding expanding

hardscapes (e.g., driveway expansions), planting trees and other vegetation, and properly grading their property. The current study showed that residents are more likely to have intentions to perform non-GSI and small-scale GSI stormwater management actions. This is because these methods can be more affordable and can be easier to implement in current property uses, than large-scale GSI.

5.1.3. Government has a greater level responsibility and needs to show leadership on GSI

Another key finding of the current study was related to residents' view that the government has a greater level of responsibility for GSI than private residents, and that government needs to show leadership on GSI. This is because residents feel stormwater management is a community-scale issue and because whole streets have experienced flooding or excess stormwater flow in the study neighbourhood. This finding is confirmed by the literature. For example, Keeley et al. (2013) in their study of GSI in Cleveland and Milwaukee found that residents thought stormwater management was mainly the responsibility of the municipality. In contrast, Thistlewaite et al. (2018) found that residents partially accept stormwater management as their responsibility, as home flooding is a personal issue.

Recommendation 3

Municipal governments need to be more proactive when engaging the public in GSI initiatives. This includes showing leadership by implementing GSI in key community amenities and features (e.g., parks, community centres and schools), before asking residents to install GSI on their own properties. This would be an opportunity for municipalities to provide exposure, education and knowledge on GSI to residents and to demonstrate how GSI works, offsetting some residents' concerns about GSI functionality. This would also build residents' trust in the government and heighten residents' perception that the government cares about stormwater management in the community. Residential support and trust would also be heightened, as residents might feel that the government has made an effort to handle stormwater management in the community instead of acting passively, or downloading responsibilities to residents.

In addition, municipalities should organize programs to mobilize GSI action among residents. This would build off the momentum created by education and public engagement efforts and

ensure that support and enthusiasm for GSI is maintained. Efforts should be made to use local environmental organizations to organize these efforts and overcome the mistrust that may exist between residents and municipal government.

Furthermore, municipalities should explore public-private partnerships for stormwater management. Partnering with the private sector to organize and implement GSI could serve as an important means of delivering GSI in new residential developments and on existing properties in the community. This is especially important as a means of funding GSI as homeowners may benefit from the financial savings offered by residential stormwater management.

Lastly, planning practitioners should explore utilizing the *Drainage Act, R.S.O. 1990*, c. D.17 (Ontario) implement GSI in communities in Ontario. The Drainage Act is a provincial statute that provides a mechanism for building and maintaining community drainages features on private and public property, including on streets. The Drainage Act allows communal drainage projects on public and private property, which can be inclusive of GSI. The Credit Valley Conservation Authority has published a number of reports addressing use of this act to perform stormwater management with GSI (Credit Valley Conservation Authority, 2017).

5.1.4. Residents value current landscaping and uses

Participants in the current study greatly valued their yard, garden and landscaping uses and did not want to modify them or their layout. This result corresponds with Brown et al. (2016), who found that negative views of rain gardens were related to the reduced garden space and household disruption during installation. Participants in the current study community expressed similar concerns over limited space and loss of ability to perform other gardening and recreational activities on their properties. The literature indicates that space, time, improper property layout, as well as other social and environmental factors are commonly occurring limitations to GSI installation (Blake, 1999; Brown et al., 2016); behaviour (Myers & Macnaghten, 1998; Lorenzi & Pidgeon, 2006; Dietz, Dan, & Schwom, 2007; Karvonen 2011).

However, the current study also parallels Brown et al. (2016) in so far as residents were interested in installing infiltration galleries and decorative trees. After the education treatments, study participants indicated that they were likelier to install infiltration galleries. They were also interested in performing other means of small-scale GSI and non-GSI stormwater management

such as planting more trees and other vegetation on their properties. In addition, participants who indicated they would not alter their property now to install GSI suggested that they might do so if they relocated to a new property. Similarly, Brown et al. (2016) found that participants thought GSI might improve the attractiveness of their property, which might increase its value when selling the property. Nevertheless, other participants in the Brown et al. (2016) study were deterred from implementing GSI by the required investments in time and money.

Recommendation 4

By and large, residents value their current landscape features and are not willing to modify them for GSI installation. To address the issues associated with retroactive GSI implementation, GSI should be mandated in new developments. This sentiment was expressed by several participants in the current study. GSI installation when new residential developments are built would be easier and less costly than retroactive installation on already existing and landscaped properties. This proactive GSI installation in new developments would also be easier politically to mandate than embarking on activities to fund GSI and convince property owners to install GSI retroactively after a residential development has been constructed. Having GSI installed in new developments would improve stormwater functionality and ecosystem services and would serve to educate residents en-masse about GSI and stormwater management. In addition, it might also provide educational opportunities for non-residents when visiting these neighbourhoods. Municipalities such as Mississauga, Ontario, have included GSI in new residential developments and redevelopments such as in the Lakeview neighbourhood.

Regulations for installing GSI in residential developments cannot be inserted into the building code by municipalities, as the building code is provincial jurisdiction. However, to facilitate installation of GSI in new developments, municipalities might consider adding GSI to guidelines for new residential developments. This might encourage developers to incorporate GSI proactively into residential properties during the construction of new developments.

5.1.5. Desire for more stormwater and GSI education

Participants' desire for more GSI education was another key theme that emerged from the current study, which is consistent with literature findings. The study by Wright et al. (2009) has demonstrated that residents who observed rain garden demonstration sites showed an increased willingness for rain garden installation on their own properties. This finding by Wright et al. (2009) coincides with the current study as many design charrette participants felt demonstration sites in the community would be useful for building residents' support for GSI. Other studies have also shown that displaying GSI installations in the community, circulating communications on GSI and stormwater management, as well as publicity on GSI projects increased interest and involvement in GSI projects among residents (Brown et al., 2016; Mayer et al., 2012; Meder & Kouma, 2010).

Recommendation 5

Municipalities should update flood zone mapping, map flooding risks and inform residents of their flooding risks. This information should be used by municipal land-use planners to classify and prioritize risk and stormwater management interventions to better mitigate against flooding risks and stormwater management issues. In addition, municipal planners should inform residents of their flood risk levels. This information should be paired with better education on home insurance and urban floods, which hopefully will help to mobilize residential adoption of GSI and non-GSI lot-level stormwater management actions. Finally and as recommended previously, education would be useful on GSI and non-GSI options for stormwater management and associated cost factors, enabling residents to choose the stormwater management actions that seem right for them.

5.1.6. Research needs

Additional studies that examine stormwater management will be important given the changing weather patterns and dynamics caused by climate change. It is critical to create awareness of urban stormwater management and build community resilience. GSI also serves as a climate change mitigation and adaptation measure, in addition to its use for stormwater management. These aspects of GSI will become increasingly urgent in the wake of climate change, as extreme weather events will overwhelm conventional stormwater management infrastructure.

There are a number of areas that future research should focus on. Studies should be directed at researching flood risk mapping in combination with neighbourhood stormwater management to make residents aware of their level of flooding risk. Mapping flood risk can serve as an important means of educating the public about urban flooding and stormwater management, which is a topic that is frequently overlooked by residents. The literature and the current research highlighted that residents largely underestimate their level of flood risk. Sharing this information may serve as an important means for spurring action on residential stormwater management. In this context, studies should investigate the effects of flood mapping as a means of educating the public and promoting engagement in neighbourhood stormwater management initiatives.

Furthermore, because of the community-level costs involved in residential GSI installation, municipalities must investigate non-financial incentives to garner residents' participation in GSI installation. Studies have shown that financial incentives are very beneficial for garnering participation in GSI implementation projects among neighbourhood residents. However, additional studies are needed that investigate other ways of encouraging residents to install GSI beyond financial incentives. This is important because municipalities, and other organizations, have limited financial funds to offer support to install GSI at a community-scale. In this context, studies should examine the values residents hold, which motivate their participation in stormwater management initiatives. Such studies should examine which values motivate residents to install GSI and what can be done to overcome the barriers that limit residents' adoption of GSI and engaging in stormwater management.

In addition, studies should investigate more closely the personal and individual property-scale benefits of GSI, and means of financial cost mitigation for GSI installation. This is especially important for fostering GSI installation among property owners who are not yet personally affected by urban flooding. Urban flooding is a community-level problem and the benefits of installing GSI for urban flood mitigation will be greatest if large numbers of residents participate, including those that have not yet been affected by flooding.

