WINNIPEG FOOD COUNCIL

Green Infrastructure for Food Production

Winnipeg Food Council

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Table of Contents

Executive Summary

Green infrastructure includes the natural vegetation, soils, water and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living. Green infrastructure is most often employed in urban areas to manage stormwater events, but can also provide a host of social, environmental, and economic co-benefits to benefit urban life.

Green infrastructure projects that take narrow focus on stormwater management risk overlooking opportunities to leverage additional social and economic benefits for improved community benefit. At its most impactful, green infrastructure involves an interconnected network of large and small, public and private green infrastructure components that work collectively to improve urban life, while leveraging green infrastructure's multiple benefits based on local context.

The City of Winnipeg CSO Master Plan allots $104.6 million over 27 years for green infrastructure projects. To date, there has not been significant discussion about the potential for green infrastructure in Winnipeg.

The Winnipeg Food Council is examining the ability for green infrastructure in the City of Winnipeg to address issues of combined sewer overflows and sustainable food systems for social equity, wellbeing, and climate change resilience. A number of green infrastructure options for stormwater management can complement goals of sustainable food systems by 1) be designed with food production as a central element, 2) including edible components, or 3) including food production practices that benefit from stormwater harvesting systems.

Soil based green infrastructure managed in such a way as to increase the levels of organic matter, like those found in urban agriculture, are particularly capable of managing storm water. Increases in soil organic matter increase soils water retention capacity, causing it to function as a sponge during heavy rainfall events. In this way, urban agriculture management practices can improve compacted and high clay content soils over time, such as those commonly found in Winnipeg.

Ultimately, determining which type of green infrastructure is appropriate depends on project objectives, opportunities, and constraints. While urban agriculture will not be appropriate in all cases, it does protect and improve permeable urban areas increasing their stormwater retention capacity and thus has a place in planning for stormwater management through green infrastructure.

The Winnipeg public service anticipates undertaking green infrastructure pilot projects over the next five years to determine the feasibility and benefits to runoff volume reduction performance in Winnipeg. This report takes a high level look at how urban agriculture can be conceptualized within green infrastructure for municipal stormwater management.

Background & Rational for the Report

City of Winnipeg Combined Sewer Overflow (CSO) Master Plan is a long term infrastructure upgrade program to reduce the amount of sewer overflows entering rivers in Winnipeg from combined sewer system infrastructure (Jacobs Engineering Group Inc, 2019). These combined sewers account for approximately 22 overflow events each year, where diluted untreated sewage flows into our rivers during heavy rainfall (City of Winnipeg, nd.). The CSO Master Plan provides direction for this infrastructure program covering all 43 combined sewer districts at a total estimated capital cost in excess of $2 billion over 27 years, with an objective of 85% capture (Jacobs Engineering Group Inc, 2019). On November 13, 2019 the CSO Master Plan received approval from the Province.

The CSO Master Plan focuses primarily on grey infrastructure interventions to meet the proposed targets, including sewer pipes and storage tanks, but also offers opportunities for green infrastructure components (Jacobs Engineering Group Inc, 2019). While green infrastructure will not eliminate combined sewer overflows on its own, it can provide significant contributions to solving this problem while increasing climate resilience. 10% of the CSO Master Plan budget is allotted for green infrastructure projects, totalling $104.6 million over 27 years (Jacobs Engineering Group Inc, 2019).

While green infrastructure is often used for storm water management, it also provides multiple ecosystem services, social and economic benefits important for cities. Green infrastructure can include food provision components, increasing their potential to enhance community food security, contribute to social equity, and produce economic benefits (American Planning Association, 2015; City of Vancouver, 2019). To date, there has not been significant discussion about the potential for green infrastructure in Winnipeg. **The Winnipeg Food Council is examining the ability for green infrastructure in the City of Winnipeg to address issues of combined sewer overflows, sustainable food systems, social equity and wellbeing, and climate change resilience, and proposes an urban agriculture be considered within green infrastructure pilot projects.**

Green Infrastructure

Green infrastructure has been defined as:

> *"the natural vegetation, soils, water and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living. Natural areas such as forests, wetlands and floodplains, and engineered systems like bioswales and rain gardens conserve natural resources and mitigate negative environmental effects, benefiting both people and wildlife. When green infrastructure is connected as part of a larger framework, a green infrastructure network is created."* (Metro Vancouver, nd. p. 5)

