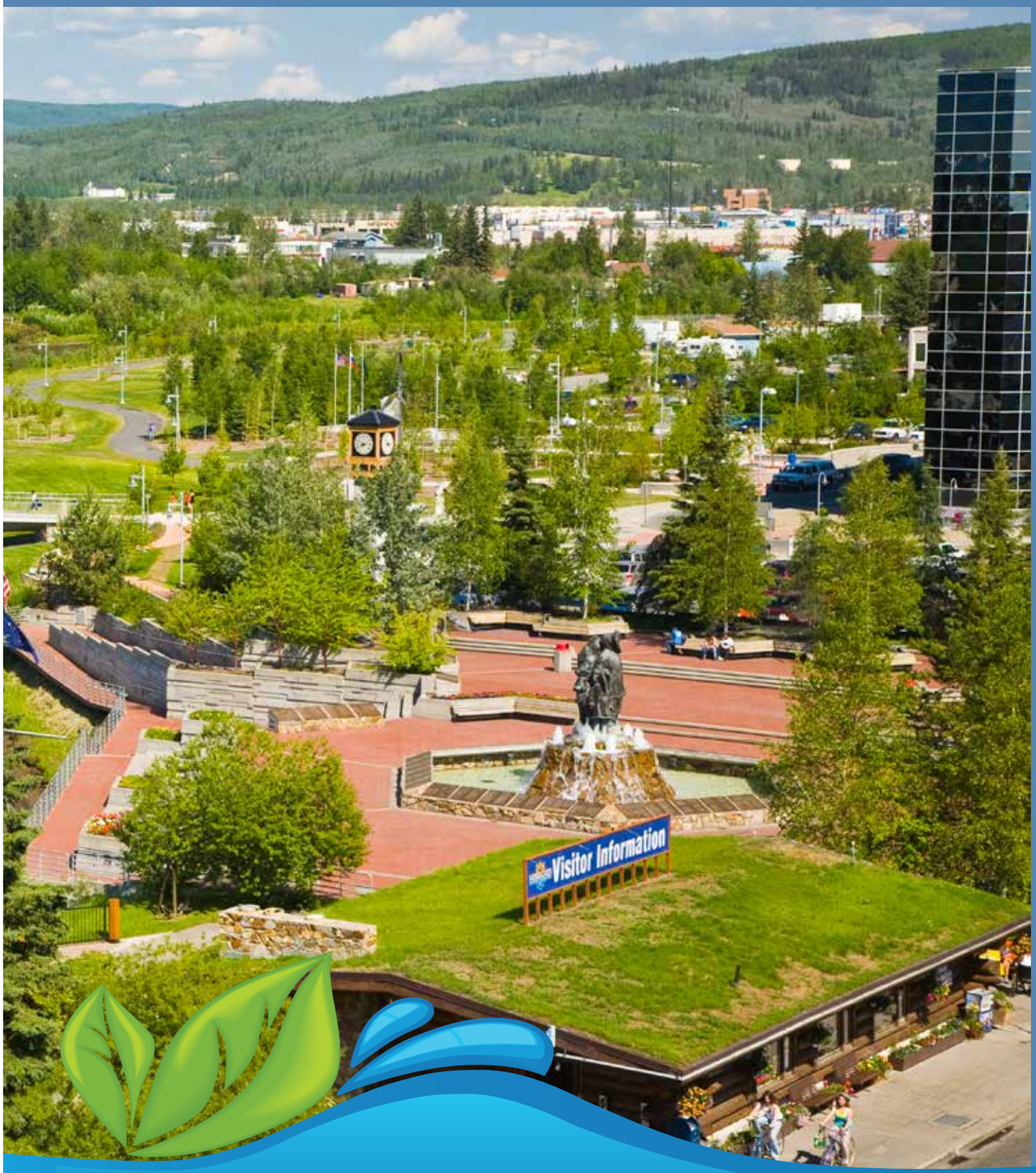
GREEN Infrastructure for Interior Alaska

Local Benefits and Implementation of Best Management Practices



Fairbanks Green Infrastructure Group

This guide was developed by the Alaska Department of Natural Resources Community Forestry Program, Alaska Department of Environmental Conservation Water Division, the Tanana Valley Watershed Association and the Fairbanks Green Infrastructure Group. Funded by the Community Forestry Program of the Alaska Department of Natural Resources through the "Using Green Infrastructure to Restore the Chena River Watershed" grant from the USDA Forest Service.

www.FairbanksGIG.com

The Fairbanks Green Infrastructure Group (GIG) works to renew a cleaner and healthier watershed by making green infrastructure a common practice for home and business owners. Through community support and involvement, the GIG promotes sustainable use of our natural environment for the benefit of present and future generations.

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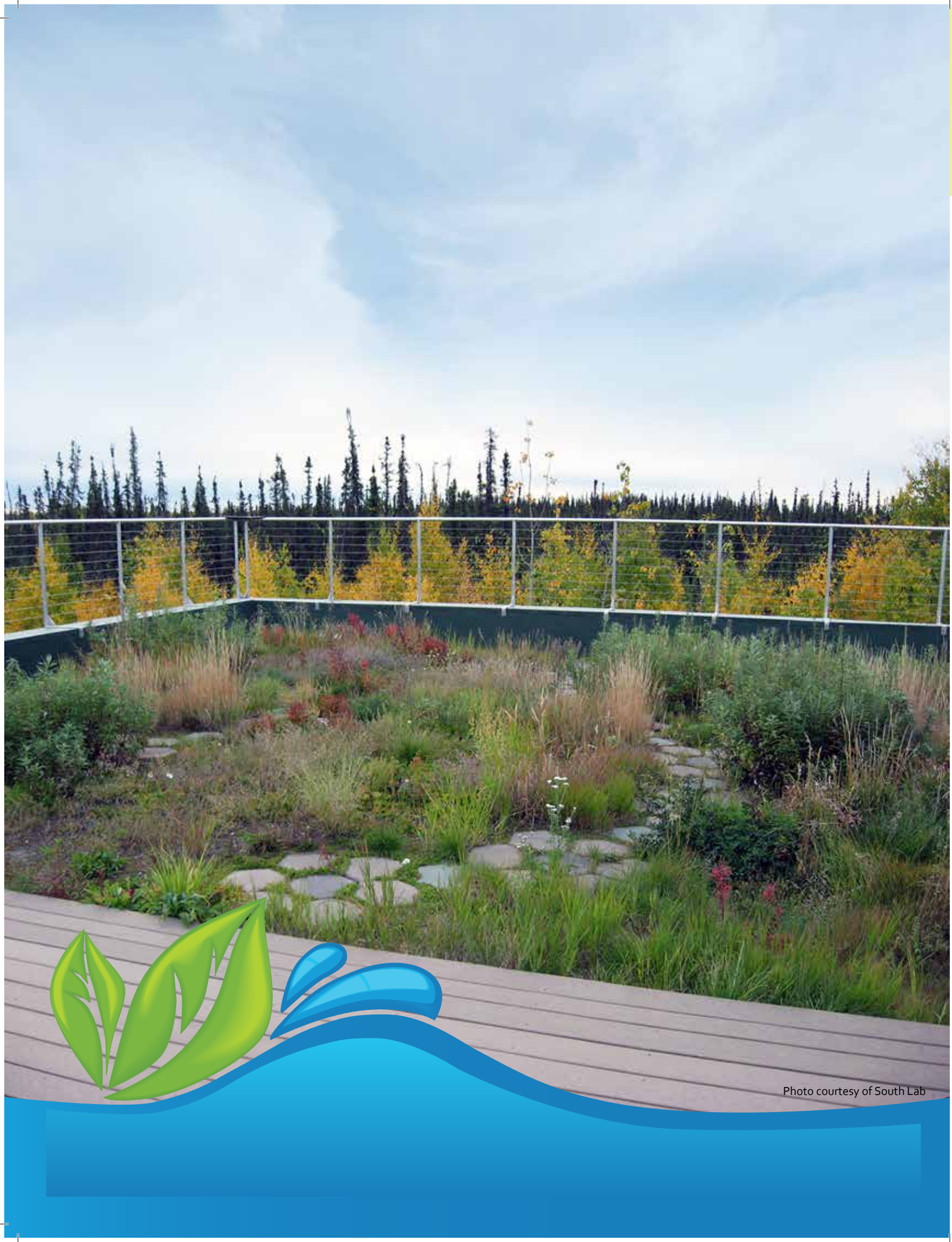


Photo courtesy of South Lab

A. Introduction

What is Green Infrastructure?

Green infrastructure is an approach to managing rain and snowmelt runoff that uses natural or engineered systems that mimic natural processes. Green infrastructure uses soil and vegetation to allow runoff to soak in or be used by plants and people at its source.

While gray infrastructure, such as gutters, storm sewers, culverts, and detention basins move water away from the built environment, green infrastructure reduces and treats stormwater at its source.

Impervious surfaces cover most of downtown Fairbanks. As Fairbanks has grown, the aging gray stormwater system has reached or exceeded its capacity. Rather than replace the system, which would be disruptive and expensive, new city regulations require developed areas to retain stormwater on site. This makes the demonstration of cost-effective green infrastructure methods timely.

Using green infrastructure for stormwater management can improve the health of local waterways by reducing erosion, sedimentation, and pollution in waterbodies. This leads to improved water quality, channel stabilization, and overall riparian health and aesthetics. These green spaces or features also serve multiple uses such as adding beauty and interest to urban areas or creating habitat and space for recreation.