Moreover, studies should explore programs that promote the implementation of inexpensive and small-scale forms of GSI and non-GSI options for property level stormwater management. Residents are hesitant to install large-scale GSI due to cost concerns as well as because of space

and other landscape limitations on their properties. However, participants indicated that they were willing to perform other initiatives to handle stormwater management on their property.

6.0 Conclusions

The current study investigated the impact that educational treatments had on residents' attitudes, views, values and actions towards GSI in Cambridge, Ontario, following an urban flood event in August 2016. This study was the first of its kind in Canada to examine the effect of a design charrette, in addition to the effect of an educational brochure, on influencing the norms and actions of residential actors.

A number of key themes have emerged from this research that are relevant for practitioners and researchers of stormwater management and public engagement. One important theme was the need to find more effective ways to engage the public in installation of residential GSI. Urban areas need comprehensive GSI implementation as soon as possible. But this requires engagement in stormwater management at all levels: private residents, developers, and the government. Integrating GSI into new residential developments is easier than retroactively implementing GSI after neighbourhoods are built out. Within existing communities there is a need to engage members of the community and build off momentum and support generated by community demonstration sites. There also is a need to translate this support into individual actions by homeowners and community-scale solutions.

The analysis indicated that the design charrette activity and the educational brochures were largely ineffective at changing participants' attitudinal and behavioural intentions toward GSI. Evidence for this assessment included the statistically insignificant findings in the quantitative data and recurring themes emerging from the qualitative data. Participants' lack of enthusiasm for installing GSI was driven by their attachments to their properties' current uses and landscaping, as well as concerns about GSI costs. Participants also felt that the municipal government should be responsible for GSI implementation and overall stormwater management. If residents are expected to implement property-scale GSI modifications, the government should further assist by providing guidance and substantial financial assistance to facilitate implementation. Since the effects of the educational treatments were marginal, it will be important for future studies to continue researching effective means of public education to increase residents'' engagement in lot-level stormwater management and GSI installation.

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Appendix A Site Visit Checklist

REEP Home Visit-Site Visit Checklist/Questions

Setting

- Residence Type
  - Dethatched □ Semi-detached □ Other_____
- Homeowner name_____
- Location (neighbourhood, address)
  - _____
    _____
    _____

Paved Area

Permeability

- Priority for Action □
- Needs Consideration □
- Best Practices □

Slope

- Priority for Action □
- Needs Consideration □
- Best Practices □

Notes

_____

_____

_____

_____

_____

Eaves and Downspout

Rain Barrels

- Priority for Action □
- Needs Consideration □
- Best Practices □

Cistern

- Priority for Action □
- Needs Consideration □
- Best Practices □

Notes

_____

_____

_____

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_____

Drainage and Infiltration

Permeable Surface

- Priority for Action □
- Needs Consideration □
- Best Practices □

Plantings (Rain Gardens)

- Priority for Action □
- Needs Consideration □
- Best Practices □

Notes

_____

_____

Other GSI BMPs

- Type(s)
  - _____

    _____

Type of GSI Interested in Installing/ Have Installed

- Permeable Pavement
  - Yes □ No □ Already installed □
- Water Harvesting (Rain Barrels/Cisterns)
  - Yes □ No □ Already installed □
- Rain Garden/ Bio/Grass Swales
  - Yes □ No □ Already installed □
- Infiltration Trench Pit/Soakaway Pit
  - Yes □ No □ Already installed □
- French Drain/Weeping Tile
  - Yes □ No □ Already installed □
- Other GSI interested in(e.g. stormwater management pond/wetland)
  (Please List & explain)

  _____

  _____

General Questions on GSI & education & behaviours/perceptions

Motivations & Facilitators of GSI Implementation

- To handle Stormwater management on my property
  - Yes □ No □
- To handle Stormwater management for the neighbourhood?
  - Yes □ No □
- Saves time/effort on property maintenance
  - Yes □ No □
- Beautify my property and/or the neighbourhood
  - Yes □ No □
- Collect water for gardening/watering plants (rain barrels)
  - Yes □ No □
- Wildlife(to attract birds, bees, butterflies, showy insects)
  - Yes □ No □
- Recreation/Relaxation
  - Yes □ No □
- Heightened property value (with landscaping feature that has more greenspace)
  - Yes □ No □

- Having knowledge on GSI
  - Yes □ No □
- Resources
  - Being able to cover the costs of GSI
    - Yes □ No □
  - Having the skills to install GSI
    - *Yes* □ *No* □
- Can make use of financial Incentives(e.g. SW Credit Program, Insurance)
  - Yes □ No □
- Other (Please explain)

  _____

  _____

Barriers to GSI Implementation

- Feel it is too high a cost
  - Yes □ No □
- Maintenance requirements
  - Yes □ No □
- Lacking ability to do it
  - Skills Yes □ No □
  - Sufficient Space Yes □ No □
  - Limitations (related to property [design, etc.]) Yes □ No □
  - Lack of Awareness/knowledge Yes □ No □
- Not feeling responsible for urban stormwater management in the neighbourhood (feel it is someone else's responsibility)
  - Yes □ No □
    - *If Yes*- explain whose

      _____

      _____

      _____
- Safety concerns
  - Yes □ No □
  - If Yes,
    Explain:_____

    _____

    _____

    _____

    _____

    _____

- Other barriers (Please explain)

  _____

  _____

  _____

Experienced extreme weather

Experienced flooding, ponding, extreme weather or other stormwater issues on property

- Yes □ No □
- Type(s) experienced

  _____

  _____

Type_____

- Not on current property
  - Yes □ No □
- On current property
  - Yes □ No □
- Where occurred on current property

_____

_____

_____

- Experienced damage to property (home/personal possessions)
  - Yes □ No □

Type_____

- Not on current property
  - Yes □ No □
- On current property
  - Yes □ No □
- Where occurred on current property

_____

_____

_____

- Experienced damage to property (home/personal possessions)
    - Yes □ No □

Type_____

- Not on current property
    - Yes □ No □
- On current property
    - Yes □ No □
- Where occurred on current property

_____

_____

_____

- Experienced damage to property (home/personal possessions)
    - Yes □ No □

- *If installed GSI*- When did you install these GSI/stormwater management features (before experienced flooding-proactive, or after –reactive)?
    - Proactively
        - Yes □ No □
    - Reactively
        - Yes □ No □
- Photos, videos, documents, journals, etc. of extreme weather willing to share
    - Yes □
    - No □

Notes

Appendix B Pre Charrette Survey

Green Stormwater Infrastructure (GSI) Questionnaire

reep Green Solutions

RAIN

CAMBRIDGE CANADA PEOPLE • PLACE • PROSPERITY

PARTNERS FOR ACTION

Green Communities CANADA

Green Stormwater Infrastructure Questionnaire

Thank you for taking the time to fill out this questionnaire. All answers will be kept confidential and will help us understand what factors help or hinder residents in the implementation of Green Stormwater Infrastructure (GSI) on private properties.

Please fill out all questions to the best of your ability. Some questions may look similar to others but they are all important for helping us understand your views and actions regarding GSI. Throughout the questionnaire, the term **Green Stormwater Infrastructure (GSI)** is used to encompass all installation options, **including, but not limited to, rain barrels, cisterns, rain gardens, infiltration galleries /soakaway pits, and permeable paving.** These can each be used alone, or in combination, **to help collect, store and absorb stormwater.** Some questions are about specific GSI, which will be indicated within the question.

Most questions will be answered using a six-point scale ranging from strongly disagree to strongly agree. Please choose the answer that you believe is the most appropriate response for each of the questions. There is space at the end of the questionnaire for you to provide more details, if needed.

A personal information section follows at the end of the questionnaire. It does not ask for any information that would allow you, as a participant, to be individually identifiable. Please fill out any information you are willing to provide. This information is important for helping us understand individual factors that affect your views and actions around GSI. All information collected will be kept confidential and will only be shared with those in the research team.

Thank you very much for your time.

Any questions can be directed to Danielle Coore through the following email: dcoore@reepgreen.ca

Picture Dictionary

GSI Method	Picture	Description
Rain Barrel		Barrels that can collect and store rainwater from eavestroughs or downspouts.
Cistern		Similar to a rain barrel, cisterns collect and store rain water and runoff), but they store larger amounts of water (350-5200 liters). They can be above or below ground.
Rain Garden		Gardens that have been dug deep enough to collect and store significant amounts of rainwater and runoff.
Infiltration Trench/Gallery or Soakaway Pit		A basin built that collects water and allows it to absorb deep into the ground.
Permeable Pavement/Permeable Paver		A special type of paving that allows water to absorb into the ground. They also have a stone reservoir underneath that can collect rainwater or runoff.

