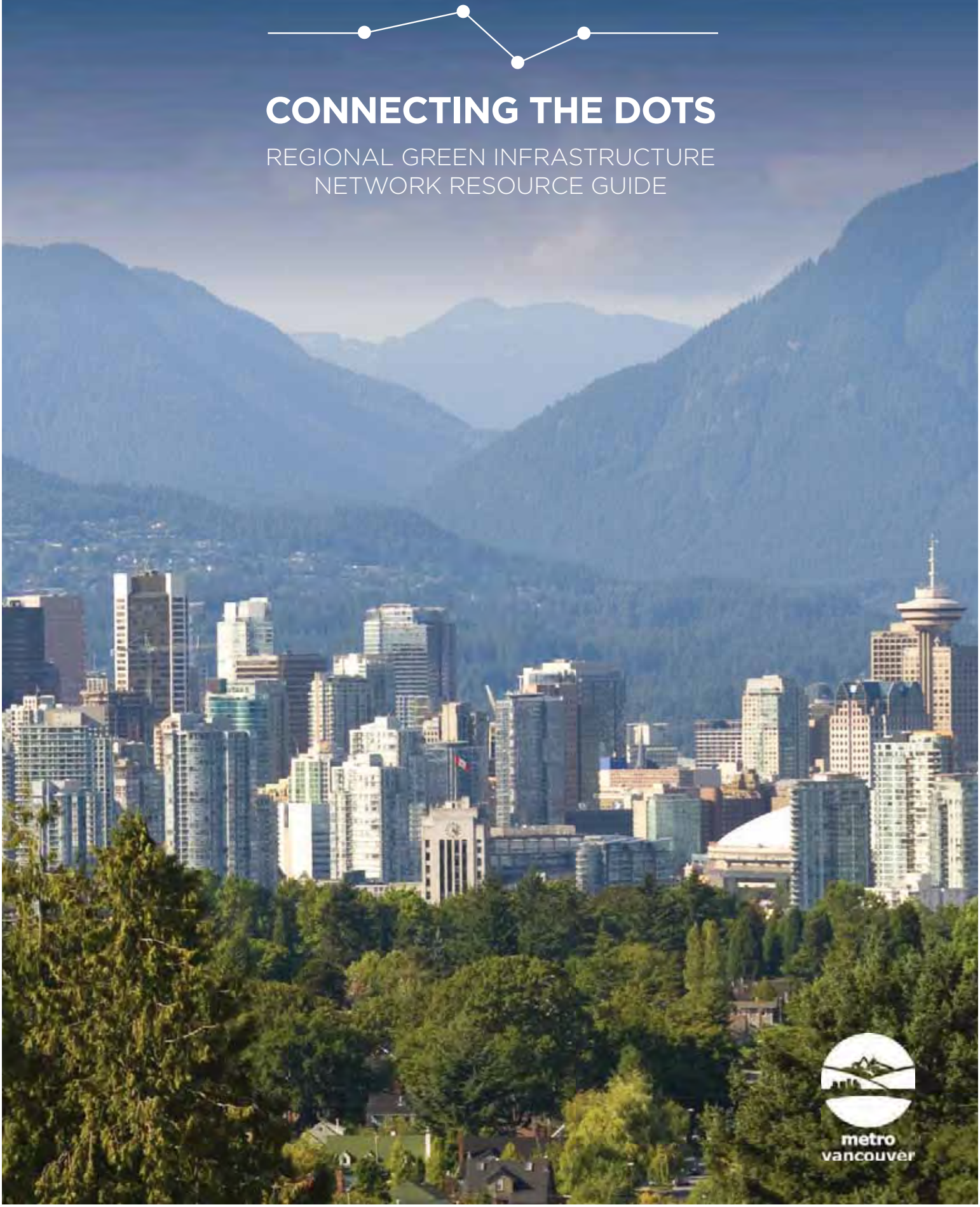
CONNECTING THE DOTS

REGIONAL GREEN INFRASTRUCTURE NETWORK RESOURCE GUIDE



metro vancouver

Lafarge Lake, Coquitlam.

Table of Contents

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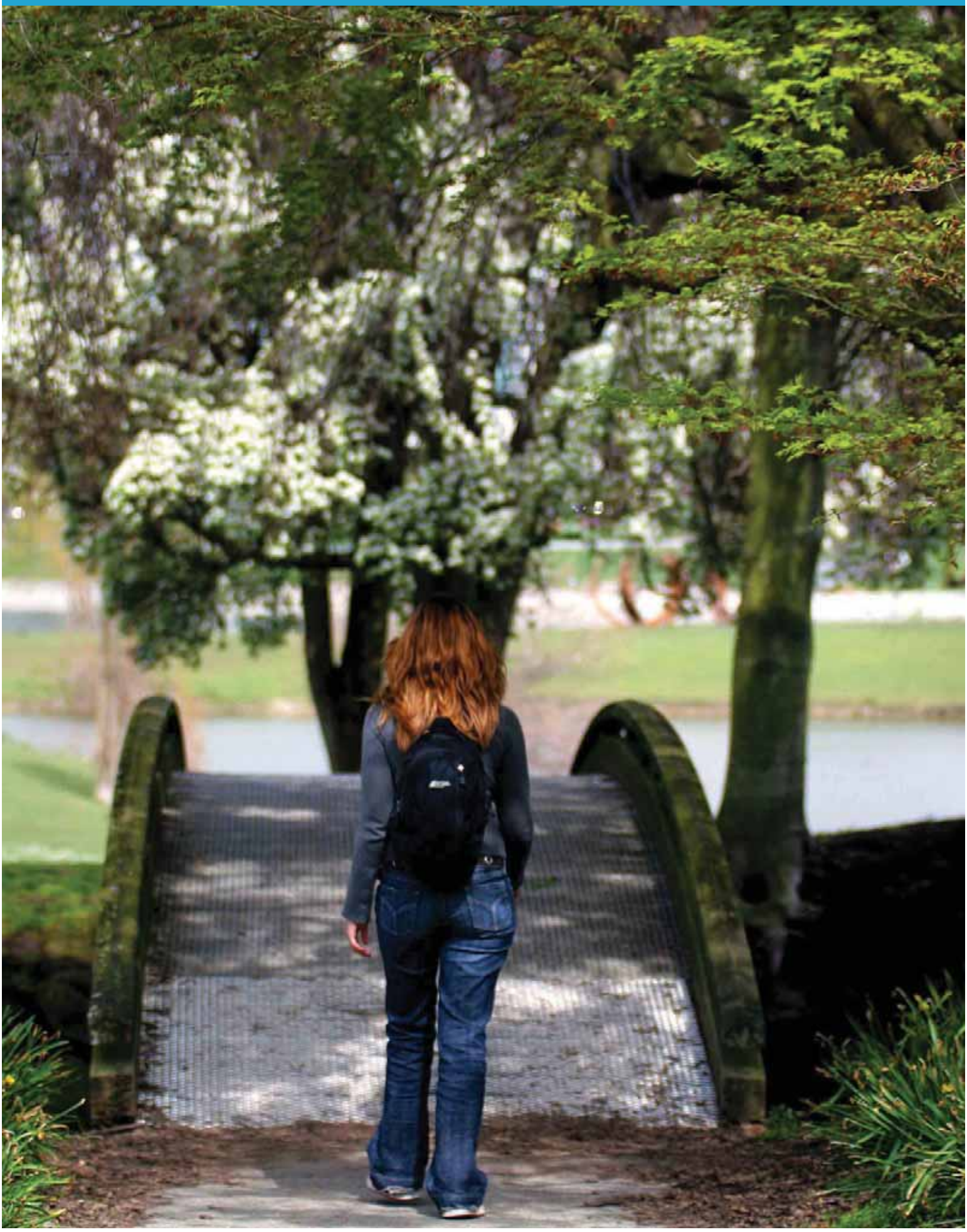


Introduction: A regional green infrastructure network

The ocean, mountains, forests, and rivers of Metro Vancouver provide a spectacular natural setting for the region's neighbourhoods, urban centres, parks, agricultural and industrial lands. Collectively, this environment supports over 2.4 million residents, in addition to the diversity of plants and animals that call it home.

The region's prosperity is tied to our natural environment. The diverse landscape and plentiful natural resources supported First Nations for thousands of years and later attracted new immigrants from eastern Canada, Europe and around the world. Population growth and human development has resulted in significant changes to the landscape, diminishing the health and abundance of many natural features. However, in recent years our appreciation of the value of nature and the many services it provides has grown and is reflected in our regional and municipal plans and policies as well as the management of our properties, facilities and greenspaces.

The Connecting the Dots Resource Guide supports the developing Regional Green Infrastructure Network Strategy of Metro Vancouver. This document describes different forms of green infrastructure and how it provides integrated benefits across the regional landscape. It supports the development of a regional green infrastructure network that will increase the resiliency of our natural systems and provide ecological, environmental, and socio-economic benefits to our communities.

DEFINITION

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

Environmental change, whether human-caused or natural, has the potential to significantly affect the livability of our region in the future. Metro Vancouver is expecting warmer, drier summers and milder, wetter winters as a result of climate change. Impacts expected to affect the region include rising sea levels, spring flooding, summer drought, air quality degradation, impacts to ground water and more frequent and severe weather events. Ecosystem changes may also happen more quickly than most native plants and animals can adapt, while adaptable, invasive species may flourish. These potential impacts could have serious repercussions for human health, communities, infrastructure, ecosystems and lifestyles.

Naturalized path at UniverCity at Simon Fraser University, Burnaby, BC.

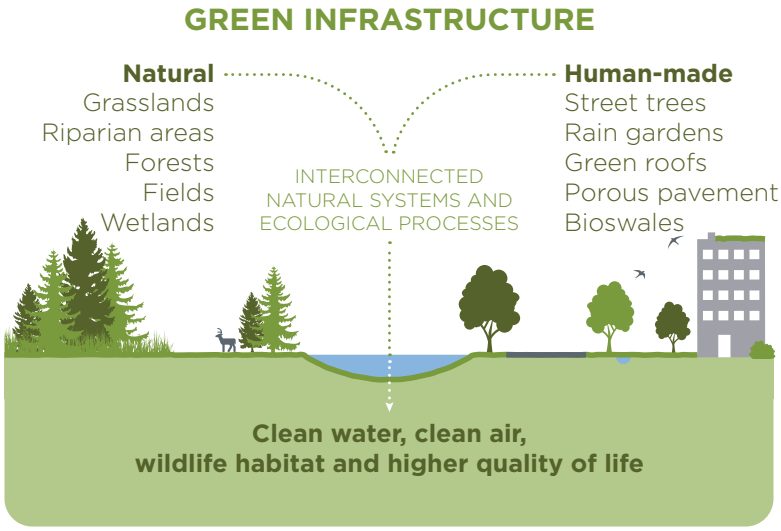
A primer on green infrastructure

Green infrastructure is a relatively new term and there is some variability in how it is used. This section describes some of the basic concepts of green infrastructure and its potential applications in Metro Vancouver and member municipalities.

What is green infrastructure?

Green infrastructure is a broad term that describes the integration of natural and semi-natural components in land use planning, engineering and urban design. These components vary in size and scope, but work collectively to improve the condition of our urban environment and support healthier, more livable and sustainable communities. Green infrastructure generally shares the following characteristics:

- **MULTI-FUNCTIONAL.** Green infrastructure provides a variety of benefits and "free" ecosystem services to people and wildlife.
- **ADAPTIVE.** Green infrastructure has many forms, both natural and constructed, and can be implemented at different scales and surfaces (hardscape to softscape).
- **SUSTAINABLE.** Green infrastructure supports broad-based community sustainability goals, including social well-being, community health, and ecological and environmental sustainability. It can also provide economic benefits by reducing capital, maintenance and replacement costs of some conventional grey infrastructure.



