Green Infrastructure and Placemaking Strategies for the Rush Line Bus Rapid Transit Project

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RAMSEY COUNTY

Resilient Communities Project
University of Minnesota
Building community-university partnerships for sustainability

The project on which this report is based was completed in collaboration with Ramsey County as part of the 2018–2019 Resilient Communities Project (RCP) partnership. RCP is a program at the University of Minnesota's Center for Urban and Regional Affairs (CURA) that connects University faculty and students with Minnesota communities to address strategic projects that advance local resilience and sustainability.

The contents of this report represent the views of the authors, and do not necessarily reflect those of RCP, CURA, the Regents of the University of Minnesota, or Ramsey County.

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Resilient Communities Project

University of Minnesota

Building Community-University Partnerships for Resilience

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Connecting Downtown Saint Paul to White Bear Lake

University of Minnesota - Ramsey County

University of Minnesota Driven to Discover

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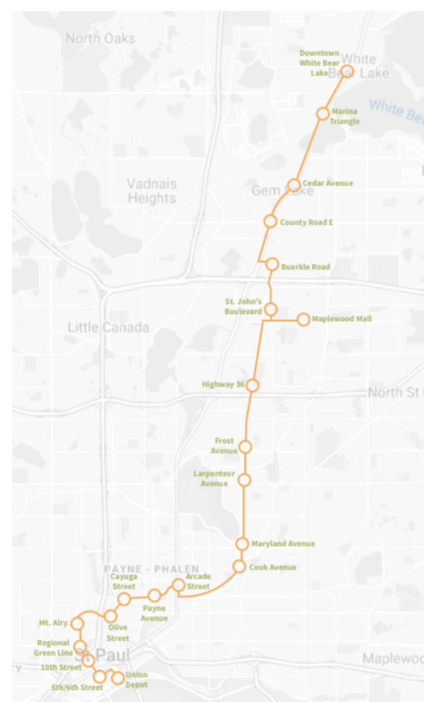
Executive Summary

The Rush Line Bus Rapid Transit (BRT) is a new proposed bus line running fourteen miles altogether from downtown White Bear Lake to downtown Saint Paul, passing through areas such as Maplewood, Vadnais Heights, Gem Lake, and White Bear Township. The newly proposed line would follow some existing roadway, include the construction of new transit-only roadway, and revitalize sections of the recreational Bruce Vento Regional biking and walking trail. The current status of this large project has reached the Environmental Analysis Phase as of 2018, which is where the University of Minnesota's Sustainable Communities class had come to collaborate within the project. This phase consists of reviewing surrounding environments, station area planning, public engagement, and preliminary engineering.

The BRT Rush Line's FTA process timeline

The students were given the task to select a viable spot or two along the route for green stormwater management, given maps and resources to aid their decision. Once the optimal locations were selected, they were to complete the task of proposing a development plan of new green infrastructure to mitigate the stormwater impacts from the bus route that can also be used as a means to enhance the aesthetics and recreational value of the surrounding areas of the Rush Line. The other main goals of the students' efforts in collaboration with the project was to determine which techniques would have the greatest positive ecological and social impacts if truly implemented on the BRT project. The several methods in determining these recommendations were to draw on existing reputable scientific research surrounding innovative stormwater management and green infrastructure tactics, and examine existing sites where these practices have been implemented to weigh the costs and benefits of implementing them into the BRT project. The team used the resources available to them as well as reaching out and conducting interviews with knowledgeable individuals who were experts in the political, managing, and planning aspects surrounding development of green infrastructure.



The team ultimately decided to work on point (9B) that is located directly next to the Arcade Street Station, as well as a linear strategy along the Bruce Vento Regional Trail. By the end of the semester, the students had come up with several proposed recommendations of strategies to achieve these aforementioned goals. The recommendations, elaborated in detail later in this work, include pervious pavement, bioswales, an above-ground drainage system along the Bruce Vento Trail. The stationary location of (9B) has been recommended strategies of mitigating stormwater runoff through a rain garden with native, perennial pollinator species.