Images (excluding rain barrels) Sourced from: City of Kitchener (n.d.). Managing Stormwater for your Home. Accessed June 19, 2017 from: https://www.kitchener.ca/en/livinginkitchener/Managing_Stormwater_for_your_Home.asp#Rain Barrels

Rain Barrels Image Sourced From: City of Kitchener (n.d.). About the Residential Credit Application. Accessed June 19, 2017 from:

https://www.kitchener.ca/en/livinginkitchener/Stormwater_Credit_Application_Residential.asp;

*Shaded boxes are questions where the "Do Not Know" response is not applicable. Please select from the other qualifying responses (the unshaded boxes).

Knowledge & Education	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
I have been formally educated on the functions and benefits of GSI in the past (i.e. through courses at an educational institution or through career-based education). *see Picture Dictionary for photos	1	2	3	4	5	
1. I have been informally educated on the functions and benefits of GSI in the past (i.e. through marketing material such as pamphlets or for personal interest).	1	2	3	4	5	

GSI Effectiveness	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I believe that if I installed a GSI method on my property, it would lower the chance of my basement being flooded.	1	2	3	4	5	
2. I believe that installing GSI on my property would not reduce the amount of polluted runoff going into local streams and rivers.	1	2	3	4	5	
3. I believe that GSI at the property level does not at all help protecting the quality of local drinking water.	1	2	3	4	5	

GSI Personal Effectiveness	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I think that installing stormwater GSI on my property would be a waste of time and money.	1	2	3	4	5	
2. I think that my basement is at risk of flooding in the next five years. *Not Applicable □	1	2	3	4	5	
3. I believe installing a rain garden would be very unpleasant.	1	2	3	4	5	
4. I would take pride in a rain garden and would maintain it to maximize water absorption.	1	2	3	4	5	
5. I believe that GSI on my property would benefit my own property and my neighbourhood.	1	2	3	4	5	

GSI Responsibility	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I have a responsibility to help the city manage stormwater, on my property, through the installation of GSI such as rain gardens or rain barrels.	1	2	3	4	5	
2. I will not be installing any GSI on my property because I am not interested in changing my property.	1	2	3	4	5	
3. I feel an obligation towards preserving the features that help manage rain in my neighbourhood.	1	2	3	4	5	
4. I believe that the municipal government should be solely responsible for stormwater management and I should not have to install any GSI on my property.	1	2	3	4	5	

5. Please describe what you feel your neighbours' responsibility towards GSI should be.

6. If or when a new development was to occur in your neighbourhood, how should responsibility towards handling stormwater in the community be distributed (among existing residents, new residents, government, etc.)?

GSI Capability	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I am able to spend the money required to install and maintain GSI on my property.	1	2	3	4	5	
2. I am able to spend the time required to install and maintain GSI on my property.	1	2	3	4	5	
3. I do not have the time to care for a rain garden on my property.	1	2	3	4	5	
4. I do not have enough space in my yard for any type of GSI.	1	2	3	4	5	

GSI Installation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I am likely to install a rain garden on my property. *see Picture Dictionary for photo	1	2	3	4	5	
2. I am likely to install a rain barrel on my property. *see Picture Dictionary for photo	1	2	3	4	5	
3. I am likely to install an infiltration gallery on my property. *see Picture Dictionary for photo	1	2	3	4	5	
4. I am likely to install permeable paving on my property. *see Picture Dictionary for photo	1	2	3	4	5	

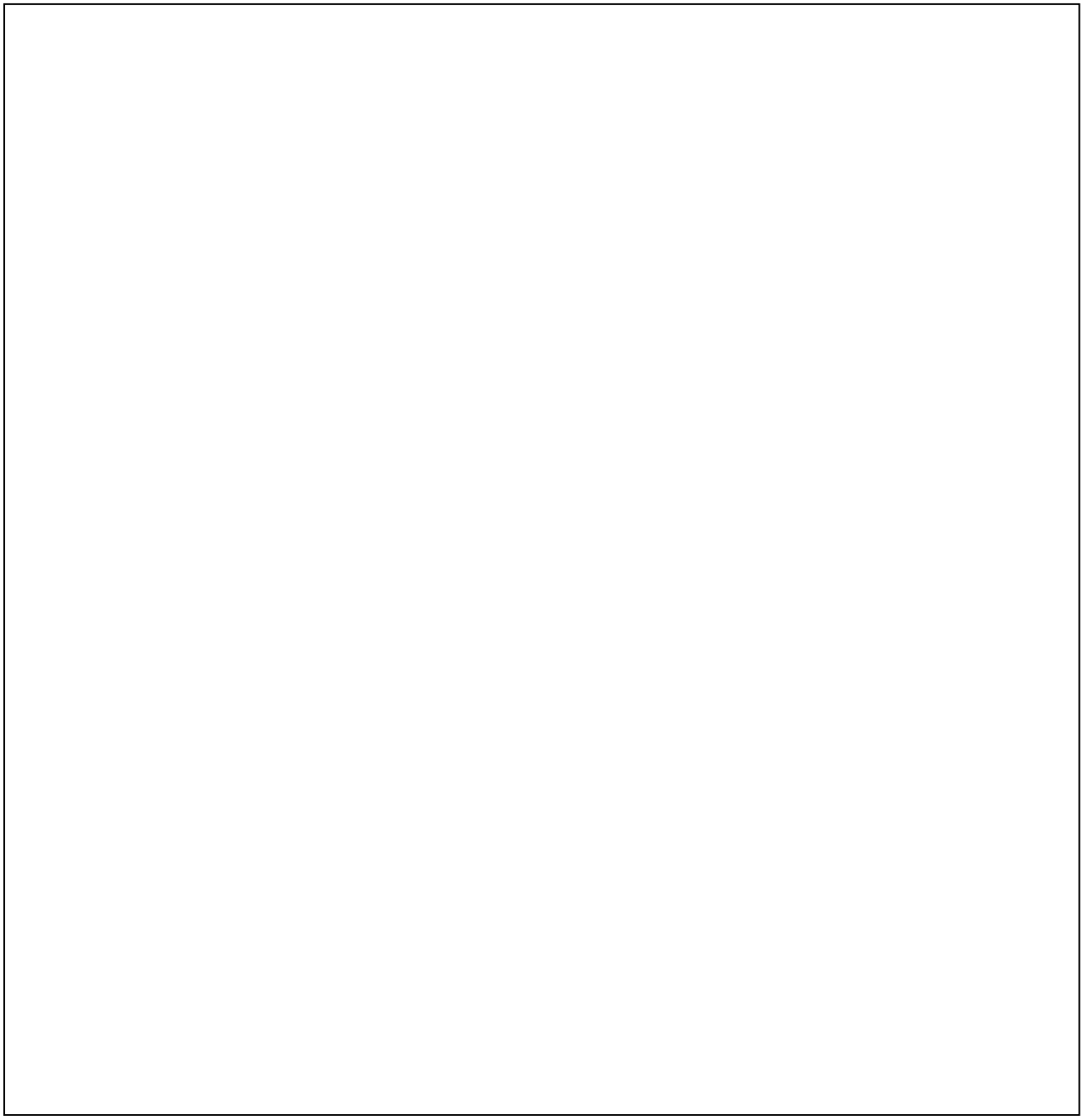
Intentions Regarding GSI	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I am planning to install a GSI option on my property within the next year.	1	2	3	4	5	
2. I am willing to make an effort to manage my property so that it positively affects nearby water bodies.	1	2	3	4	5	
3. I intend to control stormwater on my property rather than allowing it to flow into storm drains.	1	2	3	4	5	
4. If a local workshop about GSI was to be held in my neighbourhood, I would try to attend it.	1	2	3	4	5	

Taking Action on GSI	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I have already installed/started installing some GSI on my property, such as a rain barrel or rain garden. *see Picture Dictionary for photo	1	2	3	4	5	
2. I have changed the landscape on my property to prevent runoff to the street.	1	2	3	4	5	

Charrettes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	**Do Not Know**
1. I am familiar with the idea of neighbourhood spaces design workshop/landscape design workshop (where planners and residents work together to design how GSI could work to benefit the neighbourhood).	1	2	3	4	5	

I have attended and/or participated in a neighbourhood spaces design workshop/landscape design workshop ('Revisioning' workshop) before. (Please check Yes or No)
____ Yes
____ No

Do you have any comments or ideas on how to improve a neighbourhood spaces design workshop/landscape design workshop ('Revisioning' Workshop)? If yes, please write them in the box below.



