

**Building the Future:
Green Infrastructure Approaches to Rural Service
Delivery & Economic Development in Southwest
Ontario**

by
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Abstract

This paper explores the use and benefits of Green Infrastructure in rural and small-town communities in Southwestern Ontario. 19 key informant interviews inform the qualitative findings that rural communities are engaging in and receiving diverse benefits from collaborative Green Infrastructure projects and initiatives. While Green Infrastructure is prevalent on the rural landscape, this term covers a wide array of natural and human made features and is rarely used to describe projects and initiatives aimed at improving ecosystem services on rural service provisioning in the study area. Regardless of terminology, interviewees identified both economic and non-economic outcomes of GI projects that resonate with rural stakeholders and have served as motivating factors to expand GI on public and private land. A lack of awareness and consideration of rural needs and opportunities related to Green Infrastructure has slowed the uptake of this important approach to planning and development and should be addressed through further research initiatives and support from senior levels of government in policy, funding, and training.

Keywords: Green Infrastructure; Natural Assets; Rural Development, Economic Development; Land Use Planning; Ontario

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List of Acronyms

ALUS	Alternative Land Use Services Canada
BMP	Best Management Practices (relating to rural stormwater)
BTF	Building the Future research initiative
CA	Conservation Authority
DMAF	Disaster Mitigation and Adaptation Fund (federal infrastructure funding)
FCM	Federation of Canadian Municipalities
G2G	Guelph to Goderich Trail
GI	Green Infrastructure
GIO	Green Infrastructure Ontario Coalition
LID	Low Impact Development (relating to urban stormwater)
MCIP	Municipalities for Climate Innovation Program (FCM funding)
MNAI	Municipal Natural Assets Initiative
MOECP	Ontario Ministry of the Environment, Conservation, and Parks
MNRF	Ontario Ministry of northern Development, Mines, natural Resources, and Forestry
NbS	Nature-based Solutions (most often relating to climate action)
OMAFRA	Ontario Ministry of Agriculture, food, and Rural Affairs
PPS	Provincial Policy Statement (Ontario's guiding planning document)
RTO4	Regional Tourism Organization 4 Inc

Chapter 1. Introduction

1.1. Purpose and Objectives

My research aims to provide a snapshot of the current state of green infrastructure practice in rural and small-town communities. Green infrastructure can be defined as natural or human-made elements that provide ecological and hydrological functions. Green infrastructure is becoming a priority topic in urban planning for its ability to mitigate negative impacts of human development like excessive stormwater runoff and flooding, the urban heat island effect, water and air pollution, and loss of wildlife habitat and biodiversity, all while providing communities with access to high-quality greenspace. Existing literature has largely ignored the potential role and benefits of green infrastructure in rural communities. There is a need to better understand the unique challenges and opportunities faced by rural communities to improve the use of green infrastructure as an alternative and emerging approach to managing infrastructure pressure and economic development.

My analysis of rural green infrastructure is based on a qualitative analysis of interview data from a regional case study of leading green infrastructure initiatives in Southwestern Ontario. The findings of the research are intended for use by federal, provincial, and municipal policy makers as well as any other organization or group interested in improving green infrastructure policy and programming.

The key research objectives of this study are to:

- Identify how rural communities are using green infrastructure and what the main **economic motivators** are to pursue nature-oriented development.
- Identify how awareness of and **capacity** to manage ecological systems influence the utilization of green space and natural areas as green infrastructure.
- Determine how the **regulatory environment** around land use and development processes support or constrain the effective application of green infrastructure in rural areas.

1.2. Research Scope

This paper is part of a research partnership with the University of Guelph and the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA). The Building the Future research initiative is an Ontario-focused study working to identify the capacity of rural communities to respond to infrastructure pressures of all kinds and the impact this capacity, or lack thereof, has on communities' short and long-term economic development. The outcomes of this initiative and all its contributing works are intended to enhance understanding of the diversity and varying levels of rural community capacities, improve more nuanced public policy, and enhance rural infrastructure development programming.

The results of this paper are focused on green infrastructure as one piece of the infrastructure and development puzzle faced by rural communities. The theme of green infrastructure is explored through a regional case study to showcase leading approaches throughout Southwestern Ontario. This study is not an exhaustive representation of green infrastructure approaches in the study region, but rather highlights some of the benefits and challenges as told by professionals engaged in the topic through semi-structured interviews.

1.3. Restructuring of Rural and Small-town Canada

Communities of all sizes face the challenge of providing residents with high-quality services while balancing fiscal realities, changing economies, aging infrastructure, demographic shifts, and a challenging climate future. Rural communities, which can be characterized by their low population density or their distance from dense metropolitan centres (Bollman & Reimer, 2018), are diverse with varied and unique assets, character, and capacity to manage change. The diversity of rural communities must be considered in responses to planning and policy issues at all levels of government (Markey et al., 2008; Reimer, 2006; Vodden et al., 2015)

Historically, rural communities have been at the heart of Canada's resource economy and represent regions of immense natural wealth. National and private sector investments in rural regions in the post World War II era used Keynesian policies to boost economic activity through natural resource extraction (Halseth et al., 2019). These

investments supported an expansion of rural regions and greatly improved rural infrastructure, services, and ultimately raised the standard of living for rural residents (Halseth et al., 2019; L. Sullivan et al., 2015). However, dependence on senior government investments and single large industries left many communities vulnerable to economic shocks and policy reform (Halseth et al., 2019). Further, investments in rural communities have typically focussed on moving resources, and ultimately wealth, out of periphery regions (Hiller, 2003; Markey & Heisler, 2010). The adoption of neoliberalist policies in response to the recession of the 1980s and 1990s spurred reductions in government spending and service provisioning in rural regions (Markey et al., 2009), leaving communities to independently search for new economic opportunities without critical supports previously provided by senior governments (Halseth, 2016; Halseth et al., 2019). Many rural communities have struggled to adjust to this restructuring, losing important social services, as well as the ability to maintain and reinvest in aging infrastructure (Douglas, 2005; Halseth et al., 2019). Rural communities have also been challenged by the loss of young people and skilled labour to urban centres and remote labour markets (Corbett, 2005).

Infrastructure is a critical part of community resilience as it provides services that support the health and wellbeing of people in a well-functioning society. Further, infrastructure provides the organizational structures and physical amenities required for the movement of people, information, goods, and services that allow economic activity to take place (Breen, 2015). As such, infrastructure is commonly correlated with economic development and regional potential for economic growth. Communities with high-quality infrastructure or the capacity to invest in new infrastructure are generally thought to be more productive and competitive in global markets (Manggat et al., 2018; Oyedele, 2012). Investments in productivity-enhancing infrastructure, like transportation, water management, and digital information networks, have and continue to be pursued as the most powerful mechanism for supporting immediate and long-term economic development in Canada (Advisory Council on Economic Growth, 2016; CRRF, 2016). However, investments have failed to adequately maintain existing assets and keep pace with population growth and shifting infrastructure demands for a broader range of social and technological approaches to infrastructure, including renewable energy and transportation, digital infrastructure, green infrastructure (or nature-based solutions), and social equity approaches to service provisioning (Infrastructure Canada,

2021; Ragan, 2020). This investment gap has left Canada with an estimated infrastructure deficit of more than \$150 billion, with disproportionate impacts on rural, remote and indigenous communities (Advisory Council on Economic Growth, 2016). Additionally, the application of space-oriented infrastructure and development policies have attempted to reduce the distance to rural resources but have largely been insensitive to the diversity of rural places (Halseth et al., 2009; Markey et al., 2008). These policies have promoted the growth of industries and development patterns that impose high costs to social and natural systems. Costs, which are no longer being tolerated by rural residents (CRRF, 2016).

Rural and small-town Canadian communities are at a critical turning point following decades of dramatic change and separation from policy processes and decisions over infrastructure and development investments. Capacity to manage and respond to development and service pressures has a direct impact on community's ability to meet their current and future needs, though decisions about investment should be made carefully to prioritize long-term solutions over short-term relief (Ragan, 2020). The need to respond to these pressures is supporting a growing movement to develop resilient communities that are better able to respond to and manage shocks or disturbances that challenge traditional development models (Christopherson et al., 2010). Resilient communities and regions are dynamic and continually evolve to meet new demands and opportunities presented by local and global factors (Boschma, 2015; Christopherson et al., 2010). The development of resilient communities must also be place-based to build on the unique natural, built, and social assets of a community or region (Markey et al., 2015) and to respond to development pressure in a locally and regionally appropriate manner (Barca et al., 2012; Douglas, 2005; OECD, 2019a).

To be resilient, rural communities must have the financial, technical, and human resources to adequately plan for a future that may look very different from their past. This requires new strategies, policies, and partnerships to make rural communities more resilient (Markey et al., 2015) – particularly regarding infrastructure (Freshwater, 2017; Spears, 2016). Infrastructure is more than the assets that service communities. Infrastructure is tied to community identity; It connects people to each other and the places we live, work and play (Connelly et al., 2009).

Expanding the concept of infrastructure to be more inclusive of place-based community assets presents exciting opportunities to advance community resilience and economic development while also improving human connections and relationships with each other and the land. Green infrastructure is a rapidly growing topic area for both community resilience and place-based infrastructure development, though its application and impacts remain understudied in the rural context. This will be explored through the remainder of this paper.

1.4. Understanding Green Infrastructure

Nature and its ecosystem services ultimately form the basis for all human society and economies to function (Costanza et al., 2014; WWF, 2018). Allowing nature and natural services to be degraded, not only harms “the environment” but also the wellbeing of the communities that live in and depend on it (Costanza et al., 2014). Much like built infrastructure, the abundance and quality of natural resources or natural assets have been and continues to be a key determinant of community development and economic success. Ecosystems will always provide the necessary, life-giving amenities of air, water, soil, and raw materials (Swiss Re Institute, 2020), but more recently have gained recognition for their value in providing core infrastructure services to communities, like water purification and flood control, with added benefits that improve local quality of life (Kim & Song, 2019). When thought of and used in this way, natural features and their ecosystem services are often termed Green Infrastructure (GI).

Many definitions of green infrastructure exist depending on the intended use and field of study (Bartesaghi Koc et al., 2017; Matsler et al., 2021). The Canadian government uses a definition of GI that focuses entirely on engineered systems aimed at reducing environmental impacts and improving human health. This includes things like water and wastewater facilities, storm sewers, electric vehicle charging stations, and renewable energy projects (Government of Canada, 2020). This definition does not reflect the primary definitions of GI within a wide body of academic and grey literature that define GI as networks of natural and semi-natural features, that can provide multiple ecological, social, and economic benefits (Bartesaghi Koc et al., 2017).

The terminology that is used to discuss GI is highly dependant on the context and intended use/benefit of a project or initiative. For instance, when applied to

stormwater management GI relates to networks of natural and engineered green spaces that are integrated within a stormwater management system and are often termed Low Impact Development (LID) in urban areas (Fletcher et al., 2014; U.S. EPA, 2015), or best management practices (BMP) in more rural agricultural areas (Matsler et al., 2021; Yang, 2016). In the context of conservation terms like stewardship and ecosystem restoration are common (Bittman et al., 2021); in the realm of climate action and sustainability planning GI is increasingly discussed as nature-based solutions (NbS) (Cohen-Shacham et al., 2016); and in economics, GI is usually considered in a broader context that addresses all the benefits humans derive from nature and these benefits are termed ecosystem services or natural capital (Chenoweth et al., 2018; Farber et al., 2002). These perspectives and terminologies generally have substantial overlaps in meaning and intent, but the ways they are used in policy will influence how GI is discussed, planned for, and applied (Conway et al., 2020; Matsler et al., 2021).

The term ‘green infrastructure’ was coined largely to change perceptions of green space among those who otherwise may have little interest in conservation. Because infrastructure has close associations with economic development, framing natural and enhanced natural systems as infrastructure has helped build the economic case for GI in the eyes of developers and economically minded organizations (Horwood, 2011). A growing body of literature—starting with applied studies out of the United Kingdom—has demonstrated that GI can have a diverse range of economic benefits that fit in four categories (**Table 1**). While terminology and approaches may vary, GI is becoming an increasingly common development tool used to meet a variety of planning objectives. GI’s popularity comes largely from its multifunctionality of using natural systems as adaptable and interconnected assets and amenities (Demuzere et al., 2014; Kim & Song, 2019; Kraehling, 2018; Wang & Banzhaf, 2018; Zidar et al., 2017). Regardless of the primary function, GI systems can be integrated with surrounding traditional or grey infrastructure to provide a wide range of services and community benefits.