ENVIRONMENTAL IMPACTS

GOAL: CONSIDER POSSIBLE EFFECTS ON THE LOCAL ENVIRONMENT FROM USING GREEN INFRASTRUCTURE

Project Impact to Local Environmental Conditions

Public transportation systems play a massive role in an urban community, it has the ability to connect people from their residence to workplace with reduced time commuting and reduced traveling expenses. The Bus Rapid Transit (BRT) will expedite the use of public transportation by avoiding traffic congestion and decrease the traveling time by minimizing the need for transfer. The Rush Line BRT Project seeks to provide a transit service that can satisfy the users mobility and accessibility for their business and other various travels (Rush Line BRT Project, 2019). Alongside the benefits to the public community, the BRT project can also have positive impacts on the surrounding environment, such as enhancing the natural area with aesthetically appealing water management tactics that simultaneously improve ecosystem health and quality.

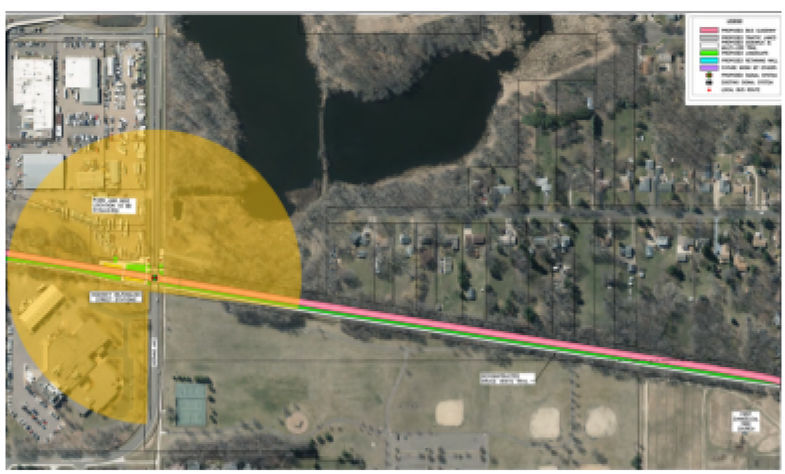
Projected Impact

Water Quality

The project area contains several watershed districts. One of the projected sites is the watershed by Highway 36 and English Street where the proposed bus stops can potentially negatively affect the quality of the water.

Water quality in urban areas can be impacted for multiple reasons. Colder climate regional states tend to use more road salt, in comparison to warmer climate states. As a result road salt can impact the water quality - Chloride is a main chemical that is contained in the road salt and it degrades the water quality, which the water is used as drinking water and habitat for fish.

In addition, stormwater runoff in urban areas can be impacted by road traffic, building materials, construction sites, and fertilizers (Blecken et al., 759). The sediment contamination discharges into groundwater and affects the watershed ecosystem. The fine-grained sediment particles can increase due to snowmelt runoff after winter, with changes in runoff intensity, and high sediment loads (Blecken et al., 758).



"City of Maplewood and Bruce Vento Trail along Hwy 36 and English Street"

Lastly, groundwater can be impacted during the construction of this project, as it potentially imposes creation of land disruption through pollution and degradation of groundwater quality (Preene and Brassington, 63). The degradation occurs due to the leakage of fuel and other construction materials, and surface water runoff from topsoil removal and excavation (63). As water quality is directly connected to the local community as a drinking water, leisure activity, etc., it is highly recommended to have a Best Management Plan (BMP) for managing stormwater runoff and contaminants entering the waterbody.

Ecosystem Health

The BRT Rush Line project can provide a positive environmental impact as it can reduce greenhouse gases by allowing more accessibility to public transit (Carrigan et al., 10). A study examined in two cities from Latin America showed how transportation infrastructure can improve the environment if managed correctly. It concluded that the BRT system reduced the time of users being exposed to the air pollution and simultaneously reduced the amount of greenhouse gases, which is a known factor of affecting the surrounding ecosystem (Carrigan et al, 11). The BRT system is expected to create more resilience to the ecosystem and communities when it is combined with green infrastructure.

Impact	How does BRT achieve the Benefit?	Empirical Evidence
Greenhouse Gas and Local air pollutant emissions reductions	- Replacing traditional vehicles that pollute more - Adopt new technologies for BRT buses	- Bogota, Columbia: able to save 1 million t CO_2 per year - Mexico City, Mexico: significant reductions in carbon monoxide
Reduce exposure to air pollutants	- Lower concentration of air pollution - Reduce the time of exposure	- Bogota, Columbia: significant reduction on gases

Summary of benefits that BRT system offers (Carrigan et al. 11)

The Rush Line BRT project seeks to implement green stormwater management into the surrounding stations and route area. Green stormwater benefits ecosystems in various ways such as improved water quality, improved habitat for wildlife, and community involvement and education (EPA, Benefits of Green Infrastructure, 2018). Stormwater runoff from urban areas contains pollutants from fertilizers, constructions, sediments and sewage, and may enter nearby watersheds. As a result it becomes more difficult to treat the water when the flow gets bigger. Stormwater management can better retain the stormwater by reducing the discharge when it is combined to green infrastructure and also reduce the frequency of flooding by slowing and reducing the stormwater discharge (EPA, Benefits of Green Infrastructure, 2018). Natural habitats in approximation to the green infrastructure can also benefit from green stormwater management. By managing the erosion and sedimentation from stormwater, green infrastructure can improve wildlife habitat along the bus stops or the trails by bringing more resilience.