Demographics

1. Gender
    A) Male
    B) Female
    C) Other
2. Age Group
    - 18-25
    - 26-30
    - 31-35
    - 36-40
    - 41-45
    - 46-50
    - 51-54
    - 55-59
    - 60-64
    - 65+
3. Educational Background
    A) No diplomas
    B) High school diploma
    C) College diploma
    D) Undergraduate degree
    E) Graduate degree
    F) PhD
    G) Other

If you have chosen ‘other’, please describe:

4. Household Income

    A) Less than $19,999

    B) $20,000 - $39,999

    C) $40,000 - $59,999

    D) $60,000 - $79,999

    E) $80,000 - $99,999

    F) $100,000 - $119,999

    G) $120,000 - $139,999

    H) $140,000 - $159,999

    I) $160,000 - $180,000

    J) More than $180,000

5. Length of time at current residence

    A) Less than a year

    B) 1-5 years

    C) 6-10 years

    D) 11-15 years

    E) 16-20 years

    F) More than 20 years

6. Do you own or rent your current residence?

    A) Own

    B) Rent

    C) Other

If you have chosen ‘other’, please describe:

_____

7. Dwelling Type

a. Single detached house

b. Semi-detached house

c. Other (Please List) _____

8. Have you ever experienced home flooding before? (Please check Yes or No)

____ Yes ____ No

a. If yes, please describe below in more detail.

9. Have you ever experienced any type of extreme weather (heavy rainstorms, drought, and severe amounts of snow, ice storm, tornado, hurricanes etc.) at your residence)? (Please check Yes or No)

____ Yes ____ No

a. If yes, please describe below in more detail.

10. Have you been impacted by extreme weather (property loss/damage to your home, injury, loss/damage to personal belongings, injury)? (Please check Yes or No)

____ Yes ____ No

a. If yes, please describe below in more detail.

11. Do you have any additional comments, thoughts or feelings that you would like to share with us? If yes, please describe below.

Dear Resident,

I would like to thank you very much for your participation in this Green Stormwater Infrastructure (GSI) Questionnaire. As a reminder, the purpose of this research is to understand the factors that shape residents' views and actions regarding GSI. We are very interested in learning what the opportunities and possible barriers are that residents experience when deciding whether or not to install GSI.

This information is very useful for helping us understand engagement activities surrounding managing stormwater in the community.

We have not collected any information that could identify you personally and please be ensured that all collected data will be kept strictly confidential. Once all the data for this project are collected and analyzed, I plan to share summarized information with partners involved in this study in the form of a report and presentation as well as for academic publications. Anonymity will be assured in any publications, as your personal information will not be shared with anyone outside of the research project. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please contact me through email. In the meantime, if you have any questions about the study, please do not hesitate to contact me.

Danielle Coore

RAIN Communications Research Intern

REEP Green Solutions

dcoore@reepgreen.ca

reep Green Solutions

RAIN

CAMBRIDGE CANADA PEOPLE • PLACE • PROSPERITY

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Appendix C Post Charrette Survey

Green Stormwater Engagement- PostEvent Questionnaire

Mail Box Pick Up:

_____

Code:

_____

*Please do notthrow away-see instruction s for what to do if survey not picked up on this date

Reep Green Solutions

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Green Communities CANADA

Images (excluding permeable pavement, and stormwater systems) Sourced from: City of Kitchener (n.d.). Managing Stormwater for your Home. Accessed September 13th, 2017 from: http://www.kitchener.ca/en/livinginkitchener/Managing_Stormwater_for_your_Home.asp

Permeable Pavement image sourced from: Immanuel Giel September 25th, 2007. Grass Pavement. Accessed September 13th, 2017 from: https://en.wikipedia.org/wiki/Permeable_paving#/media/File:Rasenpflasterstein_1.jpg,

Stormwater System sourced from: City of Waterloo (n.d.). Local Best Practices. Accessed September 13th, 2017 from: http://www.waterloo.ca/en/living/local-best-practices.asp

Note survey based on Stormwater Best Management Practices (BMPs) Questionnaire survey prepared by Sarah Sinasac, University of Waterloo, School of Planning.

Green Stormwater Engagement-Post Event Questionnaire

Thank you again for your participation in the Green Stormwater Infrastructure (GSI) circulated in your neighbourhood this summer.

We are reaching out to you again to understand how your views and actions towards GSI may have been changed since we reached out to you first (The Greening Your Neighbourhood Workshop held Wednesday September 20that Avenue Road Baptist Church, RAIN Home Visits and Stormwater Management Property Guides distributed).

You do not need to have participated in any of the previous engagement activities listed above to be able complete the survey. This questionnaire may seem similar to the first survey, but the questions are important for measuring any changes to your views and actions on **Green Stormwater Infrastructure (GSI)** that may have happened since the occurrence of our engagement activities. By completing this follow-up survey, you will help us understand how residents respond to community engagement activities.

Please fill out all questions to the best of your ability. Some questions may look similar to others but they are all important for helping us understand your views and the choices you are making.

Throughout the questionnaire, the term **Green Stormwater Infrastructure (GSI)** is used to encompass all installation options, **including, but not limited to, rain barrels, cisterns, rain gardens, infiltration galleries /soakaway pits, and permeable paving.** These can each be used alone, or in combination, to **help collect, store and absorb stormwater.** Some questions are about specific GSI, which will be indicated within the question.

Most questions will be answered using a six-point scale ranging from strongly disagree to strongly agree. Please choose the answer that you believe is the most appropriate response for each of the questions.

There is space at the end of the questionnaire for you to provide more details, if needed.

A personal information section follows at the end of the questionnaire. It does not ask for any information that would allow you, as a participant, to be individually identifiable. Please fill out any information you are willing to provide. This information is important for helping us understand individual factors that affect your views and actions around GSI. All information collected will be kept confidential and will only be shared with those in the research team.

Thank you very much for your time.

Any questions can be directed to Danielle Coore through the following email: dcoore@reepgreen.ca or by calling (519)-744-6583 ext. 239.

Picture Dictionary

GSI Method	Picture	Description
Rain Barrel		Barrels that can collect and store rainwater from eavestroughs or downspouts.
Cistern		Similar to a rain barrel, cisterns collect and store rain water and runoff), but they store larger amounts of water (350-5200 litres). They can be above or below ground.
Rain Garden		Gardens that have been dug deep enough to collect and store significant amounts of rainwater and runoff.
Infiltrati on Trench/ Gallery or Soakaway Pit		A basin built that collects water and allows it to absorb deep into the ground.
Permeable Pavement/Permeable Paver		A special type of paving that allows water to absorb into the ground. They also have a stone reservoir underneath that can collect rainwater or runoff.

Images (excluding rain barrels) Sourced from: City of Kitchener (n.d.). Managing Stormwater for your Home. Accessed June 19, 2017 from: https://www.kitchener.ca/en/livinginkitchener/Managing_Stormwater_for_your_Home.asp#Rain Barrels

Rain Barrels Image Sourced From: City of Kitchener (n.d.). About the Residential Credit Application. Accessed June 19, 2017 from: https://www.kitchener.ca/en/livinginkitchener/Stormwater_Credit_Application_Residential.asp;

Knowledge & Education	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I have been formally educated on the functions and benefits of GSI* in the past (i.e. through courses at an educational institution or through career-based education).	1	2	3	4	5
2. I have been informally educated on the functions and benefits of GSI in the past (i.e. through marketing material such as pamphlets or for personal interest).	1	2	3	4	5

*see Picture Dictionary for photos

GSI Effectiveness	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I believe that if I installed a GSI method on my property, it would lower the chance of my basement being flooded.	1	2	3	4	5
2. I believe that installing GSI on my property would not reduce the amount of polluted runoff going into local streams and rivers.	1	2	3	4	5
3. I believe that GSI at the property level does not at all help protecting the quality of local drinking water.	1	2	3	4	5

GSI Personal Effectiveness	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that installing stormwater GSI on my property would be a waste of time and money.	1	2	3	4	5
1. I think that my basement is at risk of flooding in the next five years. *Not Applicable □	1	2	3	4	5
2. I believe installing a rain garden*would be very unpleasant.	1	2	3	4	5
3. I would take pride in a rain garden* and would maintain it to maximize water absorption.	1	2	3	4	5
4. I believe that GSI on my property would benefit my own property and my neighbourhood.	1	2	3	4	5

*See picture dictionary for photo

GSI Responsibility	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I have a responsibility to help the city manage stormwater, on my property, through the installation of GSI such as rain gardens or rain barrels*.	1	2	3	4	5
2. I will not be installing any GSI on my property because I am not interested in changing my property.	1	2	3	4	5
3. I feel an obligation towards preserving the features that help manage rain in my neighbourhood.	1	2	3	4	5
4. I believe that the municipal government should be solely responsible for stormwater management and I should not have to install any GSI on my property.	1	2	3	4	5

*See picture dictionary for photo

5. Please describe what you feel your neighbours' responsibility towards GSI should be.

6. If or when a new development was to occur in your neighbourhood, how should responsibility towards handling stormwater in the community be distributed (among existing residents, new residents, government, etc.)?