Table 1. The economic benefits of Green Infrastructure. Adapted from Caldwell et al., 2016 and Ecotec, 2008

Direct benefits	<p>Growth of green industry – jobs in design, construction, maintenance (e.g., engineering, landscaping, and horticulture)</p> <p>Eco-tourism – recreation focused on or benefiting from natural spaces and GI features</p> <p>Increased property values – esthetics and access to green space</p> <p>Resource economies – timber sales and local food production</p> <p>Payments received for ecological goods and services – paid to landowners for conservation efforts (e.g., ALUS, and offset programs)</p> <p>Money from fees – park entrance</p> <p>Leverage funding received from others outside the local community – multi-functional projects can access multiple funding sources (e.g., environmental, infrastructure, recreation, and health)</p>
Indirect Benefits & Spinoffs	<p>Attracting visitors – spending in the local economy</p> <p>Attracting & retaining residents – provide valued community amenities</p> <p>Reduced health care costs – clean air & water, green space for improved physical & mental health</p> <p>Increased farm field yields – conserving topsoil, promoting soil development, and improving pollinator habitat</p> <p>Education – connecting people and particularly children to nature</p>
Cost Savings	<p>Decreased infrastructure spending – lower capital/operating expenses</p> <p>Decreased energy and maintenance costs – passive energy mechanisms</p> <p>Cost savings to farmers – improve soil and reduce need for chemical inputs</p> <p>Complements ‘grey’ infrastructure provision – reduce pressure on and extend lifespan of built infrastructure roads, buildings, storm sewers</p>
Risk Management	<p>Avoids cost of flooding – slow runoff and protect roads and properties</p> <p>Mitigates drought costs – retains water on the landscape</p> <p>Lower health cost during extreme heat events – moderate temperature with greenspace and provide shade to reduce heat stress</p> <p>Safeguarding soils – reduced erosion</p> <p>Environmental resilience – preserves biodiversity & native species</p>

Some of these benefits, most notably direct and cost-saving benefits like job creation, land prices, infrastructure cost savings, and resource values are relatively easy to measure using standard economic procedures, though approaches vary depending on objectives, resources, and other considerations (Elmqvist et al., 2015; U.S. EPA, 2013). Other benefits have more complicated ties to GI and can be difficult to accurately account for. This is especially true for indirect benefits or economic spinoffs, which are some of the main ways GI supports economic development (Gómez-Baggethun &

Barton, 2013; Wild et al., 2017). GI is a major contributor to community livability, which is critically important to how communities can attract and retain residents and investments in the local economy, especially with the current hypermobility of information, labour, and resources (Kim & Song, 2019; Rottle & Maryman, 2012). GI provides important social, recreation, and leisure amenities, as well as esthetic values that make communities attractive places to live and do business (Firehock, 2015; Herbert & Dale, n.d.). GI is also receiving substantial attention for its ability to make infrastructure systems and communities more resilient to climate change and avoid or reduce the costs of extreme events like floods, heatwaves and droughts while providing additional co-benefits (ACT, 2020; Moudrak et al., 2018; Swanson et al., 2021). Despite challenges in accounting for complex benefits, GI's importance to community wellbeing has been well demonstrated to this point and efforts continue to improve the ways we value ecosystem services (Bassi et al., 2019; Caldwell et al., 2016; Elmqvist et al., 2015; GIO, 2020; Horwood, 2011).

Most often the base infrastructure function of GI relates to stormwater management with other outcomes considered as co-benefits. This is a dominant theme in both academic and grey literature (Matsler et al., 2021), which focuses on GI as a response to a loss of natural hydrology in urbanized regions. GI helps manage stormwater when green spaces like parks, boulevards, streams, wetlands, trees, and other vegetation are strategically used to retain rainwater where it lands and absorb runoff from nearby impervious surfaces. Green spaces surrounding communities (e.g. farmland, forests, and floodplains) also offer important stormwater protection functions, storing rainfall and moderating stream flows to low-lying development (Haghighatafshar et al., 2018; Zhen et al., 2006). However, GI can serve many functions beyond stormwater management. GI of all types can improve water quality and groundwater recharge (Nowak et al., 2014; Sage et al., 2015; Spatari et al., 2011). Farmland and forests offer provisioning services through crops and timber (Amati & Taylor, 2010). Public parks and greenways provide recreational opportunities and corridors for active transportation (Rottle & Maryman, 2012). Parks, forests, and other vegetated areas moderate temperatures during summer heatwaves through shading and evaporative cooling (Gill et al., 2007; Sun & Chen, 2017). These thermal benefits can reduce heat stress on vulnerable populations and even lower building energy use when trees, green roofs, and building façades are used effectively (Kim & Song, 2019). The full range of

benefits provided by GI will depend upon the type and scale of a particular system or frame of analysis but planning for GI is most effective at a regional scale and at the onset of development.

Unfortunately, the rapid surge in development since industrialization has largely ignored natural systems for their benefits to service provisioning and community wellbeing (Rottle & Maryman, 2012). In many cases, services provided by forests, wetlands, streams, and natural areas have been removed or radically altered in favour of expensive networks of engineered or grey infrastructure (Wild et al., 2017). Conventional development has supported rapid population and economic growth but has been accompanied by a host of unintended and undesirable consequences like pollution, biodiversity loss, and climate change that are estimated to be costing the world economy between \$4.3 and \$20 trillion annually in lost ecosystem services (Costanza et al., 2014). Additionally, replacing natural systems with grey infrastructure has high Lifecycle costs when considering construction, maintenance, and ultimately asset disposal or replacement as grey infrastructures are subject to continual degradation over their designed lifespan (Denjean et al., 2017).

In contrast, GI can provide a dynamic, low-cost solution to many infrastructure problems that may result from environmentally insensitive development. Early consideration of GI can ensure that development takes place in a way that conserves natural features to make the best possible use of ecosystem services and minimize the impacts of development (Roe & Mell, 2013). GI solutions often have low or even no capital costs if considered before development, and while GI can be integrated within existing grey infrastructure networks, it can be expensive to restore a natural service retroactively. Yet, even in retrofit scenarios, GI can provide cost-effective services that reduce pressures on or expand the capacity of other aging grey infrastructures like roads, storm sewers, and building systems that are relatively inflexible to shifting service demands and climate conditions (Roe & Mell, 2013). Unlike grey infrastructure, GI can become more resilient over time as biological systems grow to provide a fuller range of services and develop a stronger capacity to withstand and adapt to environmental conditions (Demuzere et al., 2014; Denjean et al., 2017). Furthermore, GI can be cheaper and easier to maintain than grey infrastructures like storm sewers buried under roads, requiring less heavy equipment and more human labour, creating green jobs (Piazza & Clouse, 2013). The visibility of GI also adds attractive community assets and

helps to demonstrate its value and connect people to infrastructure and the environment, building support for sustainable practices (Connelly et al., 2009).

Applications of GI vary from the highly localized scale at the building or site level (e.g. green roofs, street trees, and Rain Gardens) to the landscape scale which generally focuses on a watershed-level analysis of green space and natural areas (Schiappacasse & Müller, 2015). Some large-scale conservation initiatives may also be thought of as GI and consider ecosystem connections on a continental scale like the Yellowstone to Yukon initiative for wildlife conservation (Kraehling, 2018). Applications also vary greatly depending on local context and development pressure and are likely to vary within and among urban and rural communities. Because of the relatively high population density and acute development pressures present in urban areas, most research, policy, and program development surrounding GI has focussed on these larger centres. Rural regions, with their seemingly abundant natural assets and small populations, have consequently been underrepresented in GI discourse. There is a theme within some GI literature that presents rural areas as part of the GI assets that serve nearby cities more so than communities that benefit from the local assets themselves (Horwood, 2011). An example of this type of urban-oriented, yet rural situated GI planning can be seen through the Greenbelt Initiative in the Greater Toronto region of Ontario (Amati & Taylor, 2010; Green Analytics, 2016). In actuality, rural communities may experience many of the same benefits seen in cities, like cost-savings related to natural stormwater management (Town of Gibsons, 2017), as well as unique benefits related to their proximity to and relationship with natural areas (Kraehling, 2018). Figure 1 shows the diversity of GI features present in the rural landscape.

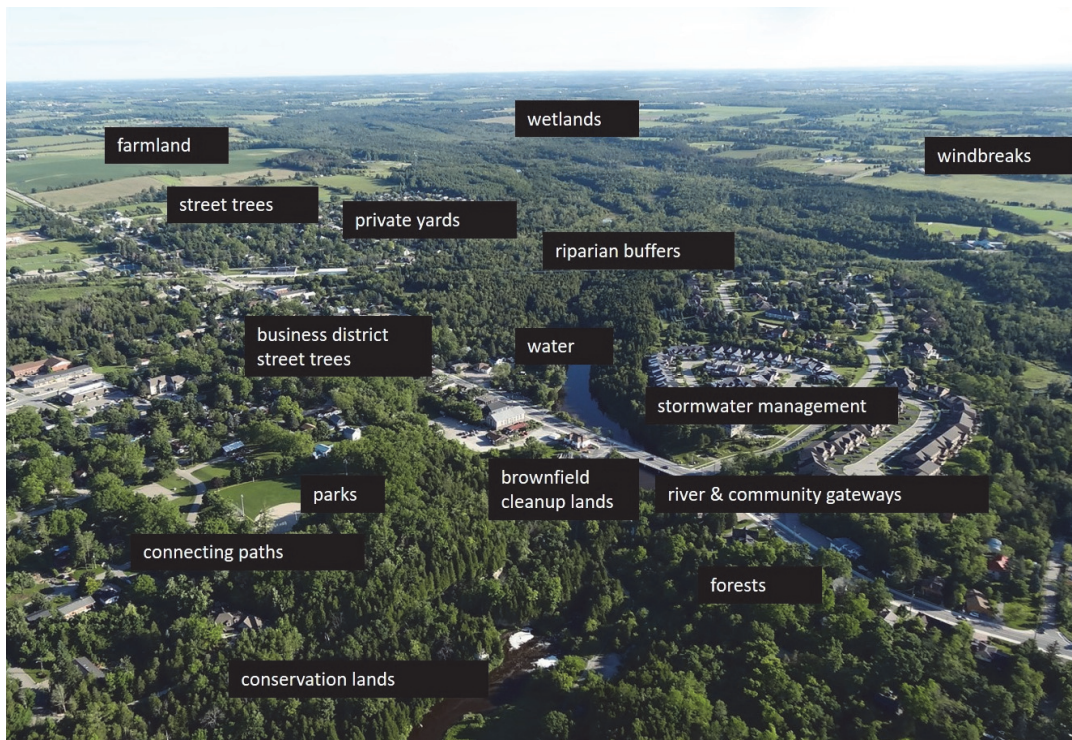


Figure 1. Rural GI in a Southern Ontario Community. Source: Kraehling, 2018.

1.5. Context for Green Infrastructure in Ontario

Consistent with the rest of North America, Ontario has seen most efforts around GI focussed in its large urban and suburban areas. Large municipalities, most notably in the Toronto Region, have been engaged in the topic of GI for many years now, adopting policies like the [Toronto Green Roof Bylaw](#) in 2009 and undertaking large restoration projects like the [Don River Mouth Naturalization and Port Lands Flood Protection Project](#) set to be completed in 2024 and cost \$1.25 billion. These types of initiatives are an increasingly common response to the glairing development pressures, environmental quality issues, and climate change risks experienced in urban Ontario (Amati & Taylor, 2010; Lilauwala & Gubert, 2019). In contrast, rural Ontario has not seen the same level of policy development or investment in GI, though smaller and more distributed GI initiatives have been going on in some communities since the late 20th century. While examples of GI exist on the rural landscape they generally have not been referred to as GI and some of their benefits have been overlooked or under utilized (Kraehling, 2018).

