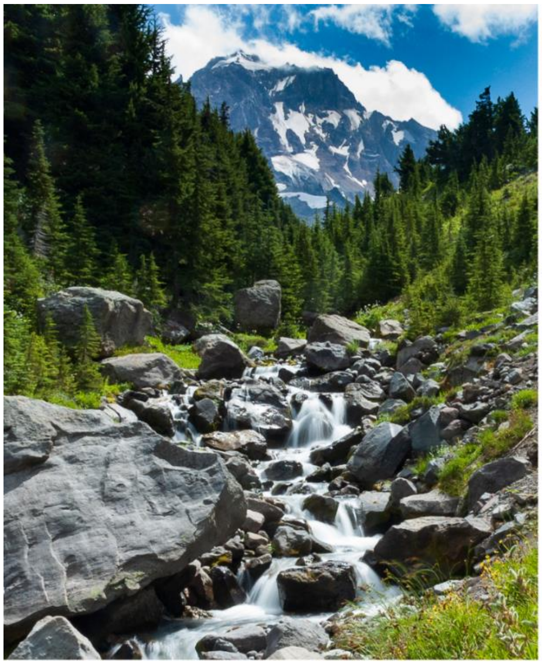
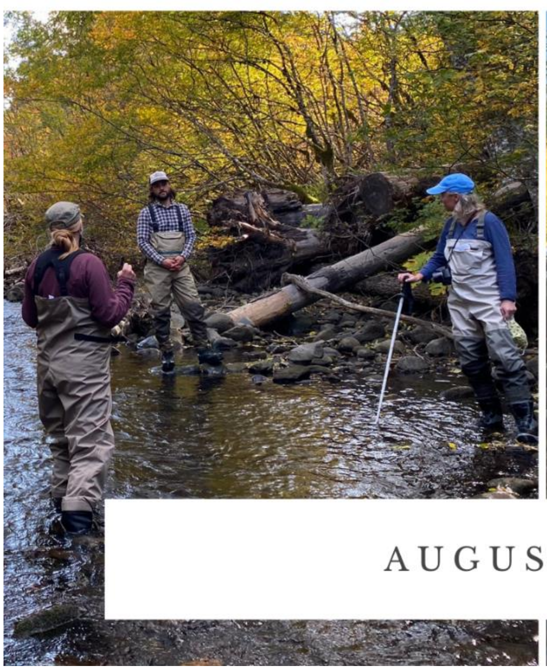



# WATERSHED 2040

*Hood River Basin Partnership*
*Strategic Action Plan*




AUGUST 2021

# Hood River Basin Partnership

# Strategic Action Plan

***Prepared by***
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**August 2021**

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**Funding provided by the Oregon Watershed Enhancement Board**

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## Acronyms

**ORGANIZATIONS:**

BEA – Bureau of Economic Analysis

BPA – Bonneville Power Administration

CGFG – Columbia Gorge Fruit Growers

CTWS – Confederated Tribes of the Warm Springs

DEQ – Department of Environmental Quality

EFID – East Fork Irrigation District

EPA – Environmental Protection Agency

FCA – Farmers Conservation Alliance

FID – Farmers Irrigation District

HRVHS – Hood River Valley High School

HRVPR – Hood River Valley Parks and Recreation

HRWG – Hood River Watershed Group

MFID – Middle Fork Irrigation District

NMFS – National Marine Fisheries Service

NRCS – Natural Resources Conservation Service

ODA – Oregon Department of Agriculture

ODFW – Oregon Department of Fish and Wildlife

OSU – Oregon State University

OWEB – Oregon Watershed Enhancement Board

OWRD – Oregon Water Resources Department

Reclamation – Bureau of Reclamation

SWCD – Soil and Water Conservation District

USDA – U.S. Department of Agriculture

USFS – U.S. Forest Service

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

WPN – Watershed Professionals Network

**OTHER:**

AQI – Aquatic Inventories

AWQMS – Ambient Water Quality Monitoring System

BMP – Best Management Practice(s)

CFS – Cubic Feet Per Second

EDT – Ecosystem Diagnosis and Treatment Model

EQIP – Environmental Quality Incentives Program

ESA – Endangered Species Act

FSP – Funding and Sustainability Plan

HECRAS – Hydrologic Engineering Center River Analysis System

IFIM – Instream Flow Incremental Methodology

IWM – Irrigation Water Management

LCRCRP – Lower Columbia River Conservation and Recovery Plan

LWD – Large Woody Debris

NASS – National Agricultural Statistics Service

OFPA – Oregon Forest Practices Act

POD – Point of Diversion

TAC – Technical Advisory Committee

TMDL – Total Maximum Daily Load

WUA – Weighted Usable Area

# Chapter 1. Plan Overview, Partners, and Goals

## Introduction

Sustaining aquatic species and their habitat is essential to the health of our environment and to the quality of human life. Healthy aquatic ecosystems provide clean drinking water and support agriculture, fishing, recreation, and other industries. Because native fish populations are central to the structure and function of aquatic ecosystems, they serve as key indicators of the overall health of these habitats (OWEB 2019).

Efforts to restore aquatic habitat and recover the watershed's threatened fish species are the foundation of WATERSHED 2040: Hood River Basin Partnership Strategic Action Plan (Strategic Action Plan), which encompasses an ambitious scope of work for restoring fish habitat, streamflow, and water quality over the next 20 years. Much of this work will also strengthen the resiliency of our community and economy, as climate change continues to impact streamflow, water temperature, and aquatic and terrestrial habitats.

This plan includes all elements recommended in the Oregon Watershed Enhancement Board's Strategic Action Plan Guidance (2018), as well as the Bonneville Power Administration's Atlas Restoration Prioritization Framework (Atlas). The plan's major components are outlined below.

> ***Watershed Profile***: Highlights the biophysical and socioeconomic context of the watershed and significant historic influences.
>
> ***Conservation Needs and Opportunities*****:** Describes primary limiting factors and threats to native fish populations in the context of life history requirements and the best opportunities to restore aquatic habitat based on water conservation and habitat assessments.
>
> ***Goals, Strategies, and Projected Outcomes*****:** Includes a 'Theory of Change' conceptual model, which shows the linkages between goals, strategies, actions, and desired ecological outcomes; also the relative significance of sub-watersheds based on the Atlas framework, fish population recovery plans, and the watershed's disturbance regime.
>
> ***Restoration, Conservation, and Community Engagement Projects***: Identifies high priority projects for aquatic habitat restoration, water conservation, riparian enhancement, conservation easements, and community engagement.
>
> ***Monitoring and Adaptive Management*****:** Describes monitoring methods and target values for short and intermediate-term ecological outcomes for a sub-set of restoration strategies and actions. The intent of monitoring is to measure progress in achieving ecological outcomes and, in some cases, to inform changes to restoration actions.
>
> ***Estimated Cost and Funding Approach***: Identifies the estimated cost to implement the Strategic Action Plan and the funding opportunities the Partnership will pursue.

The planning team comprised a large group, including representatives from each core member, and a small technical advisory committee. The large group met over the course of two years to identify goals and conservation actions, draft a 'Memorandum of Understanding', develop a 'Theory of Change' model, and create a 'Progress Monitoring Framework'. In addition, the Technical Advisory Committee met to review threats and limiting factors and delineate aquatic habitat restoration opportunities. The latter process was guided by the Atlas Framework.

## Hood River Basin Partnership

The Action Plan was developed by the Hood River Basin Partnership, which consists of nine core members who are signatories to this plan and the Hood River Basin Partnership Memorandum of Understanding (2019). **Table 1** lists the Core Partners and their roles.

**Table 1. Partnership Roles**

| Organization | Role |
|---|---|
| Hood River Watershed Group (HRWG) | Convene annual Partnership meetings to plan projects and review monitoring results; Update Action Plan project list; Raise funds for conservation and community engagement projects; Implement conservation projects; Monitor effects of restoration actions; Compile data from Partners and manage Progress Monitoring Database |
| Hood River Soil and Water Conservation District (SWCD) | Provide conservation education for agricultural community; Raise funds for conservation and technical assistance projects; Implement conservation projects |
| Confederated Tribes of the Warm Springs (CTWS) | Secure funds for conservation projects; Implement conservation projects; Monitor effects of restoration actions |
| East Fork Irrigation District (EFID) | Implement water conservation projects and monitor effectiveness; Support HRWG and SWCD capacity for water conservation project fundraising and implementation |
| Middle Fork Irrigation District (MFID) | Implement water conservation projects and monitor effectiveness; Support HRWG and SWCD capacity for water conservation project fundraising and implementation |
| Farmers Irrigation District (FID) | Implement water conservation projects and monitor effectiveness; Support HRWG and SWCD capacity for water conservation project fundraising and implementation |
| U.S. Forest Service (USFS) | Provide funds, materials, and/or staff capacity for conservation projects; Implement conservation projects; Monitor effects of restoration actions |
| Oregon Department of Fish and Wildlife (ODFW) | Support conservation projects; Share monitoring data that helps evaluate effects of restoration actions |
| Oregon Department of Environmental Quality (DEQ) | Support conservation projects; Share monitoring data that helps evaluate effects of restoration actions |

The Natural Resources Conservation Service (NRCS), Columbia Land Trust (Land Trust), Hood River County, and the Hood River Forest Collaborative are also important local partners but are not signatories to the 2019 Memorandum of Understanding. NRCS will play a vital role in supporting Strategic Action Plan projects through their conservation funding/cost-share programs, including the Environmental Quality Incentives Program, Regional Conservation Partnership Program, and PL 566 funding.

The Land Trust and County own 300 and 100 acres of land, respectively, along the mainstem Hood River. This property, locally referred to as the Powerdale Corridor, has high conservation value and restoration potential, making the Land Trust and the County critical partners for projects that have been identified for this reach. The Land Trust also holds a conservation easement on private land along the East Fork Hood River and may have the capacity to hold other easements in the future. In addition to the Powerdale Corridor, the County owns and manages approximately 36,000 acres of forestland, as well as other parcels that contain reaches of Neal Creek and the upper East Fork Hood River. The riparian zones and aquatic habitat within County ownership are strong candidates for restoration projects.

The Hood River Forest Collaborative consists of local stakeholders interested in the Forest Service's management of natural resources on the Hood River Ranger District. The HRWG, SWCD, and FID are members of the Collaborative, which meets regularly to discuss upcoming Stewardship Planning Areas, build consensus around forest management practices, and provide input on Retained Receipts spending.

New partners we hope to increase collaboration with include the City of Hood River and Port of Hood River. HRWG is particularly interested in collaborating with the city on urban water conservation and with the port on aquatic habitat restoration at the mouth of the Hood River.

## Vision

***The Hood River Basin Partnership envisions a resilient landscape that supports native fish and wildlife, a community willing to protect and restore its natural resources, and a local economy that thrives within the natural systems of the watershed***. This vision speaks to the critical need for the watershed to provide the full suite of ecological functions for native fish under changing environmental conditions. It also acknowledges that the local community needs to be aware of their role in the watershed and be willing to conserve and protect it. Finally, the vision supports a thriving local economy that operates within the capacity of the watershed's natural systems. The Strategic Action Plan supports all three elements of this vision through conservation and restoration actions, community engagement, and monitoring the ecological response to our actions.