GSI Capability	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am able to spend the money required to install and maintain GSI on my property.	1	2	3	4	5
2. I am able to spend the time required to install and maintain GSI on my property.	1	2	3	4	5
3. I do not have the time to care for a rain garden on my property.	1	2	3	4	5
4. I do not have enough space in my yard for any type of GSI.	1	2	3	4	5

GSI Installation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am likely to install a rain garden* on my property.	1	2	3	4	5
2. I am likely to install a rain barrel* on my property.	1	2	3	4	5
3. I am likely to install an infiltration gallery* on my property.	1	2	3	4	5
4. I am likely to install permeable paving* on my property.	1	2	3	4	5

*see picture dictionary for photo

Intentions Regarding GSI	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am planning to install a GSI option on my property within the next year.	1	2	3	4	5
2. I am willing to make an effort to manage my property so that it positively affects nearby water bodies.	1	2	3	4	5
3. I intend to control stormwater on my property rather than allowing it to flow into storm drains.	1	2	3	4	5
4. If a local workshop about GSI was to be held in my neighbourhood, I would try to attend it.	1	2	3	4	5

Taking Action on GSI	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I have already installed/started installing some GSI on my property, such as a rain barrel* or rain garden*.	1	2	3	4	5
2. I have changed the landscape on my property to prevent runoff to the street.	1	2	3	4	5

*see Picture Dictionary for photo

Charrettes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I am familiar with the idea of neighbourhood spaces design workshop/landscape design workshop*.	1	2	3	4	5

*A workshop where planners and residents work together to solve problems and come up with new visions like designing how GSI could work to benefit the neighbourhood.

Complete if you received the Your Guide to A RAIN Smart Home Brochure, attending the Greening Your Neighbourhood Workshop or had a RAIN Home Visit.

Education	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Educational material on GSI* helped me learn more about GSI and understand its benefits.	1	2	3	4	5
2. Educational material/activities on GSI* made it easier for me to understand how to install GSI on my property.	1	2	3	4	5
3. Educational material/activities on GSI* made me feel a greater sense of responsibility to make the effort to manage stormwater on my property.	1	2	3	4	5

*Educational material/activities on GSI (e.g. stormwater management improvement guides, attending workshops, a RAIN Home Visit)

I attended the Cambridge *Greening Your Neighbourhood Workshop (held September 20th*, 2017*)*. (Please Check Yes if you attended or no if you did not attend the workshop).

Yes □ No□

Complete if attended the Greening Your Neighbourhood Workshop

Greening Your Neighbourhood Workshop	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Neighbourhood landscape design workshops are beneficial and /or useful for creating engagement with residents for taking action in their neighbourhood to address stormwater issues.	1	2	3	4	5
2. Neighbourhood landscape design workshops are beneficial and/or useful for problem solving.	1	2	3	4	5
3. Attending the *Greening Your Neighbourhood Workshop* improved my understanding of GSI.	1	2	3	4	5
4. The *Greening Your Neighbourhood Workshop*, helped me understand different ways implement GSI.	1	2	3	4	5

5. After attending the *Greening Your Neighbourhood Workshop*, I feel it is important install GSI in the neighborhood.	1	2	3	4	5
6. After attending the *Greening Your Neighbourhood Workshop* I can identify opportunities for installing GSI in my neighbourhood.	1	2	3	4	5
7. The workshop improved my understanding of GSI (what it is, uses, benefits).	1	2	3	4	5

Workshop Activities	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Identifying areas of opportunity, issue areas and areas of concern helped me feel empowered to tackle stormwater management (as I can identify potential areas and to implement GSI to address stormwater management in my neighbourhood).	1	2	3	4	5
2. The Opportunities for GSI (workshop card) exercise helped me identify places in the neighbourhood to install GSI.	1	2	3	4	5
3. The timeline feasibility activity helped me feel it is possible to address stormwater management with GSI in the community.	1	2	3	4	5

4. Activities at the workshop increased my feeling of responsibility for implementing GSI.	1	2	3	4	5
5. Activities at the workshop impacted my views towards supporting GSI installation.	1	2	3	4	5

RAIN Home Visits	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I have heard about Reep RAIN Home Visits before.	1	2	3	4	5
2. I know what a Reep RAIN Home Visit is.	1	2	3	4	5
3. Reep RAIN Home Visits are useful for learning how to improve stormwater health on residential properties.	1	2	3	4	5

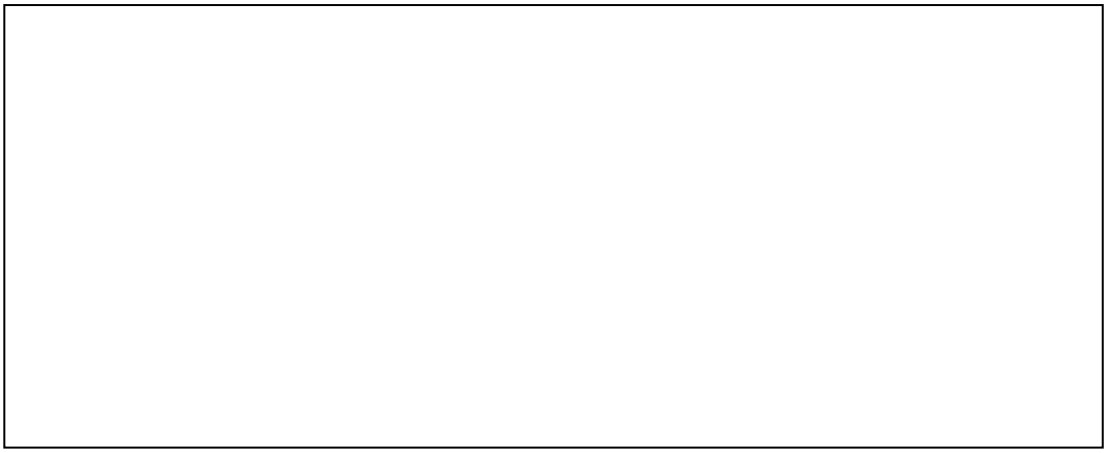
I have had a REEP RAIN Home Visit on my property before.

Yes □ No □

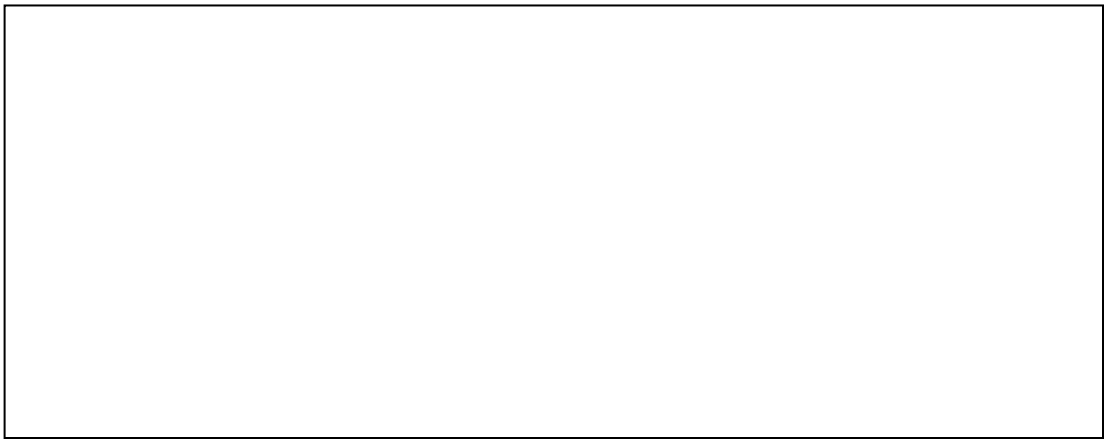
Answer if you had a Reep Green Solutions RAIN Home Visit on your property.