In 2014, Ontario officially recognized the importance of green infrastructure by adding it to the Provincial Policy Statement (PPS). The definition of GI adopted in the PPS is consistent with the nature-based approaches described in the literature, which focuses on protecting and enhancing biodiversity and ecosystem services.

“Green infrastructure means natural or human-made elements that provide ecological and hydrological functions and processes and includes natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs.” (Government of Ontario, 2020a p.44)

This is an important definition as the PPS sets the province’s planning priorities and provides high-level guidance for all municipal planning and development processes. While this definition offers new consistency for the GI sector in Ontario, there is still substantial variation in the specific typologies used to describe and characterize specific approaches to GI. For instance, natural heritage feature designation and systems planning are prevalent approaches to promoting GI, particularly in rural areas, but the connection to infrastructure service provisioning and natural heritage is not clear within the PPS beyond the definition of GI. Additionally, inconsistencies in the definition and intent of GI between the provincial and federal governments remain problematic for building support and developing effective GI policy and programming at a broad scale (Conway et al., 2020).

GI has also been prioritized provincially through Asset Management Regulation (O/Reg. 588/17) which requires all municipalities to complete a natural asset inventory and management plan by 2024 (Government of Ontario, 2017). Asset management is an increasingly common way that municipal governments are recognizing and prioritizing the benefits of green infrastructure to improve local services with low life-cycle costs (Molner, 2020). The Municipal Natural Asset Initiative (MNAI) has contributed substantially to advancing the practice and body of knowledge through applied research and pilot projects with local governments across the country.

The provincial and municipal governments play an important role in the management of GI through land use planning and development regulation but, Ontario’s Conservation Authorities (CAs) are generally the largest proponent of GI especially in rural regions of Ontario. CAs are a unique organization to Ontario and operate as non-

profit organizations with the mandate to regulate development and environmental impacts on a watershed scale (Conservation Ontario, n.d.), placing them in a strategic position to manage GI resources and support GI-related activities. However, recent changes to the Conservation Authority Act have the potential to substantially reduce this mandate and the capacity of CAs to influence GI implementation (Conservation Ontario, 2021; Government of Ontario, 2020b; Macnab, 2020). In areas in the province where CAs do not exist (mostly northern and remote locations containing only 5% of Ontario's population) the Ministry of Natural Resources and Forestry regulates land use and development and has an influence on GI similar to the CAs in other parts of the province (Conservation Ontario, 2021). The federal government and other funding organizations like the Federation of Canadian Municipalities are also important players supporting the delivery of GI by providing financial recourses to local municipalities and stakeholders.

Beyond their regulatory powers, municipalities and CAs are also important contributors to GI as the owners of substantial GI assets in the form of parks, conservation areas, and other natural heritage features like county woodlots. Natural heritage is the policy term used to describe areas with natural land cover (e.g., forest, meadows, shrub thickets, and wetlands). While natural cover is very limited in most of Southwestern Ontario, these areas are regulated through land use policies to prevent further unwarranted losses (Government of Ontario, 2020a; Wise et al., 2014). Because many natural heritage features occur on private land, private landowners and developers also play a key role in the delivery and management of GI in rural regions. Agricultural landowners are particularly important as agriculture is the dominant land use in most rural communities of Southern Ontario, accounting for over 90% of the land cover in some municipalities (Perth County, 2020). Farmers make their living off the land and are generally good stewards, but rising land prices, shifting tenure systems, and consolidation of agricultural production are placing increasing pressure on the rural landscape (Rotz et al., 2019).

Because the land use and associated development pressures differ greatly between urban and rural communities in Ontario, so too do the applications and management of GI. Rural communities have comparatively small challenges with runoff from hard surfaces and most GI responses are instead focused on conservation and stewardship efforts that improve natural ecosystems, reduce soil erosion from agricultural fields, and improve water quality in streams, rivers, and ultimately the Great

Lakes (Kraehling, 2018). GI work is collaborative and is usually carried out through partnerships between CAs, landowners, municipalities, and potentially a host of other stewardship and environmental organizations or community groups. **Table 2** presents a more comprehensive view of the organizations involved in GI in rural regions of Ontario.

Table 2. Organizations involved in Green Infrastructure in rural and small-town Ontario. This is not an exhaustive list of all organizations and stakeholders, but demonstrates the diversity of Green Infrastructure actors from the local to national scale.

Sector	Organization
Agricultural	Landowners Farmers' groups (e.g., National Farmers Union, Federation of Agriculture) Soil and Crop Improvement Associations Certified Crop Advisors
Tourism and Recreation	Trail societies (e.g., Maitland Trail Association, Bruce Trail Association) Tourism Organization (e.g., RTO4)
Government & Government Related	Local and regional municipalities, and Indigenous communities Conservation Authorities, Conservation Ontario Community Futures Provincial Ministries (e.g., OMAFRA, MNR, MOECP) Federal Ministries (e.g., Infrastructure, and Environment) FCM Ontario Trillium Foundation
Stewardship and Environmental NGOs	Green Infrastructure Ontario ALUS Canada National conservation groups (e.g., Ducks Unlimited Trout Unlimited) Tree Canada Local stewardship groups (e.g., Elgin stewardship council, Healthy Lake Huron) Land trusts
Private Sector	Land developers Planning and engineering consultants Landscaping, drainage, and restoration contractors
Research and Information	Universities and colleges Government agencies

	NGOs, think tanks, and Conservation Authorities
The Public	All other interested Citizens within rural communities

While agriculture is the most dominant pressure on rural lands in Southern Ontario, manufacturing, tourism, forestry, aggregate extraction, and other industrial and resource activities also play an important role in local economies (Freshwater, 2017). These, economic sectors, along with conservation efforts for wildlife and biodiversity have also been the target of rural initiatives that contribute to regional GI networks. Tourism and quality of life more generally are a critical interest point for the economics of GI and present opportunities for expanding project benefits beyond improving infrastructure capacity and environmental quality. Access to natural environments and lifestyle amenities like trails, beaches, and parks is a major draw for people visiting and living in rural communities, though these amenities tend to be secondary to or dependent on additional factors like housing, employment, and support services (Luke, 2015; Vuin et al., 2016). Nevertheless, the organizations that promote and maintain natural amenities are key stakeholders in delivering rural GI.

Recent efforts to quantify the economic impact of GI in Ontario found that GI-related activities contributed \$8.4 billion in gross outputs (revenue) and \$4.43 billion in GDP with roughly 66,000 people employed in related industries. When indirect and induced impacts were considered, employment rose to 122,000, and GDP was estimated to be \$8.33 billion (GIO, 2020). This study demonstrated the GI sector to be a larger contributor to the provincial economy than other major industries like the computer and electronic product manufacturing sector (\$3.5 billion in GDP and 16,335 jobs), and the pharmaceutical and medicine manufacturing sector (\$3.4 billion in GDP and 26,600 jobs) and identifies substantial growth potential if awareness and supporting policies are improved. Optimistic projections estimate the GI sector could see 73% growth by 2030 with direct GDP reaching \$10.02 billion and 146,200 jobs (GIO, 2020).

GI presents an opportunity for considering adaptive infrastructure investment frameworks that address the current and potential future realities of rural development. The remainder of this paper aims to address the rural gap in GI literature by exploring how communities in Southwestern Ontario are planning for, managing, and benefiting from the services tied to natural areas and projects that fit within the province's definition of green infrastructure.

Chapter 2. Methods

As part of the larger [Building the Future](#) (BTF) research initiative, this study draws from and builds on a broad foundation of research in rural infrastructure and economic development. Early in the BTF project, a literature review was completed to position the research in the context of infrastructure-specific rural economic development capacity, new strategies for approaching infrastructure investment and its economic complements, and ways of conceptualizing differing types of rural from a policy perspective. Subsequently, a province-wide survey collected data from municipal staff and elected officials on the prevalence of multi-community collaboration on infrastructure, local infrastructure stresses, and local capacity to understand and plan for future infrastructure needs. This survey data and literature review were used to produce a foundational paper for the overall research initiative and identifies initial themes and communities for further investigation through deep-dive case studies and vignettes. Survey findings were also used to guide a series of workshops/meetings to engage key stakeholders in the research process, as well as develop channels for knowledge mobilization.

2.1. Study Area

While substantial progress has been made over the last 20 to 30 years, GI planning and practice are still in their infancy in rural Ontario. Additionally, the diversity of rural needs and infrastructure pressure mean that GI approaches vary depending on the local context. As a result, few communities demonstrate a comprehensive approach to GI. For these reasons, a regional case study that highlights success stories and challenges was determined to be the best approach to cover the breadth of GI's potential benefits. Southwestern and northern portions of South-Central Ontario were broadly selected as the most populated and developed/impacted region of the province outside the direct influence of major metropolitan centres. These regions can be predominantly characterized as a working agricultural landscape, with small settlements that support the agricultural, manufacturing, and tourism sectors. Manufacturing has declined in some areas, particularly primary agricultural processing, and has concentrated along major transportation routes. Tourism is most significant in lakeshore

communities but is generally not considered to be a key sector regionally (Freshwater, 2017).

Case study communities or GI-related initiatives were selected using a positive deviance selection method (Bisel et al., 2019) based on their engagement or leadership on GI issues and their position within the rural landscape. All examples are outside the influence of Ontario's major urban region of the Golden Horseshoe, and most are located more than half an hour drive from the smaller urban centres of London, Kitchener/Waterloo, and Guelph. Like GI, definitions of rural vary. For this study, a general definition of rural was used to select upper and lower-tier municipalities (counties, and townships/local municipalities) with generally low population density and no large urban settlements or single-tier municipalities (cities) with a population less than roughly 20,000 and a location distant from larger centres. This approach is sufficiently flexible to capture existing best practices in "rural" GI and to represent a spectrum of rurality as described by Bollman and Reimer (2018).

2.2. Key Informant Interviews and Analysis

The study objectives outlined in section 1.1 were investigated through a qualitative analysis of key informant interview data from 19 semi-structured interviews with professionals working on projects and policy related to the management of the natural environment, delivery of rural infrastructure, and/or regional economic development. 16 out of 19 interviewees reported having direct experience related to the implementation of GI projects and programs, or experience related to GI policy development and advocacy. The other 3 were able to talk more generally about rural needs for infrastructure and economic development and identified key challenges and opportunities that may arise in GI planning. Interviewees were selected through a combination of internet research to identify exemplary GI projects and through interviewees' professional networks using a snowball sampling technique to connect with experts not easily identified through online resources. Three interviewees were also selected for their participation in and answers to the BTF survey, which self-identified their community's participation in a GI initiative. The BTF survey was distributed to municipal staff and elected officials across the province of Ontario in the summer of 2020 and successfully engaged 303 people representing 238 municipalities.

Interview questions covered a range of topics with an emphasis on rural capacity, policy and program needs, and economic benefits associated with GI in rural regions. Efforts were made to attain roughly equal representation from Conservation Authority staff, municipal staff, municipal elected officials, economic development professionals, planning and engineering consultants, and NGOs involved in the advocacy and delivery of GI policy and programs. Notably, Interviewees from Conservation Authorities and the planning profession tended to have a robust knowledge of and experience working with GI. Municipal elected officials and economic development professionals tended to be less familiar with specific applications of GI but could speak well to broader ideas of natural capital, ecosystem services, and community wellbeing, as well as community priorities that may support or constrain the use of GI **Table 3** shows the distribution of professionals engaged in the interview process. Interviews took place between October 2020 and March 2021 and were conducted via video calls lasting an average of 60 minutes.

Table 3. Key informant interviews by sector.

Role/Sector	Number of interviews
Municipal Planners	3
Municipal Elected Officials	3
Municipal CAO	3
Economic Development Professional	3
Conservation Authority Staff	3
Planning Consultants	2
NGOs	2
total	19

All interviews were recorded and later transcribed to provide a text record. Text files were analyzed using a mixed method of inductive and deductive coding thematic analysis to identify, code, and categorize themes that emerged through the interview process (Fereday & Muir-Cochrane, 2006). Interview transcriptions were coded and analyzed using NVivo 12 software. Initial themes for deductive analysis were developed by compiling a list of keywords from the literature review and discussions with BTF team members regarding project objectives. These themes were used for initial coding of the interview data. The data were then reviewed and coded a second time independently of the initial themes to identify and code unique themes not previously identified and to

make connections across themes through inductive analysis. Interview themes were ultimately used to develop recommendations for improving the delivery of GI policy and programming in rural regions of Ontario and Canada more generally.