Green infrastructure provides a range of ecosystem services. Most often in urban centres, green infrastructure is associated with stormwater management, using soil systems, permeable pavements, storm water harvesting and reuse systems, and landscaping (Environmental

Protection Agency, 2019) to store, infiltrate, or evaporate storm water and reduce flows into sewer systems or surface waters (Environmental Protection Agency, 2019; Jacobs Engineering Group Inc, 2019; City of Winnipeg, nd.). Examples of green infrastructure technologies for stormwater management include rainwater harvesting, bioswales, rain gardens, permeable pavements, green streets and alleyways, green roofs, urban tree canopies, land conservation, downspout disconnection, planter boxes, and wetlands (Environmental Protection Agency, 2019; City of Calgary, 2018)

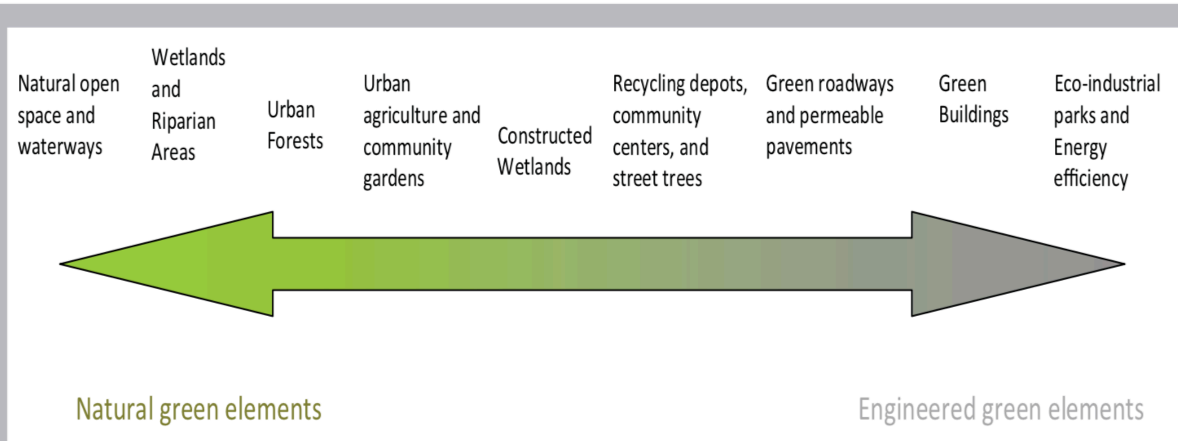


Figure 2-4: Green infrastructure is an interconnected network of natural and engineered green elements

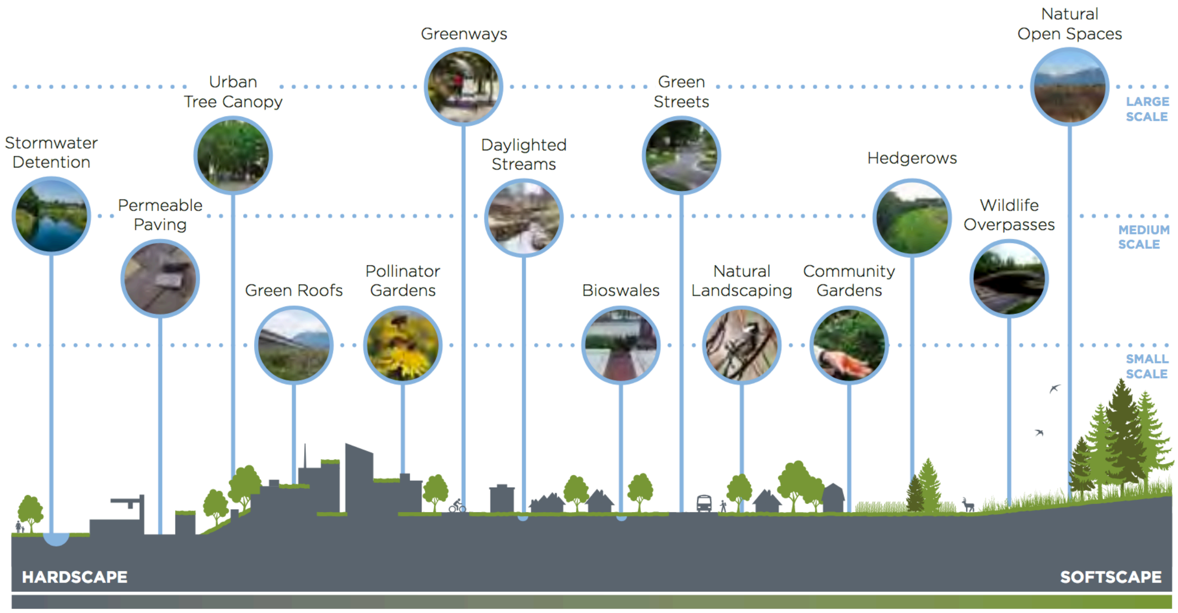
The City of Calgary's Municipal Development Plan acknowledges natural and engineered green elements of green infrastructure, including urban agriculture and community gardens.
(City of Calgary Municipal Development Plan, 2018, p. 2-41)