Environmental Priorities to Local Communities and Watershed Districts

Several priorities should be taken into consideration by local communities and watershed districts when implementing green infrastructure to the BRT Rush Line project. Ronald B. Leaf from Kimley-Horn is a Water Resources Lead for the Rush Line Design Team and he mentioned that, "the typical system is not enough because we can recognize that reuse systems can only work for a few months, and may be more of a disposal approach than reuse, when it comes to stormwater management". The planning for stormwater BMPs (Best Management Practices) is still in early stages, and many other factors need to be studied. To implement BMPs, local communities and watershed districts should consider the following as priorities: pollinators, bioretention, and road salt. The Minnesota Pollution Control Agency provides more options for stormwater runoff management in their Minnesota Stormwater Manual[1].

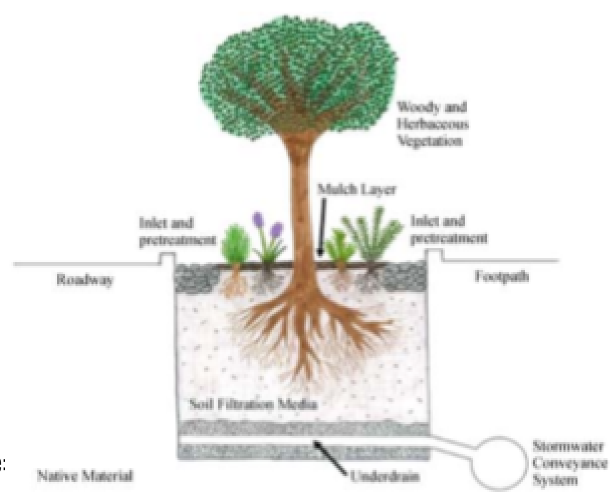
Pollinators

Pollinators are an important medium for flowering plant reproduction, production of crops and other food sources, and enhancing biodiversity (U.S. Fish & Wildlife Service, 2019). The USDA provides several Pollinator Friendly Practices (PFP) for managing the pollinator habitat (USDA, Pollinator Friendly Practices). One possible PFP for local community to implement is to manage the pollinator habitat by creating a shelter. Shelters can provide nesting sites for pollinators and protect them from the severe weather and natural predators (USDA, Pollinator Friendly Practices).

"Bioswales combined with a pollination habitat"

Bioretention

Bioretention is a common stormwater management practice applied in urban watersheds with low impact development practices (Kratky et al, 1). The management system seeks to manage runoff by filtering it through the soil in the planted bed before it reaches the watershed, and vegetation in the soil planting bed uptakes the pollutants and runoff ("New Jersey Stormwater Best Management Practice Manual", 1). The system's mulch layer on the surface provides an environment for



"Bioretention System"

[1] Further information about the stormwater runoff management can be found here: Management (Minnesota Pollution Control Agency, 2019)

plant growth, with moisture, microorganisms, and decomposing of organic matter (8). Additional study is required as cold climate challenges the stormwater system (Kratky et al, 10), however, bioretention is still one of the best options to be implemented in the BRT Rush Line project. The management system can be applied either along the Bruce Vento trail or bus stops where heavy traffic exists.

Road Salt

Minnesota is one of the coldest states in the United States, large snowfall is expected every winter and hefty amounts of road salts are consumed in snow management. When the snow and ice melts after the road salt is applied, otherwise known as the melt period, the salt is carried away into the adjacent watersheds and groundwater (Minnesota Pollution Control Agency, 2018). The Minnesota Pollution Control Agency points out that managing meltwater is vital because it contains accumulated materials of atmospheric pollutants and road salt that can contaminate the water ("Cold Climate Impact on Runoff Management", 2019). Given that chloride, a main contaminate in road salt, affects the biodiversity surrounding the site, the Minnesota Pollution Agency provides multiple steps and strategies for managing the road salt[2].