## Plan Scope

The geographic scope of the Strategic Action Plan is the entire Hood River Watershed (**Figure 1**). This scope aligns well with land ownership and management by partners implementing the plan. For example, the Mt. Hood National Forest covers half of the watershed and USFS is a core partner. The watershed is also ceded lands for the Confederated Tribes of the Warm Springs, which operates a fish production and habitat restoration program, and co-manages the basin with ODFW. Finally, many of the watershed's tributaries are important sources for irrigation and/or municipal water, making an all-watershed approach to water conservation essential. The core partners that manage irrigation water include the three major irrigation districts (EFID, MFID, FID). The HRWG and SWCD work with all these partners to implement habitat, water conservation, and community engagement projects.

The plan's geographic scope also reflects the life history needs and movement of anadromous fish, which move up and downstream and between the watershed's three forks in response to changes in water temperature, flow, and disturbance events. A whole watershed restoration approach is also consistent with a growing consensus among fishery scientists that fish need a diverse portfolio of habitat across a watershed to take advantage of different life history strategies and to maintain a viable population in the face of disturbance (Brennan *et al*. 2019). This is particularly salient for the Hood River Watershed, which has a high diversity of anadromous fish populations coupled with semi-frequent disturbance from debris flows, many of which originate on Mt. Hood.

The plan's implementation timeframe is 20 years. This amount of time allows for implementation of all the high priority habitat and water conservation projects. It also provides enough time for effectiveness monitoring, adaptive management, and achieving some of the intermediate-term ecological outcomes.

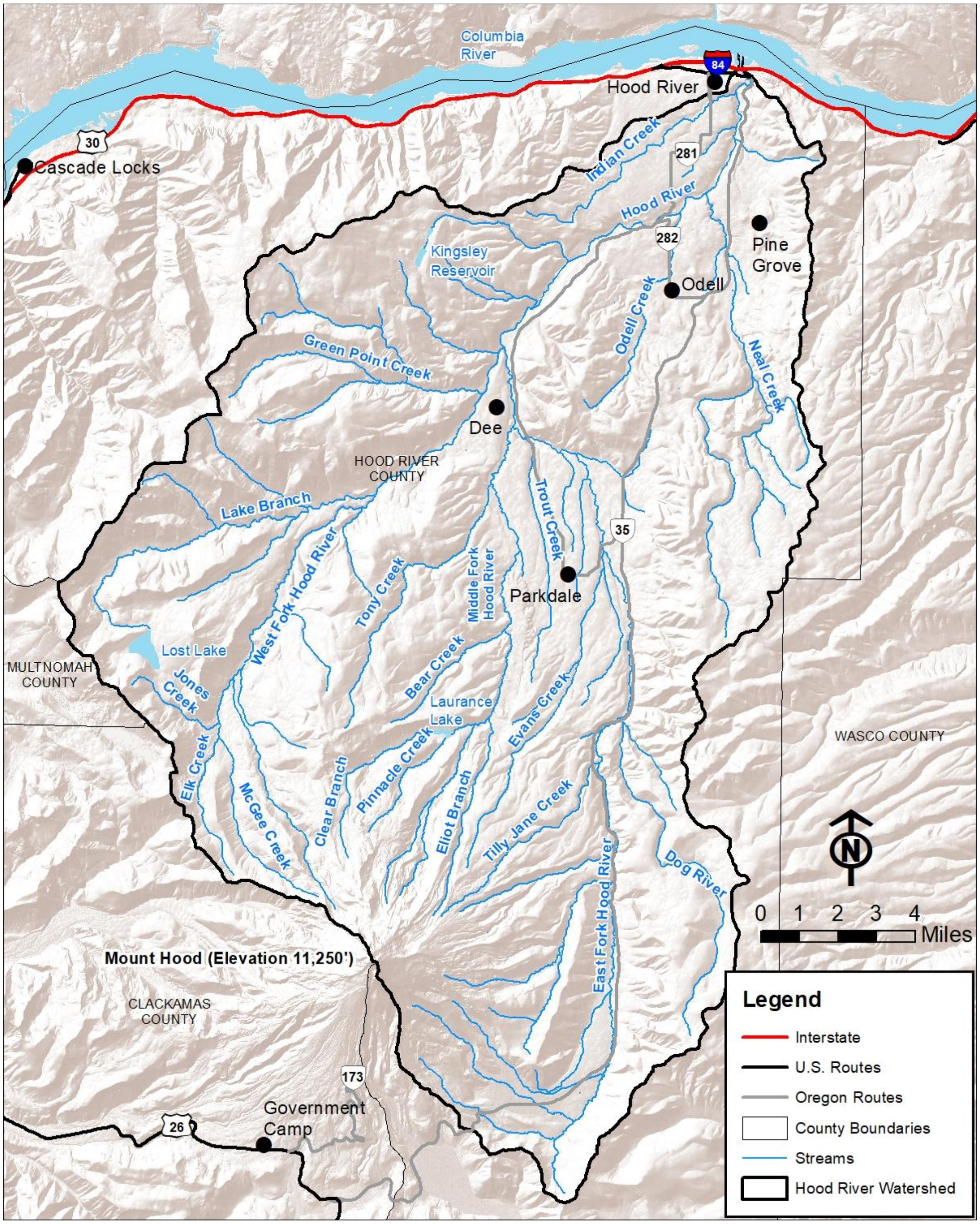



**Figure 1.** Hood River Watershed Geographic Features and Boundaries.

## Conservation Accomplishments

The Strategic Action Plan builds on several decades of watershed conservation work to restore fish habitat, conserve water, and improve water quality. Aquatic habitat restoration began in the 1980s on the National Forest and extended to private lands in the early 2000s. To date, large wood has been placed on over 10 stream miles, riparian areas have been restored along 12 miles/40+ acres, and approximately 40 fish passage barriers have been removed, including the Powerdale Dam removal on the Hood River mainstem in 2010.

In the last 40 years, irrigation districts in the Hood River Valley have replaced over 115 miles of open canals and lateral lines with sub-surface pipelines, resulting in the elimination of hundreds of end-spills that discharged unused irrigation water and approximately 30 cfs of water left instream or returned downstream of the MFID and FID power plants. Districts have also eliminated the use of streams for irrigation water conveyance on over 20 stream-miles, resulting in lower turbidity on naturally clear streams, including Neal Creek, Evans Creek, Trout Creek, Wisehart Creek, and Griswell Creek. At the farm-level, about 40% of orchard land has been converted from low efficiency to high efficiency irrigation systems.

The Hood River Watershed was the first basin to participate in DEQ's Pesticide Stewardship Partnership (PSP) Program. DEQ initiated pesticide monitoring in 1999. Initial results showed chlorpyrifos and azinphos methyl levels above state instream criteria in several Hood River tributaries. In response, watershed partners including the SWCD, Columbia Gorge Fruit Growers (CGFG), Oregon Department of Agriculture, OSU Extension Service, and CTWS developed a program to reduce instream pesticide levels. Highlights included a Best Management Practices handbook put out by CGFG, trainings put on by OSU Extension for pesticide applicators, and free riparian stream-buffer plantings in orchards. Monitoring over the past two decades has shown that pesticide levels in streams have declined significantly (**Figure 2**). The success of this ongoing program showcases the cohesiveness and efficacy of the longstanding Hood River Basin Partnership.

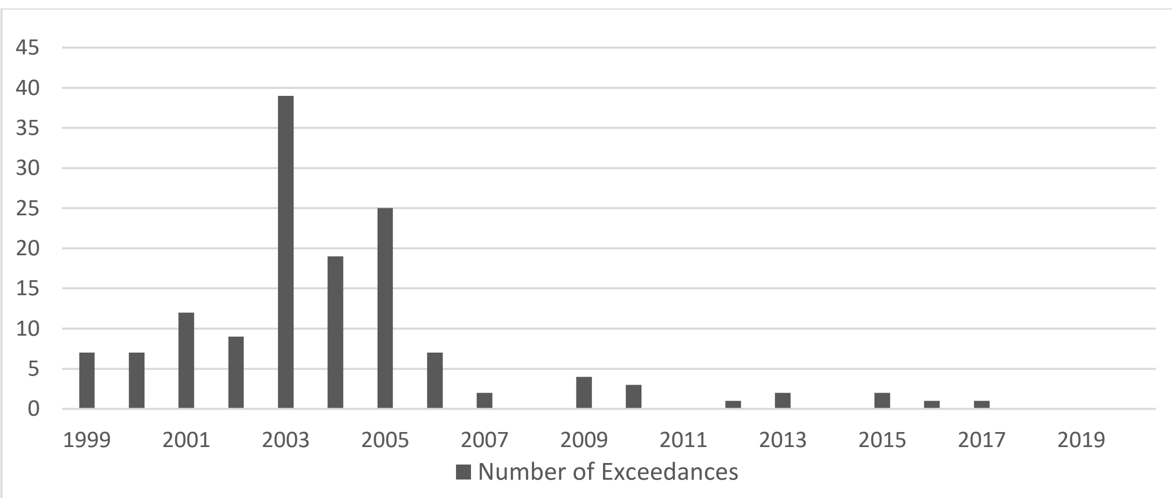



**Figure 2.** Total number of pesticide benchmark exceedances from all samples collected on Neal Creek, Odell Creek, Lenz Creek, and other Hood River tributaries between 1999 to 2020. Samples collected between 1999 and 2008 were tested for 15 pesticides; starting in 2009 samples were tested for over 120 pesticides (AWQMS).

Three previous Hood River Watershed action plans (Coccoli 2002, Stampfli 2008, Thieman 2014) and the Upper West Fork Hood River Watershed Restoration Action Plan (Asbridge *et al*. 2012) guided this conservation and restoration work. These action plans were informed by the Hood River Watershed Assessment (Coccoli 1999), the Hood River Subbasin Plan for Fish and Wildlife (Coccoli 2004), and the Hood River Basin Aquatic Habitat Restoration Strategy (Shively 2006). The Subbasin Plan and Aquatic Habitat Restoration Strategy were intended to guide restoration for a period of ten to fifteen years and most of the recommended projects have been completed.

## Restoration Goals

Although past conservation and restoration efforts have led to measurable improvements, many instream habitat restoration and water conservation projects remain to be completed. This need is demonstrated by findings from watershed models and assessments over the past decade, which predict the expected hydrologic impacts from climate change (Reclamation 2015), the total potential for water conservation (Christensen 2013b), and the estimated benefits to fish habitat and survival (Normandeau 2014, WPN *et al*. 2013, ODFW 2017). In addition, the recovery plans for salmon and steelhead in the Columbia River Basin (ODFW 2010, NFMS 2013) specify the need for substantial additional instream habitat restoration in the Hood River Watershed to achieve delisting and broad sense recovery of salmon and steelhead populations.