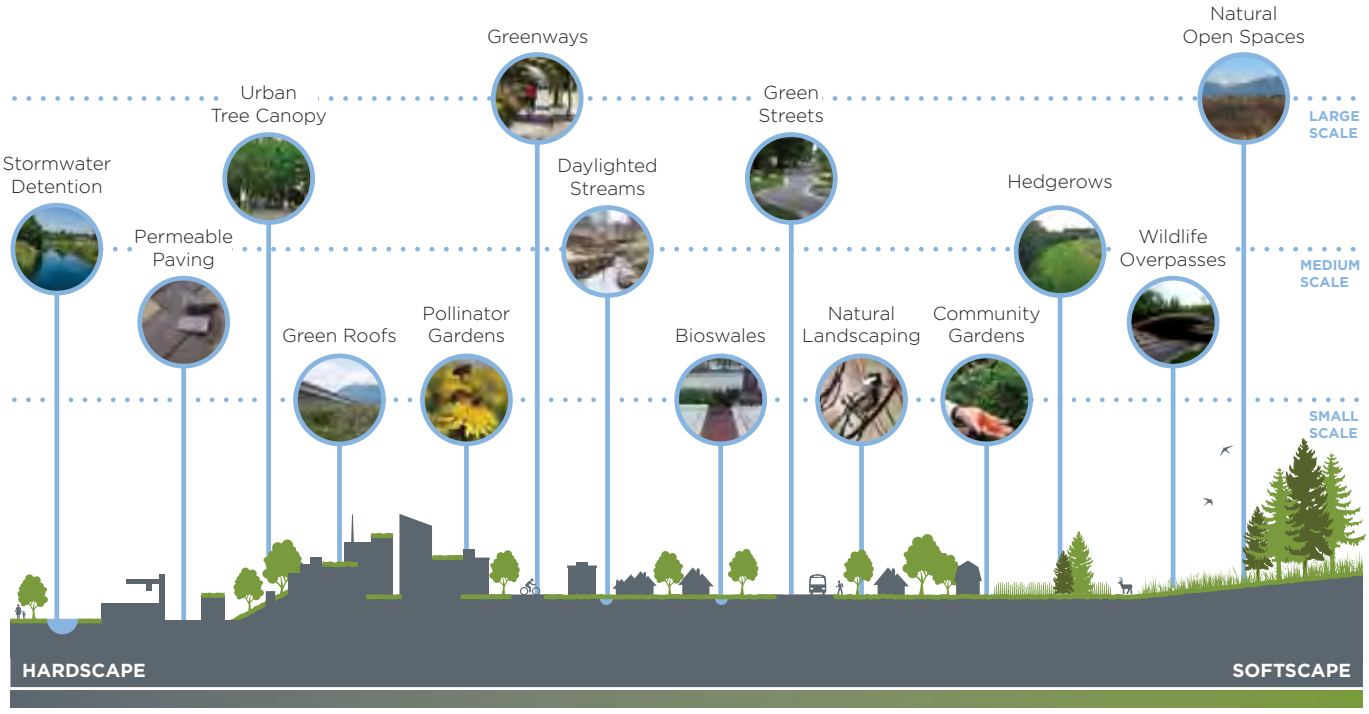
DEFINITION

Ecosystem Services
The aspects of ecosystems used, actively or passively, to contribute to human wellbeing. They include the provision of clean water and air, pollination of crops, mitigation of environmental hazards (e.g., flooding), pest and disease control and carbon sequestration.

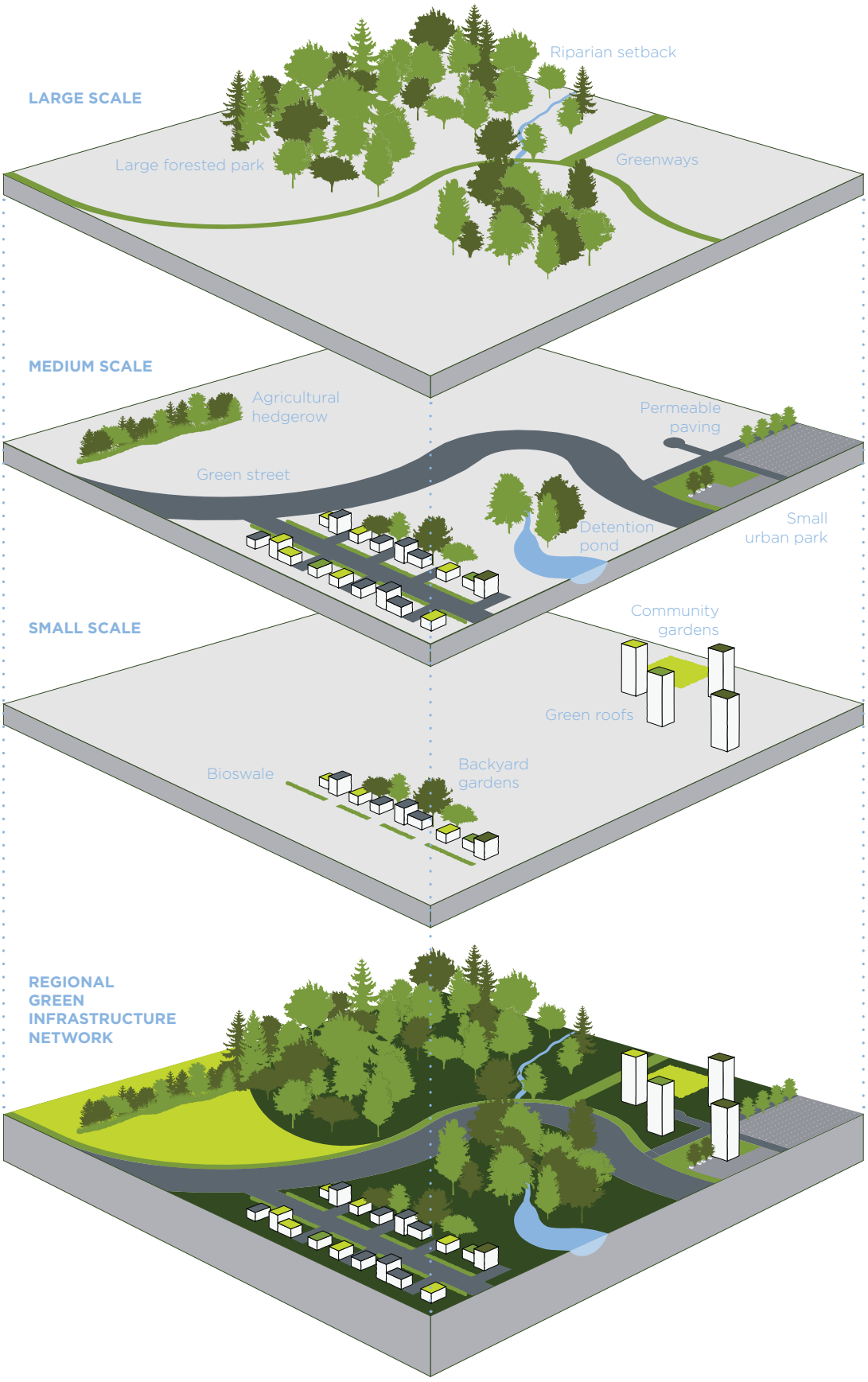
Green infrastructure can be implemented across a range of landscapes, from urban centres to rural and agricultural areas. One of the distinctions that separate these landscapes is the amount of hard or impermeable surfaces, or hardscape. Generally, the more developed a landscape is, the more hardscape exists. Green infrastructure can sometimes replace hardscape with more permeable surfaces, create additional greenspace, and demonstrate greater value in conserving natural areas. The amount and type of hardscape that exists can influence the kind of green infrastructure that can be implemented.

Green infrastructure projects can range in size from small, street or lot-level interventions to a neighbourhood-wide scale. Determining which type of green infrastructure is appropriate depends on a project's objectives, opportunities and constraints (e.g., cost, land use, regulations). Refer to Appendix A for a more detailed description of the types of green infrastructure.

Rooftop herb garden.



Green infrastructure opportunities across the urban landscape



Components of green infastructure link together to form a functional network

What is a green infrastructure network?

When different green infrastructure components are connected, the resulting framework is referred to as a green infrastructure network. A green infrastructure network is typically composed of core greenspaces (called hubs) and corridors that link them together.

Hubs form the heart of the network and provide significant benefits and ecosystem services for people. For example, watersheds are protected to ensure water quality; agricultural land supplies food; forest stands improve air quality, filter water, and store carbon; and large "natural" parks provide recreational amenities and health benefits. These areas also provide habitat for a wide variety of plants and animals.

Corridors tie the network together and make it bigger than the sum of its individual parts. Improved connectivity among hubs supports movement of people (e.g., greenways), plants and wildlife (e.g., riparian corridors).

The Matrix refers to the landscape outside of the hubs and corridors. It includes a multitude of smaller natural features that are not connected to one another, but together provide important benefits. Conservation, restoration and infrastructure interventions in the matrix support ecosystem functions such as stormwater infiltration, pollinator mobility, and seed dispersal for plants. They can also act to buffer and/or complement adjacent ecosystems or features in a green infrastructure network.

Opportunities to preserve and enhance natural corridors in less urbanized environments are often supported by the availability of open space and, in some instances, fewer development pressures. Many regulatory protections also exist to preserve sensitive areas, including riparian corridors (vegetated areas that buffer watercourses). But what happens in dense, urban environments that are largely built over and are often subject to significant development pressure? In these areas, green infrastructure can be pieced together at the site level to form linkages. Re-development, retrofitting, and municipal incentives provide opportunities to improve connectivity.

PIECING GREEN INFRASTRUCTURE TOGETHER

The City of Wilsonville, south of Portland, Oregon, has implemented a variety of natural resource protection policies to encourage development of green infrastructure. Stormwater management objectives include protecting natural watercourses; restoring and daylighting streams; encouraging developers to use open drainage systems, implementing Low Impact Development (LID) strategies; and protecting existing vegetation. Development charges and stormwater user fees pay for these capital investments.

DAYLIGHTING URBAN STREAMS AND STORMWATER MANAGEMENT

Acclaimed by Fisheries and Oceans Canada (DFO) as the largest creek project of its kind in BC, the daylighting of Thain Creek in North Vancouver in 2000 involved the removal and replacement of a 200-metre long culvert with a fish-friendly open channel and enabled the restoration of a section of the creek to near-natural conditions. The project, which cost $1.4 million and won a Consulting Engineers of BC Award of Merit, has created an attractive creek corridor and contributed to the preservation of endangered salmon stocks, all while offering improved flood protection in the area.

How do we benefit from green infrastructure?

Green infrastructure, in both its natural form (e.g., forests, riparian areas, wetlands, etc.) and its human-made form (e.g., bioswales, street trees, green roofs, etc.) provides "free" ecosystem services that support sustainable development and livable communities. Ecosystem services that benefit the region include clean air and water, pollination of crops and carbon sequestration. By investing in green infrastructure, we will continue to receive the environmental, economic, and social benefits nature provides.

$5.4B

THE ECONOMIC VALUE OF NATURE

A 2010 report estimated that a conservative estimate of the annual economic value of the services provided by the forests, wetlands, grasslands, and croplands in BC's Lower Mainland is $5.4 billion (Natural Capital in BC's Lower Mainland: valuing the benefits from nature Pacific Parklands Foundation and the David Suzuki Foundation). Building connectivity across the region supports and enhances this natural capital.

Benefits of Green Infastructure

QUALITY OF LIFE. Greenspaces improve livability, enhance local character, and provide access to nature.

HUMAN HEALTH. Interaction with nature is essential to human health. A large and growing body of research in Canada and abroad clearly demonstrates that physical, social and psychological well-being are positively influenced by our views of and access to nature.

RECREATION. Connected and expanded green networks increase both passive (e.g., walking, bird watching) and active (e.g., jogging, cycling) recreation opportunities.

FOOD PRODUCTION. Green infrastructure supports a diversity of insects, plants, animals and other organisms, many of which are beneficial to local food production. Community and backyard gardens contribute to livability and provide an affordable local food source.

ENVIRONMENTAL EDUCATION. Urban greenspace creates more opportunities for people to experience, engage with, and learn about nature and ecosystem services.

FINANCIAL. Greener environments can attract businesses and employees, and provide jobs in tourism, agriculture, and other sectors. Green infrastructure can also minimize capital requirements and reduce long-term maintenance and replacement costs associated with traditional infrastructure.

STORMWATER MANAGEMENT. Green infrastructure can mimic and replace conventional grey infrastructure such as stormwater pipes and tanks resulting in reduced capital and maintenance costs. Trees and vegetation decrease the amount of hard surfaces and increase rainwater interception and infiltration, reducing the risk of storm sewage overflows and flooding.

ENERGY EFFICIENCY. Trees and vegetation shade and cool buildings in the summer, and help insulate buildings in the winter.

AIR QUALITY. Trees help cool the atmosphere, reducing the production of harmful pollutants. Trees and vegetation also absorb and store carbon dioxide, and release oxygen into the atmosphere.

WATER QUALITY. Vegetation and healthy soils clean urban runoff and allow water to be absorbed into the ground, recharging streams and groundwater.

HAZARD REDUCTION. Vegetated landscapes absorb water and stabilize slopes, helping to protect the built environment against hazards like flooding and landslides.

BIODIVERSITY. Restored natural vegetation, streams, lakes, and wetlands provide habitat, including food and shelter for a diversity of species. Natural corridors allow plants and animals to move between larger habitat areas, overcoming the effects of habitat fragmentation and helping to diversify the gene pool.

