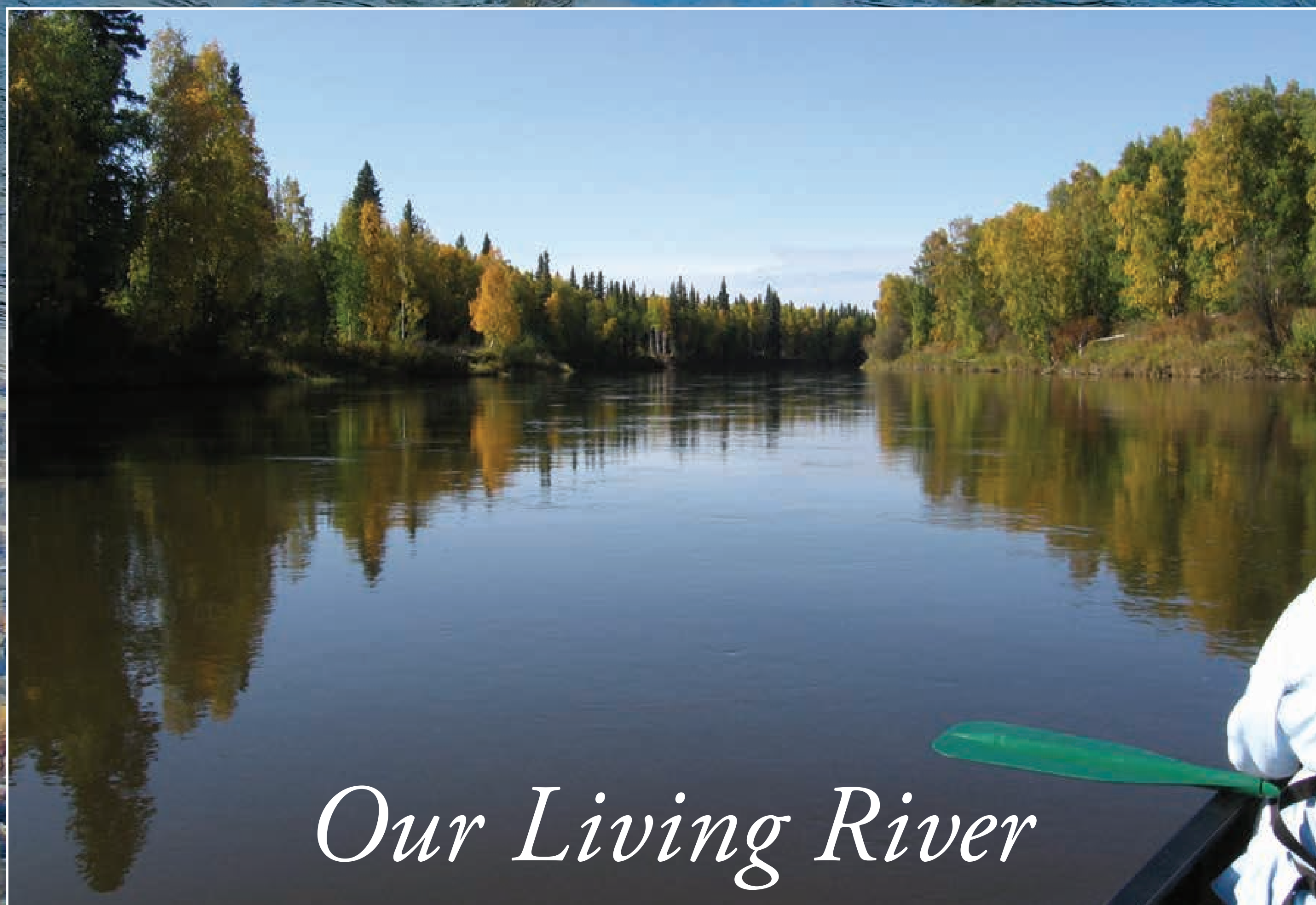
The Chena



Our Living River

The Chena
Our Living River

Acknowledgements

Produced by:
Funding by Alaska Clean Waters Act grant through the Alaska Department of Environmental Conservation ACWA-14-09 awarded to Tanana Valley Watershed Association. This guide was made possible by the generous in-kind donation from Kenai Watershed Forum, Kenai River Center, and Kenai Peninsula Borough. *On the River, A Guide to Owning and Managing Waterfront Property on the KenaiPeninsula* provided the template to produce this book.

Layout and Graphics:
Kathy Lepley, Galaxy Graphics

Contributing Organizations:
Alaska Department of Fish and Game
Chena Riverfront Commission
City of Fairbanks
Fairbanks Green Infrastructure Group
Fairbanks North Star Borough: Community Planning | Parks and Recreation
Fairbanks Soil and Water Conservation District
National Park Service
Tanana Valley Watershed Association
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service
U.S. Bureau of Land Management
University of Alaska Fairbanks

The authors of this guide would like to thank the many individuals who donated their time, energy and talent toward the publication of this book:

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Printed in the United States of America

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Foreword

The Tanana River watershed covers 44,000 square miles of Alaska. The waters of the Tanana River valley have supported civilizations for thousands of years. Today, people are more likely to choose a waterfront home for its stunning beauty than for its abundance of food, but these waters still feed many people. As development in the Fairbanks North Star Borough has boomed, we have learned a few things about how to protect our rivers, lakes and wetlands, and protection for the whole systems they support—including humans. This book is written to introduce you to some of these lessons.

Healthy rivers, lakes and wetlands are vital to healthy economies and good local standards of living. In Fairbanks, Alaska's second largest city, much of the local history, economy and culture is centered on the Chena River, a tributary of the Tanana. Rivers were early transportation corridors that made the founding of Fairbanks and Interior Alaska possible.

Those who live closest to rivers and streams can have the largest direct impact on water quality. Thus, people whose land is on or near the waterfront have a special obligation to take extra care to protect water quality and aquatic habitats. This awareness will protect property values as well as public resources. If you live on or near waterfront property, or care about healthy waterbodies now and in the future, these pages are written for you.

PHOTO © SUSAN PORT

Chena River State Recreation Area encompasses 397 square miles of rivers, forests, and alpine tundra. You can hike, bike, dogsled, ski, horseback ride, skijor, snowmachine, 4-wheel, or snowshoe on over 100 miles of maintained trails.


BROOKS RANGE
SEWARD PENINSULA
Sound
331
Tanana R
Yukon
ALASKA
471
MT McKINLEY
20300 FT
ALASKA RA
Susitna
Bethel
Anchorage
Valdez
Cordova
198
65
Seward

PHOTO © SUSAN PORT

Chapter 1: Water's Journey

To understand your local waterbodies, it helps to appreciate the journey that water takes to get to the river, lake or wetland outside your door, and where that water is headed next. The first thing to realize is that the water you see outside, the water in your body, even the water in your coffee, is the same water that quenched thirsty dinosaurs millions of years ago. Water is a finite resource traveling on a continuous cycle—from clouds to rain and snow, into glaciers, rivers, lakes, oceans, plants and animals, and back to the clouds. Therefore, how we treat our water today affects its quality tomorrow.

Watersheds 101

No matter where you live, you live in a watershed. We all know that water flows downhill. Any precipitation that falls within a watershed, but is not used by existing vegetation, will ultimately seek the lowest points. The Tanana Valley watershed includes all the land from the northern ridges of Mount McKinley to the tundra of the valley; any rivers, streams, lakes and tributaries draining rain, snow or glacial melt into the Tanana River.

Small creeks and sloughs eventually feed large rivers, the small watersheds that drain into creeks are also part of larger watersheds. For instance, if you have a home on the banks of Badger Slough you are in the Badger Slough watershed. Badger Slough empties into the Chena River, which in turn drains into the Tanana River, which then drains into the Yukon River, which means you also live in the Chena River, Tanana Valley, and Yukon River watersheds. Each of these watersheds comprises an increasingly larger area.

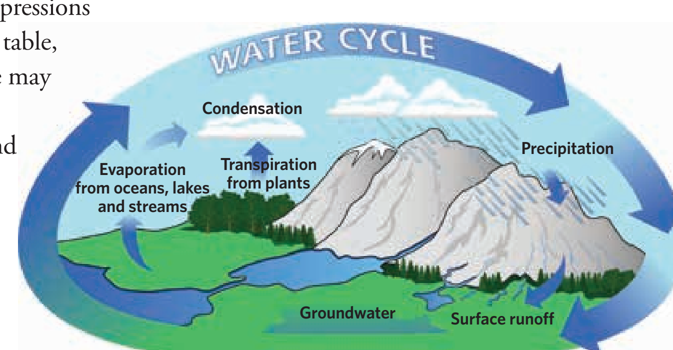
Watersheds are fed by subsurface water, more commonly known as groundwater, as well as surface water. Water can move back and forth between surface and subsurface, sinking into the ground and moving through the soil only to reemerge as a spring or seep. Water can also seep into the ground from rivers and lakes, or can emerge from the ground into lakes and rivers to help recharge them.