At the city or borough scale, green infrastructure is a patchwork of parks, forests, buffers of trees, and other natural areas that provide flood protection, wildlife habitat, and clean air and water. At the smaller neighborhood or site scale it may consist of rain gardens or rain barrels.

A growing number of communities are saving money, improving water quality, and creating a higher quality of life for residents by adding green infrastructure to their toolkit for managing stormwater.

Environmental

Green Infrastructure uses stormwater management systems that mimic nature to soak up and store water, improving water quality.

Social

Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits.

Economic

Cost-benefit analysis compares gray infrastructure with green infrastructure, showing the cost savings that green infrastructure can provide.

Water Quality in Fairbanks

The Chena River runs through the Fairbanks North Star Borough and supports the second largest spawning population of Chinook salmon in the Yukon River drainage. Commercial, sport, and subsistence fishing are integral parts of the Alaskan lifestyle.

The image of Fairbanks in 1938 (above) and the more recent image (below) show how the community has expanded, increasing its paved surfaces.

Photo courtesy of Bob Henszey, USFWS.

Driving and Motivating Factors

Healthy Environments: Support social and environmental wellness by celebrating Interior Alaska's cultural heritage, unique landscape, natural aesthetics, and wildlife habitat.

Economic Development: Establish a thriving economic environment which supports technological innovation, green job creation, and tourism.

Community Connectedness: Create a network of open green spaces that provide recreational opportunities.

Urban Revitalization: Replace existing impervious land surfaces with porous material over time and restore deteriorating urban infrastructure within the city of Fairbanks to better manage stormwater runoff.

Flood Mitigation: Alleviate the social, environmental, and economic impacts of major flood events along the Chena River and adapt existing infrastructure to accommodate such events.

The Bad News

The expansion of impermeable surfaces (buildings, parking lots, sidewalks, streets and other hard surfaces) in Fairbanks, along with the decrease in natural vegetation, has increased stormwater runoff into the Chena River. Stormwater runoff is a major cause of water pollution, negatively impacting salmon and other species.

Increased sediment, increased water temperature, and low dissolved oxygen conditions harm cold water fish species like salmon and arctic grayling. Increased metals, solvents, pesticides, fertilizers, nutrients, and pathogens are additional concerns. Development along the riverbank has also removed much of the riparian vegetation that is critical for maintaining a healthy habitat, providing food and cover from predators.

In 2012, the U.S. Department of Commerce declared the Chinook salmon fishery a disaster for the Yukon drainage due to low salmon returns.

The Good News

The Chena River was first included on the impaired waters list (303(d)) in 1990 for exceeding the water quality criteria for several pollutants associated with urban runoff, including sediment, petroleum hydrocarbons, and turbidity. The turbidity listing was removed in 1996 and the petroleum hydrocarbon impairment was removed in 2010.

Recent data shows that the Chena River is also meeting the criterion for sediment, and it was proposed for de-listing in 2018. Many things have changed in Fairbanks which led to improvements in water quality in the Chena River during the 1990s and early 2000s including:

- Reductions in stormwater runoff, some of which is associated with the implementation of a municipal separate storm sewer system (MS4) permit;
- Additional permit requirements for construction sites; and
- Efforts to increase green infrastructure applications and reduce the amount of impervious surfaces in the urban area.

Despite these improvements, stormwater runoff, and its associated pollutants, remain a threat to the Chena River as Fairbanks grows.

What is the purpose of this guide?

The Green Infrastructure Project Guide 3rd Edition, January 2015 (https://www.fairbankssoilwater.org/user-files/pdfs/GI_Manual_January2015.pdf) was aimed at residential properties. This publication focuses on larger scale commercial and public property projects that have been successfully installed in Fairbanks. It describes their benefits and encourages duplication on other sites as appropriate.

Fairbanks is built on the banks of the Chena River. The green infrastructure installations implemented here help maintain the health of this river and the community that enjoys it.

B. Benefits of Green Infrastructure

Benefits of Replacing Gray with Green Infrastructure

In some ways, modern storm and wastewater infrastructure would be familiar to ancient Roman engineers who designed similar water management systems. Today, however, the scale of this challenge has increased exponentially. According to the Environmental Protection Agency, communities across the U.S. are facing a total need of $106 billion in stormwater management and combined sewer correction upgrades or improvements. Budgetary restrictions at all levels of government limit investments in these critical components of our environmental, public health, and safety infrastructure. Green infrastructure can help us meet the demands of a growing population, allowing natural systems to provide valuable ecosystem services such as air and water filtration.

Benefits at a Glance

The benefits of green infrastructure often overlap and interconnect. This section, while not comprehensive, examines the breadth of green infrastructure benefits.

Environmental

- Pollutant removal from air and water
- Protection from soil erosion
- Rainwater retention
- Pest control
- Increased land quality
- Enhanced pollination
- Improved wildlife habitat
- Ecological corridors
- Landscape permeability
- Climate change adaptation and mitigation
- Flood alleviation
- Ecosystem resilience
- Carbon storage and sequestration
- Urban "heat island" mitigation
- Disaster prevention (e.g. storms, forest fires, landslides)

Social

- Attractive, greener cities
- Increased recreational opportunities

Economic

- Job creation
- Diversification of local economy
- Increased property values and local distinctiveness
- Integrated transport and energy solutions
- Enhanced tourism

"When we try to pick out anything by itself, we find it hitched to everything else in the Universe."

~John Muir

The following icons and matrices are an illustrative summary of how these practices can produce different combinations of benefits.

Yes	Some	No
●	◉	○

Environmental Benefits			Economic (Community) Benefits	

Water Quality | Air Quality | Habitat | Recreation | Aesthetics

	Environmental Benefits			Economic (Community) Benefits	
Practices (BMPs)	**Improve Water Quality**	**Improve Air Quality**	**Improve Habitat**	**Increase Recreational Opportunities**	**Enhance Aesthetics**
Water Harvesting	●	◉	○	○	○
Tree Planting	●	●	●	●	●
Bioretention	●	●	●	●	●
Permeable Pavement	●	●	○	○	◉
Green Roofs	●	●	●	◉	◉

Water Quality

When rain falls in undeveloped areas, it is absorbed and filtered by soil and plants; the amount of runoff is greatly reduced and is less polluted. When rain falls on streets, parking lots, roofs, driveways, construction sites, agricultural fields, lawns, industrial areas or other hard surfaces it cannot soak in to the ground. It runs into gutters and storm drains, carrying pollutants into waterbodies. Pollutants carried by runoff include oils, sediment, heavy metals, fertilizers, pesticides, pet waste, and litter.

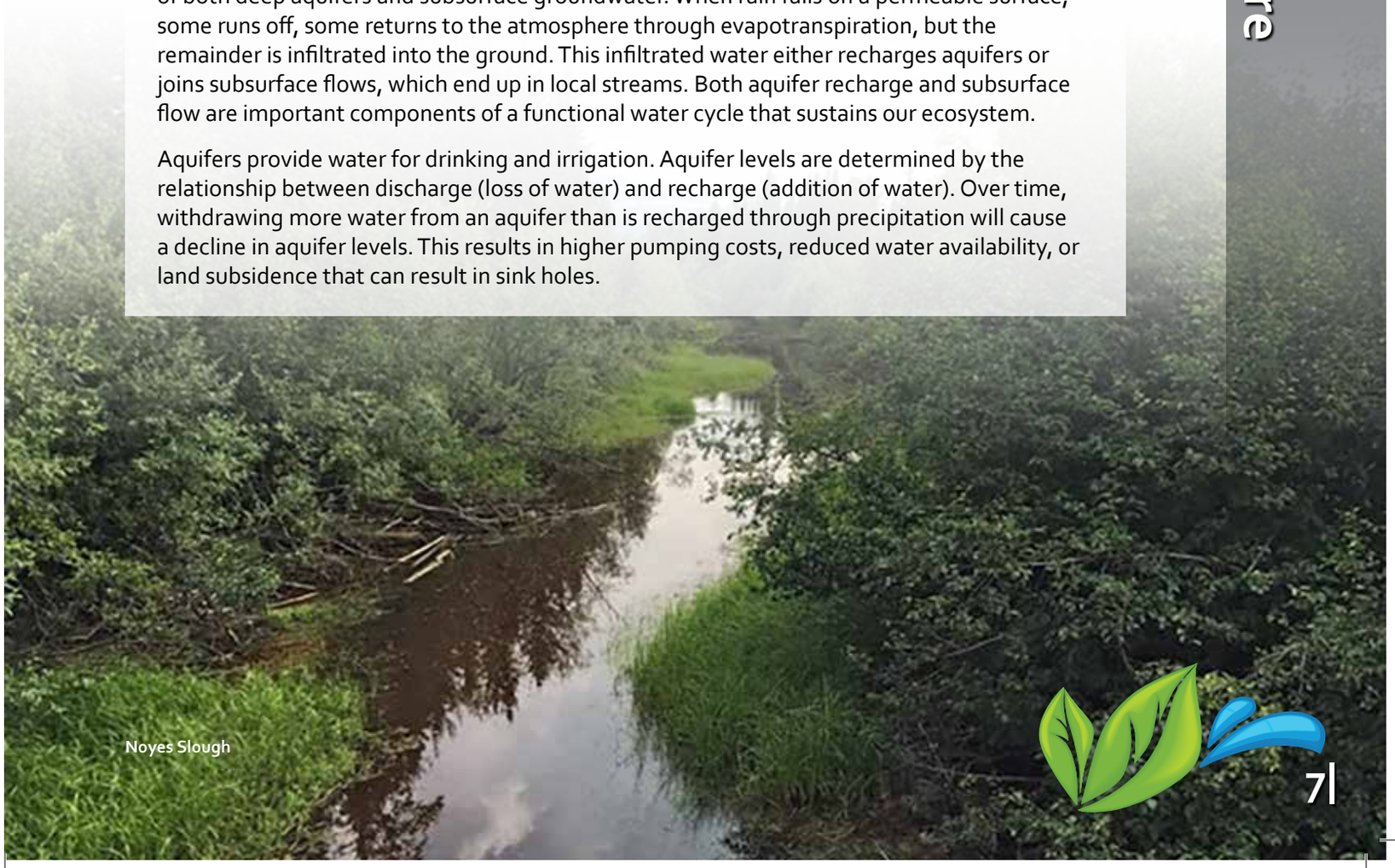
Reduced Flooding and Erosion

In addition to adding pollutants to rainwater or snowmelt, impervious surfaces cause large amounts of stormwater to run off into concentrated areas—usually gutters and storm drains—that can become overwhelmed and cause flooding. Heavier flow from rains and snowmelt can also scour stream and river channels, causing erosion and flooding that may damage habitat, property, and infrastructure.

