

Natural Infrastructure in Oregon

Common Challenges, Opportunities for Action, and Case Studies



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INTRODUCTION

Across the state, Oregonians face complex water challenges. Aging water infrastructure is failing in many communities; in others, the infrastructure is simply inadequate for meeting a growing population's needs. Changing precipitation patterns and land-use pressures further exacerbate existing water challenges. Water is increasingly scarce, more polluted, less seasonally reliable, and the future seems to hold more of the same.

We need to embrace and implement creative responses to the water challenges that have been building for decades. Incorporating nature into water management can address these challenges head-on while also supporting prosperous communities and healthy ecosystems. With their direct and associated co-benefits, natural infrastructure approaches will be a crucial component of Oregon's water future.

We created this report to help various stakeholders — from management staff in utilities, governmental agencies, and engaged non-profits, to people who inform and guide decision-makers — advocate for more natural infrastructure solutions. The report is full of information about the benefits of natural infrastructure, responses to common challenges in its implementation, and eight successful case studies. People and groups can use these resources to engage and inform community members and help infrastructure practitioners overcome common challenges so that they can integrate more natural infrastructure solutions.

WHAT IS NATURAL INFRASTRUCTURE?

When we think of infrastructure, we often imagine the roads, bridges, pipes, and cement of "built" or "grey" infrastructure. However, built infrastructure is not the only type of infrastructure on which we depend.

Natural infrastructure is the strategic use of natural lands, such as forests and wetlands, and working lands, such as farms and ranches, to meet infrastructure needs. Natural infrastructure can also mimic natural systems to achieve outcomes.

Watersheds, floodplains, and forests are a critical part of our water management system. They naturally provide water storage, reduce pollution, and lessen flood impacts. However, these natural lands lose their critical water functions through development, fragmentation, and resource extraction. Incorporating them explicitly into our future water infrastructure projects will restore and maintain their functionality, ultimately benefiting our communities now and generations to come.

The thoughtful, integrated use of natural and built infrastructure can provide a broader set of benefits to both people and nature, often at a lower cost than built infrastructure solutions alone. Taking a natural approach to water infrastructure means using natural systems or nature-based built systems operating at a landscape scale to provide services we usually associate with built infrastructure. Imagine:

- A [functioning floodplain](#)² that allows a river to spread out during high water events, protecting roads and homes from floods without the use of levees and riprap that try to confine the rising waters;
- A [healthy and sustainably-managed forest](#)³ that filters drinking water, moderates water flow in streams, and reduces costly treatment requirements, rather than relying on grey infrastructure alone to store water;
- A [series of built wetlands](#)⁴ that provide a final round of treatment to wastewater rather than expensive and expansive filtration systems and concrete cooling towers; and
- A [healthy and functioning riparian woodland](#)⁵ that cools water above the wastewater treatment plant's discharge pipe, ensuring that the water discharged by the plant is cool enough for fish and other aquatic species.

Greater incorporation of natural infrastructure projects into Oregon's water management systems will require financial, social, regulatory, and political commitments from municipalities, state agencies, utilities, and developers. Fortunately, the returns on investment from those projects are high.

WHAT ABOUT GREEN INFRASTRUCTURE?

"Green infrastructure" is a subset of natural infrastructure. It mimics natural systems at the neighborhood or site scale and can be part of an integrated approach to addressing water management challenges in residential, municipal, and industrial developments. Examples of green infrastructure include eco-roofs, [green street swales](#), and [neighborhood natural areas](#)¹ that filter sediment and other pollutants carried by stormwater runoff.

BENEFITS OF NATURAL INFRASTRUCTURE AS AN INTEGRAL COMPONENT OF WATER MANAGEMENT

Natural infrastructure projects can be more cost-effective than their built infrastructure counterparts, and that's no small thing for a municipality looking to do more with less. They also often allow infrastructure providers to access a greater diversity of funding sources - federal, state, local, and sometimes even private investment can make these projects more achievable, even if the cost is similar to or greater than a built infrastructure alternative.

Natural infrastructure projects also often provide more "bang for the buck," because they provide a broader set of benefits. In addition to meeting the primary infrastructure objective, the myriad co-benefits increase the value of natural infrastructure and offer integrated solutions.

The direct benefits of natural infrastructure projects are the main goals of the project. For example, constructed wetlands provide direct benefits by cooling wastewater temperatures and reducing pollutants before releasing the water back into natural waterways.

Co-benefits are what we get above and beyond the direct benefits of a particular project or activity. Built infrastructure is usually engineered with a single or few challenges in mind, and such projects are therefore limited in their co-benefits. On the other hand, natural infrastructure offers a wide range of environmental, economic, and community benefits. By systematically recognizing and valuing both the direct and co-benefits of natural infrastructure, Oregon can set up structures that promote integrated solutions.



Photo provided by The Wetlands Conservancy

Photo by Guilherme Cunha

WHAT KIND OF BENEFITS?



Ecological benefits: Natural infrastructure includes so many environmental co-benefits because the design often restores habitat, improves biodiversity, and strengthens ecological systems. A great example of ecological co-benefits occurs when a wastewater utility partner works with a willing landowner to restore riparian areas above the wastewater discharge pipe. Shade from the riparian plantings cools upstream water, creating habitat for aquatic plants and animals, including fish. That same community forest can provide groundwater storage and wildlife habitat.

Natural infrastructure also helps temper the impacts of climate change, and improves community resilience – issues of very real and growing importance in Oregon. Examples include carbon sequestration, ambient cooling, and generating access to cooler shaded areas by lower income community members without access to air conditioning. Parks and restoration areas associated with natural infrastructure projects are increasingly acknowledged in community climate action plans for these benefits.



Economic benefits: Natural infrastructure can be highly cost effective, which reduces current and future water and infrastructure costs and, in some cases, may introduce new revenue streams. For example, a community forest managed to protect drinking water sources can also provide municipal revenue if the city participates in carbon markets. The same forest can provide income from sustainable timber harvesting.



Community benefits: Natural infrastructure improves community wellness and health. Contaminated water, water scarcity, and poor air quality are associated with poor health outcomes, especially if communities are exposed over a long period of time. Natural infrastructure is a public health intervention because it improves water, air, and soil quality, all of which are critical elements of a healthy community. If a natural infrastructure project allows for public access, it offers a space to connect with the outdoors, reducing stress and encouraging physical activity. Last, natural infrastructure projects can provide education, workforce development, and jobs. This strengthens the financial health and prosperity of a local community.

A single natural infrastructure project can provide many different kinds of co-benefits. For example: a constructed wetland can lower wastewater discharge temperature and reduce other pollutants to meet water quality standards. Meeting water quality standards is the direct benefit.



The constructed wetland is significantly less expensive than installing a cooling tower and other wastewater treatment technologies (economic co-benefit)



Maintaining the wetland provides job opportunities, jobs requiring different skills and expertise than maintaining a cooling tower (community co-benefit)



A constructed wetland provides habitat for native birds, pollinators, and other wildlife populations that are under increasing stress from urbanization and intensive management practices (ecological co-benefits)



A constructed wetland supports community climate change mitigation and sustainability objectives (ecological and community co-benefits)



A cooling tower immediately begins depreciating as soon as it is built, whereas the constructed wetland increases in value over time as the plants mature, wildlife moves in, and people become accustomed to using the area as a recreational site (ecological, economic, and community co-benefits)



A cooling tower operates only periodically, to meet compliance needs, whereas the benefits and co-benefits of wetlands are constantly provided (ecological, economic, and community co-benefits)

Many benefits impact both nature and people because of the interconnectedness of our systems. The table below lists common co-benefits from natural infrastructure projects and their intersection with the environment, economy, and the community.

Co-Benefits Primary co-benefit (green) Secondary co-benefit (blue)	Ecological	Economic	Community
	Achieves other water quality compliance objectives	Green	Blue
Conserves and augments water supply	Blue	Blue	Green
Provides clean and ample drinking water	Blue	Blue	Green
Sequesters carbon or mitigates carbon emissions	Green	Blue	
Improves water and air quality	Green		Blue
Reduces greenhouse gas emissions	Green	Blue	Blue
Reduces urban heat effect	Blue	Blue	Green
Reduces or prevents fertilizer and other runoff from entering waterways	Green	Blue	
Restores and improves soil health	Green	Blue	
Expands green spaces and natural habitat	Green		Blue
Protects, restores, or repairs watershed functions, such as bank stability, channel integrity, fish and aquatic life habitat, flood/peak flow management, and aquifer recharge	Green		Blue
Creates recreation areas that promote physical, mental, and community health	Blue	Blue	Green
Diversifies city revenue		Green	Blue
Supports business, industry, or agriculture		Green	Blue
Provides green jobs and opportunities for workforce training		Green	Blue
Decreases water utility and wastewater treatment rates for customers		Blue	Green
Builds community resilience for natural disasters		Blue	Green
Prevents property damage from flooding		Blue	Green
Offers educational opportunities for students and the community			Green



Photo by The Freshwater Trust

II

NATURAL INFRASTRUCTURE POLICY: COMMON CHALLENGES AND OPPORTUNITIES FOR ACTION

Natural infrastructure offers integrated solutions to immediate infrastructure problems while strengthening the community through various economic, ecological, and human health co-benefits. **If natural infrastructure is efficient, cost-effective, and offers many co-benefits, why is it an uncommon solution?** By addressing some of the prevalent challenges and offering opportunities for action to overcome them, Oregon can encourage widespread adoption of natural infrastructure approaches.

We asked various infrastructure practitioners why natural infrastructure is not a common approach. The frequent responses were:

- “It’s not allowed, it’s not a priority, or it’s not required.”
- “There’s not enough funding.”
- “There’s too much risk and uncertainty.”
- “It’s too complicated and so many partners are involved.”
- “There’s not enough capacity in my community to deliver natural infrastructure.”
- “There’s not enough community buy-in.”

Some of these challenges are policy issues, while others are related to unclear definitions, expectations, and perceptions. Natural infrastructure advocates can respond to policy challenges through various strategies and related actions so that it is easier for utilities, wastewater treatment providers, municipalities, landowners, and other stakeholders to integrate natural infrastructure solutions into common infrastructure practices.

WHO ARE THE ACTORS?

In many strategies, we suggest some of the following actors to implement change.

State and federal agencies: Government agencies that are involved or can be involved in funding, planning, or permitting of natural infrastructure. They include the Environmental Protection Agency (EPA), U.S. Army Corps of Engineers, Oregon Water Resource Department (ORWD), Oregon Department of Environmental Quality (DEQ), Business Oregon, Oregon Health Authority (OHA), and others, depending on the project.

Infrastructure providers: Any combination of stakeholders that have the potential to contract, plan, and implement natural infrastructure solutions. They include utilities, wastewater treatment providers, municipalities, landowners, environmental non-profits, engineering firms, watershed partnerships, and public-private partnerships.

Natural infrastructure specialist: A person or organization that is highly skilled in planning and implementing natural infrastructure. This can be an engineering firm, consulting company, environmental non-profit, state agency staff, or other expert.

Community-based organizations: Formal and informal organizations that work at the local level to meet community needs.

Research institutions: Institutions that can conduct research, including universities, non-profits, and consulting firms.