The water table is the level below which the soil and rock are saturated with water. Where depressions in the land surface go deeper than the water table, ponds and lakes can form even though there may be no rivers or streams feeding them. The numerous excavated gravel pits in and around the Fairbanks North Star Borough are examples of places where the water table is exposed. Groundwater and surface water are connected, which means anything that affects either usually affects both.

Healthy watersheds are critical for healthy rivers. Those who live closest to rivers and streams can have a large impact on water quality, but so does land use throughout the entire watershed. This book is designed to give you the information and resources you need to take the best care of the stream, river or lake in your home watershed.

Grey Infrastructure, Changing Water's Course

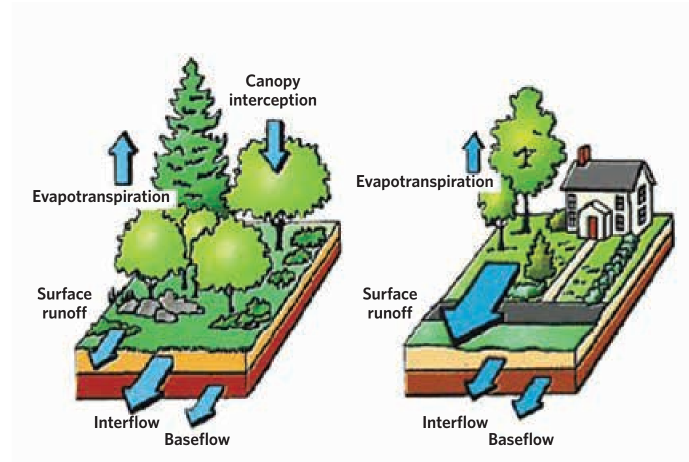
The Chena River begins in the White Mountains east of Fairbanks and flows westerly to the confluence with the Tanana River just past Fairbanks, conveying a large volume of water through both natural and urban landscapes. In the upper watershed—east of Fairbanks, much of the rain water and snowmelt will filter into the forest floor or return to the



atmosphere by evapotranspiration. A smaller portion will travel across the landscape as runoff and drain into the river. In this natural forested environment, the water reaching the Chena River is clean and free of pollutants. Along the lower portion of the river that runs through the center of Fairbanks, however, it is entirely a different story.

In urban areas such as Fairbanks, much of the land surface is covered by buildings, paved streets and parking lots, referred to as gray infrastructure. These surfaces do not allow rain and melting snow to soak into the ground or readily be taken up by vegetation. Instead, the urban area relies on a combination of ditches and a piped storm drain system buried beneath city streets to carry water from these surfaces directly to the river. Living in Fairbanks, you may have noticed some of the 2,500 plus storm drain inlets located throughout the city along the edge of the streets, either in the curb face or bottom of a ditch. And, if you have ever taken a boat ride on the Chena River through Fairbanks, you may have noticed a few of the over 100 outfalls from the piped system protruding out the banks of the river.

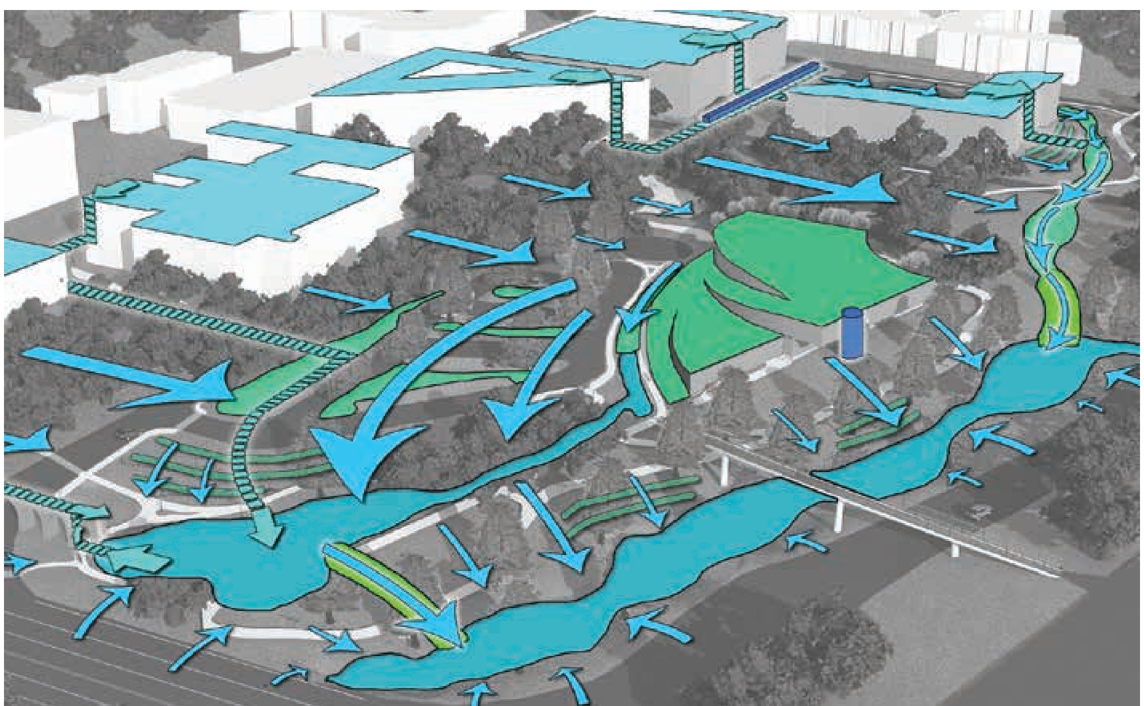
A common misconception among residents is water that flows into these inlets travels to the sewer treatment plant. This is not true in Fairbanks, nor is it true for the majority of cities across the United States. Sewer treatment plants are generally not designed to treat the immense volume of water they would receive from rain and melting snow. In the Fairbanks North Star Borough rainwater is not treated in any way; the rain water travels across roads and parking lots picking up pollutants and this polluted water flows right into the river.



Local hydrologic cycle before construction (left) and after (right).

The purpose of the storm drain system is quite simply to prevent streets, parking lots and building basements from flooding and causing property damage. However, there is also a consequence of this system—water pollution. When water from rain and melting snow travels over the urban area, certain pollutants are picked up by the water and carried to the river. These pollutants can include vehicles fluids, detergents, litter, excess sediment and nutrients, bacteria and various other chemicals—all of which can harm fish and wildlife, kill native vegetation and make recreating on the river unsafe as well as unpleasant.

Currently, in the lower part of the Chena, there are fewer opportunities for slowing down pollutants before they reach the river. Natural landscaping and preserving existing vegetation in strategic areas, such as along streambanks, can help reduce the amount of runoff and pollutants reaching the river, as well as providing important benefits for the fish and other wildlife that share our watershed with us.



Waterflow image from the EPA's Campus Rainworks Challenge.

Polluted runoff from the 21,000 square-foot parking lot at Gordon Wear Park drained directly into the river via this concrete chute.

The city installed this catch basin to receive the runoff and capture some of the sediment and litter before spilling the water down the newly vegetated bank.

With the concrete chute removed, volunteers worked diligently to rehabilitate the river bank with topsoil, grass seed and live willows.

PHOTOS © JACKSON FOX

Gordon Wear Park

The summer of 2013 saw huge improvements along the Chena River at Gordon Wear Park, located on the north bank of the Chena River directly across from downtown Fairbanks. The park has a large parking area for residents and visitors, tables to have a picnic and access to downtown on foot via a pedestrian bridge over the river. However, there were two issues with the park that greatly needed attention. The first issue was that the rainwater runoff, which collects pollutants such as leaking vehicle fluids and litter from the parking lot, drained directly into the river via a concrete chute. The 21,000 square foot parking area receives an average of 10.5 inches of rain a year. That equates to 18,375 cubic feet or 137,455 gallons of rainwater runoff per year, entering the Chena River directly with no filtration to remove pollutants. The second issue was that there was a missing segment of pedestrian pathway between the park and the pedestrian bridge. This meant pedestrians had to enter the busy parking lot to get to the next section of path. Our goal was to eliminate the danger to pedestrians and improve the quality of the water entering into the Chena River.

In August 2013 a collaborative effort by the City of Fairbanks Public Works Department, Alaska Department of Transportation and Public Facilities Maintenance Division, Tanana Valley Watershed Association, Student Conservation Association, U.S. Fish and Wildlife Service, Wounded Warrior Project, and Fairbanks Soil and Water Conservation District Youth Corps crew implemented improvements. First, the concrete chute was removed from the river bank and a catch basin for the runoff was installed. Then, approximately 125 feet of new concrete pathway was poured. To fortify the bank of the river 40 feet of riparian area was rehabilitated with new soil and 70 willow shoots were hand-dug and replanted along the riverbank. The roots from these trees will help stabilize the bank and filter the water as it passes through the soil. It was an amazing effort accomplished in just one week's time by a diverse partnership in a high use area. Educational signage will also be installed in the spring of 2014.