GREEN CORRIDORS AND THE NECTAR TRAIL PROJECT

The Nectar Trail is a new Vancouver-based community initiative that will connect existing pollinator-friendly habitats in the urban environment by building corridors of native flower gardens between them. This program is organized and maintained by the Environmental Youth Alliance, the City of Vancouver, the Vancouver Park Board and local residents. These greenways will encourage pollinator travel, which in turn supports nature and local food production while offering opportunities for environmental education and improved livability in the surrounding community. The first Nectar Trail project will link Queen Elizabeth Park to the Van Dusen Gardens along the Ridgeway Greenway.

THE "GREEN EFFECT"

Views of nature (e.g., trees and greenery) from offices and schools reduce stress, increase productivity, and support higher results in cognitive tests. Seniors tend to live longer when living next to and recreating in green-space, while negative social behaviour (e.g., illegal activity, aggression, littering) is lower in urban areas with more trees and greenspace.

Can we afford to build a Green Infrastructure Network?

The costs associated with building the Regional Green Infastructure Network largely stem from securing land through purchasing or covenants and restoring sites in more modified environments. These costs can be significant, especially with the high land prices in Metro Vancouver.

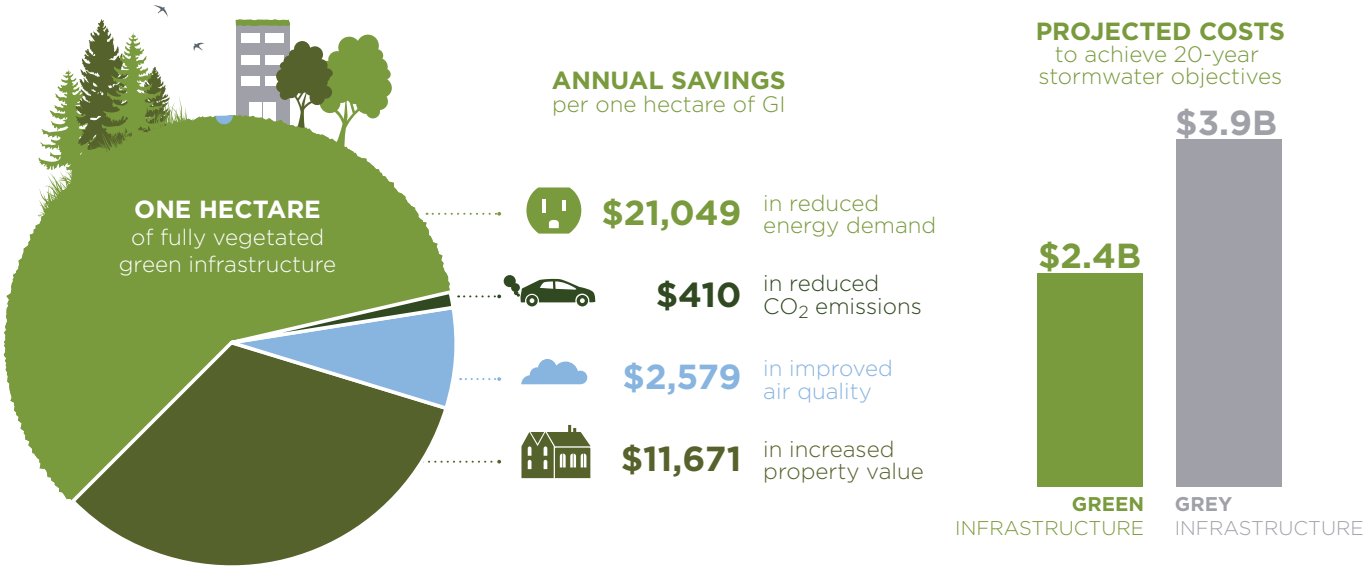
DIRECT COST SAVINGS: Building and maintenance costs for green infrastructure can be less than conventional grey infrastructure. Municipalities and developers can also save money through reduced capital and land acquisition costs. For example, green infrastructure is often designed to manage stormwater runoff at its source, and is often integrated into existing landscaping or buildings. Traditional grey infrastructure requires a much larger footprint to collect, direct, store, and potentially treat stormwater off-site. Green infrastructure also typically has a longer lifespan than conventional systems, reducing replacement costs.

INDIRECT COST SAVINGS: The up-front costs of green infrastructure are paid back over time through the benefits and services they provide. For example, green roofs and trees can save money by reducing energy costs. A U.S. study of 27 green infrastructure stormwater management projects found that all but two projects had internal rates of return of greater than 13%. In many municipalities, permeable pavement is being used to replace aging hard surfaces. Although initial installation costs can be higher than conventional paving, these costs are recouped over time through savings in maintenance and stormwater management.

MULTIPLE BENEFITS: The economic value of green infrastructure projects is compounded given the multiple functions they perform. As an example, green infrastructure stormwater management projects often provide concurrent recreation (passive and active), ecological, transportation (e.g., bike and pedestrian paths), health, and urban design and beautification benefits.

The benefits of green infrastructure

Estimates based on the 2010 NYC Green Infrastructure Plan

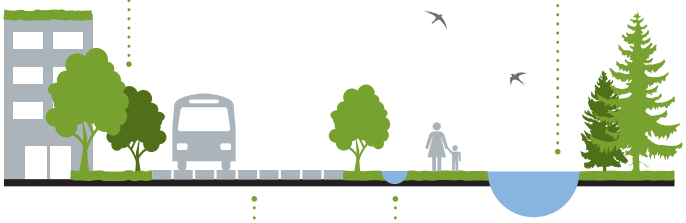


Cost comparison of green street infastructure vs grey infastructure

GREEN ROOFS
According to Portland's Green Roof Program, green roofs can cost one and a half times more than conventional roofs to install. However, a green roof will last twice as long before needing to be replaced, and will reduce annual stormwater volumes by over 50%.

PERMEABLE PAVING
Permeable pavement in alleys can have a life expectancy of 30 – 35 years and runoff reductions of 70 – 90%.

TREES
Economic benefits related to stormwater management, improved air quality, reduced energy consumption, carbon sequestration, and better aesthetics can be $1.50 - $3.00 per tree for every $1 invested in planting/maintenance.



WETLANDS AND DETENTION PONDS
Building a wastewater treatment system using constructed wetlands costs about $5 per gallon of capacity compared to roughly $10 per gallon of capacity for a conventional advanced treatment facility.

BIO-SWALES
The City of Portland found vegetated bio-swales reduced 25 year peak storm flows by 88% and total flow into local sewers by 85% compared to conventional infrastructure.

GREEN VS. GREY CHICAGO CASE STUDY

Chicago (America's third largest city) is implementing new green infrastructure policies to address its aging stormwater system and vast amount of impervious surface, which accounts for 58% of its urban area. Chicago's Green Alley Program aims to transform the world's longest network of paved alleyways using green technology. Permeable, high albedo pavers are installed to retrofit existing alleys. Cost is comparable to traditional pavers, but comes with additional benefits of permitting increased stormwater infiltration (up to 80%) and reducing the urban heat island effect. This approach is being championed to help increase the City's triple bottom line, linking improved environmental conditions with reduced government expenditures and better quality of life.

Bell Street Park plan. SVR Design.

GREEN VS. GREY SEATTLE CASE STUDY

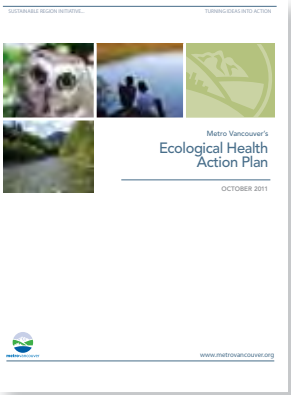
The City of Seattle incorporates green infrastructure as part of its nationally acclaimed Natural Drainage Systems (NDS) projects. These projects use innovative street designs to manage (slow and filter) stormwater and reduce runoff into natural watercourses. Bioswales, small wetlands, natural landscaping, and permeable surfaces are integrated into streetscapes. Cost analyses have proven that NDS designs can be significantly less expensive to install than traditional streets that use grey infrastructure. This can be attributed to reduced paving requirements and engineered infrastructure, lower installation costs, and reductions in maintenance. Perhaps most importantly, these alternative stormwater strategies have been proven to work exceptionally well, with post-construction project monitoring in Seattle demonstrating up to a 99% reduction in stormwater volumes.

Moving towards a regional green infrastructure network

The existing elements of the regional green infrastructure network are the result of the combined and often collaborative efforts of municipalities and Metro Vancouver. Many local plans, strategies and action have played a large role in creating the landscape we value today.

At the regional scale, the building blocks of a regional green infrastructure network can be traced back to 1975's groundbreaking *Livable Region Plan*. This plan established the policy foundation for conserving and connecting greenspace in the region. Subsequent updates to this plan have further refined these policies to address the new challenges emerging in our rapidly changing urban environment.

In 1996, the *Livable Region Strategic Plan* identified a Green Zone to help define the limit to urban expansion. A Regional Park and Outdoor Recreation System was proposed to expand and improve major recreational sites and the linkages between them to "allow people and wildlife to move more freely across the region.".



The most recent regional growth strategy, *Metro Vancouver 2040 – Shaping our Future*, was adopted in 2011. One of its policy goals was to "Protect and enhance natural features and their connectivity.". The strategy was followed by the release of Metro Vancouver's *Ecological Health Action Plan*, which proposed 12 projects to maintain and enhance ecosystem services in the region and help realize the commitments articulated in the *Sustainable Region Initiative*. One of the Action Plan's 12 projects is advancing a regional green infrastructure network. This is recognized as an area of opportunity where Metro Vancouver could take a leadership role in identifying and coordinating important regional connectivity.

This Resource Guide provides important information about green infrastructure that will support municipalities, government agencies, planners, developers, stewardship groups and the general public in implementing the regional green infrastructure network. Objectives of this guide are to:

- describe the different types of green infrastructure;
- communicate the benefits and values of green infrastructure;
- demonstrate how municipalities are already successfully implementing green infrastructure across different land uses and at a variety of scales; and
- support policy development that promotes green infrastructure.

Rooftop gardens

Developing our regional green infrastructure network

Metro Vancouver is working with regional partners to recognize and enhance locally and regionally important linkages between our natural and built environments. Realizing the goal of a regional network will require a variety of approaches. In some areas, opportunities may include expanding existing protected areas such as regional parks, wildlife management or conservancy areas. Elsewhere, new landscaping, street trees and bioswales will be the focus.

The Regional Green Infrastructure Network provides a conceptual framework to view greenspace. The RGIN is the spine of a multi-faceted network made up of hubs, corridors and the matrix. It strengthens collaboration across municipal boundaries by focusing on linking and conserving large sensitive ecosystems, expanding human-made green infrastructure and delivering important ecosystem services. This regional network will support and connect to local green infrastructure programs and demonstrate the benefits of implementing different types of green infrastructure on a variety of scales.

ISLANDS OF NATURE

Initially slated for industrial development, Surrey Bend Regional Park was preserved through a Metro Vancouver and City of Surrey partnership that began with land acquisition in 1995 and a series of joint meetings commencing in 2004. Now, this park protects one of the few remaining un-diked sections of the Fraser River and provides a critical and diverse wetland habitat along an otherwise highly impacted stretch of waterway. In addition, the Transportation Investment Corporation has undertaken a Habitat Enhancement Project within the park, which includes improvements to park infrastructure that will support and sustain salmon and wildlife habitats.

City of Surrey

The regional green infrastructure network today

Urban development has resulted in significant changes to Metro Vancouver's landscape over time. However, our region is also fortunate to have retained an abundance of natural hubs that provide tremendous value and benefits. Forested watersheds have been protected to ensure clean drinking water. Protected foreshore, intertidal zones and riparian areas provide important habitat and movement corridors for wildlife. Agricultural lands occupy significant areas of lowland floodplains that can also provide important natural habitat. Our well established parks support recreation and protect the many plants, animals and habitats found in our region. Together, these areas form the foundation of the regional green infrastructure network.

The challenge in developing a Regional Green Infrastructure Network is creating functional connections through highly urbanized and mostly privately owned landscapes. Innovative planning is required to capitalize on opportunities to bridge these gaps. In many cases, successful implementation will require a collaborative approach among multiple partners. While there will doubtless be many challenges, the opportunities to better link, expand and improve a regional network are exceptional. In addition to the building blocks (i.e., the hubs) that are already in place, much technical background work has been completed (e.g., Metro Vancouver's *Sensitive Ecosystem Inventory and Land Cover Classification)*, and other complementary local level plans and strategies (e.g., the City of Surrey's Biodiversity Conservation Strategy). Perhaps most importantly, the commitment and capacity amongst regional partners and member municipalities is evident in the number of green infrastructure projects underway or completed.