The Strategic Action Plan focuses on improving aquatic habitat and watershed conditions to support threatened salmon and steelhead, as well as bull trout, Pacific lamprey, and other resident fish species. The plan's goals reflect key ecological attributes that are essential to support these species, as well as the community support to implement conservation practices and projects.

**Goal 1**: By 2040, there will be enough habitat complexity and floodplain connectivity in the Hood River Watershed to meet the freshwater life history needs of all returning salmon, steelhead, and Pacific lamprey, as well as the local bull trout population and resident fish species. This goal will be supported by restoring 25 miles of perennial stream habitat and reconnecting and restoring 15 miles of side channels.

**Goal 2**: By 2040, large wood recruitment potential will have increased in the Hood River Watershed. This goal will be supported by protecting steep headwater areas from intensive timber harvest and managing for larger trees in high priority wood recruitment areas.

**Goal 3**: By 2040, fish passage barriers with at least one-quarter mile of high-quality, anadromous upstream habitat (or one-half mile for resident fish) are passable. This goal will be supported by remediation of road-stream crossings, improving low-head diversions, and passage around dams.

**Goal 4**: By 2040, average monthly summer stream flows below some irrigation diversions will remain at current levels or increase.[1] This goal will be supported by piping all remaining canals and eliminating end spills, providing cost-share to upgrade approximately 8,000 acres of on-farm irrigation equipment across the Hood River Watershed, and promoting efficient irrigation water management for agricultural and rural residential lands.

[1] This goal assumes the 'median' climate change scenario is correct (see Table 3). If 'more warming/drier scenario occurs, then stream flows below irrigation diversions will decrease even with aggressive water conservation.

**Goal 5**: By 2040, the impact of forest roads on the magnitude and timing of winter stream flows will be decreasing. This goal will be supported by improved road maintenance and road decommissioning on National Forest, County, and private forestland.

**Goal 6:** By 2040, summertime water temperature on 303(d) listed stream reaches will be trending towards state standards for salmon and steelhead spawning. This goal will be supported by increasing shade along streams, eliminating spills from open canals, and potentially changing reservoir management.

**Goal 7**: By 2040, pesticide concentrations in streams will remain at current levels or decrease. This goal will be supported by providing education on pesticide best management practices and integrated pest management.

**Goal 8**: By 2040, the per capita rate of municipal and residential water use will have decreased from current levels. This goal will be supported by education and promotion of residential water conservation practices, partnerships with municipal water providers and irrigation districts, and collaboration with commercial water users.

# Chapter 2. Watershed Profile

## Biophysical Profile

The 339-square mile Hood River Watershed originates on the eastern side of the Cascade Range in Oregon. Its rivers flow north from the 11,245-foot peak of Mt. Hood to the Columbia River at an elevation of 74 feet, 22 miles upstream from the Bonneville Dam. As watersheds go, it is compact and steep, and its hydrologic response is fast. The watershed's great topographic relief is reflected in steep gradient streams with coarse streambed material. The headwaters drain into three main tributaries, the east, middle, and west forks of the Hood River, which converge to form the Hood River mainstem about 12 miles upstream from its confluence with the Columbia River. Five headwater tributaries are fed by glaciers and, at times, discharge large amounts of sediment downstream. Consequently, non-glacial tributaries in the watershed provide important habitat and refuge for salmonids during periods of high glacially derived stream turbidity.

There is significant variation in the amount of precipitation falling across the watershed, with the summit of Mt. Hood receiving roughly 150 inches of water per year, while the low-elevation portions of the basin typically receive 45 to 24 inches moving west to east (Oregon State University PRISM Climate Group 2012). This precipitation gradient is caused by air masses moving inland from the Pacific Ocean and rapidly rising and cooling as they cross the Cascade Range. The cooling air loses some capacity to retain water vapor, causing condensation of vapor into water droplets or ice crystals that fall as rain or snow. Condensation and precipitation rapidly diminish as the air mass dries while traveling east across the watershed. This precipitation pattern influences the distributions of plant communities, stream flows, and fish.

The geology of the watershed is also complex because it is at the transition zone between the Columbia Plateau and High Cascades geologic provinces. The underlying bedrock is mostly Columbia River Basalt more than 5 million years old, topped by layers of younger lava flows from prehistoric eruptions on Mt. Hood and smaller volcanoes scattered across the basin (Timm 1979, USGS Volcano Hazards Program 2020). Shallower layers of rock, sand, and silt come from numerous Mt. Hood lahars and debris flows, as well as from the colossal Missoula floods that descended the Columbia River Valley more than 10,000 years ago. Pleistocene-era glaciers carved steep narrow valleys into the basalt and layers of sediment on the flanks of Mt. Hood, and remnants of these glaciers are present at elevations above 6,000 feet on Mt. Hood today. Runoff from melting of these glaciers and adjacent snowfields provides a major source of irrigation and domestic water in the Hood River Watershed.

The watershed has one of the most diverse assemblages of anadromous and resident fish in Oregon. It includes spring and fall Chinook salmon, summer and winter steelhead, coho, Pacific lamprey, bull trout, sea-run and resident cutthroat trout, and rainbow trout. The high diversity of fish species is mainly due to the watershed straddling the transition zone between fish populations that reside either west or east of the Cascades. For example, both summer and winter steelhead are present, whereas most basins have one or the other (**Figure 3**). The diversity of salmon, steelhead, and bull trout is also due to the watershed's snow and glacier-fed streams providing cold water. The Hood River's cold water also makes it one of fourteen cold-water refuges along the Columbia River (EPA 2020).

**Spring Chinook** generally return to the watershed in the spring, spending the summer in deep pools before spawning in late summer (August – September) in the mid to upper elevations of the watershed. Most of the spring Chinook spawning occurs in the West Fork Hood River and its tributaries. After incubation and emergence, juveniles will spend over a year in the watershed before migrating to the ocean as yearling smolts. **Fall Chinook** typically return to the watershed in October and November, spawning soon after they return. Fry emerge in the spring and migrate to the ocean in the fall as sub-yearlings. The fall Chinook run in the watershed is small, spawning mostly along the mainstem Hood River where suitable habitat is limited.

The wild spring Chinook population went extinct circa 1970 and starting in 1993 a hatchery program was developed and implemented for reintroduction. Today, CTWS operates a full-term spring Chinook spawning and acclimation facility on the Middle Fork Hood River and an acclimation/juvenile rearing facility on the West Fork Hood River. The primary goals of the production program are to provide consistent tribal harvest opportunities and re-establish naturally sustaining spring Chinook salmon (CTWS 2020).

**Winter steelhead** return to the watershed from December through May and generally spawn from March through May. They are mainly found in the East and Middle Fork Hood River subwatersheds. **Summer steelhead** return in early summer, but because they are sexually immature, they remain in the mainstem and West Fork Hood River for up to a year before spawning the following spring. Unlike salmon, a small percentage of adult steelhead will return to the ocean for a year or two and return to spawn a second time. As juveniles, both summer and winter steelhead remain in the watershed for an average of two years. Their ability to utilize a wide range of habitat types (i.e., riffles, pools) and tolerance for higher velocities make them particularly suited to the steep, riffle-laden Hood River Watershed.

**Rainbow trout** are genetically identical to steelhead and are only distinguished by the fact that they remain in freshwater. It is not possible to distinguish between a resident rainbow trout and juvenile steelhead until the steelhead becomes a smolt and migrates to the ocean. Even more confusing (and remarkable) is that progeny from two rainbow trout parents can 'smoltify' and migrate to the ocean as a steelhead. The distribution of rainbow trout in the watershed is widespread, although they are most abundant in the West Fork Hood River and tend to be absent in headwater streams and some tributaries.

**Coho** return to the watershed in the fall and generally spawn in November and December. They have been observed across the watershed but are most likely to spawn in the mainstem Hood River and lower tributaries, such as Neal Creek. Fry emerge in the spring and juveniles remain for one year before migrating to the ocean the following spring.

**Pacific lamprey** began recolonizing the watershed after the 2010 removal of the Powerdale Dam, which had excluded them from most of the watershed for almost 90 years. CTWS has been documenting this recovery and found adults and ammocoetes several miles up the East Fork Hood River and upstream of Punchbowl Falls on the West Fork Hood River (**Figure 3**). Pacific lamprey spend the adult phase of their life in the ocean, returning to freshwater after a few years. Like summer steelhead, they arrive in early summer and hold for up to a year before spawning. Lamprey larvae will spend approximately seven years in their natal stream. They spend most of the time burrowed into the sediment where they filter feed on algae, which improves surrounding water quality (USFWS 2016).

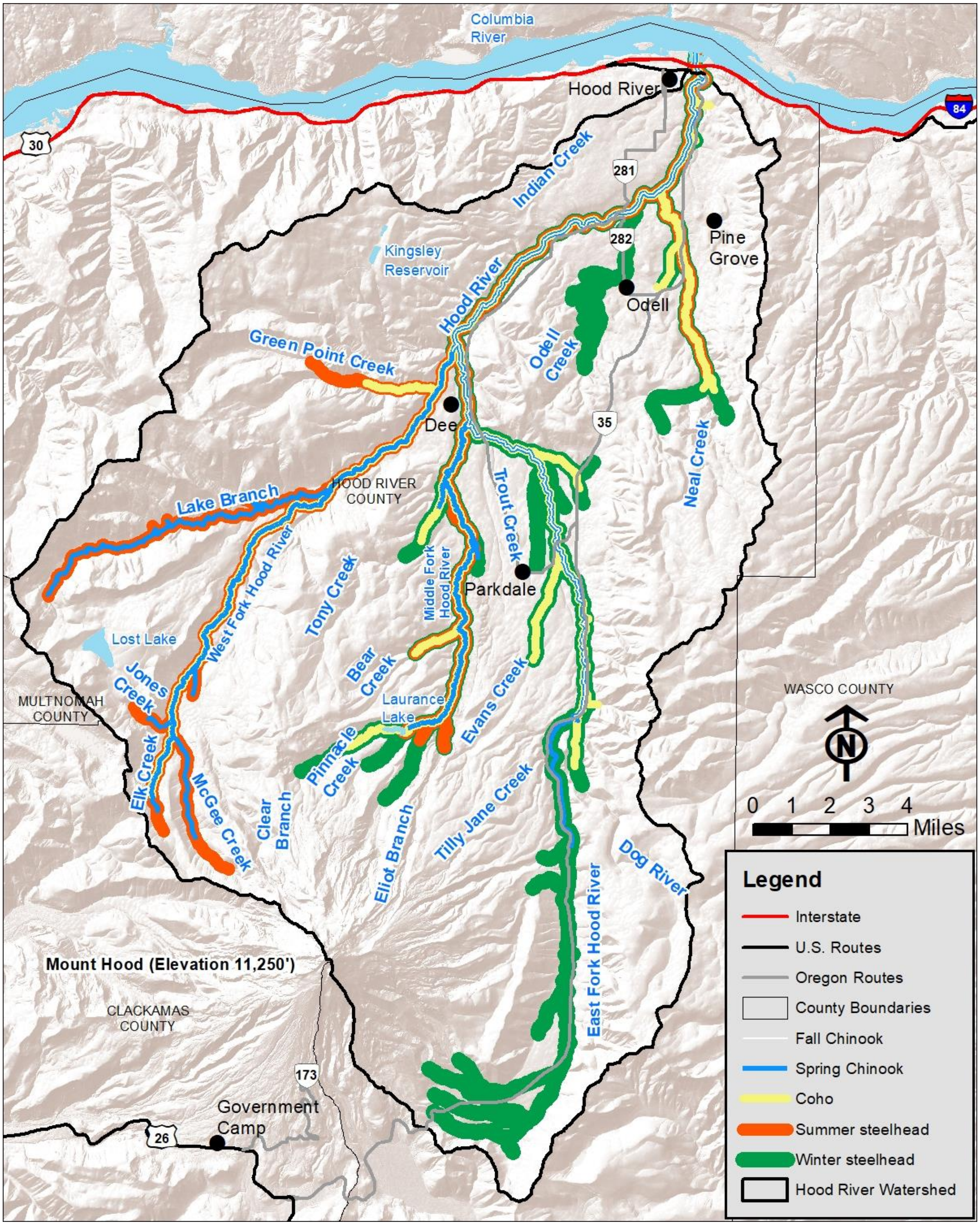



**Figure 3.** Distribution of Hood River Watershed Salmon and Steelhead Runs (includes historic extent of coho and steelhead runs above Laurance Lake).