RAIN Home Visits	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The RAIN Home Visit helped me learn about GSI and understand its benefits.	1	2	3	4	5
2. The RAIN Home Visit made it easier for me to install GSI.	1	2	3	4	5
3. The RAIN Home Visit helped me learn about ways I could improve stormwater management on my property.	1	2	3	4	5
4. The RAIN Home Visit influenced my decision to take action to change my property to improve stormwater management.	1	2	3	4	5
5. After receiving a RAIN home Visit, I decided to change my property to address stormwater management.	1	2	3	4	5

Could you tell us more about how the RAIN Home Visit affected your intentions (e.g. installing a GSI, re-arranging items or features on your property, changing your activities) towards to improving stormwater management on your property.



Do you have any further comments, thoughts, or ideas on how the RAIN Home Visit may have affected your views or actions on stormwater management? If so, please write them in the box below.



Do you have any additional comments, thoughts or feelings that you would like to share with us? If yes, please write them down below.

Dear Resident,

I would like to thank you for your continued participation with our project and for your participation in this follow up survey, the Green Stormwater Engagement Questionnaire. As a reminder, the purpose of this research is to understand how education and engagement help shape the views and actions that residents' have when deciding whether to install GSI.

This information is very useful for helping us understand engagement activities surrounding managing stormwater in the community.

We have not collected any information that could identify you personally and please be ensured that all collected data will be kept strictly confidential. Once all the data for this project are collected and analyzed, I plan to share summarized information with partners involved in this study in the form of a report and presentation as well as for academic publications. Anonymity is assured in any publications. If you did share your personal information with us, we promise not to share it with anyone outside of the research project. If you are interested in receiving more information regarding the results of this study, or would like a summary of the results, please contact me through email. In the meantime, if you have any questions about the study, please do not hesitate to contact me.

Danielle Coore

RAIN Community Engagement Research Intern REEP Green Solutions

dcoore@reepgreen.ca (519)-744-6583 ext. 239

Appendix D Pre Charrette Interview Script

Pre 'Revisioning Workshop' Interview Questions

Knowledge on GSI

1. Could you please tell me about your knowledge of GSI?
    a. Have you heard of Green Stormwater Infrastructure (GSI) or Low Impact Development (GSI) before?
    b. Do you know what GSI is (definition)?
    c. Do you know what GSI is used for?
        i. Main purpose of using GSI
        ii. Other benefits that are linked to it
    d. Can you name a type of GSI?

Attitudes on GSI

1. Tell me about how you feel about GSI overall? (circle response)
    a. Favourable/ Neutral/ Unfavourable
    b. Do you feel GSI is beneficial or not beneficial?
        i. In General
    c. Do you feel GSI is beneficial for handling stormwater management on your property?
    d. Do you feel GSI is beneficial for handling stormwater management in the community?
        i. Why/Underlying reasons?

2. Have you installed any types of GSI on your property?
    a. Yes□ No□
    b. Why?
        I. Can you tell me more about the underlying reasons behind this?

3. **If No:** If you have not currently installed any type of GSI, would you be willing to install GSI on your property in the future?
    a. Why?
        i. Can you tell me more about the underlying reasons behind this?

    If Yes: Would you be willing to install more if you if you already installed a type of GSI on your property?
    b. Yes □ No □
        i. Why?
            1. Can you tell me more about the underlying reasons behind this?

4. Do you have any concerns about GSI or reasons that you would not install GSI?

5. Tell me about how you feel about installing GSI on your property?

a. Do you feel you have a role in stormwater management for your community, such as installing GSI or other stormwater management initiatives on your property?
b. Overall, I feel that installing GSI on my property is worth it, or that is not worth it?
c. Can you tell me about what motivates you to install GSI on your property?

Expectations of Charrette

1. How are you feeling about the upcoming 'Revisioning' Workshop?
2. Is there anything that you hope to get from attending the 'Revisioning' Workshop?
   a. Learn (gain knowledge) about GSI (what it is, how to do it, benefits for SWM [quality and quantity], environment [climate changes, wildlife etc.], SWM reducing flooding)?
   b. Feel are better prepared with resources for GSI (skills of how to do it, have the ability to do it on property)?
   c. Participate/share ideas/express opinions/views
   d. Develop understanding
   e. Opportunity to collaborate with others
   f. Understanding of stormwater management in the community
3. Do you have any concerns about the upcoming 'Revisioning' Workshop or about GSI?

Experiences with recent extreme weather, possible local flooding, Videos, Material to share on extreme weather

1. Have you ever experienced flooding, ponding, extreme weather or other stormwater issues in the local neighborhood, or on your property?
   a. Yes □ No □

2. What type(s) of extreme weather have you experienced?
   a. When did you experience this?
   b. Not on current property
      - Yes □ No □

   i) On current property
      - Yes □ No

3. Can you tell me more about this experience/these experiences?

4. Have you experienced damage to property (home) or your possessions because of flooding or stormwater issues on your property?
    - Yes □ No □
    a. Could you explain more?

5. Do you have any photos, videos, documents, journals, etc. of extreme weather that you would be willing to share with me?
    - Yes □
    - No □

Notes

Appendix E Post Charrette Interview Script

Post 'Revisioning Workshop' Interview Questions

Knowledge on GSI

1. Could you please tell me about your knowledge of GSI?
    a. Have you heard of Green Stormwater Infrastructure (GSI) or Low Impact Development (GSI) before?
    b. Do you know what GSI is (definition)?
    c. Do you know what GSI is used for?
        i. Main purpose of using GSI
        ii. Other benefits that are linked to it
    d. Can you name a type of GSI?

Attitudes on GSI

1. Tell me about how you feel about GSI overall? (circle responses from participants)
    a. Favourable/ Neutral/ Unfavourable
    b. Do you feel GSI is beneficial or not beneficial?
        i. In General
    c. Do you feel GSI is beneficial for handling stormwater management on your property?
    d. Do you feel GSI is beneficial for handling stormwater management in the community?
        i. Why/Underlying reasons?

2. Did you install any types of GSI on your property before going to the 'Revisioning' Workshop?
    a. Yes□ No□

3. **If No:** If you had not installed any type of GSI before the 'Revisioning' Workshop, would you be willing to install GSI on your property in the future, now that you have attended the 'Revisioning' Workshop?
    a. Why?
        i. Can you tell me more about the underlying reasons behind this?

If Yes: Would you be willing to install more GSI if you if you already installed a type of GSI on your property?
    b. Yes □ No □
        i. Why?
            1. Can you tell me more about the underlying reasons behind this?

4. Do you have any concerns about GSI or reasons that you would not install GSI?

5. Tell me about how you feel about installing GSI on your property?
    a. Do you feel you have a role in stormwater management for your community, such as installing GSI or other stormwater management initiatives on your property or is it someone else's responsibility?
    b. Overall, I feel that installing GSI on my property is worth it, or that is not worth it?
    c. Can you tell me about what motivates you to install GSI on your property?

<u>Experience of 'Revisioning' Workshop</u>

1. How was your experience at the 'Revisioning' Workshop?
    a. Good, bad or neutral (circle response)
2. Is there anything that you feel you gained from attending the 'Revisioning' Workshop?
    a. Learn (gain knowledge) about GSI (what it is, how to do it, benefits for SWM [quality and quantity], environment [climate changes, wildlife etc.], SWM, reducing flooding)
    b. Feel it better prepared me with the resources for GSI (skills of how to do it, have the ability to do it on property)
    c. Participate/share ideas/express opinions/views
    d. Develop understanding
    e. Opportunity to collaborate with others
    f. Understanding of importance of doing stormwater management in the community
    g. Was Effective at promoting participation and getting engagement on project from me and others in my community

3. Do you have there any concerns about the how the 'Revisioning' Workshop went or about GSI?
    a. 'Revisioning' Workshop
        i. Not effective use of time and resources
        ii. Too focused on the professionals, residents in the community were not able to contribute to the session in the same way.

b. GSI

How you think knowledge and attitudes might have changed as affected by 'Revisioning' Workshop

1. After attending the 'Revisioning' Workshop, how do you feel your knowledge about GSI might have changed?
    a. Definition
    b. Types
    c. Main reason why used
    d. Other benefits
    e. Made me more supportive of GSI

2. After attending the workshop, how do you feel your perception towards GSI has changed?
    a. I view GSI as more beneficial for stormwater management on my property than I did before attending the 'Revisioning' Workshop
    b. I view GSI as more beneficial for stormwater management in my neighborhood than I did before attending the 'Revisioning' Workshop
    c. I view GSI as being more useful for the other environmental benefits it has (climate change, wildlife etc.) than I did before attending the 'Revisioning' Workshop
        i. Why/Underlying reasons?

