Hylebos Watershed Plan

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1 Introduction

The ecological planning and mapping efforts of this document were completed by EarthCorps and supported by the Rose Foundation for Communities and the Environment. The Rose Foundation's mission "to support grassroots initiatives to inspire community action to protect the environment, consumers and public health", is exemplified by their provision for and encouragement of this project.

1.1 History of EarthCorps/Friends of the Hylebos

EarthCorps is a non-profit environmental organization based in Seattle, WA. Founded in 1993, its mission is to build a global community of leaders through local environmental service. EarthCorps trains emerging environmental leaders from across the United States and around the world through hands-on ecological restoration projects. EarthCorps also engages more than 10,000 volunteers each year to restore natural areas around the Puget Sound region, including the Hylebos watershed.

Beginning in 1983, Friends of the Hylebos (FoH) worked to protect and restore streams, wetlands, forests and open space throughout the Hylebos watershed. EarthCorps and FoH had collaborated for over a decade when, in 2011, FoH officially joined forces with EarthCorps. At that point, EarthCorps sought out expertise to determine how to move forward in implementing scientifically valid, community-based ecological restoration in the Hylebos watershed. Daniel Evans, an ecologist and conservation biologist, reviewed the available literature in 2012 and made four implementation recommendations for EarthCorps' work in the Hylebos. This Watershed Plan incorporates these four recommendations into 'solutions', broken down into *information*, *planning*, and *action* steps, throughout this document.

1) Conduct a Watershed-wide Assessment of Land Ownership and Basic Habitat Conditions
2) Conserve and Connect Remaining Riparian and Wetland Areas
3) Conduct Local Habitat Assessments to Characterize Ecological Integrity
4) Restore Degraded Habitat

(Evans, 2012, p.6)

Concurrently, with technical assistance from the National Park Service's Rivers, Trails and Conservation Assistance Program, EarthCorps conducted a community stakeholder-driven process with 91 participant interviews and surveys to determine priorities for the Hylebos watershed. The resulting *Hylebos Watershed Action Plan* prioritizes 1) conservation, 2) community engagement and 3) sustainability (EarthCorps, 2013, p.1). The first strategy under the conservation priority is "Ecological Planning - to evaluate watershed health and prioritize conservation and restoration actions" (p.2).

1.2 Key Stakeholders

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2 Purpose of Report- The Why

Why write a Hylebos Watershed Plan? The purpose of this report is to engage in the process of watershed-scale restoration planning for the Hylebos watershed. The report adopts a holistic management approach in order to identify, prioritize and act on behalf of ecological and human health in the Hylebos watershed. More specifically, the purposes of this process are to:

1) *Concentrate disconnected information and identify missing information.* This plan reviews previous documents and adds new information in the form of maps, ecological assessments, technical reports and stakeholder contributions.

2) *Unify planning and restoration actions*. This plan will support EarthCorps staff and partners - including responsible land and surface water managers in two tribes (Puyallup and Muckleshoot), five cities (City of Federal Way, City of Milton, City of Fife, City of Tacoma and the City of Edgewood), and two counties (King County and Pierce County), , as well as state agencies and other nonprofit organizations- to strategically cooperate in the planning, regulation and restoration of the watershed, driven by ecological processes and priorities. This plan will enable EarthCorps and other practitioners to connect and improve isolated restoration project sites ranging from the rare peat bogs in the Hylebos Wetlands to Superfund mitigation project sites in Commencement Bay.

3) *Unlock barriers to funding.* This watershed-level plan may unlock funding opportunity mechanisms previously inaccessible due to the lack of such a plan- federal, state, tribal and nonprofit grants, as well as capital investments by aforementioned cities and counties.

4) *Raise public awareness*. The plan creates a vision that can inspire, encourage service from, and educate adjacent property owners, community members, and other nearby stakeholders as to the importance of the Hylebos watershed as a coherent ecological system.

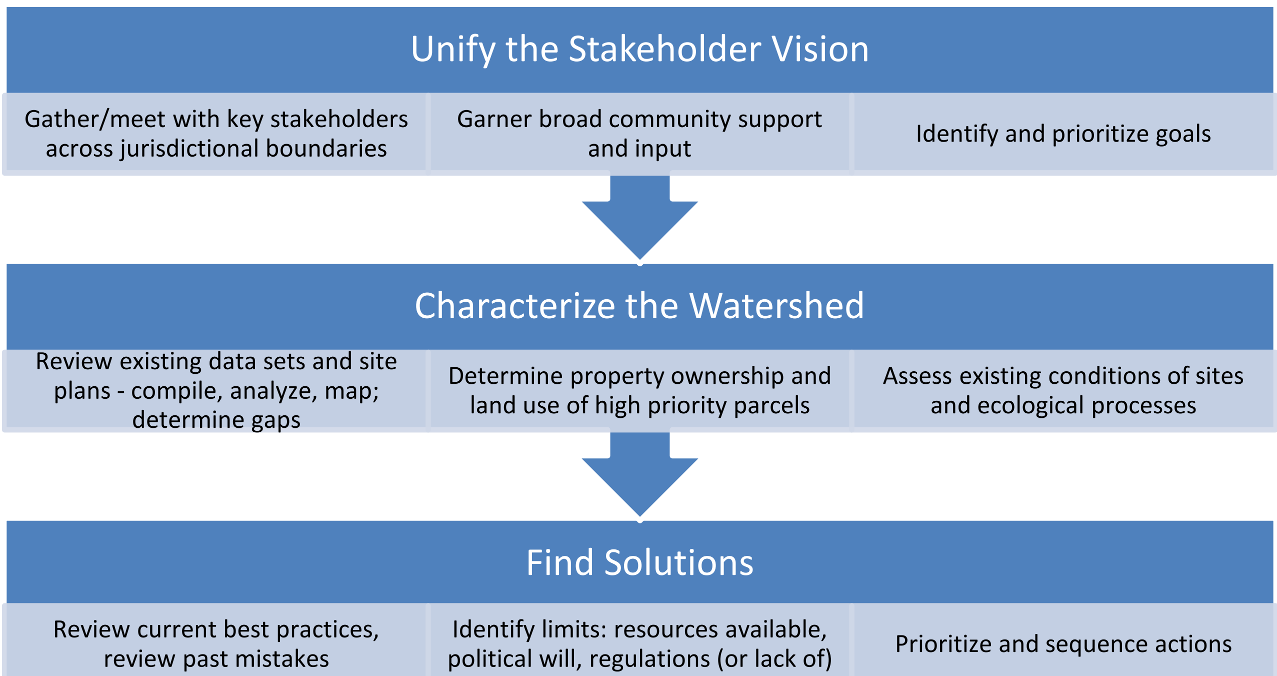
3 Goals and Process- The What and The How

What does the Hylebos Watershed Plan attempt to accomplish? The specific goals of the Hylebos Watershed Plan are:

1) Unify the Stakeholder Vision
2) Characterize the Watershed
3) Find Solutions

3.1 Planning Process

How does the Hylebos Watershed Plan set out to accomplish these goals? Key aspects (many are ongoing) of the process employed to meet these three goals:



4 Background on the Hylebos Watershed

Hylebos Creek drains approximately 12,000 acres[1] from tributaries in Federal Way to the north and Milton, Edgewood, and unincorporated King County to the east, through portions of Fife and unincorporated Pierce County to the mouth of the creek at the Hylebos Waterway in Tacoma's Commencement Bay. The lower mainstem as well as the lower West and East forks course through Puyallup Tribal lands. The Muckleshoot Tribe maintains fishing rights on Hylebos Creek.

The original name for the creek was *XaxtL* (or *Haxtl')*, meaning 'brushy' (GeoEngineers, 2010, p.6), but it was renamed by settlers after Peter Francis Hylebos, founder of a Catholic Indian School on the Puyallup Reservation in 1888 (Caster, 2009). Hylebos Creek is part of Water Resource Inventory Area (WRIA) 10, the Puyallup/White River Basin, although it drains not to the Puyallup River but directly to Commencement Bay. The watershed includes over 35 stream miles and 250 acres of wetlands (Steward and Associates, 2006, p.1). Once home to substantial runs of coho (*Oncorhynchus kisutch)*, chum (*O. keta)* and chinook salmon (*O. tshawytscha),* as well as cutthroat (*O. clarkii)* and steelhead trout (*O. mykiss*), the stream now has diminished fish populations.

As in many urban watersheds in the Puget Sound region, the process of development and urbanization has led to significant degradation. Analyzing salmon habitat limitations for WRIA 10 in 1999, John Kerwin wrote, "habitat within the Hylebos Creek subbasin can only be described as severely altered from its historical natural state. Residential development, erosion and frequent flooding threaten the creek. Portions of this subbasin have been channelized with an associated loss of riparian habitat." (p.82)

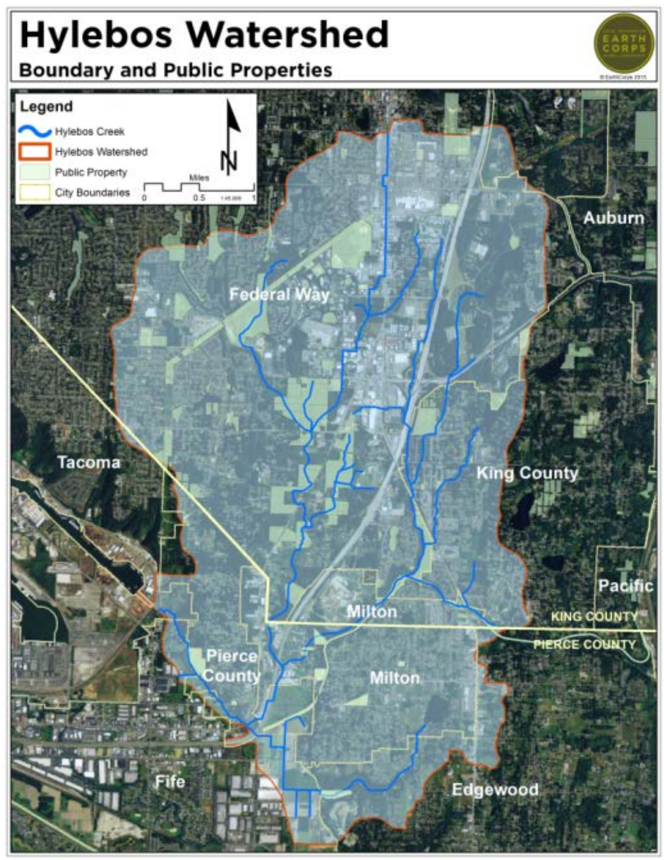


Figure 1: Hylebos Watershed Map (EarthCorps)
See Appendix A for full page view

In 2006, Steward and Associates described challenges including "extensive hydromodification (e.g., bank armoring), loss and fragmentation of riparian and off-channel habitats, introduction of invasive plant and animal species, and increased pollution from point and non-point sources" (p.2). Despite these issues, however, Hylebos Creek continues to support salmon spawning, including threatened chinook, and has significant areas where well-preserved healthy and diverse riparian ecosystems have been conserved in the midst of urban development.

The Hylebos watershed can be divided into three sub-basins: the West Fork, the East Fork, and the Lower Hylebos. The West Fork drains the central and southern portion of Federal Way. It has smaller tributaries of its own, several of which converge at the West Hylebos Wetland Park in Federal Way. A significant tributary in this sub-basin, often called the "North Fork," joins the West Fork slightly farther downstream, just below the crossing under Pacific Highway S. (SR99). Together, this branch of the creek continues

[1] Many sources list this figure at over 18,000 acres. For purposes of this report, we are not including the Wapato Creek watershed as a subset of Hylebos Creek.

downstream to just past the King County line (also the Federal Way city limits), where it crosses under I-5 to meet the East Fork.

The East Fork, meanwhile, begins with several smaller tributaries in eastern Federal Way, near North Lake and Lake Killarney, and drains southward into Milton. Other tributaries flow through the City of Edgewood. West of SR161, the East Fork flows through a narrow ravine known as the East Hylebos Ravine, before emerging onto a broader floodplain near its confluence with the West Fork.

The Lower Hylebos is the mainstem downstream of this confluence. It follows closely along I-5 to where it is joined by the Surprise Lake tributary. This tributary drains from Surprise Lake in Milton to the east, and flows through a highly channelized series of agricultural ditches, including portions of Fife. From this confluence, the mainstem turns to the northwest, flowing through Fife and unincorporated Pierce County before emptying into the Hylebos Waterway of Commencement Bay in Tacoma.

"The Hylebos Waterway is one of seven waterways situated within the Commencement Bay tide flats… the Hylebos Waterway is an estuary that receives fresh surface water from Hylebos Creek, Fife Ditch, Surprise Lake Drain, and direct runoff from the surrounding tide flats. Aquifers within the Puyallup valley and the adjacent uplands also contribute fresh water to the waterway." (WDSOT, 2006, p.3-25)

In sum, Hylebos Creek flows through a variety of residential, industrial, commercial, agricultural and tribal areas. Unlike communities in Seattle to the north and Tacoma to the south, this in-between region is underrepresented in terms of conservation organizations and resources, and is underserved in terms of environmental stewardship. As population pressures increase in this area, this Watershed Plan is an effort to address the most ecologically important needs of the watershed in a way that supports partnerships across diverse jurisdictions at a critical time.

Figure 2: Monitoring Plot in East Hylebos Ravine. Photo Credit: Anna Hiatt

4.1 Status of Fish Populations in Hylebos Creek

Salmon (*Oncorhynchus* spp*.)* are a major driver of ecological restoration in the Pacific Northwest. They are often seen as an ecological indicator of healthy streams and watersheds, as well as an important cultural and economic symbol of the region. Hylebos Creek historically supported substantial runs of salmonids: "Hylebos Creek is believed to have been one of the most productive small stream systems in southern Puget Sound. Accounts of Puyallup Tribal elders and early European settlers indicate the system supported several thousand coho and chum salmon plus perhaps hundreds of chinook salmon, steelhead and cutthroat trout." (Kerwin, 1999, p.82)

Washington Department of Fish and Wildlife records show that Hylebos Creek still supports populations of chinook, coho, chum, cutthroat and steelhead (WDFW, 2016). The City of Federal Way describes the life cycle and typical use patterns of chinook and coho in Hylebos Creek:

> Adult fall chinook swim upstream into the West Branch Hylebos Creek to reaches north of the Montessori station, holding and spawning in the fall (October – December). Fry emerge from March through April and begin their downstream migration several weeks after emergence. Juveniles may rear in the stream from two months to a year. Adult coho salmon generally enter the West Hylebos Creek in the fall and spawn in fall-winter (September – January) throughout the West Branch (up to Brooklake) and North Fork (up to South 364th). Fry emerge in the spring, and juveniles will rear for one to two years prior to migrating to sea during the spring.
>
> (Smith, 2005, pp.12-13)

The Puyallup Tribe releases between 10 and 20 thousand juvenile fall chinook into the West Fork on an annual basis, and has documented the successful return of spawning chinook in this reach (Marks et al, 2014, p.139). Backpack electro-fishing surveys, conducted in the city of Federal Way by HDR Engineering in the summer of 2014, directly confirmed the presence of juvenile coho and cutthroat trout in both the West and East Forks, as well as non-salmonid species including sculpin (*Cottus spp.),* stickleback (*Gasterosteus aculeatus)*, and Western Brook Lamprey (*Lampetra richardsonii).* Furthermore, volunteer conducted fish counts from 2002-2005 "documented an average of 10 chinook and an average of 80 coho" per year (Friends of Hylebos Wetlands, cited in Smith, 2005, p.3).

"In addition to the Puyallup Tribe, several other entities have salmon releases in the watershed. The Spring Valley Montessori School (~100 Coho/year), private residents and the City of Federal Wy (~500-1,000 Coho/year) all have separate salmon release events. "(Doucette, 2016)

As in many other watersheds throughout the region, these populations are significantly lower than historical levels. In 2012, the Salmon Habitat Protection and Restoration Strategy for WRIA 10/12 looked at population models to estimate the current average abundance of returning chinook in Hylebos Creek at 40 individuals, compared to a historic baseline of 500. Similarly, the average abundance of coho is down to 200 individuals, compared to a historic baseline of 1,800. In addition, the productivity of these populations is a metric that "represents the density-independent reproductive rate (or success) of a life history pattern over an entire life cycle… probably the most critical measure of the resilience of a life history pattern" (p.7). This return rate of adult fish per spawner is also significantly reduced, from a historic level of 15.6 to just 2.6 for chinook, and from 25 to 6.5 for coho. Finally, the diversity of the population, defined as "variety of life histories, sizes, and other characteristics" (p.7), has declined from 100% to 50% for chinook and from 100% to 70% for coho. (Pierce County, 2012)

Figure 3: Juvenile coho, found in Hylebos Creek (HDR Engineering, 2014)

The listing of Puget Sound Chinook salmon under the Endangered Species Act drives a lot of the funding for salmon recovery related work. Puget Sound Watershed Salmon Recovery planning documents therefore focus on Chinook salmon and other listed species and important stock, such as steelhead, bull trout and coho salmon.

The Salmon Habitat Protection and Restoration Strategy for WRIA 10 does not prioritize Hylebos Creek as an area for salmon recovery, due to the small size of these populations when compared with the mainstem Puyallup, White and Carbon Rivers and the tributaries that have been identified as highly productive, nor does it discuss other species of salmonids beyond chinook and coho. The size of Hylebos Creek precludes it from producing a large run of Chinook salmon. However, despite the industrialization of the historic river mouth, salmon do continue to return to and ascend the river. Local governments and community members take a strong interest in salmon habitat within their jurisdictions. Moreover, while the salmon themselves are important, the process of ecological restoration to improve salmon habitat and conditions also serves to benefit local communities and ecosystems in much larger ways. Ecological restoration of urban stream ecosystems has benefits for stormwater management, water quality, wildlife habitat, biodiversity, recreation and local economies. Therefore, efforts to restore salmonid populations are seen as a key driver of the greater watershed restoration process, and a strong indicator of the progress in establishing healthy habitat and functioning ecosystem services in the Hylebos watershed.