RECOGNIZING THE ROLE OF OUR HISTORIC WATERWAYS

Experience the Fraser (ETF) is a unique vision to connect communities, parks, natural features, historic and cultural sites and experiences along the Lower Fraser River. The Canyon to Coast Trail and Recreational Blueway are the backbone of the project, connecting Hope to the Salish Sea by over 550 km of trail and via the river itself. By bringing together destinations, experiences and amenities along the river, ETF will act as a catalyst to add strength and dynamism to local tourism and economic development initiatives, acting as a catalyst. The hope is for all to be inspired to become more active stewards on behalf of the river, and for the Lower Fraser River to become one of the world's great river destinations.

Photo: *Nicholas Scapillati*

FIRST NATIONS AND GREEN INFRASTRUCTURE

First Nations are important partners in our green infrastructure efforts. There are 11 First Nations in the Metro Vancouver region. Of these, Tsawwassen First Nation is a Treaty First Nation and is a full member of Metro Vancouver, while several others are in advanced treaty negotiations with the Province and Canada. Collectively and individually, First Nations are important partners and stakeholders in both supporting and facilitating the development of a regional green infrastructure network. As landholders, political partners and residents of the region, their engagement and involvement will also help ensure that the important cultural values and benefits of green infrastructure are included in any new projects.

Essential concepts of connectivity

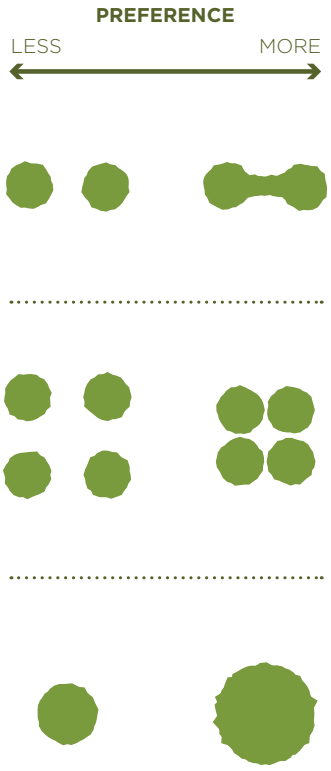
A functioning and protected green infrastructure network is an integral part of our region's future. It will connect the natural landscape and provide a framework for more sustainable land development and stewardship in Metro Vancouver. The process to complete the network will not be immediate and will involve a phased approach over time. Advance planning is necessary to ensure that green infrastructure is implemented strategically when opportunities arise and avoids unintended consequences. This requires a coordinated, integrated approach involving local and regional politicians, planners, engineers, ecologists, biologists, and developers.

There are many opportunities available for implementing green infrastructure. Expanding and/or buffering existing protected natural areas can greatly increase their ecosystem service value. Aging or underperforming grey infrastructure should be replaced wherever practical or possible. Urban renewal, revitalization and redevelopment projects provide excellent opportunities to replace or enhance traditional infrastructure with green alternatives.

Green infrastructure should also be incorporated into the planning and design of all new development at both the building and site level from the outset, with the objective of minimizing grey infrastructure and hardscape. Opportunities to enhance local and regional green infrastructure connections should also be explored. Integrating green infrastructure with regional infrastructure projects and planning (e.g., sewer, water, transportation) provides further opportunity to improve connectivity.

Major network hubs are managed (sometimes co-operatively) by a variety of different partners and include municipal, regional and provincial parks, protected watersheds and ecological reserves. Municipalities will play the primary role in determining where and when green infrastructure can be implemented to connect hubs. A variety of planning tools and mechanisms can be employed to help protect existing hubs and implement green infrastructure projects.

When developing the Regional Green Infastructure Network, general principles of conservation biology should be observed. These will improve overall habitat quality, and can help prioritize and enhance sites for inclusion as part of the network.



Principles of conservation biology.

CONNECTIVITY. Green infrastructure should be connected wherever possible. Multi-partner coordination is required to overcome obstacles associated with jurisdictional boundaries.

PROXIMITY. Green infrastructure projects located close to one another provide more benefits than those that are farther apart.

SIZE. Although existing land use will dictate the type of green infrastructure that can be implemented, generally speaking, larger projects will provide more benefits than smaller ones.

Exploring regional opportunities for green infrastructure

There are numerous opportunities for implementing green infrastructure projects across Metro Vancouver. While land use is categorized to a finer level of detail at the municipal level, the six landscape types depicted below are the most typical ones represented across the Metro Vancouver region. The unique characteristics of each landscape will influence the types of green infrastructure opportunities that may be considered. Many of the great design elements and innovative technologies presented in some of the case studies in this guide will be better suited to certain landscape types than others; however, there is a place for green infrastructure throughout the region. In keeping with the policy direction of Metro 2040, the most important decision to support green infrastructure is location. Industrial, high density and medium density development should all happen within existing urban areas (e.g. within the Urban Containment Boundary). Directing development in this manner supports retention of existing green infrastructure (e.g., forested natural areas), which can lead to substantially more benefits than building new green infrastructure alone.

INDUSTRIAL. Areas supporting industrial and employment activity, including port lands, rail yards, business parks, heavy manufacturing, factories, and warehousing.

HIGH DENSITY. Urban and town centres with office and residential towers, mixed-use developments and large commercial centres.

MEDIUM DENSITY. Urban neighbourhoods with residential and commercial development. Low rise buildings, townhouses, and more compact single-family neighbourhoods.

RURAL. Neighbourhoods and subdivisions featuring low-density residential development. Single-family homes on larger residential lots and acreages in rural areas.

AGRICULTURAL. Areas often designated for agricultural use or other resource management purposes. Some rural residential acreages with larger single-family homes along with farmhouse homes and ancillary buildings (barns, storage and processing facilities).

GREENSPACE. Managed "natural" areas, including protected watersheds, parks, and other open spaces that provide significant nature services, in addition to conservation and recreation (passive and active) values.

Generalized Metro Vancouver landcape types.

The following matrix shows the types of green infrastructure opportunities that are considered appropriate for each landscape. Specific types of green infrastructure should not be considered exclusive to any one landscape; indeed there may be opportunities to implement one or all depending on specific site conditions and project objectives.

GREEN INFRASTRUCTURE OPPORTUNITY	LANDSCAPE TYPE: INDUSTRIAL	HIGH DENSITY	MEDIUM DENSITY	RURAL	AGRICULTURAL	GREEN SPACE
Hubs	less	less	less	more	more	more
Small natural/open areas	more	more	more	more	more	more
Riparian corridors	more	less	more	more	more	more
Urban tree canopy	more	more	more	more	more	more
Greenways	more	more	more	more	more	more
Detention/Infiltration ponds	more	less	less	more	more	more
Bioswales	more	less	more	more	more	less
Rain gardens	more	less	more	more	more	less
Permeable pavement	more	more	more	less	less	less
Community gardens	less	more	more	less	less	less
Green roofs/walls	more	more	more	less	less	less
Natural landscaping	more	more	more	more	more	more
Container gardens	less	more	more	more	less	less
Green streets	less	less	more	more	less	less
Daylighted streams	more	less	more	more	more	more
Hedgerows	less	less	less	more	more	more
Pollinator-friendly gardens	less	more	more	more	more	more

more opportunities less opportunities

Green infrastructure opportunities by landscape type

CASE STUDIES

GREEN INFRASTRUCTURE ON THE GROUND

The following case studies highlight successful regional green infrastructure projects implemented in each of the six landscape categories. Each case study provides the following information:

- **PROJECT DESCRIPTION**
  An overview of the project and its objectives.
- **PROJECT PLANNING AND IMPLEMENTATION**
  An overview of what planning tools and mechanisms were used to implement the project.
- **PROJECT OUTCOMES AND LESSONS LEARNED**
  An overview and summary of project successes, challenges and lessons learned.
- **ENABLING FISCAL AND POLICY TOOLS**
  A list of the tools used to design, plan, fund and implement the projects.

CREEKWAY PARK STREAM RESTORATION

PROJECT LOCATION

North of Hastings Park (McGill Street), Vancouver, BC

PROJECT DESCRIPTION

Creekway Park is one of the City of Vancouver's newest parks. Located just north of busy McGill Street and next to the CN Rail corridor, it begins to build ecological and human connections between Hastings Park (PNE) and New Brighton Park on Burrard Inlet. The park is an initial phase of a project that will eventually restore an historical stream that once flowed through Hastings Park to Burrard Inlet. This park also improves east-west bikeway and pedestrian connections through east Vancouver.

PLANNING AND IMPLEMENTATION

Creekway Park was developed in an abandoned parking lot as part of the Hastings Park revitalization program. The project was designed by an interdisciplinary team that included landscape architects, water resources engineers, geotechnical engineers, biologists, and transportation planners. It also went through an extensive public engagement process including open houses and meetings with the Hastings Park Open Space Advisory Group.

The water system consists of a series of vegetated wetlands connected with a cobble-lined channel. Stormwater from the immediate area is recirculated using a pump-based system. At a later stage, stormwater from the larger Hastings Park catchment will be redirected to ensure the stream and wetlands have year-round flow. Diverse herbaceous, wetland, and shrub communities provide the foundation for increasing biodiversity over time. Eventually, stormwater filtration through the constructed stream will help restore fish habitat in a tidal salt marsh in New Brighton Park.

Creekway Park is a novel ecosystem that emulates some of the forms and functions of native ecosystems, while blending them with urban landscape components. While the plant communities are generally native, they also include blue irises and other flowering plants that are not native to coastal BC. These were included to increase diversity and create bolder colours and textures to enhance the park experience. Many of the native plant species such as coastal strawberry, thimbleberry, and spiraea are important for native bees and other pollinators.

PROJECT OUTCOMES AND LESSONS LEARNED

Creekway Park was built in a narrow linear parcel at the intersection of a broad range of municipal infrastructure: roads, rail lines, storm drains, regional sanitary sewers, gas lines, and power lines. The design needed to respond to these infrastructure constraints by building above the existing ground plane to avoid sub-surface disturbance. This precluded the creation of deeper wetlands and streams enclosed in a shallow ravine. Trees could only be planted along the park's perimeter.

Setting clear targets for habitat restoration projects ensures that expectations are met. Some members of the public felt that fish habitat should be an important component of Creekway Park. However, given the highly urbanized catchment, channel gradient issues, and small stream size, salmon and trout habitat was not considered an appropriate restoration target. Instead, the design promoted the goal of restoring a dynamic ecosystem that will benefit many urban species.

ENABLING FISCAL AND POLICY TOOLS

- Greenest City Action Plan (Access to Nature target)
- Hastings Park/PNE Master Plan

CAMPBELL HEIGHTS BUSINESS PARK

PROJECT LOCATION

Campbell Heights Business Park, Surrey, BC

PROJECT DESCRIPTION

Campbell Heights Business Park is a large (101 hectare) greenfield development located in south-east Surrey. The overall development concept envisions a high quality industrial business park that reflects the area's natural surroundings. Green infrastructure is integrated to manage stormwater on site, protect environmental features, and improve overall aesthetics. Over 2.4 million square feet of office, commercial and industrial space had been constructed between 2003 and 2013.

PLANNING AND IMPLEMENTATION

Campbell Heights is located on the Brookswood Aquifer, a highly productive groundwater resource. Water in the aquifer is used for drinking and irrigation and also provides base flows to valuable fish bearing creeks including the Little Campbell River. The area also has a large percentage of forested land and numerous watercourses. Design and servicing guidelines were created prior to development to protect these environmental values and encourage integration of green infrastructure to manage stormwater.

Wildlife corridors have been maintained to provide connectivity between the habitats in Campbell Valley Regional Park, and those in the Nicomekl River and Serpentine River lowland areas. Riparian corridors and salmon-bearing watercourses are preserved, enhanced or reconstructed. There is coordinated development among buildings, landscaping and site features.

A portion of the Campbell Heights area was a former quarry pit for sand and gravel. Stormwater servicing for areas previously mined consist of onsite bioswales, onsite oil-water interceptors, perforated City storm sewers, stormceptor devices at each piped outfall, a settling pool prior to stormwater entering the creek system and a community detention facility. Areas not previously mined have significant gravel deposits and better infiltration potential. Servicing for these areas consists of full infiltration (exfiltration) for both onsite and offsite runoff up to the 100 year return period that also serves to address water quality issues. Where soil conditions allow for effective groundwater recharge, the stormwater system is designed to release stormwater back into the ground. This mimics the way stormwater naturally moves in the area while also reducing the requirements for stormwater sewers and detention ponds.