AT-A-GLANCE

Common Challenges	Strategies
"It's not allowed, it's not a priority, or it's not required."	<ol style="list-style-type: none"> 1. Authorize natural infrastructure 2. Prioritize natural infrastructure 3. Require natural infrastructure
"There's not enough funding."	<ol style="list-style-type: none"> 1. Create new natural infrastructure funding 2. Expand natural infrastructure funding by defining the watershed as infrastructure 3. Dedicate funding for natural infrastructure maintenance 4. Consider natural infrastructure as cross-sectoral investments in infrastructure, environment, and public health
"There's too much risk and uncertainty."	<ol style="list-style-type: none"> 1. Increase safety net for infrastructure providers 2. Manage different forms of risk 3. Create quantification tools to effectively plan, monitor, and evaluate natural infrastructure projects and reduce uncertainty
"It's too complicated and there are so many partners involved."	<ol style="list-style-type: none"> 1. Provide technical assistance and planning support 2. Coordinate interagency collaboration
"There's not enough capacity in my community to deliver natural infrastructure."	<ol style="list-style-type: none"> 1. Increase training opportunities for natural infrastructure 2. Incentivize workforce development
"There's not enough community buy-in."	<ol style="list-style-type: none"> 1. Increase community engagement opportunities and develop partnerships with community organizations 2. Increase education and communications on the benefits of natural infrastructure 3. Analyze potential benefits and harm of natural infrastructure projects

"IT'S NOT ALLOWED, IT'S NOT A PRIORITY, IT'S NOT REQUIRED."

This challenge is as much about clear communication as it is policy. In many cases, natural infrastructure is already authorized. Beyond authorization, natural infrastructure can be prioritized and incentivized, or include requirements that encourage natural infrastructure alternatives.

STRATEGY 1:

Authorize natural infrastructure

Not all infrastructure providers know that natural infrastructure is already authorized in many state and federal programs. This lack of awareness limits opportunity to deploy existing programs and funds towards natural infrastructure. State and federal agencies can clarify that natural infrastructure is authorized, eligible for funding, and meets agency requirements.

- **Opportunities for Action**

- ◇ State and federal agencies with infrastructure funding programs can explicitly authorize natural infrastructure, clarify that natural infrastructure is essential infrastructure, and ensure legal authorization.
 - Example: The EPA's [Green Infrastructure Policy for the Clean Water State Revolving Fund Program](#)⁶ (CWSRF) establishes a policy that promotes increased CWSRF financing of green infrastructure projects nationally.
 - Example: [Business Oregon's Infrastructure Programs](#)⁷ are open to natural infrastructure projects but not many people apply for natural infrastructure. There is an opportunity to explicitly state that natural infrastructure is essential infrastructure and inform potential providers that it is authorized.

STRATEGY 2:

Prioritize and incentivize natural infrastructure

In addition to authorization of natural infrastructure, agencies that fund, permit, or support infrastructure work can legitimize and encourage natural infrastructure projects through increased incentives and support.

- **Opportunities for Action**

- ◇ State and federal agencies can explicitly prioritize natural infrastructure.
 - Example: FEMA's [Building Resilient Infrastructure and Communities](#)⁸ (BRIC) prioritizes natural infrastructure by including nature-based solutions as one of their technical evaluation criteria.
- ◇ Formalize interagency agreements to prioritize natural infrastructure development.



STRATEGY 3:

Requirements that promote natural infrastructure

There are various approaches to requirements that promote natural infrastructure solutions. For example, state agencies could require consideration of natural infrastructure alternatives as part of permit or funding applications. Another approach is to require that major infrastructure projects have a community benefit component. Natural infrastructure projects would often meet these requirements because of their incorporated community co-benefits.

Equity Consideration: Any requirement should be accompanied by technical assistance funding and support. This is especially important for smaller communities with limited resources. Governmental agencies, NGOs, and research institutions should create tools and resources to make natural infrastructure simpler to plan, implement and monitor. For more strategies regarding tools and resources, look at “There’s too much risk and uncertainty.”

- **Opportunities for Action**

- ◇ Funding and permitting agencies can require consideration of a natural infrastructure approach or alternative if getting any state infrastructure funding.
 - Example: [Water Resources Development Act](#)⁹ (WRDA) of 2020 requires the U.S. Army Corps of Engineers to adopt procedures to include more consideration of environmental and social goals and regional economic benefits during project planning and selecting the preferred alternative.
- ◇ State and federal agencies can require the use of natural infrastructure strategies to the extent possible to address the following critical water issues:
 - Sourcewater protections
 - Protected groundwater recharge
 - No net loss of instream flows
- ◇ State and federal agencies can require the use of natural infrastructure strategies to the extent possible to update forest and agricultural practices, such as using wetlands for nutrient control.
- ◇ Funding and permitting agencies can include a community benefit requirement for all major infrastructure projects, and local governments can also set that requirement for themselves. Natural infrastructure can be specifically included as an approach that meets the community benefit requirement.
 - Example: Portland statutes [require significant infrastructure and commercial development to include benefits to the community](#).¹⁰
- ◇ Larger municipalities manage stormwater runoff (via MS4 permits) and sometimes require on-site retention, treatment, and prioritization of green infrastructure, to the maximum extent practicable. For small or rural communities that do not need MS4 stormwater permits, funding bodies can establish incentives, resources, and workforce capacity to implement local stormwater treatment. In statewide 1200-C permits for new construction or permits for post-construction stormwater permits, require sites to treat or offset 100% of pollution loads.
 - Examples: Permits for the [Oregon municipal separate storm sewer system](#),¹¹ commonly called an MS4, include robust stormwater treatment requirements for large and mid-sized municipalities. Other examples include the [North Carolina Stormwater Rules and Regulations](#)¹² and [Virginia Stormwater Management for construction stormwater permits](#).¹³



"THERE'S NOT ENOUGH FUNDING."

One of the significant challenges for natural infrastructure is the lack of funding. With creative policy changes, however, natural infrastructure projects could qualify for diverse funds because the direct benefits and co-benefits impact various sectors like infrastructure, water, and health. With explicit authorization, natural infrastructure may be eligible for more funding streams such as the Clean Water State Revolving Fund, Office of Wetlands, Oceans, and Watersheds, FEMA's Hazard Mitigation Program, HUD Sustainable Communities Regional Planning Grants, NOAA's Community-Based Restoration Program, and USDA Rural Development Water and Environmental Programs. In addition to state and federal agencies, there are creative opportunities for private-public partnerships, non-profit organizations, and local governments to contribute to natural infrastructure funding.

STRATEGY 1:

Create new natural infrastructure funding

State and federal governments can create specific natural infrastructure funding programs to ensure financing and implementation of new natural infrastructure projects without competing with other types of projects. Additionally, these new funds should include flexible timelines to make them easier to use alongside other existing funding sources.

Equity Consideration: By creating new programs, there is an opportunity to prioritize funding for projects in communities that have been harmed or neglected by past infrastructure projects.

- **Opportunities for Action**

- ◇ Federal, state, and local governments can collaborate across agencies to create a "General Investment Fund in Water."
- ◇ State and federal agencies can work with community-based organizations to offer specific water funding for BIPOC, rural, and low-income communities.
- ◇ Any new natural infrastructure funding programs can create flexibility in, or extend the schedule for, expending grant funds so that utilities can more easily align these dollars with their capital project schedule.
- ◇ State agencies can set aside funds for communities to use as match to help pull in federal grants and loans.
 - Example: Business Oregon set aside Special Works Fund dollars as match to help fire-impacted communities access FEMA and other federal dollars.

STRATEGY 2:

Expand natural infrastructure funding by defining the watershed as infrastructure

State and federal government can define the watershed as integral components of water infrastructure. Rivers and forests become as crucial as levees and canals, infrastructure funds can be used for restoration and protection, utilities can easily justify watershed restoration, and water quality funding can support natural infrastructure projects.

- **Opportunities for Action**

- ◇ A legislative bill or executive order can declare watersheds as integral components of infrastructure eligible for infrastructure financing.
 - Example: [California AB-2480 Source watersheds: financing](#)¹⁴
- ◇ State and federal agencies can create dedicated funding streams for natural storage and source water protection.
- ◇ State agencies can clarify that natural infrastructure is eligible for their program funding.
 - Example: Business Oregon can clarify that the [Special Public Works Fund](#)¹⁵ under Business Oregon can be used for natural infrastructure if there is a documented community development benefit.
 - Example: Oregon Watershed Enhancement Board (OWEB) can clarify that funds can be used for natural infrastructure if there is a documented habitat benefit.

STRATEGY 3:

Dedicate funding for natural infrastructure maintenance

Dedicate funding for monitoring and maintenance is needed to ensure the long-term efficacy and benefits of natural infrastructure. Funding specifically for maintenance can come from federal or state agencies, utilities, environmental non-profits, land trusts, or other private-public partnerships. Funds for monitoring could result from collaborative partnerships with research institutions.

- **Opportunities for Action**

- ◇ State and federal agencies and infrastructure providers can dedicate funding for maintenance and monitoring of natural infrastructure projects.
- ◇ Accounting standards can be modified to allow infrastructure providers and other project developers to fold maintenance costs into the eligible capital costs of a natural infrastructure project.
 - Example: Governmental Accounting Standards Board (GASB) 62 provides accounting standards for regulated utilities. [GASB's 2018 Implementation Guide](#)¹⁶ clarified how these standards apply to distributed infrastructure, and [Earth Economics' Go Green](#)¹⁷ publication provides guidance for water infrastructure providers on using GASB 62 in financing natural and distributed infrastructure.

STRATEGY 4:

Consider natural infrastructure as cross-sectoral investments in infrastructure, environment, and public health

Natural infrastructure offers integrated solutions that can open up funding from a diversity of sources and sectors, from infrastructure to conservation to public health. State and federal agencies, along with infrastructure providers, can create systems that promote cross-sectoral collaboration and overcome the challenges that siloed, single-solution systems create.

- **Opportunities for Action**

- ◇ State and federal agencies, local governments, other infrastructure providers can convene collaborative tables to plan, finance, and implement natural infrastructure projects.
 - Example: [Business Oregon organizes One-Stop Meetings](#)¹⁸ to quickly and efficiently find funding solutions for communities.
 - Example: EDA's [Regional Economic Development Summit \(REDS\)](#)¹⁹ is a framework for strategic cross-sectoral collaborations to fill resource and capacity gaps, leverage investments from multiple sources, and achieve maximum results.
- ◇ Infrastructure funding programs can prioritize projects that offer solutions in multiple areas, such as environment and health.
 - Example: Washington's [Floodplains By Design](#)²⁰ is a private-public partnership that funds projects to provide multiple cross-sector benefits and involve a diversity of community partners.
 - Example: [Oregon's Clean Water State Revolving Fund](#)²¹ has dedicated funding for green infrastructure projects.



"THERE'S TOO MUCH RISK AND UNCERTAINTY."

Natural systems are full of complexity and change. Some changes from natural infrastructure are expected: trees grow over a period of time, water increasingly cools, and wildlife returns. Other changes are unknown or a surprise: a flood changes the path of a stream and wildlife alters the planned landscape. Utilities, municipalities, and other infrastructure providers may prefer a natural infrastructure alternative, but are hesitant because of the risk that the project won't be approved or won't meet performance requirements. They might worry about litigation. Those concerns are reasonable — the current compliance and permitting system was created with grey infrastructure solutions in mind, making it difficult for natural infrastructure projects to meet requirements.

This isn't all unique to natural infrastructure — grey infrastructure also faces risk and uncertainty. What's novel, though, is that natural infrastructure continues to change after the project is developed, often appreciating in value and benefit. There are many strategies we can take to address the risks for providers and state agencies while maintaining accountability for project outcomes.