[2] Further information for the road salt management can be found here: Minnesota Stormwater Manual. Road salt, smart salting and winter maintenance (Minnesota Pollution Control Agency, 2018)

EXEMPLARY CASE STUDIES

GOAL: ANALYZE AND INCORPORATE BEST PRACTICES OF STORMWATER MANAGEMENT INTO BRT PROJECT

Green Stormwater Infrastructure and Placemaking Case Studies

In efforts with the BRT project, the team examined three green stormwater management case studies from North American transportation projects. Saint Paul Minnesota's Green Line Railway, Maplewood, Minnesota's Living Streets, and Portland Oregon's Green Streets policies are analyzed by discussion of their background and tactics, cost and benefits, and lessons learned.

Saint Paul, Minnesota's Green Line Railway

Background Information and Tactics

In 2010, construction began on Saint Paul and Minneapolis' Green Line Metro Transit railway intended to connect the two cities. When the project began, the Capitol Region Watershed District (CRWD) took the opportunity to implement green infrastructure projects along the railway with the goals of effectively treating stormwater and conserving water, as well as beautifying the route along University Avenue (CRWD, 2019).

"Trains at Snelling"

CRWD employed four different Best Management Practices (BMPs) along the route of the Green Line to intended to improve water quality and control runoff. CRWD utilized rain gardens and stormwater planters on the boulevards of side streets adjacent to the project, built infiltration trenches along side streets, and created five miles of tree trench, including about one thousand trees, along University Avenue (NATCO, 2017). The specific purposes of each of these BMPs differed slightly: the rain gardens and planters were intended to control erosion, encourage water infiltration, and filter runoff, as well as add to the aesthetic value of the area. The infiltration trenches were intended to increase infiltration of stormwater, and filter out pollutants before excess water enters the storm sewer. The tree trenches along University Avenue were built adjacent to storm drains to work in tandem with existing infrastructure, and included permeable surfaces to further increase infiltration (CRWD, 2019).

Costs and Benefits

The green stormwater and placemaking strategies implemented along the Green Line were funded by a State Clean Water Fund Grant, CRWD, Metropolitan Council and the City of Saint Paul, and cost about $5,000,000. Estimated benefits of the project include a reduction of stormwater runoff by 50%, and the removal of 80 pounds of phosphorus and 40,000 pounds of other sediments (NACTO, 2017). The project also had benefits that are less quantitatively measurable including reducing the urban heat island effect, improving air quality, and creating pollinator habitats. The project has also had an impact on community education, through interpretive signage implemented in English, Spanish and Hmong (CRWD, 2019).

"Rain Garden at Marrion"

Lessons Learned

The Green Line project faced some unique challenges including limited land space for green infrastructure improvements, existing above- and below-ground utilities, contaminated soils, and a limited budget for the project (CRWD, 2019). The National Association of City Transportation Officials identified three key components that allowed the Green Line project to be successful: Close coordination and alignment of utility infrastructure installation reduced redundancy of efforts and reduced timelines. Frequent and early meetings with stakeholders reduced conflict, improved design elements, and positively impacted the outcome of the project. Finally, inviting wide participation in the project introduced unique partnerships to ensure alignment of project goals with the needs of the surrounding community (NATCO, 2019).

Maplewood, Minnesota's Living Streets

Background Information and Tactics

In 2013, the Living Streets Policy was adopted by the City of Maplewood. The goals of the policy are myriad, including enhancing biking and walking conditions, enhancing the safety of the street, enhancing the urban forest, improving neighborhood aesthetics, and improving stormwater quality. The policy was intended to further these goals by setting construction guidelines for new and renovated roadways, providing incentives for participating in the rain garden initiative, updating city codes and more ("Living Streets | Maplewood, MN", 2013).

"General Vision for Living Street"

The Living Streets Policy includes an aggressive rain garden implementation program that requires all new construction and reconstruction projects to incorporate rain gardens, as well as encourage and support the construction of rain gardens as retrofits. This policy was implemented to compliment Maplewood's existing rain garden program, originally implemented in 1996. Maplewood has been a leader in innovative stormwater management and as a rain garden proponent, and have implemented nearly seven hundred gardens since the original implementation of the program. The Living Streets Policy seeks to expand the existing program, as well as improve stormwater management through other methods. For example, the Living Streets Policy also calls for the narrowing of new roadways, which would decrease the amount of impervious pavement, therefore reducing runoff and increasing stormwater infiltration ("City of Maplewood, Minnesota Living Streets Policy", 2013).