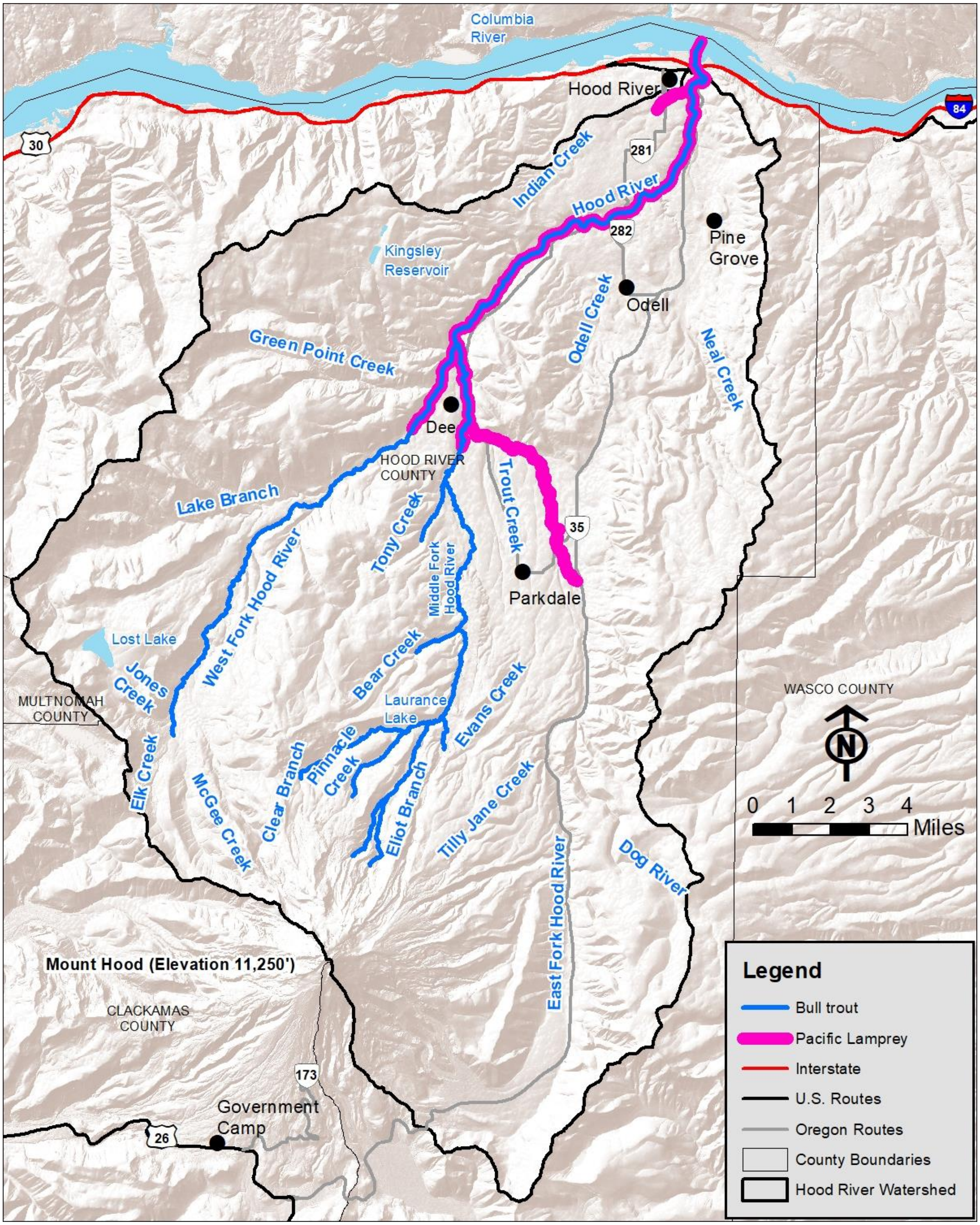



**Figure 4.** Current distribution of Pacific lamprey and designated critical habitat for bull trout in the Hood River Watershed.

**Bull trout** in the Hood River Watershed are thought to exist as two reproductively independent local populations (USFWS 2002, Rieman and McIntyre 1995). The "Clear Branch" population was isolated from the rest of the basin by the construction of Clear Branch Dam in 1968. This dam provides limited downstream fish passage during periods of spill and no voluntary upstream passage. Bull trout in this population inhabit Laurance Lake reservoir, upper Clear Branch, and Pinnacle Creek. The "Hood River" population is currently found in the mainstem Hood River, Middle Fork Hood River, and a few Middle Fork tributaries (**Figure 4**). Although a population has not been documented in the West Fork Hood River, individual bull trout have been caught in ODFW's smolt trap near Moving Falls on the West Fork and the sub-watershed is designated critical habitat based on habitat suitability. Fluvial migrants from the Hood River population forage and winter in the Columbia River (Rod French pers. comm. 2020).

Most of the **cutthroat trout** in the Hood River Watershed are resident (i.e., non-migratory), although ODFW pit tag data have shown that some individuals have an anadromous life history, in this case being referred to as 'searun'. Cutthroat trout are rarely found in the West Fork of the Hood River but are widely distributed in the rest of the watershed's upper reaches. Additional resident fish species common to the watershed include **mountain whitefish**, **long-nosed dace**, **speckled dace**, **bridge-lipped sucker**, **large-scaled sucker**, and several species of **sculpin**. The distribution of these species is not well documented.

## Socioeconomic Profile

The Hood River Watershed is widely known for its picturesque orchards, bustling tourism, and abundant recreational opportunities. Eighty percent of the watershed is covered by forest, approximately two-thirds of which is within the Mt. Hood National Forest and the remaining one-third split between Hood River County Forest, private timberland, and unmanaged woodlands (National Land Cover Database 2016). National Forest land within the watershed is managed to support a wide range of public interests, including recreation, timber production, and fish and wildlife habitat. Three 'Wild and Scenic' river corridors, 76,084 acres of Wilderness, one Scenic Area, many miles of trail, and a major ski resort on the southeast side of Mt. Hood attract almost a million visitors per year (Claire Fernandez, USFS pers. comm.). Federal, county, and private timberlands support the local timber industry, including a sawmill and many timber service companies.

Irrigated agriculture covers ten percent of the watershed, and the dominant crop is tree fruit, 90% of which comes from pear trees that supply a quarter of the Nation's fresh pears. Three percent of the watershed is rural residential and less than one percent is urban, including urban residential, industrial, and commercial land use. Most of the irrigation water delivered to agricultural and residential land comes from surface water diversions managed by five irrigation districts, whereas most of the potable water comes from springs developed by the City of Hood of River and the Ice Fountain and Crystal Springs Water Districts (**Figure 5**).