Groundwater Recharge

Green infrastructure practices that enable rainwater infiltration contribute to the recharge of both deep aquifers and subsurface groundwater. When rain falls on a permeable surface, some runs off, some returns to the atmosphere through evapotranspiration, but the remainder is infiltrated into the ground. This infiltrated water either recharges aquifers or joins subsurface flows, which end up in local streams. Both aquifer recharge and subsurface flow are important components of a functional water cycle that sustains our ecosystem.

Aquifers provide water for drinking and irrigation. Aquifer levels are determined by the relationship between discharge (loss of water) and recharge (addition of water). Over time, withdrawing more water from an aquifer than is recharged through precipitation will cause a decline in aquifer levels. This results in higher pumping costs, reduced water availability, or land subsidence that can result in sink holes.



Noyes Slough

Air Quality

Green infrastructure plays an important role in supporting adaptation to climate change. Green infrastructure practices can provide shade, insulation, and protection from wind, resulting in lower energy costs, which reduces fossil fuel burning and the greenhouse gas emissions associated with it.

Trees in urban green space can directly influence air quality by direct absorption of gaseous pollutants, interception of particles onto leaf surfaces, and creation of oxygen during photosynthesis. They can also reduce air temperatures in urban areas, reducing the formation of ozone.

Habitat

Green infrastructure improves urban biodiversity by increasing habitat for a variety of plants and animals. It provides living space for both resident and migratory species and nurseries for species that live their adult lives elsewhere. The population and diversity of species is directly linked to the size of available habitat.

Natural areas can provide corridors of habitat between developed areas. These corridors allow for movement of wildlife and reduce conflicts with people. Urban green space is important for a range of species, including the small, but valuable pollinators such as birds, butterflies, and bees.

Constructed green spaces, such as rain gardens, are especially valuable because they usually include a variety of native plant species.

Recreation and Aesthetics

The vegetation and green space created by green infrastructure improves recreational opportunities within a community. Access to green space raises levels of physical activity, which improves health. Green space can also have a restorative effect and improve mental well-being.

Studies show that people with access to parks and green space are less stressed and prone to anxiety, have lower blood pressure and cholesterol, have faster recovery from surgery and heart attacks, and are better able to manage attention and behavioral disorders.

Incorporating green space into urban areas through green infrastructure enhances community livability and provides opportunities for recreation for all ages, leading to healthier lives and reduced medical costs.

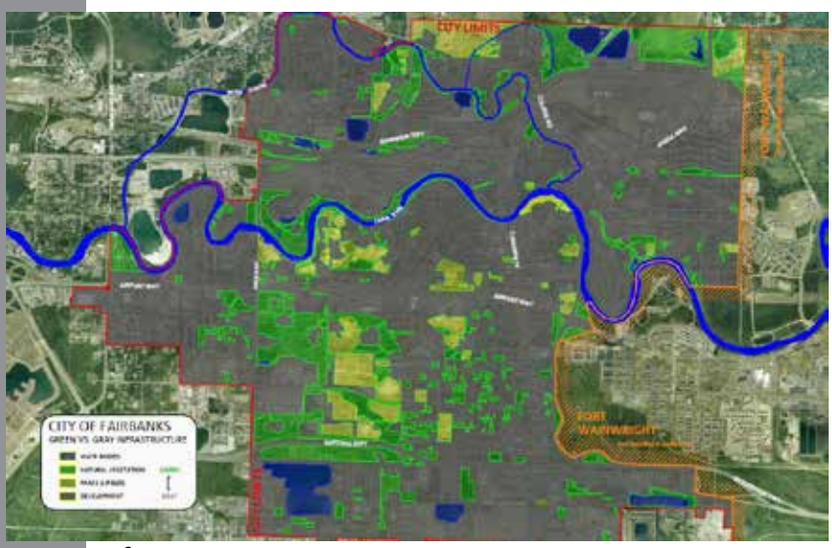
Green Infrastructure is Cost-Effective

While gray infrastructure, such as storm drains and pipes, serve only one purpose, green infrastructure and natural areas serve multiple purposes. Trees and natural areas reduce runoff and limit flood damage. They also generally cost less to install and maintain over a 20-year period than gray infrastructure.

Like all infrastructure, green infrastructure requires monitoring and periodic maintenance to continue to function as designed.

Green vs. Gray Savings

- Lower capital investments
- Reduced infrastructure replacement costs due to longer life of the investment
- Reduced equipment and installation costs
- Reduced wear on system components
- Lower operation and maintenance costs
- Reduced land acquisition costs if land owners treat runoff onsite
- Increased water quality reliability and predictability, which can reduce long-term capital costs
- Increased value from vegetation, especially trees, as they mature



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Urban Garden Opportunities

As urban populations grow and the costs associated with rural food production and distribution continue to increase, urban agricultural systems are being considered in order to address concerns related to food security and cost (Argenti, 2000). According to the USDA, 15% of the world's food supply is currently produced in urban areas (AFSIC, 2010).

Green infrastructure practices, such as green roofs and tree planting, can provide increased opportunities for urban agriculture and urban foraging. Benefits areas include economic development, recreational activities, community-building, educational opportunities, and increased habitat within the urban ecosystem.

C. Best Management Practices (BMPs)

There are a number of Best Management Practices (BMPs) that can be implemented by managers to support water conservation and stormwater management. The practices detailed in this guide include the installation and maintenance of infrastructure for **water harvesting, tree planting, bioretention and infiltration systems, permeable pavement, and green roofs.** The success of BMPs depends on the behaviors and activities of community members.

Stormwater pollution results when people dispose of trash and recyclables, dispose of pet waste, apply lawn chemicals, wash cars, change motor oil, or dispose of other household chemicals. Public ducation about BMPs is very important and should include clear guidance on steps and specific actions to reduce stormwater pollution.

Water Harvesting


Tree Planting


Bioretention & Infiltration


Permeable Pavement


Green Roofs

Costs: Investment in Saving vs. Reinstall

- Reduced building cost (equipment and installation)
- Reduced repair, maintenance, and operation costs
- Lower land acquisition costs
- Reduced wear and replacement costs
- Increased water quality reliability in municipal drinking water
- Increased development benefits through demand and pricing for "green" properties
- Increased benefits to the public such as flood control and groundwater recharge

78% of the American public does not understand that runoff from agricultural lands, roads, and lawns is now the most common source of water pollution.

NEEFT 2005

RAIN WATER HARVESTING

Water Harvesting: Saving and Storing

Definition

Water harvesting involves the redirection and collection of stormwater for reuse by plants or people onsite. It treats rainwater as a resource rather than waste and reduces the public costs of moving and treating runoff.

How it Works

Water is usually collected by disconnecting downspouts from roofs and directing runoff into rain barrels or storage tanks for irrigation or graywater purposes (e.g., toilet flushing).

Note: It is not advisable to use roof runoff for food plants such as vegetables.