Costs and Benefits

The envisioned benefits of the Living Streets Policy were varied, due to its wide scope. Benefits related to stormwater management and environmental impact included improved water and air quality, reduction of the urban heat island effect, increased stormwater infiltration, and runoff and pollutant reduction. The street trees were expected to reduce soil erosion, add organic matter to the soil to improve its water-holding capacity, and increase the resiliency of the soil in response to rain events. The rain garden program itself contributes to many of these benefits and more, including infiltrating 30% more runoff than lawns, recharging groundwater, improving aesthetics, and creating pollinator habitat ("City of Maplewood, Minnesota Living Streets Policy", 2013).

"Living Streets Rain Garden"

The Living Streets Policy aimed to ensure construction, replacement and future maintenance costs of new streets in accordance to the policy were equal or less than those of a standard street section. Cost savings are to be ensured through feasibility reports, long-term maintenance savings through the narrowing of streets, and context sensitive selection of appropriate locations for each intervention ("City of Maplewood, Minnesota Living Streets Policy", 2013).

Lessons Learned

In discussion with Shann Finwall, the City of Maplewood's Environmental Planner, she identified the Living Street's rain garden policy as Maplewood's most successful green stormwater management tactic. She stated that community members were most enthusiastic about the gardens, and happy about the idea that they were helping create pollinator habitats.

Portland, Oregon's Green Streets

Background Information and Tactics

Portland is well-known for their green stormwater management, as they have one of the most mature and comprehensive programs in the country. In addition to many overlapping stormwater policies and programs, the city has seen many iterations of its programs which have allowed it to become well-established and very successful ("Green Infrastructure Case Studies", 2010). Portland has a variety of city-wide programs that work together to improve their stormwater management through the use of diverse green technologies. For example, across the city, rain gardens, swales, porous pavers, green streets, planters, and disconnected downspouts can be found ("Green Infrastructure Case Studies", 2010).

"Green Street Planter"

Portland's Green Streets Program focuses on stormwater management along roadways throughout the city. The program is a cross-bureau policy that was adopted by Portland's City Council in 2007, to increase the use of green street facilities throughout the city ("Green Infrastructure Case Studies", 2010). One key aspect of the program is the implementation of green street planters along streets throughout the city. The green street planters are rain gardens implemented along the streets, typically placed close to storm drains to benefit existing sewer systems ("Green Streets", 2019).

Costs and Benefits

Portland has invested in green infrastructure, in part to offset the costs associated with gray infrastructure. The City of Portland has reported that its $9 million investment in green infrastructure across the city saves ratepayers an estimated $224 million in maintenance and repair costs for a traditional combined sewer overflow tunnel system ("Green Infrastructure Case Studies", 2010). The green street planters implemented through Portland's Green Streets Program help collect runoff, increase the efficiency of existing grey infrastructure, prevent sewer back-ups. Ecologically, they also improve air quality, replenish groundwater, reduce air temperature and increase urban green spaces ("Green Streets", 2019).

"Green Street in Planting Strip"

Lessons Learned

Key practices that helped make Portland's green stormwater system successful were the use of demonstration projects and through partnerships. The demonstration projects allowed the city to monitor and learn how vegetated systems could usefully be implemented into a hybrid grey and green stormwater system. Throughout the initial stages of creating new policies, working with partners to implement small projects that could later evolve into official policy was the most successful tactic ("Green Infrastructure Case Studies", 2010).

COMMUNITY ENGAGEMENT & PLACEMAKING

GOAL: DEVELOP PRINCIPLES TO GUIDE STORMWATER MANAGEMENT DECISIONS IN BRT PROJECT

Community Involvement and the Impact on Sustainability

What is community involvement?

In this context, community involvement is the engagement of local residents in the decision making process for the Rush Line. This can be done in many ways, such as educational seminars, community meetings with the Rush Line coordinators, a community forum, and many more.

Why community involvement?

Because the project is based along a long corridor of residential neighborhoods and areas of increased population, it is imperative that the project's scope reflects that. Research shows that community involvement and community-based models have a positive impact on the successful implementation of sustainability practices. In one study, a select few participants were asked to join a Sustainability Leadership Development Program (SLDP) to see how an educational and individual engagement plan could shape the context of sustainability for participants (Alkaher & Avissar, p. 507, 2018). The study had some interesting results, as many of the people who had the opportunity to see a broader view of sustainability were committed to use it more in their daily lives, whether that be in a social or environmental context. This study shows the importance of individual engagement, but also reflects the effects of general education. Without public engagement and education, the green initiatives being put in place could appear to some as expensive and unnecessary and could thwart the placemaking efforts being conducted by the Rush Line.