STRATEGY 1:

Improve the regulatory safety net for infrastructure providers to engineer with nature

State and federal regulatory agencies can increase assurances for infrastructure providers so that they will not be unfairly penalized for expected or unexpected changes in natural infrastructure projects.

- **Opportunities for Action**

- ◇ Regulatory agencies can ensure legal authorization of natural infrastructure and provide a stronger permit shield for public utilities implementing natural infrastructure.
- ◇ Regulatory agencies can match the length of compliance schedules or change compliance rules appropriate for natural infrastructure.
- ◇ Regulatory agencies can ensure that permit compliance provided by the natural infrastructure project is permanent or goes with the life of the natural infrastructure project.

STRATEGY 2:

Identify and manage different forms of risk in natural infrastructure

Risk is a significant challenge for *all* infrastructure, not just natural infrastructure approaches. Based on our conversations with natural infrastructure providers, managing risk remains one of the biggest concerns. There are legal risks, financial risks, fire and flood risks, and risks for small communities that have limited resources and staff. By defining and addressing various forms of real and perceived risks, we can demystify natural infrastructure.

- **Opportunities for Action**

- ◇ Consider programmatic mechanisms to address commonly cited risks. State agency staff can consider programmatic or state-level mechanisms that address risks related to working in a dynamic river or land environment (e.g. define a range of acceptable project trajectories that will not influence credit value, support development of insurance products or state credit reserve pools); tracking and accountability for dispersed actions (e.g. required use of registries, approved remote monitoring methods); and, BMPs that are slow to mature (e.g. insurance products and reserve pools, allow credits to be renewed for multiple cycles).
- ◇ State and federal agencies and infrastructure providers can take a holistic approach to managing uncertainty. A successful program will have a [suite of mechanisms to address various forms of risk](#),²² including scientific or biophysical risk, extreme events, regulatory risk, market risk, and buyer risk.

For more details on how to manage risk and uncertainty in natural infrastructure, take a look at the following toolkits:

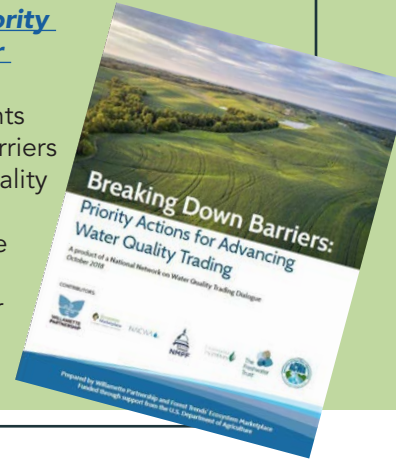


Building a Water Quality Trading Program: Options and Considerations (2015)

Building a Water Quality Trading Program walks through 11 key elements many trading programs consider in their design. Included is a suite of mechanisms to address various forms of risk and as applicable in natural infrastructure projects.

Breaking Down Barriers: Priority Actions for Advancing Water Quality Trading (2018)

Breaking Down Barriers presents how to break down the top barriers affecting demand for water quality trading. The section on risk applies to natural infrastructure and includes how to address the real and perceived risks for buyers and identifies the risk of litigation.



STRATEGY 3:

Create quantification tools to effectively plan, monitor, and evaluate natural infrastructure projects and reduce uncertainty

Evidence-based tools can help to demystify natural infrastructure and address perceptions of risk and uncertainty. State and federal agencies and research institutions can create tools that allow infrastructure providers to better predict, measure, and demonstrate the benefits of natural infrastructure projects.

• **Opportunities for Action**

- ◇ State and federal agencies and research institutions can create data-driven, standardization tools to plan and assess natural infrastructure components, such as natural cooling in floodplains.
 - Example: DEQ’s [Heat Source tool](#)²³ includes a “Shade-a-Lator” that calculates the cooling impact trees and vegetation provide.
- ◇ State and federal agencies and research institutions can create criteria for acceptable site-specific assessments to evaluate natural infrastructure outcomes.
 - Example: [Measuring Up: Synchronizing Biodiversity Measurement Systems for Markets and other Incentive Programs](#)²⁴ is an example of how to standardize systems for measuring outcomes while leaving room for local customization.
- ◇ State and federal agencies, research institutions, and infrastructure providers can invest in evidence and tools for natural infrastructure, such as Best Management Practice manuals, planning models, and monitoring tools.

STRATEGY 4:

Reevaluate project success so that co-benefits and project appreciation are appropriately valued

In addition to meeting a specific infrastructure outcome, natural infrastructure projects should be evaluated on the value of co-benefits and how natural infrastructure projects appreciate overtime. For example, while a built infrastructure project may have a 50-year lifespan, a natural infrastructure project could last much longer and become more effective over time. Natural infrastructure can meet more than one specific outcome measure, and it should be valued accordingly. State and federal infrastructure funding programs or other research institutions can create tools to help quantify true costs and benefits of projects.

• **Opportunities for Action**

- ◇ State and federal agencies, infrastructure providers, and researchers create or adopt tools that weigh risks of natural infrastructure projects against co-benefits.
 - Example: [FEMA Flood Design](#)²⁵
- ◇ State and federal agencies, infrastructure providers, and researchers can create or adopt tools to calculate and compare value depreciation of built infrastructure and value appreciation of natural infrastructure projects.

"IT'S TOO COMPLICATED AND THERE ARE SO MANY PARTNERS INVOLVED."

Natural infrastructure can involve landscape-scale variables that require landscape-scale collaboration. State and federal agencies, infrastructure providers, and natural infrastructure specialists need to brainstorm the best ways to provide technical assistance and interagency collaboration. Natural infrastructure case studies in Oregon offer various examples of how stakeholders have come together to implement landscape-scale projects.

STRATEGY 1:

Provide technical assistance and planning support

Natural infrastructure specialists can offer specialized technical assistance and support to collaborate across diverse variables and with various partners.

- **Opportunities for Action**

- ◇ State and federal funding and regulatory agencies can hire natural infrastructure specialists to facilitate the collaborative design and delivery of projects across the state.
- ◇ Infrastructure providers can invite neutral third-parties to facilitate projects by streamlining processes for landowners and the municipality, and removing some of the risk and uncertainty associated with alternative water quality improvement project.
 - Example: The Freshwater Trust acted as a third-party facilitator in the [Medford Water Quality Trading Program](#).²⁶

STRATEGY 2:

Coordinate interagency collaboration

Natural infrastructure requires a shift from siloed, single-solution systems to integrated and cross-sectoral planning and partnerships. State and federal agencies can continue to develop systems to coordinate planning and permitting. Infrastructure providers can take advantage of existing interagency collaboration while also advocating for more opportunities to streamline permitting and planning.

- **Opportunities for Action**

- ◇ Infrastructure providers can convene multiple regulatory agencies at the same time to coordinate consultation and permitting.
 - Example: The U.S. Army Corps of Engineers, Portland District (Corps), and the Oregon Department of State Lands (DSL) convene "[Kaizen meetings](#)"²⁷ for complex projects to work out interconnected permitting issues. They can also be referred to as early assistance meetings or pre-application meetings.
- ◇ For projects that are particularly complicated with multiple agencies involved, the state can offer "integration navigators" to help municipalities, wastewater providers, and other infrastructure providers navigate regulatory permits. Some projects, such as those with wetland infiltration, may need to work with DEQ, EPA, OWRD, and ODFW.
 - Example: Collaborative solutions is one of the key principles in [Oregon's Integrated Water Resources Strategy](#).²⁸ Integration navigators are one way that the state can build upon this key principle and help advance equity by ensuring that all communities, even smaller ones, have access to successful interagency collaborative processes.
- ◇ Infrastructure providers and regulatory agencies can improve relationships and communication to streamline permits, overcome policy barriers, and work together towards innovative solutions.
 - Example: A recent study found that increased communications between utility managers and regulators was one of the best ways to overcome regulatory barriers and increase permitting flexibility.²⁹

Equity Considerations: Larger municipalities and infrastructure providers may have sufficient resources and capacity to navigate permitting coordination between various regulatory agencies. For smaller communities with limited resources, however, it may be harder to engage state agencies in collaborative processes. Integration navigators are important for smaller communities because they increase capacity for permit coordination and maximize success of natural infrastructure solutions.

"THERE'S NOT ENOUGH CAPACITY IN MY COMMUNITY TO DELIVER NATURAL INFRASTRUCTURE."

There is an exciting opportunity to support economic development, expand the green workforce in urban and rural communities, and grow capacity to implement natural infrastructure across Oregon. A new workforce requires ample training and incentives for workforce development. All stakeholders, from engineering firms to state and federal agencies, can invest in and promote workforce development in natural infrastructure.

STRATEGY 1:

Increase training opportunities for natural infrastructure

It is essential to create new training opportunities for natural infrastructure or expand training within existing certification programs. Infrastructure providers, environmental non-profits, universities, and state and federal agencies can develop pathways for natural infrastructure training.

Equity Consideration: Stakeholders who can fund apprenticeships should partner with community-based organizations to build community engagement and power in the natural infrastructure field.

- **Opportunities for Action**

- ◇ Wastewater and drinking water certification programs can include natural infrastructure training.
- ◇ State and federal agencies, local government, non-profits, and engineering firms can help fund scholarships or subsidies for Oregonians to complete the [National Green Infrastructure Certification Program](#).³⁰
- ◇ State and federal agencies, local government, non-profits, and engineering firms can fund grants for natural infrastructure apprenticeship programs with community-based organizations like the [Blueprint Foundation](#),³¹ [Ecotrust](#),³² and [Verde](#).³³
- ◇ Infrastructure providers increase community capacity by offering green training and resources for contractors, and apprenticeship grants for communities underrepresented in the field.
 - Example: The [Contracting Assistance Center](#)³⁴ at the San Francisco Public Utilities provides training, consultation, and tools to help small businesses compete for contracts.
 - Example: San Francisco Public Utilities' [Project Learning Grant](#)³⁵ collaborates with various community-based organizations to provide youth with hands-on work experience in various fields including engineering and wastewater planning.



Photo of Johnson Creek Bank Stabilization, © City of Portland, courtesy Bureau of Environmental Services

STRATEGY 2:

Incentivize workforce development

Engineering firms play an essential role in workforce development by offering training and apprenticeship opportunities. Incentives can be given to firms that prioritize workforce development related to natural infrastructure.

- **Opportunities for Action**

- ◇ Infrastructure providers can include procurement preferences for contractors that help develop the natural infrastructure workforce.

"THERE'S NOT ENOUGH COMMUNITY BUY-IN."

Some community stakeholders may be hesitant to support natural infrastructure projects, especially if there is a perception that it will negatively impact their livelihood and well-being or that it could increase their utility bills. Community members will better understand and support natural infrastructure projects if they are part of the visioning and decision-making process and their concerns are respectfully addressed.



Photo provided by Columbia Slough Regional Water Quality Facility

STRATEGY 1:

Increase community engagement opportunities and develop partnerships with community organizations

Communities who are directly impacted by a proposed infrastructure project should be part of the initial community visioning and subsequent decision-making processes. Good community engagement requires time and resources. However, the end result is a natural infrastructure with meaningful co-benefits and community support. Infrastructure providers can increase community engagement in many areas.

- **Opportunities for Action**

- ◇ Infrastructure providers can map out the critical relationships required for a successful program in a given watershed.
- ◇ Infrastructure providers can engage community members and stakeholders early and often.
- ◇ State and federal agencies and infrastructure providers can improve transparency of meetings, data collection, and decision-making processes.
- ◇ Infrastructure providers can design projects with community values in mind to maximize the co-benefits that the community members want and value.