In addition to stormwater management, green infrastructure can also provide other environmental benefits such as building resiliency to drought, lowering building energy demands, managing flood risk (Office of Wastewater Management, 2016; City of Vancouver, 2019), reducing the urban heat island effect (City of Winnipeg, nd.; Cohen & Wijsma, 2014); sequestering carbon and regenerating soil fertility (City of Vancouver, 2019; La Rosa & Privitera, 2013); conserving biodiversity (Dubbling, 2014); producing food (City of Calgary, 2018; Rouse, et al., 2016); improving air and water quality (Metro Vancouver, 2015); and enhancing urban greenspaces through beautification, and improvements to the tree canopy and landscaping (City of Winnipeg, nd.; La Rosa & Privitera, 2013).

Further benefits of green infrastructure include social and economic benefits, such as improvements to quality of life, health and wellbeing, increased property values, recreation opportunities, job creation, community building, environmental education, and savings from energy efficiency. Green infrastructure can also be more cost effective than grey infrastructure, in part because of this multifunctional nature (Cohen & Wijsma, 2014; Metro Vancouver, 2015).

Green infrastructure projects have been criticized for taking too narrow a focus on stormwater management and failing to leverage possible social and economic benefits for improved community benefit (Lovell & Taylor, 2013). Indeed, **at its most impactful, green**

infrastructure involves an interconnected network of large and small, public and private green infrastructure components that work collectively to improve urban life, while leveraging green infrastructure's multiple benefits based on local context (Metro Vancouver, 2015; Lovell & Taylor, 2013; United States Office of Rainwater Management, 2016).



Green infrastructure opportunities across the urban landscape

Metro Vancouver regional green infrastructure policy documents list small, medium, and large-scale green infrastructure interventions on a range from soft- to hard-scape options. At its most impactful, green infrastructure involves an interconnected network of projects, including urban agriculture components such as community gardens.
(Metro Vancouver, nd., p. 7)

Green Infrastructure, Stormwater Management and Urban Agriculture

A number of green infrastructure options for stormwater management can be designed with food production as a central element, include edible components, or benefit from stormwater harvesting systems. **Green roofs, urban canopies, and planter boxes can include food producing components; rainwater harvesting and reuse systems can provide important water infrastructure for community gardens and other types of urban agriculture; and urban agriculture projects preserve porous areas while increasing their stormwater retention capabilities through improving urban soils.** These interventions offer opportunities to provide green infrastructure ecosystem services to the city while simultaneously enhancing the City's foodscape, contributing to municipal food security, creating jobs, enhancing climate resiliency and increasing social cohesion and wellbeing, and ultimately recognize urban agriculture as green infrastructure and a multifunctional tool to address various city problems.