A participant of the previous study, an administrative staff member & director of campus laboratories and field trips at College of Education, Technology, and Arts in Tel-aviv, Israel, said that after participating in SLDP she "sees spreading the messages of sustainability to the public as an important component of EfS [Education for Sustainability]" (Alkaher & Avissar, p. 507, 2018). This emphasizes further the need to focus on education and the need for participation from the public in the BRT project.

Found in Knowlton's work, "The process of ensuring an adaptive prevention system and a sustainable innovation that can be integrated into ongoing operations [will] benefit diverse stakeholders". This emphasizes the success of innovation which includes community engagement (Knowlton, et al, 2013, 325). This type of successful engagement can be seen through various methods, but the two most common forms are community input for the purpose of informing the design of the project and continued engagement through education and awareness practices. Both of these offer the surrounding communities a part of the ownership of these spaces and do a lot to inspire individuals to take action.

Community Involvement in the Rush Line

Overall, the project has done a lot of planning to involve the community. Here is a summary of key goals from the Communication and Public Engagement Plan completed by project heads (Communication and Public Engagement Plan, 2018).

- Walk-and-engage program
- One-on-one and small group meetings.
- Listening/informing sessions.
- Conversations and/or surveys.
- Culturally-relevant pop-ups and community events.
- Traditional and multicultural social media communications.
- Community and multicultural media.
- Effort to reach out to underrepresented communities
- Strong effort to involve communities

Despite this strong connection with the public already, this report will include specific and actionable ways to incorporate more placemaking strategies to make the public feel that they have a say in the project, even after it has been completed.

Action Planning

The theme of community involvement is the basis of any large scale project like the Rush Line, but it is the main focus as consultants for the stormwater management BMPs. To use this going forward, Rush Line coordinators need to make sure they are connected to community members that will use the Rush Line as well as the Bruce-Vento Trail. There is a need to find a way to intertwine new designs into the communities that have been using the area before it begins renovation for the Rush Line. One of the biggest suggestions we want to bring forward to the project is the need for transparency in the actions that will affect the surrounding communities.

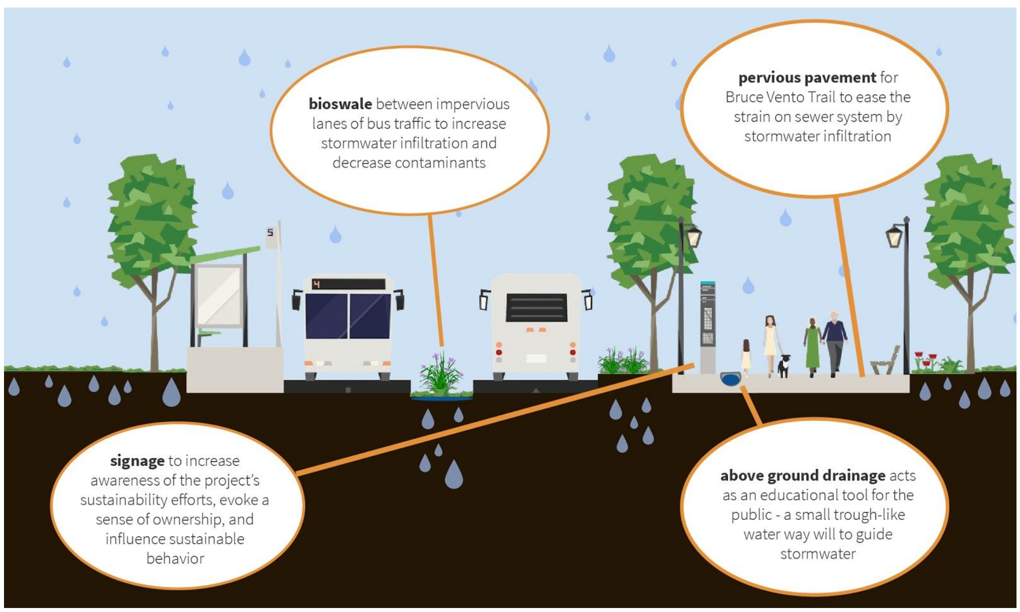
Although most of the larger details of the project have already been approved by Ramsey County, there are a lot of smaller details that could be used to engage the public. That being said, the communities should be able to give more input on the final design of these details. By giving the community a say in the process, however small, there is a chance to open them up to new ideas and foster support for the project and the sustainability practices implemented in it.