2.3. Statement of Positionality

As the lead researcher on this case study and as the sole person responsible for the collection and analysis of the key informant interview data, I feel it is necessary to recognize my positionality and any potential bias it may have for the results presented in this paper.

I am an early career researcher with a background in environmental science and planning. I have pursued these fields of study based on my interest in and love for spending time in the outdoors and learning about the natural world. I am motivated by a desire to improve the relationships between humans and our environment and consequently approach the topic of GI with hopeful optimism for the benefits this planning concept offers. Through the interview process, I sought out the opinions and expertise of others who have participated in successful GI projects or who advocate for the consideration of better environmental approaches to development. As a result, interviewees tended to share a similar sense of optimism toward the concept of GI and were generally supportive and enthusiastic about advancing GI as a priority planning issue.

My focus on GI as a planning issue and an approach to improve rural infrastructure and economic development also mean that I have engaged with a relatively narrow group of GI stakeholders. I was unable to directly engage with engineers, contractors, developers, landowners, or Indigenous communities who also play important roles in the delivery and management of GI assets. Insights from these groups are important and deserving of further research.

I am based in British Columbia, and due to COVID-19 was unable to visit and spend time in the case study region. While I conducted an extensive regional profile and engaged with rural development literature focused on Ontario, my lack of deeper case context knowledge, which could have been enhanced with field research, also represents a limitation of this study.

Chapter 3. Findings

3.1. Drivers of GI in rural regions

GI projects and initiatives offer a wide range of benefits and may be pursued for a variety of environmental and social values. However, similar to traditional infrastructure projects, economic factors are usually the primary motivator for communities and landowners to implement GI on the ground. While many GI features exist naturally on the landscape, deciding to actively protect or expand these assets usually comes as a response to a regulatory, environmental, or service delivery problem with economic consequences. As such, the most successful GI projects whether in rural or urban communities solve a problem for one or more stakeholders in a cost-effective manner.

Responses to the BTF Survey show 35% of municipalities a participation in GI initiatives as either a lead organization or supporting partner.

3.1.1. Economic drivers

The following subsections highlight key themes associated with the economic benefits of GI determined through the interview process. Themes represent the most commonly identified benefits of green infrastructure by interviewees with a focus on benefits that tie into the broader theme of rural economic development.

Soil and property protection

As agriculture remains the dominant economic sector in most rural communities in Southwestern Ontario, farmers have a vested interest in land stewardship particularly as it relates to soil conservation and improvement. Soil forms the foundation for the agricultural economy and protecting soil represents the protection of farmers' investment in the land. Examples of green infrastructure initiatives to conserve soil on farmland are prevalent throughout the study area and include applications such as cover crops/no-till agriculture, windbreaks/tree planting, bank stabilization/stream buffers, and rural stormwater management. These initiatives are usually completed in partnership with the local conservation authorities who provide technical and often financial support to landowners. Conservation authorities have a shared interest in soil conservation for the benefits of improved water quality and reduced sediment load in receiving streams and

lakes. Agricultural green infrastructure projects have been most effective and widely adopted in counties that deliver clean water projects, which provide 50% funding to landowners interested in reducing their contribution to water pollution through improvements to septic systems, manure storage and treatment, and erosion control.

Several interviewees noted that rising agricultural land values present a challenge for expanding green infrastructure and are a key driver for increasingly large-scale agriculture. Existing farmers are faced with increasingly tight margins and are incentivized to crop as much land as possible. This economic pressure has also contributed to the amalgamation of larger farms and a reduction in the variety of crops produced to a few high-value crops. Additionally, the high cost of land makes it increasingly difficult for new farmers to enter the market, further supporting the move to fewer, larger producers operating on larger more homogeneous fields. These pressures make it difficult for farmers to choose to expand natural cover and improve their green infrastructure at the expense of highly valuable farmland

“We’ve seen our farmland at least quadruple if not go up five times in value. That seems to have levelled out now, but it has caused this sort of pressure for the farming community to farm every square inch that they can. The other thing is that with bigger equipment they’re kind of forced into having squarer fields and the way that they square them up is by taking out natural heritage more often than adding to it. They could square up either way, but they’re almost always going to take it out.” ~ Municipal CAO and former CA staff.

One interviewee noted that the amalgamation of large farms and the reduction in the variety of agricultural products being produced is concerning not only for its strain on the natural environments but also for rural economic resilience.

“The agricultural sector here is getting less and less diverse. If you look at the products we produced 40, 50, and 60 years ago and you look at what we’re producing today, there is no question that we are a lot more productive in dollar values now than we were then, but we’ve gone from making two dozen different things to making soybeans and corn and maybe wheat and some livestock operations. It is economically risky to have your single largest sector dominated by a few very large players. What happens if one of them goes down, too big to fail right?” ~ County Economic Development Officer

Secondary to agriculture land use, many communities in Southwestern Ontario, particularly those near the Great Lakes, have substantial cottage development. Much of this development is in waterfront locations and areas at high risk of flooding and bank erosion. The value of property at risk was estimated by one Interviewee to be upward of \$300 million in Huron County alone. Initiatives aimed at addressing this risk were not commonly identified in the study area by interviewees or in literature research, though this was highlighted as an area in need of future attention and investment. Risks associated with climate change were frequently noted by interviewees as an opportunity to advance GI programming in rural areas to protect private property and public infrastructure from extreme weather events. Local climate action planning initiatives are becoming more common and are likely the place where these issues will be addressed

“In our communities now we’re talking a lot about climate change and how we can adapt to and mitigate the effects of extreme weather events. I think these natural areas and green infrastructure certainly have a role to play in that. The water levels in the lakes here are very high right now and there’s a lot of damage to properties and accessory buildings that are on top of the bluffs. So, I think of green infrastructure when we’re looking at land-use in particular and keeping development away from hazard areas or how can we use these natural areas to help adapt to the effects of those extreme weather events.” ~
County Planner

Infrastructure cost savings

Infrastructure cost savings were one of the most common benefits identified with green infrastructure for rural municipalities. The GI applications most frequently noted related to stormwater management, particularly within urban settlement areas, as well as windbreaks or living snow fences, which can reduce soil erosion and maintenance costs for road repairs and snow removal. Conservation of natural heritage features within the recharge zone of municipal wells and projects aimed at improving nearshore water quality in the Great Lakes were noted for their value in reducing water treatment costs and improved water quality. While infrastructure cost savings were widely believed to be a benefit of GI, monitoring and quantifying benefits were noted as challenges. All examples given had only anecdotal evidence with no funding directed to pre-and post-project monitoring. However, some interviewees argued that GI has obvious intuitive advantages compared to grey infrastructure, particularly concerning adaptable stormwater management.

“Climate change adaptation is critical and if we're not planning for it, we are planning for failure, and green infrastructure permits a more responsive infrastructure. For example, if the bio swale isn't working, you can make it a little bit bigger for minimal cost, but if an oil grid separator isn't working or is overwhelmed by the volume of stormwater you need to buy another bigger oil grid separator.” ~ Municipal CAO

GI approaches to stormwater management were noted to be especially valuable for small urban settlement areas, many of which have minimal stormwater infrastructure to begin with and sufficient land to manage stormwater on-site. GI applications like rain gardens can also be visually appealing and contribute to the charm and aesthetic of small towns. This was noted by one interviewee as a key benefit of incorporating GI in the form of LID features into a major downtown redevelopment and infrastructure upgrade.

“One of the reasons they're pushing to get it done next year is because the main Street is a retail area and the project will enhance the streetscape for local businesses.” ~ Planning Consultant

Woodlots, wetlands, and diversified farm activities

Preserving and restoring natural heritage features can have a wide range of benefits for ecosystem health and environmental quality, but in many cases, these areas can also provide economic values to both private and public landowners. Woodlots provide an important source of income for both rural landowners and local governments as timber can be harvested periodically on a sustainable basis. Given the economic pressures on farmland in Ontario discussed above, this can be a valuable way for landowners to offset the opportunity cost of keeping land out of agricultural production. Counties also use revenue from forest management to fund municipal services and programs.

Several interviewees noted that farmers are often looking for ways to diversify farm incomes and that this is likely to be an increasingly important motivator for landowners to consider restoration and stewardship projects. The non-profit organization alternative Land Use Services Canada (ALUS) has been an important group accelerating the uptake of restoration projects on agricultural land and offers landowners payment for providing ecological services associated with restoring natural features like wetlands, wood lands, and meadows and keeping them in a natural state (ALUS, 2021).

Programs like these are most valuable to landowners in areas where low productivity or marginal land can be taken out of agricultural production.

Interviewees noted that farmers' interest in diversifying farm incomes is likely to lead to other opportunities to improve rural GI in the future.

Tourism and community attraction

Access to green spaces is a major appeal of rural communities both for tourists and residents. Amenities like beaches, nature parks, and trails were the most common features noted by interviewees as having a direct benefit for economic development for their ability to attract people to rural communities. These features contribute to the overall stock of GI within rural regions and benefit from other GI initiatives that improve water quality and ecosystem health. Lakeshore communities and the larger tourism and recreation economy tied to the Great Lakes were identified as the largest beneficiaries of GI initiatives within the upstream watersheds. The [Blue Flag](#) beach program is a specific tourism initiative that demonstrates the connection between environmental quality and economic performance as certified beaches are perceived as higher-quality and can attract more visitors. Interviewees also identified economic spinoffs from reframing traditional services like Stormwater treatment ponds and even wastewater lagoons as community assets that incorporate GI to provide wildlife and recreational values.

“One tourism-related example is that we did convert a number of sewage treatment plant cells into wetlands. They are a major economic driver for our community because we promote them hard and they attract stopover birds. They’re particularly good at attracting unique birds. As a municipality, we are getting better and better at promoting our wetlands as something for people to come to town and see and drop some of their other money while they’re here.” ~ Municipal CAO and former CA staff

Connection to nature and green spaces more generally was identified by all interviewees as a key reason people are attracted to rural communities and most noted that they have seen an increase in visitation and residency associated with the COVID-19 pandemic. Travel restrictions and closures of indoor amenities are thought to have spurred an increase in regional tourism and outdoor recreation promoting record use of natural amenities in many rural communities. Trail networks like the Guelph to Goderich Rail Trail, the Bruce Trail, the Maitland Valley Trail, and others were noted numerous times for their increased traffic and value to local economies. One interviewee also noted

that trails and outdoor recreation amenities can be important assets to communities for attracting new residents and important service providers like doctors to small communities.

Some interviewees identified issues present in their communities related to the capacity of other infrastructure like roads and amenities like campgrounds, public washrooms, and waste management to support the increasing interest in rural communities.

“We’ve been very successful at tourism promotion and development to the point where we are now at a juncture where we have people coming to specific locations and we now have capacity issues around some of the signature spots. In terms of infrastructure, we are really at this pivotal point where we have to start addressing specific issues around how we manage these natural resources and the impact of visitors to the area.” ~ County Economic Development Manager

For many communities that have experienced a lack of investment over past decades these problems have been ongoing but are amplified by the pandemic. Interviewees also noted that while natural amenities and GI may be valuable for attracting visitors and improving quality of life in rural communities, resident’s decision to locate there remains highly dependent on employment opportunities and public services like schools and healthcare, though this has been shifting with increasing opportunities for remote working.

Several interviewees, particularly those working with conservation authorities, also noted that stay-at-home orders related to the pandemic response prompted an increased interest in restoration and stewardship projects like tree planting on private land as people seemed to gain an appreciation for the beauty of where they live and a desire to improve their own green space.

“People are actually spending a lot more time in the spaces where they live whether it’s an acre or 100 acres. It gives us an opportunity to reach out to a lot more people because they’re reaching out to us and there sitting at home getting pretty bored of watching TV. They’re starting to understand or learn a little bit more about where they are and what they can do to make their place better, which also benefits society.” ~ CA Staff

Some interviewees noted that progressive developers have been considering the benefits of including improved green space to attract homebuyers and this was generally believed to be a trend that will continue to grow over time.