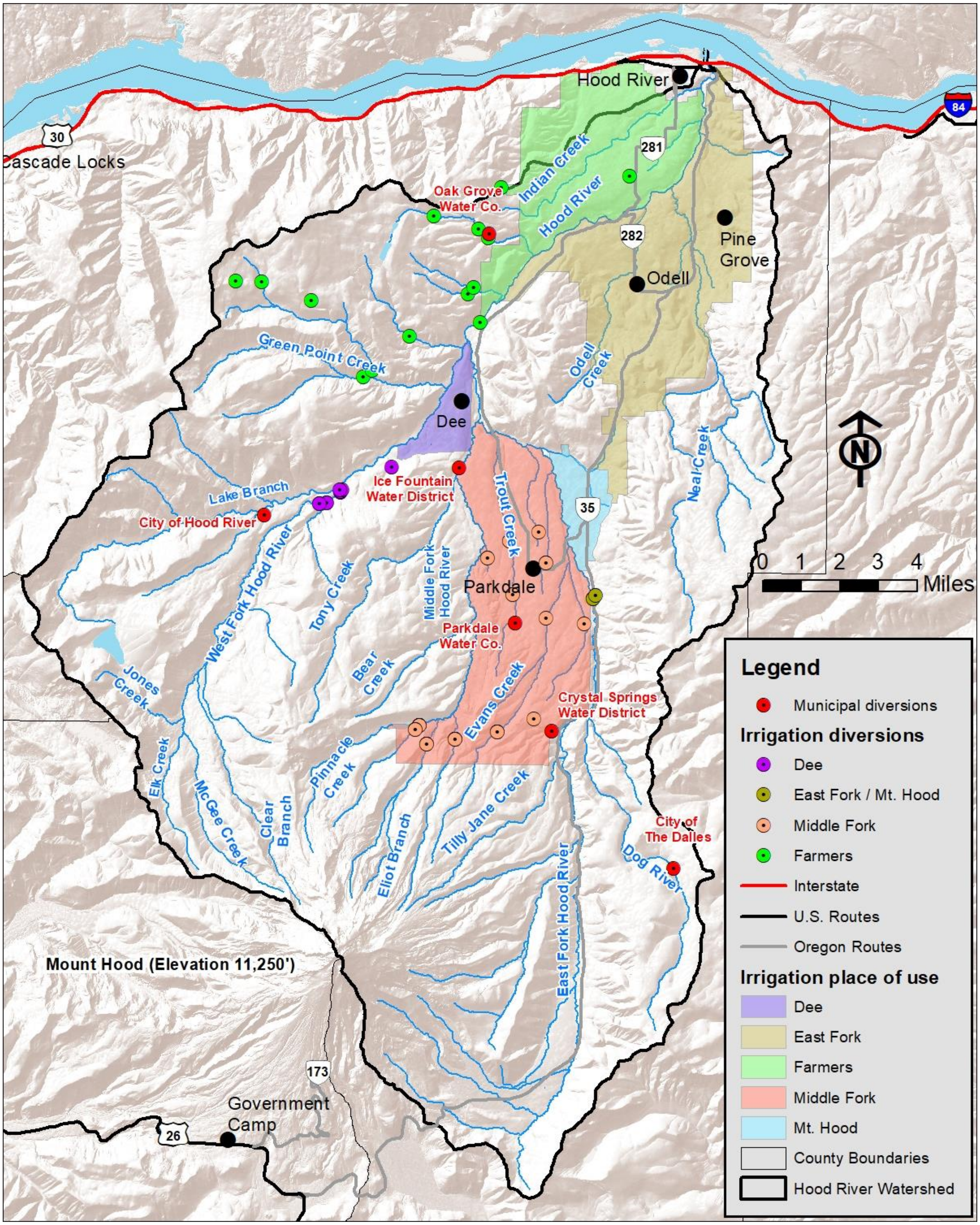
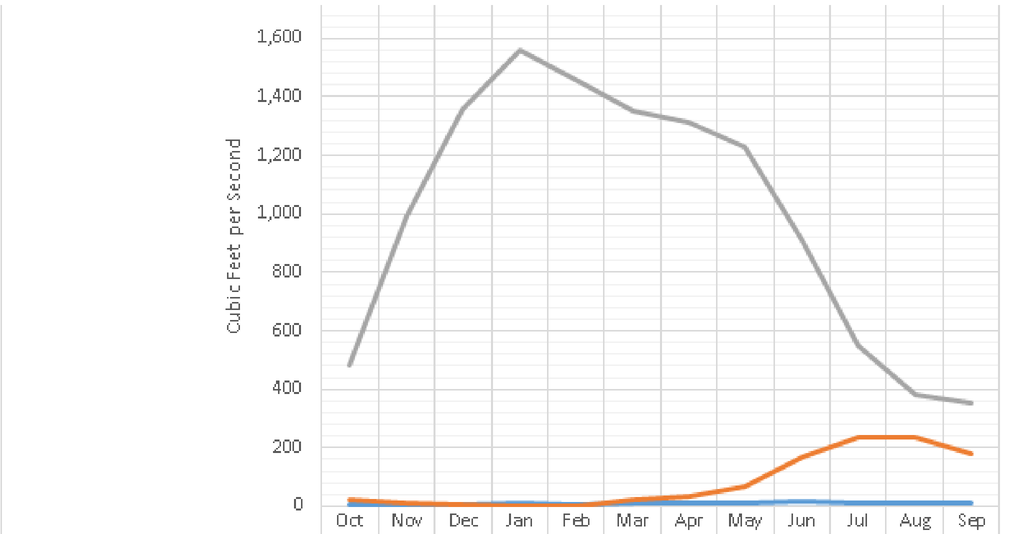



**Figure 5**. Principal points of diversion for municipal and irrigation water districts, and irrigation district boundaries.




| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Domestic use | 7.5 | 7.4 | 7.8 | 8.7 | 7.2 | 8.4 | 9.5 | 12.0 | 13.9 | 12.4 | 10.6 | 9.2 |
| Irrigation | 22.6 | 8.3 | 3.2 | 2.0 | 0.9 | 23.9 | 33.3 | 67.7 | 166.0 | 237.1 | 233.0 | 178.0 |
| Hood River @ Tucker Bridge | 482 | 995 | 1360 | 1560 | 1460 | 1350 | 1310 | 1230 | 908 | 550 | 382 | 352 |

**Figure 6**. Mean monthly stream flow at Hood River (Tucker Bridge) and mean monthly water use for irrigation and domestic/commercial consumption (includes potable water for industry).

**Figure 6** shows monthly average irrigation and potable water use, as well as stream flow on the Hood River at Tucker Bridge located about six river miles above the confluence with the Columbia River. The figure illustrates that, during the summer, irrigation water use is roughly 20 times that of potable water use, and on average diverts one third of the total streamflow of the Hood River.

The predominant economic industries in Hood River County, based on annual earnings from 2001 to 2016, are presented in **Figure 7** (Pilz *et al.* 2019, original source: BEA 2017). The high earnings in healthcare, social assistance, and professional/technical/scientific services reflect the higher income levels generated in these sectors and, perhaps, the presence of a growing number of residents who telecommute or commute to Portland. Agriculture, forestry, fishing, and to some extent manufacturing rely on the watershed's natural resources. Relatively abundant, high-quality water is key to many of the manufacturers, including breweries, distilleries, cideries, juice companies, and fruit packing plants.

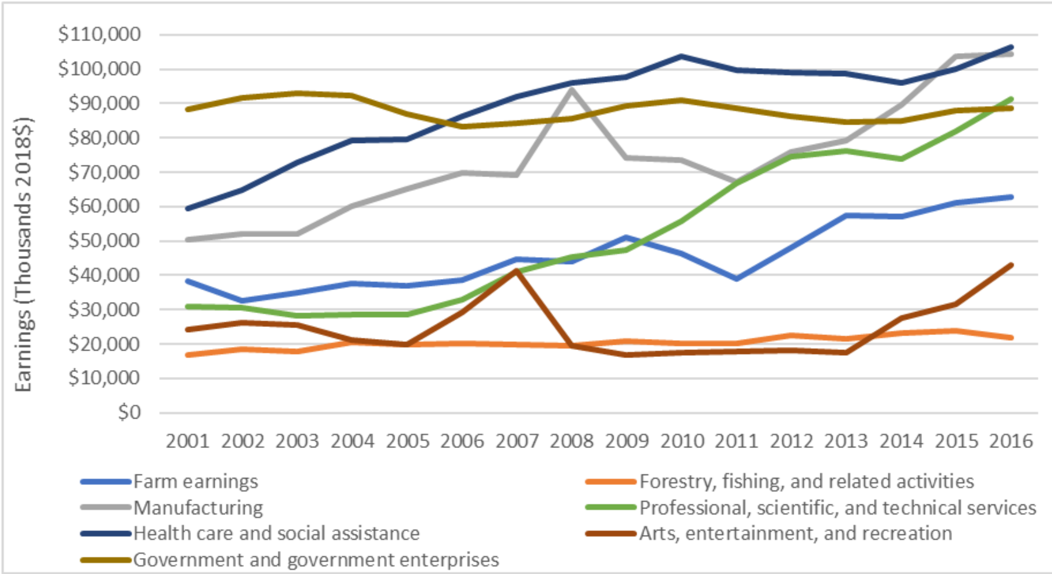



**Figure 7.** Earnings of Select Industries in Hood River County, 2001-2016 (Courtesy of AMP Insights)

Although earnings from farms are lower than those of some industries, a significant portion of the county population is employed in the agricultural industry and most of the farms are small and family owned. In 2012, a total of 7,663 farm workers were reported in Hood River County, accounting for one-third of the county population at that time. Although most of them worked less than 150 days/year, 1,183 farm workers plus 554 principal operators worked over 150 days, accounting for 7.5% of the county population (Pilz *et al.* 2019, original source: USDA 2014). That same year, gross agricultural commodity sales in Hood River County were $112,094,000 (www.oain.oregonstate.edu). The estimated value added as the fruit crop moves through the first handler level is two times the gross sales (Oregon State University 2007). These data underscore agriculture's importance to Hood River County's economy and workforce, in addition to its influence on culture and character.

Another noteworthy aspect of the watershed is hydropower production, which began in 1909 with the construction of the first Powerdale dam on the Hood River (Coccoli 1999). The dam was later relocated and built in 1923, where it remained until 2010. In the mid-1980s, the Middle Fork Irrigation District (MFID) and Farmers Irrigation District (FID) developed hydropower projects within their existing irrigation delivery systems. The resulting infrastructure enables them to capture energy from their diverted irrigation water during the summer. They also have separate water rights to generate hydropower in the winter. Since construction of the MFID and FID power plants, they have generated over $100 million in gross revenues, which have helped fund extensive delivery system upgrades, on-farm irrigation efficiency upgrades, fish-screening projects, and removal of fish passage barriers within these districts. The delivery system and on-farm upgrades have saved approximately 25 cfs, which is returned to the river downstream of the power plants. The delivery system upgrades also enabled FID to eliminate 1,450 individual pumps, which has conserved 1.45 million kilowatt hours of electricity annually. At the same time, the FID and MFID plants together are generating roughly 47.5 million kilowatt hours annually, which is enough to power over 4,100 homes a year and provides close to 18% of the power consumed in Hood River County (Perkins 2013).

## Watershed History and Historic Impacts

Native Americans have been living in the Columbia Basin and Hood River Watershed for over 10,000 years. Wasco-Wishram are two closely related Chinook tribes from the Columbia River, up and downstream from The Dalles. The Hood River Wasco people inhabited two village sites: *Ninuhltidih* on the east bank of the mouth of the Hood River, and a second site five to six miles farther down the Columbia River. The Wasco people were fishermen, harvesting the abundant salmon from the Columbia and Hood Rivers. They also traded root bread, salmon meal, and bear grass with nearby tribes. In 1855, the superintendent for the Oregon Territory negotiated a series of tribal treaties including the one establishing the Warm Springs Reservation. Under the treaty, the Warm Springs and Wasco Tribes relinquished approximately ten million acres of land but reserved the Warm Springs Reservation for their exclusive use. The tribes also kept their rights to harvest fish, game, and other foods off the reservation in their usual and accustomed places, also known as ceded lands (CTWS 2020). Tribal members continue to harvest salmon and steelhead from the Hood River for subsistence and ceremonial purposes. However, fishing opportunity has significantly decreased because of low fish populations and the need to protect threatened stocks.

On October 20, 1899, the Glacier newspaper commented on settler Chris Dethman's fishing luck in the mouth of Neal Creek stating that "his season's catch so far has amounted to 112 fine salmon trout" (Krussow 1989). Pat Moore, valley resident, recalls his grandfather saying that steelhead in Neal Creek were so numerous (circa 1915) that "you could stand there and pitchfork them out". Mr. Moore also remembers a run of searun cutthroat in Shelley Creek, a small tributary entering Neal Creek on the east bank below Fir Mountain Road bridge at Highway 35. Longtime residents Jerry Routson and David Winans recall large numbers of salmon or steelhead migrating up into the West Fork over Punchbowl Falls even before 1957 fish ladder construction, noting that the scene "resembled Celilo Falls except on a smaller scale" and attracted crowds of tourists on warm weekends (Coccoli 1999).