5 *The EarthCorps Framework for Watershed-Scale Ecological Problem Solving*

Researchers at the Northwest Fisheries Science Center have noted that restoration projects along Puget Sound creeks are often conducted on a site-by-site basis by local citizen groups. This is largely the case in FoH's and EarthCorps' previous work in the Hylebos watershed. Restoration is currently underway at a variety of sites in the watershed, including numerous properties owned by the city of Federal Way (on the West Fork), in the City of Milton (in East Hylebos Ravine), and at several Natural Resource Damage Assessment (NRDA) sites on the Lower Hylebos. However, the natural processes that create functional hydrology (and fish habitat), occur at a watershed scale- they cannot be adequately addressed by any single site-specific project. As Roni et al (2002) wrote, "Unfortunately, local citizen groups often lack adequate guidance on which types of restoration or enhancement to conduct first or which techniques are most successful. More importantly, it is often unclear how individual site-specific actions might fit into a larger context of watershed restoration and recovery of salmon stocks" (p.1). They emphasize that the restoration of watershed processes is "widely accepted as the key to restoring watershed health and improving fish habitat" (p.2). This strategy requires planning for restoration projects on a scale that goes beyond the individual site. Although, as the report points out, "activities that restore processes (e.g., road removal and stream restoration, culvert removal, and riparian and upslope restoration) are often conducted at the site or reach level" (p.2), they must be part of a broader scale watershed plan, in coordination with other actions. As the Washington Department of Ecology stresses, "to protect and restore our lakes, rivers, wetlands, and estuaries, we must consider the watershed processes that occur outside these ecosystems" (Stanley et al, 2005, p.1).

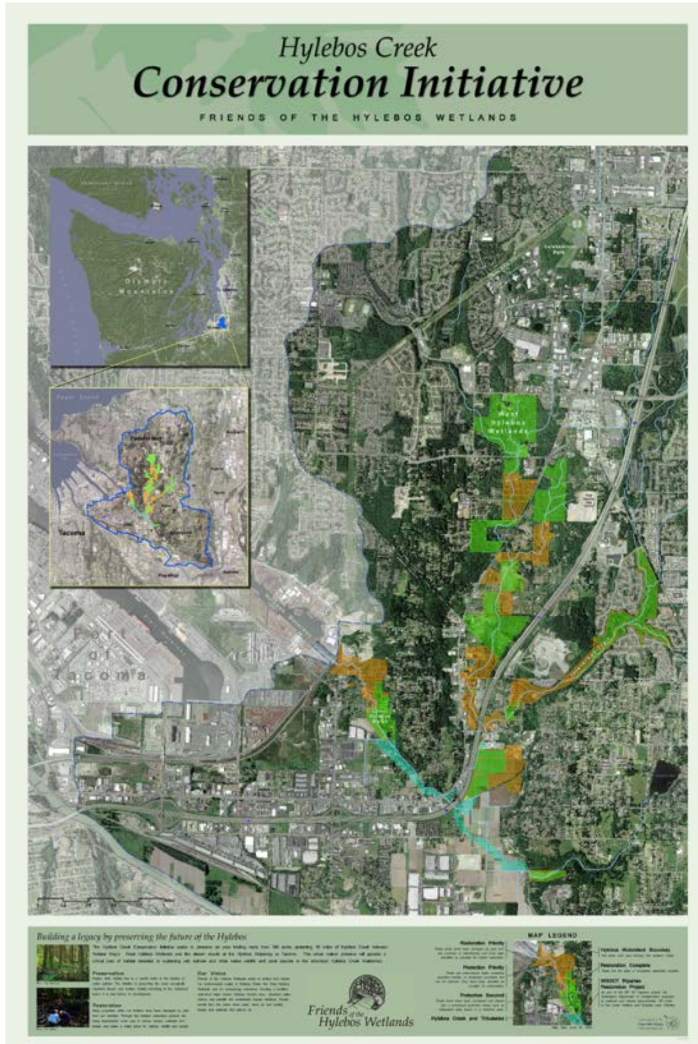


Figure 4: Map of the Hylebos Conservation Initiative. See Appendix A for full page view. (Friends of the Hylebos, 2006)

In the early 2000s FoH recognized the importance of this type of planning, and initiated a plan and prioritization of restoration actions on a watershed scale. This led to the publication of the report "Hylebos Creek Preservation and Restoration Prioritization Strategy," better known as the "Hylebos Strategy." This report sought to prioritize known opportunities for restoration across the watershed, "using the best available science and information to balance the desire to address pressing habitat constraints with the probability of long term project success and cost effectiveness" (Steward and Associates, 2006, p.1). At the same time, FoH also developed the "Hylebos Conservation Initiative" map, a poster for use in public outreach throughout the watershed. This map shows parcels prioritized for restoration and conservation under this strategy (Figure 4). Several of the *Information* steps in Section 6 call for an updating of this map.

EarthCorps' approach to watershed-scale planning in the Hylebos watershed builds on these previous efforts with the development of *The EarthCorps Framework for Watershed-Scale Ecological Problem Solving* in Figure 5. This is adapted from the watershed-planning framework laid out by the Environmental Protection Agency's National Estuary Program (NEP) watershed restoration and protection program.

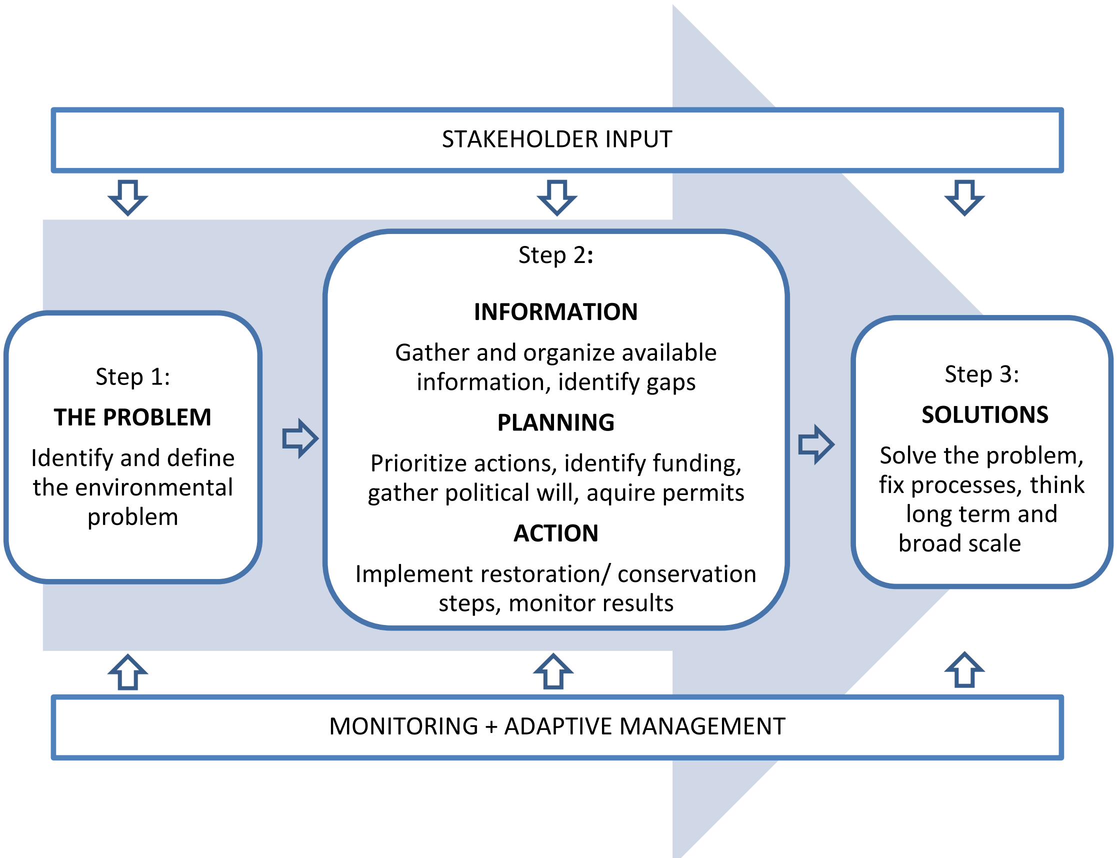


Figure 5: The EarthCorps Framework for Watershed-Scale Ecological Problem Solving. Modified from EPA National Estuary Program.

Though this specific framework is new and has not been previously applied to the Hylebos watershed, progress on many of the steps in the process has already been made by multiple stakeholders working in the watershed. This Hylebos Watershed Plan aims to synthesize and extract the most relevant information from previous reports, considering the three steps in Figure 4. All three steps continually consider *Stakeholder Input* and *Monitoring + Adaptive Management*.

STEP 1: The Problem

Many different, but interrelated ecological "problems or issues" have been identified by previous reports. Varying degrees of progress have been made towards addressing them. This information is synthesized and organized into nine problems in Section 6.

STEP 2: Information/ Planning/ Action

This report, viewed in its entirety, is an effort to piece together the most important historic and current information about the watershed for planning and action purposes. Each *Solution* is a different recipe of information gathering and organizing, planning and prioritizing, and implemented action steps. It is worthy to note that often each of these steps is heavily influenced by the regulations and permitting at play, depending on the environmental problem at hand.

STEP 3: Solutions

Solutions are broad and long term fixes for the Problems.

ALL STEPS: Stakeholder Input

Every step is a collaborative effort of past and present stakeholders and requires input in order to be successful.

ALL STEPS: Monitoring + Adaptive Management

Every step is a dynamic process that requires monitoring and updating in order to stay relevant and effective. Depending on the project, specific monitoring plans can inform adaptive management decisions. Long term monitoring can also verify whether a project is continuing to meet or miss its goals over time.

6 Problems & Solutions

This section propels all nine of the identified environmental problems through the *EarthCorps Framework for Watershed-Scale Ecological Problem Solving (*Figure 4). This approach is adapted from the steps laid out in the EPA's NEP watershed-planning process: to identify and gather available watershed-based information regarding these issues, to integrate and apply this information, and to develop actions that lead to solutions for each one. Of course, many of these environmental problems are closely related to one another, and there is significant overlap between categories. For example, both urban development and degraded forest conditions contribute to water quality issues that affect salmon. Despite treating these categories separately, we make every attempt throughout this report to point to opportunities where multiple concerns and issues can be addressed together using a comprehensive, watershed-scale approach.

Due to regional values and categories of funding, watershed planning in the Pacific Northwest often uses a lens of salmon recovery. Most literature about the Hylebos also adopts this lens. This Hylebos Watershed Plan attempts to embrace salmon recovery as one of several principal drivers within the overall watershed. Climate change may threaten the growth, health, and very survival of salmon and salmon prey all along the Pacific coast (Beamish et al, 2009), so this consideration reminds us to plan for healthy watershed processes, as well as for the recovery of a specific animal.

The *Problems*, as well as the *Information*, *Planning* and *Action* steps are not prioritized. However, 'The Strategic Priorities for the Hylebos Watershed' in Section 8 does provide an order to ecological recovery and references these nine Problems.

6.1 Urban Development Causes Reduction/ Degradation of Habitat

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Urban development causes reduction, splintering and/or degradation of habitat	• *INFORMATION*: Update the 2006 Hylebos Conservation Initiative map (Figure 4) to prioritize and direct habitat restoration and land conservation. Use existing land cover data to determine priority properties for acquisition, conservation, and restoration strategies at the basin, sub-basin, stream reach, and individual parcel level. Develop an information platform for stakeholders and land managers to provide input and guidance on prioritization at both a local and watershed-scale level. • *PLANNING*: Direct funding towards conserving and restoring top-priority parcels. • *ACTION*: Conserve and restore top-priority parcels of high value habitats. Options include land acquisition, conservation easements, transfer of development rights, and gaining permissions to conserve/restore parcels of willing landowners.	• Conserve and restore high priority parcels
	• *PLANNING*: Coordinate between jurisdictions to manage development on a watershed scale. Mandate Low Impact Development (LID)/Green Stormwater Infrastructure (GSI) methods for new developments.	• Promote sustainable development
	• *INFORMATION*: Identify % of impervious or low pervious surfaces per jurisdiction (completed in Section 8) Identify specific locations where stormwater retention, green infrastructure, de-paving or additional urban green spaces could be implemented/ developed to reduce impacts of stormwater in the Hylebos watershed. • *PLANNING*: Develop a comprehensive basin-wide stormwater management plan that will encompass and coordinate jurisdictional planning efforts (see Section 6.1.2). • *ACTION*: Require Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) methods for new developments and retrofits to existing stormwater infrastructure.	• Implement GSI management

Land development is a major issue affecting water quality, habitat conditions, and ecological functions in the Hylebos watershed. In many cases, properties that include wetlands, riparian areas, or the creek itself were built upon prior to the existence of current regulations that would limit development in these environmentally critical areas. These developments have direct impacts on the creek including filled wetlands, hardened streambanks, disconnection of floodplains, altered sediment delivery, elimination of trees and other vegetation, and erosion. Furthermore, outside of these critical areas, ongoing development has a major impact on the creek. Construction of roads, parking lots, buildings, and other impervious surfaces dramatically increases the quantity and degrades the quality of runoff into the creek and its tributaries when precipitation occurs. As noted in a WRIA 10 study, "extensive filling of wetlands, removal of historical forested areas, and impervious surfaces have reduced base flows and increased peak flow volume and durations" in the Hylebos watershed (Kerwin, 1999, p.85). Kerwin also highlights, "non-permitted filling of wetlands, lack of compliance and enforcement are all contributing to the remaining functional habitat degradation of this watershed" (p.85).

Urban development is a root cause of many of the other identified problems in the watershed. For example, runoff from urbanized areas increases non-point-source pollutants in the creek (see Section 6.7). It also alters the flow regime of the creek, with severely increased spikes after heavy rainfall events, compared to lower baseflow conditions: "runoff is quickly conveyed to the tributaries, which results in short duration, high volume flows" (WSDOT FEIS, 2006, p.3-26). This contributes to flooding (Section 6.8) and has major effects on stream geomorphology, and other instream habitat conditions (Section 6.3).

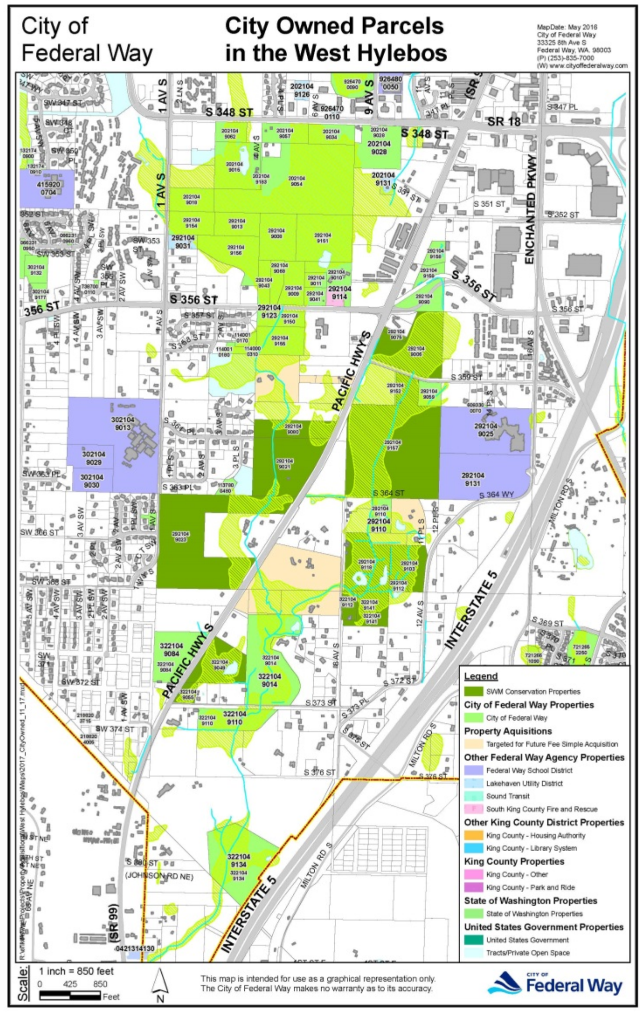


Figure 6: City of Federal Way land acquisitions. See Appendix C for full page view

6.1.1 Property Acquisition

Urban development and growth in the Hylebos watershed is ongoing, and undoubtedly will continue as the population of the Seattle-Tacoma metropolitan area continues to grow. Nonetheless, significant opportunities for conservation of undeveloped lands still exist. Acquisition and protection of habitat is preferable to restoration because it is easier, less expensive and ultimately more successful to maintain high-quality habitats than to attempt to recreate or restore degraded habitats (Beechie et al. 2003, Bilby et al. 2003, Roni et al. 2002).

Analysis by the city of Federal Way suggests that, as of 2005, less than 5% of residential and commercial parcels (243 acres) in the basin are designated as developable (Smith, 2005, p.14). As the region approaches the maximum level of development possible under current regulations, stormwater impacts may level off rather than continue to increase, as restoration and retrofit opportunities arise. As Steward and Associates note, "extensive areas of relatively undeveloped lands in rural residential, small scale agriculture, and parkland use provide a strong foundation for open space preservation to maintain and rehabilitate degraded watershed processes and implement localized habitat improvement projects" (Steward and Associates, 2006, p.2).

Conservation of certain key parcels is a critical component of watershed-scale restoration. Private properties with high ecological value (both undeveloped and already developed) should be acquired for the purposes of restoration and conservation. This process is already underway in the City of Federal Way (Figure 5), where several properties have been purchased and brought into restoration. The City of Milton has also acquired several strategic properties and plans to bring them into restoration as well. Aside from direct acquisition, other forms of protection include conservation easements, and transfer of development rights programs. Furthermore, outreach to landowners can substantially increase restoration and stewardship of key parcels without needing to acquire them. Priority parcels for acquisition and conservation are noted in the watershed inventory (Section 7). An update to the 2006 Conservation Initiative map (Figure 4) would provide a clear visual reference for the acquisition and connection of prioritized properties.

6.1.2 Limits on Development/ Stormwater Management

The foremost challenge with watershed scale planning is cooperation across jurisdictions. However, this is also strength of the region. A diversity of perspectives and project designs, when shared, can empower the management of water across the land.

6.1.2.1 Pervious vs. Impervious Surfaces

In general, significant degradation of instream processes and functions can occur when the level of impervious surfaces surpasses 10%. Unfortunately, the Hylebos watershed is estimated at an average of 38% impervious surface. However, when broken into sub-basins, there are several areas of the Hylebos watershed that have not crossed the threshold into *Non-Supporting*.