“I think that’s exactly the economic value is that people will start looking for places that have more open space around them. So, if you’re incorporating this sort of green infrastructure into your development you might not make money off it directly in terms of selling a property, I think you might see more interest in the remainder of the development because of that park. Not to mention the social and environmental benefits that go along with that.” ~ Planning Consultant

Jobs and local economies

Finally, a significant yet often underrecognized benefit of GI is its contribution to the labour market both directly through jobs in the planning, construction, and maintenance of GI features and indirectly through employment and economic activity in supporting and spinoff industries like nurseries, Parks, and Recreation programming, and recreation and tourism-related retail and service industries. A recent study commissioned by the Green Infrastructure Ontario Coalition (GIO) demonstrated the significant contribution the green infrastructure sector makes to the provincial economy (GIO, 2020). The report projects that the GI sector has significant growth potential over the coming decade and this observation was supported by interviewees who identified a substantial need to improve GI on the rural landscape, which provides a valuable opportunity for stable, decent employment in essentially all communities.

“I think it’s part of this whole green economy that we need to be developing around the world. Maintaining, restoring, and protecting nature needs to be a part of that and there is a huge economic benefit to restoration that requires employing people. You need contractors, you need people with expertise around things like wetland construction, you need people to do the work. It’s hands-on work and I think it’s a way to provide quality jobs in rural Canada that will keep young, highly educated people in the community” ~ ALUS representative

Many existing jobs that contribute to GI in both rural and urban communities may not commonly be thought of for their contribution to infrastructure services or other co-benefits. For instance, landscaping and park maintenance jobs may not be thought of for their contribution to stormwater management or pollinator habitat. Better recognition for

the multiple functions of GI and the workers who support these services presents further opportunities to expand employment in the field and improve the benefits received from natural systems.

3.1.2. Social and policy drivers

While interviewees identified economic factors to be the most common motivator behind GI projects and initiatives, nonmonetary values and political factors also contribute in some instances. Interviewees reported that some portion of the population is always going to be more inclined to engage with the topic of GI through stewardship or conservation activities and that this portion of the population may be more interested in wildlife or other conservation values more so than economic motivators like protecting farmland or private property. However, several interviewees noted that the portion of the population that is interested to engage with the topic of GI is relatively small. For instance the proportion of farmers adopting BMPs like cover crops, and erosion control is between 25% and 40% across Canada (MacKay et al., 2010), with only a fraction of this being motivated by non-economic factors. Interviewees noted that adoption of these practices have been stuck at these relatively low levels for many years and it can be difficult to make progress where it is most needed (i.e., where environmental impacts are greatest). Similarly, results from the BTF survey show that only 35% of municipalities are engaged in projects that respondents consider to be GI.

Some interviewees also noted that political factors are likely to drive interest in GI both at the provincial and local levels. Regulation of the natural environment can be a contentious issue in rural communities, particularly with agricultural landowners. Interviewees noted substantial challenges in developing natural environment plans and implementing stewardship initiatives through CAs. These challenges vary between communities with some municipalities and conservation authorities experiencing stronger support and more functional working relationships with municipalities and land owners. One interviewee noted that there has been an increase in anti-regulatory and anti-environmental attitudes in many parts of rural Ontario over the last two decades. The cause of these attitudes are complicated, but declining levels of education with young farmers and negative interactions with CAs and government officials are thought to be contributing factors (Brick et al., 2016; Traxler & Li, 2020). Conversely, agricultural BMPs and environmental regulation have been well supported in some areas where

farmers have a history of trust and supportive working relationships with CAs and other agencies to improve farm operations and environmental outcomes (Traxler & Li, 2020). All interviewees agreed that landowners play a critical role in the provisioning of rural GI and that the framing and communication of initiatives aimed at improving ecosystem services are critical to their success. Interviewees also noted that in many communities, residents have a strong sense of pride and identity tied to local parks, natural heritage, and open space that can boost support for GI if the connection is made to the services these features provide.

“I would say the politics of it likely does come into play. We approached it from an objective informed approach, which I think is important. We framed it in the context of our infrastructure deficit. I don’t think we ever really use a singular term. From the staff or senior administrative perspective, it’s just about framing the issue correctly and not letting it get misled or realigned by anyone else.” ~ Municipal CAO

Support for GI-related projects was also noted to be influenced by provincial policy. For instance, one interviewee noted several rain garden projects were initiated and completed in the municipality of Bluewater as a proactive response to expected changes in provincial standards for stormwater management. A change in government meant that the new provincial standards were never adopted and interest and support for GI in the form of LID have since waned in the municipality.

Policy drivers were noted to be particularly important for motivating engineering consultants to promote GI as they are ultimately responsible for ensuring municipalities comply with provincial standards and are generally hesitant to assume the risks associated with going beyond provincial standards to pursue voluntary or experimental initiatives like LIDs.

“The municipality is looking to the engineering firm for guidance and so if there is no requirement to put in LID and do these other things, even if it’s encouraged by the conservation authority, they’re not going to go down that path. So, I think the only way it’s going to change in a major way is if the policies change.” ~ Planning Consultant

3.2. Rural capacity and awareness of GI

Capacity challenges are a real limitation for rural municipalities and other organizations working on infrastructure, development, and environmental issues in rural regions. Interviewees identified awareness, human resources, and finances to be the biggest capacity challenges limiting the uptake of GI practices in rural areas. These are challenges for all organizations working in the GI space, but the information gathered through the interview process is most representative of the experience of rural municipalities and CAs. Many interviewees noted that recent changes to the Conservation Authority Act (see introduction 1.5) presents uncertainty for the future capacity and mandate of CAs, which may have implications for their ability to champion GI initiatives.

3.2.1. Awareness and understanding

interviewees were chosen based on their participation in known GI initiatives or based on the recommendation of other interviewees for their knowledge on the topic of GI. As such, all interviewees had at least a basic understanding of the concept of GI and the variety of its applications. Notably, municipal elected officials and economic development professionals had less awareness of the topic and terminologies used generally and in specific applications compared to interviewees with a background in planning or conservation and stewardship. Municipal planners, consultants, and conservation authority staff likely have a heightened awareness of the topic due to its development as a planning issue and application through the provincial policy statement.

Questioning around the diversity of language and terminology used to discuss the topic of GI revealed a variety of opinions on the usefulness of technical and policy language and the importance of clarity in communicating the objectives of GI projects and initiatives. As noted in the introduction, the term GI is rarely used in the context of rural Ontario and rural regions more generally with few if any interviewees identifying the term to be used in their work or region of practice as it is defined in the provincial policy statement. In practice, interviewees identified that specific terminologies relating to GI features, ecosystem functions, or project objectives are most beneficial for communicating with stakeholders rather than broad catchall policy terms like GI, which may have limited meaning to those outside the planning and policy world. Some

interviewees worried that GI runs the risk of becoming meaningless jargon or that the term infrastructure may be inappropriate due to an inherent urban bias and connotation that it refers to human build systems. Others recognized potential benefits from framing natural systems as infrastructure to help people recognize the benefits that can be received from nature. Some interviewees noted that using infrastructure language may be helpful to build support for conservation and stewardship efforts by framing them as a way to improve natural service provisioning in their communities. One interviewee noted that this may be particularly useful in areas where natural heritage planning and regulation have been met with opposition from rural landowners.

“In Many counties in Ontario, they’re going through the process of developing natural heritage strategies and natural heritage plans. That has been a real hot-button issue in terms of how it can infringe on landowner rights. So, calling things natural heritage, that phrase has not landed well in the farming community. Whereas I think a phrase like green infrastructure would be welcomed a little bit more and farmers might see a way that they can participate in making more green infrastructure be it sediment control basins, rural stormwater management, windbreaks, or even if they pushed it to include things like overwinter cover crops.” ~ CA Staff

Regardless of the terminology used, interviewees were able to identify a variety of examples of GI and the benefits associated with these features and initiatives. Interviewees also noted a variety of rural advantages and challenges related to the delivery of GI services. A general lack of awareness was consistently mentioned as a barrier to the widespread adoption of GI approaches to existing and emerging development challenges. With most GI research and development efforts focused on urban communities, it can take time for the learnings from these projects to disseminate to smaller municipalities and be presented in a way that is appropriate and applicable in a diversity of rural contexts. Challenges with awareness and knowledge mobilization in rural communities are further compounded by other capacity issues including limitations in human resources and financing, which are a reality for many rural communities.

One strength noted by interviewees is that counties and CAs have access to detailed data about natural heritage features and from ortho imagery flown every five years. This imagery is used to create detailed maps and to show changes in land cover over time. CAs generally analyze these data and report it to their member municipalities who are required to identify and report on natural heritage cover in Southern and

Eastern Ontario under section 2.1 of the PPS. Interviewees thought this was a valuable process and one that could be expanded to take stock of all GI assets, not just natural heritage. The inclusion of natural assets in Ontario's asset management regulation represents an opportunity to expand the scope of natural heritage reporting and align multiple objectives between CA's and Municipalities to strengthen natural service provisioning.

3.2.2. Human resources and expertise

Given the low population density and associated development pressures, rural municipalities and conservation authorities have far fewer staff than their urban counterparts. These staff generally wear many hats and are responsible for multiple priorities within their organization meaning they may have limited time to spend pursuing new initiatives. This lack of human capacity was consistently noted as a challenge by interviewees experienced working with municipalities where staff tend to be generalists. Some interviewees perceived that municipalities with lower staff capacity are generally more likely to favour conventional approaches to development and infrastructure rather than seek out new solutions. This is partly due to a lack of awareness of alternative approaches, as well as time limitations for staff to spend learning specialized skills and applying for funding that will support alternative projects like GI.

Rural CAs still have relatively strong expertise related to GI given their mandate to manage development for human safety and to maintain the health of natural systems. Interviewees felt confident that CA staff hold the technical knowledge and expertise to effectively promote and manage the implementation of GI, though concerns remain about the capacity of CA's to drive widespread action on GI given their limited staff size and financial resources. These concerns are worsened by the recently proposed changes to the conservation Authority act and their potential impact on the mandate and regulatory power of CA's. Several interviewees also noted that while CA's have relatively strong expertise for implementing GI projects, outcomes can be limited due to a lack of municipal expertise to manage GI features after implementation. In some cases, this lack of municipal capacity has meant that the responsibility of maintenance has been deferred to community groups and volunteers.

“Our biggest challenge has been that small rural communities don’t have the staff with the expertise and know-how to look after trees and shrubs and plants. Because parks staff are part-time, they’re shifting from arenas and recreation complexes to outdoor parks, and they favour the skills associated with those other facilities. The outdoor facilities take a sort of backseat. So, they cut the grass there, but what we have had to do since we finished the park naturalization is to have a volunteer group help the community look after the park and the trail because the municipality doesn’t have the expertise to do it. That’s a huge weakness in rural Ontario.” ~ CA Manager

Limitations in municipal staff capacity are most often addressed by hiring consultants to carry out specialized planning and engineering work. Interviewees identified two main constraints applicable to the procurement of external expertise for consultants and contractors to work on GI projects. The first is related to the expertise available in rural communities. As GI is still an emerging approach, particularly in rural areas, municipalities may not have access to firms or contractors with experience working with GI most firms specializing in GI are still located in, and work primarily with urban municipalities. And second, the limited budgets of many rural communities mean that they prioritize the lowest bid in procurement, which doesn’t guarantee the best outcome. However, the opposite can also be true as contractors become familiar with GI projects, some interviewees have noted an increased enthusiasm in the work as a progressive and interesting approach.

“I think it depends on the contractor. I’ll use the wetlands as an example. We’ve got one contractor who usually digs holes for houses and stuff like that, but he loves to do our wetlands and our pits and mounds because it’s something very different and interesting. So, he seems to always give us a very competitive bid because he wants to do the projects. There can be other contractors who see the projects as a real pain too though because they’re not straightforward, it’s science and art put together.” ~ CA Staff

There is some optimism that as GI projects become more common, so will the expertise and capacity to make GI a standard practise in all communities.