Opportunities

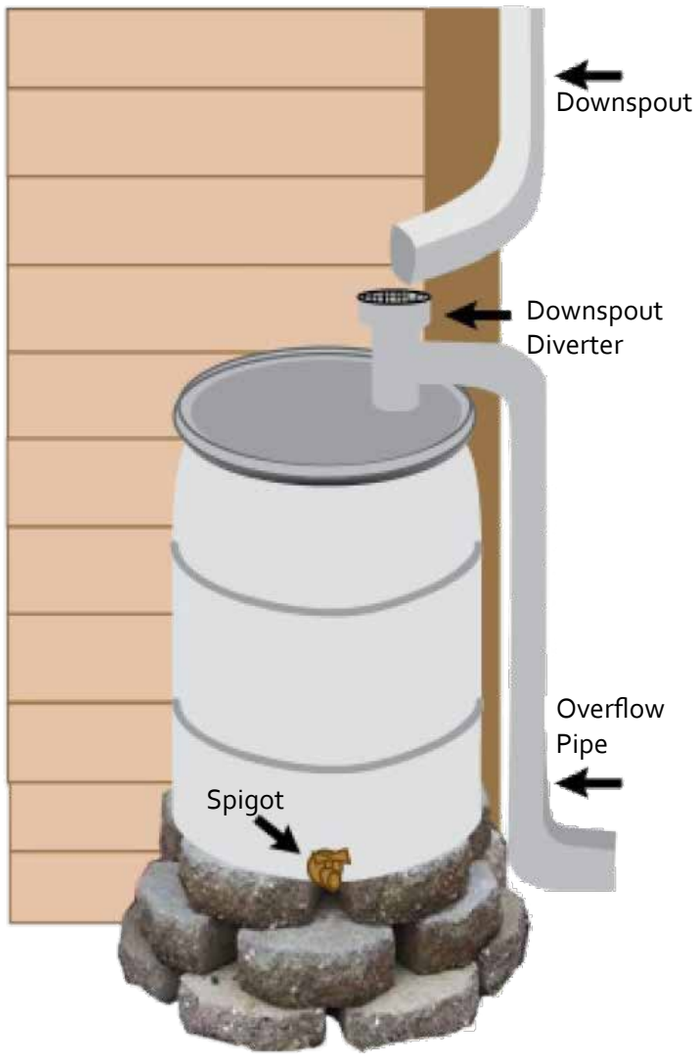
At the small scale, homeowners can use rain barrels connected to downspouts, while on a larger scale, cities can use above or below ground cisterns.

Locations

- Commercial buildings
- Residential homes
- Roads
- Public right-of-way
- Terraces

Methods

- Rain barrels
- Rain storage tanks
- Flow-through planters



The image above shows how rain barrels can be positioned to collect water from rooftop gutter systems.

The downspout diverter has a screen to keep bugs out of the barrel. It also has an overflow outlet that redirects excess water once the barrel is full.

RAIN WATER HARVESTING

Water Harvesting: The Benefits

Improves Water Quality

- Collecting and reusing rainwater reduces the volume of stormwater runoff, which reduces erosion or flooding.
- Water harvesting reduces pollution entering waterbodies by reducing the amount of water flowing through areas that have motor oil residue, trash, and other pollutants.
- Reusing rainwater onsite reduces water treatment needs, allowing communities to save on costs associated with potable water conveyance, treatment, and use.

Improves Air Quality

- Water harvesting reduces the amount of energy needed for graywater treatment practices, and the air pollutants or carbon dioxide emissions associated with them.

Above: Rain barrel at S Salon

A **flow-through planter** collects runoff water from an inlet pipe (such as a gutter downspout) or naturally from a slope. It has a closed bottom with a porous pipe that drains the water after it has been filtered by the plants and soil. These types of planters require less watering, provide filtration of pollutants, and are suitable in areas with limited space. Planters can be constructed during the winter months and installed after the ground thaws in the spring.

Above: Storage tanks at Georgeson Botanical Gardens

Rain barrels and **rain storage tanks** collect roof runoff through gutters and downspouts and store the water for other uses, such as watering flower gardens or lawns. All rainwater collection systems should have an overflow to a safe disposal location.

Maintenance

- Disconnect downspouts from the barrel, storage tank, or planter at the first freeze in the fall to prevent ice dams from forming in the gutters.
- Wash barrels and storage tanks annually to prevent algae build up.
- Check hardware on barrels and storage tanks and replace as needed.
- Weed planters as necessary.
- Clean gutters once a year to keep debris out of the downspout and inflow pipe.

Tree Planting: Nature's Toothbrushes

Definition

Planting trees is one of the most effective and least expensive means of reducing and filtering runoff. When planted in channelized depressions with other plants, trees can aid in collection, filtration, and infiltration of stormwater runoff.

How it Works

Properly planted and maintained trees intercept rain with their leaves and branches; diminish the impact of rain on soil and hard surfaces which reduces erosion and dirty runoff; increase infiltration and the soil's ability to store water; and transpire water through their leaves.

Tree planting along streets in large trenches, pits, or other features with the large volume of soil expands their benefits. Runoff is collected and filtered through layers of mulch, soil, and root systems. Pollutants can then be retained, degraded and absorbed.

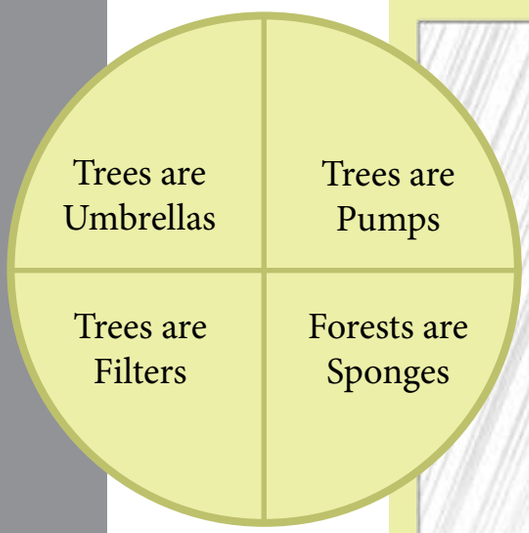
Unlike most gray infrastructure, the value and benefits of trees increase as they age and reach a mature size. To maximize benefits, the right tree must be planted in the right place and properly maintained. Trees need adequate space below and above ground to reach maturity.

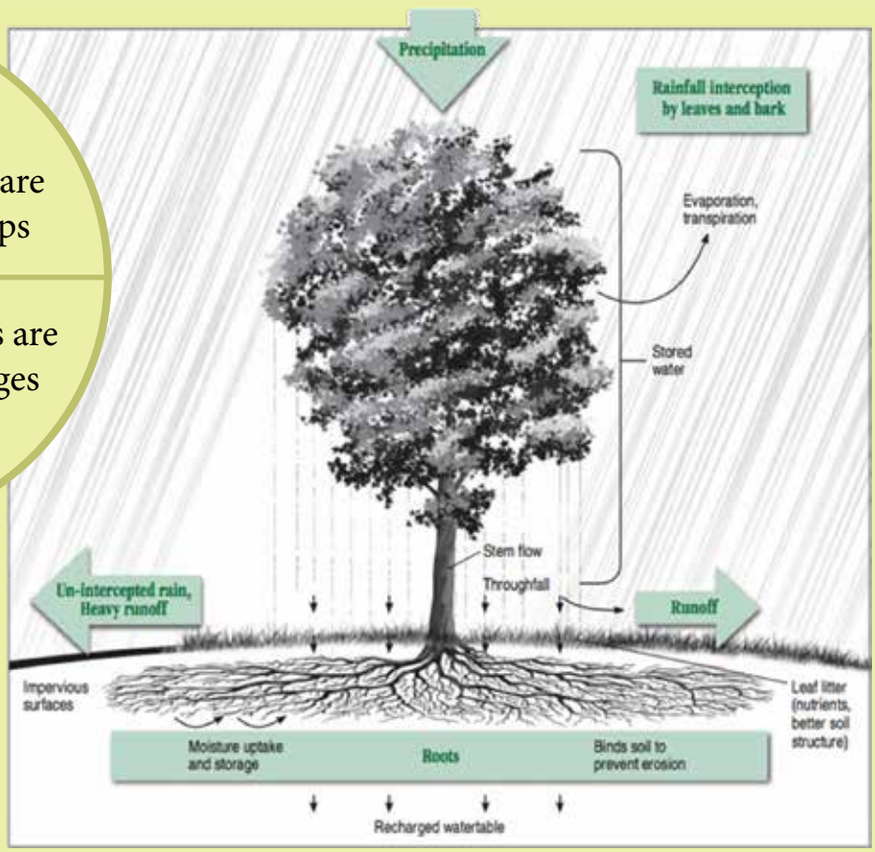
Locations

- Streetscapes adjacent to roads
- Road medians
- Parking lots and sidewalks
- Plazas and parks

Methods

- Tree planting, individual or in groups
- Tree trenches
- Below-grade, silva-cell type planter





Tree Planting: The Benefits

Improves Water Quality

- Trees intercept rainfall and help increase infiltration and the soil's ability to store water.
- Tree canopies diminish the impact of raindrops on barren surfaces, reducing erosion and turbid runoff.
- Transpiration through leaves minimizes soil moisture, reducing runoff.

Improves Air Quality

- Trees remove different types of air pollution including particulate matter (PM10), sulfur dioxide, nitrogen oxide, and ozone. Conifers capture larger amounts of PM10 than broad-leaved trees due to the larger total surface area of needles.
- Trees reduce energy consumption, improving the air quality and reducing the amount of greenhouse gases including N_2O, CH_4, and CO_2.
- Trees reduce wind speeds, which can have a significant impact on energy requirements, especially in cold climates.

Improves Habitat

- Tree planting increases wildlife habitat, especially when native plant species are used.

Improves Aesthetics and Provides Recreation and Educational Opportunities:

- Trees provide beauty and privacy, improving community aesthetics.
- Trees increase community aesthetics and recreational opportunities by improving pathways, creating places to gather, and providing shade during warm weather.
- Trees provide a sense of place and well-being, strengthening community cohesion.

Species	Total Rainfall Interception (Gal)	Total $ Value	% of Population	% of Total $	Avg. $/tree
Paper birch	91,268.65	985.77	53.46	59.89	11.60
European bird cherry	2,154.25	23.27	14.47	1.41	1.01
Alder species	14,590.76	157.59	11.32	9.57	8.76
White spruce	26,495.12	286.17	10.69	17.39	16.83
Willow	16,088.40	173.77	9.43	10.56	11.58
Black cottonwood	1,792.42	19.36	0.63	1.18	19.36
Sample total	152,389.60	$1,645.92	100%	100%	$10.35

Above: This table shows a sample inventory taken at Campbell Creek in Anchorage and studied the stormwater benefits of each species in a 1/2 acre area.