PHOTO © SUSAN PORT

Chapter 2: Rain to Rivers

The Power of Runoff

Over the past 100 years, the city of Fairbanks has grown rapidly from a small mining camp to a buzzing metropolis of over 35,000 people. As Fairbanks has become more urbanized, the quantity of runoff has increased while the quality of the water has degraded. Impervious surfaces, such as paved parking lots, roads and rooftops have increased while natural forest and pervious land that water can filter through have decreased. An increase in impervious surfaces prevents part of the water cycle by blocking movement between surface and groundwater. Instead, more water becomes runoff carrying pollutants directly into local waterbodies.

Water pollution can come from in-water sources, such as fuel from boats, ground water sources or surface water runoff which picks up pollutants as it flows over the ground and ends up in rivers, lakes and sloughs. With the increase in paved surfaces and the decrease in vegetation, pollutant sources may be miles away from the waterbodies they end up in.

Because all the water in a watershed eventually drains to the same body of water, cumulative impacts are a serious concern. A small amount of pollution in any given area may seem insignificant, but when all the various pollutants over the entire watershed are added together, the picture drastically changes. The combined effect of many sources may result in detrimental effects on water quality and environmental health.

According to the Fairbanks and North Pole Storm Water Management Program Guide (City of Fairbanks and City of North Pole, 2010) "the main pollutants of concern from residential land use are sediments, oil and grease, solvents and detergents, litter and debris, pesticides and fertilizers, nutrients, and pathogens." Green Infrastructure applications offer an easy and cost effective way for community members to become involved in improved local water quality.

The pollutants in runoff have a variety of negative effects. Antifreeze, detergents and other chemicals can be toxic to fish and wildlife. Excess sediment from construction sites and landscaping and gardening activities can cloud the river, making it difficult for sunlight to reach aquatic plants, as well as smothering fish eggs that lay on the bottom of the riverbed. Litter is unsightly for recreational users, and can also be hazardous to fish and wildlife, especially plastics such as six-pack rings. Grass clippings and fertilizers introduce nutrients that in excess can lead to algal growth and depletion of dissolved oxygen. Pet waste harbors bacteria that may pose health risks to fish, wildlife and recreational users of the river.

Green Infrastructure Principles

Many communities in the United States are looking for ways to reduce stormwater discharge from rainfall and snow melt, many have recognized the effectiveness of diverting stormwater from the sewer system and directing it to areas where it can be infiltrated, evaporated or re-used. These approaches seek alternatives to pipes, pumps, storage tunnels and other "hard infrastructure" that is traditionally used to store and channel stormwater. By reducing stormwater discharge, we can help to restore the natural hydrology, water quality and habitat of urban and suburban watersheds.

A Green Infrastructure (GI) approach is aptly named because soil and vegetation are used to manage stormwater though principles such as preserving and recreating natural landscape features. Imperviousness is minimized to create a functional drainage system that treats stormwater as a resource rather than a waste product. There are many applications currently in use in the Fairbanks North Star Borough including green roofs, rain gardens, vegetated swales, infiltration planters, vegetated median strips, reforestation and riparian buffers.

GI can be used almost anywhere where soil and vegetation can be worked into the urban or suburban landscape and is most effective when supplemented

BMP Project	Cost Estimate	Time Estimate (Days)	Ease of Installation	Runoff Volume Reduction (%)	Maintenance Level
Rain Barrel	$70 - $200	1	Easy	40	Moderate
Rain Garden	$10 - $15 per sq ft	1 - 3	Moderate	40 - 80	Moderate
Tree Pit	$10 - $100	1	Easy	50 - 90	Low
Infiltration and Flow-Through Planter	$60 - $250	1 - 2	Moderate	50 - 90	Moderate
Dry Well	$10 - $20	1 - 2	Moderate	50 - 90	Moderate
Swales and Berms	$3 - $7 per sq ft	1 - 3	Moderate	40 - 60	Moderate
Green Roof	$20 per sq ft	5 - 10	Difficult	45 - 60	Low
Permeable Paver	$10 per sq ft	1 - 2	Moderate	45 - 75	Low
Grass Protection Mesh	$1.25 per sq ft	1	Easy	10 - 20	Low
Riparian Forest Buffer	$300 - $1000	1 - 4	Moderate	10 - 20	Low

The best management practices (BMPs) were derived from the *Technical Memorandum: The Runoff Reduction Method* (Hirschman and Collins, 2008) to include materials needed, equipment rentals, shipping costs and runoff volume percentages.

with other decentralized storage and infiltration approaches, such as the use of permeable pavement and rain barrels to capture and re-use rainfall for watering plants or flushing toilets. These approaches can be used to keep rainwater out of the sewer system so that it does not contribute to the amount of untreated stormwater discharging to surface waters. These practices also allow stormwater to be absorbed and cleansed by soil and vegetation and either re-used or allowed to flow back into groundwater or surface water resources. By managing water in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed, we can maintain or restore a watershed's hydrologic and ecological functions.

This next section explores how to apply GI practices to your home or business property. Examples include rain barrels, rain gardens, green roofs, permeable pavers and an array of rainwater harvesting systems for non-potable uses such as gardening, lawn irrigation and even toilet flushing. For a full how-to guide, see the *Green Infrastructure Resource Guide for Fairbanks, Alaska.*

Green Infrastructure Practices

It's important to note the climate in Interior Alaska presents unique challenges including infrequent, but heavy rains, a brief growing season, as well as permafrost and other frozen ground conditions. Classified as subarctic, Interior residents experience some of the largest and most extreme climatic variations in North America. The GI applications presented here have been evaluated for use specifically in Fairbanks conditions. Many of the GI applications used in other states are simply not suitable for our climate.

On a residential or small business scale, there are many easy ways to manage rain water and snow melt runoff to help prevent water pollution and improve water quality through implementation of GI applications that protect, restore and mimic the natural water cycle. Although the annual rates of precipitation in the watershed are relatively low (an average of 10 inches), sudden storms and snow melt have the potential to cause significant runoff and flooding. GI applications help manage rain water through increasing infiltration, evapotranspiration, capture and reuse of water from rain and melting snow. These applications are simple, cost-effective, sustainable and friendly to the environment.

Do It Yourself

Rain Barrels – Even if rain does not overflow in your yard or puddle in the driveway, a rain barrel is a low cost, high return, investment. By capturing water from your roof via gutters, you'll save for watering your lawn, outdoor plants and garden when it's not raining. (Please note that water collected in rain barrels is not safe to drink.)

Rain Gardens – Do you have a low section of land on your property? Consider transforming it from a muddy mess to a productive rain garden. By planting the space with native water-tolerant plants, you can absorb rainfall and filter out harmful chemicals, diverting runoff from your home's gutter.

Tree Pits – By planting in gravel lined pits and leaving a shallow depression around the base of your tree, you can divert rainwater runoff and water your tree in one simple design.

Infiltration and Flow-through Planters – Consider a flow-through planter (think flower box with a gutter system running through it) with an impervious bottom and a porous pipe that drains the water after it has been filtered by the plants and soil. Another type is an infiltration planter with a pervious bottom that allows water to infiltrate the ground below. These types of planters require less watering, provide filtration of pollutants, and are suitable in areas with limited space.

Dry Well – Have trouble with flooding? A dry well is an underground structure that dissipates runoff from rainwater. A dry well is composed of a perforated pipe that directs roof runoff into a small pit lined with gravel, helping filter harmful chemicals and redirecting rainfall away from your home.

Swales and Berms – A vegetated swale is a grass-lined depression that uses plants to slow down runoff water and helps the water infiltrate the soil. They can be used to redirect runoff into other GI retaining projects like rain gardens, tree pits or dry wells. Berms are low earthen walls adjacent to ditches that can be used to help retain runoff in a designated area along the downhill side of the desired location.

Green Roofs – A green roof is completely or partially covered with vegetation over several layers of waterproof membrane, root barrier and a drainage board. The two basic types of green roofs are extensive and intensive. An extensive roof has a layer of growth that is six inches or less, supporting grasses and some small shrubs. An intensive roof has a six to twenty four inch layer of growth and can support larger shrubs and trees.

Permeable Pavers – Consider using porous concrete blocks for driveways, paths and sidewalks that allow water to pass through them into the soil. This allows any waste or chemicals to soak into the ground and filter through the dirt and gravel layers, rather than flush into the stormwater drain.

Grass Reinforced Mesh – Muddy yard? A polyethylene grid placed directly on grass and secured with metal U-Pins or plastic pegs, helps stabilize grass to handle more traffic without damage. There are several grades of mesh, some of which are suitable for driving on or vehicle parking.

By using GI approaches to reduce runoff and preserve natural open space throughout our watershed in neighborhoods, we are impacting our watershed's native ecosystem in a positive way. Small scale projects facilitate large scale improvements by connecting residents with nature and creating an urban environment supporting habitat for birds, mammals, amphibians, and insects.

A variety of types of rain barrels are available, from simple garbage cans, wooden, galvanized, ceramic clay or decorative plastic pictured, your needs and budget will determined which is the right application for your project.