European immigrants began settling in the watershed in the mid-1800s, rapidly harvesting trees for lumber, clearing land for homesteads, grazing livestock, and planting berries and fruit trees. Beginning in 1861, sawmills, dams, and mill ponds operated on Neal Creek, the East Fork Hood River, Green Point Creek, and the mainstem Hood River. The Hines Dam on the East Fork Hood River at Dee was in place from 1906 to 1966 and during this time processed lumber and generated hydropower (Coccoli 1999). Splash damming was used extensively to carry logs downstream to mills and railroads, which continued through the 1940s. During the 1960s and 1970s, stream 'clean out' was an encouraged practice thought to benefit fish passage. "In 1979, salvage operations removed all wood from the East Fork mainstem between Robinhood and Sherwood campgrounds (USFS 1996b)." The combined effects of splash damming, extensive timber harvest in headwaters and riparian areas, and stream 'clean out' still influence instream habitat today. This effect is reflected in more incised channels, less stream sinuosity, fewer pools, less gravel and cobble-sized sediment, and lower levels of instream wood.

The first commercial apple orchard was planted by Peter Mohr in 1886 on the east side of the Hood River Valley. In the 1890s, many other European immigrants came to the Hood River Valley to buy land and establish orchards. They were followed by Japanese immigrants in the early 1900s. By 1907, there were approximately 350,000 apple trees, 9,000 pear trees, 4,500 cherry trees, and 7,000 peach trees in the valley. At the same time there were seven private irrigation schemes under development, leading to hundreds of miles of irrigation ditches delivering water from the three forks of Hood River to support the growing fruit industry (Doncaster 2020; originally cited from Burkhardt 2007, Tamura 1993, The Commercial Club 1909, & Irrigation in the Hood River Valley 1926). The biggest project was the Farmer's Irrigation Ditch originally started by Jeremiah F. Davenport. It was completed in 1897 to irrigate the west side of the valley and "…changed the Hood River Valley almost overnight from a poverty pocket to a land boom" (Burkhardt 2007, 25). Agriculture in the valley continued to develop and modernize during the 1900s. Between 1936 and 1937, the Farmers Irrigation District constructed the upper and lower Kingsley Reservoirs, providing storage of 1,000 acre-feet to improve irrigation water delivery to patrons in the upper half of the district (FID 2020). In 1968, the Middle Fork Irrigation District, with financial and technical support from the USDA Soil Conservation Service, constructed Laurance Lake Reservoir on Clear Branch, providing storage of 3,500 acre-feet (MFID 2020).

The Hood River Railroad was built in 1906 to transport wood from the Oregon Lumber Company mill in Dee to the Union Pacific Line in Hood River. By 1910 it had been extended to Parkdale (Asay 1991). Over the past 100 years it has transported lumber and fruit, and at times local commuters and tourists. The first three miles of the railroad were built along the Hood River, and between River Mile 1 and 2 the railroad grade cuts off approximately 13 acres of historic floodplain.

Significant changes began at the mouth of the Hood River after completion of Bonneville Dam in 1938, which severely reduced the upstream migration of Columbia River salmon and created the Bonneville Pool. Between 1950 and 1970, the Port of Hood River with cooperation from the U.S. Army Corps of Engineers, Bonneville Power Administration, and the State of Oregon placed fill up and downstream of the mouth of the Hood River to increase developable land (Port of Hood River 2020). Today, this area contains three levee protected basins, a major hotel, and numerous commercial businesses. It also draws many thousands of visitors per year who come to the waterfront for swimming, boating, and world-renowned wind surfing and kite boarding. While good for recreation and commerce, these changes have drastically affected the ecological function of the Hood River Delta. As seen in **Figure 8**, the historic delta was highly complex, which dissipated the river's energy and facilitated an exchange of nutrients with its floodplain. The combination of nutrients, slow velocities, and varying channel size created habitat for different types and life stages of fish and wildlife. Today, the Hood River abruptly empties into the Columbia River.

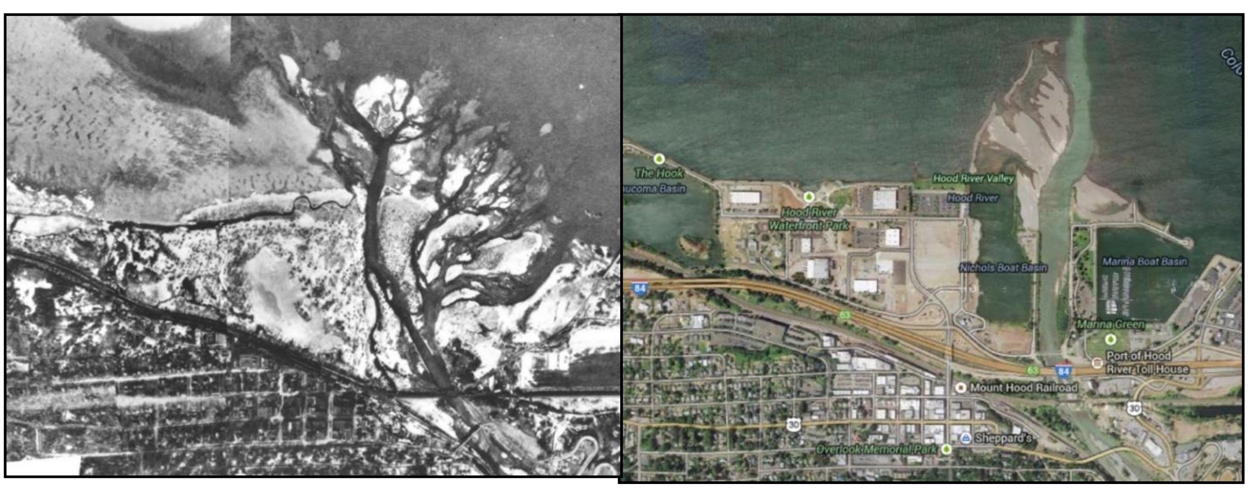



**Figure 8**. Hood River Delta: early 1900s (left), circa 2018 (right).

# Chapter 3. Conservation Needs

Bull trout were federally listed as threatened throughout their range in 1998 under the Endangered Species Act. Steelhead, Chinook, and coho were listed as threatened in 1998, 1999, and 2005, respectively, for the Lower Columbia Distinct Population Segment. According to the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead, the current extinction risk is considered 'high' for winter steelhead and 'very high' for summer steelhead, coho, and Chinook within the watershed. Federal and state fishery agencies estimate that recovery of Hood River winter steelhead and spring Chinook populations is likely with appropriate restoration and conservation actions (ODFW 2010).

The overarching goal of this Strategic Action Plan is that, **by 2040, conditions in the Hood River Watershed will support viable[2] populations of salmon, steelhead, bull trout, Pacific lamprey, and other native fish.** These conditions include sufficient water quantity, water quality, connectivity, and habitat diversity and complexity to support each stage of their lives in freshwater.

The major freshwater life history stages of anadromous fish include adult holding, spawning, incubation, emergence, and juvenile rearing. Each stage has unique requirements for stream velocity, depth, and physical habitat structure. Stage length and seasonality vary by species and run. For example:

- Deep pools are important holding habitat for spring Chinook that are in the watershed all summer before spawning in August and September. Adult steelhead are not particularly dependent on pools for holding.
- Salmon, trout, and lamprey spawning habitat must have gravel or small cobbles at suitable water depths and velocities.
- Runs that spawn in late summer/early fall (i.e., spring Chinook, coho) are more vulnerable to having their redds scoured away by volatile winter flows.
- Juvenile life history varies, with coho remaining for one year, spring Chinook for over a year, and steelhead an average of two years. A common challenge for these species is their relatively long period of juvenile rearing in the watershed, during which they must forage, avoid predation, and find refuge from volatile winter flows and low summer flows.

**Appendix A** summarizes optimal habitat characteristics, length, and season for the freshwater life stages of threatened salmon and trout species in the watershed.

## Supporting Assessments and Analyses

An analysis of current and future conditions as they relate to each species' life history needs was the foundation for identifying primary limiting factors and threats in the watershed. The analysis was informed by assessments, plans, and modeling efforts conducted over the past twenty-five years, with the earliest being watershed analyses conducted by the Mt. Hood National Forest Hood River Ranger District for federal lands within the watershed (USFS 1996a & b). These detailed reports are particularly useful in understanding the historic and current impacts from timber harvest, forest roads, and public highways, as well as the status of fish and wildlife in the late 1990s. The Hood River Watershed

[2] A "viable" salmonid population has a negligible extinction risk over the next 100 years, as evidenced by abundance, productivity, spatial distribution, and diversity data. (NMFS 2013)

Assessment built upon the Forest Service reports and documented conditions in the rest of the watershed (Coccoli 1999).

**Table 2** describes more recent assessment and modeling efforts aimed at identifying primary limiting factors, quantifying conservation opportunities, and prioritizing restoration strategies. Some of these studies were completed as part of state and federal planning efforts and others were developed to help prioritize local restoration and water conservation efforts. Temperature, turbidity, stream flow, and fisheries data collected in select reaches over the past twenty years were also used to prioritize strategies.

**Table 2. Assessments and models used to identify limiting factors and conservation opportunities**

| Assessment or Model | Affiliated Document | Description |
|---|---|---|
| Heat Source (mainstem Hood River, East Fork Hood River, Neal Creek, Middle Fork Hood River and tributaries, Laurance Lake) | Western Hood Subbasin Total Maximum Daily Load (ODEQ 2001); MFID evaluations of flow management (Berger *et al*. 2005; WPN 2018) | Assessed thermal response of stream temperature to increased riparian vegetation and increased streamflow |
| Ecosystem Diagnosis and Treatment model | Hood River Subbasin Plan for Fish and Wildlife (Coccoli 2004) | Identified and prioritized limiting factors to spring Chinook and steelhead based on estimated habitat and biological attributes for 147 reaches under historic and current conditions |
| Limiting factors models for salmon and steelhead- based on stream habitat surveys, fish monitoring, mortality models, and more | National Marine Fisheries Service and ODFW salmon and steelhead recovery plans (NMFS 2013, ODFW 2010) | Fish habitat model that uses estimates of habitat area and fish densities per habitat type to predict capacity at different life stages and smolt production potential |
| Intrinsic potential for spring Chinook and steelhead spawning; based on Cooney and Holzer 2006 | Intrinsic Potential Analysis for West Fork Hood River, East Fork Hood River, Neal Creek, Mainstem Hood River, Middle Fork Hood River (WPN 2011, 2013, 2014, 2019, 2020) | Assessed and mapped relative potential for a stream reach to support spawning and initial rearing for spring Chinook and steelhead based on bankfull width, channel gradient, and valley confinement |
| Instream Flow Incremental Methodology | WPN *et al*. 2013, Normandeau 2014 | Developed area-weighted fish habitat suitability curves and streamflow; habitat suitability defined by optimal depths and velocities for each life-stage and fish species (**Appendix A**) |
| Assessment of irrigation and potable water conservation | Hood River Basin Water Conservation Assessment (Christensen 2013a) | Quantified conservation potential for irrigation delivery and on-farm application based on crop need, existing infrastructure, & irrigation technology; also evaluated potential for residential water conservation |
| Models of climate change and hydrologic impacts | Hood River Basin Study (Reclamation 2016) | Developed climate and surface water models to predict future stream flows and habitat conditions under alternative water management scenarios |

## Primary Limiting Factors and Threats

The Partnership's technical advisory committee (TAC), including staff from ODFW, USFS, HRWG, and CTWS, reviewed and incorporated the limiting factors identified in the Hood River Subbasin Plan, the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead (ODFW 2010), and the Recovery Plan for the Coterminous United States Population of Bull Trout (USFWS 2015). The TAC also identified threats contributing to each primary limiting factor based on the assessments and models noted in **Table 2**, fisheries data, and scientific literature. **Figure 9** outlines these primary limiting factors and threats.