PROJECT OUTCOMES AND LESSONS LEARNED

The purchase and development of lots has progressed at a steady rate within the Campbell Heights Business Park. The most significant lesson learned was the importance of having good design guidelines for the habitat compensation/restoration areas. The highly pervious sands and gravels posed unforeseen challenges and extra costs associated with establishing a healthy plant community. The reliance on exfiltration systems for stormwater servicing required that more prescriptive guidelines be provided to engineering and design consultants who were more familiar with conventional servicing systems. As development has progressed, this requirement has lessened. Erosion and sediment control (ESC) during construction has been a significant issue. Education is needed to ensure all onsite staff and contractors are aware of the consequences of poor ESC practices.

ENABLING FISCAL AND POLICY TOOLS

- Cluster Development ("Eco-clusters")
- Sustainable Design Guidelines
- Density Bonusing
- Conservation Habitat Covenants
- Local Area Bylaws for green infrastructure and parkette maintenance

NEW CONCEPTS FOR ARTERIAL ROAD DESIGN

PROJECT LOCATION

New Dollarton Highway, North Vancouver (District), BC

PROJECT DESCRIPTION

This project included construction of collector, arterial and local roads through a newly developed commercial/industrial area, the largest on the North Shore. This innovative approach to road design was used to protect the ecological sensitivity of the Maplewood Flats foreshore along Burrard Inlet. The ecology of this conservation area is highly dependent on the quality of ground water and protection of natural vegetation, which provides important habitat for birds, mammals and fish. The drainage design for the new highway increases groundwater recharge and provides better control of stormwater runoff, while also incorporating large center and sidewalk boulevard plantings to improve aesthetic appeal and wildlife habitat.

PLANNING AND IMPLEMENTATION

This project was completed in accordance to the Metro Vancouver Integrated Stormwater Management Plan (ISWMP) guidelines. Goals of the drainage design for this project are to service the entire 40.6 hectare catchment area of the Maplewoods neighbourhood and to maintain the level and quality of ground water. Existing site conditions (high water table, flat terrain and gravelly soils) presented a challenge.

Typical road standards were maintained. Lane widths were not reduced to accommodate the new boulevards. Underground piping was also retained due to presence of a large underground main. Runoff is exfiltrated via catch basins and a dispersal drain system that is incorporated in green strips located between the roadway and a meandering path on both sides of the highway. During extreme rainfall events, the runoff overflow is piped via a storm sewer to an outfall structure. An oil and grit separator is incorporated in the outfall design; only low flow events are passed through the separator. Flow is diverted into the separator by means of concrete benching in the storm sewer that forms a small dam in the pipe invert.

PROJECT OUTCOMES AND LESSONS LEARNED

This project was completed over five phases from 1999 to 2003 at a total cost of $8 million, which is more expensive than a conventional design. Maintenance costs are also higher, but this was expected prior to construction. The drainage system is functioning as designed; however, an easier cleanout system would have been an improvement. As a result, the lifetime efficacy of the dispersal drain system is expected to be shorter than planned due to construction related sediment.

Planted areas in the center and walkway boulevards are well established and are contributing positively to the wider community as greenways that are used predominantly by pedestrians. Neighbouring businesses generally favour the new street design and some have incorporated complementary green infrastructure features (e.g., rain gardens, pervious pavement in parking lots) into their sites.

ENABLING FISCAL AND POLICY TOOLS

- North Vancouver District Official Community Plan (OCP)
- Integrated Stormwater Management Plans for the surrounding watercourses
- Metro Vancouver ISWMP Initiative
- Development Service Bylaw
- Maplewood and Lower Lynn Town Center Plan

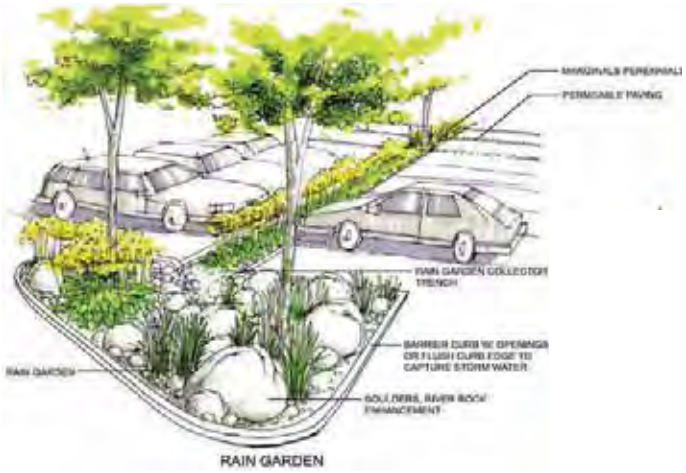
TOWN CENTRE GAMING FACILITY

PROJECT LOCATION

Lougheed Highway and 227th Street, Maple Ridge, BC

PROJECT DESCRIPTION

A former brownfield site in the heart of Maple Ridge was turned into an innovative urban landscape supporting a mixed-use entertainment and community gaming facility. This project set out to create a new vibrant space in the Town Centre, with priorities to remediate contaminated soils and incorporate green infrastructure into the building and site design. Further work to enhance habitat and restore ecosystems on the Gaming Centre site and the municipal park conservation areas to the south add to the community and ecological health benefits of the project.



RAIN GARDEN

PLANNING AND IMPLEMENTATION

The facility was designed to ease the transition between commercial lands along the Lougheed corridor and adjacent residential development. A variety of green infrastructure elements are part of the building and site design. The building design includes a 1,000 m^2 green roof and a green wall. Rainwater is diverted from the roof and parking areas into rain gardens, bio-swales, and bio-filtration wetland areas, directing the water into the soil where silt and pollutants can be filtered out before the water slowly enters the municipal stormwater system. The 'heat island effect' (caused when heat energy is absorbed by pavement and other surfaces) is minimized through the green roof and planting of 36 large canopy street trees along the streets and parking areas. Approximately 2,800 m^2 of other tree and shrub plantings were also added to the site.

Ecological enhancements were required as part of the environmental development permit. Ecological restoration works were completed and funded as part of a compensation package for in-fill of a smaller degraded ravine area on site. New wetlands, bio-swales, and bio-filtration ponds provide habitat for wildlife, including two species at risk (red-legged frog and Oregon forestsnail). These features also improve water quality for downstream fish habitat.

TRENCH-COLLECTOR

A conservation area of 0.74 hectares was dedicated as Parkland on the south side of the property. Additional habitat improvements and restoration work was required on existing municipal Park Conservation lands southwest of the site. Enhancements on these lands included construction of ponds and wetland habitats, retention of mature forest, invasive plant species management, and design and construction of a nature trail. Native vegetation was extensively re-planted in areas that were disturbed or sparsely vegetated within the park or surrounding steep slopes.

PROJECT OUTCOMES AND LESSONS LEARNED

Integrating green infrastructure and landscaping into the design helped create a vibrant space and a more natural transition between the commercial corridor and residential lands. The innovative urban design and collaborative process were key elements leading to the success of this project. Careful coordination amongst consultants and stakeholders is necessary in a project that requires multi-disciplinary integrated solutions.

Green infrastructure, integrating ecological, engineering, and building solutions where landscape and natural processes help inform and guide development design can be cost effective in the long term because of the added services and benefits they provide. Green infrastructure can also be used effectively as a good marketing and public relations tool. Integration of park lands into the site design can be highly valuable. This is especially true if there are mutual benefits to the municipality, the natural environment and the developer from habitat enhancements, rainwater management, tiered stormwater source controls, improved aesthetics, and public access to greenways.

ENABLING FISCAL AND POLICY TOOLS

- Parkland Dedication
- Streamside Protection Regulation guidelines
- Sustainable Design Guidelines
- Environmental Development Permit requiring ecological enhancement

UNIVERCITY COMMUNITY

PROJECT LOCATION

UniverCity, Simon Fraser University (SFU), Burnaby, BC

PROJECT DESCRIPTION

UniverCity is a mixed-use community located at the top of Burnaby Mountain. When fully developed, the population is expected to be 10,000 residents. It is envisioned as a 'complete community' integrating a variety of green infrastructure and natural ecosystems and features into its design.

PLANNING AND IMPLEMENTATION

Planning for UniverCity began in the early 1990s. Sustainability and environmental protection were key principles included in the 1996 SFU Official Community Plan. In 1997, the SFU Community Trust was created to plan and implement development in the community in partnership with the City. This collaboration resulted in development guidelines and requirements for green building performance, stormwater management and natural landscaping.

The 2002 Stormwater Management Plan outlines specific approaches for reducing runoff, protecting water quality of downstream creeks, and enhancing watercourses on-site. Rainwater percolates into the soils via permeable pavement, infiltration galleries and bioswales, and is detained in underground cisterns, before making its way into constructed streams, wetlands and downstream watercourses. This design means that no standard stormwater pipes are used within the community, with the exception of overflow facilities to safely convey extreme rain events. The features are designed to be attractive, fit into the urban landscape, and provide wildlife habitat. Each development site is required to infiltrate and detain rainwater to specified standards, and to monitor and report how the systems are functioning for at least two years. Systems must be approved by SFU Community Trust and the City through the development permit process. Covenants are registered over stormwater infrastructure on each property specifying these requirements. Monitoring of hydrology and water quality is overseen by an Adaptive Management Committee.

SFU Community Trust and the City of Burnaby also allowed for nature to permeate throughout the community. By preserving individual and groups of large trees and incorporating them into pedestrian greenways, the site became a part of its surroundings, instead of an urban enclave surrounded by forest. On private property, significant trees identified for retention, greenways and riparian corridors are protected by covenants held by SFU Community Trust and/or the City of Burnaby. In some cases, guidelines for tree management, view management, and replanting criteria (in

case trees need to be removed for safety reasons) are attached to the covenants. More manicured areas such as boulevards and strata-managed landscaping also must comply with the Development Guidelines and Requirements, with specific types and percentages of native plants, depending on the location.

PROJECT OUTCOMES AND LESSONS LEARNED

Rainwater management at UniverCity has, so far, largely met the intent and goals of the Stormwater Management Plan, successfully minimizing runoff to replicate pre-development conditions, and protecting or improving water quality, while intensively developing the land for residential and mixed-use. The monitoring and adaptive management process allows for adjustments and application of new knowledge and innovations on-site, and elsewhere across the City and region.

Meeting the original infiltration requirements has been challenging for some sites, as some soils were found to be less permeable than expected. In these cases designs had to be modified and innovative approaches used; having a structure for adaptive management has allowed this to occur.

Covenants have proven to be effective mechanisms to ensure specific requirements are met. However, there have been some challenges in communicating the intent and requirements of these legal documents, particularly when responsibility for certain areas has changed hands. To address this, a user-friendly guide was developed to clearly describe the intent of the covenants, illustrate their locations, outline maintenance guidelines to ensure habitat values are maintained, and describe the roles and responsibilities of various parties for long-term maintenance of these areas (e.g., SFU Community Trust, City of Burnaby, building strata).

Knitting rainwater management into the landscape and ecology adds value to the neighbourhood. For example, a stormwater treatment wetland is affectionately called "the frog pond" by residents. Choruses of frogs and birds can be heard echoing throughout the community – not just in the "natural" forest nearby. Greenways and trees contribute to a walkable community and provide pleasant places to socialize with neighbours and for children to play safely. A sense of safety and comfort in the community has led to a large family-based demographic in this high density community. Whereas most high density communities in the Metro Vancouver region typically consist of 10-12% families, at UniverCity, families represent close to 40% of the population.

ENABLING FISCAL AND POLICY TOOLS

- Development Guidelines for stormwater management, landscaping and green building performance
- Covenants with descriptive guidebooks

STREET BUS BULGE RAIN GARDEN

PROJECT LOCATION

Lonsdale Avenue & 21st Street, North Vancouver (City), BC

PROJECT DESCRIPTION

The City of North Vancouver renovated a busy section of Lonsdale Avenue in North Vancouver, converting a 45m long section of conventional roadway with a longstanding bus stop into an attractive bus bulge and rain garden.

PLANNING AND IMPLEMENTATION

This rain garden was installed as part of a public transportation and park improvement project. The site fronts one of the City's busiest streets and is also located next to an urban pocket park. The rain garden provides an added park feature and improves the natural aesthetic of the street. Civil works were contributed following negotiations with a developer on an adjacent site.

City staff seized the opportunity to integrate multiple objectives and increase functionality by managing stormwater on site. The rain garden captures run off from a six lane arterial road and bus route, thus becoming more than just a passive landscape element. A curb inlet at the upper end of the bulge channels the water into a pipe underneath the sidewalk, which then diverts the water into the rain garden. Water flowing through the rain garden is also channeled into a pipe where the seat walls and bus shelter are located. Soils, granular material and large aggregate were placed in the bottom of the channel to ensure as much water as possible was detained and encouraged to infiltrate into the substrate. During storm events or when the soils are saturated, water overflows into a grate at the southern end (bottom) of the rain garden.