PHOTO © SUSAN PORT

Chapter 3: Habitats and Inhabitants

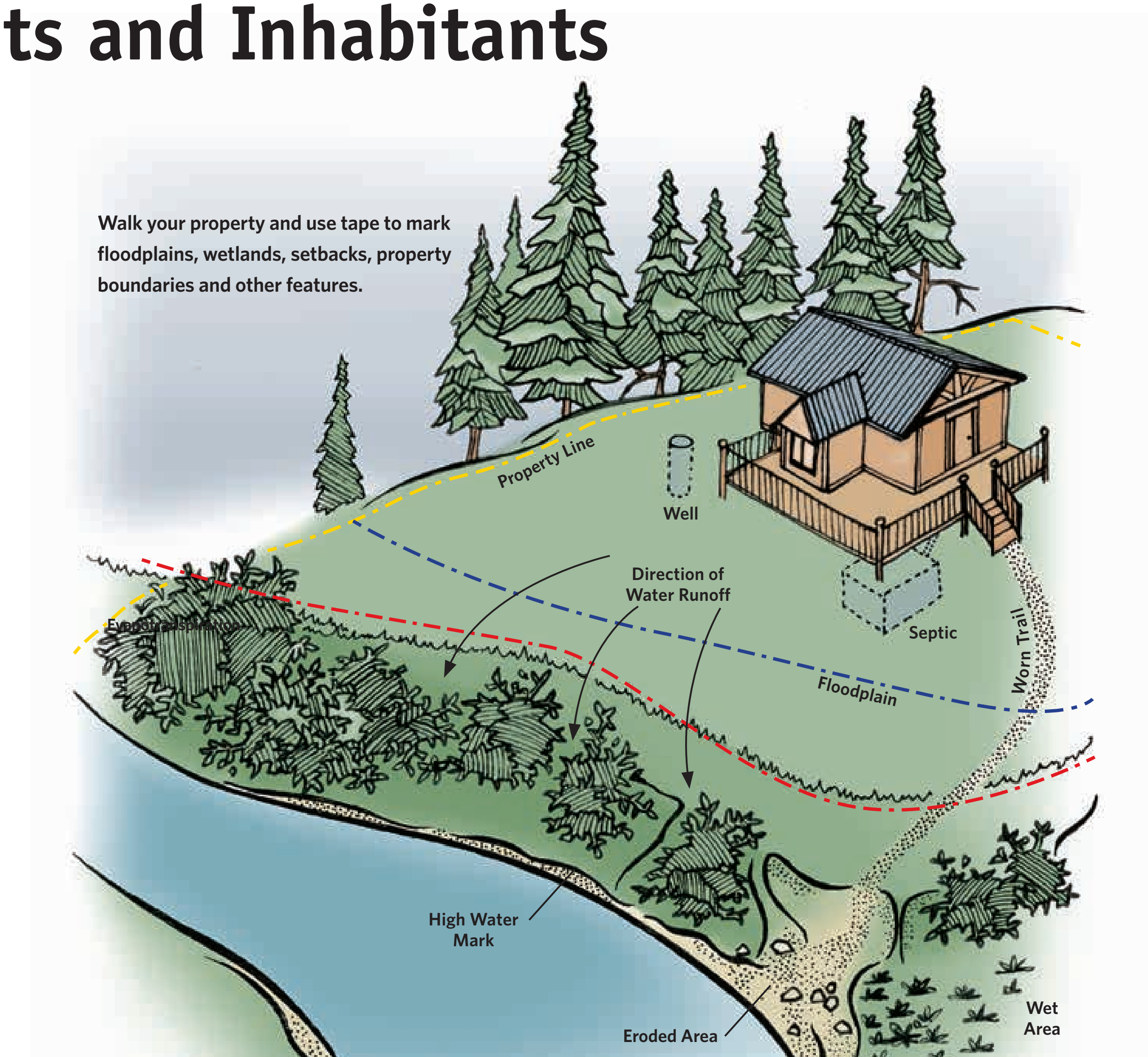
Wild Neighbors

Living near water often means sharing your property with wildlife, both in and near the water. Small fish and aquatic insects rely on slower water and overhanging vegetation for shelter, while other animals come to the water to drink and use vegetated riparian areas for shelter and as travel corridors. Riparian areas or 'zones' are the areas that interface between the land and a river or stream.

In the floodplain forests of the Tanana River watershed, riparian areas have been shown to support water-dependent animals such as beaver, mink, otter and water shrew. Other mammals that depend on early successional vegetation of riparian areas for food include moose, snowshoe hare and yellow-cheeked voles.[1] Bird species, such as peregrine falcons, bald eagles, waterfowl and shorebirds use the floodplains of the Tanana River watershed for foraging and or nesting.[2]

Wild animals are vital to the Alaskan landscape. As more people move into and develop wild habitat, it becomes increasingly important to find a balance that allows humans and animals to coexist. Just a few simple steps can make you a good neighbor to wildlife.

When planting, choose species that are native to the area. Remember that smaller lawns with surrounding



[1] Coles-Ritchie

[2] Magoun and Dean, 2000

trees are more wildlife friendly than large grass expanses. As an extra benefit, they also cut down on the time and expense for maintenance and offer more privacy.

You can be a good neighbor to fish by maintaining overhanging vegetation along your waterfront and by leaving downed trees and other woody debris in the water, where it provides small fish (including young salmon) with critical protection from predators. Minimize or avoid the use of chemical fertilizers and herbicides on your lawn. These can leach or be washed into lakes and streams, harming aquatic life.

Always remember that no matter how often you see them or how comfortable they may appear to be around your home, wild animals are wild. Being a good neighbor means helping them stay that way.

Along the Edge

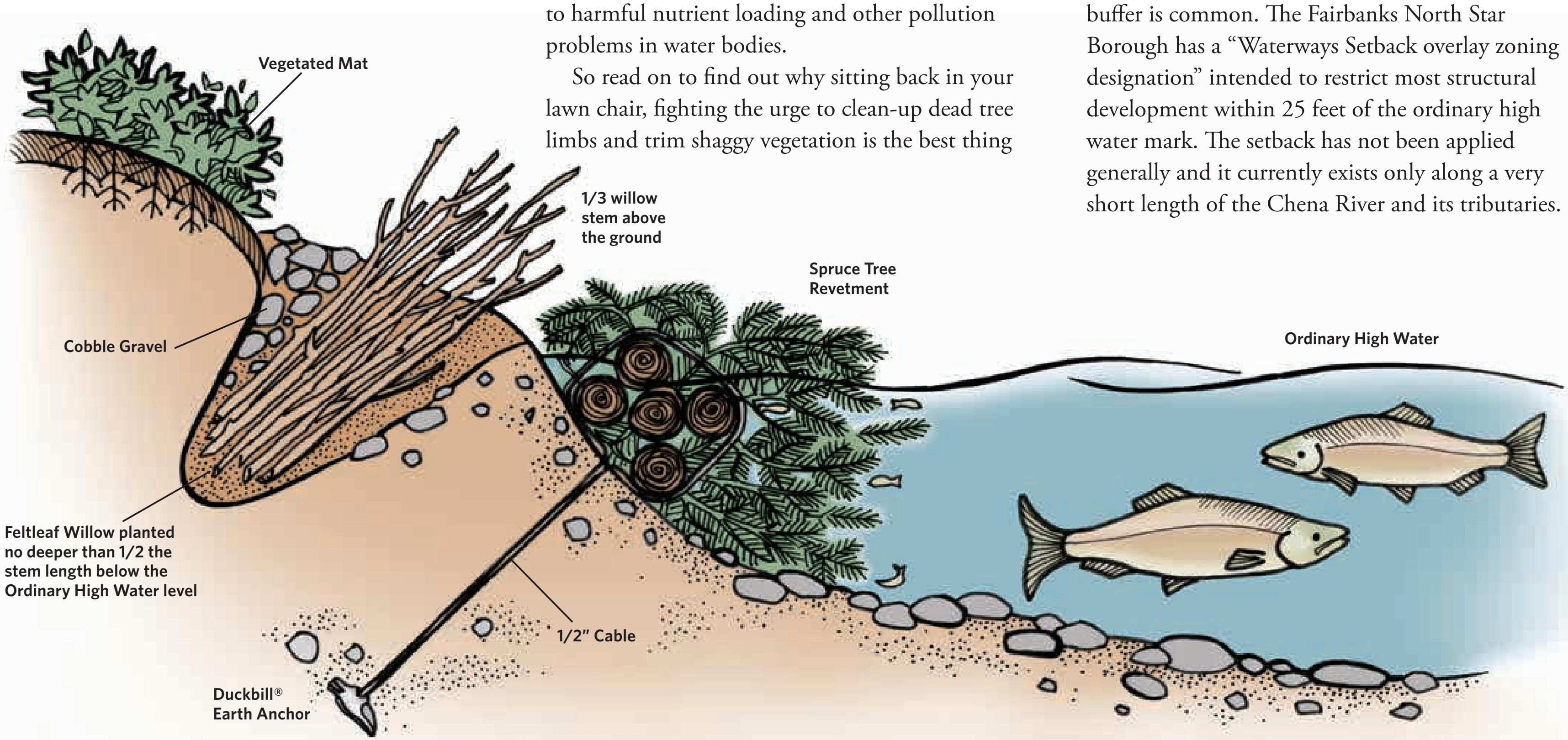
Nothing is more important for maintaining the health of your river or lake and the value of your property than the riparian zone, the land along the edge of a water body. The word riparian can refer specifically to the edges of rivers, but the principles discussed here apply to rivers, lakes and coastlines.