STRATEGY 2:

Increase education and communications on the benefits of natural infrastructure

Communication and outreach are an important part of establishing diverse and widespread support for a proposed natural infrastructure project. When exploring and implementing a natural infrastructure project, utilities, environmental non-profits, and trusted community-based organizations can work together to increase communications with the greater community.

- **Opportunities for Action**

- ◇ Infrastructure providers develop a natural infrastructure communications kit that matches the right messages and messengers to target audiences.
- ◇ Infrastructure providers collaborate with trusted local leaders to create a public education campaign around natural infrastructure that is accessible and connects to community values and priorities.
- ◇ Infrastructure providers use storytelling to creatively engage the community in the many benefits of natural infrastructure projects.

STRATEGY 3:

Analyze potential benefits and harm of natural infrastructure projects

Infrastructure investments have not been distributed equitably across Oregon. Communities of color are more likely to be exposed to toxic contamination from past infrastructure investments and rural communities have had limited investments in water infrastructure because of population density. Infrastructure providers should learn the history of infrastructure investments both in Oregon and nationally, map the benefits and harms of a proposed project, and use that information to inform project type, site selection, and any harm mitigation policies needed. This can help build community trust and buy in.

- **Opportunities for Action**

- ◇ Infrastructure providers can use power mapping tools to understand the interests and influence of various stakeholders involved to improve transparency in the collaborative process.
- ◇ Infrastructure providers can include anti-displacement policies in natural infrastructure planning.
 - [Greening in Place: Protecting Communities from Displacement](#)³⁶ provides strategies to promote equitable green development that does not displace communities.
- ◇ State agencies and infrastructure providers can prioritize the equitable distribution of natural infrastructure. When planning natural infrastructure on a regional scale, planners can use tools like an interactive environmental justice map to prioritize communities who have survived historical and present environmental injustices and would most benefit from natural infrastructure investment.
 - Example: The [CalEnviroScreen](#)³⁷ and the [Washington Environmental Health Disparities Map](#)³⁸ are examples of interactive maps that show environmental health disparities. It can be used to make natural infrastructure and green investments in communities that need it most.





Photo from Roseburg Urban Sanitary Authority by Ryon Kershner



NATURAL INFRASTRUCTURE IN PRACTICE: CASE STUDIES

Cities, utilities, landowners, and watershed partners across the state are already proving that a natural infrastructure approach can help us meet water quality standards, protect drinking water sources, restore healthy habitats, and keep rates affordable for Oregonians today and in the future.

We spoke to regional natural infrastructure champions about what makes these projects possible, why this is the pathway to a more resilient water future, and what Oregon needs to make these approaches a viable option for communities and watershed partners across the state.

Several themes emerged from these conversations:

1. Human and natural systems are inextricably linked, and we can lean on natural systems to keep our water clean and ample;
2. Community engagement and outreach is paramount to an equitable and meaningful project;
3. We need to continue studying and managing risk while appropriately calculating the appreciative value of natural infrastructure projects; and finally
4. Natural infrastructure projects would benefit from cross-sectoral collaboration and prioritization by governmental agencies, organizations, and infrastructure providers.

These themes call for a paradigm shift in how we think about infrastructure.

The following case studies offer local examples of how natural infrastructure has met water infrastructure challenges in more efficient, creative, integrated, and sustainable ways. They inspire and serve as proof of concept for budding nature-based projects. Natural infrastructure must become more accessible and widespread to serve as the backbone of healthy, equitable communities, vibrant economies, and resilient freshwater and coastal ecosystems.

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1. PRESERVING DRINKING WATER QUALITY AND QUANTITY THROUGH SOURCE WATER PROTECTION

More examples include: [City of Forest Grove Watershed Stewardship Management Plan](#); [Moss Creek Carbon Forest](#)

1.1 CITY OF ASTORIA: PROTECTING DRINKING WATER WITH SUSTAINABLE FORESTRY AND CARBON CREDITS

The City of Astoria purchased forest land to protect drinking water. In addition to source water protection, the City brings in revenue through sustainable logging practices and carbon credit sales.

Project Type: Source Water Protection

Goal: Protect water quality and quantity and mitigate risks to the water source

Total Acreage: 3,700 acres

Co-Benefits:

- **Ecological benefits** - Provides clean and sufficient drinking water, reduces greenhouse gas emissions
- **Economic benefits** - Keeps water rates low for customers, diversifies city revenue through carbon credits and timber sales, increases water flow into the hydroelectric dam, provides clean water for seafood processing
- **Community benefits** - Provides clean and sufficient drinking water, creates recreation areas, supports community resilience for future earthquakes and landslides

Funding Partners Include:

- The Climate Trust

Stakeholders Include:

- Forest Stewardship Council
- Forestry Consulting Firm
- Forest Carbon Consulting Firm
- The City of Astoria

Innovation: The City of Astoria generated net revenue of \$1.8 million for the city's capital improvement fund from carbon offsets by reducing timber harvest in the city's drinking watershed.

Photo of Astoria Project by The Climate Trust

Introduction and Primary Goal

The port city of Astoria is located on a narrow spit of land where the strong current of the Columbia River charges into the Pacific Ocean. To the South, the terrain rises quickly and continues to rise until it reaches Wickiup Mountain and the Wickiup Ridge. At the base of these features sits the Bear Creek Reservoir, the source of Astoria's drinking water. Surrounding the reservoir is the 3700-acre, forested Bear Creek Watershed.

This region is prime industrial timber land. Understanding the impact timber harvesting can have on water quality, the City slowly purchased the entire 3700-acre property and established the Bear Creek Watershed Forest Resource Management Plan in 2014. According to the plan, the primary purpose is to "provide the very best quality and quantity of potable water for the customers it serves."³⁹

Natural Infrastructure Solution

Healthy forests are an essential factor in water quality and quantity for several reasons. Tree roots stabilize the forest floor and prevent the erosion of sediment into the water. Arch Cape, a nearby city pursuing a community forest, reported that they need to shut down the water treatment facility each year to remove five dump trucks worth of sediment. The costs to perform the work are passed on to ratepayers.

In terms of water quantity, studies show that forest canopies account for about 35%, and soil accounts for about 34% of water storage in a watershed. Not only can these forested areas store incredible amounts of water, they can deliver a wide range of benefits such as biodiversity, water quality protection, recreation, and climate change resilience as well.⁴⁰

The City doubled down on its commitment to its water consumers and agreed to preserve even more of the forest. In 2015, The Climate Trust decided to purchase 245,000 carbon credits that would be sold to fossil fuel energy generators in the region to offset greenhouse gas emissions. Revenue from the carbon credits stays in the community and will be funding improvements to the water transmission line from the reservoir and other capital projects.

Climate change significantly impacts water, especially in coastal cities. Warmer ambient temperatures mean warmer water temperatures, which directly affect temperature-sensitive fish and aquatic species. Less snow and melting snowpack also contribute to warmer in-stream temperatures and less water quantity, especially in drier summers. Precipitation is changing from snow to larger volumes of rain, increasing flooding. Lastly, more severe weather can result in high rates of erosion and sediment in the water.

Preserving the natural function of a forest provides many infrastructure-scale benefits to a community. Overall, research indicates that effective implementation of forestry best management practices (BMPs) — e.g., maintaining forested buffers on streams and designing stream crossings and forest roads to minimize sedimentation from storm events — can reduce water quality impacts from 80 to more than 99 percent.⁴¹

Co-Benefits

Aside from the direct benefit the protected community forest has on drinking water, the preservation of the forest ecosystem protects fish and wildlife habitats within the watershed and populations living downstream.

Not only does the forest directly support the city's revenue through carbon credit and timber sales but water flowing from the reservoir passes through a hydroelectric dam which covers the energy needs of the water treatment facility with the surplus being sold to a utility. All of these factors contribute to Astoria's comparatively low water rates.⁴²

Financial Considerations

The cost to acquire land can be high. The cost to inventory the timber stands, hydrologic features, and the riparian regions can add up. However, over time, the avoided treatment costs and the timber revenue from BMP harvests will level these costs.

To help reduce the cost to a community, the U.S. Forest Service Community Forest Program provides grants to "tribal entities, local governments, and qualified conservation non-profit organizations" to purchase private forest land for the community's benefit. Oregon communities that have had projects funded by this program include Butte Falls, Eagle Creek, and Arch Cape.

The Oregon Watershed Enhancement Board also provides land acquisition grants for similar organizations to acquire land to maintain or restore watersheds and habitat for native fish or wildlife.

Policy Considerations

Many towns across Oregon face similar drinking water challenges as a result of declining forested areas. Current regulations on the timber industry require minimal stream buffers on privately owned lands, leaving community water supplies vulnerable to logging pollution, land instability, and water scarcity. More than two dozen communities have had at least 40% of the forests around drinking water sources cut down in the past 20 years.⁴³ Stakeholders can advocate for policy changes that make it easier for communities to purchase private timber lands.

1.2 EUGENE WATER & ELECTRIC BOARD (EWEB) AND PURE WATER PARTNERS: IMPROVING DRINKING WATER BY PROTECTING UPSTREAM RIPARIAN BUFFERS

EWEB worked with various groups to create the Pure Water Partners Program, a voluntary drinking water source protection program.

Project Type: Source Water Protection

Goal: Ensure high-quality water at EWEB's McKenzie River intake by protecting the upstream land area adjacent to the river

Total Acreage: ~8,500 acres in program boundary; 77 acres in Pure Water Partners (PWP) agreement; 790 acres in PWP program

Co-Benefits:

- **Ecological benefits** - Restores and repairs watershed functions, improves soil health, reduces or prevents fertilizer and other runoff from entering waterways, expands green spaces and wildlife habitat, sequesters carbon
- **Economic benefits** - Offers financial incentives for landowners, lower long-term costs for EWEB and their rate-payers to maintain water quality, provides green job training for youth and young people through Northwest Youth Corp
- **Community benefits** - Provides clean and sufficient drinking water, supports community resilience for future floods

Funding Partners Include:

- Eugene Water & Electric Board (EWEB)
- Metropolitan Wastewater Management Commission (MWMC)
- Oregon Watershed Enhancement Board (OWEB)
- US Forest Service Stewardship Contracting

Stakeholders Include:

- McKenzie River Land Trust
- Landowners
- Eugene Water & Electric Board
- The Freshwater Trust
- Upper Willamette Soil and Water Conservation District
- McKenzie Watershed Council
- Willamette Partnership
- US Forest Service
- University of Oregon
- Metropolitan Wastewater Management Commission
- Cascade Pacific Resource Conservation and Development

Innovation: The Pure Water Partners is the model for collaborative conservation. They are a collection of agencies, organizations, and businesses working together to protect and restore water quality in the McKenzie River Watershed and maintain clean, healthy drinking water for more than 200,000 people.

Photo of the McKenzie River

Introduction and Primary Goal

The McKenzie Watershed begins in the high Cascades. The volcanic soils found in this area do an excellent job of filtering and producing high-quality water through natural springs. These healthy springs provide clean water and deliver it at a stable rate, especially in the summer when other watersheds experience low flows. The Eugene Water & Electric Board (EWEB), a drinking water provider to approximately 200,000 customers,⁴⁴ recognizing the water resource's susceptibility to upstream impacts, began to develop a drinking water source protection program in the early-2010s.