> **Sensitive Streams:** 0-10% watershed impervious cover. Consequently, sensitive streams are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects. Since impervious cover is so low, they do not experience frequent flooding and other hydrological changes that accompany urbanization. Once riparian management improves, however these streams are often expected to recover.
>
> **Impacted Streams:** 11-25% watershed impervious cover. These streams show clear signs of degradation due to watershed urbanization. The elevated storm flows begin to alter stream geometry. Both erosion and channel widening are clearly evident. Streams banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
>
> **Non-Supporting Streams:** +25% watershed impervious cover. Stream quality crosses a second threshold. Streams in this category essentially become conduits for conveying stormwater flows, and can no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water recreation is no longer possible due to the presence of high bacterial levels. Subwatersheds in the non-supporting category will generally display increases in nutrient loads to downstream receiving waters, even if effective urban BMPs are installed and maintained. The biological quality of non-supporting streams is generally considered poor, and is dominated by pollution tolerant insects and fish.
>
> (Center For Watershed Protection, 1998)

Furthermore, it is important to consider beyond simply pervious vs. impervious surfaces. Pervious areas range in their ability to infiltrate water. For example, healthy forest soils with deep rooted conifer trees may have extremely high infiltration capacity, while a residential yard with a fertilized and highly compacted lawn may have a very poor infiltration capacity. A municipal effort to convert residential lawns into rain gardens, for example, can be a strategic management action to transform poor pervious surfaces into excellent ones.

Considering the size of impervious areas, it is very important to break them up into smaller sections. Contiguous impervious surfaces are often more detrimental than mixed pervious and impervious surfaces to water quality and quantity. Limiting or retrofitting large, contiguous impervious surfaces is a high priority.

6.1.2.2 Management Actions

Possible actions to limit the effect of ongoing development outside of critical areas are numerous. They include further regulation of development at a local or regional level, increased enforcement of development regulations and designation of new parks or natural areas. Without a regulatory driver, conversion to green stormwater techniques may be slow to be achieved.

Actions specifically related to stormwater management include:

- Implementation of capital improvements that retrofit stormwater management facilities (e.g., municipal retention ponds or swales)
- Increased vigilance in facility inspections and maintenance (i.e., invasive vegetation) of existing public stormwater facilities
- Implementation of Low Impact Design (LID) and Green Stormwater Infrastructure (GSI) techniques (e.g., rain gardens, permeable pavement, bioswales, downspout disconnection to reduce stormwater overflow, depaving, and many other techniques[2])
- Education to the public about stormwater pollution (e.g., vehicle oil leaks, pet waste disposal, etc.).

Opportunities to retrofit stormwater infrastructure, in particular, may have a significant positive impact on instream conditions for fish habitat, water quality, flooding, and erosion from increased stream energy.

Many of these opportunities are currently being pursued by local jurisdictions as part of surface water management division efforts to meet municipal stormwater permits. For example, the City of Federal Way and King County are currently working on a project to assess the effectiveness of bioretention projects to reduce stormwater impacts at a site on S 356th St in Federal Way, which drains to Hylebos Creek. Additionally, the City of Milton is currently going out to bid on two LID projects. One will install pervious concrete parking lots on public property and the other will install bio-retention cells and bio-filtration swales in a portion of town that drains down the hill to Hylebos Creek. Both of Milton's projects have a strong focus on monitoring for effectiveness. These individual projects are significant, however, an effort to accomplish basin-wide stormwater planning, across jurisdictions, is necessary to overcome such a large and historically overlooked challenge. As Steward and Associates (1996) noted, "much of the Hylebos watershed was developed prior to modern requirements for stormwater detention" (p.2).

It is important to note that GSI implementation around the Puget Sound is extremely site specific. The history of glacial deposits and movement across our landscape has contributed to a stark mosaic of soils. Thorough and very localized soil infiltration tests must be completed to reveal appropriate sites for GSI.

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[2] See Low Impact Development Technical Guidance Manual for Puget Sound at:
http://www.psp.wa.gov/downloads/LID/20121221_LIDmanual_FINAL_secure.pdf
and 2012 Stormwater Management Manual at: https://fortress.wa.gov/ecy/publications/summarypages/1210030.html

6.2 Lack of Habitat Connectivity

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Lack of connectivity of existing habitat areas	• *INFORMATION*: Update 2006 Hylebos Conservation Initiative map (Figure 4) to prioritize land conservation and restoration of new connective parcels. • *PLANNING*: Direct funding towards conserving and restoring top-priority parcels. • *ACTION*: Conserve and restore new parcels to connect pockets of existing conserved land. Options include land acquisition, conservation easements, transfer of development rights', and gaining permissions to conserve/restore parcels of willing landowners.	• Conserve and restore parcels for connectivity
	• *INFORMATION*: Create a comprehensive fish barrier map, encompassing existing Federal Way data and the WDFW SalmonScape fish passage map • *PLANNING*: Plan and prioritize fish barrier projects for maximum impact on habitat access. • *ACTION*: Implement local projects to remedy fish passage barriers, such as culvert replacements, according to prioritization.	• Remove barriers to fish passage throughout the watershed

Lack of connectivity between habitat areas is often a critical limiting factor for wildlife. In urban and semi-urban areas, mammals, birds, insects and fish are commonly blocked, isolated, or separated by physical alterations to the landscape. Projects to connect splintered habitats often have a high probability of success and a quick response time once implemented.

In the Hylebos, migratory fish, including salmonids, are a major focus of recovery and reconnection. Full or partial barriers to fish passage cut off access to upstream areas that would otherwise meet the criteria to serve as fish habitat. Fish passage is limited as a result of human impacts, either by physical barriers such as impassable culverts, or by low seasonal water flow due to altered hydrological conditions.

Figure 7: Culvert under 356th St in need of replacement, West Hylebos (HDR Engineering)

In 2014, the city of Federal Way hired HDR Engineering, Inc. to assess fish use and aquatic conditions in the Hylebos watershed within Federal Way city limits. The purpose of the study was "to record existing aquatic and riparian habitat characteristics, the presence and condition of potential barriers to fish passage, and to sample fish within the three branches of Hylebos Creek to gain an understanding of baseline species presence and utilization"[3] (HDR Engineering, 2014, p.1). This study identified a number of possible partial barriers to fish passage in the West Fork, including the culverts under Pacific Highway and 356th Street. The culvert under Pacific Highway was replaced by WSDOT in 2016[4]. The Culvert under S 356th St is on the City's CIP Projects List, but is grant funding dependent. In the North and East Forks, low seasonal flows were found that may also inhibit fish passage, causing woody debris jams or other instream obstacles that block fish, such as a beaver dam at the North Fork culvert under 8th Avenue. As the Puyallup Tribal Fisheries annual salmon report points out, low flow will be an obstacle to chinook before blocking coho, chum or other smaller fish. According to the Tribe, "the upper extent of Chinook spawning is generally a half mile past the convergence of the East and West Forks [on the West Fork]" (Marks et al, 2014, p.139).

The authors of the 2014 HDR Engineering study hypothesized that fish in the North and East Forks are likely to become stranded in isolated pools: "the lack of adequate flows and deeper pools for refuge during drier periods is probably the major limiting factor to salmon use in the North and East Forks" (p.16). Despite this concern, however, the greatest number of salmonids (coho) found in the associated fish survey were found in the East Fork. Coho spawning does appear to occur in the East Fork, though it is possible that spawning occurs downstream of the surveyed areas, and the juveniles move upstream to the areas of the East Fork where they were observed (p. 17).

The HDR study did not include areas downstream of the Federal Way city limits. According to the Hylebos Browns-Dash Point Basin Plan (Mahan, personal communication, 2004- cited in Pierce County, 2006, p.5-14), "no major impediments to fish passage are currently known to exist in the reaches of Hylebos Creek that lie in unincorporated Pierce County." The presence of anadromous fish upstream provides clear evidence that fish are able to migrate through the lower reaches. However, no detailed information is currently available about possible fish passage barriers or obstacles downstream that may be limiting or impacting the salmonid population.

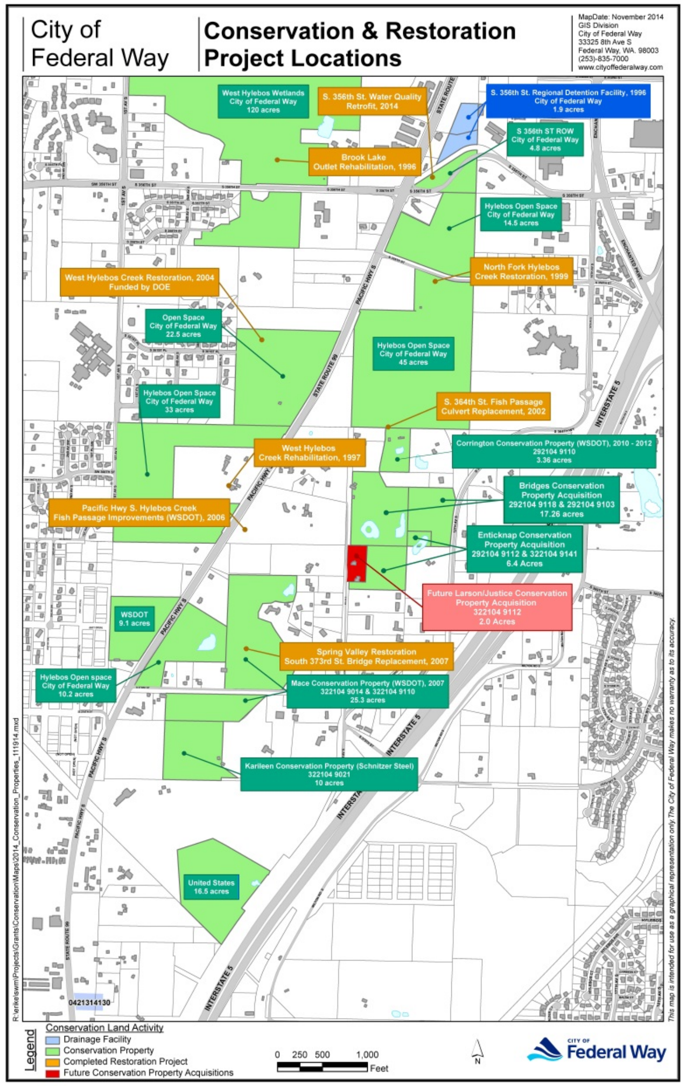


Figure 8: City of Federal Way Conservation & Restoration Project Locations. See Appendix D for full page view

Land enhancement on high priority properties through landowner permissions, conservation easements and/or acquisitions by willing landowners that either connect isolated habitats or

[3] The "three branches" refer to the upper West Fork, the North Fork, and the East Fork. Refer to HDR Engineering report for exact sampling locations.

[4] "Contractor crews working for the Washington State Department of Transportation replaced six by six foot culvert under SR 99 in Federal Way with a new concrete box culvert that is 10 feet high by 20 feet wide. The culvert carries West Fork Hylebos Creek under the highway. The old culvert was a barrier for several types of fish that can be found in the stream including chinook and coho." (WSDOT, 2016)

allow for restoration of connectivity (e.g., culvert replacement or creation of side channels) is a critical solution to habitat disconnection. Mapping initiatives such as Figure 8, illustrate the challenge of unifying disconnected habitat pockets. As indicated, the City of Federal Way has taken great strides towards successful habitat connection in certain areas.

An updated comprehensive fish barrier survey that critically examines current downstream fish barriers (and incorporates the existing Federal Way data) is recommended in order to provide a watershed wide perspective on prioritizing connectivity solutions. Figure 9 illustrates a Fish Passage map of Hylebos Creek from the SalmonScape webpage of the WA Department of Fish and Wildlife. Many of the survey data points, however, appear outdated.

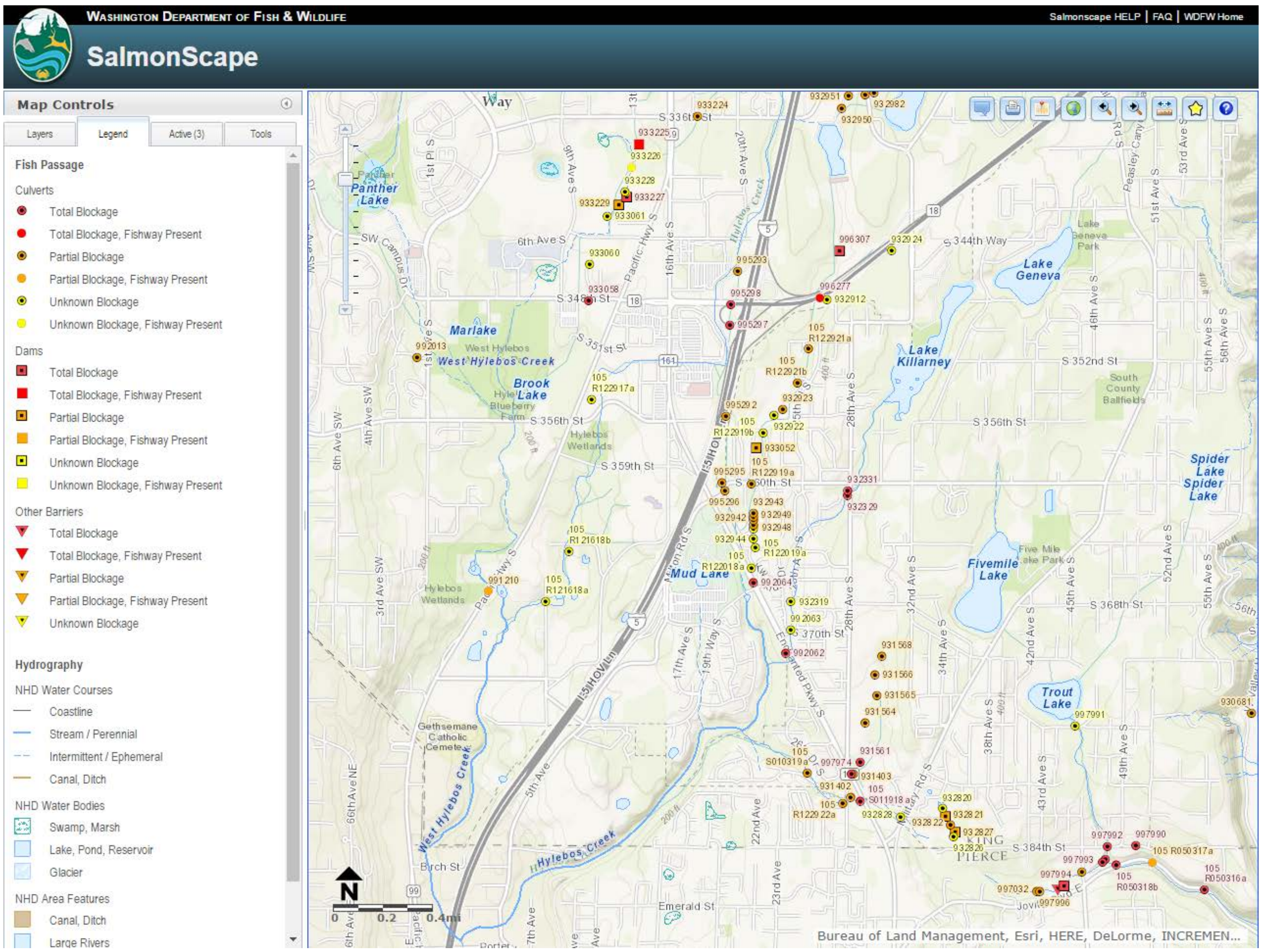


Figure 9: Map of fish passage/barriers (WDFW 2016, SalmonScape)

6.3 Degraded Forest Conditions and Processes

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Degraded forest conditions and processes	• *ACTION*: Continue restoration in priority areas where re-vegetation has already begun, with emphasis on a multi-layered forest canopy and evergreen tree planting. ——— • *INFORMATION*: Inventory and map existing land cover and forest canopy throughout the watershed. Use LIDAR and orthophotography to categorize vegetation cover and heights- summarize this information for all individual parcels in the watershed (begun in Section 8). This information can be used to prioritize areas for conservation, restoration, and revegetation efforts. Complement the comprehensive instream survey (recommended in Section 6.3) with riparian vegetation surveys. • *PLANNING*: Develop planting plans for high-priority sites where no action is currently underway. • *ACTION*: Initiate restoration in priority areas where re-vegetation has not begun, with emphasis on a multi-layered forest canopy and evergreen tree planting. ——— • *ACTION*: Increase native vegetative cover on private property= encourage residential native tree and shrub planting through educational campaign, subsidized plant giveaways[5], etc.	• Establish native plant communities and evergreen canopies on public and private land

Figure 10: Ivy vine “Survival Rings” salvage Doug fir trees in East Hylebos Ravine

Restoration of healthy riparian forest processes, especially the establishment of native coniferous trees, is known to improve water quality, reduce flooding, stabilize soils, and benefit instream habitat for fish. Restoration efforts typically aim to increase the abundance and diversity of plant species and plant structure adjacent to a stream. This establishes multi-layer riparian vegetation which can provide: habitat for wildlife, reduced instream temperatures through shading (and subsequently increased dissolved oxygen content), habitat for terrestrial insects (food for juvenile salmon), increased recruitment

[5] Refer to Seattle reLeaf program for an example program

of large woody debris, bank stabilization, reduced raindrop impact, and increased filtration of runoff and stormwater, among other benefits.

6.3.1 Hylebos Creek Forest Conditions

Fortunately, significant portions of the Hylebos Creek riparian corridor remain undeveloped, and currently provide at least some of the benefits associated with vegetated buffer zones along urban streams. However, the condition of these natural buffer zones is widely varied, ranging from healthy conifer forests with diverse native plant communities to monocultures of invasive non-native species.

Historic logging throughout the watershed has greatly reduced the cover of native conifer trees, leaving short-lived deciduous trees and non-native plants to disproportionately thrive. An absence of conifers leaves a critical gap in the keystone role that they play as the evergreen structural pillars of the Pacific Northwest forest ecosystem. These trees include western red cedar (*Thuja plicata)*, western hemlock (*Tsuga heterophylla),* Douglas fir (*Pseudotsuga menziesii),* and Sitka spruce (*Picea sitchensis)*. These large, long-lived and evergreen trees provide year-round shading of water and soil. Their roots have tremendous capacity for water uptake and filtration, as well as soil stability. In the long term, conifer forests also provide a source of large woody debris recruitment to the stream and serve as direct habitat for small mammals, birds and insects.

Homeless encampments are a growing issue in several areas within the Hylebos watershed as population pressures continue to increase in the region. Sometimes, homeless encampments can be sources of trash accumulation and impact forest conditions, as well as water quality.