For information on how to select, plant, and maintain trees, see Plant a Tree: *Alaska's Guide to Tree Selection, Planting, and Care*.http://forestry.alaska.gov/Assets/uploads/DNRPublic/forestry/pdfs/community/publications/plant%20a%20tree%20web.pdf

Bioretention and Infiltration: Slow it Down, Soak it In

Definition

Bioretention and infiltration systems are catchments designed to slow and temporarily store runoff from developed areas. Common features are rain gardens and bioswales, but larger treatment wetlands are also effective.

How it Works

Bioretention and infiltration systems direct water into an area to pool for a period of time before draining and are designed to allow for overflow into the sewer system if necessary. Soil and plants in an infiltration system naturally filter runoff and remove pollutants.

Opportunities

Biorention and infiltration are used to treat runoff from impervious surfaces in commercial and residential areas. Well-designed systems capture much of the water that falls on the feature and its drainage area. The percentage of runoff that can be accommodated depends on available square footage and ponding times.

Locations

- Building downspouts
- Parking structures
- Roads and right-of-ways
- Terraces and private gardens

Methods

- Rain gardens and swales
- Detention and retention ponds
- Curb cuts
- Dry wells

Local Examples

- Garden and swales at Carlson Center
- Swales at Chief Andrew Isaac Health Center
- Rain garden at the farmers' market
- Dry well under Golden Heart Plaza
- Curb cuts at the bus depot

Left: Rain Garden at Raven's Landing, installed by Fairbanks Soil and Water Conservation Group, Youth for Habitat Class

Right: Swale in Graehl Park that allows water from the culvert to collect and filter into the ground.

A **rain garden** is a low area, natural or created, with plants that tolerate and absorb rainwater and filter pollutants. They are generally located where they can intercept runoff from a roof downspout, parking lot, or other hard surface, and planted with native vegetation. They allow water to pool and drain, be used by plants, or evaporate. Designs may allow for overflow.

Maintenance: Weeding and watering when necessary.

A **swale** is a depression designed to slow and direct surface runoff, often located to collect runoff from hard surfaces. It traps silt and other pollutants, lets the water soak into the ground, and is often vegetated with native plants for natural filtration. Swales may be designed to direct water into rain gardens, slowing it during times of high flow to limit damage to plants.

Maintenance: Routine removal of debris and weeds.

Bioretention and Infiltration: The Benefits

Improves Water Quality

- These practices store and filter stormwater, mitigating flood impacts and preventing stormwater from polluting local waterways.

Improves Air Quality

- Infiltration improves air quality through uptake of critical air pollutants and the deposition of particulate matter.
- Bioretention and infiltration reduces carbon dioxide emissions through direct carbon sequestration.

Improves Habitat

- Bioretention and infiltration provides habitat, increasing biodiversity.

Improves Aesthetics and Recreational Opportunities:

- Bioretention and infiltration improves local aesthetics and enhances recreational opportunities within communities if properly maintained.
- These practices can potentially reduce noise transmission through sound absorption in neighborhoods.

Above: Bus Depot in downtown, Fairbanks.

Curb cuts are a way to implement green infrastructure practices without major reconstruction. Since curb cut openings are perpendicular to the flow of stormwater on the street, they usually collect only a portion of the water flowing along the gutter. The use of multiple curb cuts along the street can reduce even more stormwater flows. They can divert stormwater from the street into a depressed, vegetated infiltration area similar to a rain garden.

Maintenance: Check for signs of erosion and repair/reinforce as needed.

Above: Golden Heart Plaza in downtown, Fairbanks.

Dry wells carry water from a downspout to an underground holding container with holes in its sides that allow runoff to percolate into well-draining soil.

Maintenance: Drywell must be disconnected from downspout in the fall to prevent ice dams from forming in the gutters.

Photos courtesy of Festival Fairbanks

Permeable Pavement: Flow Through—Not To

Definition

Permeable surfaces allow rain and snowmelt to flow through them and soak into the ground, rather than flowing into a storm water system. Natural soils and vegetation are used. There are several different names that refer to types of permeable pavement including pervious or porous concrete, porous asphalt, and interlocking permeable pavers.

How it Works

Typical concrete and asphalt surfaces cause water to flow downhill into gutters and storm drains.

Opportunities

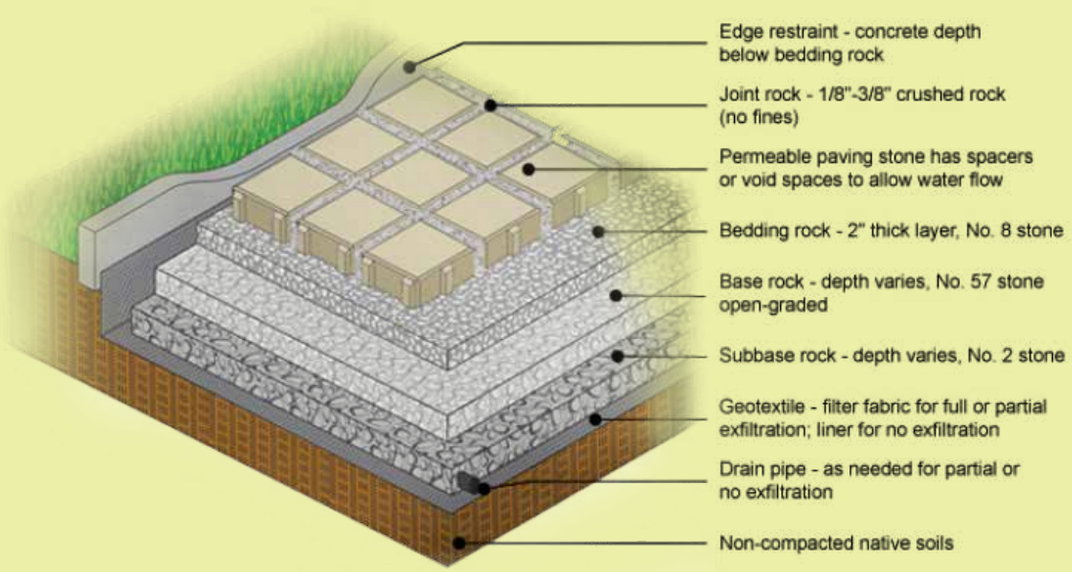
Downtown Fairbanks has an overwhelming amount of impervious surface. Transforming these areas would reduce the amount of runoff entering the Chena River.

Locations

- Parking lots
- Driveways
- Sidewalks and trails
- Streets and alleys
- Plazas and patios

Methods

- Permeable pavers
- Pervious pavements
- Soil stabilizers
- Infill pavers (grass or gravel)
- Grass-reinforcing mesh



Permeable Pavement: The Benefits

Improves Water Quality

- Permeable surfaces decrease stormwater runoff, reducing erosion and flooding.
- Permeable surfaces decrease pollution entering waterbodies by reducing the amount of water flowing through areas that have motor oil residue, trash, and other pollutants.

Improves Air Quality

- Permeable surfaces reduce carbon dioxide emissions when they replace asphalt and cement that have high lifecycle carbon footprints.

Improves Aesthetics

- Some types of permeable pavement reduce noise pollution by increasing street porosity levels.
- Reinforced grass areas can be a functional or aesthetically pleasing alternative to concrete and increase property values.

Above: Georgeson Botanical Garden in Fairbanks

Permeable pavers are concrete blocks or pavers set in gravel to allow water to pass around them and into the soil. They can be used instead of solid concrete or asphalt for driveways, patios, and walkways.

Maintenance: Permeable pavement types can be susceptible to cracking and breaking during the freeze/thaw cycle. Additionally, blocks may catch and cause damage to plows in areas that need snow removal.

Above: Big I adjacent to the Chena River

Grass-reinforcing mesh is a thick plastic mesh that is installed to protect, reinforce, and stabilize grass against damage caused by traffic (pedestrians and vehicles). This allows grass to be used as a rainwater infiltration surface while controlling mud problems.

Maintenance: Most varieties of this mesh can withstand temperatures below -50° F and snow shoveling, but snow plows should not be used.

Green roofs: The Basics

Definition

A green roof, or living roof, is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It can also include additional layers such as a root barrier, and drainage and irrigation systems. Green roofs are separated into different categories based on the depth of their growing media.

How it Works

Instead of shedding water like typical roofing material, green roofs collect and absorb stormwater and snowmelt. This green, vegetated layer protects the roofing membrane and adds to the insulation factor, prolonging the life of a roof.

Opportunities

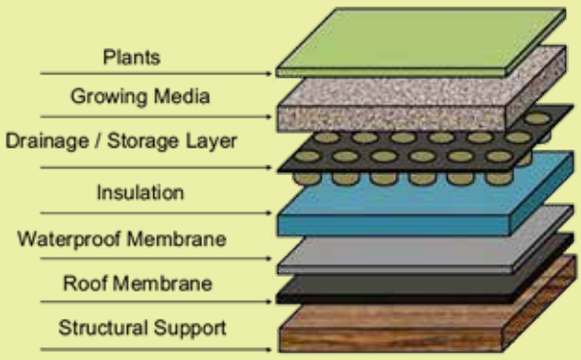
Green roofs are encouraged on buildings in Alaska as they offer reduction in energy costs, additional insulation, reduced maintenance, and habitat creation.