The drinking water source protection program's primary goal is to ensure high-quality water at the utility's McKenzie River intake by protecting the upstream land area adjacent to the river and its tributaries. This area, called a riparian

area, serves as a buffer between the clean water in the river and contaminants that could run off the land and into the river.

Partners and Stakeholders

Early in program development, EWEB partnered with The Freshwater Trust to identify parcels along the river that were healthy and should be preserved. To connect with eligible landowners, EWEB tapped the Upper Willamette Soil and Water Conservation District (SWCD) to conduct outreach and build trust and support for the project. Much of the "on-the-ground" work is done by the SWCD and the McKenzie Watershed Council. Together, these organizations and others form the Pure Water Partners collaborative. The Willamette Partnership coordinates the collaborative.

Natural Infrastructure Solution

Vegetated riparian systems can buffer the surface water from contaminants and filter sediment, directly impacting water quality. Development, invasive species, and non-native landscaping in these buffer areas can affect and even eliminate a riparian area's ability to provide benefits. With data that showed the McKenzie River's water quality was high, EWEB developed the Pure Water Partners program to protect those riparian areas and preserve its water resource.

There are three pathways within the Pure Water Partners (PWP) program. The Protection, Restoration, and Naturescaping Pathways aim to protect the water resource and prioritize the riparian areas. In the Protection Pathway, a landowner could be paid an annual fee on a per-acre basis to preserve the healthy zone. Landowners who qualify for the Protection Pathway can also take advantage of free conservation work from PWP partners to keep that critical forested area intact. In the Restoration Pathway, a landowner may qualify for technical assistance and restoration work when funding has been secured. The Naturescaping Pathway, available to landowners with smaller properties, offers technical assistance and access to other incentives like one-time invasive species removal services and wholesale pricing on native plants. All pathways prioritize individual stewardship of the critical riparian areas along the McKenzie River.

Co-Benefits

One of the many co-benefits of vegetated riparian buffer areas is that they can absorb some of the rising water and help limit erosion during a flood event. Functioning riparian regions also contribute to groundwater recharge, provide habitat for fish and wildlife, and shade the surface water keeping water temperatures cool.

The PWP program enlists the Northwest Youth Corps (NYC) to perform a portion of its fieldwork. NYC provides job training and skill-building experiences for young people. Participants in the program can earn school credits and a weekly stipend for their work and access career resources and an extensive alumni network.

Alternatives Evaluated

Should the riparian areas along the McKenzie River degrade, contaminants and sediments could enter the river resulting in increased treatment at the point of intake. This would result in increased drinking water treatment and associated costs. Processes associated with this treatment are chlorination, coagulation and flocculation, sedimentation, and filtration. These processes can come at very high cost to the utility and ultimately the ratepayer.⁴⁵ Costs would either translate to water rate increases or reductions in capital improvements, maintenance and operations, or other critical program budgets.

Financial Considerations

The program's goal is to align funding from multiple watershed partners, grants, and private funds.⁴⁶ The McKenzie Watershed Conservation Fund was established to align those funds and simplify the administration of PWP activities. Cascade Pacific Resource Conservation and Development serves as the fund's administrator.

According to a PWP boundary valuation study, riparian buffers represent a value range of \$1,031 to \$6,713 per acre per year.⁴⁷ A willingness-to-pay survey of EWEB ratepayers showed that a majority supported a \$0.50 monthly increase to protect water quality in the McKenzie Watershed.

Policy Considerations

EWEB does not have jurisdiction or control over how land is managed in the watershed. Therefore, the utility needs to engage private landowners upstream and coordinate best management practices with them. Because landowner participation is voluntary, the incentive program was developed to attract participants.

A Memorandum of Agreement and formal governance handbook⁴⁸ guides the program and establishes a framework for program administration so that all participants, agencies, and funders are aligned and in pursuit of the same goals.

2. BUILDING FLOOD RESILIENCE WITH FLOODPLAIN RESTORATION

2.1 CITY OF PORTLAND: REDUCING FLOOD RISK BY RESTORING URBAN FLOODPLAIN

The City of Portland restored wetland and floodplain habitat in the Lents neighborhood to reduce the impact of devastating floods on the community.

Project Type: Floodplain Restoration

Goal: Mitigate flood damage, promote biodiversity, and increase access to recreation for locals

Total Acreage: Added 140 acre-feet of flood storage; restored 63 acres of wetland and floodplain habitat

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, expands green spaces and wildlife habitat, sequesters carbon
- **Economic benefits** - Reduces frequency and severity of floods, which lowers damage costs, reduces flood insurance costs, offers willing sellers fair market value for properties
- **Community benefits** - Supports community resilience for future floods, creates recreation areas, improves water quality, improves air quality, mitigates urban heat

Funding Partners Include:

- Federal Emergency Management Agency (FEMA)
- US Department of Housing and Urban Development (HUD)
- City of Portland Bureau of Environmental Services stormwater funding

Stakeholders Include:

- Bureau of Environmental Services (BES)
- Residents and property owners in Lents neighborhood

Innovation: The Willing Seller Program allows homeowners to sell their properties at fair market value voluntarily. This program decreases the harm that infrastructure projects can have by inequitably displacing communities.

Photo of Deer at Foster Floodplain, © City of Portland, courtesy Bureau of Environmental Services

Introduction and Primary Goal

The Lents community east of Portland was impacted by 64 significant flood events from 1941 to 2014.⁴⁹ Aside from the direct damage to property that these floods caused, there were several property owners that, due to their proximity to the natural Johnson Creek floodplain, were required to carry high premium flood insurance. In the mid-1990s, the City of Portland proposed a solution to the flooding problem that would mitigate flood damage, promote biodiversity, and increase access to recreation for locals. However, it would require that 60 residents in the area give up their property to make way for a 63-acre green space that would be designed to flood.

The Federal Emergency Management Agency (FEMA) describes the type of flooding experienced by Lents residents as riverine flooding. A watershed collects and

sends excess water downstream where it flows over banks and into a natural floodplain. In flat areas, shallow, slow-moving floodwater may cover the land in a floodplain for days or weeks.⁵⁰ For instance, in 2009, a significant rainstorm dropped 3 inches of rain in the area. This heavy, but not unusual, amount of rain pushed Johnson Creek's elevation over 4.5 feet above the bank's elevation, filling the floodplain for multiple days.⁵¹ After a particularly bad flood, some residents were trapped by the floodwaters for 12-15 hours.⁵²

If a waterbody, like Johnson Creek, could be connected to its natural floodplain, the number and severity of floods in the area would be reduced. This reconnection of the creek to its floodplain is what the City of Portland proposed to the Lents neighborhood.

Partners and Stakeholders

In the decades after Portland annexed the Town of Lents, residents reported seeing little in terms of street and sewer improvements, and over the years, Johnson Creek continued to flood. Long-term residents were understandably skeptical of the proposals. A few years earlier, the I-205 Freeway project physically split Lents, creating an east and west side of the community and did not create the economic growth that residents had hoped.⁵³ To make room for the highway, 500 homes were forcefully taken using condemnation.

Alternatives Evaluated

We have relied on engineered solutions for hundreds of years. However, not only do these built alternatives like levees, canals, and reservoirs allow us to exist in dangerous areas where water naturally flows, but these alternatives can be prone to failure, as well. When they fail, the results can be catastrophic and expensive. Families can lose homes, communities can be displaced, and the cost of reconstructing flood protection infrastructure can be high.

Traditionally, floods have been held back by adding fill soil and rip rap (engineered bank hardening) to the banks and low-lying areas to hold back the rush of water. While this addresses the immediate flood risk, it creates a situation where, when the water breaches the banks, it travels further across the floodplain and, perhaps more critically, it may not recede over the artificially heightened banks. In the 1930s, the Works Progress Administration did just that. Rocks were arranged in an attempt to block floodwaters, creating the situation described above along Johnson Creek and across the nation.

Johnson Creek was not going to stop flooding, and with the ever-increasing magnitude of flooding due to climate change, it became clear that the floodplain needed to be restored.

The Natural Infrastructure Solution and Co-benefits

The newly restored floodplain helps filter sediment from Johnson Creek before it reaches the Willamette River. It created 63 acres of native fish and wildlife habitat in a salmon-bearing watershed. Other benefits include increased access to green space and improved air quality for those living near the Foster Floodplain Natural Area.⁵⁴ Before the restoration of Foster Floodplain, Foster Road and nearby businesses flooded about every other year. Now with the restoration complete, the area is expected to flood only every 6 to 8 years. When the creek does flood, it will not impact those living in the most vulnerable areas because they have been relocated.

The City of Portland's Bureau of Environmental Services restored wetland and floodplain habitat, with a half-mile of restoration along Johnson Creek benefitting threatened salmonid species. The natural area boasts paved, ADA-compliant paths and access to the multi-use Springwater Corridor, a segment of Portland's 40-Mile Loop. The project included tens of thousands of native tree and shrub plantings that sequester carbon, mitigate urban heat, cool Johnson Creek, and provide wildlife habitat.

Financial Considerations

The project was funded primarily by a FEMA Pre-Disaster Mitigation grant. The \$2.7 million award was based on BES demonstrating, among other things, a cost-effective approach that would maximize the mitigation of the disaster and benefits to the community. As a result of amendments by the Disaster Relief and Recovery Act of 2018, the Pre-Disaster Mitigation program is being replaced with the new Building Resilient Infrastructure and Communities (BRIC) program. According to the Fiscal Year 2020 BRIC Notice of Funding Opportunity Fact Sheet, among the program's priorities are to "incentivize projects that incorporate nature-based solutions."⁵⁵

Policy Considerations

BES needed to create a tool for fairly acquiring the 60 properties within the project area. Condemnation had been used before, but BES was committed to a fair and open process. In 1997, fifteen years before restoration began, the City of Portland's Bureau of Environment Services implemented Johnson Creek Willing Seller Land Acquisition Program to acquire property and help move those living within the floodplain to safer homes.

In the years before restoration began, BES and the Willing Seller Program often met with local groups and individuals to describe the project and best available options for floodplain management in Lents. There are reports that show public, open-door meetings were held at the proposed project site, an essential component of good civic engagement. These reports also show residents of Lents leading the sessions, giving testimony that, in some cases, undermined the project. An article in the local newspaper published BES responses to citizen's questions. Ultimately, through the Willing Seller Program, the City of Portland purchased 60 properties at fair market value and helped move residents out of this flood-prone area to create the Foster Floodplain Natural Area.

2.2 TILLAMOOK COUNTY: REDUCING FLOOD DAMAGE BY RESTORING TIDAL WETLANDS

Tillamook restored critical tidal wetlands to reduce the impact of flooding in surrounding communities.