FINAL RECOMMENDATIONS & STRATEGIES

Recommended Green Infrastructure & Placemaking Strategies

Site I: Linear Application Along the Bruce Vento Trail

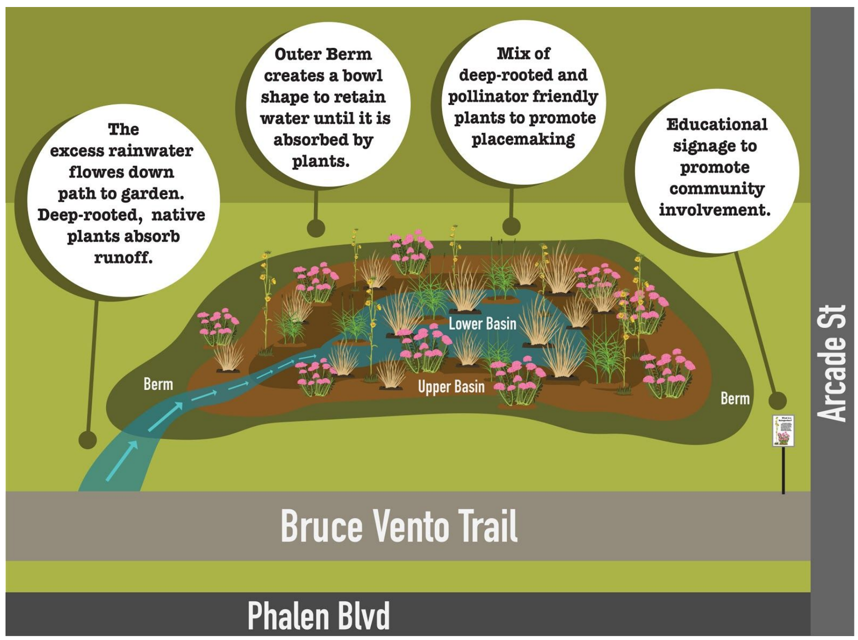
With the high expected use of the proposed BRT Rush Line, traditional impervious pavement is recommended for the bus roadways as it can withstand heavy vehicles, heavy vehicle braking, and overall pressure. In addition, traditional pavement can tolerate sanding for ice during the winter better than pervious pavement, as pervious pavement can clog and need to be cleaned with an industrial vacuum (Morton, 2015). Pervious pavement helps rainwater reach the ground as its voids “allow moisture to run through, like pouring liquid through a fine mesh sieve” (Morton, 2015). Pervious pavement is recommended for use on the Bruce Vento Trail and for any potential pavement replacing on the bus roadways, as it suitable for areas of light traffic or in strips (Morton, 2015). To combat the excessive use of traditional pavement, it is recommended to integrate bioswales between the bus lanes for stormwater mitigation. “Bioswales are vegetated drainage courses with sloped sides that trap sediments and treat contaminants” and have been “effective at slowing and capturing water, settling sediments, and reducing nutrients, metals, and hydrocarbons” in stormwater runoff (Anderson et al, 2016). Because stormwater runoff, especially in urban areas, can contain high levels of various contaminants, management is crucial in terms of protecting downstream waterways and freshwater ecosystems (Chevalier, 2017). Another linear strategy recommendation is the implementation of above-ground drainage for excess stormwater runoff. Since heavy rain showers can strain a sewage system or treatment plant and lead to water in the street, “above-ground drainage of rainwater keeps that water visible in the city and is in many cases less costly than installing a separate sewage system” (Lenderink, 2011). By bringing this system into the sight of nearby residents, bus riders, and trail users, people can learn about overall urban water management, its issues, and potential actions people can take. It is recommended that the above-ground drainage system and bioswales be accompanied by accessible, informational signage to further education on the subject.