3.2.3. Financial capacity

The small population of rural communities also means that municipalities have a small tax base and by extension limited financial resources. While population density is low, the landmass of rural jurisdictions is large and highly impacted by agricultural

activities. This mismatch of resources to landscape pressures and service demand means that infrastructure projects often rely heavily on funding from senior levels of government and other external grant providers. Interviewees identified possible benefits with GI projects to address limitations in financial capacity as GI can often be implemented with lower construction and maintenance costs than traditional grey infrastructure, for instance, stormwater management in a new subdivision. However, interviewees noted GI projects that aim to improve or restore natural features and hydrology on the agricultural landscape that has been badly degraded, can be expensive and require funding support. See the [Garvey Glenn Shoreline Watershed Project](#) for an example cost breakdown (p. 27) of stewardship and restoration efforts to improve one sub-watershed on the East shore of Lake Huron (MVCA, 2012). However, considering the lifecycle cost of restoration projects including all ecosystem services and co-benefits may reveal long-term savings to landowners, for instance, by limiting erosion and improving crop pollination. Additionally, restoration often results in net societal benefits like improving climate resiliency and safeguarding against biodiversity loss (OECD, 2019b). Interviewees also noted GI co-benefits as a way for municipalities, landowners, and developers to receive more value from their investments.

While restoring degraded ecosystems can be expensive, GI tends to provide more services at a relatively low cost compared to the singular functions of traditional grey infrastructure (Molner, 2020; Roe & Mell, 2013). The relatively low cost of GI projects that make use of existing or enhanced natural features to provide services like flood or drinking water protection was also identified as a potentially compelling factor for small municipal budgets as a relatively small amount of funding can go a long way. For instance, the clean water project in Huron County allocates \$400,000 annually to support GI projects and other water stewardship efforts on private land. In the case of clean water projects, partnerships with landowners are also important for sustaining funding as landowners are expected to contribute 50% of project costs. Landowners are often motivated to undertake stewardship and land improvement initiatives but value the opportunities provided through cost-share programs like clean water projects.

The financial constraints of both municipalities and landowners make both parties relatively risk-averse, which can limit their willingness to pursue innovative or alternative approaches to problems like erosion or stormwater management.

“I would say that generally they are fairly limited due to their small budgets. So, unless they have a lot of confidence in the outcome, they tend to be quite hesitant to go out on a limb and do something new or different. In all of the projects we’ve talked about there’s been some kind of grant or assistance in the funding and that’s why they were willing to take the risk and go with a different kind of infrastructure component.” ~ Planning Consultant

Risk aversion has likely slowed the uptake of some GI approaches, but interviewees stress the importance of good information and demonstration projects in overcoming this challenge. Substantial success has been seen with some of the more cost-effective applications of GI such as cover crops, which is now a widely used agricultural practice and provides significant benefits for soil conservation and water quality.

3.3. Opportunities and constraints of the regulatory environment of GI

The many forms, small-scale distributed nature, and multifunctional benefits of GI make it more complicated to manage than traditional forms of infrastructure. Regulation, funding, and guidance of GI practices involve collaboration among many different stakeholders from local to national scales and their relationships can be nuanced. Interviewees identified a variety of opportunities and constraints for improving rural GI policy and programming within the current regulatory environment in Southern Ontario.

3.3.1. Regulation and standards

Many GI features on the rural landscape, particularly natural heritage features, are regulated through both provincial legislation and municipal policy documents or plans. Natural heritage is primarily regulated for conservation purposes and to avoid the unnecessary loss of Southwestern Ontario’s natural environment. While regulatory approaches to conservation and land use have proven to be contentious at times, interviewees expressed that regulation is often the fastest mechanism for senior and local levels of government to drive changes in development practices on the ground.

Regional governments (i.e., counties) were noted as having some power to set regional priorities and standards to influence GI most notably through land use policy

and planning, but numerous interviewees noted the importance for the provincial government to set a level playing field and ensure consistency across regions. Interviewees noted positive progress over the years on regulation relating to natural heritage, urban development, stormwater management, and asset management. The largest opportunity to improve GI practices through provincial regulation was through updating the drainage act which was recently reviewed for administrative purposes but not for improvements to the purpose and outcome of the act. Interviewees noted that drainage in urban areas has improved substantially, and GI is becoming increasingly common in urban development. However, the agricultural landscape is the largest contributor to stormwater quantity and quality issues in rural communities in southwestern Ontario, and drainage practices have seen little improvement from a regulatory standpoint.

“There are lots of Ministry of Environment regulations for urban development and working to control urban stormwater, but there really is nothing for rural stormwater. So, when we have some of those flash thunderstorms that we are seeing as a result of the changing climate it is just as bad if it happens to the northeast of town in the rural landscape as if it happened right in town. In some ways, it’s even worse because it’s already in the river system by the time it reaches town, and our conduit is designed for a 100-year storm event but it seems like we’re having those more and more frequently so we are seeing our conduit already experiencing stress.” ~ Municipal CAO

To date, most efforts to improve GI on the rural landscape have come through voluntary efforts and incentive-based programs. Incentive and grant programs come from a variety of organizations with a specific interest in GI applications and benefits. Organizations like federal and provincial Ministries related to agriculture, infrastructure and the environment, local and regional municipalities, and non-profit organizations focussed on ecosystem restoration and land stewardship. Interviewees spoke highly of the stewardship ethic that has guided many projects with landowners and developers but also recognized limitations of voluntary efforts.

“I think that needs to be a stream of money from government or it has to be some sort of regulation that has teeth. If it’s voluntary or something like a tax credit, I think the industry (referring to agriculture) is inherently conservative and frankly, people are focused on other things.” ~ County Economic Development Officer

3.3.2. Funding and incentives

Funding was the most common opportunity and constraint noted by interviewees as a way to promote the uptake of GI practices. Funding, whether through competitive grants or more stable formula-based programs, serves as a major incentive for organizations to prioritize projects and resources.

“For example, municipal drains get a one-third grant from the Ministry of agriculture and food. Maybe the grant should only go towards those drains if they’re putting in rural stormwater management systems.” ~ CA Manager

Because GI offers multiple functions and benefits, there are a variety of funding pathways and programs that are currently supporting GI work. The many organizations involved in the management and delivery of GI are diverse and so are their funding sources. This represents both an opportunity and a challenge in that projects may have access to a broad range of funding sources, but coordinating multiple applications can be onerous and raise questions of accountability among multiple partners.

In rural communities, GI work often focuses on natural heritage features and restoration projects that draw on funding from environmental programs with the federal government, donor organizations, or through the local tax base in the case of counties that run clean water projects and contribute funds to CA run programs. Infrastructure funding has been increasing for GI projects through programs like the Disaster Mitigation and Adaptation Fund (DMAF) and FCM’s Municipalities for Climate Innovation Program (MCIP). But two interviewees noted that this type of infrastructure funding has limitations for funding GI projects, which tend to be smaller than other infrastructure projects and may not meet funding thresholds for grants.

“Infrastructure Canada has a number of programs that fund green infrastructure but they’re really targeting more traditional infrastructure like wastewater treatment plants or things like renewable projects and EV charging infrastructure. Because of that, it does present challenges for funding green and natural infrastructure. For example, the DMAF provides funding for green infrastructure but the threshold is incredibly high. It’s projects of \$20 million or more. It sounds counterintuitive to say it’s too much money, but it can be very challenging to put together enough natural infrastructure work to reach that threshold when one of the advantages of green and natural infrastructure projects is that they are very cost-effective and they often tend to be smaller scale. So, to get to that

point where you have \$20 million worth of work it excludes a lot of smaller communities and smaller projects that could have a very significant impact.” ~GIO representative

The multifunctional benefits of GI are also not well captured in infrastructure funding applications, which tend to prioritize singular benefits/functions and measure their impact based on human use, further disadvantaging rural communities where project impacts may be limited to a smaller number of people.

There are other challenges around the co-benefits piece. Thinking of DMAF again and filling out the application form, you know it’s a mandatory government form with lots of checkboxes and fields and applicants have to select one impact that the project will have. So, that kind of works against these projects because they might not have one impact that offers the same return on investment as say a dedicated wastewater treatment plant, which is going to be very good at its one job of managing wastewater. Green infrastructure projects like a stormwater pond will help manage stormwater but they’ll also do a lot of different things and these co-benefits aren’t accounted for, but if they were they would have a more favourable return on investment.” ~GIO Representative

“One of my problems in doing funding applications is that they ask how many people will use this or when I’m getting funding for an event, how many people are going to come? That’s a real challenge here in rural Ontario where a hundred people are a lot to get to an event whereas in Toronto you can get a thousand people. I think there’s a real need to look at that for providing funding to rural Ontario because it will pay back but it’s not necessarily as obvious. You know, a bridge is pretty quick and easy to look at, you can do traffic counts and that kind of thing and see how many people are using it, whereas a windbreak or a buffer along a stream it’s a lot harder to quantify the benefit of that.” ~ CA Staff

One solution proposed by interviewees to improve rural funding for GI is to link the cumulative benefits of distributed GI projects to downstream improvements in water quality in the Great Lakes, which has relevance to large international populations, and economic activity. Additionally, funding needs were identified for more long-term projects that include pre and post-monitoring programs to improve understanding of the benefits of GI and continue to build the business case for small municipalities and landowners to pursue GI projects. This is particularly important for rural GI initiatives where projects are diverse, small-scale, and distributed, making the impact of any one project difficult to measure. Cumulative benefits from GI projects, especially concerning

climate change impacts, were of interest to many interviewees particularly those working with conservation authorities on watershed management. One interviewee noted that the distributed nature of GI may be fundamentally at odds with conventional infrastructure funding programs.

“The whole issue around natural infrastructure has been very frustrating and I am of the mind that this is not best dealt with through Infrastructure Canada or infrastructure departments but through environmental departments or natural resource departments because having infrastructure funding to do small distributed projects across the landscape doesn’t fit within current government mandates. My policy development in that area was telling Infrastructure Canada that they need to set up a different fund because they have so much money, but you actually have to have another department administer it because it doesn’t work from the infrastructure side. There’s a long history there, but I think the takeaway is that we have to look at these small distributed projects and judge the outcome on the sum of the parts.” ~ ALUS Representative

Despite challenges in funding delivery, interviewees generally agreed there is a need to separate GI funding from other infrastructure projects to avoid competition between GI and necessary services like water and wastewater treatment and to more appropriately allocate funds at a magnitude appropriate to the small-scale distributed nature of most GI.

“The problem I see is that when infrastructure projects are available municipalities, and urban and rural are no different, we have a whole bunch of aging infrastructure that needs replacement. So, the sewer main on Main Street is always going to take priority over something that’s maybe green and new. So, I think it would be good if there was a separate category designated by the government that only directed funding to green infrastructure projects and I don’t even think the pool would have to be that big to have huge impacts on communities.” ~ Municipal CAO

3.3.3. Guidance and training

Awareness of and implementation of GI requires a strong understanding of its functions and potential benefits among all parties involved in the planning, construction, and management of GI assets. To date, CAs have been leading the knowledge mobilization around GI, developing guidance documents for GI approaches and implementation. These efforts have been further supported by organizations like GIO,

MNAI, and FCM who also advocate for improved provincial policy and offer webinars and educational resources to promote community and educational learning about GI. These resources have still been focused mainly on Ontario's urban communities, though one interviewee noted that the move to remote delivery of services with COVID-19 allowed a broader range of communities to access resources and contribute to the GI conversation through webinars and online workshops. These organizations also promote GI through research initiatives that offer valuable contributions to the body of knowledge surrounding GI in a context specific to Ontario communities. Interviewees also noted the value of partnerships with research institutions like universities to further build awareness and understanding of GI benefits and best management practices. Most interviewees noted that information around the benefits of GI has improved, but there remains a need for more regional studies to demonstrate the benefits of rural applications of GI.

CAs were identified as being strategically positioned to improve capacity and understanding of GI given staffs specialized ecological knowledge and mandate to engage with and support municipalities, landowners, and developers with project planning and implementation. CAs have helped to build awareness and understanding of GI through pilot projects and demonstration sites with municipal and private partners many of which receive substantial interest after completion.