6.3.2 Forest Restoration Planning and Implementation

Restoration of riparian zones, especially on the straightened channels of the lower Hylebos Creek is highly recommended in the City of Milton Shoreline Restoration Plan,

> …the denser physical barrier provided by plants serves to attenuate storm flows, provide shade, decrease sedimentation, remove excess nutrients and pollutants, and slow riverbank erosion. The overall increase in native vegetation provides greater availability of terrestrial habitat and higher potential for large woody debris recruitment. Higher plant species and structural diversity increases food production and nest/travel/rest site availability for different species.
>
> The Watershed Company and Makers, 2011a, p.21

This recommendation can be applied to many natural riparian areas in the watershed. At a site level, once the invasive plant control described in Section 6.4 is complete or well underway, the next step in riparian restoration is the establishment of native species. In many forested sites, the goal is to mimic natural forest succession with a long term objective of establishing a diverse canopy of evergreen trees. In most cases along Hylebos Creek, replanting with a native plant palate of evergreen trees, interspersed with deciduous trees and hardy shrubs, is the top priority for restoration. Continued maintenance to ensure the establishment of the native plantings (often entails curtailing invasive plant re-growth) is necessary for an absolute minimum of 5 years and ideally continues indefinitely. Additionally, maintaining the deciduous canopy trees that are already growing is important by removing ivy vines and reducing competition from invasive weeds.

It is important to note that some areas of the riparian corridor may not but suitable for reforestation, but should instead be restored to the site-specific conditions of light, moisture, soil, topography and micro-climate. In some cases along Hylebos Creek, restoration of emergent or scrub-shrub wetlands is appropriate. In some cases, the planting of native shrubs such as willows (*Salix spp.)* or dogwood (*Cornus sericea)* is a valuable tool in areas of well-established invasive plant monocultures, such as reed canarygrass. These native shrubs can provide dense shade and reduce regrowth of the invasive infestation.

6.3.3 Active projects

A number of specific sites in the watershed have riparian forest restoration projects underway, and/or existing written plans describing restoration tasks to be undertaken.

On the West Fork, the city of Federal Way has undertaken restoration on a number of properties, with a strong focus on the reaches between the West Hylebos Wetlands at the upstream end and the city line (just upstream of the stream crossing under I-5) at the downstream end. Federal Way has identified this area as a top priority for conservation within their jurisdiction, and has undertaken a significant effort to both acquire properties and to begin restoration of degraded areas.

On the East Fork, Friends of the Hylebos planned for restoration across a range of contiguous forested properties. Over 100 acres of riparian forest in Milton and SE Federal Way was identified as the "East Fork Hylebos Forest," and described in a 2009 Forest Management Plan written by Natural Systems Design. Significant progress on plan implementation was achieved by EarthCorps in 2015-2016. The plan was also updated to adapt management plans according to progress made in 2016.

In the Lower Hylebos, the riparian restoration proposed in conjunction with WSDOT's SR-167 Completion Project, will include invasive plant removal and native plant establishment, as well as long-term management in the 167+ acres area associated with riparian buffer zones.

6.4 Non-Native Invasive Plants

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Non-native invasive plant proliferation	• *ACTION*: For high priority sites where invasive plant control has already begun- continue control. Multi-year maintenance is necessary. • *INFORMATION*: Inventory and map presence of priority invasive weeds. Incorporate existing data from King and Pierce Counties. <u>High priority species</u>: either have most significant habitat impacts (e.g., knotweed, reed canary grass), or are classified as Class A+B noxious weeds (eradication/control required). <u>Lower priority species</u>: (e.g., ivy or blackberry) inventory and map on a site-specific basis as funding is available. • *PLANNING*: Based on the above inventory, identify priority restoration sites for expanding invasive plant control. For certain species (notably knotweed), control will require a coordinated watershed approach from headwaters-to-mouth. • *ACTION*: For high priority sites where no action is currently underway- begin invasive plant control efforts. • *ACTION*: Encourage residential non-native plant control through educational programming	• Identify and control invasive plants on public and private land using Integrated Pest Management

Major human impacts on vegetation within the Hylebos watershed include significant loss and/or fragmentation of vegetative and canopy cover (especially coniferous forests), reduced species and genetic diversity of plant species, vulnerabilities due to climate shifts, and reductions in symbiotic organisms, such as soil microbes or pollinators. These weaknesses in the vegetative systems facilitate the invasions of aggressive non-native plant species. Non-native plant species can have significant negative effects on both terrestrial and aquatic ecosystems. These plants often out-compete native species, and may create monocultures, reducing diversity of species and structure within the ecosystem.

Figure 11: Removal of a ground ivy carpet in East Hylebos Ravine. Photo credit: Anna Hiatt

Restoration of riparian and upland forests in the Hylebos watershed often begins with the removal of non-native invasive plant species. These species include reed canarygrass (*Phalaris arundinacea)*, knotweed (*Polygonum spp.)*, poison hemlock (*Conium maculatum)*, tansy ragwort (*Senecio jacobaea),* purple loosestrife (*Lythrum salicaria),* Himalayan blackberry (*Rubus armeniacus)*, English ivy (*Hedera helix)*, and many others. Invasive plant control methods are widely varied and should be used within an Integrated Pest Management plan. They may include manual, mechanical, chemical, biological or other means. Control methods are site- and context-specific and should be selected for a given restoration project following best management practices for the particular species.[6] In most cases, complete eradication of any non-native species throughout the Hylebos watershed is not a realistic goal due to the complicated land ownership matrix. Invasive plant control is unlikely to occur on many parcels, especially if they are privately owned. However, on the scale of individual restoration projects it is possible to successfully control or even eliminate many non-native species within specific boundaries.

Certain invasive plants, such as knotweed, are known to use waterways including streams, roadside ditches, irrigation canals and other water drainage systems as a vector to spread. Knotweed stems can break off and wash downstream, where they root and establish new infestations. Therefore this species should be managed on a watershed level, with control beginning at the top of the watershed in each fork and working down to the mouth. Knotweed control takes several years of re-treatment. Fortunately, knotweed is not widely established in the Hylebos watershed, but control of this species is a high priority and will likely require coordination between multiple local agencies. Continuous ground-truthing surveys of the watershed are necessary to identify infestations of this and other non-native species and ensure that control is implemented across the entire watershed.

Continuation of restoration efforts already underway to manage invasive species in identified priority areas (ie: West Fork in Federal Way and the East Hylebos Ravine) should be of high priority. This ensures that time and money invested in previous removal is not lost.

A basin-wide effort to assess and inventory invasive non-native plants and noxious weeds should cross jurisdictional lines. This will enable a prioritization of new areas in which to begin control. Furthermore, this inventory can be incorporated into an educational campaign aimed towards interested community members as well as property owners with invasive plants on their land.

Figure 12: Reed canarygrass on West Hylebos Creek. (HDR Engineering)

[6] Refer to King County and Pierce County noxious weed control programs for guidance

6.5 Instream Conditions for Fish Habitat

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Degraded instream conditions	• *INFORMATION*: Complete comprehensive instream habitat survey, encompassing existing Federal Way data. Full inventory would include stream habitat types (pools, riffles, runs), substrate conditions for spawning, off-channel habitats for rearing, Large Woody Debris (LWD) presence, riparian vegetation conditions. Map shoreline armoring. • *INFORMATION*: Further survey/monitor the overall salmonid population, including habitat utilization by species and life history stage. Migration and spawning surveys may be used to assess range and migration patterns. This can inform salmon releases. • *INFORMATION*: Further survey/monitor the stream flow regime. Determine impacts of flow regime on both fish passage and sediment transport processes. Analyze a 'Hylebos Sediment Budget' to improve understanding of sediment processes on habitat creation. • *PLANNING*: Using the survey/study information, develop plan for restoration (to the extent possible) of flow and sediment processes. • *ACTION*: Increase evergreen canopy cover throughout entire watershed to improve hydrological function, to encourage long term LWD recruitment, and for year-long erosion control from precipitation. • *ACTION*: Increase flood storage, increase vegetative stream buffers, remove shoreline armoring where possible, replace failing culverts • *ACTION*: Modify channel network in critical areas to absorb/ dissipate unnaturally high stream energy. Create off-channel and spawning habitats. For example, install additional "picket fences," or LWD to address sediment transport issues in the East Fork.	• Restore *broad-scale* sediment delivery and hydrologic processes • Restore *local-scale* sediment delivery and hydrologic processes in *high gradient* streams • Restore *local-scale* sediment delivery and hydrologic processes in *moderate and low gradient* streams
	• *INFORMATION*: Identify specific locations where stormwater retention, green infrastructure, or additional urban green spaces could be implemented/ developed to reduce impacts of stormwater in the Hylebos watershed. • *PLANNING*: Develop a comprehensive basin-wide stormwater management plan that will encompass and coordinate jurisdictional planning efforts (see Section 6.1.2). • *ACTION*: Require Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) methods for new developments and retrofits to existing stormwater infrastructure.	• Implement GSI management

Instream conditions that create good salmonid habitat are driven by watershed-scale processes, and therefore the best approach to salmon habitat enhancement is through the restoration of these processes (Roni et al, 2002; Beechie et al, 2010). Prioritizing restoration of processes holds true for Hylebos Creek (Steward and Associates, 2006, p.4). The natural flow regime of the creek is a process shaped by multiple drivers within the watershed: land cover, topography, soils, climate, and precipitation patterns. Subsequently, the flow regime has tremendous impact on the creek's sediment transport capacity, driving erosion and sedimentation processes. Changes to the watershed drivers, therefore, have great impacts on the geomorphology of the creek. Important aspects for fish habitat include gravel size in different reaches (critical to fish spawning habitat) and the creation of pools, riffles and meanders. Likewise, natural forest succession processes in riparian areas allow for recruitment of large woody debris (LWD, also called large woody material or LWM), which is understood to be a critical component of fish habitat, providing hydraulic complexity as well as refuge for the fish and habitat for fish prey (Dolloff and Warren, 2003). WRIA 10's study of salmon habitat limiting factors notes, "there is an almost total absence of any functional LWD within this [Hylebos Creek] system" (Kerwin, 1999, p.84).

In the case of many urbanized streams, including Hylebos Creek, full restoration of the stream's flow regime is not a realistic goal due to irreversible modifications of hydrological processes. Nonetheless, an understanding of the changes to the geomorphological processes that create habitat is essential to strategizing which processes we *can* restore. In the Hylebos watershed, like many urban streams in western Washington, "high levels of impervious surface and elevated peak flows result in increased sediment delivery and channel erosion that have increased the total sediment budget beyond the natural transport capacity of the stream channel" (Steward and Associates, 2006, p.2). As far back as the early 1990s, Pierce County, cited in the WSDOT FEIS (2006, p.3-26), estimated that "flood peaks on the West Fork Hylebos Creek have increased 80% over the pre-developed forested condition", as a result of increased urbanization in the watershed. Likewise, in the East Fork, King County estimated that flood peaks had increased 60% by 1990. These degraded processes may constrain the possibilities for restoration of instream habitat in Hylebos Creek. "Local habitat enhancement efforts are less likely to be effective over long time periods if they are implemented in the context of degraded watershed process conditions" (Steward and Associates, 2006, p.4).

The importance of first tackling *processes* is highlighted in The Strategic Priorities for the Hylebos Watershed (Section 7). Firstly, projects that address stormwater management on a watershed scale, increase canopy cover throughout the entire watershed, improve flood storage for large areas of the creek, and increase riparian buffers on contiguous stretches of creek, are prioritized when enacted on a watershed scale. Secondly, these priorities are followed by restoration of local processes in high gradient streams (>4% slope, feeds sediment downstream) which can include modifying channel networks to absorb or dissipate unnaturally high stream energy, removing shoreline armoring, or planting conifer trees to encourage large woody debris recruitment. Thirdly, local scale processes in moderate (1-4% slope, sediment neutral) and low-gradient (<1% slope, receive sediment from upstream) should be restored, using tactics such as modifying channel networks to increase the floodplain, removing shoreline armoring, or planting conifer trees to encourage large woody debris recruitment.

6.5.1 West Fork

As part of their 2014 study, HDR Engineering (2014) looked at existing instream conditions for fish habitat in several reaches of the creek within the City of Federal Way. The survey included qualitative observations of habitat diversity, bed substrates, overhanging cover, and large woody material, among other instream characteristics. They described the Hylebos stream system in Federal Way as "comprised almost entirely of single channel, shallow, low gradient streams, with a few areas of cascades and artificially-created step pools (p.4)". The West Fork of Hylebos Creek "had the highest quality fish habitat of the three branches that were surveyed," with diverse structure and varied substrates (p.16). According to the Hylebos Browns-Dash Point Basin Plan,

> the best habitat in the system currently exists in the Spring Valley area on the West Branch, within the jurisdiction of Federal Way upstream of Pierce County. This area has consistent base flows in the fall from seepages north of 356th Street that feed the stream. The area is of moderate to flat grade and still exhibits connected floodplain along the banks of the creek. (Pierce County, 2006, p.5-14)

Figure 13: Confluence of West and North Forks in Spring Valley, Federal Way (HDR Engineering)

In 2003, a report of strategic priorities in WRIA 10 identified the West Fork Hylebos Creek as a top priority area for chinook habitat. The report distinguishes between protection and restoration. For *protection*, the upper West Fork, followed by the lower West Fork, are recommended as the most important areas. For *restoration*, the lower mainstem below the forks and the lower reaches of the West Fork are recommended as the most important areas, primarily challenged by habitat diversity and flow conditions. It is noted in the report that quality of habitat may be of greater importance than quantity of habitat for salmon recovery. For this reason, acquisition and enhancement of high-quality habitat was ranked as a higher priority than restoration of degraded properties downstream. (Mobrand, 2003. p.29) The City of Federal Way has undertaken a substantial effort to acquire property in these critical areas to protect some of the highest-quality existing habitat areas in the watershed (See Appendix C: City of Federal Way land acquisitions).

WRIA 10 also identified priority areas for coho habitat. Key areas for *protection* are the lower and upper portions of the West Fork (reaches upstream of Highway 99). Key areas for *restoration* are the lower and upper West Fork, Surprise Lake drainage, and lower East Fork. The top factors in these areas are habitat diversity, flow conditions, sediment loading and habitat quantity. (Mobrand, 2003, p.31)

6.5.2 East Fork

It was noted in a WRIA 10 study that "West Fork Hylebos Creek is intrinsically more stable than the East Fork Hylebos Creek to impacts from urbanization because of stream gradient, water diversions and hydraulic buffering" (Kerwin, 1999, p.85). For this reason, efforts to restore fish habitat, particularly in the East Fork, must take into consideration broader flow regime and sediment processes before attempting local, site-specific restoration projects such as construction of pools or placement of large woody material.

The East Fork of Hylebos Creek is more constrained by topography. Through the riparian area known as the East Hylebos Ravine the banks are sloped at a higher gradient, minimizing floodplain potential. As HDR Engineering (2014) noted, parts of the East Fork also have a "wide, forested riparian zone" which provides protection from development and instream shading. Furthermore, "instream structure and habitat heterogeneity with a substrate that is predominantly gravel and small cobble," provide excellent habitat condition, but "low flows throughout all survey periods presumably limit fish use" (p.8). Shallow flows, lack of major pool habitat and lack of off-channel areas, may cause fish stranding or limit places for juvenile salmon to rear. For these reasons the East Fork may not be a priority for chinook, but if restored properly, retain potential as high-quality habitat for coho and trout.

The Picket Fence project, an instream restoration project conducted in the East Fork of Hylebos Creek in 2008-2012, was designed specifically to address the issue of increased sediment delivery due to alterations to morphology in the East Fork. Instream 'picket fences,' are control structures built from wooden stakes and natural materials. They were designed as "an inexpensive and low-tech means of slowing the transport rate of small sediment… enhancing bed and bank stability and improving instream fish habitat" (Anderson, 2013, p.4). This technique was found to be very effective at trapping sediment, with the bed control structures in particular proving to be most effective (as opposed to bank control or fish habitat structure). However, no further study has been done to determine whether the overall impact of these structures on the sediment budget of the creek has had a significant effect on habitat-forming processes downstream. There is great potential for further use of this technique to continue to restore sediment processes in the watershed. As noted in WRIA 10's analysis of salmon habitat limiting factors, the development of a watershed-scale sediment budget is a critical step for ongoing restoration efforts (Kerwin, 1999, p.85).

The City of Milton identified priorities for instream restoration in the Milton reach of the East Fork, which can be generally applied to most stream reaches in the watershed. These tasks include "enhancing habitat with large woody debris and promoting large woody debris recruitment, promoting pool, riffle and gravel bar development, enhancing hydrologic condition, removing non-native and invasive vegetation, improving water quality, and restoring degraded wetlands" (Watershed Company, 2011a, p.20).

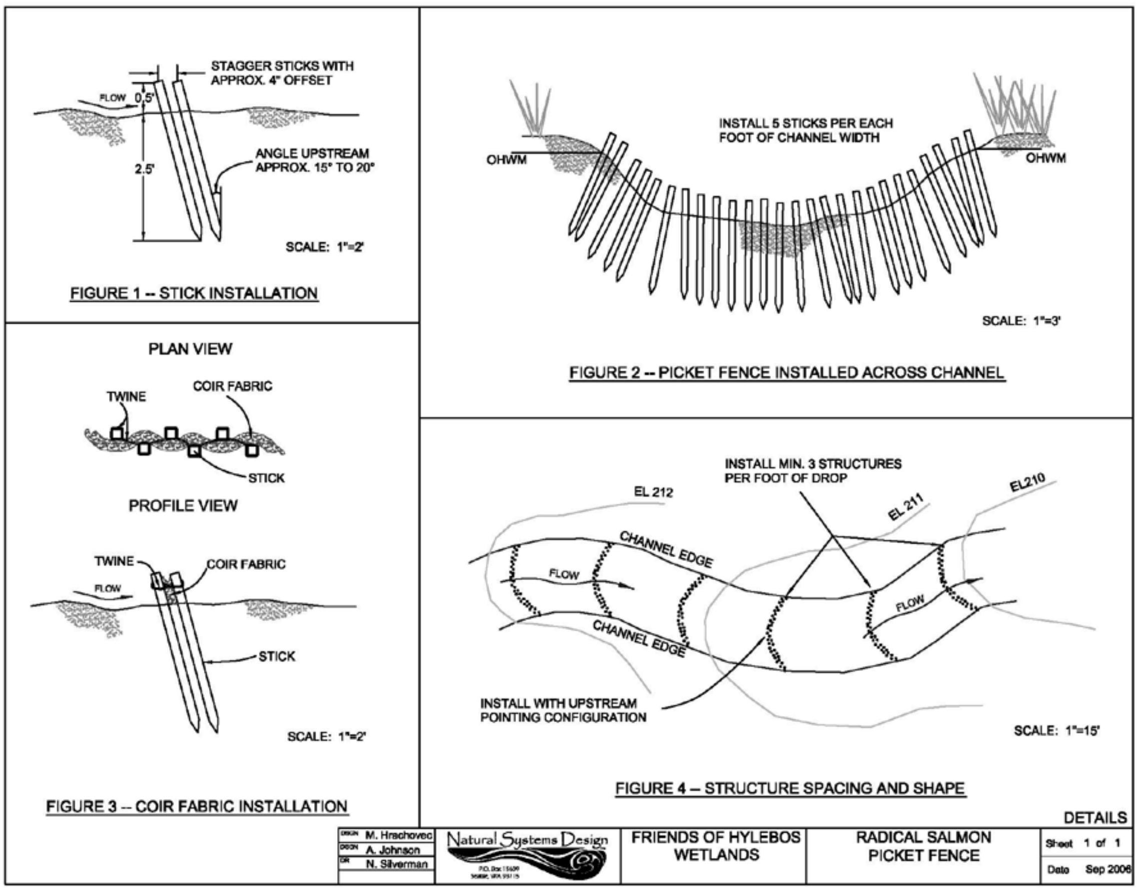


Figure 14: Picket Fence Design (Natural Systems Design)

6.5.3 North Fork

The HDR report described habitat in the North Fork as…

> …generally fair, with large areas of riparian vegetation. However, the stream channel is small and shallow and low flows limit fish movement. Large gravel beds suitable for spawning were generally lacking in the North Fork. The log weirs and culvert under S 359th Street are in poor condition and pose at least a partial passage barrier. Further, flows through that reach were inadequate to support year-round rearing and migration throughout the study. (HDR, 2014, p.16)

6.5.4 Lower Stem

Outside of the HDR study area in Federal Way, little detailed or updated information about instream habitat is available. Below the confluence of the East and West Forks, the creek follows closely along Interstate-5 for a distance of approximately ½ mile, before turning northward again and re-entering a forested riparian buffer. This reach adjacent to I-5 is likely the lowest quality fish habitat in the watershed. According to King County (1990), adjacent land development and channelization of the creek in the lower Hylebos, impacts habitat by removing the natural floodplain. As WSDOT notes, “in Lower Hylebos Creek the floodplain has been filled, channelized, and encroached upon, resulting in a reduction of floodplain storage… there is no riparian vegetation or large woody debris along this reach” (WSDOT, 2006, p. 3-27).