Project Type: Floodplain Restoration

Goal: Reduce flooding in the surrounding communities and farmlands and restore critical habitat for Oregon Coast coho salmon

Total Acreage: 689 acres total; 443 acres restored to full tidal inundation

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, expands green spaces and wildlife habitat, sequesters carbon
- **Economic benefits** - Reduces frequency and severity of floods, which lowers damage costs, supports port transportation options, protects private and commercial property
- **Community benefits** - Supports community resilience for future floods, creates recreation areas, improves water quality

Funding Partners Include:

- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration Fisheries (NOAA)
- Oregon Watershed Enhancement Board (OWEB)
- Oregon State Lottery Bonds
- US Fish and Wildlife Service (USFW)
- Oregon Business Development Department
- Regional Solutions
- National Fish and Wildlife Foundation

Stakeholders Include:

- Oregon Solutions and Declaration of Cooperation
- Port of Tillamook Bay (POTB)
- City of Tillamook
- Tillamook Estuaries Partnership (TEP)
- Tillamook Bay Flood Improvement District
- Oregon Office of Emergency Management (OEM)
- Dairy farmers, business owners, and landowners
- US Fish and Wildlife Service
- Institute for Applied Ecology

Innovation: Sheer number of environmental benefits; estuary restoration for climate resilience and critical environmental habitat

Photo of Tillamook by Dan Meyers, Unsplash

Introduction and Primary Goal

In 2007, a significant flood event damaged property in the City of Tillamook, including a stretch of railroad tracks used to transport goods to and from the port. The Federal Emergency Management Agency offered to fund the repairs to the railroad, which would cost approximately \$56 million but would require a 10% local contribution, or \$5.6 million, from the City. While the railroad was down, freight businesses found that transporting via truck was more

cost-effective in the area and had no interest in chipping to bring the railroad back online.⁵⁶ Further complicating the current decision was that only 11 years earlier, the City had used similar funds to repair the exact railroad when it was damaged during a previous flood event. Regional flooding was a common occurrence, and the current dikes and levees did not seem to be working for all. Life safety and private and commercial property were threatened, and new solutions needed to be explored.

Partners and Stakeholders

After the 2007 flood, then-governor Ted Kulongoski directed Oregon Solutions to begin the process of convening stakeholders in pursuit of sustainable flood mitigation solutions in the Tillamook Bay area.⁵⁷ Oregon Solutions was tasked with creating a structure and function that would bring together area partners to address a politically and technically challenging community need. In Tillamook, these diverse partners included City and County agencies, dairy farmers and landowners, businesses, conservation-focused organizations, and community groups. Together, they would sign a Declaration of Cooperation and begin work on alternative project proposals to address flooding.

Natural Infrastructure Solution

Instead of accepting the restrictive emergency funds, the City opted to accept a FEMA Alternate Projects grant, which required the City to contribute 25% of the project cost but allowed them to pursue a more beneficial natural infrastructure project at a much lower price (\$11.17 million). The resulting project, the Southern Flow Corridor - Landowner Preferred Alternative, completely altered the landscape and how water flows through it. Crews removed approximately 200,000 cubic yards of fill soil and 7 miles of levees and roads, reconnected 18 channels, and restored 14 miles of natural channels. Instead of keeping water out, the 522-acre area was returned to the historical tidal wetland that existed before the levees and dams were built. The "flow corridor," now designed to move water into the bay, will reconnect the estuarine basin and the wildlife that naturally live in those habitats. Invasive grasses that were before untouched by water will die off under the saltwater, creating food for insects, which will attract native fish species to the restored estuary habitat. When the high water subsides, native grasses will grow and provide acres of pasture to support the local dairy industry.

Shortly after the project was completed, a flood occurred in Tillamook. The flood levels around Highway 101 were almost 1 foot lower than average, the duration of the flood was reduced by 3-4 hours, and a total of 4,800 acres showed some level of flood reduction. These results are consistent with the flood mitigation and life safety goals set at the beginning of the project.⁵⁸

Co-Benefits

In addition to protecting property and businesses from flood impacts, restoring tidal wetlands helped to restore critical habitat for Oregon Coast coho salmon and other wildlife. The expanded natural areas create recreation and aesthetic value to the surrounding community.

Alternatives Evaluated

Several alternatives were considered throughout the design process, but FEMA's Environmental Impact Statement examined four. Two options would have removed approximately 400 acres of grazing and pasture land and were generally not supported by landowners. Periodic dredging was also a component of the solutions considered, though it was determined that the flood reduction levels were lower and the benefits more localized than the Landowner Preferred option.⁵⁹

Financial and Political Considerations

The cost-effectiveness of the Landowner Preferred Alternative was a significant hurdle to overcome in the planning stage of the project. Originally, the proposed action was denied because FEMA disagreed with the early cost-benefit analysis (CBA) findings saying that the values were inconsistent with default values used by the agency. The project management team argued that using FEMA default values for a CBA did not capture the actual value of potential damages and loss to possible floods in the area.⁶⁰ Appeals to the agency were ultimately successful but not without executive and congressional intervention. Two U.S. Senators, a Member of Congress, and the Governor of Oregon sent letters to FEMA to support the appeal and the method by which the CBA was completed. They also wrote requesting that FEMA expedite their review of the appeal as matching state funds were at risk of arbitration should the process lag.⁶¹

According to Tillamook County, flood losses in Tillamook County exceeded 60 million dollars between 1996 and 2000. With the project completed and inland flooding mitigated, projected avoided costs associated with flood damage alone are approximately \$9.2 million over 50 years.⁶²

3. TREATING WASTEWATER WITH CONSTRUCTED WETLANDS

3.1 CITY OF PRINEVILLE: CHEAPER AND EFFECTIVE TERTIARY TREATMENT BY CONSTRUCTING WETLANDS

The City used natural engineering to polish effluent of sediment and other pollutants and to cool the temperature of the water before it reenters the adjacent river through groundwater infiltration.

Project Type: Municipal Constructed Wetlands

Goal: Maintain low costs for customers and release cleaner and cooler water from wastewater treatment facility.

Total Acreage: 120 acres

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, expands green spaces and wildlife habitat, sequesters carbon and lowers energy and carbon footprint
- **Economic benefits** - Offers substantially cheaper and effective wastewater solution, decreases rates for homeowners and businesses, promotes industrial and residential development
- **Community benefits** - Creates recreation areas, improves water quality, offers educational opportunities

Funding Partners Include:

- Economic Development Administration Rural Development Grant (EDA)
- Business Oregon
- Oregon Department of Environmental Quality (DEQ)
- Confederated Tribes of Warm Springs and Portland General Electric (Pelton Fund)
- Oregon Watershed Enhancement Board (OWEB)
- Oregon State Parks
- Prineville Kiwanis
- East Cascades Audubon Society
- City of Prineville

Stakeholders Include:

- School districts
- Crook County Health Department
- US Fish and Wildlife Service
- National Oceanic and Atmospheric Administration
- Crook County Parks and Recreation

Innovation: It centered the values of the community in its design. The project has diverse partners, thorough public outreach and recreation, and flexible expansion and growth.

Photo of Prineville Wetlands, City of Prineville

Introduction and Primary Goal

When water enters our household toilets and drains, it becomes wastewater and must be treated before being returned to the environment. As cities grow, the amount of wastewater grows with it and a city must plan, build, and operate new wastewater treatment infrastructure to keep pace with community growth. This was the situation the City of Prineville found itself in in the mid-2000s. Prineville saw a significant increase in residents from 1999 to 2000 and a slower but steady increase in the years after. The wastewater treatment capacity was nearing its limit. Two alternatives were proposed: an expansive wetland complex that would provide many community benefits or a costly mechanical treatment plant that would serve a single purpose and have a limited lifespan. The primary goal of wastewater wetland treatment is to polish effluent, removing additional sediment and other pollutants, and cooling the water temperature before it reenters surface water.

Partners and Stakeholders

In the mid-2000s, the City of Prineville became aware that it would need to expand its wastewater treatment capacity. They began identifying stakeholders and engaging them early. Stakeholder meetings were held at the beginning of the project and at five intervals during the design process. At each phase of project development, stakeholders were invited to express concerns and ideas. The stakeholder group directly impacted components of the project relating to riparian area improvements, wetland habitat, recreational opportunities, educational elements, and pest control methods.

Alternatives Evaluated

The estimated cost of the proposed mechanical facility was approximately \$62 million. These costs would have been passed on to ratepayers, which would have increased development permit fees three-fold and would have required user fee increases. The ability for ratepayers to pay had already been tested as sewer

fees had been increased from \$15 per month to \$52 per month over seven years. To maintain its attractiveness to new development and commerce, the City would need to explore cheaper options. Aside from being the more expensive option, the built facility would have had a finite lifespan. Not only will the wetland complex meet the treatment needs of the facility but, if it is maintained properly, it will operate and provide community benefits for decades.

Natural Infrastructure Solution

Prineville constructed a 120-acre wetlands complex, which brought the City's treatment capacity up to 2.5 million gallons per day. The wetlands take advantage of natural bacteria in the wetland to reduce ammonia levels in the treated water. The wetlands also cool the effluent to groundwater temperatures and eliminate the direct discharge of treated wastewater to the Crooked River. The water in the wetlands infiltrates into the ground and travels via groundwater toward the Crooked River to reach the river. The facility does not use mechanical pumps in the wetland system and instead use a series of water control weirs and gravity to move water throughout. The system has the added benefit of reducing electricity costs. Though Prineville's surface water wetland relies on many engineered components to control flow and detention time, it is the wetland's natural function that achieves the primary goal of the project.

Co-Benefits

The 120 acres of constructed wetland serves as habitat for waterfowl, invertebrates, amphibians, birds, pollinator species and other wildlife. Throughout the space, informational kiosks were researched and developed by local students and provide the school district with a natural area to visit on field trips. Two miles of riparian improvements along the Crooked River have enhanced cold water refuge for temperature-sensitive fish species. The wetland complex also features public trails that provide access to birdwatchers and other recreational activities. It also keeps the City's energy and carbon footprint down and sequesters atmospheric carbon.

Financial Considerations

A total of \$3 million in funding came from a federal rural development grant (EDA), a state business development grant (OBDD), an energy utility restoration fund grant (PGE/Pelton), a state watershed agency fund (OWEB) and a parks and recreation grant, with the remaining \$4.7 million coming in the form of a low-interest Clean Water State Revolving Fund loan that will be repaid by the City and its ratepayers.

The City engaged potential funding agencies early on and focused on building those relationships to ensure that everyone's needs were met and their questions were answered. The City listened to the local parks and

recreation board and applied their funds to the trail system, filling a huge need for active recreation space in town.

Policy Considerations

Natural infrastructure projects come with a unique set of challenges. Planning, financing, and permitting are a few barriers that practitioners have reportedly struggled within the early stages. Prineville found success in the planning and financing stages, in part because they brought together stakeholders early on. These groups came together to advise on "wetland habitat, riparian improvements, education/recreation, and pest control." They demonstrated to funders that the wetland system would achieve the treatment goal with the most benefits.

The City faced a significant permitting challenge. State and federal agencies were hesitant to approve permits for the project, given that it was so unconventional. The City engineer understood that to get the agencies' attention, they would need the full backing of Prineville's mayor. After consultation, it was determined that it would be best for the mayor to call the initial meetings so as to provide clout to the project team.

Risk was mitigated by performing low-cost preliminary data collection early in the concept development stage. Soil testing and groundwater modeling helped prove that the project area was suitable for a wetland treatment facility. The City provided this data to the regulatory agencies and received a letter back stating that the site could obtain the necessary permits based on the initial data.

One of the biggest policy challenges that infrastructure providers face is streamlining permits. In this case study, DEQ initially approved the project but it was later denied by the EPA. Although the City and agencies were able to find a resolution, it required significant work and intervention by the Governor and congressional representative. By addressing the policy challenge of streamlining permits between agencies, natural infrastructure solutions will be an easier alternative for many utilities and other infrastructure providers to adopt.