"It's a perfect example of rural Extension. So, one farmer agrees to work with the conservation authority to rework his farm, then you have two other farmers over to see it and eventually put hundreds of people on-site to see what the changes are, then you develop those local champions that say this is a good idea. Again, I reiterate this is a good idea not just for the natural environment, but also for the economic viability of our farms." ~ Community Futures Manager

ALUS was also mentioned repeatedly as a valuable organization for its ability to engage with and mobilize action from landowners who may otherwise avoid conservation and stewardship initiatives.

"The conservation authorities are all learning to love ALUS. This is probably going to change with the government we have now and the bills they have proposed, but conservation authorities are very different than other parts of the country, they're seen as very regulatory and part of government, ALUS is seen as a farmer's program. So, we

have access to farmers and the conservation authorities don't. One conservation authority wants us to do a program in their area because they say there are roads that they can't drive their trucks up, so they want us to be there to talk to the farmers." ~ ALUS Representative

Interviewees perceived that there remains a general lack of awareness or engagement with the topic of GI and identified professional development opportunities as a valuable way to engage stakeholders in the topic and build capacity and support for GI initiatives. Engineers, drainage and landscaping contractors, and municipal staff were the target audiences most noted for improved GI training. Interviewees working with conservation authorities emphasized the importance of provincial training programs like OMAFRA's Erosion Control Specialist to keep engineers and contractors informed of best practices. Extending and improving training for municipal staff was also noted as an opportunity to improve GI outcomes, particularly in terms of ongoing maintenance.

3.3.4. Scale of management

Because GI takes so many different forms, and its functions or services often depend on the connection or cumulative effect of many small, distributed features on private and public land, management and jurisdictional issues can be complicated. As discussed previously, the many stakeholders involved in GI all have a role to play in ensuring the full value of GI assets/systems are realized, but special consideration of the mandate and interactions between these stakeholders is needed to make GI successful at local, regional, and provincial scales. One interviewee summarized the need to consider the scale and jurisdictions of GI management by stating the following.

"In terms of the planning scale, I like the Ontario model. You've got the province establishing provincial policy and establishing a relatively level playing field, which is really important and the Province of Ontario has been pretty good about recognizing that the bar for the north should be different than the bar for the South because of the different land tenure and systems. The counties as broader planning areas have a role too. I also think the conservation authorities rolling it up by watershed is a great idea. I think the watershed level analysis is a very technically sound way of doing it, but the difficulty is that the watershed boundaries don't line up with the boundaries of municipalities and you end up with complex relationships of different watersheds doing it different ways and different municipalities ending up in different watersheds. So, I think

that brings it back to the importance of the province setting the standard of how things should be mapped and managed.

The other scale to get down to is the community scale. There is still a place in my view for a local municipality or even a dedicated group of individuals, not the County, to provide services at a very local level because if they know what the big picture plan is all they need to do is implement it.” ~ Municipal CAO and former CA staff

Interviewees generally agreed that GI is most effectively managed using a systems approach at a regional scale. CAs were again identified for their strategic position in Ontario as they are the only organization of their kind to operate within the natural boundaries of a watershed with the mandate and expertise to improve natural systems. As a result, CAs were generally thought to be in the best position to oversee the delivery and management of GI programs within their jurisdiction. However, challenges do arise with the overlap in boundaries between CAs and multiple counties. Counties and CAs generally have strong partnerships to deliver programs and services, but many of the most successful GI-related programs are funded based on the discretion of county councils. While this is largely a reflection of local choice and political priority, the lack of consistency among regions has likely limited the progress and ultimately the benefits received from GI throughout the province.

Despite the complex relationships among GI stakeholders and the capacity challenges present in many communities and organizations, collaboration is key to successful program and service delivery. This is true for all rural programming but is exemplified in the diversity of GI projects that require commitments from local landowners to federal funding providers as well as ongoing support from CAs, regional governments, and other organizations to maintain and monitor benefits. This is a sentiment that was clearly articulated by nearly all interviewees.

“It has been our experience that we can achieve more through partnerships with other groups. Whether it be agencies, individuals, or community groups, we certainly can achieve more when we partner with other people on these initiatives. Building those relationships and looking for partnership opportunities is important in the topic of green infrastructure.” ~ County Planner

Chapter 4. Discussion and Recommendations

4.1. GI and Rural Restructuring

Following decades of disinvestment and piecemeal approaches to economic development (Halseth et al., 2019; Markey et al., 2008; L. Sullivan et al., 2015), rural communities need new strategies to manage an ever-growing infrastructure deficit and unprecedented challenges including the accelerating impacts of climate change, biodiversity loss, and global economic shocks. Interviews summarized in this paper revealed numerous challenges facing rural communities in Southwestern Ontario, including intense agricultural land pressure from high land values, a lack of affordable housing, limited social services and employment opportunities, and demographic challenges associated with an aging population. These are all important issues to be addressed, but limited human and financial capacity leaves many communities in a difficult position to effectively respond to both challenges and opportunities. Shocks like the COVID-19 pandemic and the impacts of climate change are illuminating the strengths and weaknesses of both urban and rural communities and are reshaping development and service demands. For instance, the move to remote-work during the pandemic has supported the first substantial urban-rural migration in many decades (Pelley, 2021; Van Dyk, 2021). If this trend continues, proximity to employment will continue to become less important and people will be free to seek out communities with lifestyle amenities and healthy environments. This means that rural and small-town communities will continue to become more desirable places to live. However, while many rural communities have seen new residents during the pandemic, the largest shifts in population have been to suburban communities raising concerns over accelerated urban sprawl (Statistics Canada, 2021). Regardless, development pressures are changing and rural communities will need to prepare for a future that may look very different from their past.

GI and its diverse applications offer flexible and often low-cost solutions to ease the pressure of infrastructure deficits and support the development of communities that are rich in natural amenities and resilient to a changing climate (Demuzere et al., 2014; Kraehling, 2018; Lilauwala & Gubert, 2019; Molner, 2020). Rural communities are generally well-positioned to take advantage of the benefits of GI, given their low

population density and position relative to natural spaces (Caldwell et al., 2016; Kušar, 2019). This gives rural communities the freedom to preserve, restore, and enhance natural features into healthy functioning ecosystems that do work for communities. Further, GI approaches are place-based, making use of the unique geography and assets of a region allowing communities to pursue the GI strategies that are best suited to their local strengths and needs (Roe & Mell, 2013). Many of the GI examples noted throughout the study reflect the adaptability of GI to meet community needs, whether expanding the capacity of existing built infrastructure in small urban settlements (e.g., bioswales, stormwater wetlands, and rain gardens), or improving soil retention and productivity of agricultural land (e.g., cover crops, windbreaks, stream buffers, and pollinator habitat), or restoring floodplain and forests to support biodiversity, natural hydrology, and recreation amenities. All of these examples have been implemented in Ontario communities and have demonstrated value to a diverse group of rural stakeholders.

GI functions differently than traditional built assets though both must work together to effectively meet community service demands. GI can not replace the need for built systems like roads, water treatment and distribution, sewers, and other core community services, but in many cases, GI can reduce environmental strain and boost the capacity of these systems while providing a broader range of co-benefits than could be achieved with built infrastructure alone (ACT, 2020; Kim & Song, 2019; Raymond et al., 2017). The many distributed components of GI provide both site-specific and cumulative benefits at a regional scale. The planning and management of diverse GI assets requires system thinking to assess how specific elements will interact with one another and with other forms of built infrastructure to provide broadscale environmental, social, and economic benefits. **Figure 2** illustrates a conceptual planning framework to understand the interconnections of grey and green infrastructure elements and their contribution to community well-being and resilience.

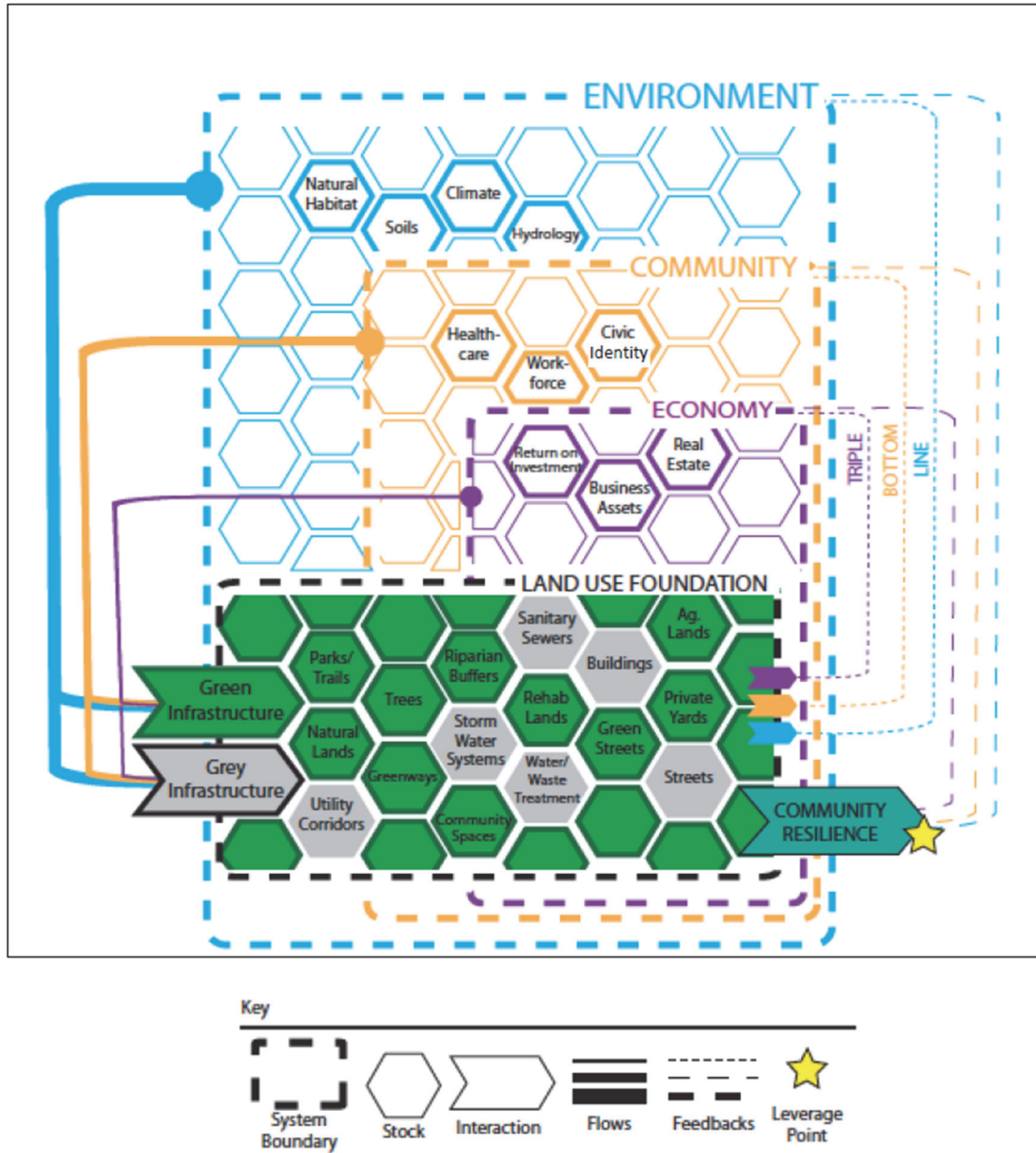


Figure 2. GI systems planning framework for rural communities. Source Kraehling, 2018.

Accounting for the total value of GI remains a challenge everywhere, yet the lack of discourse surrounding GI in rural regions and the limited capacity of rural actors to pursue new approaches has likely slowed the uptake of GI practices relative to urban areas. Further, the lack of a unified approach to GI in rural areas makes it difficult for communities to properly value and invest in GI. This is also complicated by inconsistent terminology, overlapping jurisdictions, and competing political and service priorities.