Figure 15: Riparian Restoration Proposal (WSDOT, preliminary design (subject to change) from the 2006 SR 167 FEIS). See Appendix D for full

This segment of the watershed is a high priority for instream and riparian restoration, as all anadromous fish must pass through these degraded conditions en route to better habitat upstream in Milton and Federal Way. WSDOT has proposed a major restoration project in this area, in conjunction with the proposed expansion of State Route 167.

> WSDOT is a state agency, landowner, and proponent/ developer of the planned SR 167 Completion Project, the new six mile long new freeway in Pierce County from the current terminus at SR 161 (Meridian Rd), through the Puyallup River Valley and connecting to SR 509 near the Port of Tacoma. WSDOT’s Riparian Restoration Program (RRP) is an important water resources mitigation and restoration strategy identified in the project’s Tier II Final Environmental Impact Statement (FEIS) completed in November 2006. The RRP is a project environmental commitment, and will relocate and restore portions of Hylebos Creek within the Lower Hylebos drainage. (Fuchs, 2016)

The Final Environmental Impact Statement (FEIS) for this project, published in 2006, describes an approach to stormwater management for the highway that includes relocation of channels, removal of fill and impervious surfaces, and restoration of riparian buffer zones along Hylebos Creek and the Surprise Creek tributary. This approach is proposed as an alternative to common stormwater management use of retention ponds and other traditional infrastructure.

This restoration would affect over 4,000 linear feet of the Hylebos mainstem, and over 5,000 linear feet of the Surprise Lake tributary. Among other elements, this proposal is intended to improve instream habitat for fish by increasing complexity and variety of channel form, increasing vegetation, providing off-channel rearing habitat, and increasing large woody debris.

Figure 16: Artist's visualization of a possible design for an interchange connecting SR 167 and I-5 (looking northwest). Creek corridor at lower right is the re-channelized and restored Surprise Lake tributary (WSDOT, SR 167 FEIS)

Figure 17: Lower Hylebos Creek, near I-5 (WSDOT SR 167 FEIS)

"Figure 16: Artist's visualization of a possible design for an interchange connecting SR 167 and I-5 (looking northwest). Creek corridor at lower right is the re-channelized and restored Surprise Lake tributary (WSDOT, SR 167 FEIS) is a WSDOT graphic from the 2006 FEIS. This was a conceptual visualization for the 'ultimate configuration' (full-build) scenario for the I-5 / SR 167 interchange. However, it is important to understand that although the SR 167 Completion Project (as part of the 'Puget Sound Gateway Program') was included in the July 2015 'Connecting Washington' legislation, the project is currently not fully funded. Dependent on stakeholder input and WSDOT's practical design process currently underway to determine essential needs for the project, the final design and constructed facility may not include this full interchange at I-5. The RRP and relocated Hylebos Creek and Surprise Lake Tributary are still planned as project features and are environmental commitments. WSDOT will coordinate with applicable agencies and stakeholders via the RRP Technical Advisory Group as project design moves forward." (Fuchs, 2016)

6.6 Benthic Macroinvertebrates / Salmon Food Sources

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Lack of benthic invertebrates and other food sources for salmon	• *INFORMATION*: Further monitor and assess instream conditions, including benthic macroinvertebrates across watershed, incorporating existing data. Additional monitoring may be needed on the North and East Forks, including resampling at the 2001 site on the East Fork in order to update the data. • *INFORMATION/ PLANNING*: Further analyze overall B-IBI data on a watershed scale. Assess likely causes of identified impacts to invertebrates; prioritize restoration actions to address these causes. • *PLANNING*: Evaluate strategies for restoration and management including Green Infrastructure Management, addition of instream Large Woody Debris, and seeding invertebrates. • *ACTION*: Continue active native plant restoration projects for salmon food source habitat- emphasize multi-layered stream vegetation.	• Restore habitat for an abundance and diversity of salmon prey

Benthic macroinvertebrates are animals with no backbone that can still be seen with the naked eye, including aquatic insects and crustaceans. They play a critical role in the ecosystem of freshwater streams, and provide one of the primary food sources for juvenile salmon. They are found amongst the plants, woody debris, stones and sediments of riverine and lake systems. Many species are intolerant of water pollution and sedimentation. They generally thrive in cool, clean, oxygenated water. Benthic macro-invertebrates are often monitored in Puget Sound streams as an indicator of the biological health of the overall stream system. The Benthic Index of Biotic Integrity (B-IBI) is a quantitative method of monitoring that allows for comparison between different stream systems.[7]

6.6.1 Completed Monitoring

The City of Federal Way conducted monitoring of benthic invertebrates at eight sites on the West Fork of Hylebos Creek during the period 1998-2014. Overall scores ranged from 18 to 30, which fall in the “fair to poor” range on the 50 point B-IBI scale (see *Federal Way data summary*). Further examination of the detailed scoring in recent years (2010-2014), shows some interesting trends. In general, scores were lowest for *Ephemeroptera (*mayflies), as well as for the general categories of “long-lived” taxa (those that require more than a year to complete life cycles) and “intolerant” taxa (those most sensitive to human disturbances). Fair scores were generally recorded among *Plectoptera (*stoneflies), *Trichoptera (*caddisflies), and in the general categories of “clingers” (taxa that “cling” to smooth surfaces along the streambed). Overall taxa richness is fair (and even excellent at some locations) and the percent of the total sample made up of tolerant species was excellent (i.e., relatively low) at nearly all sites.

Benthic invertebrate sampling was also completed on the East Fork in 2001, immediately downstream of the East Hylebos Ravine. This location scored 35 out of 50 overall, with high scores in overall species richness. (Taylor and Associates, 2002)

[7] See www.pugetsoundstreambenthos.org for more information on B-IBI methodology.

Additional insect monitoring using fall-out traps along the streambank is ongoing by EarthCorps at several sites in the watershed, including the East Hylebos Ravine and the Natural Resource Damage Assessment (NRDA) sites on the Lower Hylebos. Once complete, this data will provide additional information about insect productivity in the riparian vegetation surrounding the creek.

Legend	Excellent	Excellent/Good – Good	Good/Fair – Fair	Fair/Poor – Poor	Poor/Very Poor – Very Poor

			Quantities												Scores											
Row	Site Code, Location	Year, Project	Taxa Richness	Ephemeroptera Richness	Plecoptera Richness	Trichoptera Richness	EPT Richness	Clinger Richness	Long-Lived Richness	Intolerant Richness	Percent Dominant	Predator Percent	Tolerant Percent	Organisms	Overall Score	Taxa Richness	Ephemeroptera Richness	Plecoptera Richness	Trichoptera Richness	Clinger Richness	Long-Lived Richness	Intolerant Richness	Percent Dominant	Predator Percent	Tolerant Percent
1	HylbFW35...	2014, Macr...	45	2	4	8	14	15	7	0	51.1%	39.7%	9.2%	348	**54.3**	6.2	1.4	4.3	8.8	4.7	6.2	0.0	4.8	10.0	7.9
2	HylbFW35...	2013, Macr...	42	2	6	8	16	15	8	0	63.6%	42.4%	4.6%	500	**55.1**	5.2	1.4	7.1	8.8	4.7	7.5	0.0	1.5	10.0	8.9
3	HylbFW35...	2012, Macr...	39	3	6	9	18	13	5	0	58.2%	17.5%	11.0%	498	**50.0**	4.1	2.9	7.1	10.0	3.5	3.8	0.0	2.9	8.2	7.4
4	HylbFW35...	2011, Macr...	40	1	6	7	14	11	4	0	48.1%	11.8%	20.4%	499	**40.3**	4.5	0.0	7.1	7.5	2.4	2.5	0.0	5.6	5.4	5.3
5	HylbFW35...	2010, Macr...	40	3	3	7	13	12	5	0	39.6%	15.6%	11.2%	500	**47.0**	4.5	2.9	2.9	7.5	2.9	3.8	0.0	7.9	7.3	7.4
6	HylbFW35...	2009, Macr...	44	4	4	5	13	12	2	0	44.3%	6.8%	15.0%	499	**38.5**	5.9	4.3	4.3	5.0	2.9	0.0	0.0	6.7	2.9	6.5
7	HylbFW35...	2008, Macr...	38	2	4	2	8	7	5	0	57.3%	2.8%	18.3%	496	**24.3**	3.8	1.4	4.3	1.2	0.0	3.8	0.0	3.2	0.9	5.7
8	HylbFW35...	2007, Macr...	35	2	4	7	13	13	7	0	71.2%	16.2%	46.6%	500	**33.4**	2.8	1.4	4.3	7.5	3.5	6.2	0.0	0.0	7.6	0.0
9	HylbFW35...	2006, Macr...	32	2	5	6	13	12	3	0	58.8%	28.0%	27.0%	500	**35.8**	1.7	1.4	5.7	6.2	2.9	1.2	0.0	2.8	10.0	3.7
10	HylbFW35...	2005, Macr...	38	2	6	6	14	11	3	0	63.4%	57.6%	3.2%	500	**43.0**	3.8	1.4	7.1	6.2	2.4	1.2	0.0	1.5	10.0	9.3
11	HylbFW35...	2004, Macr...	27	3	5	6	14	14	5	0	74.5%	24.0%	3.0%	333	**42.0**	0.0	2.9	5.7	6.2	4.1	3.8	0.0	0.0	10.0	9.3
12	HylbFW35...	2003, Macr...	30	2	5	5	12	12	4	0	64.2%	11.2%	9.8%	500	**32.7**	1.0	1.4	5.7	5.0	2.9	2.5	0.0	1.3	5.1	7.7

Figure 18: Example of Tabulated Results from Benthic Macroinvertebrate Sampling 2003-2014, CO Federal Way (Puget Sound Stream Benthos)

The chart below in Figure 19 was published in a document that outlines potential restoration actions based on B-IBI scores. Recommendations for the Hylebos were not made in this report, however, below is an example from a different WRIA 10 site, Spiketon Creek (King County, 2015). It is an excellent example of prioritized actions to improve the invertebrate community. A similar strategy for the Hylebos is recommended.

Restoration and Management Actions		Likelihood action would help restore the basin
In-stream	add wood	2
	add substrate	2
	enhance sinuosity	2
	replace culverts	2
	stabilize stream banks	2
Riparian	stabilize slopes	2
	plant vegetation, extend buffer	3
Agricultural BMPs	exclude livestock	3
	manage waste	3
	prevent soil loss	2
Forest BMPs	road maintenance	2
	minimize clearcutting	4
	replant	2
Mining BMPs	mining BMPs	0
Stormwater BMPs	flow controls	4
	treatment	4
	maintain storage and treatment facilities	4
	street sweeping	1
Other Approaches and Actions	limit pesticide use	3
	outreach and education campaign	3
	create incentives to follow BMPs	3
	purchase and protect property	2
	seed invertebrates	3
Is the basin at risk of further degradation?		4

Key for colors and numbers used in table:

not applicable	unlikely	possibly	likely	highly likely
0	1	2	3	4

Figure 19: Evaluation of Potential Restoration and Management Actions for Spiketon Creek (King County, 2015, p.98)

6.7 Water Quality

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Poor water quality	• *INFORMATION*: Summarize existing water quality data on a watershed-scale. Assess data gaps for further study, including collection of additional/updated water quality samples as needed. Engage students and/or community members in citizen science as appropriate. • *PLANNING/ ACTION*: Establish a Total Maximum Daily Load (TMDL), which is required of Hylebos Creek but not currently established.	• Centralize a database for updated water quality data
	• *INFORMATION*: Identify specific locations where stormwater retention, green infrastructure, or additional urban green spaces could be implemented/ developed to reduce impacts of stormwater in the Hylebos watershed. • *PLANNING*: Develop a comprehensive basin-wide stormwater management plan that will encompass and coordinate jurisdictional planning efforts. See Section 6.1.2 for comprehensive basin-wide stormwater management planning. • *ACTION*: Require Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) methods for new developments and retrofits to existing stormwater infrastructure.	• Implement GSI management
	• *INFORMATION*/ *PLANNING*: Identify and prioritize opportunities for further riparian restoration projects to improve water quality. • *ACTION*: Continue active riparian restoration projects that increase buffer zones, to increase filtration of polluted water and create shade for creek.	• Restore vegetative riparian buffers
	• *INFORMATION*/ *PLANNING*: Identify point sources of pollution. • *ACTION*: Take appropriate legal action against polluters.	• Enforce compliance with point source pollution regulations

Poor water quality is a major issue in urban streams in the Pacific Northwest, with impacts on downstream waterbodies, habitat conditions, salmon and other wildlife populations, and human health. Water quality is degraded in urbanized creek systems by inputs of polluted water from both point and non-point sources. Furthermore, the loss of native forests can decrease filtration of surface water, groundwater recharge, and shade on streams, and can increase turbidity and nutrient flushing. The increase in impervious surfaces associated with urban development also results in rapid delivery of stormwater to stream systems, frequently with a corresponding influx of pollutants during storm events. Water quality is routinely monitored in many Pacific

Northwest streams for temperature, pH, turbidity, dissolved oxygen, fecal coliform, phosphorus, nitrogen, copper, zinc, and other chemicals.

6.7.1 Existing Water Quality Data

Water quality issues have been identified in Hylebos Creek for many years. Both King and Pierce counties have identified concerns about high concentrations of pollutants from runoff (especially during storm events), high concentrations of fecal coliform, suspended solids, heavy metals, and increased water temperatures (King County, 1990; Pierce County, 1991). More recently, King County conducted a more localized study in the East Fork of Hylebos Creek. This 2002 study by Taylor and Associates, found that during both baseflows and storm events- levels of fecal coliform and phosphorus exceeded EPA criteria. The study found that only during storm events (likely generated by runoff) - zinc, copper, total suspended solids and turbidity exceeded recommended thresholds, and oil sheens were observed.

Hylebos Creek (West and North Fork) is currently listed on the EPA's 303(d) Clean Water Act watershed assessment listing as 'Polluted Waters' for fecal coliform bacteria, as well as under the 'Bioassessment' parameter (definitive biological degradation of aquatic life). It is a 'Water of Concern' for dissolved oxygen. Hylebos Creek East Fork is listed separately as 'Polluted Waters' for fecal coliform and copper levels. Although a Total Maximum Daily Load (TMDL) is required, none is currently established.

Additional water quality monitoring has been conducted by several entities. The City of Federal Way conducted temperature monitoring[8] from 2002-2005 (Smith, 2005) and the Washington Department of Ecology most recently found fecal coliform, mercury, and oxygen levels below water quality standards in 2011[9].

6.7.2 Work Flow for Future Information → Planning → Action

Further water quality monitoring across the watershed should be implemented in a manner that compiles and utilizes the existing data to determine localized sources of pollutants, or hotspots for pollutant accumulation. At this time, there is no centralized or comprehensive source of water quality data for the watershed. The creation of such a centralized database is beyond the scope of this report, but would be an important next step for planning restoration projects to specifically address water quality issues in the Hylebos watershed.

Strategic data collection enables the identification and prioritization of specific polluted stream reaches. Data collection can include community members and students through citizen science and extracurricular programming.

Mapping of land use (pervious vs. impervious surfaces, and forest vs. other vegetative cover) across the watershed could further identify areas of pollutant load during storm events. After this information is gathered and organized, action can be taken. For stormwater pollution specifically, problem areas can be alleviated through Green Stormwater Infrastructure (GSI) techniques. As iterated in Section 6.1, a comprehensive basin-wide stormwater management plan is imperative to improving polluted waters.

Even before such a comprehensive effort is underway, on-the-ground riparian restoration projects can be undertaken that will work to improve water quality conditions in Hylebos Creek. From an ecological restoration perspective, the top priority for improving water quality is the establishment of a healthy riparian forest buffer zone along the creek. These buffer zones provide critical filtration of runoff and

[8] http://wa-federalway.civicplus.com/DocumentCenter/Home/View/682
[9] https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear

stormwater before they reach the stream, reducing the influx of pollutants such as fecal coliforms, metals, and excess nutrients. They also provide shade that cools water temperatures, which increases dissolved oxygen levels. Furthermore, the establishment of an evergreen canopy slows runoff and minimizes erosion through interception and evapotranspiration of precipitation on a year round basis. For these reasons, projects that restore riparian corridors along Hylebos Creek should be understood not only as habitat restoration, but also for the ecosystem services they provide- stormwater filtration and improved water quality.