One of the easiest, and yet most important, things you can do to protect wildlife habitat is to choose wildlife-friendly landscaping. Maintain as much natural vegetation as possible on your property. Leave vegetated buffer strips near the water and along wildlife travel routes. In short, a clean and tidy lawn makes for dirty lakes and rivers, because fertilizing and mowing turf grass contribute to harmful nutrient loading and other pollution problems in water bodies.

So read on to find out why sitting back in your lawn chair, fighting the urge to clean-up dead tree limbs and trim shaggy vegetation is the best thing you can do for fish, wildlife and your property.

Healthy riparian vegetation stabilizes banks. Roots, and the community of microbes associated with them, bind soil together and strengthen it against the erosive forces of water and wind. A naturally vegetated bank not only stabilizes the soil, but may allow natural undercutting of the bank. These undercut banks provide shelter for various fish species by providing cover from predators as well as reduced water velocities. A highly vegetated bank, even with some undercutting, is much more stable during high flow conditions than banks with reduced vegetation.

Of the municipalities and boroughs in Alaska that have riparian buffer policies, a 50-foot riparian buffer is common. The Fairbanks North Star Borough has a “Waterways Setback overlay zoning designation” intended to restrict most structural development within 25 feet of the ordinary high water mark. The setback has not been applied generally and it currently exists only along a very short length of the Chena River and its tributaries.



Spruce tree revetments, willow plantings and vegetated mat are three commonly used methods to slow erosion and stabilize banks.

Carlson Center Project

Since the early 1990's, the Alaska Department of Fish and Game (ADF&G), in partnership with other local, state and federal agencies has worked to protect and revegetate along rivers across the state using bioengineering techniques. Typically these techniques reinforce riverbanks, by reestablishing natural ecological structure and function (planting native vegetation) consequently reducing bank erosion and adding improved fish and wildlife habitat. In 1995, Gay Muhlberg (ADF&G) and Nancy Moore (Alaska Department of Natural Resources) authored the original ADF&G guide, *Streambank Revegetation and Protection: A Guide for Alaska,* most recently revised in 2005. During September 2012 a project using techniques from this guide was implemented along an eroded section of river bank of the Chena River. The project was located on the south bank adjacent to the community bicycle path at the Carlson Center. Various partners worked together to plant over 1,200 dormant willows with a technique known as live siltation. The technique was used to secure the toe of a slope, trap sediment and create fish rearing habitat. Sixty feet of bank have been transformed into a living brushy system at the water's edge, providing cover and fish habitat while other revegetation plantings become established. This project demonstrates how bioengineering techniques create attractive scenery, while improving water quality, fish habitat and stability of this section of the riverbank.

PHOTOS © JEWELZ BARKER

Placement of homes and other structures too close to a river can result in the undermining of the structure over time. Clearing of vegetation also hastens the loss of stream bank from erosion.

Not all vegetation acts as a riparian buffer equally. Native trees, shrubs, wildflowers and grasses are the best choice because they are adapted to local conditions, such as the soil, temperature variations and amounts of rainfall and sunlight. Native plants also provide excellent habitat for fish and wildlife. Some animals live in or near riparian zones (including several species of salmon fry, like Chinook salmon in the Chena River); others are just passing through. They use the riparian area for drinking, feeding, traveling, resting or hiding from predators. Overhanging vegetation along shorelines is important not only as cover for fish, but often is a source of food items, such as insects that find refuge within this vegetation. If you want to watch birds and mammals around your home and enjoy fishing from your property, then it helps to make sure your land is fish and wildlife friendly.

Bioengineering vs. Streambank Hardening

Bioengineering is a technique that involves using plant material (bio) and mechanical elements (engineering) to control erosion and make riverbanks more stable. These techniques have the benefit of mimicking natural systems, including the self-sustaining characteristic of riparian vegetation. Some examples of bioengineering activities include brush mattress, brush layering, wattling bundles, dormant willow post method, vegetative geogrid (fabric encapsulated soil), coir rolls and mats made from coconut or other fibers and logs/root wads. Bioengineering techniques are already being implemented in the Fairbanks North Star Borough.

For more information on bioengineering, see:

- *Streambank Revegetation and Protection: A Guide for Alaska* (Walter et al. 2005) Presents techniques (with diagrams and photos) to prevent erosion and help revegetate streambanks in Alaska.
- *Field Guide for the Identification and Use of Common Riparian Woody Plants of the Intermountain West and Pacific Northwest Regions* (Hoag et al. 2008) Provides information about species that can be used for bank stabilization.

Streambank hardening is a way to stabilize banks and prevent erosion using rigid, generally inorganic materials like concrete. In the early 1900's, as the United States became more mechanized, the historical use of soil and vegetation to stabilize banks was practically abandoned as rigid stabilization materials such as rock, steel and concrete became more readily available. These techniques are referred to as streambank or shoreline hardening. In the early years of Fairbanks many "hard" items were used in efforts to stabilize the riverbanks. Floating down the Chena River today, one can still see cars, bathtubs and scrap metal emerging from the banks. More recent bank hardening has included more aesthetic material such as rock, rip-rap and keystone blocks. The purpose of bank hardening is to deflect erosion and protect land, but this occurs at the cost of the removal of vegetation, which removes benefits such as stream shading, organic inputs, habitat for fish and wildlife, sediment trapping, pollutant filtering and deflected flow. Additionally, bank hardening in one location can cause greater stream velocities and greater erosion from the deflected flow to properties downstream.

Stream Crossings

Another issue related to protecting the water's edge is how you cross a creek or stream on your property. Poorly designed stream crossings often result in perched culverts. Culverts that are too small or too high for stream flows not only prevent salmon from migrating upstream to spawning grounds, but are also destined to wash out during high water. Repairing a washed out road is more costly and inconvenient than installing a well-designed crossing in the first place, so it pays to get assistance in designing any stream crossings.

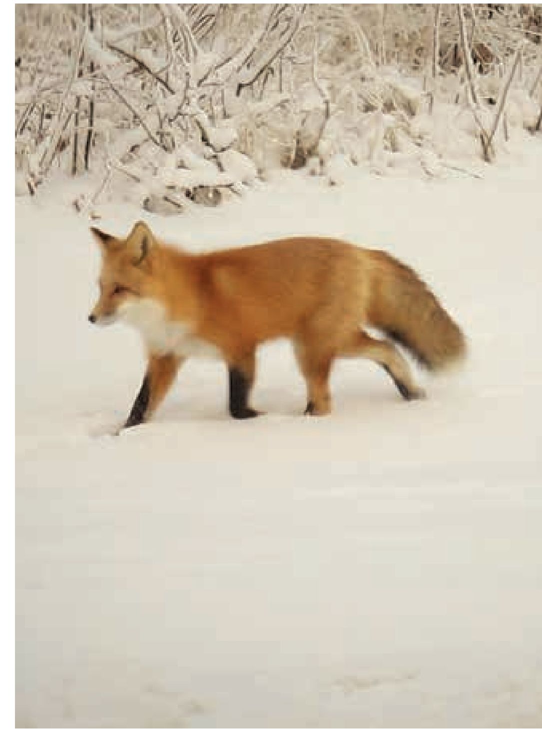
Driving through creeks or other drainages, no matter how small, destroys fish habitat, contributes to erosion and pollution, as well as can leave you stranded when high water comes. To ensure safe crossings and healthy habitat, the Alaska Office of Habitat Management and Permitting requires that a permit be obtained for stream crossings and culvert placement. The U.S. Department of Fish and Game as well as Fish and Wildlife have cost share culvert replacement programs.

Driving vehicles through creeks destroys fish habitat, affecting salmon, grayling and other fish such as sculpin.

Green Spaces

Just as growing communities need to upgrade and expand their built infrastructure of roads, sewers and utilities, they also need to upgrade and expand their green infrastructure, the interconnected system of green spaces that conserves natural ecosystem values and functions, sustains clear air and water, and provides a wide array of benefits to people and wildlife. Large scale GI is a community's natural life support system, the ecological framework needed for environmental and economic sustainability. By planning and managing urban parks as parts of an interconnected green space system, communities can protect biological diversity and preserve essential ecological functions while serving as a place for recreation and civic engagement. Keep in mind our wild neighbors are valued by most Interior residents.

Green spaces are designed to preventing development of the area and allowing wildlife to return and be established. Many of the benefits are shared by humans, fish, furry and feathered residents:



PHOTOS © SUSAN PORT

Many animals depend on green spaces for use as contiguous cooridors year round.