Plants are a mix of regionally adaptive ornamental perennials and native plants suited to rain gardens. Native soft rush (*Juncus effusus*) for example, has a striking spikey growth habit and evergreen foliage, is tolerant of full immersion in water and extensive drought periods, has minimal to no maintenance requirements, and is tolerant of pollution and siltation. Boulders and stones were included in the design, many of which were salvaged from the site.

PROJECT OUTCOMES AND LESSONS LEARNED

This project created a visually attractive and natural landscape feature that works simultaneously as an important piece of civil infrastructure. The City is still assessing the value of this investment to determine the change in quality and quantity of water leaving the site. There are plans to replicate this project elsewhere using civil works contributions adjacent to major projects, in addition to integrating this style of roadway design into regular updates to street infrastructure in areas of high stormater flow.

ENABLING FISCAL AND POLICY TOOLS

- Sustainable design guidelines
- Official Community Plan (OCP) goals
- Urban wildlife habitat creation
- Civil works contribution

COQUITLAM GREEN STREET PROJECT

PROJECT LOCATION

Upper Hyde Creek Neighbourhood, Burke Mountain, City of Coquitlam, BC

PROJECT DESCRIPTION

The West Watkins green street, in the Upper Hyde Creek Neighbourhood of Coquitlam, was initiated as the City's first green street pilot project in 2007. This green street connects homes with a neighbourhood park and the City's trail system, while also providing a public greenspace. The unpaved public road is used for pedestrian, cyclist and emergency vehicle access and is an integral part of the stormwater management plan. The street was designed to meet planning, environmental and engineering objectives.

PLANNING AND IMPLEMENTATION

The Upper Hyde Creek Neighbourhood Plan includes policies for green streets and the Hyde Creek Integrated Watershed Management Plan identifies the need for sustainable approaches to land development and protection of the watercourses and natural environment.

The West Watkins green street was constructed by a developer in place of a traditional paved road as part of their development servicing requirements. This helped the project meet criteria established by the Engineering department for rainwater management. Sanitary, storm, water mains and other utilities are located under the green street as they would be for a typical road design. A primary access lane at the rear of the green street provides vehicular access to residences and additional on-street parking. Sidewalks are the only impervious surface on the green street and they are graded towards pervious areas so that rain runoff is captured and infiltrated. The green street lawns and planted beds have additional topsoil to provide water detention and nutrient holding capacity, which maximizes stormwater infiltration. Swales or infiltration facilities can also be incorporated on one or both sides.

PROJECT OUTCOMES AND LESSONS LEARNED

Coquitlam's Strategic Plan (2012) includes policies which support the incorporation of additional green streets. The City continues to assess the value of these projects based on feedback from residents, traffic impacts, real estate values, cost, maintenance, and performance. Benefits can be optimized by situating green streets where they support or enhance a natural feature or public open space. For West Watkins, the development community was part of the neighbourhood planning process and supportive of the City's objectives. Information to date indicates that green streets are a marketable feature and also help developers meet rainwater management criteria for their sites.

ENABLING FISCAL AND POLICY TOOLS

- Official Community Plan direction for watershed planning
- Strategic Plan goals for sustainable design and infrastructure
- Integrated Watershed Management Plan (IWMP)
- Neighbourhood Plan policies reflecting watershed plan recommendations
- Rainwater Management Requirements for all watersheds with an IWMP
- Development servicing requirements

COUGAR CANYON ELEMENTARY SCHOOL RAIN GARDEN

PROJECT LOCATION

Lyon Road, Sunshine Hills Neighbourhood, Delta, BC

PROJECT DESCRIPTION

In 2006, the Corporation of Delta installed its first demonstration rain garden at Cougar Canyon Elementary School. The rain garden improves fish habitat in Delta's waterways by collecting rainwater from the paved parking lot and allowing it to infiltrate into the soil instead of flowing into storm sewers. Students learn how the rain garden connects to their local watershed and how everyday actions may impact nearby watercourses. By maintaining the garden, students also gain a direct appreciation of nature.

PLANNING AND IMPLEMENTATION

This project was supported by the Cougar Creek Streamkeepers, the Corporation of Delta, Delta School District, and Stream of Dreams, with a grant from the Pacific Salmon Foundation. In 2006, Delta Engineering decommissioned two storm drains in the school parking lot. The solid curb was replaced with wheel stops, and a sunken garden was excavated along the full length of the parking lot. Next, drain rock, highly absorbent soils and boulders, and a dozen larger trees were installed. Lastly, nearly all of Cougar Canyon's K-7 students and students from Seaquam Secondary's Volunteer Club came together to plant 600 rain garden shrubs and ground covers, under the supervision of the Streamkeepers.

The rain garden program is also integrated into the school curriculum. Students and streamkeeper volunteers maintain the rain garden throughout the year. A "Rain Gardeners" education package for Grade 4 & 5 students is included. One class adopts the school rain garden each year, and teachers use the rain garden package to teach the curriculum outcomes using interactive lesson plans. Students make observations and conduct experiments in the garden to learn about science and the environment.

PROJECT OUTCOMES AND LESSONS LEARNED

In 2007, the Cougar Canyon school rain garden was honoured with an Environmental Stewardship award from the BC Landscape and Nursery Association. Delta has expanded its rain garden program to include most of the elementary schools in North Delta. City

employees design and construct rain gardens at schools and then coordinate a community planting day with local streamkeepers, students, and neighbourhood volunteers. Educational benefits of the school rain garden program are already evident. Students entering secondary school who have "owned" rain gardens at their old elementary schools continue to be involved in other rain garden activities in their local community.

Each rain garden is designed to fit the school site and to collect as much rain water as possible from the surrounding paved areas. However, it can be challenging to communicate the purpose and function of rain gardens to construction crews who may be unfamiliar with the concept of infiltrating rain water into the ground. Therefore, it is critical for the project manager to oversee construction during the entire process to ensure the rain garden functions correctly.

ENABLING FISCAL AND POLICY TOOLS

- Annual inclusion in drainage budget
- Delta's Corporate Climate Change Initiative (Green Infrastructure section)
- Regional Rain Garden Design Guidelines
- Stewardship Partnerships

HAMPSTEAD ECO-CLUSTER DEVELOPMENT

PROJECT LOCATION

Silver Valley, Maple Ridge, BC

PROJECT DESCRIPTION

The Hampstead community at Silver Ridge is located on the forested hills of northeast Maple Ridge. The homes in the community are clustered to protect sensitive natural areas. Single unit and row homes are on gentle slopes to preserve views, trees, watercourses, and other natural open spaces. By preserving forests, wetlands, soils, and other environmental features, additional benefits such as clean air, water, and wildlife habitat are provided. Green infrastructure is also integrated into the site design to help manage stormwater and provide recreational opportunities. The District of Maple Ridge is working with developers to protect, manage, and restore ecosystem features such as forests and soils as they provide benefits like clean air and water to people and wildlife.

PLANNING AND IMPLEMENTATION

The Hampstead development is part of the Silver Valley Area Plan. Housing in this area is condensed into smaller pockets or "eco-clusters" which are surrounded by open space. Eco-clusters and ecological based designs are typically being used for low density, larger sized, greenfield sites with more complex or environmentally sensitive topography.

Innovative design guidelines help preserve trees and natural features. These include: establishing 30 metre streamside setbacks, placing buffers next to agricultural land, maintaining common use open space fronting homes, and clustering development on slopes less than 20% to minimize site grading. Corridors are retained to connect neighbourhoods and allow people and wildlife to easily move across the landscape. The development incorporates bioswales, rain gardens, detention and biofiltration

ponds, and permeable pavement to help manage stormwater from roads and other hard surfaces. On-lot underground detention pits are also used to retain water that is shed from roofs, which is then redirected to surrounding natural areas or ponds.

Density bonusing is used as an incentive to preserve additional open space. The municipality also accommodates density requirements and affordability concerns in complex topographic environments, on condition that appropriate sustainable design and mitigation measures are used by developers. Conservation habitat covenants are sometimes used rather than full scale dedication of environmentally sensitive lands for park conservation. This permits a larger parcel size for development yield. In exchange, the developer sets aside or provides additional conservation protection in the form of habitat covenants for significant natural areas and/or features on site that are not regulated to ensure an overall net benefit to the natural environment. Some yearly maintenance costs for parkettes and green infrastructure are passed on to the property owners through a Local Area Bylaw.

PROJECT OUTCOMES AND LESSONS LEARNED

Silver Ridge has won numerous national, provincial, and regional awards. By preserving greenspace and using green infrastructure, livability has increased, but so have some of the costs. Increased costs are associated with design, servicing infrastructure, risk mitigation, and restoration. For example, appropriate building and landscape materials are required to reduce wildfire risk. Secondary emergency access corridors are also needed. In Silver Valley, these double as service corridors and multi-use trails between Eco-clusters. Although there were increased up-front costs, many of these initial investments are expected to offset longer term costs that would otherwise be transferred to neighbouring properties, public taxpayers and to the District. The District now requires developers to evaluate how and where they plan on using ecological design principles and sustainable design practices to improve livability and protect the natural environment.

ENABLING FISCAL AND POLICY TOOLS

- Cluster Development ("Eco-clusters")
- Streamside Protection Regulation guidelines
- Sustainable Design guidelines
- Density Bonusing
- Conservation Habitat Covenants
- Local Area Bylaws for green infrastructure and parkette maintenance

Photo: *David Bradbeer*

GRASSLAND SET-ASIDE, WEST DELTA FARM

PROJECT LOCATION

Delta, BC

PROJECT DESCRIPTION

A West Delta farm had a field that was struggling with reduced yields due to salinity issues. The farmer was looking for ways to increase productivity and transition it to organic production. These challenges and desired objectives made the farm a perfect candidate for the Delta Farmland and Wildlife Trust (DF&WT) Grassland Set-aside Program. Farm fields in Delta and Richmond often integrate fallow grassland into their regular crop rotation. This "rest" period provides an opportunity for soil fertility to be improved by introducing tall grass that later becomes green manure. Additional benefits to farmers and the environment can be achieved by strategically planting and managing these spaces.

PLANNING AND IMPLEMENTATION

Through the Grassland Set-aside Program, the farmer of this 5.7 ha site planted a specific mix of grasses in the field, including orchardgrass, tall fescue, timothy and double cut red clover. Grasses were left to mature for four years. This Grassland Set-aside helped improve soil fertility by increasing soil porosity and allowing rain water to percolate into newly installed tile drains and flush salt from the field. The Set-aside also increased soil organic matter content, which is important to maintain long-term productivity. Other benefits of maintaining grass during the fallow period include reducing soil erosion from wind and rain, suppressing weeds by increasing competition for light, soil, and water, and breaking pest cycles. The tall grass habitat also supports an array of grassland raptors, songbirds, small mammals, and native pollinators, some of which are listed as Species at Risk in Canada.

The Grassland Set-aside Program was developed using DF&WT's "Partners in Stewardship" Model. The model explores challenges to farming and wildlife habitat requirements through scientific research. The results of studies (by DF&WT, often in partnership with post-secondary institutions) are presented to local farmers. If supported by the agricultural community, the Trust raises funds through grants and long-term partnerships to initiate a Stewardship Program. All Stewardship Programs operate as cost-shares. Farmers are compensated for providing ecosystem services, and reimbursed for a portion of their cost. Ongoing monitoring, evaluation and research are used to refine management practices, improve habitat elements and address farm challenges.

The Delta Farmland and Wildlife Trust was established in 1993 with a mission to promote the preservation of farmland and associated wildlife habitat in the Fraser delta through sustainable farming and land stewardship; the Grassland Set-aside Program is one of six stewardship programs run by the Trust.

PROJECT OUTCOMES AND LESSONS LEARNED

After the field that was 'set-aside' was put back into agricultural production, the farmer experienced greatly improved vegetable yields. Says the farmer: "The Grassland Set-aside Program has proven to be a valuable tool for improving problem soils." DF&WT's Grassland Set-aside Program is unique in Canada and has been successful in providing green infrastructure on farmland for over 20 years. On average, there are 10 to 15 farmers who establish and maintain an average of 220 hectares of tall grass habitat for the benefit of agriculture and wildlife per year. To learn more about The Grassland Set-aside Program, visit www.deltafarmland.ca.