Soil based green infrastructure managed in such a way as to increase the levels of organic matter, like those found in urban agriculture, are especially capable of managing storm water. Soils with high organic matter have increased water retention capacity, acting as sponges during heavy rainfall events. Organic matter enhances soil water retention because of its hydrophilic nature and its positive influence on soil structure. Organic matter improves soil structure by helping form aggregates, thereby increasing porosity to retain plant-available water, enhance infiltration and water retention in the rooting zone (Huntington, 2016). **Soil management activities such as adding woodchips, compost and other amendments undertaken while cultivating food can improve compacted soils and/or those with higher clay content over time, such as those commonly found in Winnipeg** (Grittman, 2015). Studies have shown that amending urban soil with compost at a 2:1 ratio doubles infiltration rates (Grittman, 2015). Increasing soil organic matter and friability in this way improves urban soils ability to absorb storm water (Gittleman, 2015). Urban agriculture is especially suited to improve soil structure, as improved soils also increase productivity for food production.

Ultimately, determining which type of green infrastructure is appropriate depends on local context, project objectives, opportunities, and constraints (Metro Vancouver, nd(b)). When green infrastructure is evaluated solely for stormwater capture, urban agriculture may not be the most impactful. However, soil based urban agriculture preserves areas of permeable surfaces and improved soils which have more rainwater capture capabilities than areas with compacted soils, pavement or other solid surfaces, and can also benefit from rainwater capture and retention projects such as cisterns or bioswales. Therefor urban agriculture is part of the rainwater capture solution and has a place in planning for stormwater management through green infrastructure.

Case Studies

The following case studies outline ways in which other cities have recognized urban agriculture's contributions to green infrastructure and stormwater management.

New York

New York City has a 20 year strategy to reduce combined sewer overflows through managing the first 1 inch of precipitation on 10% of impervious areas in all combined sewer districts (Department of Environmental Protection, 2010). It is estimated this will result in an 8.1% reduction of combined sewer overflows citywide from green infrastructure alone (Department of Environmental Protection, 2016). Prioritizing green infrastructure over grey in controlling combined sewer overflow was determined to be more cost effective in meeting overall capture targets. The 20 year 5.3 billion USD plan earmarks 45% of the budget, or 2.4 billion dollars, for green infrastructure. The same targets achieved through grey infrastructure alone was estimated to cost 6.8 billion USD. Through green infrastructure investments, taxpayers are predicted to instead save 1.5 billion USD (Department of Environmental Protection, 2010; Cohen & Wijsma, 2014), while at the same time receiving an estimated $139 million to $418 million in co-benefits of green infrastructure, such as reduced energy bills, increased property values, and improved health (Department of Environmental Protection, 2010; Grittman, 2015).

Since 2011 New York City has been providing funding for urban agriculture projects through its Green Infrastructure Grant program. Projects receiving funds from this program must demonstrate feasibility, and the ability to capture and retain at least 1 inch (2.54 cm) of storm water from an impervious tributary area (Cohen & Wijsma, 2014). While the grant focuses on projects abilities to manage storm water, urban agriculture and edible landscaping components are seen as positive features because of the co-benefits of food production. Funds for the grant program come from bonds issued by the public authority and paid by water and sewer rate payers, rather than the general municipal capital budget, making funding more stable and less subject to budget cuts (Cohen & Wijsma, 2014).

The Brooklyn Grange is an urban rooftop soil-based farm in New York City that has received funds through the Green Infrastructure Grants program for its ability to absorb and slow the flow of storm water during heavy rainfall events. It covers one acre of rooftop in the Brooklyn Navy Yard, and manages over 1 million gallons – almost 3.8 million litres – of storm water per year (Cohen & Wijsma, 2014). The rooftop farm grows 40 varieties of tomatoes, salad greens, carrots, herbs, peppers, beans radishes, and chard using organic practices, which it sells to local restaurants and retail stores, Community Supported Agriculture members, and weekly farm stands. It has also expanded its business to include an educational non-profit component, and urban farm and green roof consulting and installation services (Cohen & Wijsma, 2014).

Philadelphia

The City of Philadelphia has a 25 year plan to manage stormwater in the city through a citywide network of green infrastructure, aimed to decrease combined sewer overflows by 85%. The city decided to spend $2.4 billion USD, augmented by large expenditures by the private sector, to create a city wide mosaic of green infrastructure to meet these targets. The same targets achieved solely through grey infrastructure investments were estimated to cost $9.6 billion USD (Stutz, 2018). These interventions range from home rain barrels to complex bioretention swales. By the mid 2030s, Philadelphia hopes to have the largest green infrastructure network for stormwater retention in the United States (Stutz, 2018).