Locations

- Commercial/government buildings
- Private residences
- Large industrial facilities
- Parking structures
- Walls

Methods

- Extensive green roof (less than 6 inch depth growing media)
- Intensive green roof (greater than 6 inch depth growing media)
- Green walls



Above: Traditional Alaska cabins have often used 'green roof' systems, back when roofing materials were scarce and grass sod was the best protective and insulative material available.

Green Roofs: The Benefits

Improves Water Quality

- Green roofs can store significant amounts of water in their growing media. Water eventually evaporates or is transpired by the plants, reducing run-off entering sewer systems and waterways.

Improves Air Quality

- Vegetation planted on green roofs absorbs air pollutants and intercepts particulate matter while lowering energy consumption.

Improves Habitat

- Increased vegetation supports biodiversity and provides valuable habitat for a variety of flora and fauna.

Additional Opportunities:

- Soil and vegetation reduce sound transmission, reducing noise pollution.
- Green roofs can increase recreational opportunities by providing outdoor areas for people to use and enjoy. These spaces improve community interactions and help build social capital.
- Green roofs provide opportunities for urban agriculture.

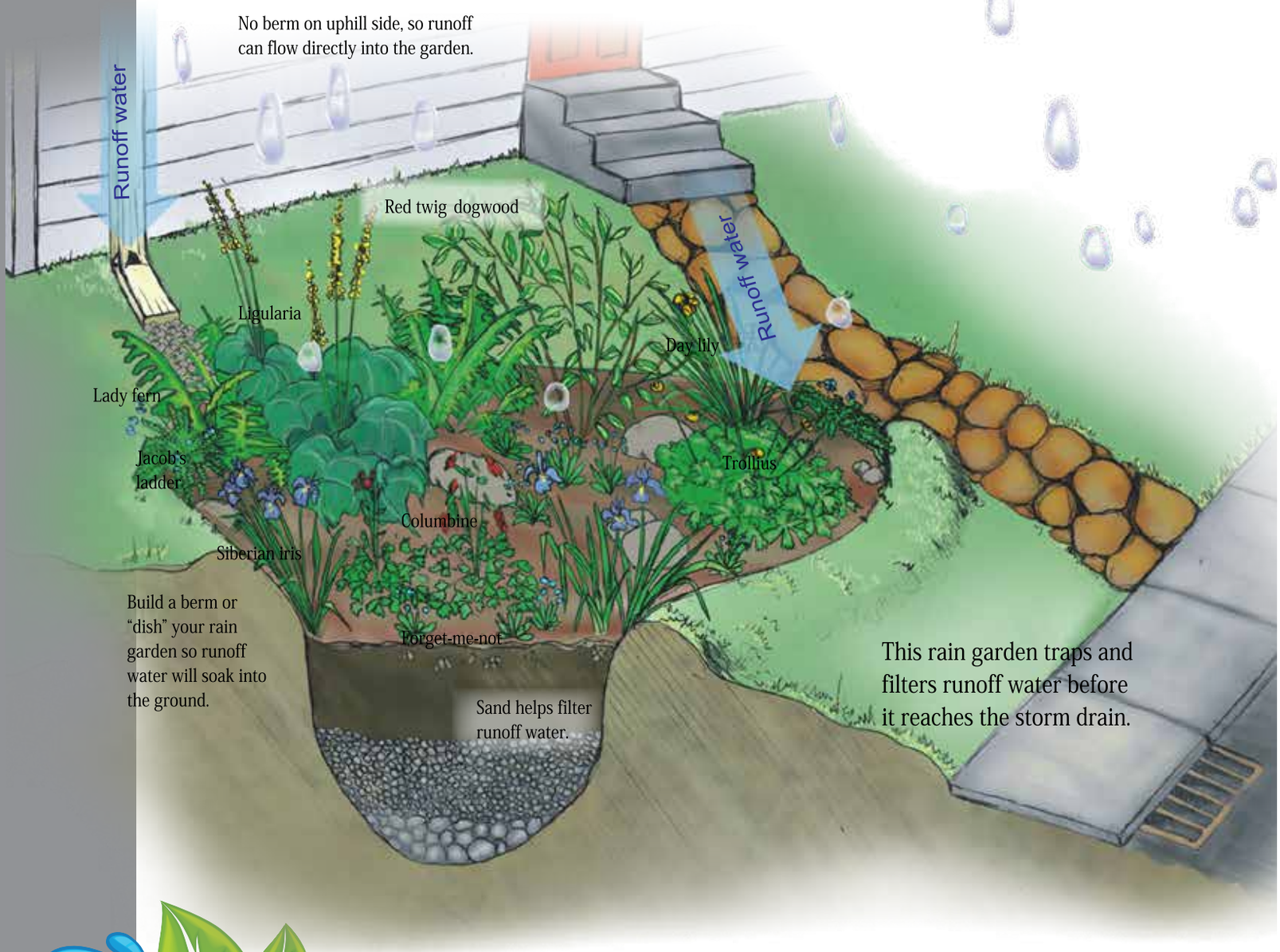
Above: The green roof on the Eielson Visitor Center in Denali National Park is an example of an intensive green roof. It provided tundra sod over deep growing media in order to blend in with the surrounding landscape as much as possible. This very efficient facility received a LEED (or Leadership in Energy and Environmental Design) platinum rating.

Photo courtesy of Peter Briggs

Above: The green roof on the Downtown Juneau Transportation Center is an example of an extensive green roof with shallow, lightweight growing media and an assortment of sedums and drought-tolerant plants. This project was installed using a system of trays allowing unique design patterns to be created.

Photo courtesy of JYL Architects/Corvus Design

Hardworking Rain Gardens



D. Small-scale Projects

As a complement to the downtown Fairbanks Complete Streets renovation project, completed in 2016, several local businesses used the BMPs to manage the impacts of stormwater runoff from their properties.

S Salon

S Salon incorporated green infrastructure designs into aesthetic landscaping along the front of the building. This small-scale project was designed to have big impacts and show other businesses how to reduce stormwater runoff.

The green infrastructure included rain water harvesting and permeable pavement. Two types of water catchment devices were installed. First, a 60-gallon rain barrel connected to a downspout allowed retention of roof runoff to be used for landscaping. Second, a flow-through planter box was connected to another downspout and directed runoff into the box to water the plants. The overflow allowed excess water to escape. These two water retention applications kept water from running directly into the parking lot where it would have drained into the street, causing ice hazards for pedestrians during colder months. Permeable pavers were installed from the parking area to the entrance. These pavers allowed for infiltration of water before it reached the street. Combined, these green infrastructure applications trap and filter runoff water before it reaches the storm drain.

Above: The rain barrel, planters, and pavers at S Salon show how green infrastructure installations and BMPs can help a business look good while reducing their impact on local waterbodies.

Above: Before green infrastructure Installations

Above: After green infrastructure Installations

The Big I

The Big I is a popular local business with property adjacent to the Chena River. As part of an expansion of their usable area for customers, they worked with local non-profits to install a permeable paver patio, a rain garden, and grass mesh to protect the lawn near the parking area.

The project was designed and installed with help from the Fairbanks Soil and Water Conservation District Youth for Habitat students. Interpretative signage describes the purpose and benefit of all the green infrastructure applications.

Above: The Big I BMPs were designed and built by a group of eighth and ninth graders (part of the SWCD Youth for Habitat) with funding provided by grants.

Left: an installation of grass mesh soon after installation and before seed germination. This will help stabilize the lawn near the parking area.

Left: an installation of permeable pavers used to create a patio near the picnic tables, directly adjacent to the Chena River.

Max C. Lyons Transit Center (The Bus Depot)

Green infrastructure improvements at the Fairbanks North Star Borough Bus Depot include new vegetation and a permeable walkway. Infiltration plantings were placed near the corner of the property where water tended to pool and freeze. The new, permeable pavers made a pathway that connects the bus depot parking area with the main sidewalk, allowing for access to the intersection.

This project was also installed with help from the Fairbanks Soil and Water Conservation District Youth for Habitat students.

Right: Interpretive signage was installed to highlight the permeable paver installation and planting.

Cushman and Noble Streets

Cushman and Noble streets are main traffic corridors in downtown Fairbanks. They connect many businesses with the Chena River corridor. The sidewalks along this street were last upgraded in 1972 before the redesign and construction in 2016. This corridor is now designated as a Complete Street, or a road that is built to accommodate all forms of traffic including pedestrians, bicycles, buses, wheelchairs, and motorists. An important part of the design for this road was the inclusion of trees to increase the aesthetics, making the corridor more enjoyable for users. Trees were planted in underground SilvaCell planters that provide maximum soil volume and protection from compaction. Additional planters with evergreen trees were placed along the corridor.