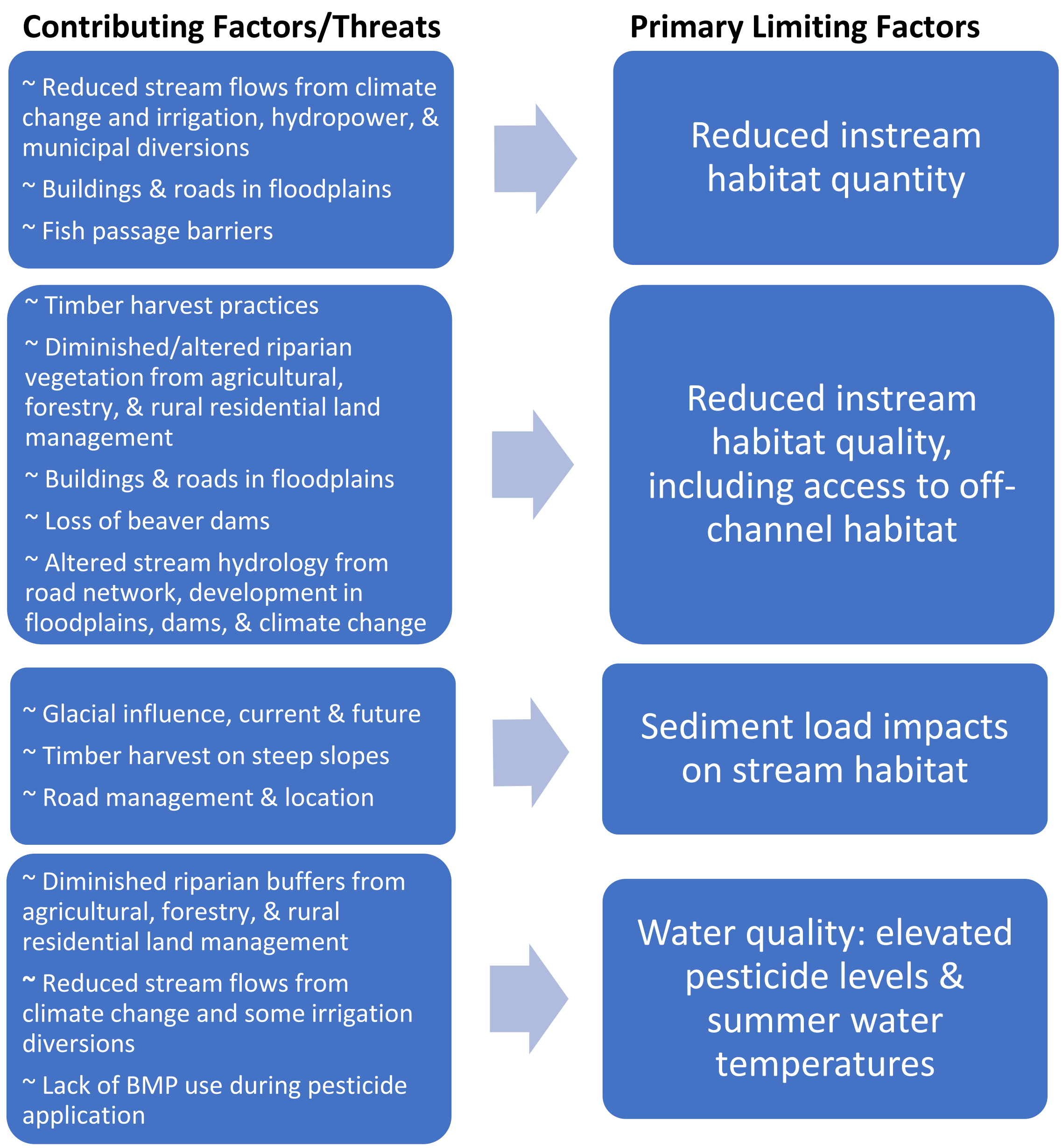



**Figure 9.** Primary limiting factors and threats to native anadromous and resident fish in the watershed.

The TAC also provided a fine-scale assessment of threats to salmon, steelhead, and bull trout by life stage and sub-watershed, which was used in the prioritization of sub-watersheds and instream habitat restoration projects within the Atlas framework. These results can be found in **Appendix B**. Primary limiting factors and related threats are discussed more fully below.

## Reduced Instream Habitat Quantity and Quality

Fish habitat quantity and quality is influenced by a variety of characteristics, including amount of large woody debris, stream gradient, floodplain connectivity, substrate, stream velocities, and water depth. A reduction of instream habitat *quantity* in the watershed has been caused by low stream flows decreasing the depth and surface area of streams in the summer; road and other fill in former floodplains; channel straightening; and fish passage barriers that interfere with up and downstream migration. Reduction in total habitat quantity causes more competition between species and individuals for habitat and food. It can also increase pathogen transmission between individual fish.

A reduction of instream habitat *quality* in the watershed has been caused by loss of large wood in streams due to past and, in some cases, current timber management practices; decreased stream-floodplain interaction due to channel straightening, levee development, and floodplain fill; loss of native riparian vegetation; changes to stream hydrology; and loss of beavers. The combined effect of less wood and floodplain interaction leads to flume-like channels with long riffles, very few pools, and low amounts of spawning gravel. In contrast, streams with ample wood and good floodplain connectivity respond to high flows by forming pools, trapping spawning gravels, and spilling out into the floodplain where juvenile fish forage and find refuge from high velocities.

### Changes to Streamflow

Mt. Hood glaciers and snowmelt are a significant source of summer streamflow, with 50 to 70 percent of flow during late summer provided from glacial melt (Nolin *et al*. 2010). Climate change is expected to negatively impact the hydrology and surface water availability in the basin as Mt. Hood glaciers continue to retreat. In 2015, the Bureau of Reclamation published the Hood River Basin Study, which looked at the effects of climate change on the hydrology of the basin under three modeled scenarios: 'More Warming/Drier', 'Median', and 'Less Warming/Wetter'. When compared to a projected baseline (1980- 2010), model results show a 3% to 12% increase in average precipitation in the fall and a 15% to 33% decrease in average precipitation in the summer. Average temperature is expected to increase in every season under each scenario, ranging from 0.7 °C to 2.4 °C (**Table 3**). This change will increase the amount of precipitation falling as rain, decrease the snowpack, and continue to melt the glaciers.

**Table 3. Changes in Average Precipitation and Temperature by 2060 under Climate Change Scenarios**

| **Climate Change Scenario** | **Average Precipitation Change** | | | | **Average Temperature Change (°C)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall |
| More warming/drier | -3% | -7% | -33% | +4% | +1.2° | +1.5° | +2.4° | +1.5° |
| Median | +7% | 0% | -14% | +3% | +1.2° | +1.1° | +1.5° | +1.2° |
| Less warming/wetter | +5% | 0% | -15% | +12% | +0.8° | +0.7° | +1.3° | +0.9° |

**Figure 10** shows historic and predicted future average monthly streamflow for the Hood River. Between 1980 and 2010, average monthly flow reached 1,275 cfs in March and went down to 225 cfs in September. By 2060, predicted average monthly flow will reach 1,500 cfs earlier in the winter with a sustained average increase of about 250 cfs. In the summer, predicted average flow will drop to 187 cfs in September with an overall decrease of about 20%.

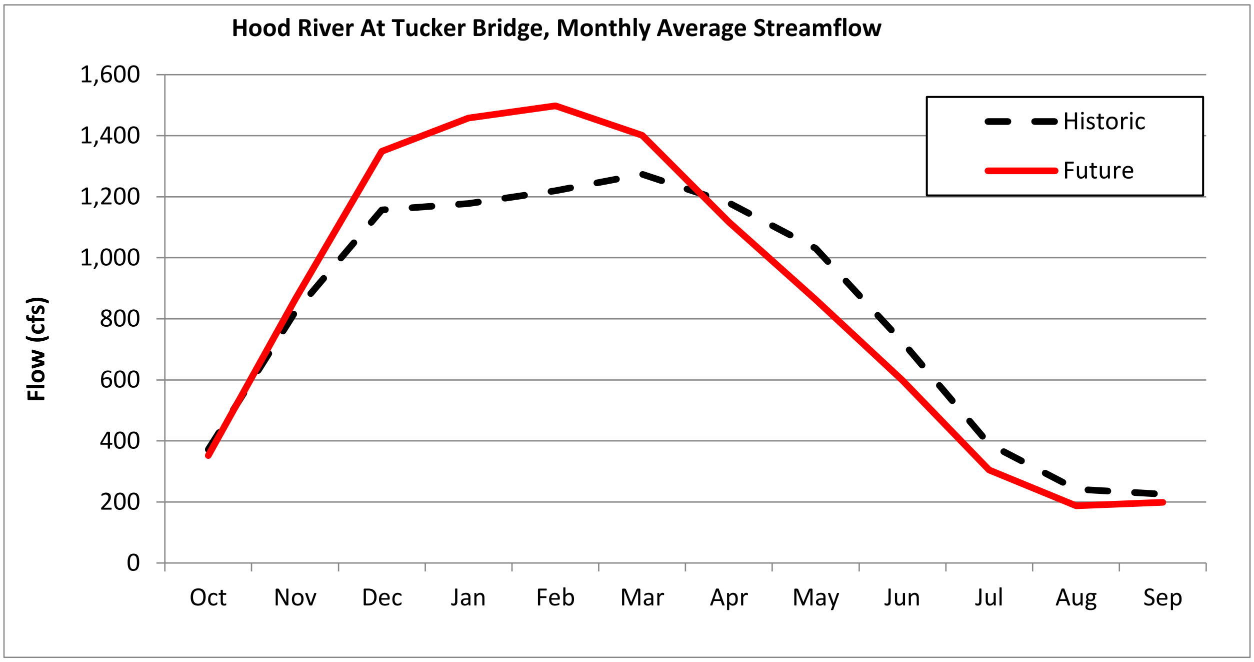



**Figure 10.** Historic (1980-2010) and predicted future (by 2060) average monthly streamflow on the Hood River at Tucker Bridge under median climate scenario. Predicted future streamflow does not include any new water conservation measures (Reclamation 2015).

Currently, instream water rights are established at seven locations across the watershed. These rights are held in trust by the state for public benefits including recreation, pollution control, and fish and wildlife. Because of their priority date, instream water rights are junior to most other water rights in the watershed. **Appendix C** lists the instream water rights and shows mean monthly flow, when available, over the past twenty years. Instream water rights are not consistently met during the summer at four of the seven locations based on a comparison of water rights and locally collected streamflow data.