Additional resources can be found in a report co-published by the Oregon Department of Environmental Quality and the Oregon Association of Clean Water Agencies. It provides greater technical detail on natural treatment systems for local decision makers and public works professionals considering them ahead of treatment plant expansion or upgrades.⁶³

3.2 ROSEBURG URBAN SANITARY AUTHORITY: CHEAPER AND MORE EFFECTIVE TERTIARY TREATMENT BY CONSTRUCTING WETLANDS

RUSA implemented natural treatment systems to treat and cool wastewater discharge. The water now discharged is 7°C cooler than the river temperature, which far exceeds the temperature reduction RUSA was required to achieve.

Project Type: Municipal Constructed Wetlands and Indirect Discharge

Goal: Reduce phosphorus and temperature of wastewater discharge while reducing costs for the community

Total Acreage: 340 acres

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, expands green spaces and wildlife habitat and cools South Umpqua River temperature, sequesters carbon
- **Economic benefits** - Offers substantially cheaper and effective wastewater solution (reduced new water treatment system costs from \$100M to \$8M), maintained low rates for customers, treated water irrigates active farm on property

- **Community benefits** - Improves water quality, offers educational opportunities and improves livability of the area by protecting open space that was slated for development

Funding Partners Include:

- Roseburg Urban Sanitary Authority
- Business Oregon

Stakeholders Include:

- Oregon Department of Environmental Quality
- Landowners
- Community groups

Innovation: Integrated reuse of treated water with a nearby agricultural operation. The City of Roseburg reduced its costs for a new water treatment system from \$100 million to \$8 million by choosing treatment wetlands instead of a conventional treatment plant and indirect discharge is now significantly colder than required. This is a huge ecological benefit beyond strict compliance with the standard.

Photo from Roseburg Urban Sanitary Authority by Ryon Kershner

Introduction and Primary Goal

The Roseburg Urban Sanitary Authority (RUSA) operates the Roseburg Regional Water Reclamation Facility, with the capacity to treat 7.9 million gallons of wastewater per day. On average, the facility treats around 3 million gallons per day in the summer, and 6 million gallons per day in the wet winter months. After the wastewater undergoes primary and secondary treatment, further processing is required to meet established water quality criteria for temperature and phosphorus before being discharged into the South Umpqua River, a fish-bearing water body home to temperature-sensitive species. When discharged into a water body, heat and phosphorus can create uninhabitable conditions for native fish species.

Partners and Stakeholders

RUSA provides sewer and wastewater treatment services to customers living within the city's urban growth boundary. When regulation for wastewater discharge changed, RUSA began to explore options for additional treatment capability.

They hired private firms to evaluate water reuse to irrigate a poplar forest or a golf course. RUSA also began performing feasibility studies on the site that would soon become the natural treatment system.

To fund the project, RUSA received a loan from the Infrastructure Finance Authority (IFA), an infrastructure-focused group within Business Oregon, the state's economic development agency. The IFA prioritizes applications for assistance, both technical and financial, to maximize the state's limited infrastructure monies. The financing programs include but are not limited to, brownfields redevelopment, drinking water infrastructure funds, special public works (i.e. rail, airports, energy systems, etc.), seismic rehabilitation, and wastewater funds.⁶⁴

Natural Infrastructure Solution

Completing the natural system began with clearing of invasive species, reversing heavy compaction resulting from long-term grazing, and planting native grasses and ash trees. Additionally, cuttings of native plants

like willows, wild roses, and oak from the property were propagated and grown throughout the site.

During the dry season, water is diverted from the Water Reclamation Facility to the adjacent 340-acre natural treatment facility, where it is discharged into a storage pond and treatment wetland.⁶⁵ The facility, which is former pastureland, only discharges water from the treatment ponds through irrigation sprinklers after ammonia and nutrients, including phosphorus, have been removed. Water applied to the grasslands is polished further either by plant uptake or subsurface migration, where nutrients are immobilized. Water moving through the soil or overland reaches low-lying, shaded wetlands where it is cooled before entering a creek at the bottom of the property. Water is only discharged into the South Umpqua River through the creek. Nutrient loading into the river went from 100 lbs. a day before the natural facility to 3 lbs. or less after it had been constructed.⁶⁶ Water discharged from the creek to the river is as much as 7°C cooler than the river temperature, which far exceeds the temperature reduction RUSA was required to achieve.

This natural treatment system relies on two natural treatment methods: wetland treatment and indirect discharge. Wetland treatment depends on existing or constructed wetlands to achieve water quality improvements by the plants' water uptake, microbial breakdown of organics, sedimentation, and passive cooling.⁶⁷ Indirect discharge uses natural subsurface chemical and physical processes to remove contaminants from water that seeps into the soil.

Co-Benefits

In addition to direct water quality benefits, the RUSA natural treatment system provides other co-benefits to the community. The active farm property is irrigated with the treated water which provides lush grazing pastures for a herd of sheep. The large property features grass lands and forested habitat for wildlife and has protected valuable greenspace adjacent to the City of Roseburg. The 340-acre site also has a 133 million gallon storage capacity between the surface and subsurface features.⁶⁸ The area where the property's creek discharges into the South Umpqua River creates an improved environment for fish migrating upriver.

Alternatives Evaluated

In the early planning phases, it was determined that a tertiary treatment plant was needed to meet established water quality standards. This plant would have cost RUSA nearly \$100 million and would only be used seasonally, from May 1 to October 31.⁶⁹ The built option would have been more costly and less sustainable, required additional chemical inputs, and would not have provided the co-benefits associated with the natural treatment system.

Financial Considerations

The natural infrastructure alternative cost \$8 million to complete, \$92 million less than the built option, and achieved the same or better water quality goals. Of this cost, \$4 million accounted for the cost of the land, which will increase in value over time. Other upfront costs included the built/natural options analysis, project design, construction administration and inspection, and the construction contract.

RUSA funded the improvements from accrued savings and a loan from the Oregon Infrastructure Finance Authority. The loan, \$2,374,380 in total, came from IFA's Water/Wastewater Financing Fund. While grants (capped at \$750k for construction and \$20k for technical assistance) from the fund are made available to applicants, market-rate loans (subsidized-rate loans are available depending on community needs) up to \$10 million can be used for stormwater and wastewater treatment projects.⁷⁰

Policy Considerations

A report co-published by the Oregon Department of Environmental Quality and the Oregon Association of Clean Water Agencies provides greater technical detail on natural treatment systems for local decision makers and public works professionals. In the paper, the regulatory framework for wetlands treatment and indirect discharge are briefly discussed.⁷¹

As it relates to wetlands treatment, the main takeaways described in the paper are to gather hydraulic, geomorphic, and soil data ahead of the planning process, map the nearby wells, identify the point-of-compliance, and engage DEQ on NPDES or WPCF specific permit requirements. It is important to remember that constructed wetlands are not subject to EPA, USACE, or Oregon Department of State Lands regulations.

Indirect discharge will ultimately reach waters of the state so a NPDES permit is required for a system of this kind. The state's Department of Environmental Quality's policy for indirect discharge is discussed in Disposal of Municipal Wastewater Treatment Plant Effluent by Indirect Discharge to Surface Water via Groundwater or Hyporheic Water (2/07) and is available on the agency's website.⁷²

4. COOLING WATER TEMPERATURE WITH UPSTREAM RIPARIAN RESTORATION

Other Examples: [The City of Ashland is working with the Freshwater Trust](#)⁷³ to plant vegetation and reduce water temperature along Bear Creek. [Streamside restoration](#)⁷⁴ may have improved wildfire resilience during the 2020 wildfire season. More research is needed to determine if riparian restoration can benefit climate and fire resiliency.

4.1 CITY OF MEDFORD: TEMPERATURE COOLING THROUGH RIPARIAN RESTORATION AND WATER QUALITY TRADING

The City set up a water quality trading program to compensate landowners for riparian restoration that cools upstream water. This was a much more cost-efficient solution than building storage lagoons or mechanical chillers to cool wastewater effluent.

Project Type: Riparian restoration and water quality trading

Goal: To address the temperature limit for City of Medford's wastewater effluent.

Total Acreage: 49 acres

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, improves soil health, reduces or prevents fertilizer and other runoff from entering waterways, cools water temperature, expands green spaces and wildlife habitat, reduces carbon footprint, and sequesters carbon

- **Economic benefits** - Keeps water rates low for customers, as an alternative to chillers or storage lagoons, riparian restoration saved taxpayers \$8M, landowners are paid between \$100 and \$300 per acre/per year
- **Community benefits** - Provides clean and sufficient drinking water, improves air quality

Funding Partners Include:

- City of Medford

Stakeholders Include:

- The Freshwater Trust
- Landowners
- Local businesses

Innovation: The City of Medford saved \$8 million and created wildlife habitat and natural water filtering buffers by investing in water quality trading to meet standards.

Photo by Skyris Imaging for The Freshwater Trust

Introduction and Primary Goal

The City of Medford sits near the Rogue River. The river has an international reputation for its beauty and salmon runs. Medford treats millions of gallons of wastewater per day and discharges the treated effluent into the Rogue River. Because the native salmonid species need cool water to survive, a temperature limit was placed on discharges to the Rogue River. The discharged effluent from the City of Medford's treatment facility was going to exceed that limit at the discharge point, raising downstream temperatures.

Fewer and fewer salmon are returning to their natural freshwater habitats from the ocean to spawn.⁷⁵ These numbers are influenced by ocean conditions, fish harvest, obstructed passage, and impacts of climate change, but the decline in salmonid population is also due to instream water temperature increases from human activity. Warmer water temperatures create stressful and disease-prone conditions for already-vulnerable migrating salmon, so keeping rivers cool is essential to support healthy salmon populations.⁷⁶ Reshaping of rivers, runoff from rural and urban areas, water discharges from wastewater facilities, and removal of streamside vegetation are some of the many ways humans contribute to warmer temperatures in surface water bodies.⁷⁷

Alternatives Evaluated

To address the temperature limit for its wastewater effluent, the City of Medford weighed three options. First, the City evaluated constructed lagoons to store water to be discharged at a time when effluent would not exceed the temperature limits. This option would have required large areas of land to be disturbed. Second, the City evaluated mechanical chillers to address the temperature exceedances. This option would have increased greenhouse gas emissions and ongoing energy and chemical consumption, limited the beneficial effect on the temperature in the river, and have a limited lifespan. Both alternatives, the effluent storage and effluent chillers, cost around \$15 million.⁷⁸ Third, the City considered restoring riparian areas by increasing effective shade upstream so that water temperatures could be reduced over the entire stretch of the river. The final riparian restoration option cost around \$6.5 million.⁷⁹

It is important to note that this last approach was a realistic option for Medford's wastewater utility because water quality trading was already written into its wastewater discharge permit as an allowed means of meeting its temperature requirements. In locations that do not already have this flexibility in their permit language, pursuing a

water quality trading program to mitigate temperature impacts might take more time and effort to obtain necessary approvals. Ultimately, the City chose the natural infrastructure option and restored riparian areas upstream. This saved approximately \$8 million compared to storage lagoons or mechanical chillers.⁸⁰

Natural Infrastructure Solution

As an alternative to installing expensive technology to meet the federal Clean Water Act requirements, point sources, like wastewater facilities, can work with landowners within the watershed to implement conservation and restoration practices that reduce pollutants at a lower cost through water quality trading (WQT). Landowners are compensated for their efforts and are often heavily involved in the water quality improvement measures, mainly when those measures include implementing Best Management Practices (BMPs) on farms or rangeland. After the water quality benefits of restoration or implementation of BMPs are verified, they become credits, which can be purchased by point sources to meet regulatory requirements. Water quality trading can create new revenue sources for farmers, ranchers, land managers, and conservation groups. Also, trading projects provide a range of additional environmental benefits, such as air quality improvements, fish and wildlife habitat creation, and climate change mitigation. These benefits are provided year-round as opposed to built infrastructure. Studies show that after 20 years, planted buffer areas 45 feet wide can block 18.8 million kilocalories (kcal) per day per mile. Costs associated with planting trees along 35 miles of stream may only reach \$12 million, saving roughly \$50 million over 20 years relative to a mechanical chiller.⁸¹

The City agreed to offset the heat units, measured in kilocalories (kcal), or the amount of energy required to raise a liter of water temperature by 1.0°C, at a rate of 2 to 1 to account for the length of time it takes new riparian plantings to achieve maturity and maximum impact. To do this, they contracted with The Freshwater Trust to plant trees upstream that block solar energy from the river to mitigate the 600 million kcal per day impact to the Rogue. Since 2011, the City has planted over 6 miles of native vegetation with The Freshwater Trust and participating landowners. In this case, the water quality credits produced by landowners' restored riparian buffers have a lifetime of 20 years, as written into the project contract. Landowners committed to ensuring access to the restored areas to allow for project monitoring and maintenance. The Freshwater Trust set up agreements with local businesses to conduct these services throughout the credits' durations. Landowners are paid an annual land rental fee from the project budget for their restored, credit-generating riparian areas.