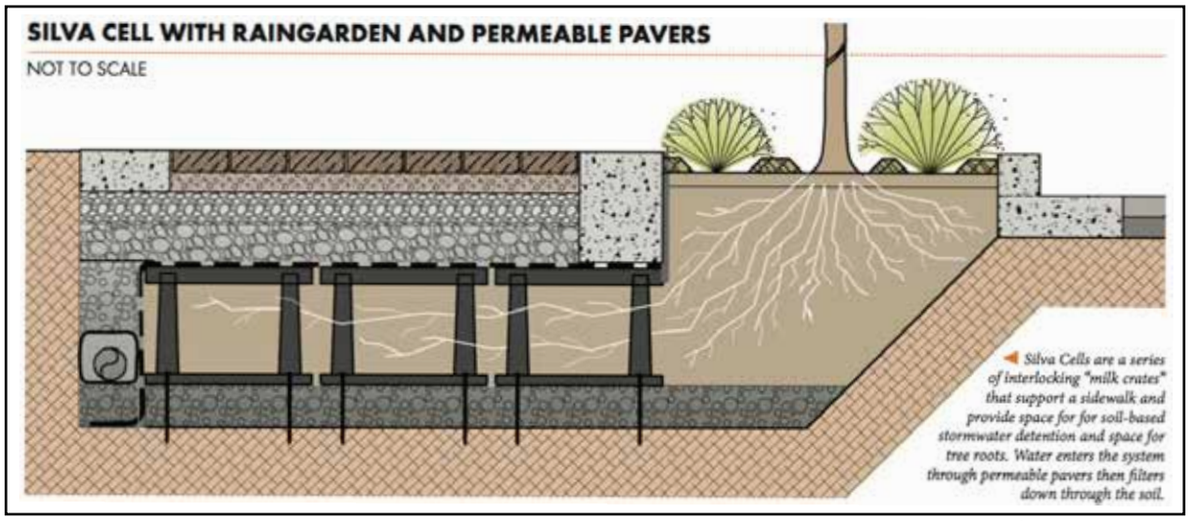


Diagram courtesy of Bay View Compass

Cushman Street was renovated into a Complete Street with large trenches to accommodate the needed soil volume for street trees.

SilvaCells (below sidewalks) protect tree roots and soils and prevent soil compaction in harsh, urban environments.

Trees planted in SilvaCells provide pedestrian scale and separation from the roadway.

Photos courtesy of Pat Greeley, DeepRoot

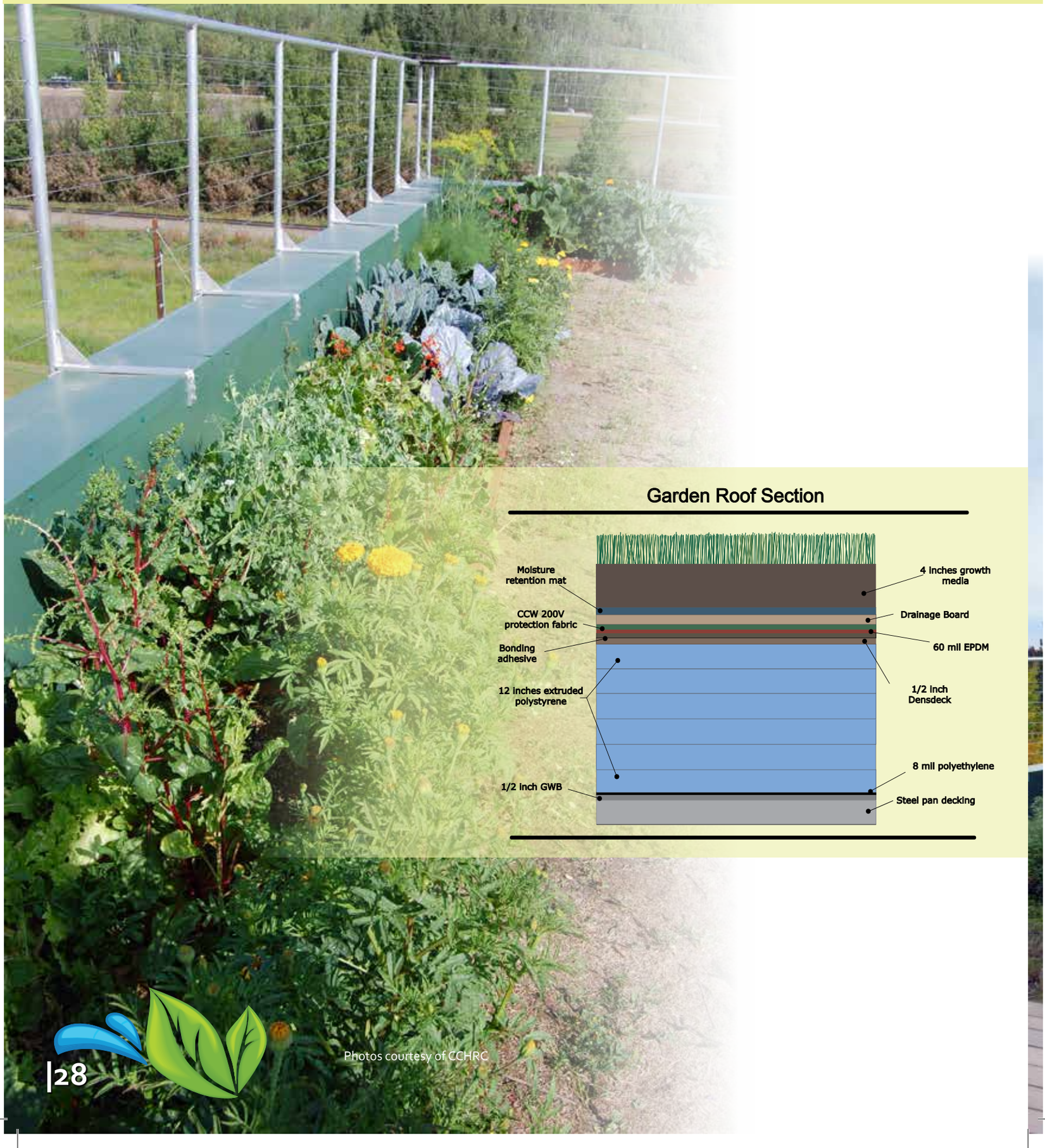
The Carlson Center

The Carlson Center is a 35,000-square-foot arena in the heart of Fairbanks. It is used for a variety of activities year round, from concerts to sporting events. With a large area of impervious surface for the parking area and roof, there is substantial stormwater runoff. The Chena River flows just behind the property.

Community partners came together in 2013 to install a vegetative swale and rain garden to filter runoff pollutants before the water reaches the Chena River. The swale increases infiltration, using layers of gravel and soil to store excess runoff during heavy rain fall events. Native plants with deep root bases were chosen to encourage absorption.

For the 2016 spring, summer, and fall, a monitoring and water testing project was set up to compare water levels and soil saturation at Carlson Center with the Chief Andrew Isaac Health Center (CAIHC). This report was developed by PDC Engineers, Shannon & Wilson, and Tanana Valley Watershed Association (TVWA) and is available with PDC Engineers or TVWA.

The rain garden at the Carlson Center was installed by Tanana Valley Watershed Association and receives a large volume of water from the parking lot. It currently does not drain to the Chena River, but GIG is looking for ways to provide an overflow mechanism that would drain under the trail to the river, during high water events.



Garden Roof Section

Photos courtesy of CCHRC

E. Large-Scale Projects

Cold Climate Housing Research Center

The Cold Climate Housing Research Center (CCHRC) is the farthest north LEED Platinum building on earth. It has many green infrastructure applications including a green roof, water retention system, and an on-site wastewater treatment system. Free public tours of the facility are offered monthly.

CCHRC has three living green roof areas. These spaces provide natural habitat, reduce energy costs and water runoff, and provide a green space for recreation. The total green roof space is approximately 7400 square feet.

Chief Andrew Isaac Health Center

The Chief Andrew Isaac Health Center (CAIHC) is one of few buildings in Alaska to attain LEED Gold certification. The facility consumes 30% less water than average and reduces energy usage by 30%. The building was designed around the landscape, which saved more than 50 mature birch and aspen trees. Native landscaping adds to the building's appeal. Water from rain and snowmelt feeds the landscape, eliminating the need for irrigation. A green roof above the registration wing of the clinic reduces energy costs and water runoff.

Photos courtesy of Bettisworth North

Highlights

The CAIHC project was unique in the Interior. It used native plant material, which has many environmental benefits including reduced shipping costs (materials are available locally) and reduced water requirements (the material is adapted to our climate). It still requires maintenance to remove seedlings and weeds until it becomes well-established. Native landscapes do not require the long-term use of fertilizers or weed-killers that mown lawns require. This project educates people about how native landscapes are an attractive alternative to more resource-intensive traditional landscaping.

For more information:
https://www.pdceng.com/projects/chief-andrew-isaac-health-center/

Morris Thompson Cultural and Visitors Center

The mission of the Morris Thompson Cultural and Visitors Center is to "celebrate Alaska's people, land, and culture." With that in mind, great care was taken to use native landscaping.

A water feature along the south side of the building filters runoff from the parking lot. A line of birch trees planted around the front of the building reduces wind speeds, absorb air pollution, and provide wildlife habitat.

Additionally, a 1901-period cabin with a garden sits outside the main visitors center. The garden provides more than 100 pounds of fresh, locally-grown vegetables to the Fairbanks Community Food Bank each summer.

Complete Streets 101

What are Complete Streets? And why do they matter to us?

Streets are an important part of the livability of our communities. They ought to be for everyone, whether young or old, motorist or bicyclist, walker, or wheelchair user, bus rider, or shopkeeper.

Now, in communities across the country, a movement is growing to **complete the streets**. States, cities, and towns are asking their planners and engineers to build road networks that are safer, more livable, and welcoming to everyone.

Instituting a **Complete Streets policy** ensures that transportation planners and engineers consistently design and operate the entire roadway with all users in mind - including bicyclists, public transportation vehicles and riders, and pedestrians of all ages.