6.8 Water Quantity- Flooding

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Flooding, increasingly high peak flows, lack of floodplain and storage capacity.	• *INFORMATION*: Update 2006 Hylebos Conservation Initiative map (Figure 4) to prioritize conservation and restoration of historical floodplains. • *PLANNING*: Direct funding towards conserving and restoring top-priority parcels. • *ACTION*: Acquire top-priority parcels for restoration of floodplains (see Section 7) by government agencies + conservation groups. Investigate 'Transfer of Development Rights' as an option. • *INFORMATION*/ *PLANNING*: Identify and prioritize opportunities for future riparian restoration projects to improve floodplain capacity, reconnect floodplains, and encourage on-site infiltration. • *ACTION*: Continue active riparian restoration projects that increase buffer zones and restore natural water storage capacity, including reconnection of restored floodplains and formation of an evergreen canopy. • *ACTION*: Coordinate with and support WSDOT's implementation of a Riparian Restoration Program (RRP) to address stormwater issues and flood concerns in the floodplain area related to the SR 167 Completion Project. • *INFORMATION*: Identify specific locations where stormwater retention, green infrastructure, or additional urban green spaces could be implemented/ developed to reduce impacts of stormwater in the Hylebos watershed. • *PLANNING*: Develop a comprehensive basin-wide stormwater management plan that will encompass and coordinate jurisdictional planning efforts. See Section 6.1.2 for comprehensive basin-wide stormwater management planning. • *ACTION*: Require Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) methods for new developments and retrofits to existing stormwater infrastructure.	• Re-connect floodplains to creek • Restore vegetative riparian buffers • Reduce stormwater flows • Implement GSI management

Loss of natural floodplains to development decreases the capacity of a creek system for flood storage. Combined with the conversion of riparian and upland vegetation into impervious surface, peak flows increase during storm events beyond what the physical creek can hold.

6.8.1 Past and Future Flooding of Hylebos Creek

Flood season for Hylebos creek (October-March) sees greater floods by rainfall rather than snowmelt. A high percentage of impervious surfaces and steep topography in the upper watershed combine with winter rainfall to cause these larger floods. (WSDOT, 2006, p.3-29) These are likely to increase as the basin continues to develop and more intense rainfall events are predicted with climate change.

Figure 20: Flooding in February 1996, Hylebos Creek at I-5 (looking south). WSDOT, SR 167 FEIS

Significant floods of Hylebos Creek have occurred several times in recent history, most notably in 1990, 1996 and 1997. The 1996 flood extended beyond the defined 100-year floodplain, even as the storm that caused it was classified only as a 20-year rain event (WSDOT, 2006, p.3-27). As noted by Pierce County, "these problems are typical of areas built prior to comprehensive site development stormwater regulations and areas that contain small projects built incrementally without master drainage planning" (Pierce County, 2006, p.5-1).

The most vulnerable area to flood surrounds the proposed SR-167 highway project, near the confluence of the Surprise Lake tributary. As part of the FEIS for this project, WSDOT conducted hydrological analysis and modeling of the watershed. They determined that approximately 246 acres are currently expected to flood during a 100-year flood event, including the area between SR 99 and I-5, with spillover onto the southbound I-5 traffic lanes (WSDOT, 2006, p.3-29). The proposed restoration project is expected to reduce this flood area by over 25%. It also creates over 116 acres of riparian buffer zone, which could provide more flood storage with little damage to infrastructure. (WSDOT, 2006, pp.3-64, 3-66)

It is also important to note that the City of Federal Way and the Department of Ecology are in discussion about flow control requirements for the basin. If additional regional flow control is required to support upstream development, the resulting decrease in flow rate may adversely affect the wetlands complex.

6.8.2 Improving Water Infiltration and Storage

On a local scale, efforts to decrease flooding likewise serve efforts to improve water quality. These include a) mapping of land use to identify areas contributing runoff, (See Figure 23), b) mitigation of stormwater runoff on new or existing developments using LID/GSI techniques, and c) riparian and wetland restoration projects that slow the movement of stormwater into and through the creek system.

Key components of natural drainage systems and related GSI projects to minimize flooding are:

- Encouraged on-site infiltration minimizes the distance that water travels overland. Water should infiltrate into the ground as close to where the precipitation falls as possible. This minimizes runoff and maximizes local groundwater recharge. Ample urban green space is key to providing localized infiltration in the Hylebos watershed.
- Vegetation stabilizes slopes and aerates soil. Soil compaction and steep slopes are two major factors in high runoff areas- vegetation serves to alleviate this issue in both cases, through interception, evapotranspiration, and increased porosity of the soil. Evergreen trees, in particular, provide these services year round, and use their deep roots to open subterranean access for surface water to reach the water table.
- Increased surface roughness of slopes slows down runoff and allows for pooling- where water can sit and infiltrate into the ground. This can be accomplished by large woody debris (LWD) placed in stream or recruited from installed conifer trees.

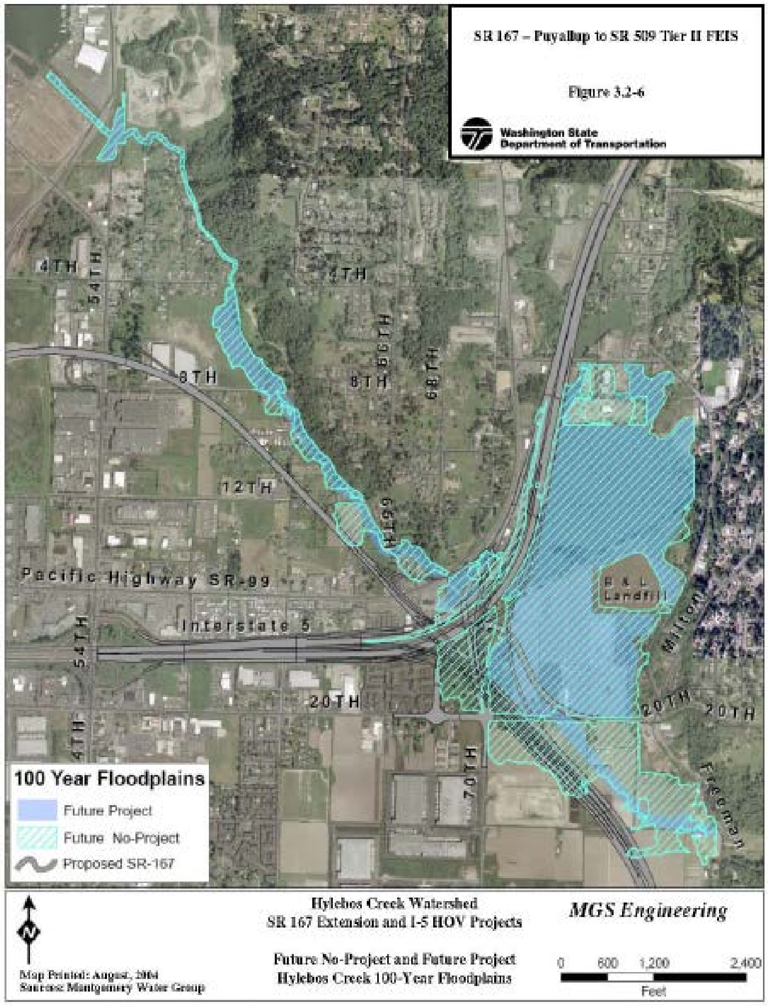


Figure 21: 100-year floodplains, before and after SR-167 project (preliminary design from WSDOT FEIS 2006)

6.9 Climate Change

PROBLEM	INFORMATION/PLANNING/ACTION	SOLUTIONS
Climate Change	• *INFORMATION*: Summarize existing research on watershed scale effects of climate change. • *PLANNING*: Make explicit considerations for climate change in all current and future land use planning. Direct funding towards restoration projects that increase ecosystem resilience. • *PLANNING / ACTION*: Identify, prioritize and implement opportunities for restoration projects that improve the resilience of forest, riparian and nearshore ecosystems. Examples of 'resilience goals' include: increased floodplain capacity, increased erosion controls in landslide prone areas, increased vegetative buffers along waterbodies, improved genetic diversity of vegetation to mitigate pest outbreaks, etc.	• Improve plasticity and resilience of natural systems

Climate change is an environmental problem that may have unpredictable consequences for the entire Puget Sound region. Sea level rise, ocean acidification, drought, loss of snowpack, invasive plant and insect invasions, landslides, and flooding are several of the issues that are already beginning to impact the abundance, diversity and quality of ecosystems in the Pacific northwest. Specifically in the Hylebos watershed, instream conditions, native and non-native plant composition, plant and animal survivability, water quality, and flood risk may all be affected by long term shifts in temperature and moisture regimes, as well as by increased extremes in short term weather events.

Planning for ecological function in the watershed will need to consider climate change based on the best available models. Due to the unpredictable nature of climate change, improving resilience of the natural systems that are in place is critical in ensuring that these systems can function into the future. Efforts should be made to coordinate and partner with regional goals and initiatives to mitigate the effects of climate change including the published 2015 King County Strategic Climate Action Plan and the forthcoming Pierce County Climate Change Resilience Strategy.

7 Strategic Priorities for the Hylebos Watershed

The process for deriving the following strategic priorities is explained in Section 7.1. These priorities are a way to strategically dive into the nine environmental problems described previously. Note the overlapping nature of the solutions inherent in prioritizing problems that are so systemically related. Refer to the indicated sections for full descriptions and action steps.

STRATEGIC PRIORITIES FOR THE HYLEBOS WATERSHED

1. Reconnect fragmented habitats (Section 6.2)
    a. land acquisition/ conservation easements/ transfer of development rights/ stewardship education with private landowners
    b. remove fish barriers

2. Preserve high quality habitat (defined as having functioning hydrology and sediment delivery processes) (Section 6.1,6.5)
    a. land acquisition/ conservation easements/ transfer of development rights/ stewardship education with private landowners
    b. regulate/limit impacts from urban development, stormwater
    c. restore/maintain native vegetation

3. Rehabilitate broad-scale watershed processes (Sections 6.1,6.3,6.4,6.5,6.8)
    a. retrofit stormwater detention and implement green stormwater infrastructure
    b. increase evergreen canopy cover throughout entire watershed
    c. riparian restoration- increase flood storage and improve vegetative stream buffers

4. Rehabilitate local-scale processes in degraded high-gradient streams (>4% slope, feeds sediment downstream) (Section 6.5)
    a. modify channel network in critical areas to absorb/ dissipate unnaturally high stream energy, remove shoreline armoring
    b. plant conifer trees to encourage long term Large Woody Debris (LWD) recruitment, or install LWD

5. Restore vegetative conditions on high priority habitat sites (Sections 6.3,6.4,6.5,6.6)
    a. encourage increased infiltration, interception of precipitation
    b. reduce sediment inputs from channel and bank erosion
    c. increase soil stability
    d. encourage plant and insect diversity

6. Rehabilitate local-scale processes in degraded moderate-gradient (1-4% slope, sediment neutral) and low-gradient (<1% slope, receive sediment from upstream) stream channels (Sections 6.3,6.4,6.5)
    a. modify channel network in critical areas to increase floodplain, remove shoreline armoring
    a. accommodate passage of chronic fine sediment inputs
    b. plant conifer trees to encourage long term LWD recruitment, or install LWD

7. Create off-channel and spawning habitats (Sections 6.5,6.8)

7.1 The Process of Prioritization

The strategic priorities outlined above were created using the following framework for prioritization of projects (see Figure 22), This framework was presented by Steward and Associates (2006), and originally adapted from the comprehensive strategy for watershed-scale restoration developed by the NOAA Fisheries Northwest Fisheries Science Center (Beechie et al, 2003, which in turn was modified from Roni et al, 2002).

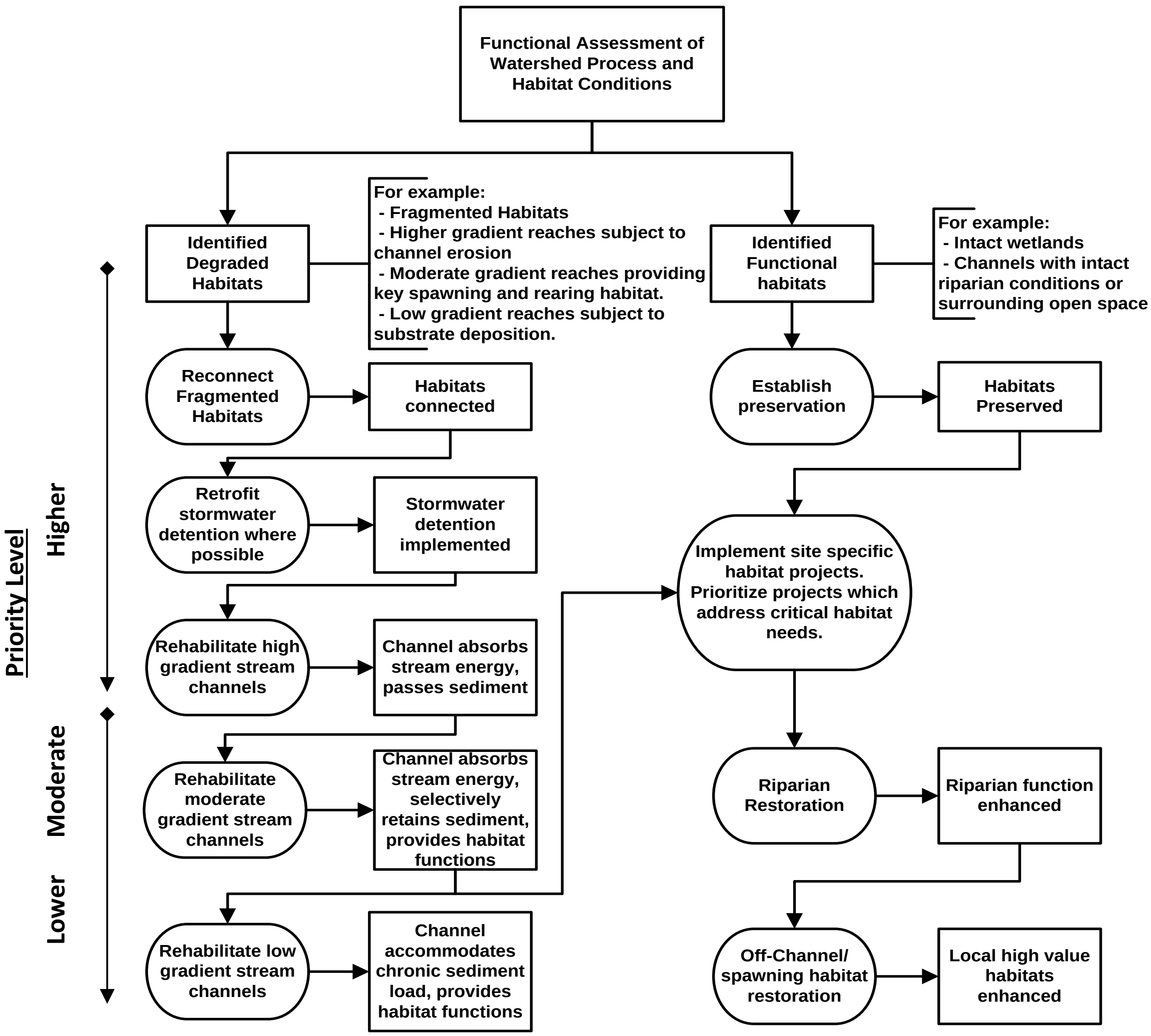


Figure 22: Hylebos Watershed Habitat Preservation and Restoration Prioritization Strategy (Steward and Associates, 2006, p. 6)

Their method strongly emphasizes watershed scale processes, especially flow regime and sediment transport processes. As Steward and Associates (2006) point out, "Local habitat enhancement efforts are less likely to be effective over long time periods if they are implemented in the context of degraded watershed process conditions" (p.4).

However, they also emphasize the need for modification of the Roni/Beechie strategy for urban ecosystems, for the following reasons:

- Watershed conditions leading to degraded hydrologic and sediment delivery processes are effectively permanent;
- In light of these conditions, increased stream energy, sediment delivery and channel erosion will remain chronic problems;
- Without active intervention, the natural adjustment of the channel network to the existing process regime will result in ongoing degradation of stream habitat conditions.

(Steward and Associates, 2006, pp.4-5)

For these reasons, "appropriate measures for the Hylebos watershed should focus on modification of the channel network in critical areas to absorb and dissipate unnaturally high stream energy, encourage increased infiltration, reduce sediment inputs from channel and bank erosion, and accommodate passage of chronic fine sediment inputs." (Steward and Associates, 2006, p.5)

Following this evolving methodology, the overall 'Strategic Priorities for the Hylebos Watershed' was created. It is worth noting that these previous frameworks use salmon as an indicator of a healthy watershed and thus highly considers fish habitat. For example, flooding is not as highly considered. Therefore we have adjusted the framework so that although salmon recovery is still a main driver, other natural processes and human concerns are more equally weighted. Also, Green Stormwater Infrastructure (GSI) was not previously incorporated as a tool and we have adjusted the framework to prioritize GSI as a watershed scale solution.

8 Watershed-Scale Inventory - GIS Mapping and Analysis

An analysis of existing environmental data can be a useful tool to prioritize areas for conservation, enhancement, and restoration of hydrologic watershed processes (Stanley et al, 2005, p. 2). Available data can provide detailed landcover analyses, vegetation heights, and stream gradients within the watershed. This information can be used to evaluate current land-use practices within specific areas of the watershed (or stream reach etc.) and identify key areas for protection and potential restoration. The information that was used to evaluate watershed processes in the Hylebos drainage basin included landcover data estimated into twelve class types derived from 2015 4-band NAIP orthophotography:

Impervious Surfaces

- Buildings
- Development/Impervious

Low Pervious Surfaces

- Bare soil
- Dry grass
- Irrigated Grass

Pervious Surfaces

- Conifer Forest
- Deciduous Forest
- Herbaceous Wetland
- Open Water
- Shrubland
- Shrub Swamp

Unknown

- Shadow

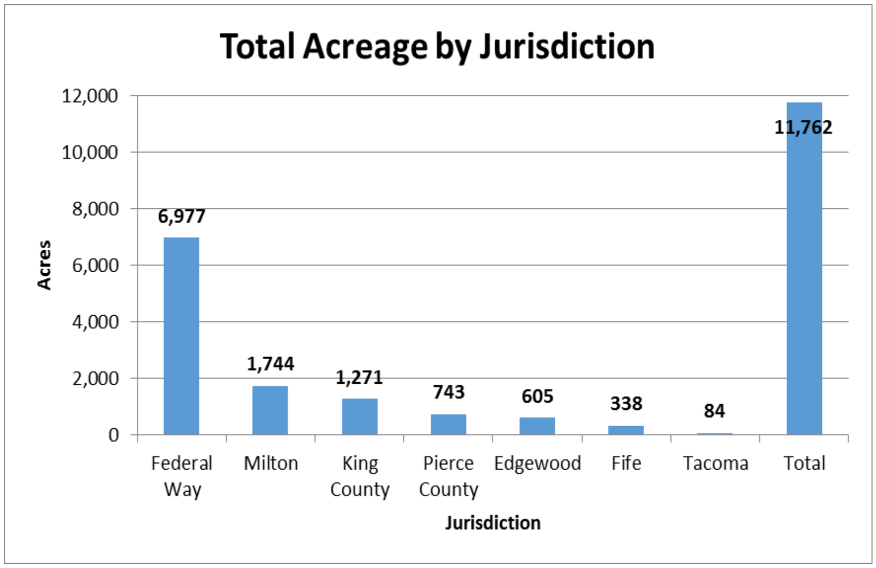


Figure 23: Figure 23: Total land cover acreage by jurisdiction derived from GIS analysis.