- Protect natural or semi-natural environments
- Improve air quality within urban areas
- Ensure that urban dwellers have access to countryside, with consequent educational and recreational opportunities
- Protect the unique character of rural communities that might otherwise be absorbed by expanding suburbs
- Walking, camping, and biking areas close to the cities and towns
- Contiguous habitat network for wild plants, animals and wildlife and
- Cleaner air and water


PHOTO © SUSAN PORT

Chapter 4: More about Rivers, Lakes and Wetlands

"Rivers run through our history and folklore, and link us as a people. They nourish and refresh us and provide a home for dazzling varieties of fish and wildlife and trees and plants of every sort. We are a nation rich in rivers."—Charles Kuralt

Ever Changing Rivers

A familiar river can feel like a dependable friend, reassuring in its stability. However, one flood or drought quickly reminds us that rivers are dynamic systems. Here we will discuss how seasons, climate and substrate all affect how rivers change over time. Rivers change both seasonally and over the course of years. In the Tanana Valley, water levels drop dramatically in the drier, colder winter months and rise with the rain and melting glaciers, ice and snow of spring and summer. How a river responds to changes in water levels depends in part on what type of river it is. In the Tanana Valley, some rivers and streams like Goldstream Creek and the Chena River are clear streams fed by snowmelt, rain events, and subsurface water. These have single-thread channels that are relatively stable, with peat or gravelly beds. Other rivers, like the Tanana and Delta Rivers, are glacial-fed with high siltloads. They have gravelly, braided channels that migrate frequently and sometimes rapidly. The banks of the Tanana are subject to a great deal of natural erosion. To understand the different factors at work, we will compare the Tanana River and the Chena River.

Tanana River – The Tanana River flows northwestward approximately 531 river miles from its headwaters near Northway, Alaska to the Yukon River near the town of Tanana. Its path flows out of the Alaska Range toward the foothills north of Fairbanks. The Tanana has been forced into this position along the north edge of its valley by the extensive alluvial outwash from the glacier-fed streams of the Alaska Range.[3] Glacial-fed tributaries drain northward from the Alaska Range and nonglacial streams drain southward from the Yukon-Tanana Uplands.

In some sections of the Tanana, like the area downstream of Fairbanks, the river naturally migrates across a wide floodplain with one or more major channels and stable, vegetated islands. Soils on the floodplain are a mixture of alluvial deposits and colluvial material from the uplands. Vegetation communities are largely primary successional stands on riverbars that form during repeated periods of high water. In other sections of the Tanana, like the area upstream of Fairbanks, the river can easily cut back and forth through this loose material, forming a series of constantly shifting, braided channels and unstable, unvegetated gravel bars and multiple channels. In places, the river runs through steep, high banks that provide no room to dissipate flood flows. These constrictions force the river to flow faster, which in turn makes it more likely to erode the banks in these sections.[4]

The Tanana River is primarily of glacial origins, with 85% of its flow coming from the glacial-fed tributaries flowing out of the Alaska Range.[5] The Tanana is an alluvial river, meaning that it carries a heavy sediment load. Fairbanks, Alaska is built on the alluvial plain of the Chena and Tanana Rivers. Such areas are poorly consolidated and susceptible to erosion. Keep this in mind when considering development in these areas.

Chena River – The Chena River is a clear water river. It carries less sediment than glacier-fed rivers, so sediment deposition and point-bar development are less pronounced. The Chena is fed by precipitation and subsurface flows.

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[3] Excerpted from "A Review of Riparian Functions and Management Focused on the Fairbanks North Star Borough," Marc Coles-Ritchie, PhD, March 2009

[4] Excerpted from "A Review of Riparian Functions and Management Focused on the Fairbanks North Star Borough," Marc Coles-Ritchie, PhD, March 2009

[5] Yarie et al. 1998

Looney Tunes

Many Alaska residents and visitors feel that they are officially in northern latitudes when they hear the calls of the Common Loon. These territorial, cautious birds have many vocalizations to communicate with each other and with us.

The **HOOT** is a soft, short contact call between birds. Adults hoot at each other, and parents hoot to chicks. It is their way of saying, "Hey, I'm over here."

Loons **WAIL** in situations when loons want to move closer to each other. It is a long, one, two, or three-note vocalization. Parents use it when they want their chicks to approach the parents for food, emerge from a hiding place, or follow them when they leave the nest.

The **TREMOLO** is a loud call that brings to mind a loon laughing. It is, however, an alarm call in threatening situations. A loon might use the tremolo to tell a person that his boat is too close. Loons in flight will use this call, and sometimes you can hear a pair calling the tremolo song as a duet.

Only male loons produce a **YODEL**. This call is used in territorial situations and aggressive encounters with other birds. A yodeling loon extends his head and neck and flattens his body so his lower bill is just above the water.

Even chicks have various sounds for different situations. Hungry chicks will peep to their parents and peck on their bills. Getting separated from parents is a scary situation for a chick, so it will peep, yelp and wail. The parents respond by moving closer, and may hoot to comfort the chick or wail to have the chick move closer.

Reprinted from Lake Tides,
Volume 28, No. 3—Summer 2003

Glacial Streams

You have probably noticed another feature of some Tanana Valley Watershed streams—many of them are gray and cloudy. These are glacial streams, meaning that they receive at least some of their water from melting glaciers. "Glacial flour" is rock that has literally been ground to powder by the movement of glaciers; as glaciers melt, the flour is released with the water, giving glacial streams their gray, blue or turquoise color. Glacial rivers are also cold, both because of their source and because warm sunlight cannot penetrate the cloudy water easily. In contrast, clear water streams are fed by springs, rainfall and surface runoff. They carry lower sediment loads and are generally warmer than glacial streams.

River Hydraulics

Rivers are complex systems. Water does not simply flow downstream in a straight line; it moves from side to side, in spirals, and occasionally it even moves upstream. Different segments and different depths of the river move at different speeds. All these movements cause the river channel itself to move over time.

To understand river hydraulics, you must appreciate how a river meanders, or bends, in its channel (see graphic on page 16). The outside bend is subject to much higher velocities of water movement than the inside bend, which translates to more erosive power. Outside bends tend to also have what are known as cut banks, which are steeper than the banks on inside bends. Cut banks continually erode at much higher rates than the inside banks. Inside bends, by contrast, are where water slows down, loses carrying capacity and drops some of its sediment. This material accumulates along the inside bank, forming a point bar. During floods, land along outside bends will be eroded much more forcefully than that along inside bends. This continual erosion and deposition is why river channels meander more and more as they age. Having property located along a relatively straight stretch does not mean that there will not be erosion or deposition along the riverbanks. Even in straight stretches water moves side-to-side as well as downstream. Objects in the water such as docks, rocks, stairs and moored boats also affect how water moves and thus change erosion and deposition patterns.

Permafrost

Permafrost is soil or subsoil that remains permanently frozen year round. Permafrost plays a big role in the Tanana River Basin, where it is present in approximately one-third to one-half of the area. Permafrost is insulated by forest cover and vegetation, which also prevent the sun's rays from warming the soil. It is important to be careful when removing vegetation along rivers because when you do this you may cause the permafrost to melt and the banks to erode.

Wave Action

Waves are more often associated with coastal areas, but they can be a powerful force on river and lakefront properties as well. Generated naturally by wind or by human sources such as boats and floatplanes, waves can have very powerful erosive effects on river and lake banks. Boat wakes and waves vary in size according to speed, boat load, hull shape and other factors. Generally, the bigger the wave, the more erosive power it has. Evidence of boat wake erosion is prevalent along the Chena River. Responsible boat use and healthy bank vegetation can protect banks from waves. Placement of homes and other structures too close to a river can result in the undermining of the structure over time. Remember that effects are cumulative: the effects of waves striking a bank are compounded by the effects of bank trampling, vegetation loss, bank hardening upstream and so on.

Ice

Rivers are slower to ice over and quicker to thaw than lakes and create special situations, such as breakup and overflow, which can be dangerous. Breakup refers to the melting of ice in the spring. It is often a gradual process, but it can occur suddenly, especially on rivers whose upper reaches thaw before downstream areas. A sudden rush of water from upstream can float the ice cover, breaking it free of its banks. This ice can break into pieces, which may then travel quickly downstream, scouring the banks and channel. The chunks of ice may also become wedged into an ice jam that blocks the channel and backs water up behind it, causing flooding.