Cushman Street - Existing Conditions

Cushman Street is one of the main corridors of our downtown, connecting many businesses with each other along the Chena River corridor. The sidewalks along this corridor were last upgraded in 1972 while the asphalt was upgraded in 2006. The City of Fairbanks is currently working on designs for this corridor to better accommodate all forms of traffic and follow the Complete Streets model.

Cushman Street Existing
Rendered from above

Cushman Street - Proposed Change

Complete Streets Design Concept for a typical intersection along Cushman Street, showing sidewalks and landscaping.

Design Concept
Rendered from

Timeline for Cushman St

- April 2015: Cushman St Construction Documents go to Bid
- May 2015: Bid Award
- June 2015: Cushman St. Construction Begins
- Late 20: Green In... Projects

Green Design
Complete Streets

Green Streets 101

Gray Infrastructure in Fairbanks (Impervious Surfaces)

As Fairbanks continues to grow in population, the amount of impervious surfaces expands. This image (right) shows the percent of impervious surfaces in 2009 and is part of our 'gray' infrastructure that contributes to stormwater runoff.

Impervious surfaces do not allow water to infiltrate into the ground. Instead, water runs off these surfaces quickly, sometimes carrying contaminants into waterbodies and stormdrain systems.

We can reduce impairments to the Chena River and Noyes Slough through this Green Streets Policy.

What is a Green Street?

A Green Street is a road that is smartly designed with **GREEN INFRASTRUCTURE** to create efficient transportation corridors that minimize environmental impacts.

Just like roads and bridges, forests and wetlands are types of infrastructure. They are types of GREEN infrastructure. Green infrastructure are natural or man-made systems that filter stormwater runoff (water from rain or melting snow) and allow it to soak into the ground instead of traveling through the underground storm drain system to the Chena River. These green areas absorb and filter stormwater before it enters the river, keeping it clean and safe for people, fish, and wildlife.

Green Infrastructure Designs

Why do Green Streets matter to us?

The Clean Water Act (CWA) requires that each state to develop a program to annually monitor and report on the quality of its waters and prepare a report describing the status of its water quality. The CWA requires all states to characterize waterbodies and identify any that do not meet water quality standards.

The Chena River, Noyes Slough, and Chena Slough are currently on Alaska's List of **IMPAIRED WATER BODIES** for sediment. Noyes Slough is additionally listed for petroleum products and debris.

Green Streets

F. Local Policy

The Fairbanks Metropolitan Area Transportation System (FMATS) adopted policies to be considered at all phases of planning and project development. These include a *Complete Streets Policy* (2015), *Green Streets Policy* (2016), and *Landscaping Policy* (2017).

Not only do these policies encourage application of green infrastructure when applicable, they promote a holistic approach to transportation planning that integrates the needs of all community users as well as the environment.

Complete Streets Policy

The *FMATS Complete Streets Policy* was approved by the Policy Committee on October 21, 2015. Resolutions of support were passed by the City of North Pole, the City of Fairbanks, and the Fairbanks North Star Borough.

Principles

- Emphasize connectivity
- Ensure that right-of-ways are planned, designed, funded, and operated with consideration of safe access for users of all ages and mobility and that all users are equally deserving of safe facilities to accommodate their travel
- Encourage the use of the latest design standards
- Allows flexibility in balancing user needs with maintenance needs and temporary snow storage
- Meet implementation and performance standards

Green Streets Policy

The *FMATS Green Streets Policy* was approved by the Policy Committee in June 2016. Resolutions of support were passed by the City of North Pole, the City of Fairbanks, and the Fairbanks North Star Borough. Letters of support were written by the Chena River Front Commission, the Downtown Association, and the Fairbanks Stormwater Advisory Committee.

The *Green Streets Policy* supports an approach that minimizes environmental impact by focusing on efforts to retain, treat, and eliminate stormwater runoff at the source using green infrastructure applications.

Landscaping Policy

The *FMATS Policies and Procedures* document includes a *Landscape Policy* approved by the Policy Committee in September 2017. It specifies that the preferred design approach "provides long-term benefits while minimizing environmental impacts by focusing on efforts to retain, treat, and eliminate runoff at the source using landscaping elements of green infrastructure applications." This policy supplements the *Complete Streets* and *Green Streets* policies. It includes lists of approved plant materials, either native or site-adapted, that appropriate for projects in Fairbanks.

G. Appendices

Definitions

Bio infiltration—Bioretention systems are soil- and plant-based facilities employed to filter and treat runoff from developed areas. Bioretention systems are designed for water infiltration and evapotranspiration, along with pollutant removal by soil filtering, sorption mechanisms, microbial transformations, and other processes.

Gray infrastructure—In the context of stormwater management, gray infrastructure can be thought of as the hard, engineered systems to capture and convey runoff, such as gutters, storm sewers, tunnels, culverts, detention basins, and related systems

Green Infrastructure—Green infrastructure is an approach to wet weather management that use natural systems—or engineered systems that mimic natural processes—to enhance overall environmental quality and provide utility services. As a general principle, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspiration, and/or recycle stormwater runoff. Green Stormwater Infrastructure/Wet Weather Green Infrastructure

Green Roof—Green roofs employ vegetated roof covers, with growing media and plants covering or taking the place of bare membrane, gravel ballast, shingles or tiles. A green roof system is an extension of the existing roof which involves a high-quality water proofing and root repellent system, a drainage system, filter cloth, a lightweight growing medium and plants

Green Streets—A green street is defined as a streetscape designed to: integrate a system of stormwater management within its right-of-way, reduce the amount of runoff into storm sewers, make the best use of the street tree canopy for stormwater interception as well as temperature mitigation and air quality improvement

Impervious Cover—Any surface that cannot be effectively (easily) penetrated by water, thereby resulting in runoff. Examples include pavement (asphalt or concrete), buildings, rooftops, driveways, roadways, parking lots and sidewalks.

Rain Garden—A rain garden is a strategically located low area planted with native vegetation that intercepts runoff. Other terms include mini-wetland, stormwater garden, water quality garden, stormwater marsh, backyard wetland, low swale, wetland biofilter, or bioretention pond. Rain gardens are designed to direct polluted runoff into a low, vegetated area, where the pollutants can be captured and filtered.

Street Trees—When properly designed, traditional tree plantings along street and road edges can capture, in- filtrate, and transpire stormwater. These virtues can be expanded by incorporating trees into more extensively designed "tree pits" that collect and filter stormwater through layers of mulch, soil and plant root systems, where pollutants can be retained, degraded and absorbed.

Stormwater or Runoff—Stormwater runoff is precipitation that becomes polluted once as it flows over driveways, streets, parking lots, construction sites, agricultural fields, lawns, and industrial areas. Pollutants associated with stormwater include oils, grease, sediment, fertilizers, pesticides, herbicides, bacteria, debris and litter. Stormwater washes these pollutants through the storm sewer system and into local streams and drainage basins. In addition, because impervious surfaces prevent precipitation from soaking into the ground, more precipitation becomes runoff, and the additional volumes and velocities of stormwater can scour stream and river channels, creating erosion and sediment problems.

References and Resources

Fairbanks Green Infrastructure Group

Mission: works to renew a cleaner and healthier watershed by making green infrastructure a common practice for home and business owners. Through community support and involvement, the gig promotes sustainable use of our natural environment for the benefit of present and future generations.

- http://www.fairbanksgig.com/

Green Infrastructure Design Manual for Fairbanks, Alaska

- http://forestry.alaska.gov/Assets/pdfs/community/publications/GI_Manual_April_2012.pdf

The Environment Protection Agency

From the basics to the specifics on all things related to Green Infrastructure

- www.epa.gov

Stormwater calculators:

- https://www.epa.gov/water-research/national-stormwater-calculator
- https://www.epa.gov/water-research/storm-water-management-model-swmm

Cost-Benefit Analysis of LID and Green Infrastructure

- https://www.epa.gov/green-infrastructure/green-infrastructure-cost-benefit-resources#costbenefitanalysis

The National Association of City Transportation Officials' *Urban Streets Stormwater Guide*

Policy, Principles, and Procedures for Green Infrastructure

- https://nacto.org/publication/urban-street-stormwater-guide/

Center for Neighborhood Technology and American Rivers

- https://conservationtools.org/library_items/orgs/460

The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental, and Social Benefits

- https://www.vibrantcitieslab.com/resources/a-guide-to-recognizing-the-economic-social-and-environmental-benefits-of-green-infrastructure/

Simplified Example Table of Rational Method Runoff Coefficients	
Ground Cover	Runoff Coefficients (c)
Lawns	0.05 - 0.35
Forest	0.05 - 0.25
Cultivated land	0.08 - 0.41
Meadow	0.1 - 0.5
Parks, cemeteries	0.1 - 0.25
Unimproved areas	0.1 - 0.3
Pasture	0.12 - 0.62
Residential areas	0.3 - 0.75
Business areas	0.5 - 0.95
Industrial areas	0.7 - 0.9
Asphalt streets	0.7 - 0.95
Brick streets	0.75 - 0.85
Roofs	0.7 - 0.95
Concrete streets	0.7 - 0.95

The Fairbanks Green Infrastructure Group (GIG) works to renew a cleaner and healthier watershed by making green infrastructure a common practice for home and business owners. Through community support and involvement, the GIG promotes sustainable use of our natural environment for the benefit of present and future generations.