3. Has the 'Revisioning' Workshop affected your support for GSI?
    a. Why/Underlying reasons?

4. After attending the Revisioning Workshop, do you feel you are better prepared to be able to install GSI on your property
    a. Skills to do it
    b. Realize can afford it
    c. Realize I can implement it on my property (design, space wise)

5. How has the ‘Revisioning’ Workshop affected how you feel about your role in contributing to tackling stormwater management in your neighborhood?
    a. Why/Underlying reasons?

6. How has the ‘Revisioning’ Workshop affected the likelihood of you installing GSI on your property in the future?
    a. Made me more supportive of installing GSI on my property
        i. Why/Underlying reasons?

Appendix F Charrette Observation Notes

Participant Observation Checklist (During the 'Revisioning' Workshop)

Table _____

Participants

1. **Residents** Yes □ No □
2. **Landscape Architect** Yes □ No □
3. **Planner** Yes □ No □
4. **Engineer** Yes □ No □
5. **Other**
   _____
6. **Other**
   _____

Number of participants in the group:
_____

Interactions among resident participants-What is Happening in the Process?

1. Share ideas
   a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

2. Share information
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

1. Agreement- on idea(s)
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

2. Disagreement
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

3. Express Support
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

4. Express Opposition to GSI
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

5. Discuss area (s) of concern (issues with GSI, problems in the neighbourhood)
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

6. Discuss Cooperation to implement ideas
    a. Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

How is the interaction

1. Positively (e.g. express enthusiasm, support) Yes □ No □
    a. Substantive Content– who said:

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

2. Neutral Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

3. Negatively (conflict, disapproval of GSI/project/neighborhood cooperation for implementation, etc.). Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

How do people interact?

Cooperation Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

Consensus building Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

Provide Feedback Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

Share Ideas Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

What kind of information is exchanged?

1. Knowledge on GSI Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

2. Information on methods of Implementing GSI Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

3. Support for GSI
    a. General Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

    b. Environmental Benefits Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

c. Other Benefits Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

4. Support for residential implementation on their properties Yes □ No □
   a. Substantive Content– who said:

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

5. Support for residential implementation in the neighbourhood Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

6. Feel Capable to implement GSI Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

7. Other Yes □ No □

Substantive Content	Who says it	When Occurs (beginning-, middle, end of workshop)	How has it changed

How engaged are participants?

1. Very Engaged
    a. Verbally □
    b. Tactilely □
    c. Other_____
2. Somewhat
    a. Verbally □
    b. Tactilely □
    c. Other_____
3. Disengaged
    a. Verbally □
    b. Tactilely □
    c. Other_____

Development of a Product (Outcome of Community Mapping and Opportunities for GSI Activities)?

1. Residential Property Strategies Developed	Complete □	Partial □	Not Developed □
a. Area of Concern	□	□	□
b. Opportunity Area	□	□	□
c. Issue Area	□	□	□
2. Municipal Strategies Developed	Complete □	Partial □	Not Developed □
a. Area of Concern	□	□	□
b. Opportunity Area	□	□	□
c. Issue Area	□	□	□

3. Types and locations:

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4. Feel can be practically implemented Yes □ No □
5. Willing to implement it on their properties Yes □ No □
6. Feel Ownership over plans developed Yes □ No □

7. Areas of Agreement/Overlap Among Groups:

_____
_____
_____
_____

8. Areas of Disagreement among Groups:

_____
_____
_____
_____

9. Consensus Among Groups:

_____
_____
_____
_____

Outcome of Feasibility and Action Items Activity

1. Action Items developed:

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2. Timescale for project implementation
    a. By End of 2018 (short term) □

_____
_____

b. By End of 2019 (medium term) □

c. After 2019 (long term) □

Notes

Appendix G Facilitator Notes

Participant Observation Checklist (During the 'Revisioning' Workshop)

Table Number_____

Participants

7. **Residents** Yes □ No □
8. **Landscape Architect** Yes □ No □
9. **Planner** Yes □ No □
10. **Engineer** Yes □ No □
11. **Other (e.g. environmental organization representative)**
    _____
12. **Other**
    _____

Number of participants in the group: _____

Interactions among resident participants-What is Happening in the Process?

Share ideas *(Highlight answer to complete electronically e.g. highlight yes to indicate yes)*

Yes □ No □

Interaction Type	**Substantive Content**	**Who says it**	**When Occurs (beginning-, middle, end of workshop)**	**How has it changed over time**
Share Ideas Yes □ No □				
Share Information Yes □ No □				
Agreement on idea(s) Yes □ No □				
Disagreement on idea(s) Yes □ No □				
Express Support Yes □ No □				

Express Opposition to GSI Yes □ No □				
Discuss area (s) of concern (issues with GSI, problems in the neighbourhood) Yes □ No □				
Discuss Cooperation to implement ideas Yes □ No □				

How is the interaction

Interaction Type	**Substantive Content**	**Who says it**	**When Occurs (beginning-, middle, end of workshop)**	**How has it changed over time**
Positively (e.g. express enthusiasm, support) **Yes □ No □**				
Neutral **Yes □ No □**				

Negatively (conflict, disapproval of GSI/project/neighborhood cooperation for implementation, etc.). **Yes □ No □**				

How do people interact?

Interaction Type	**Substantive Content**	**Who says it**	**When Occurs (beginning-, middle, end of workshop)**	**How has it changed over time**
Cooperation Yes □ No □				
Consensus building Yes □ No □				
Positive feedback Yes □ No □				
Share Ideas Yes □ No □				

What kind of information is exchanged?

Interaction Type	**Substantive Content**	**Who says it**	**When Occurs (beginning-, middle, end of workshop)**	**How has it changed over time**
Knowledge on GSI **Yes □ No □**				
Information on methods of Implementing GSI **Yes □ No □**				
Support for GSI **Yes □ No □**				
Information on methods of Implementing GSI **Yes □ No □**				
Environmental Benefits **Yes □ No □**				
Other Benefits **Yes □ No □**				
8. Support for residential implementation on their properties **Yes □ No □**				
9. Support for residential implementation in the neighbourhood **Yes □ No □**				

10. Feel Capable to implement GSI **Yes □ No □**				
11. Other				

How engaged are participants?

Very Engaged

Verbally □

Tactilely □

Other_____

Somewhat

Verbally □

Tactilely □

Other_____

Disengaged

Verbally □

Tactilely □

Other_____

Development of a Product (Outcome of Community Mapping and Opportunities for GSI Activities)?

Residential Property Strategies Developed	Complete □	Partial □	Not Developed □
Area of Concern	□	□	□
Opportunity Area	□	□	□
Issue Area	□	□	□
Municipal Strategies Developed	Complete □	Partial □	Not Developed □

Area of Concern	□	□	□
Opportunity Area	□	□	□
Issue Area	□	□	□

Types and locations:

_____
_____
_____

Feel can be practically implemented Yes □ No □

Willing to implement it on their properties Yes □ No □

Feel Ownership over plans developed Yes □ No □

Areas of Agreement/Overlap Among Groups:

_____
_____
_____
_____

Areas of Disagreement among Groups:

_____
_____
_____
_____

Consensus Among Groups:

_____
_____
_____
_____

Outcome of Feasibility and Action Items Activity

Action Items developed:

_____
_____
_____
_____

Notes:

Appendix H Brochure distributed to treatment group residents in Neighbourhood

WHY SHOULD YOUR HOME BE RAIN READY?

Having a Rain Ready home is important for several reasons:

1) it protects your home and your neighbours' homes from water damage;
2) as our climate changes, we're experiencing more intense rains that increase the threat of water invading our homes and flooding our neighbourhoods;
3) rain that flows into storm sewers carries pollutants into our rivers and lakes; and,
4) you can receive credits on stormwater utility fees in Kitchener and Waterloo.

START BY KNOWING YOUR PROPERTY

We advise you to start by understanding where rain water flows on your property. Identify problem spots, such as ground that slopes towards your home, and look for sloped surfaces to direct water to where your property can absorb it.

REEP Green Solutions offers **RAIN Home Visits** that gives you a comprehensive review of your property. We also have consultations with our **RAIN Coach** to advise you on developing a Rain Readyplan for your home.