Overflow

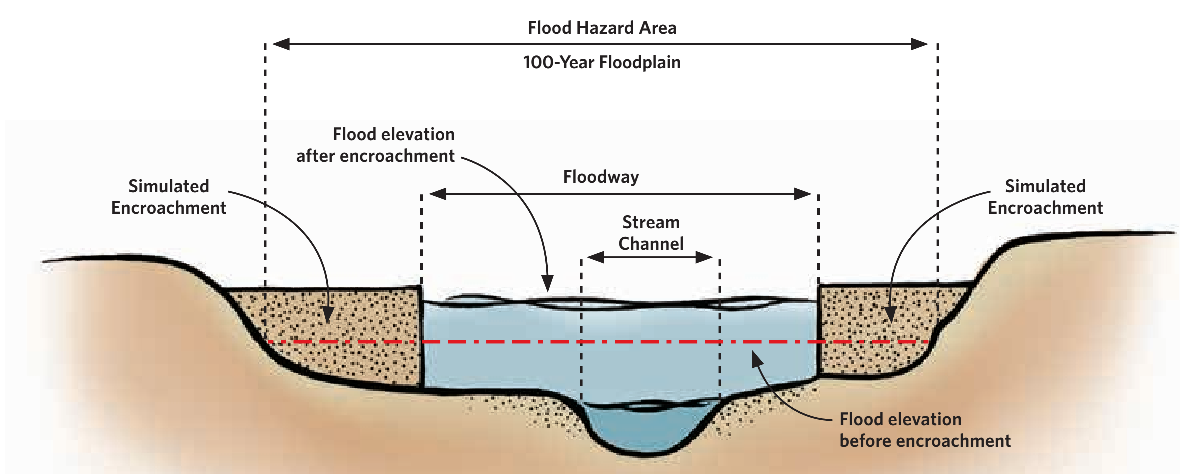
Overflow occurs when water from the river is forced up and over the surface ice, so that it is flowing on top of the ice. This water is at or barely above the freezing point and will quickly freeze to the clothing of anyone who steps or falls into it. In addition, it often has a slushy consistency and can bog down vehicles such as snowmachines or people who attempt to travel through it. Remember that ice conditions are rarely uniform across any body of water and that snow can act as an insulator, keeping ice thin even if air temperatures have been well below freezing. River ice is generally much more variable than lake ice.

Floods

Floods can occur from high rainfall, ice jams forming on the river, rapid spring melting from a large snowpack, or failure of ice dams that hold back glacial lakes. The amount of warning you will have before floodwaters arrive depends on where you live on the river, the type of event, time of day and so on. Since you might not have much time to prepare, always manage your property with floods in mind to minimize danger, damage and clean-up.

Floodplains

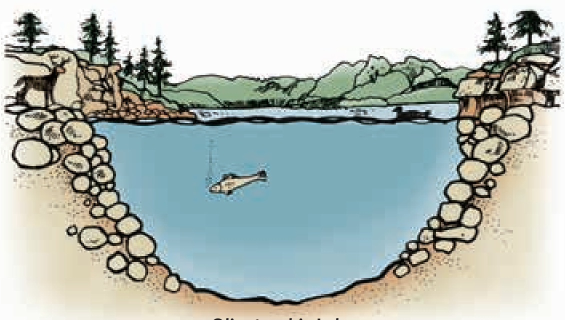
The floodplain is the area of land bordering a river that is susceptible to inundation during flood events. Structures built in floodplains are thus prone to damage during a flood. Rivers may have a broad 100-year floodplain with relatively smaller 50-year, 20-year and 10-year floodplains. How wide a floodplain is at a given spot depends on the size of the river and the topography of the surrounding land. The Fairbanks North Star Borough Planning



This illustration shows how an encroachment within the floodplain increases the elevation of floodwaters.
Source: Alaska Department of Commerce, Community and Economic Development

Department has a Floodplain Administrator who can help property owners determine floodplain boundaries and assist with permitting and construction questions within the floodplain.

"Ten year floods," "one-hundred year floods," and so on, do not mean that these flood events happen only every ten or one hundred years. Rather, a ten-year flood level is reached on average every ten years. Thus, there is a 10 percent chance that floodwaters may



Oligotrophic Lake

Mesotrophic Lake

Eutrophic Lake

reach that level in any given year—possibly more than once. The fact that there was a hundred-year flood a few years ago does not mean another won't occur soon.

Flooding becomes more common due to:

- Loss of wetlands. Their flood-reducing capabilities are often decreased by development.
- Increased development along the riverbank. This leads to hardened channels and increased water velocity and erosion.
- Loss of near shore vegetation, which when left in place naturally slows water velocity, reducing erosion.

Floodwater storage occurs in riparian areas because they act as a sponge and capture and store water during high flows. Over time some of the water is released back to the stream, which for small or dryland streams helps maintain perennial flows.

Anadromous Waters

In the Tanana River Valley, many rivers and lakes share one vital component: they are home to salmon. Fish that hatch in fresh water, migrate to salt water, where they spend most of their lives, and then return to fresh water to spawn are called anadromous fish. Rivers and lakes that these fish use as habitat are referred to as anadromous as well. All salmon species, as well as sea run Dolly Varden, steelhead trout, eulachon and longfin smelt, are anadromous fish. Anadromous rivers, lakes and streams may provide spawning habitat, rearing habitat or both. These streams are often given extra protection by limiting development in near-shore areas.

Living on Lakes

Like rivers, lakes are dynamic systems, although the changes can be more subtle. Lake levels rise and fall with the seasons and weather. Like rivers, lakes come in many varieties. Some lakes are part of river systems, with water flowing through and bringing sediment, nutrients and anything else collected along the journey through the watershed. Other lakes are isolated, fed by groundwater, runoff from melting snow and ice and from rainfall.

Clear lakes with rocky bottoms support different types of aquatic life than murky, silty lakes. Depth, temperature, age and surrounding geology all affect the character of lakes. Based on these characteristics, lakes are often classified as one of these three types.

Oligotrophic Lakes

The next time you are fishing on a crystal mountain lake, clearly watching the trout inspect and then ignore your fly, know that you are visiting an oligotrophic, or geologically young, lake. The low nutrient and sediment inputs of oligotrophic lakes result in relatively little plant growth and generally clear water with good visibility. They often have cold water and high dissolved oxygen content. They are good habitat for trout and other cold-water species but will generally support limited fish and waterfowl populations. Because glacial soils are not rich in nutrients, many of the lakes in the Tanana Valley watershed are oligotrophic. These lakes over time may progress to the geologically older stages known as mesotrophic and eutrophic.

Eutrophic Lakes

By contrast, the mucky bottom, algae-filled farm pond your friends dared you to jump into as a kid is known as a eutrophic lake. Eutrophic, or "old" lakes, have high levels of nutrients and sediments. Their waters are generally less clear and they tend to have muddy bottoms and large amounts of aquatic vegetation. Waterfowl and fish may both be abundant in eutrophic systems, although species such as trout will rarely be found because dissolved oxygen levels are often too low to support them.

Mesotrophic Lakes

Mesotrophic lakes lie somewhere in between. They have moderate nutrient and sediment inputs and are generally less clear than oligotrophic lakes. They may have sandy or silty bottoms, more aquatic plant life, and support different aquatic species. Mesotrophic lakes also lie between oligotrophic and eutrophic lakes in terms of geologic age. The nutrients that are here, with the exception of human inputs, can be traced back to salmon. As salmon swim upstream each summer to spawn and die, their bodies feed bears, eagles and smaller fish, and even help fertilize trees. As the human population of the Tanana River Valley grows and more areas are influenced by nutrients from septic discharge, fertilizers and erosion, our lakes will most likely follow the progression seen elsewhere from oligotrophic to mesotrophic and eventually to a eutrophic state.

What Good are Wetlands?

Swamp, bog, marsh, slough—wetlands come in all these varieties and more. They are a common feature in the Tanana Valley watershed, so you very well may have wetlands on your land, especially as a waterfront property owner. Determining what is a wetland is not a simple matter. There are many types of wetlands and, despite their name, they are not necessarily wet year-round. In fact, some wetlands can appear to be quite dry for most of the year. Swamps are forested wetlands that have trees as the dominant vegetation type. Bogs or muskegs are characterized by sphagnum moss, which as it dies builds up in thick layers known as peat. Marshes are what many people picture when they think of wetlands. Marshes are highly variable, but are dominated by grasses, cattails, sedges and other non-woody vegetation. Sloughs, wet meadows and potholes are all examples of marshes.


PHOTO © SUSAN PORT

Dragonflies range from small damselflies, like the metallic-green sedge sprite and the boreal bluet, up to the five-inch-long lake darner, the largest dragonfly in the state. More information is available in the book *A Field Guide to the Dragonflies of Alaska.*

Historically, wetlands were often dismissed as useless land and were frequently drained or filled for agriculture and development. However, as more wetlands were lost, the vital ecological role and enormous economic value of these lands became increasingly clear. Without our wetlands, we would spend significantly more for water treatment, flood control and flood damage, while receiving less income from visitors who come to enjoy fishing, wildlife viewing and other recreational activities.

Wetlands provide habitat for fish and wildlife by offering food, water and shelter for fish, birds and mammals. Many Alaska fish species use wetlands adjacent to rivers and streams as breeding and feeding grounds. They are effective at purifying water by filtering out pollutants and sediments, reducing or preventing flooding by storing water and releasing it slowly, and thereby helping to protect homes and other infrastructure. Wetlands are incredibly valuable for recreation. Many people visit wetlands to gather berries, to hunt ducks and moose, and to photograph the seasonal changes that occur in these rich environments.


PHOTO © SUSAN PORT

Conclusion

Books End, But the Beginning of a Journey

As you have seen, keeping our watershed healthy is vital for quality of life, health and economic well-being. Caring for our waterways and the biodiversity within them is crucial to a healthy watershed in the future. In this book, we have shown you some ways individuals can make a big difference in our watershed and community.