This information has been summarized at the watershed level and aggregated by municipality and can be used to prioritize habitat and process restoration and conservation using the concepts and principles outlined in this report.

Future efforts can use these data to determine restoration and prioritization at the planning area, neighborhood, sub-basin or parcel etc. Additionally, LiDAR data could be analyzed to categorize stream gradients in order to identify high-gradient stream reaches (>4%) that could be high priority locations for local-scale sediment delivery and hydrologic process restoration or enhancement (Section 6.3).

The following maps and summarized data charts/graphs were created to illustrate the general trends associated with landcover and vegetation and will be used to further prioritize areas for potential restoration and enhancement of watershed processes as resources become available.

Table 1. Percentage of grouped landcover types for each jurisdiction in the Hylebos Watershed based on remote analysis from 2015 orthophotography. **Impervious** includes paved surfaces and buildings. **Low Pervious** includes bare soil, dry grass, and irrigated grass. **Pervious** includes conifer forest, deciduous forest, open water, herbaceous wetland, shrubland, and shrub swamp. **N/A** is a result of dark shadows in the imagery that could not be remotely classified.

Permeability	Edgewood	Federal Way	Fife	King County	Milton	Pierce County	Tacoma	Total
Impervious	27%	40%	38%	35%	41%	27%	36%	38%
Low Pervious	29%	11%	25%	16%	19%	18%	15%	15%
Pervious	38%	42%	36%	40%	33%	51%	47%	41%
N/A (Shadow)	6%	6%	2%	9%	7%	3%	1%	6%

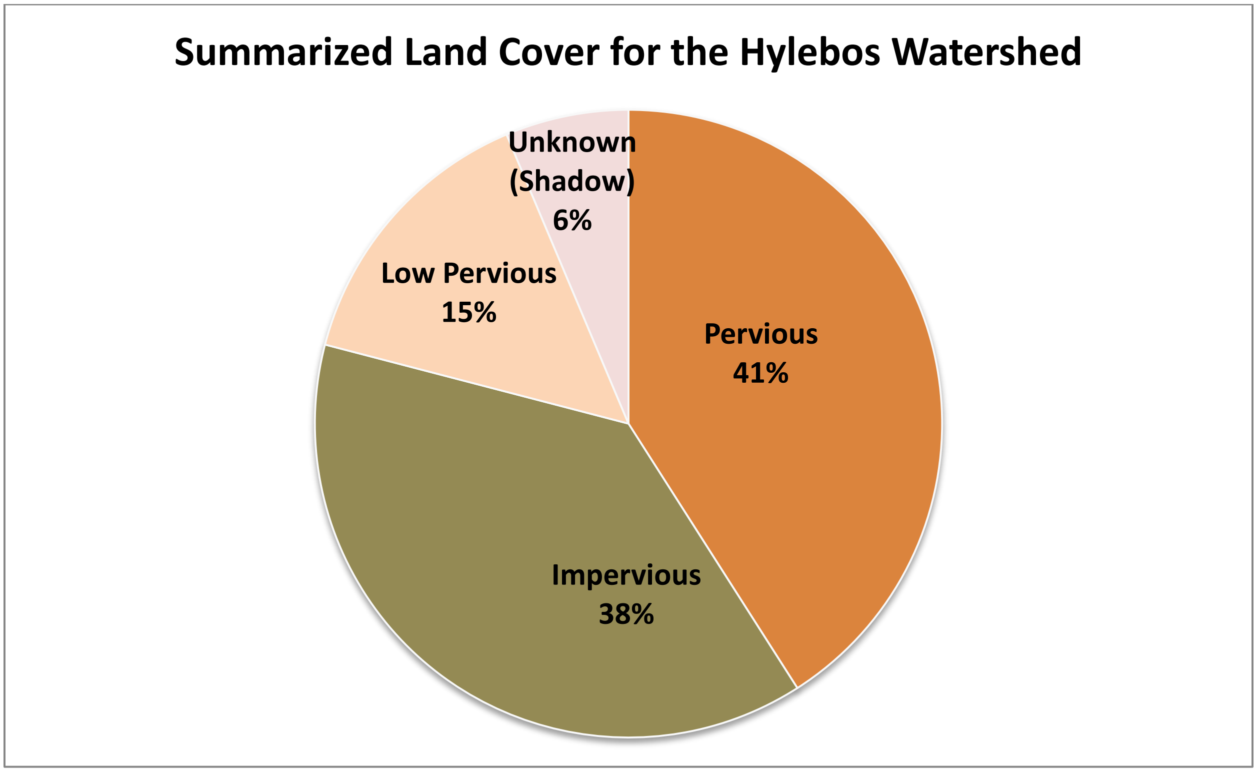


Figure 24: Summarized land cover types for the Hylebos watershed based on remote analysis from 2015 orthophotography.

Table 2. Overall landcover types for the Hylebos Watershed based on remote analysis from 2015 orthophotography

Class Name	Acres	%
Buildings	1,334	11%
Developed/Impervious	3,147	27%
Conifer	2,414	21%
Deciduous	1,279	11%
Bare Soil	166	1%
Dry Grass	910	8%
Irrigated Grass	640	5%
Shadow	748	6%
Water	130	1%
Herbaceous Wetland	45	0%
Shrub	925	8%
Shrub Swamp	23	0%
Total Acreage	11,762	

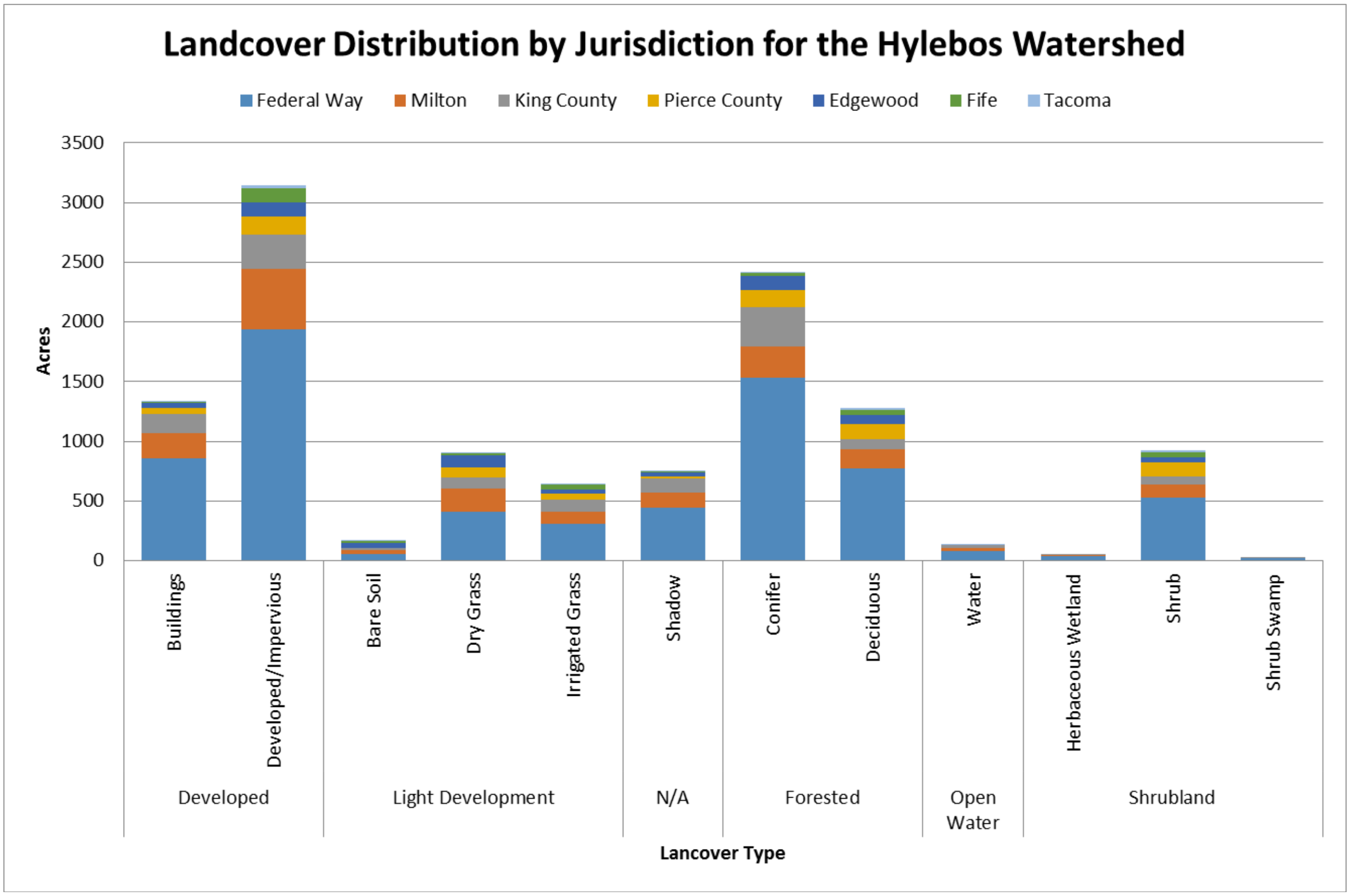


Figure 25: Land cover acreages by class type across jurisdictions based on remote GIS analysis from 2015 orthophotography.

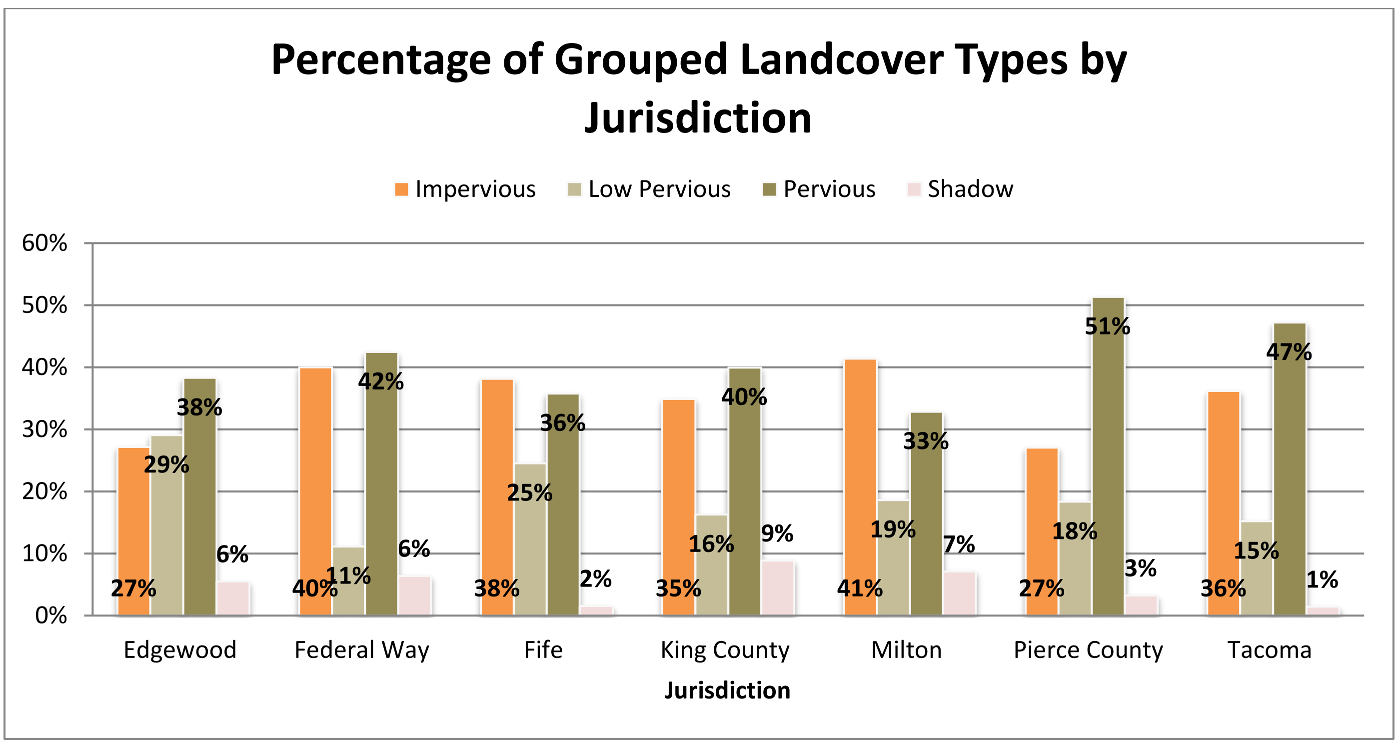


Figure 26: Percent of each summarized cover type for each jurisdiction based on remote GIS analysis from 2015 orthophotography.

Hylebos Watershed Landcover

Figure 27: Land cover types in the Hylebos watershed derived from remote GIS analysis based on 2015 orthophotography.

Hylebos Watershed Impervious

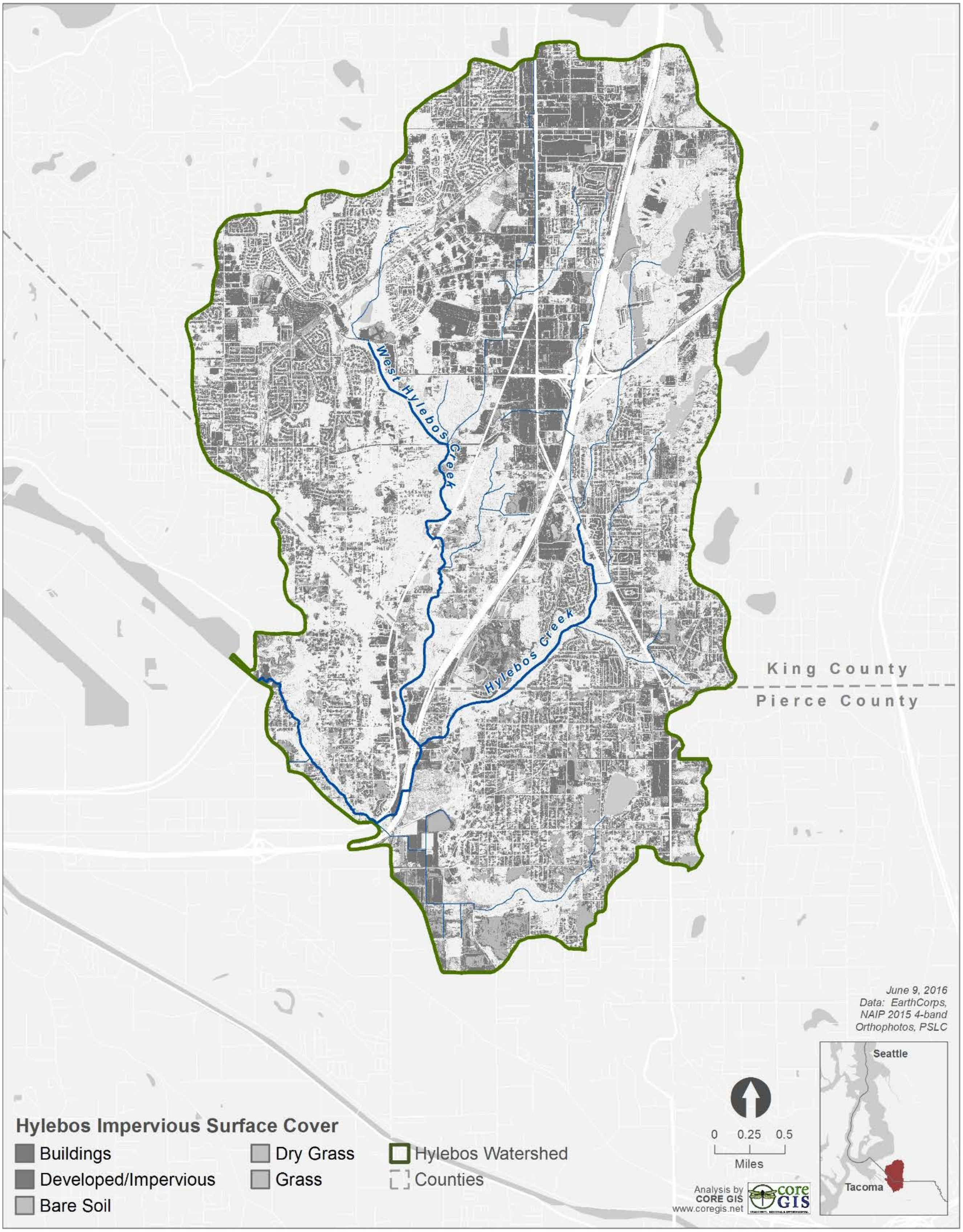


Figure 28: Impervious surfaces in the Hylebos watershed derived from remote GIS analysis based on 2015 orthophotography.