IDEAS TO

SLOW it DOWN

NATURALIZE YOUR YARD

Add more trees, shrubs and flowers. The resulting low maintenance landscape helps to manage rain on your property and provides habitat for butterflies, birds, and other wildlife.

USE A RAIN BARREL OR CISTERN

Collect rain and store it to water your plants. They love this natural soft water that is free of salt, chlorine and other substances.

AVOID SENDING RAIN DIRECTLY TO STORM SEWERS

Disconnect any downspouts that feed directly into storm sewers or direct rain down your driveway. Redirect downspouts to a permeable area where it can soak into the ground.

IDEAS TO

SOAK it up

ADD A RAIN GARDEN TO YOUR FRONT YARD

Beautify your home with a rain garden! These specially designed gardens are a mix of sand, compost and soil to absorb water directed from your home's downspouts and slowly release it into the ground.

PUT IN A SOAKAWAY (AKA INFILTRATION GALLERY)

Soakaways are small underground reservoirs that collect rain from your downspout and allow it to infiltrate into the ground. You might choose a trench featuring a perforated pipe or a pit lined with landscape fabric and filled with stones or specially designed plastic crates.

CHOOSE PERMEABLE PAVERS FOR YOUR DRIVEWAY OR PATIO

This alternative to asphalt, concrete or traditional interlocking brick driveways and patios allows water to seep between the pavers into a stone reservoir below that allows it to slowly percolate into the ground.

BEING RAIN READY MEANS FINDING WAYS TO

SLOW it DOWN

SOAK it up

Keep it CLEAN

WHERE DOES THE RAIN GO NOW?

TIPS ON KEEPING IT CLEAN

- Use less fertilizer for grass and plants.
- Be smart about salt. Choose alternatives and learn how to avoid using it.
- Pick up pet waste and put it into your green bin or a pet waste composter.
- Place cigarette butts in the garbage.
- Clean your vehicle at a car wash.

BEING RAIN READY MEANS YOU COULD BE ELIGIBLE TO SAVE ON STORMWATER FEES

In Kitchener and Waterloo, each property owner is charged a stormwater fee based on how much hard surface is on their property. The more you pave, the more you pay.

You can **save up to 65%** of your fee by making your home Rain Ready with options such as those we share here.

Learn more about stormwater credits in:

Kitchener: kitchener.ca/stormwatercredits

Waterloo: waterloo.ca/stormwatercredit

LEARN MORE ABOUT MAKING YOUR HOME RAIN READY:

reepgreen.ca/rainready

A REEP Green Solutions program:

RAIN

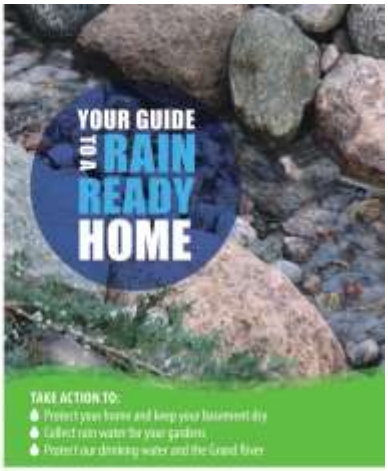
Funded by:

In partnership with:

Green Communities

PARTNERS FOR ACTION

REEP Green Solutions is a registered environmental charity (#81582 2140 RR0001)



YOUR GUIDE TO A RAIN READY HOME

TAKE ACTION TO:

- Protect your home and keep your basement dry
- Collect rain water for your gardens
- Protect our drinking water and the Grand River

reep Green Solutions

reepgreen.ca/rainready

Appendix I Research Findings Matrix of the quantitative and qualitative arms of this study into residents' perceptions, intentions and actions surrounding GSI

Research Theme	Surveys	Interviews	Site Visit	Site Visit Photographs	Charrette Observation	Charrette Facilitator Notes
Insignificant findings of impact education has at modifying views and stated actions	Results largely insignificant	n/a	n/a	n/a	n/a	n/a
Limited number of significant variables, includes affected by extreme weather, experienced extreme weather	Significant Results: • Wiling make effort positively affect nearby water bodies • Have already installed/started installing GSI • Likely install rain garden • Likely install infiltration gallery Significant covariates on some questions: • Experienced extreme weather • Impacted extreme weather • Household income	n/a	Affected by SW issues/poor SW functioning	n/a	n/a	n/a
Cost concerns/ financial concerns regarding GSI limit installation	n/a	Cost Concerns GSI	Desire rebates or incentives for GSI	n/a	n/a	GSI cost concerns hinder installation

Research Theme	Surveys	Interviews	Site Visit	Site Visit Photographs	Charrette Observation	Charrette Facilitator Notes
Government has higher level responsibility, needs show leadership on GSI, government failed to properly handle SWM	n/a	Government has higher level responsibility, needs show leadership on GSI before residents , government failed properly handle SWM	n/a	n/a	Community/municipal scale GSI	Community Scale GSI, Government should show leadership and take responsibility for GSI
Participants felt knowledge level improved	n/a	Felt knowledge level improved	n/a	n/a	n/a	n/a
GSI is a good thing	n/a	GSI is a good thing	n/a	n/a	n/a	Desire community or residential scale GSI in opportunity and demonstration areas
Desire rebates or incentives/ assistance for GSI	n/a	n/a	Rebates or incentives/ assistance for GSI	n/a	n/a	Desire incentives, resources or funding to install GSI
Value yard, garden, landscaping and current uses	Implied – insignificant Findings	Do not want modify property to install GSI now (might consider in future or if moved)	Value yard, garden and current uses	n/a	n/a	n/a
Effective engagement and sharing of ideas, cooperation among participants	n/a	n/a	n/a	n/a	Effective engagement and sharing of ideas, cooperation among participants	Desire cooperate implement GSI on property

Research Theme	Surveys	Interviews	Site Visit	Site Visit Photographs	Charrette Observation	Charrette Facilitator Notes
Desire more education on GSI	n/a	n/a	Desire more education on GSI	n/a	Desire demonstration area projects	Feel lack resource for GSI Community, demonstration based GSI Lack capability install GSI Desire more education on GSI
Interested simpler property modifications for SWM or simpler forms of GSI e.g. rain barrel	n/a	Interested simpler property modifications for SWM or simpler forms of GSI e.g. rain barrel	n/a	n/a	n/a	n/a
Not spark desire GSI own property	Results largely insignificant	Hesitant GSI on own property now (e.g. cost, change landscaping, not affected SWM issues)	n/a	n/a	Not spark desire GSI on own property	Uncertainty on intent to install GSI on own residential properties
Concern stormwater affected area	n/a	n/a	n/a	n/a	n/a	Concern SW affected areas GSI in SW affected areas prioritized
Residential Scale GSI	n/a	n/a	n/a	n/a	n/a	Residential scale GSI

Appendix J Key Research Findings from sub-questions.

Research Sub-question	Findings
How does education affect residents' attitudes on GSI?	• Qualitative methods reveal that participants largely support stormwater management initiatives in their community. After attending the charrette, residents said that they intended to perform smaller scale stormwater management initiatives on their property or undertake other actions to better support stormwater management. • Education was important at creating awareness. Some participants had never heard of GSI or paid attention to stormwater management prior to education activities. The research is an important first step for creating change and building public consensus for stormwater management in the community.
How does education affect residents' values on GSI?	• Participants deeply value their yard, garden, landscaping and current uses. This was repeatedly evident across qualitative data sources. Participants' values around and commitment to their current landscaping uses hinder their intentions of installing GSI features on their properties.

Research Sub-question	Findings
How does education affect residents' values on GSI?	• Participants revealed that they appreciated the education activities and desire more education on GSI. They felt education and knowledge on GSI was valuable and appreciated participating in education. • Participants at the charrette readily envisioned GSI in their community
How does education affect residents' beliefs on GSI?	• Participants largely believed GSI is a costly endeavor. These cost concerns limit GSI installation. • Participants noted that government has a higher level of responsibility for GSI. Participants frequently said that the government needs to show leadership on GSI before residents do. Many residents expressed the sentiment that the government has failed to properly handle stormwater management in their community. This failure is behind many of the stormwater management issues in the community. • The charrette made residents think about stormwater management. A number of residents revealed they would consider it in the future.

Research Sub-question	**Findings**
How does education affect participants' actions on GSI?	• Education treatments showed very little to no influence on residents' decision to install GSI on their property. Interviewees largely revealed they did not intend to install GSI after participating in education. • Municipalities need to develop more effective ways to reach a broader audience to keep momentum and change neighborhood-level stormwater management and GSI implementation.