ENABLING FISCAL AND POLICY TOOLS

- Stewardship Program (funding raised through grants and long-term partners)
- Cost-share program with stewardship partners
- Collaboration with local farmers
- Ongoing scientific research and evaluation
- Communication between local government, conservation non-profits, post-secondary institutions, farming community
- Promoting public awareness of agriculture and wildlife conservation

Photos: (top) *Hank Tseng*, (middle) *Sofi Hindmarch, (bottom) David Bradbeer*

SEMIAHMOO TRAIL

PROJECT LOCATION

South Surrey, Surrey, BC

PROJECT DESCRIPTION

The Semiahmoo Trail is a historic wagon road built in 1873-74. It originally crossed Surrey, extending from the Fraser River to the US border. Today, the only remaining sections of this Trail are between the Nicomekl River and 20th Avenue. These remnants form part of a popular linear park that is subject to heritage designation. Design Guidelines for the Semiahmoo Trail were established to ensure coordinated development of the public trail, and to provide guidelines for development abutting the Trail to protect the heritage value and character of this important public amenity.

PLANNING AND IMPLEMENTATION

The Semiahmoo Trail Design Guidelines are implemented and/or financed by private development abutting the Trail. Design Guidelines for new single-family dwellings and development permits for multi-family developments along the Semiahmoo Trail require preservation of the unique natural and heritage character of the Trail. This includes a review of building heights and topographical considerations to ensure minimal building massing impact along the Trail. Additionally, direct vehicular access to the Semiahmoo Trail is not permitted to new developments fronting the Trail. Existing driveways must be removed and alternative access provided as part of the review and approval of development proposals, subdivision applications and building permit applications along the Semiahmoo Trail.

Developers of properties abutting the Trail are required to dedicate additional lands to complete the Trail as necessary. Registration of a restrictive covenant is required to establish a 10 metre landscape buffer on private property fronting the Trail and to prohibit construction within the buffer. The landscaping plan for the buffer is established either on the building scheme for single-family residential lots, or as part of the development permit for multi-family projects. The Guidelines require that landscape buffer plantings emphasize native plants and flowering and fruiting shrub species that provide wildlife habitat and aesthetic appeal. New landscaping is required to complement existing Trail conditions. Prior to obtaining a building permit, applicants are required to complete landscaping and construction of split-rail fencing within the Trail's landscape buffer area.

The Friends of the Semiahmoo Trail, a local community advocacy group, act as stewards of the Semiahmoo Trail and regularly organize work parties to remove invasive species and plant ecologically appropriate species.

PROJECT OUTCOMES AND LESSONS LEARNED

The Semiahmoo Trail Design Guidelines have been in place since 2004. Project outcomes include a minimum 20 metre wide park corridor, a 40 metre wide corridor for habitat & biodiversity, pedestrian connectivity, stormwater management, and preservation of a significant natural and cultural heritage site in a relatively urban area.

Implementation of the Semiahmoo Trail Design Guidelines is a good example of collaboration between the City, the development community, and a local advocacy group. It is also a good example of what can be achieved with a plan that has a specific vision and the tools to make that vision a reality.

ENABLING FISCAL AND POLICY TOOLS

- Restrictive covenant
- Building scheme approvals
- Development permits
- Design guidelines

ROBSON PARK REVITALIZATION

PROJECT LOCATION

12678 - 100 Avenue, Surrey, BC

PROJECT DESCRIPTION

Robson Ravine Park protects over 3.6 hectares of a uniquely sensitive ecosystem. The largest portions of the park date back to 1956 when the upper ravine was protected through neighbourhood subdivision. Decades later, portions of the lower ravine were added through additional land dedication and purchase.

Robson Park represents the headwaters of Robson Creek. An older park with limited recreational opportunities and natural habitat values, Robson Park was in need of aesthetic and functional upgrades. The project was initiated based on requirements in the Manson Master Drainage Plan and commitments to Fisheries and Oceans Canada. The park revitalization project was aimed at providing stormwater management and ecosystem services, celebrating the positive attributes of the park, and inviting the citizens back into the space. Park enhancements included: re-establishing a natural watercourse through the site, providing detention facilities for erosion and water quality protection, the update and addition of recreation amenities and improved public safety using crime prevention through environmental design (CEPTED) techniques. Environmental enhancement works included: stream daylighting, the creation of in-line pond habitats, aeration of urban runoff, and restoration of streamside habitats with phased natural successional planting schemes. The project successfully merged the need for stormwater management in an older neighbourhood with the need to revitalize a dated park facility.

PLANNING AND IMPLEMENTATION

Funding was challenging due to increasing construction costs in the province since 2002. With the City's drainage priorities focused on lowland flood mitigation, the project was delayed until 2009. Final construction costs amounted to $3.35 million dollars. All works were funded through the City's Drainage Utility (Engineering Department).

PROJECT OUTCOMES AND LESSONS LEARNED

Robson Park is a great example of Surrey's commitment to sustainability and infrastructure investments through the "Build Surrey program". The community played a key role in park design and continues to be involved with participation by local organizations in planting, education and maintenance to help ensure the newly constructed facilities will be respected and cared for.

ENABLING FISCAL AND POLICY TOOLS

- Land dedication and purchase during subdivision
- Master Drainage Plan
- Engineering Department helped identify an integrated green infrastructure approach as the preferred option.

TERRA NOVA RURAL PARK

PROJECT LOCATION

Terra Nova Rural Park, Richmond, BC

PROJECT DESCRIPTION

The 63 acres of this park, together with the existing 35 acre natural area to the south, play a significant role in the ecology of the Metro Vancouver region as well as the Fraser River estuary ecosystem. It is part of the Pacific Flyway and a complex, interrelated network of marine, intertidal, and terrestrial ecosystems. It is located adjacent to the estuary and provides a combination of habitats including: open fields, ditches, treed areas, a daylighted historic slough, landscaped gardens and hedgerows. The land that has been farmed for approximately 125 years and left fallow in more recent years provides foraging and nesting sites for a large number of shorebirds, songbirds, waterfowl and wading birds. Field grasses that take up 70% of the land provide habitat for small mammals that are a food source for the raptors in the area, including: eagles, blue heron, hawks, and owls.

PLANNING AND IMPLEMENTATION

In the 1970s, Richmond was undergoing a rapid change from rural to suburban. The slow erosion of the farmland base inspired the community to respond in 1986 to the imminent residential rezoning of a former farming area called Terra Nova.

In 1996, the Save Richmond Farmland Society was formed to preserve this rural landscape. Tens of thousands of residents shared the vision of protecting the land. In 1996, voters approved the City borrowing $28.5 million to purchase 63 acres of land in Terra Nova for public use. An overall Park Plan was developed in 2005 based on bio-physical and cultural research studies and public input from three open houses. The public support was the highest that the City had ever received for a park plan with 98% of the people strongly supporting the planning principles, the key features, and the park vision: "to preserve the unique rural character while providing a balance between agricultural heritage, wildlife conservation, and recreational uses.".

Historic uses are being brought to life through community based agricultural programs run by non-profit groups. The site has become a venue for teaching about the local and global issues of food security and environmental stewardship.

The fallow farm fields which are rapidly disappearing in urban areas are now managed to maintain a rich grass environment for raptors and other birds. Through diligent historic research, lost environmental features such as a buried slough were discovered and recreated. Adaptive re-uses have been implemented and others are being considered for the five heritage buildings and former residential buildings in the park. These uses include: two park caretaker units, a Farm Centre office and meeting space for the four non-profit groups, a 'barn' that is a community learning kitchen and meeting space; and an 1892 former cannery store that is being restored to function as a shop/coffee store selling food that is grown in the park.

The uniqueness of this park has inspired Kwantlen Polytechnic University to create a diploma program, called the Richmond Farm School which conducts many of its classes in Terra Nova.

PROJECT OUTCOMES AND LESSONS LEARNED

Community involvement, engagement and partnerships are the cornerstones to the success of this park. The Richmond Fruit Tree Project has been a partner in the park for several years and manages a community based one hectare Sharing Farm. Together with the Food Security Society and Kwantlen Polytechnic University, they offer programs, food festivals and harvest vegetables for the Food Bank. The Terra Nova Schoolyard Society started a gardening program in 2006 with one elementary class and, presently, 500 students are actively involved in gardening and cooking. These community groups create an environment that inspires a value for fresh food, healthy eating habits and personal and social responsibility and ecological stewardship that will last a lifetime.

ENABLING FISCAL AND POLICY TOOLS

- Annual Parks Operations Budget
- Development Cost Charges (DCC) Capital Budget Program
- Additional funding for non-profit programming has been obtained by on-site non-profits through the Health Authority and VanCity
- Richmond Foundation Endowment Fund

WAGG CREEK PARK STORMWATER ENHANCEMENT PROJECT

PROJECT LOCATION

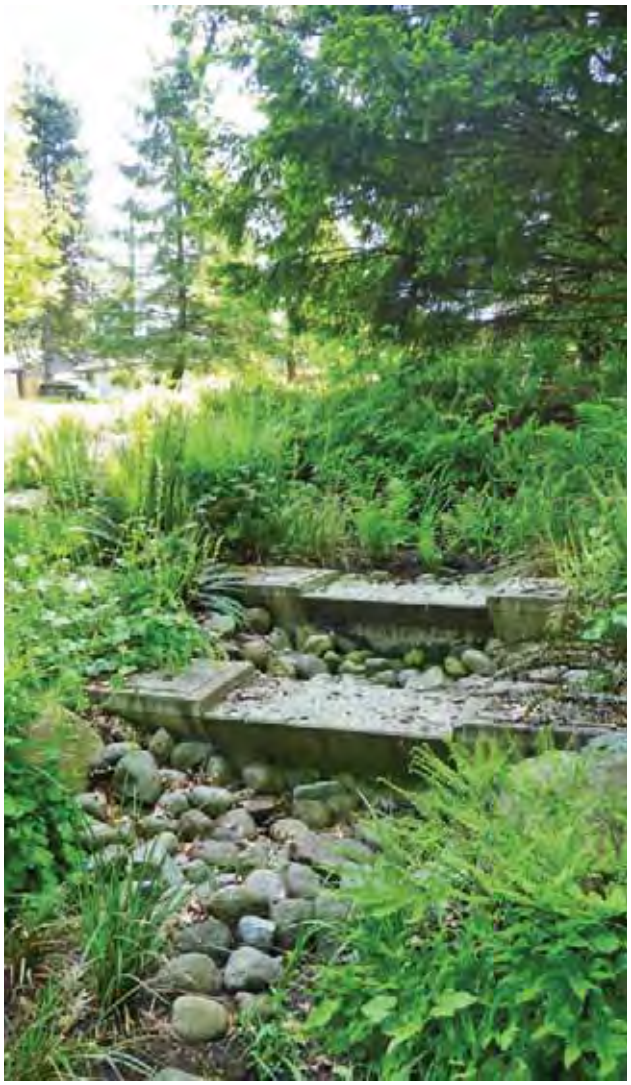
Wagg Creek Park, North Vancouver (City), BC

PROJECT DESCRIPTION

Wagg Creek Park is a remnant piece of coastal western hemlock forest located only two blocks from the City's urban core. Despite being "a green oasis in the City", the park faces many challenges. These include: invasive plant and animal species and degradation of aquatic habitat. The creek is fed by a series of stormwater outfalls that collect runoff from a quarter of the City. Silt acts as a magnet for hydrocarbons, metals and other pollutants from vehicles and roadways, which are then carried into the creek and settle in Wagg Pond. An aging, small-scale outlet structure retained water in the pond, but allowed some silt and contaminants to flow downstream into the important fish-bearing habitat of Mosquito Creek. In 2008, a number of stormwater source control features were constructed in the park to better manage these contaminants.

PLANNING AND IMPLEMENTATION

In 2008, the City initiated a Stormwater Enhancement with the main goal of enhancing fish habitat downstream of Wagg Pond by improving water quality. Other goals included flood control, habitat restoration and enhanced programming for park visitors including education.



The pond was deepened and a larger, more flood-resistant outlet structure and fish ladder were built. Both measures increased the sediment-holding capacity of Wagg Pond which helps minimize total suspended solids and contaminants downstream. A storm pipe that had previously carried run-off water directly from an adjacent lane to the creek was day-lighted. A series of terraced rain gardens and a bioswale were also installed to detain and treat the water.

This project provided an opportunity to restore and enhance riparian habitat and to rethink how park visitors interact with nature. The design goal was to balance functional demands of this stormwater feature with the experience of the park visitor. For example, a stepping stone path allows people to explore the terraced rain gardens while an adjacent interpretive sign illustrates the process. During peak storm events, water cascades over the weirs and it becomes an ephemeral water feature.