The complex regulatory and stakeholder relations governing GI present barriers that have largely been overcome through collaboration among interested stakeholder groups. Collaboration depends on the social capital of a region, which ensures rural communities have the human, technical and financial capacity to manage and strategically invest in natural and built assets (L. Sullivan et al., 2015). The rural extension model (Rivera, 2001) has proven effective in mobilizing stewardship-minded landowners, developers, and municipalities to undertake pilot projects and build local knowledge and capacity on GI through collaborative partnerships that capitalize on the unique perspectives, skills and resources each stakeholder can contribute (Bittman et al., 2021). While good examples of GI exist, intense agricultural land use and urban development pressures remain dominant throughout Southern Ontario and implementation of GI is uneven in distribution and approach depending on local priority and capacity (Kraehling, 2018; Van Esbroeck & Van Dielen, 2020). There is a need to expand the awareness and resources (financial, technical and legal) to support the prioritization of GI practices in all land use planning, infrastructure, environmental protection and development processes. This will ensure that all communities can realize the benefits of natural service delivery.

4.2. Expanding the Concept and Scale of Green Infrastructure in Rural Regions

Making GI a priority within land use and development processes requires a broader recognition of the many benefits it provides. This relies on a fundamental reshaping of what we consider to be infrastructure which tends to have a narrow association with built structures like roads and bridges. This association is particularly strong in rural regions, which interviewees described as taking a pragmatic and productivity-oriented approach to development and investments in community assets. Broadening perceptions of what constitutes infrastructure will help reframe nature as a core element contributing to the well-being of all communities, but with particular benefits for rural communities in which the land serves as a foundation for agricultural, resource, and tourism economies (Schröter-Schlaack et al., 2016).

In Ontario, the definition of infrastructure found in the Infrastructure for Jobs and Prosperity Act (2015) is sufficiently broad to include GI as a fundamental system that supports human economic well-being.

Infrastructure is the physical structures and associated facilities that form the foundation of development, and by or through which a public service is provided to Ontarians, such as highways, bridges, bicycle paths, drinking water systems, hospitals, social housing, courthouses and schools, as well as any other thing by or through which a public service is provided to Ontarians that may be prescribed (Infrastructure for Jobs and Prosperity Act, 2015, c. 15, s. 2)

Based on this definition, current evidence of the public services provided by GI (Caldwell et al., 2016; Elmqvist et al., 2015; GIO, 2012, 2020; Kim & Song, 2019) provide a sufficient argument that these systems and assets function as fundamental components of community infrastructure. With the introduction of natural asset accounting in municipal asset management regulation, Ontario has taken a large step towards valuing the services provided by GI. However, municipal asset registries typically consider only those assets directly owned by a municipality. Unlike traditional forms of infrastructure, GI assets exist on both public and private land, making system-level management complex. Effectively integrating GI within municipal asset management may require specific land use and financial policies to ensure both public and private assets are managed effectively to support cumulative efforts toward natural service provisioning (MNAI, 2019).

Beyond asset management, GI can and should continue to be prioritized through land use planning and development processes, and conservation programs. Further efforts are needed to broaden the notion of GI in both policy and practice to better recognize the numerous benefits derived from natural services. The collaborative and multi-jurisdictional nature of GI management presents opportunities for action and leadership at local, regional, and provincial/federal scales to improve GI policy, funding, and knowledge mobilization. It is important to consider similarities and differences in the mandates and capacity of different government agencies and stakeholder groups to effectively leverage resources and align action on GI projects. For instance, Infrastructure, environmental, and agricultural agencies all have an interest in particular aspects of GI and should work together to ensure funding is coordinated to projects that meet multiple objectives. This may require resources to be pooled and administered by a different agency or organization that is better positioned to deliver small, distributed projects across the rural landscape.

There was wide agreement among interviewees that the success of GI is determined at a regional scale, ideally, a watershed. Management and monitoring efforts should also be directed at this scale. Ontario's CAs provide a unique advantage in this regard due to their mandate to manage land use, natural heritage, and water resources at a watershed scale. Additionally, CAs work with both municipalities and private landowners and have the technical expertise to facilitate GI projects and partnerships. It is no surprise, therefore, that CAs have been leading the way on GI throughout the province. Capacity and jurisdictional challenges still exist in many communities making it difficult to mobilize funding and coordinate work among many stakeholders toward a common vision of GI. This has contributed to the uneven and inconsistent GI investments seen across Southwestern Ontario today.

Recognizing the unevenness in GI action, some interviewees called for a more standardized approach to GI, backed by clear, enforceable policy and regulation from the province to level the playing field among regions and communities. However, interviewees also cautioned against overly prescriptive approaches that might limit creativity and choice in addressing local priorities. Regulation of rural stormwater management was one notable area that several interviewees thought could be standardized to make GI approaches, or at minimum, consideration of GI approaches, mandatory through funding applications and approval processes for drainage works. Opposition toward increased land use regulation among private landowners was noted as a likely barrier to this type of regulatory change. Other GI priorities like the lifestyle and biodiversity benefits of GI were thought to be more effective if pursued through information and incentive-based approaches.

4.3. Recognizing the Economic Drivers of GI

The above discussion of the scale and governance of GI represents largely technical and administrative challenges, but public awareness and political support for GI also play a role in its success. There was a strong consensus among interviewees that the fastest and most effective way to build support for GI is to draw attention to its economic benefits. Economic arguments were thought to be particularly important in rural communities where residents tend to derive a larger proportion of economic activity from the land base (e.g., agriculture, forestry, and tourism), hold fiscally conservative

values, and have few public services and amenities compared to urban centres. Instead, rural communities tend to have a wealth of natural assets and amenities.

Examples from this case study and literature demonstrate that protecting and expanding community green spaces to make use of their ecological and hydrological functions can be a cost-effective way to improve infrastructure capacity (e.g., municipal stormwater) and economic problems (e.g., agricultural soil erosion) while bolstering a wide range of social and environmental co-benefits (e.g., biodiversity, recreation, carbon sequestration, etc.). Considering the co-benefits of GI is important to determine the full return on investment of projects that improve green space and ecosystem services (ACT, 2020). While efforts to quantify specific benefits of GI at a watershed scale, like reducing agricultural sediment and nutrient runoff have improved (Healthy Lake Huron, 2014; Yang, 2016), co-benefit accounting has proven to be challenging and there is a need for more studies dedicated to quantifying the diverse benefits of GI in rural regions. Interviewees noted that these studies should focus on a regional scale to show the cumulative benefits of many GI components rather than focussing on singular components and site-specific impacts, which have received greater attention to date. Additionally, regional studies were thought to be more applicable to a diversity of rural contexts, broadening the impact of study findings.

While reframing natural systems and processes as infrastructure presents opportunities to improve a broad range of social, environmental, and economic problems, the commodification of nature as natural capital also raises important questions of equity. Critics of GI, and more generally the natural capital movement in conservation, point out the economic valuation of nature perpetuates colonial notions of land ownership and exploitation for human gain (Lennon, 2015; McCauley, 2006; Rappel, 2018; S. Sullivan, 2017). The economic case for improving natural service provisioning may be sufficiently persuasive to expand conservation and restoration now, but the neoliberal foundation of ecosystem services does pose risks to long-term conservation as markets are subject to fluctuations that may devalue nature and its services over time (McCauley, 2006). Issues of justice and equity also commonly surround discussions of GI, recognizing that natural capital much like other forms of wealth is not distributed equally. Investments in nature that benefit one community or stakeholder group may still have unintended detriments to others. In the context of this paper, the most noted issue of equity was the economic cost born by farmers who

undertake stewardship projects that provide a benefit to society, though many more likely exist within rural communities. Within the wider GI literature, considerations of the accessibility of public spaces to underrepresented and marginalized groups is a key equity theme (Anderson et al., 2021; Morley, 2017), as well as the inclusion of Indigenous perspectives in the planning and management of GI assets and land use change.

Indigenous perspectives are finally gaining recognition and support in ecosystem management as demonstrated in the discussions of traditional ecological knowledge (TEK) in the Millennium Ecosystem Assessment (Reid et al., 2006) and the recognition of the importance of “indigenous and local knowledge” in the Intergovernmental Panel on Biodiversity and Ecosystem Services (2018). GI has been discussed specifically as a meaningful way to engage indigenous communities in planning processes and improve development with traditional knowledge of land management (Natuhara, 2018). However, Indigenous scholars also continue to question the validity of nature as capital and its position within settler colonial approaches to land management and reconciliation efforts (Coulthard, 2014; Simpson, 2017). It is beyond the scope of this paper to do a deep dive into equity-based approaches to GI. Nevertheless, it is important to approach all land use and development decisions with a critical eye for justice, equity, and inclusion.

Chapter 5. Conclusion and Policy Recommendations

The result of the key informant interviews provided in this paper demonstrates a wide array of benefits and challenges related to expanding the use of green infrastructure in rural regions. Interviewees generally presented a view of optimism for the service provisioning and development potential of GI when effective regional partnerships, planning, and management is achieved. Interviewees recognize that GI is a planning and policy approach aimed at improving human relations with land and water-based on an ethic of reciprocity and stewardship. In other words, if we take good care of the land the land will in turn take care of us. This notion exemplifies the foundational role a healthy environment plays in supporting a vibrant rural economy. However, this optimism was tempered by a recognition that a complex regulatory landscape and numerous competing development priorities have resulted in slow and sometimes negative progress toward improving human – nature relationships. Nevertheless, recent and ongoing developments in nature-based climate solutions and a green recovery from the COVID-19 pandemic offer hope for accelerating action on green infrastructure.

Many efforts are being made to make GI a mainstream practice, but further work is needed to develop consistent regulations and standards, and accessible funding and training programs. These policy changes are necessary to expand the uptake of GI practices beyond the most progressive stakeholder groups and to ensure a level playing field and common goals exist between regions. The following recommendations are intended to inform senior government officials and policymakers of the actions that will help build the capacity of local actors and improve the uptake of GI practices in all regions and communities.

1. Set Green Infrastructure as a priority at all levels of government and set standards to clarify how communities and stakeholders should prioritize action.

The introduction of GI into provincial policy and asset management regulation are important steps towards making GI a mainstream practice. Setting GI as a policy priority ensures all communities consider GI as an option when making investment decisions. This means strengthening regulations so municipalities conduct regular inventories and

quality assessments of GI assets and have the tools available to understand key stakeholder responsibilities and coordinate planning at a regional level. Looking for further opportunities to prioritize of GI in provincial and municipal policies and regulations will also help mobilize action and funding resources.

2. Separate Green Infrastructure funding from other types of infrastructure projects and make funding flexible to accommodate small and large-scale projects over short and long timescales. Budget for pre- and post-project monitoring.

The availability of funding is a strong determinant of municipal action. Dedicated funding should be targeted at GI projects that make use of natural services to avoid competing priorities with other necessary built systems like water and sanitary sewers, and clean technologies like renewable energy and electric vehicle infrastructure.

Funding programs need to be designed to provide communities access to more long-term funding that is available when GI partners are ready to undertake work. Project funding should also be prioritized to cover baseline studies and post-project monitoring to help quantify the many benefits of GI.

Funding needs to be addressed at both the provincial and federal levels and should continue to assess how to best support rural communitiesⁱ. Aligning terminologies and funding priorities among all levels of government would also help to reduce confusion around which projects qualify as GI and help move resources from the federal to the local level.

3. Continue to advance understanding and knowledge mobilization of the benefits of Green Infrastructure to rural stakeholders through regional studies and extension.

There remains a lack of awareness and understanding of GI, particularly in rural regions. This should be targeted through research partnerships with universities,

ⁱ Recent decisions at the federal level have at least partially addressed funding concerns of GI advocates by separating natural infrastructure from other infrastructure and clean technology solutions in budget 2020 and by reducing the funding threshold to improve accessibility for small-scale projects.

municipalities, conservation authorities, NGOs, and private landowners to study the broad application and benefits of GI in rural regions. Research efforts are needed to quantify the cumulative regional benefits of GI and should rely on collaboration among stakeholder groups to develop a common vision of GI.

4. Target information and training for Green Infrastructure stakeholders to build local capacity.

Information should be tailored directly to the target audiences of planners, engineers, financial and funding organizations, municipal staff, and landowners. Targeting GI training through professional development, guidance documents, and peer-to-peer networks will help build local capacity and credibility for GI practices.

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