Hylebos Watershed Forested

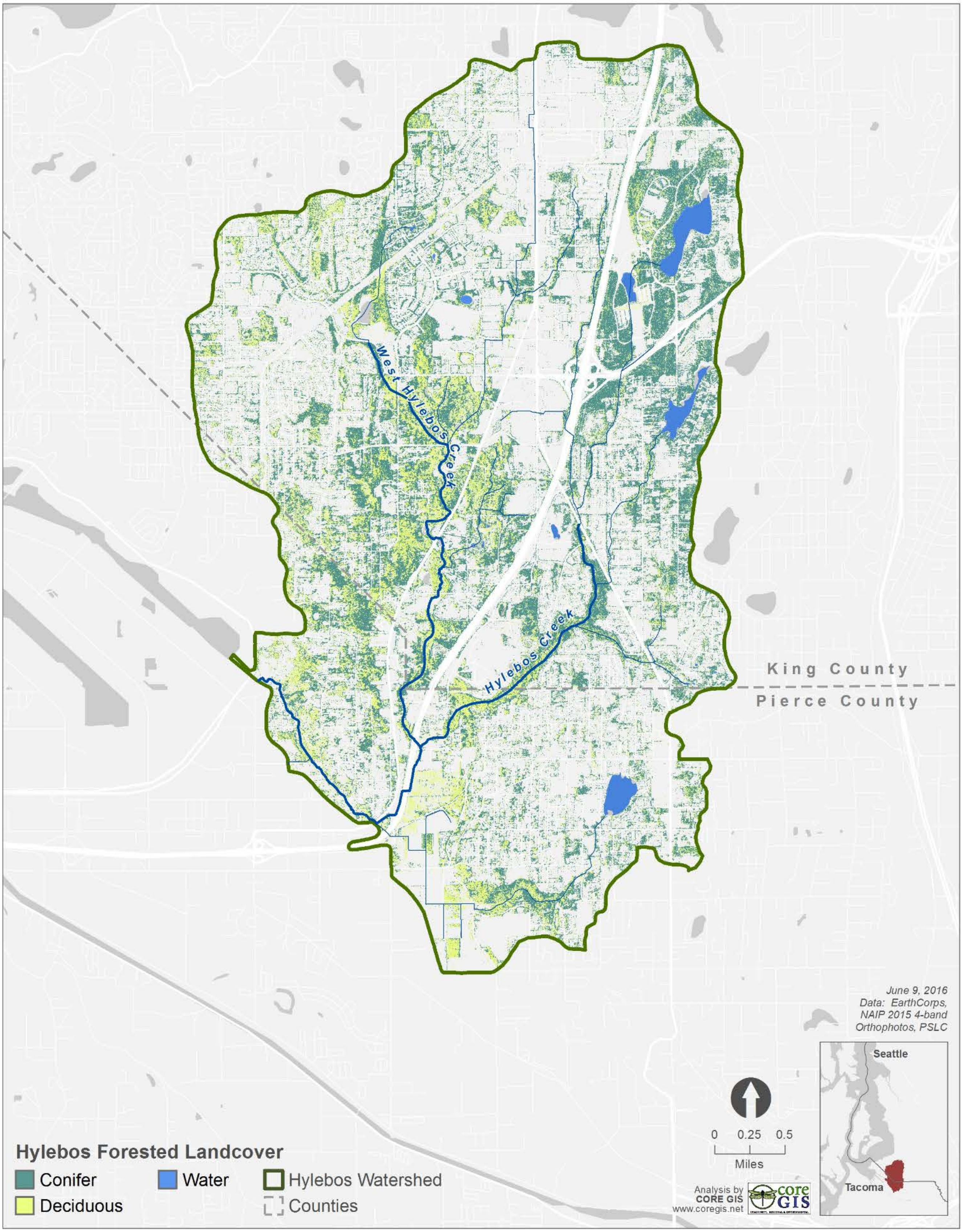
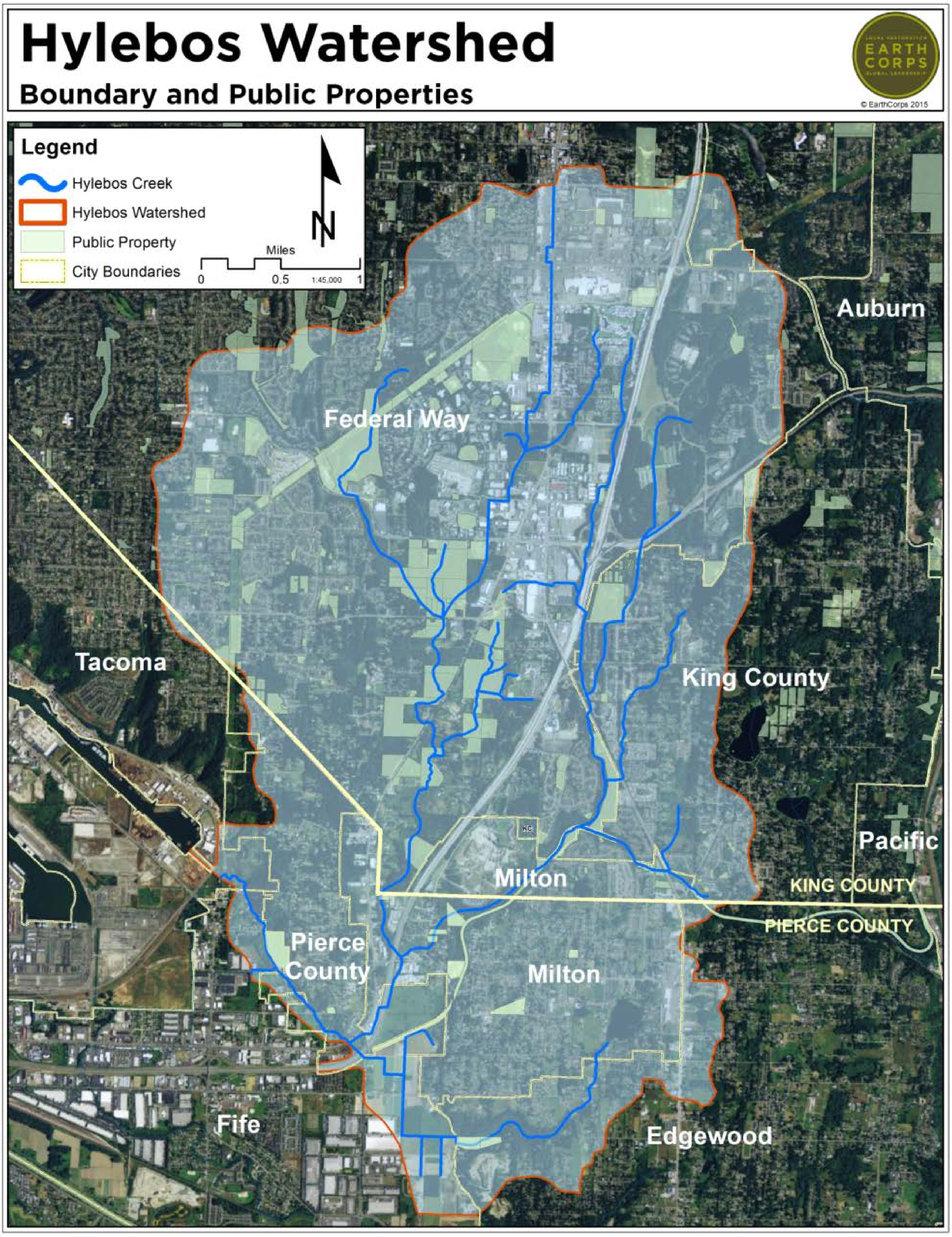


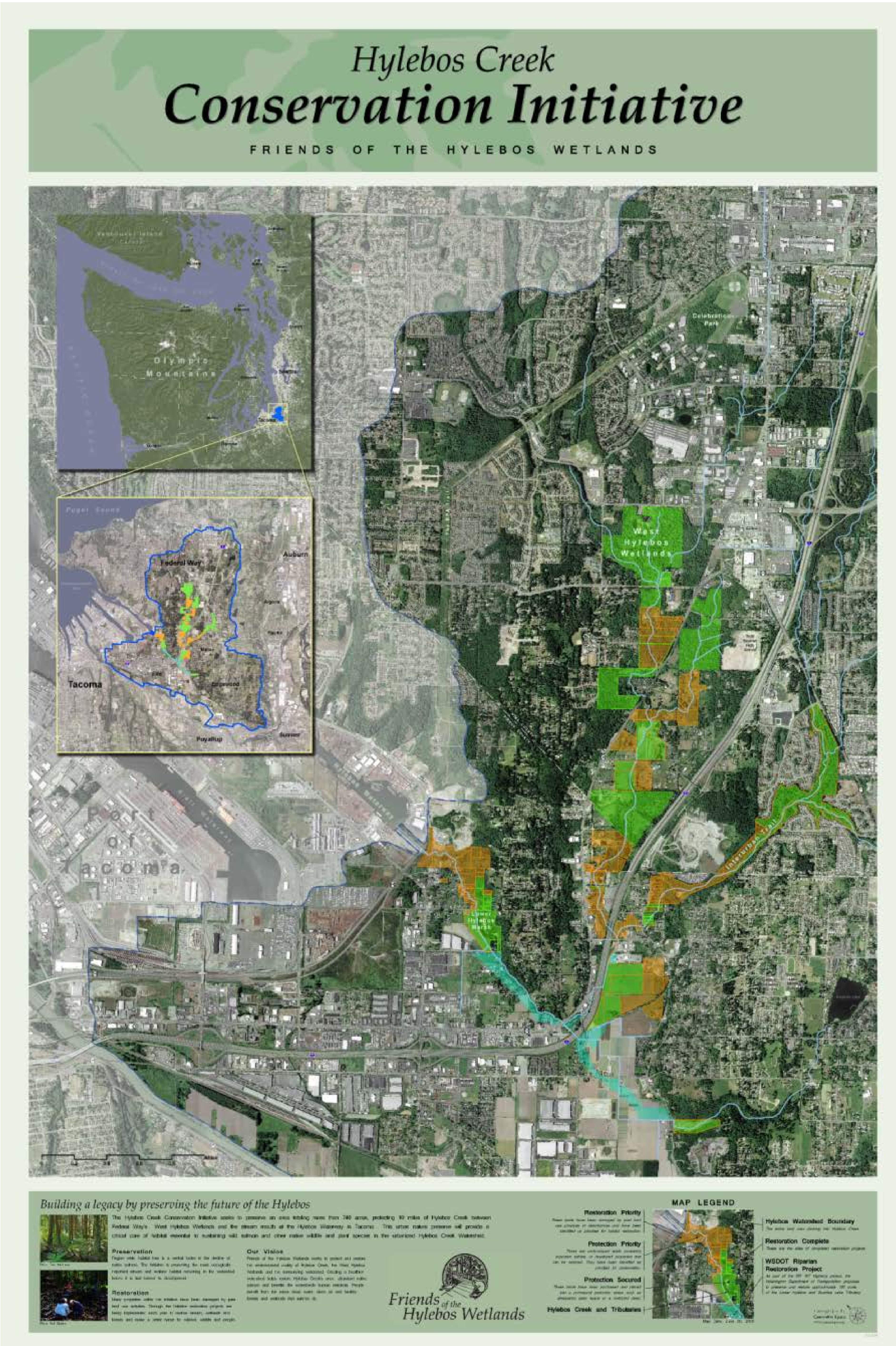
Figure 29: Forest cover in the Hylebos watershed derived from remote GIS analysis based on 2015 orthophotography.

9 Appendices

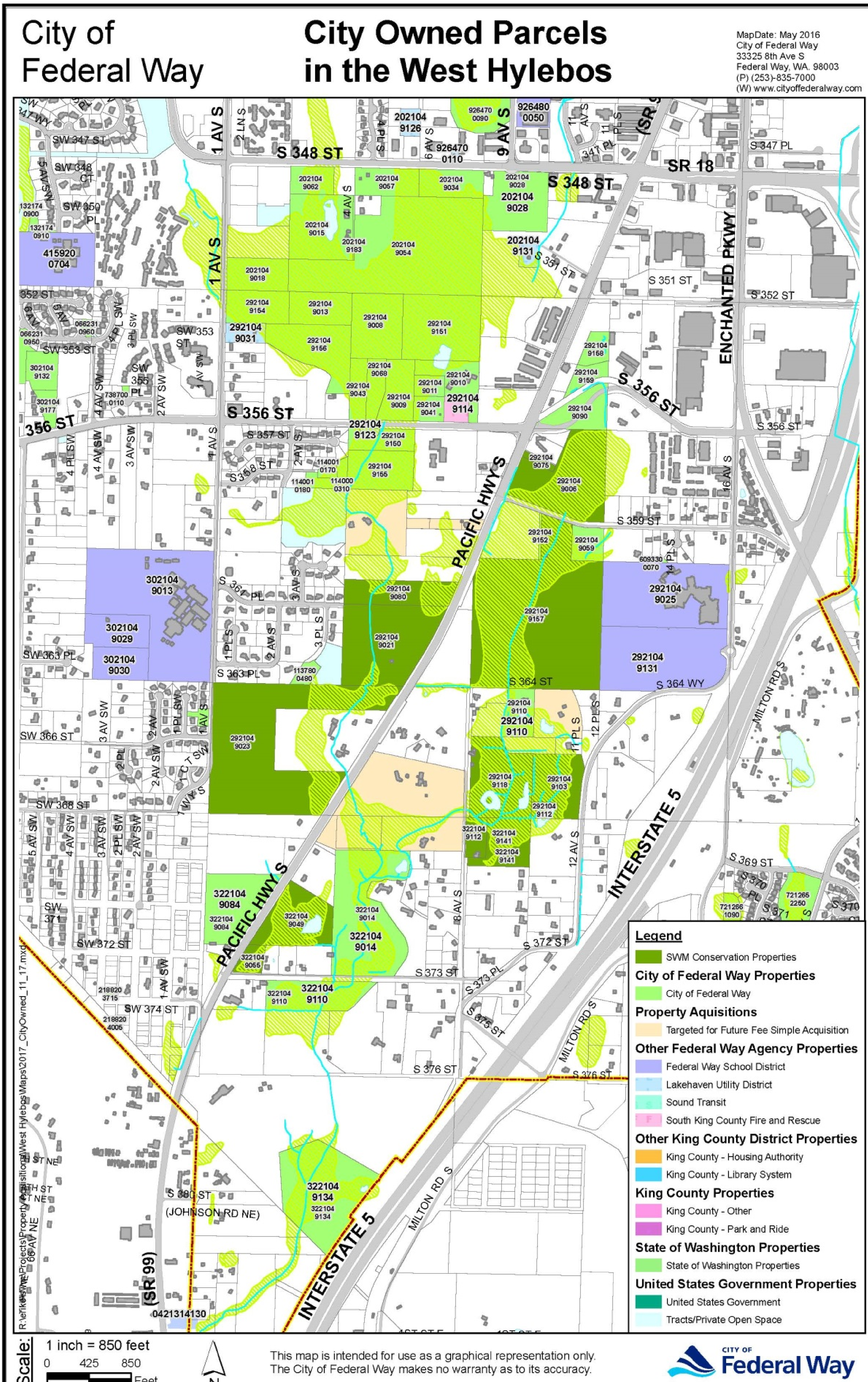
9.1 Appendix A: Hylebos Watershed Map



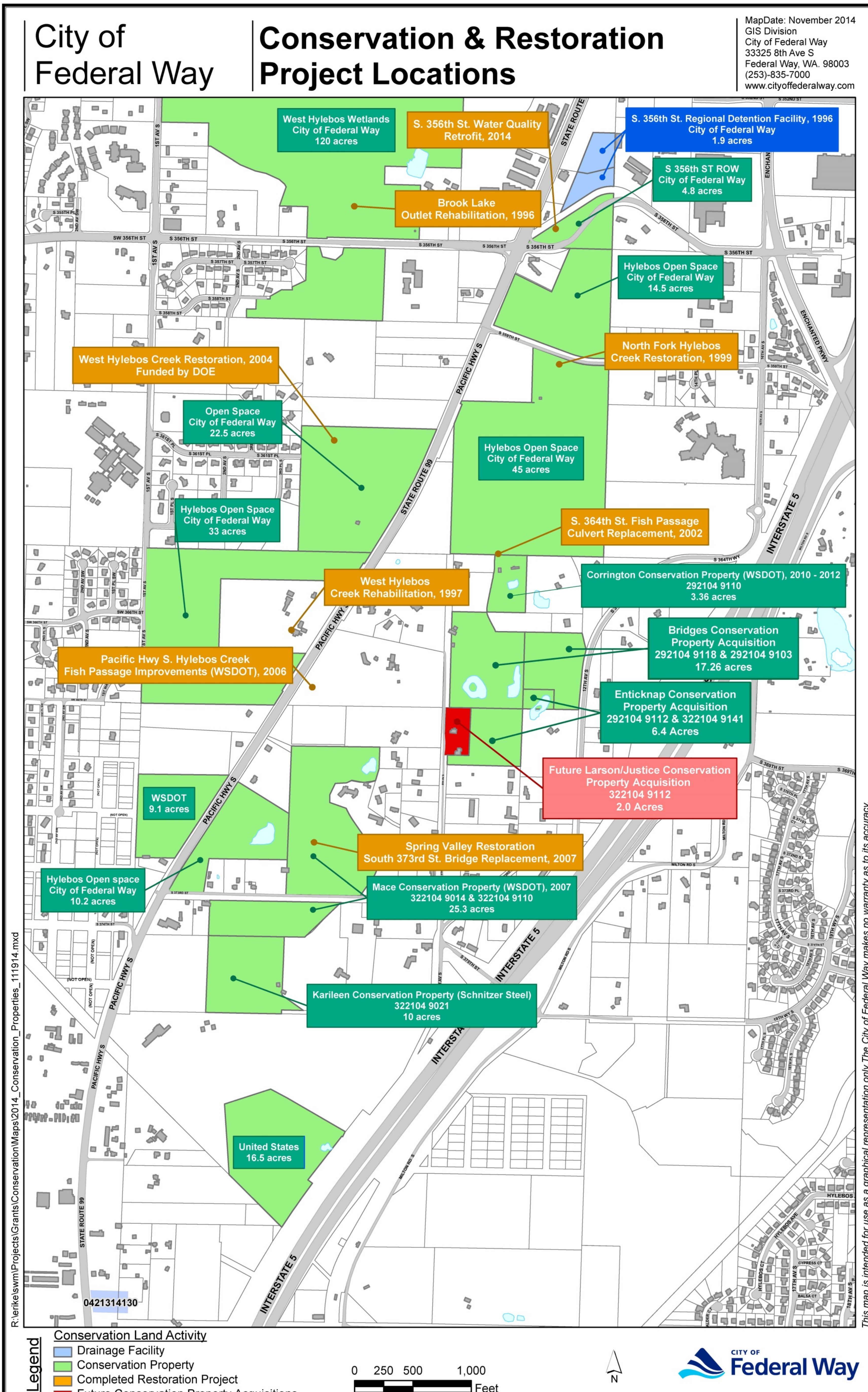
9.2 Appendix B: 2006 Conservation Initiative map



9.3 Appendix C: City of Federal Way land acquisitions



9.4 Appendix D: City of Federal Way Conservation & Restoration Project Locations



9.5 Appendix E: Riparian Restoration Proposal. WSDOT, preliminary design (subject to change) from the 2006 SR 167 FEIS

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