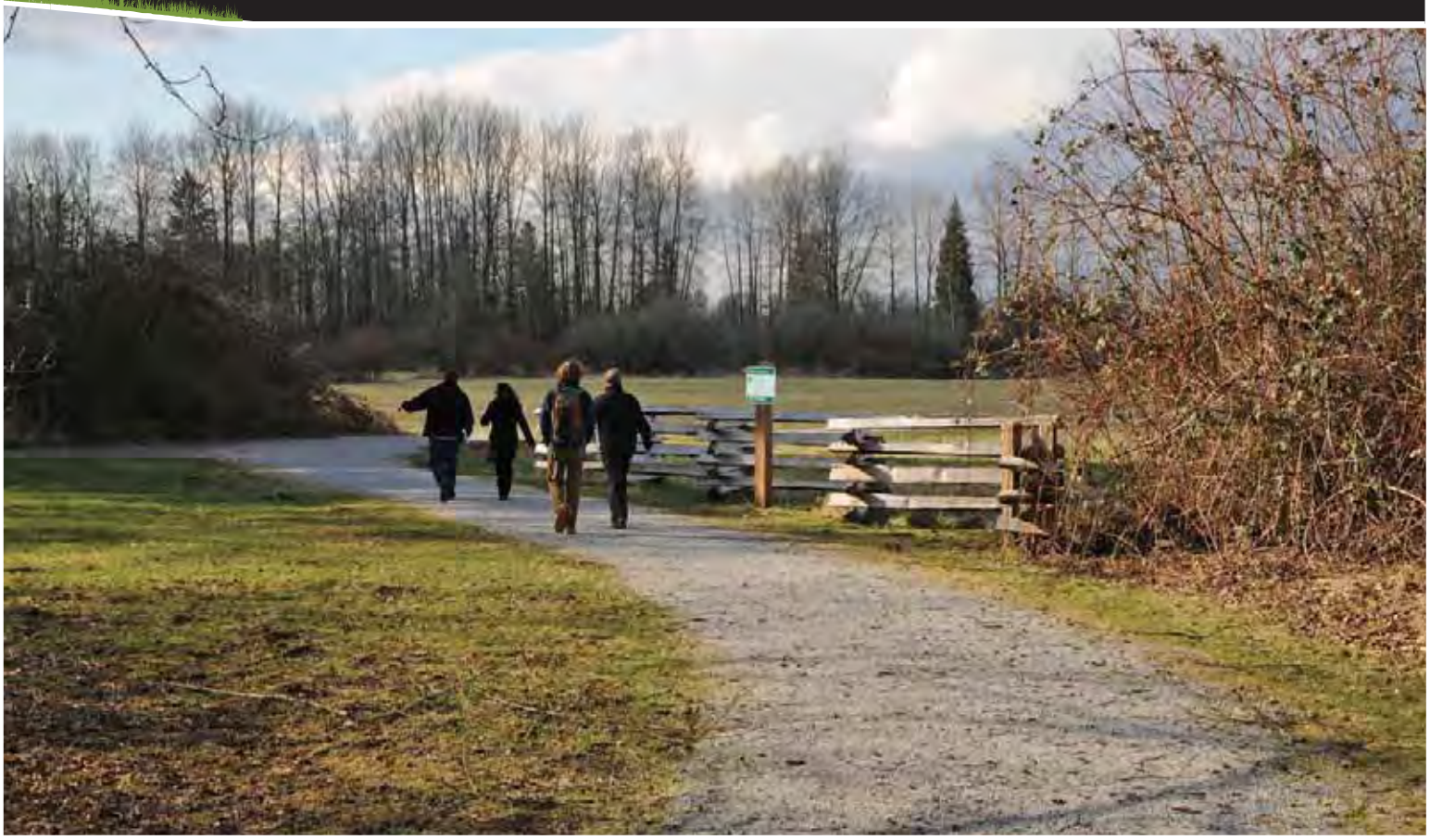
PROJECT OUTCOMES AND LESSONS LEARNED

Parks and remnant urban forests can provide valuable green infrastructure opportunities, especially stormwater management. Challenges can arise when habitat is created and incoming water is not clean. Spills of various types are also common in urban areas and can have a detrimental impact on wildlife. Public education combined with a comprehensive stormwater management strategy is needed to enhance the health of the creek and its riparian ecosystem over the long term.

At Wagg Creek Park, sediment will need to be dredged from the pond approximately every four to five years. Although maintenance access was planned for, traditional dredging methods (i.e. excavator and dump trucks) are disruptive to habitat and park visitors alike. The City is exploring dredging options that are economically sustainable and will minimize impacts on the environment.

ENABLING FISCAL AND POLICY TOOLS

- Funded through the City's Capital Plan
- City's Official Community Plan identifies and prioritizes ecological / environmental health
- Stream and Drainage System Protection Bylaw
- Integrated Stormwater Management Plan (in progress)



EXPERIENCE THE FRASER DEMONSTRATION PROJECT

PROJECT LOCATION

Fort Langley (Township), BC

PROJECT DESCRIPTION

Metro Vancouver partnered with the Township of Langley on this trail, blueway and park project to establish a key regional trail connection, provide new Fraser River focused recreational opportunities, and in doing so illustrate the potential of the Experience the Fraser project (ETF). Through this collaboration, a 12 km Canyon to Coast / Trans Canada Trail link from historic Fort Langley to the Golden Ears Bridge was established and 41 hectares of landbanked parkland was opened with new open space, river access, art and interpretive displays.

The project provides new experiences that connect people to the river and demonstrates creativity and best practices in agriculture-recreation interface planning, intergovernmental collaboration, archaeological resource management, place making and interpretation of ETF themes *(agriculture, celebration, environment and nature, first nations, heritage and culture, industry and transportation, outdoor recreation, and riverfront communities)*. Key features include: on-site stormwater management, native plantings, environmental and agricultural education, new opportunities for healthy active living and non-motorized travel.

PLANNING AND IMPLEMENTATION

This project was co-managed by Metro Vancouver and the Township of Langley. First Nations, park neighbours and the broader community were engaged at the outset of the project. Funding was provided by municipal and regional government, a provincial ETF grant and the Trans Canada Trail Foundation.

Site design and trail alignment was influenced by careful archaeological, agricultural and environmental analysis. An archeological overview assessment and monitoring during construction ensured

archeological resources were protected. The trail was routed to avoid disturbing sensitive ecosystems and no large trees were removed during construction. Trail runoff is managed on site, and new seasonal wetland habitat areas and native species plantings were established.

The project team prepared an Agricultural Strategy to minimize the project's impact on parkland leased for farming and neighbouring farm operations. This process involved engaging with neighbouring farmers, lease holders and the Agricultural Land Commission. Trail routing utilized existing farm roads and road right of ways and was aligned to keep actively farmed land intact and maintain access for farm equipment. Agricultural inspired art and interpretive features were incorporated to educate trail users.

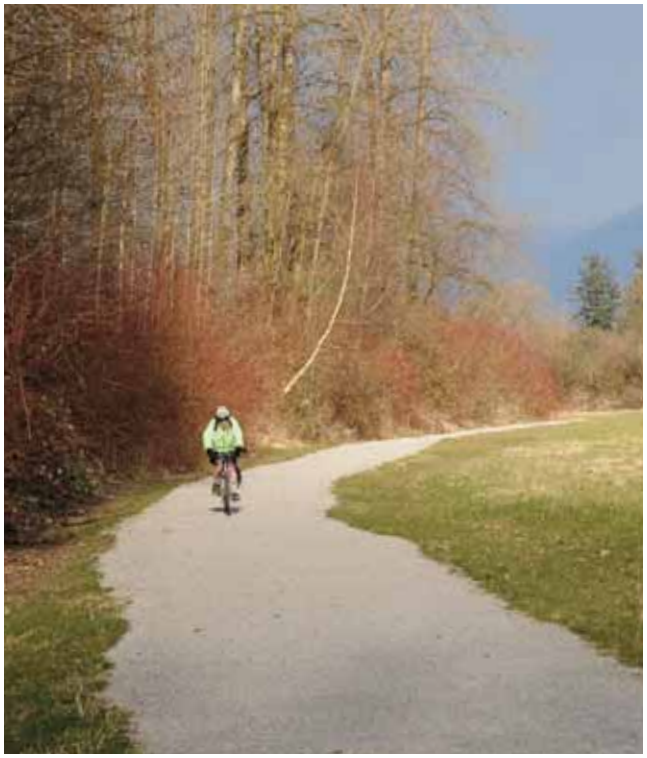
The trail route traverses varied landscapes and key points of interest. Interpretive displays along the trail celebrate ETF themes and the cultural landscape. Direct contact with the Fraser River is enhanced with a new picnic area, open space, shade trees, access to the park from the blueway and organized group camping facilities to support multi-day paddling excursions on the Fraser River.

PROJECT OUTCOMES AND LESSONS LEARNED

This project resulted in a major regional trail connection that provided new opportunities to experience the Fraser River, to connect with and learn about nature close to home, to experience an agricultural and working farm landscape, and to promote healthy, active living. This demonstration project illustrates creativity and best practice in collaborative trail and open space planning and design, agriculture – recreation interface planning and design, archaeological resource management and community partnerships, as well as the potential for great results arising from intergovernmental collaboration.

ENABLING FISCAL AND POLICY TOOLS

- Provincial grant funding of the Experience the Fraser project
- Metro Vancouver capital funding of park and trail projects
- Township of Langley capital funding of park and trail projects
- Non-government organization grant programs



BIOSWALES
RAIN GARDENS

DAYLIGHTED STREAMS

GREEN ROOFS
GREEN WALLS

GREEN STREETS
GREEN ALLEYS

GREENWAYS

HEDGEROWS

TYPES OF GREEN INFRASTRUCTURE

BIOSWALES/RAIN GARDENS

Vegetated open channels and landscaped areas designed to manage stormwater runoff from hard surfaces such as roofs, roads and parking lots. These features can also provide important wildlife habitat.

DAYLIGHTED STREAMS

Uncovered streams that had previously been diverted into pipes and culverts, and buried underground. These restored streams provide valuable urban greenspace, stormwater management benefits, and habitat for fish and wildlife. They can also provide important habitat corridors and links between larger natural areas.

GREEN ROOFS/WALLS

Green (or living) roofs are specially designed vegetated building roofs that better manage stormwater, improve energy efficiency, and provide wildlife habitat. Green walls are essentially vertical gardens; some include specialized modular elements secured to building walls.

GREEN STREETS/GREEN ALLEYS

Green streets and alleys incorporate: minimized impervious areas, naturalized stormwater management features (e.g., bioswales) and natural landscaping (e.g., boulevard trees, shrubs). They are typically designed for a variety of users (vehicles, bicycles, pedestrians).

GREENWAYS

Multi-modal pathways for pedestrians and cyclists that provide connections to important destinations. Natural landscaping on greenways also creates valuable habitat and functions as linear wildlife corridors.

HEDGEROWS

Narrow planting strips of trees, shrubs, and other plants that grow along field borders, fence lines and waterways. In more urban settings, hedgerows can function as living fences, acting as an aesthetic buffer while also providing wildlife habitat.

NATURAL LANDSCAPING

PERMEABLE PAVEMENT

POLLINATOR-FRIENDLY GARDENS

STORMWATER DETENTION INFILTRATION PONDS

URBAN TREE CANOPY

WILDLIFE UNDERPASSES WILDLIFE OVERPASSES

NATURAL LANDSCAPING

Use of native plants in garden areas provides important wildlife habitat, requires less maintenance (including watering), and provides stormwater management benefits.

PERMEABLE PAVEMENT

A type of hard surfacing that allows rainfall to percolate through to underlying soil substrate or be removed by a subsurface drain. Permeable pavement can replace conventional asphalt and concrete for sidewalks, driveways, parking areas, and road surfaces.

POLLINATOR-FRIENDLY GARDENS

With the addition of native flowering plants, public and private gardens and landscapes can provide improved habitat for pollinators (bees, butterflies, moths, beetles, etc.), which are so critical to our food security.

STORMWATER DETENTION/INFILTRATION PONDS

Artificial basins designed to collect, filter, convey and detain stormwater. Landscaped ponds provide habitat for a variety of wildlife.

URBAN TREE CANOPY

The urban tree canopy includes dense stands of trees in parks, street trees, and trees on private property. Collectively, the urban tree canopy provides numerous health and environmental benefits, including air filtration, shading and cooling, stormwater retention and detention, carbon sequestration, wind-breaks, urban beautification and habitat for birds, animals and insects.

WILDLIFE UNDERPASSES/OVERPASSES

Increasingly common in more urbanized areas, these features (ranging from simple culverts to planted overpasses) facilitate the safe movement of wildlife over and under roads and can link important habitat areas.