While urban development has the potential to reduce habitat for wildlife and lead to water quality degradation, individuals and communities can apply Green Infrastructure applications to reduce these effects. GI techniques are fun, cost-effective and fairly simple to implement and provide lasting benefits to the watershed. Let us all continue to work toward maintaining natural systems and green spaces for relaxation, recreation, and outdoor classrooms. They are essential to the community identity and well-being.

The Tanana Valley Watershed Association (TVWA) was organized in 2006 with the mission of promoting and improving the health of our watershed through education, restoration, collaborative research and diverse community involvement. In the years since, we have worked with many community partners to achieve these goals. We strive to inform and engage the public in ways that create a positive impact.

This effort culminated in 2013 with the first Chena River Summit. The formal program was held during the day and included four sessions, a featured lunch program, and refreshments. A tradeshow, featuring booths from local partners, displayed information and resources. Session topics ranged from a historic perspective of the Chena to a panel discussion on access. The event theme highlighted the little-known fact that the Fairbanks North Star Borough's Salcha and Chena Rivers hosts the two largest runs of Chinook salmon in the Alaska portion of the Yukon River drainage.

The event engaged stakeholders and community members from various fields and interests, ranging from recreation and tourism to education and advocacy. The event connected a diverse group that included key leaders and decision makers from federal, state, local and non-governmental agencies and organizations with local business owners and community members. Attendees had the opportunity to collectively address important local issues regarding our impact on the health of the watershed.

The success of the summit in 2013 led to the organization of the 2014 Chena River Summit, again bringing together a wide variety of stakeholders in the watershed, this time with a focus on environmental education.

The 2015 Summit is intended to focus on the Rains to Rivers concepts described in this book. We hope you find the information and techniques useful and inspiring introduction to the subject.

We hope you have both enjoyed and found useful information within these pages. We encourage you to become more involved in creating a healthier watershed for yourself and future generations. If you would like to learn more about other ways TVWA is working to promote and improve the health of the Tanana Valley, please visit our website at www.tvwatershed.com.

Additional Reading

Water Quality and Ecology of the Chena River, Alaska (Oswood et al. 1992)

Chena River Watershed Study: Reconnaissance Report (U.S. Army Corps of Engineers 1997)

Flooding and ecosystem dynamics along the Tanana River (Yarie et al. 1998)

Environmental and Hydrologic Overview of the Yukon River Basin, Alaska and Canada (Brabets et al. 2000)

Floodplain Forests Along the Tanana River, Interior Alaska, Terrestrial Ecosystem Dynamics and Management Considerations (Magoun and Dean 2000)

Assessment of Fish Habitat, Water Quality, and Selected Contaminants in Streambed Sediments in Noyes Slough, Fairbanks, Alaska, 2001-2002 (Kennedy et al. 2004)

A Review of Riparian Functions and Management Focused on the Fairbanks North Star Borough (Coles-Ritchie 2009)

Riparian Conditions of the Lower Chena River (Erik Friele Lie, 2012)

Glossary

Absorption Field – a field engineered to receive septic tank effluent. Also called a leeching or seeping field, an absorption field consists of a series of shallow trenches partially filled with a bed of washed gravel or crushed stone into which perforated or open joint pipe is placed.

Alluvial River – a river which carries a large amount of sediment, including sand and gravel, and in the Tanana River Valley, is often is fed by melting glaciers.

Anadromous – pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.

Aquifer – a sand, gravel or rock formation capable of storing or conveying water below the surface of the land.

Bog – a type of wetland that accumulates appreciable peat deposits. Bogs depend primarily on precipitation for their water source, and are usually acidic and rich in plant residue with a conspicuous mat of living green moss.

Braided Channel – a stream consisting of a network of interlacing small channels separated by bars, which may be vegetated and stable or barren and unstable.

Breakup – period of spring thaw during which the ground surface is excessively wet and soft, and ice is disappearing from streams and lakes.

Buffer Zone – a wide strip of vegetation along a stream that can control erosion and runoff, as well as providing privacy and protection from noise.

Carrying Capacity – the maximum number of individuals of any species that can be supported by a particular ecosystem on a long-term basis.

Confined Aquifer – an aquifer that is wedged between layers of relatively impermeable materials and is consequently under pressure. Also known as an artesian aquifer.

Cumulative Impacts – the collective effect of different impacts.

Cut Bank – the outside bank of a bend, often eroding opposite a point bar.

Easement – the right of a person, government agency or public utility company to use public or private land owned by another for a specific purpose. Easements may be granted for a number of reasons, including access, public utilities, conservation, open-space and scenic purposes.

Elevated, Light-Penetrating Gratewalk (ELP) – a structure often used to access a shoreline, that allows stabilizing vegetation to grow underneath it.

Entrenched River – a river that is confined to a canyon or gorge, usually with a relatively narrow width and little or no flood plain, and often with meanders worn into the landscape.

Eutrophic – a lake that has a high level of plant nutrients and biological productivity and a low oxygen content.

1% Flood Event – the level of flooding that has a 1% chance of occurring in any given year.

Flood Hazard Area – an area in a community that has been determined by the Federal Emergency Management Agency to have a high degree of risk for becoming damaged by a flood.

Floodplain – that portion of a river valley that is covered with water when the river overflows its banks.

Floodway – the channel of a watercourse and that inner portion of the flood plain where flood depths and velocities are generally higher than those experienced in the flood fringe.

Glacial Flour – the fine-grained sediment carried by glacial rivers that results from the abrasion of rock at the glacier bed. Its presence turns water aqua blue or brown, depending on its parent rock type.

Glacial River – a river that is fed at least partially from glacial melt. These rivers tend to be clearer and of lower volume in the winter, and increase in volume and turbidity during summer months when glacial melting rates are highest.

Groundwater – water that infiltrates the soil and is stored in slowly flowing reservoirs (aquifers); used loosely to refer to any water beneath the land surface.

Jökulhlaup – a sudden water release from a glacier or glacier-dammed lake.

Marsh – an ecosystem of more or less continuously waterlogged soil dominated by emerged herbaceous plants but without a surface accumulation of peat. A marsh differs from a swamp in that it is dominated by rushes, reeds, cattails and sedges, with few if any woody plants, and differs from a bog in having soil rather than peat as its base.

Mesotrophic – reservoirs and lakes that contain moderate quantities of nutrients and are moderately productive in terms of aquatic animal and plant life.

Muskeg – poorly drained organic terrain that is characteristic of the subarctic, covered with a thick, resilient carpet of water-sodden mosses and tussocks, and underlain by a high water table, peat of variable thickness and often permafrost.

Oligotrophic – refers to a body of water which is poor in dissolved nutrients and usually rich in dissolved oxygen.

PHOTOS © SUSAN PORT

PHOTO © SUSAN PORT

Ordinary High Water – the boundary between upland and lake or riverbed. It is the point on the bank or shore up to which the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristics.

Overflow – a layer of water that flows on top of a frozen river or lake.

Point Bar – a low ridge of sediment that forms along the inner bank of a meandering stream.

Pothole Lake – a shallow, small pond that may hold water throughout the year.

Riparian – of, on, or pertaining to the banks of a stream, river or pond.

Riprap – large, blocky stones that are artificially placed along a riverbank or shoreline to stabilize soil and slow erosion.

River Hydraulics – the characteristics of water flow in an open channel, with respect to velocity (speed and direction) and pressure, and the geomorphic behavior of the river channel.

River Reach – a length of stream channel exhibiting, on average, uniform hydraulic properties and morphology.

Seiche – a sudden oscillation of the water of a lake, bay, etc., causing fluctuations in the water level and caused by wind, earthquakes, etc.

Slough – a small, sluggish creek in a marsh or tidal flat.

Surface Water – water that sits or flows above the land, including lakes, oceans, rivers, and streams.

Swamp – land having soils saturated with water for at least part of the year and supporting natural vegetation of mostly trees and shrubs.

Toe – the lower edge of a slope, where the ground levels out and becomes primarily horizontal.

Unconfined Aquifer – an aquifer without a confining layer above it. The top surface of water in an unconfined aquifer is the water table.

Undercut Bank – an overhanging section of riverbank with water generally flowing underneath it.

Underfit – a river that is much smaller than the valley it occupies. These river valleys were generally formed by previous rivers that were much larger in volume.

Water Table – the level below the land surface at which the subsurface material is fully saturated with water. The depth of the water table reflects the minimum level to which wells must be drilled for water extraction.

Watershed – the total land area from which water drains into a particular stream or river.

Wet Meadow – wetland communities found where the soil is normally saturated and is covered with standing water only in spring. Sedges or grasses are the dominant species.

The Fairbanks Green Infrastructure Group, is a multi-agency collaboration providing information and educational material to residents of Interior Alaska to create a cleaner, healthier community by making green infrastructure common practice for home and business owners. Through community support and involvement, the group promotes sustainable use of our natural environment for the benefit of present and future generations.

The Tanana Valley Watershed Association (TVWA) 501(c)(3) non-profit organization organized in 2006 with the mission of promoting and improving the health of our watershed through education, restoration, collaborative research and diverse community involvement.