The City of Philadelphia includes a charge for stormwater management on residential water bills based on the impervious area cover on residential property. This helps the city cover costs on services provided for stormwater management, which come to $100 million USD annually for the city (City of Philadelphia, nd.(a)). The city gives discounts on this charge to community gardens, recognizing that they play an active role in managing stormwater (City of Philadelphia, nd.(b)). The discount can be for up to 100% of the stormwater management charge (Grounded in Philly, nd.). To participate in the Community Garden Stormwater Charge Discount program, 80% of the community garden parcel must be pervious. Market farms meeting the same criteria are also eligible for this program (City of Philadelphia, nd.(b); Grounded in Philly, nd.).

Vancouver

In 2019, Vancouver City Council voted to adopt the Rain City Strategy to reimagine how the city manages stormwater using green infrastructure. This is a $1.5 million CAD capital project to capture and treat 90% of Vancouver's average annual rainfall, and the first 48mm of rainfall per day (City of Vancouver, nd.). On top of other robust policies already in place to support community food assets such as food gardens, urban agriculture and urban farms throughout the city by a minimum of 50% from 2010 levels as part of their Greenest City 2020 goal (City of Vancouver, nd.(b)), this rainwater focused strategy acknowledges food gardens, food harvesting, and increased pollinator presence for edible plant pollination as a benefit of green infrastructure for stormwater management (City of Vancouver, 2019).

Green Infrastructure in Winnipeg's Combined Sewer Districts

Through the City of Winnipeg CSO Master Plan, $104.6 million is ear marked for green infrastructure over 27 years in areas of the city with combined sewer districts. To date, four green infrastructure projects have been undertaken by the Winnipeg public service, naturalized Parker Lands Stormwater Retention basin, the University of Winnipeg redevelopment project, the pilot green back ally project in the Jessie district, and soil storage cells as part of the North East Exchange improvements (Patton, 2020). The public service anticipates undertaking green infrastructure pilot projects over the next five years to determine green infrastructure solutions' feasibility, and benefits to runoff volume reduction performance (Patton, 2020).

The public service currently plans to measure success of green infrastructure pilots through monitoring pre- and post- flow levels of individual projects with only those proven effective (Patton, 2020, p. 4) to be recommended for further use. Further information on the metrics used to evaluate individual projects effectiveness is needed, however if individual projects are measured only on their ability to meet the target of 85% capture, other benefits could be missed. Measuring the success of green infrastructure projects on their individual merits as opposed to examining them within the context of a scaled network where individual projects consider benefits and constraints present in each sewer district, could preclude opportunities to use a green infrastructure network to meet rainwater capture targets while maximizing the various environmental, community, and economic benefits associated with different types of green infrastructure. While combined sewer overflow management is the priority objective, caution should be used when determining how success of green infrastructure projects are measured.

The CSO Master Plan acknowledges there are unknowns and uncertainty with green infrastructure application and recommends evaluations and pilots of these technologies to be completed within the first ten years to provide confirmation that these proposed options are appropriate and suitable for the Winnipeg sewer system (Jacobs Engineering Group Inc, 2019). Several possible challenges are listed that will need to be addressed in green infrastructure trials, including:

- High levels of clay in local soils decrease infiltration rates and storage recovery time,
- Frozen soil in spring may decrease year-round performance and inhibit water penetration during critical snow-melt periods, and
- The freeze-thaw cycle may negatively impact permeable pavement options.

Any of these complications could mean increased maintenance costs of green infrastructure to achieve the required capture rates required for established targets (Jacobs Technical Report).

Whether one green infrastructure application will address these challenges while at the same time being the correct intervention in each sewer district remains to be explored. Implementing a range of interventions to create a layered network of small, medium, and large size green infrastructure, while also leveraging co-benefits to enhance community well-being can help ensure the above concerns are addressed within a green infrastructure network. While urban agriculture has the ability to address challenges with heavy clay soils and can be an appropriate component of green infrastructure in some neighbourhoods, other designs will also be required to fit local contexts and help achieve intended targets.

In considering green infrastructure pilot projects over the next several years that can manage stormwater while providing other environmental, social, and economic benefits, the public service should consider the benefits of urban agriculture in meeting these objectives.

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Appendix A: Combined Sewer Districts Conceptual Map