Co-Benefits

As well as meeting established water quality standards, Medford's project created significant co-benefits. Non-native plant species were eradicated and replaced with

native, carbon-sequestering plant species that provide habitat for and assist in the restoration of other native plant and animal species. The restored stream sides also stabilize banks and limit erosion. Additionally, the riparian areas filter sediment, which can carry harmful chemicals in runoff.

The City of Medford's restoration along the Rogue River highlights water quality trading's cost-effectiveness as a natural water infrastructure approach. Projects such as this one are not only an investment that improves water quality, they also provide direct investments in local economies and create watershed-wide engagement in natural infrastructure solutions.

These types of sustained restoration projects require large-scale planting, long-term maintenance, and monitoring, which stimulates what is being called a "restoration economy." Projects like this natural infrastructure solution in Medford support opportunities in the local economy, including engineering, wildlife biology, plant nurseries, heavy equipment and construction, and rock and gravel.⁸² In fact, a study done on a five-county area of Southwestern Oregon found that total investments in 2,350 restoration projects supported 727–1,018 jobs.⁸³ The same study found that a \$64.3 million investment in restoration work generated an estimated \$113.7 –\$141.1 million in economic output, 80% of which stays in the local area. Finally, the project provides another source of revenue for landowners. They are paid between \$100 and \$300 per acre/per year for the length of the project.⁸⁴

Policy Considerations

There are some challenges associated with this approach. The processes related to permitting and planning can be arduous and technical, requiring capacity and financial resources.⁸⁵ Once the project has been installed, regular maintenance must be performed to achieve the compliance targets and ongoing co-benefits. Maintenance must ensure that native plants continue to grow and are not overcome by non-native or vigorous weedy plants. Another challenge is the issue of scale. To be feasible on the large-scale, many miles of streamside restoration need to be coordinated, requiring even greater capacity and a more robust trading market. Third-party organizations like The Freshwater Trust can help utilities navigate these challenges.

Third-parties can help facilitate a WQT program by streamlining the process for the landowners and the municipality, removing some of the risk and uncertainty often associated with alternative water quality improvement projects. However, it is vital that any organization playing this management role either knows the area's culture or solicits and listens to local entities' suggestions throughout the entire planning, implementation, and monitoring process. A cornerstone of the Medford WQT program's success was the contracts The Freshwater Trust made with local businesses to carry out the project's various steps.

5. TREATING STORMWATER RUNOFF WITH CONSTRUCTED WETLANDS

5.1 CITY OF GRESHAM: IMPROVING WATER QUALITY THROUGH REGIONAL STORMWATER TREATMENT

Through a private-public partnership, the City created a regional stormwater treatment site to treat stormwater runoff in a highly industrial area before it enters the Columbia Slough.

Project Type: Regional Stormwater Management Facility

Goal: Provides vegetated stormwater treatment for 965 acres of primarily industrial and commercial land using a combination of sedimentation forebays and vegetated terraces

Total Acreage: 965 acres

Co-Benefits:

- **Ecological benefits** - Restores watershed functions, expands green spaces and wildlife habitat
- **Economic benefits** - Contains major spills and saves clean-up costs, ecologically self-sustaining system keeps maintenance costs low, treats stormwater which reduces treatment costs downstream, flood control reduces the risk of flood damage

- **Community benefits** - Improves water quality, removes harmful industrial runoff, creates trails, offers educational opportunities, protects Portland and Gresham's backup drinking water supply

Funding Partners Include:

- City of Gresham's Capital Improvement Program (CIP)
- Boeing

Stakeholders Include:

- Columbia Slough Watershed Council

Innovation: The stormwater treatment facility embraced ecosystem complexity and was flexible to unexpected natural changes. Beavers have made the constructed wetlands their home and have built dams throughout the complex. To understand their impact, the Watershed Division conducted a study and found that the beaver dams demonstrably enhanced filtration and pollutant removal. They concluded that dams could exist in the facility without threatening infrastructure.

Photo by Tim Umphreys, Unsplash

Introduction and Primary Goal

The Columbia Slough Regional Water Quality Facility was constructed in 2007-2008 on a 13-acre site. The municipality constructed the wetland to treat stormwater from the surrounding 965 acres of primarily commercial and industrial land. Its primary goal is to clean stormwater before it enters the Columbia Slough while also providing habitat and offering educational opportunities. Boeing was able to meet its on-site stormwater treatment requirements and the City could use the facility to protect against major spills and other non-point pollution from surrounding areas.

Partners and Stakeholders

In 2001, Gresham's Watershed Division began conversations with Boeing of Portland & Boeing Realty to explore stormwater treatment solutions and develop a partnership. After five years of developing and strengthening their relationship, Boeing donated 13 acres of land to construct a stormwater management facility in 2006.

The City of Gresham also worked closely with the Columbia Slough Watershed Council and other stakeholders.

Natural Infrastructure Solution

The facility was designed to reduce pollutants from the surrounding industrial and commercial area that previously drained directly into the Columbia Slough. It uses vegetated terraces and sedimentation forebays to treat stormwater. The vegetated terraces include three zones: emergent wetland vegetation, willow forest with periodic inundation, and upland riparian forest. There is a sediment forebay at each point of stormwater discharge, allowing for regular maintenance and removal of sediment and other associated stormwater pollutants. The facility reduces pollutants such as heavy metals, oil and grease, harmful nutrients, polynuclear aromatic hydrocarbons (PAHs), phthalates such as DEHP, and current-use pesticides such as 2,4-D and pentachlorophenol. In addition to treating stormwater, it is also prepared for hazardous spill containment using large underground vaults and forebays.

Co-Benefits

The wetland offers co-benefits such as educational opportunities and improved habitat. Educational opportunities include a formal trail, viewing sites, and interpretive panels for visitors. It is also a field trip site for local schools. A curriculum was designed to teach students about stormwater management, wildlife species, and habitat.

The project also establishes an ecologically self-sustaining system, keeping maintenance costs low and improving natural resource habitat. As the wetland ecosystem established itself over the years, willow trees became prevalent. Willow is a favorite food for beaver, and over time, the facility became a desirable habitat for them. Beavers moved into the facility, eating willow and constructing dams where there was running water. The immediate reaction was to remove the beaver dams. However, after consulting various team members and experts, Gresham decided to conduct a study to assess whether beaver dams helped or hindered the facility's water quality treatment. The results were impressive: beaver dams reduced pollutant levels and increased ecosystem complexity. Beaver dams enhanced the facility's infrastructure by further slowing down and filtering stormwater. They concluded that dams could exist in the facility without threatening infrastructure. The City is now working with a consultant from Beaver State Wildlife Solutions to design and build "coexistence structures" that help protect infrastructure from beaver activity in key places. Examples of coexistence structures include pond levelers and culvert protection fences.

Alternatives Evaluated

Planners sought to maximize outcomes for the small amount of land available. This was the best option for controlling floods, treating stormwater quality, and improving habitat. An alternative individual stormwater proprietary device would have been more expensive in construction and especially in maintenance.

Financial Considerations

The Columbia Slough Regional Water Quality Facility was possible because of the strong partnership with Boeing, which donated 13 acres of land. Boeing was able to use the facility to manage stormwater and meet their stormwater requirements. The facility was funded through the city's Capital Improvement Program (CIP) budget, including a mix of system development charges (SDCs) and stormwater utility rates. Not including the value of the land, the facility cost \$2.4 million.

Policy Considerations

As a retrofit design, changes in design that occur naturally over time did not impact permits or requirements. The facility is flexible in how high water levels could be as a result of beaver dams. For facilities considering a similar design, it's important to build room for natural changes that occur in ecosystems while assessing if primary goals are being met. Collaborative problem-solving helped the team evaluate the impact of the unexpected beavers. They used evidence and consulted various staff to adaptively manage the changing landscape while meeting their primary treatment goals.

Another way to manage complexity and risk is to map how the facility fits into its surrounding natural and human environment. Is the facility close to a local pond that has a unique frog population? Is it close to neighborhoods that could benefit from green space access? If the facility can make amenities for the people and animals that already live there, it will better serve the community and adapt to changes of the future.

SUGGESTIONS FOR DESIGNING STORMWATER FACILITIES WITH BEAVERS IN MIND

Katie Holzer, Watershed Scientist, City of Gresham

Always consider what it might look like if beavers show up (or don't show up).

If you don't want them:

- Minimize constrictions with running water
- Avoid beaver food (willow is their favorite food, followed by red osier dogwood)

If you do want them:

- Allow space for extra ponds
- Plant food
- Be open to change

A consultant or beaver specialist can help design and build "coexistence structures" to protect infrastructure in key places. Examples of coexistence structures include pond levelers and culvert protection fences.

IV

CALL TO ACTION

Oregon's current infrastructure challenges present a unique opportunity to choose our path moving forward. Will we keep trying to solve problems in ways that aren't suited for our current world, or will we champion innovative solutions that work for our communities *and* the environments in which they live? Natural infrastructure is a winning solution that's already working in communities across the state, and we can make sure more people live in a healthier, more equitable Oregon by prioritizing these natural, cost-saving solutions.

Natural infrastructure solutions require professionals from diverse fields working together as a team. One of the most effective ways to overcome policy barriers and encourage innovation is to improve relationships and increase communication between regulatory agencies and infrastructure providers. When paired with additional resources and capacity, Oregon can continue to lead and inspire creative and effective infrastructure solutions across the country.

From engineers to policy makers and everyone in between, we want you to join us in advocating for natural infrastructure as a solution to Oregon's infrastructure challenges. We want you to help us educate communities and agencies about the health, environmental, and economic benefits of using natural infrastructure. We want you to help us shift policy so that natural infrastructure solutions get priority placement in community projects around the state. And we want you to be a part of our coalition calling for innovative solutions that make our communities more resilient to the challenges of the future, so that future generations can thrive in this place we call home.



Photo of Aerial of Foster Floodplain, © City of Portland, courtesy Bureau of Environmental Services

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Photo of Flood gate construction at Foster Floodplain. © City of Portland, courtesy Bureau of Environmental Services

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Natural Infrastructure in Oregon

Common Challenges, Opportunities for Action, and Case Studies