“Street Section”

Site II: 9B at Arcade St. Station

In regards to the potential stop at Arcade St. Station, it is recommended to implement a rain garden as a means of passive stormwater management. Designed to soak in stormwater runoff from roads, a rain garden is comprised of native shrubs, perennials, and flowers that are planted in a small depression. By collecting stormwater runoff, the rain garden allows the polluted, contaminated water to be filtered by vegetation, permeate into the soil, and thus revitalizing groundwater aquifers. Recommended rain garden plants include a mix of deep-rooted and pollinator friendly plants that are salt tolerant. Because salt pulls water away from plants, it is recommended to use salt tolerant vegetation to combat the salting of roads during the winter months. Examples of recommended plants include Blue Heaven Little Bluestem, Autumn Joy Stonecrop, and Stella De Oro Dwarf Daylily (Nichols and Jacobson, 2016). In addition to the stormwater management benefits that the proposed rain garden yields, it is recommended to address the concept of placemaking and promotion of community engagement. This facet of the recommendation includes the integration of educational signage to communicate the science behind the rain garden, specifically noting the pollinator plants that support bee habitats. By doing this, a sense of place is created as people are connected to the social and environmental issues around them; bus riders are able to interact with the landscape while waiting for the bus, making this location suitable for this type of stormwater management.



"Rain Garden"

Anticipated Impact

With the recommended strategies regarding green infrastructure, specifically stormwater management, there are numerous beneficial anticipated impacts. Beginning with pervious pavement, it helps manage the volume of stormwater and promotes ground infiltration, "a passive way to remove contaminants from runoff" (Morton, 2015). Pervious pavement also has the potential for urban heat island effect reduction, since "the pavement can breathe and moisture isn't trapped," thus holding less heat (Morton, 2015). Bioswales are another example of low impact development that support the filtering of stormwater runoff through plants and soil. The anticipated impact of the recommended bioswales between the bus lanes includes the capturing of pollutants from buses, thus preventing them from being integrated into nearby waterways after a storm. In addition, bioswales create habitat for wildlife and promote biodiversity.

As previously discussed in this document, community involvement is recommended throughout the process of this project to establish a trusting relationship between the public, stakeholders, and project team members. By building these relationships and keeping the public informed and involved, a sense of ownership is evoked and people are more likely to foster their support. The anticipated trust, support, and overall interest in the project will then lead to a development of placemaking, especially for nearby residents, bus riders, and trail users. The recommended bioswales, along with the above-ground drainage system and rain garden, are anticipated to act as catalysts for public engagement and education as well. Stormwater management applications and community involvement throughout the project are anticipated means of placemaking, as they strengthen the connection between people and the places they share.

Conclusion

The findings of this report identify a few key areas of focus in terms of ecological impacts, impacts and feasible strategies that should be taken into consideration during the planning and implementation of the BRT. Increasing community engagement in the project will be essential to ensure the successful implementation of and satisfaction with a green infrastructure system. Important environmental impacts to consider revolve around protecting water quality and maintaining ecosystem health. Key strategies to

improve environmental conditions along the BRT route are mitigation of negative impact from road salts, creation of pollinator habitats through rain gardens, and the implementation of bioretention strategies to decrease runoff to increase contaminant uptake in plants to ultimately protect watersheds and decrease stormwater loads on traditional grey infrastructure systems.

Successful implementation of green stormwater management strategies were examined in three case studies: Saint Paul's Green Line Railway, Maplewood's Living Streets Policy, and Portland's Green Streets. Each of these can be utilized as examples of successful strategies, and each provide an array of benefits and successful strategies that could be implemented during the planning and construction of the BRT.

Finally, this report identifies key recommendations for green stormwater management tactics to be implemented as linear strategies along the Bruce Vento Trail, as well as additional strategies for implementation at the 9B site at the Arcade Street station. Along the route of the Bruce Vento Trail, recommended strategies include pervious pavement, bioswales, and an above-ground demonstration drainage system. In addition, educational placards should be implemented to positively interact with and teach community members about the benefits of green infrastructure. At the (9B) stationary location, it is also recommended to include a rain garden with native, perennial pollinator species that allows for more affordable and lower maintenance.

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Page 3 - Visual map of BRT Rush Line 14-mile route created by Gina Frenette and Annika Johnson

Page 4 - “The Free High-Resolution Photo of Landscape, Tree, Water, Nature, Forest, Wilderness, Mountain, Cloud, Lake, River, Pond, Reflection, Usa, Reservoir, Body of Water, Wetland, Whale, Habitat, Loch, Minnesota, Natural Environment, Superior National Forest.” *Pxhere*, pxhere.com/en/photo/968993.

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Page 19-20 - “Street Section” and “Rain Garden.” Graphic of recommendations for Bruce Vento Regional Trail and 9B Site designed and developed by Gina Frenette and Annika Johnson.