Approximately one third of total streamflow in the Hood River in an average summer is diverted for irrigation. In late summer, the percentage diverted on some tributaries is higher. For example, approximately 45% of the East Fork Hood River was diverted, on average, between July 15 to September 15, for the years 1996 through 2019 (ODFW, unpublished data). Although municipal diversions are much smaller, they are located higher in the watershed and some have a relatively comparable impact in terms of percentage withdrawn during the summer. The City of Hood River municipal water comes from a spring in the Lake Branch Subwatershed. Although the instream water right on Lake Branch has been consistently met to date, flows in August and September are just above the instream water right. Future increases in municipal water demand will likely drop streamflow below the instream water right during late summer. The City of The Dalles has a water right on Dog River, which causes the stream to be below its instream water right during most of the year (**Appendix C**).

Streamflow is also diverted by two irrigation districts for hydropower production throughout the year. FID diverts 100 cfs in the winter from the mainstem Hood River and smaller tributaries (e.g., North Fork Green Point Cr., Gate Cr.) and approximately 40 cfs in the summer from the mainstem Hood River. MFID diverts 40 cfs in the winter from Clear Branch, Coe Branch, and Elliot Branch of the Middle Fork Hood River. In the summer, MFID diverts approximately 50 cfs for irrigation, which also generates power since their three power plants are in line with their irrigation delivery system (Christensen 2013b).

The effects of low and high streamflow on the watershed's salmonids have been evaluated with several models, including linear regression modeling, the Ecosystem Diagnosis and Treatment (EDT) model, and Instream Flow Incremental Methodology (IFIM). Results from these models predict varying degrees of impact from low and high streamflow depending on life stage, as noted in the discussion below.

Linear regression modeling completed by ODFW showed statistically significant positive correlations between wild steelhead smolt production and spring streamflow during brood year (i.e., year of egg incubation and hatch) as well as late summer streamflow the year prior to smolt migration (Simpson *et al*. 2018). In other words, the years with the greatest number of wild steelhead smolts migrating to the ocean corresponded with the fish that experienced higher spring streamflows during their incubation period and higher late summer streamflow the year before they outmigrated.

EDT modeling results found that low and high flows had a small to moderate effect on overall productivity of salmon and steelhead in the watershed. Consistent with regression modeling results, low flows affected juvenile rearing and, in some locations, spawning habitat. In addition, EDT results highlighted the effects of high flows and bed scour on incubation and emergence, particularly spring Chinook whose fry emerge in late fall (Coccoli 2004).

The IFIM studies evaluated how streamflow affected availability of suitable habitat for each life stage of listed fish species in the watershed. Habitat suitability was based on optimal velocities and depth (**Appendix A**) for each species and life stage. Stream depth and velocities were measured at several transects along each study reach to develop the ratings curves. **Figure 11** includes IFIM results showing the amounts of suitable spawning and rearing habitat for listed salmonids on the lower East Fork Hood River (Normandeau 2014) and Clear Branch below Laurance Lake (WPN *et al*. 2013). Note that at both sites, amount of suitable juvenile rearing habitat peaks at lower streamflow than spawning habitat, corresponding to optimal juvenile rearing velocities of 0.2 to 1.1 ft/sec and optimal spawning velocities of 1.1 – 3 ft/sec for coho, Chinook, and steelhead. On the lower East Fork, IFIM results show juvenile Chinook habitat peaking at 50 cfs and then declining with increasing streamflow. A similar trend was found on the Middle Fork Hood River (**Table 4**). Clear Branch (Middle Fork) IFIM results show juvenile habitat reaching optima at 50 cfs for bull trout and 70 cfs for steelhead. Unlike the lower East Fork, juvenile rearing habitat does not decrease with increasing flow. This discrepancy may be due to IFIM methodology, or it could relate to the physical habitat conditions found at each study site. For example, the lower East Fork Hood River is characterized by long riffles, reduced floodplain connectivity, and low habitat complexity due to insufficient amounts of large instream wood and, in some places, bank armoring. In this situation, increasing streamflow *without* increasing habitat complexity to absorb energy and partition flow may not provide as much benefit to fry and early juveniles. Clear Branch is a much smaller stream and has comparatively high habitat complexity and floodplain connectivity.

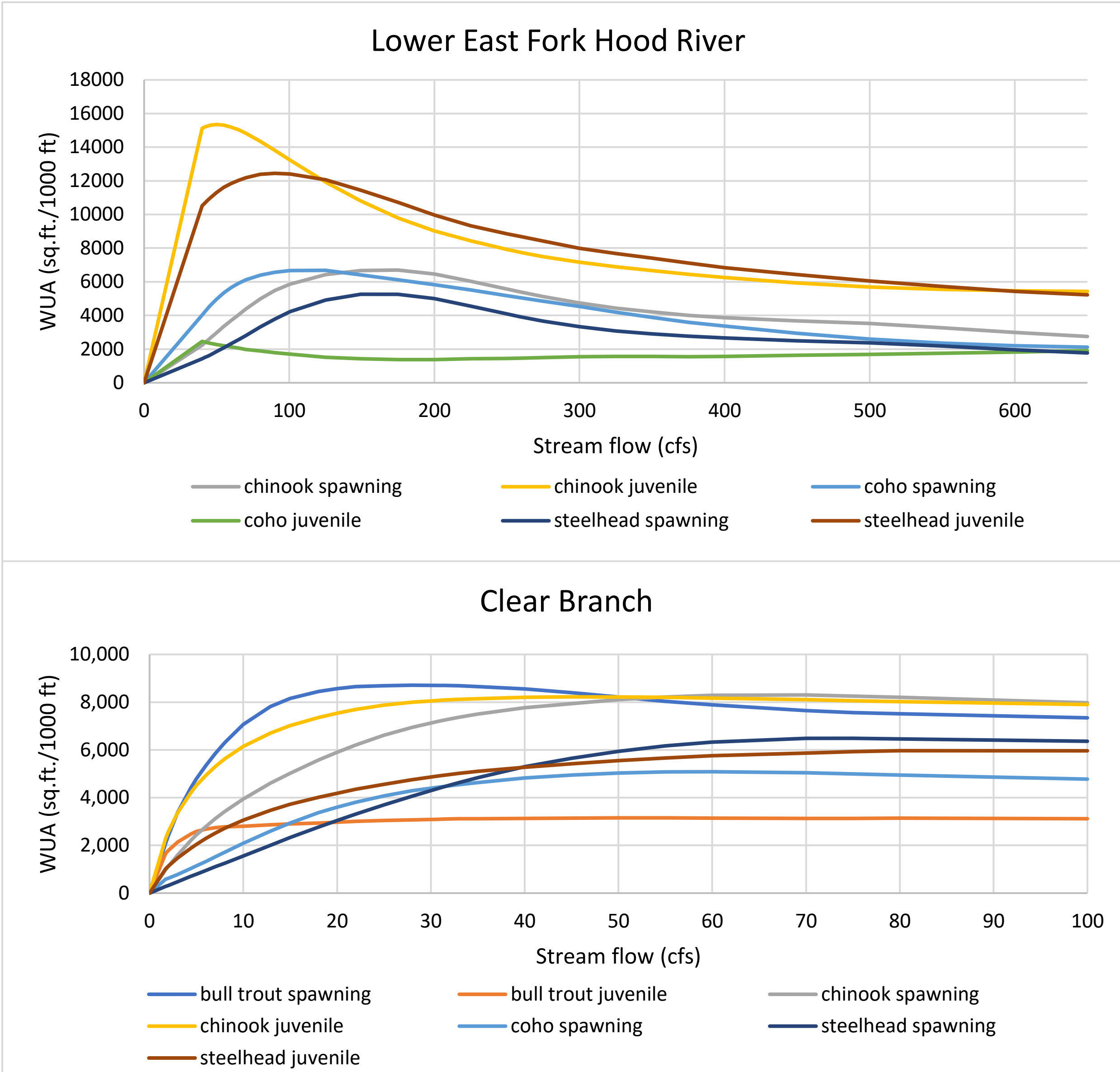



**Figure 11**. Suitable habitat availability for salmon, steelhead, and bull trout spawning and rearing at increasing streamflows on the lower East Fork Hood River and Clear Branch. Habitat availability is expressed as weighted usable area (WUA), which is the square feet of optimal habitat per 1000 linear feet of stream.

**Table 4** shows optimal streamflows for juvenile rearing and **Table 5** shows optimal streamflows for spawning for the dominant salmonids on the East Fork, West Fork, Middle Fork, and Clear Branch. The tables also include September streamflows in an average and drought year (i.e., 2015) and show the relative habitat impact of additional streamflow from potential water conservation. The boxes highlighted in gray indicate where additional summer streamflow has the biggest biological benefit.

Key points from **Table 4** and **5** include:

- The greatest biological benefit from summer streamflow restoration is on the lower East Fork Hood River and lower Clear Branch.
- Increasing streamflows on the East Fork Hood River appear to increase spring Chinook spawning habitat but decrease juvenile rearing habitat. This could potentially be offset by increasing habitat complexity.
- The IFIM model identifies 80 cfs as optimal for juvenile steelhead rearing, however average streamflow into the reservoir in September is typically 15 to 20 cfs. In other words, with or without a reservoir and irrigation diversion, Clear Branch would not have 80 cfs in late summer. This highlights the importance of looking at IFIM results in the context of expected seasonal streamflows.

Similar to Clear Branch, flow restoration opportunities and benefits may exist for Evans Creek, Rogers Spring Creek, and Green Point Creek because they are small, clearwater tributaries with irrigation diversions. A detailed comparison of streamflow restoration and habitat benefits, like those presented in Tables 4 and 5 was not possible because IFIM studies have not been completed and/or consistent historic streamflow data is not available.

**Table 4. Optimal Streamflows for Juvenile Rearing, September Streamflows, & Restoration Scenarios**

| SpCh= spring Chinook<br>Sthd= steelhead | **East Fork Hood River near mouth** | | **West Fork Hood River above East Fork Confluence** | | **Middle Fork Hood River near mouth** | | **Clear Branch upstream of Coe Confluence** | |
|---|---|---|---|---|---|---|---|---|
| | SpCh | Sthd | SpCh | Sthd | SpCh | Sthd | Bull trout | Sthd |
| Optimal flow | 50 cfs | 90 cfs | 140 cfs | 300 cfs | 40 cfs | 80 cfs | 50 cfs | 80 cfs |
| Average September flow | 83 cfs[1] | | 150 cfs[2] | | 91 cfs[1] | | 11.8 cfs[3] | |
| Percent optimal habitat at average September flow | 94% | 100% | 100% | 96% | 88% | 99% | 90% | 55% |
| Percent optimal habitat with water conservation in an average September | 86% (+20 cfs) | 100% (+20 cfs) | 100% (+5 cfs) | 96% (+5 cfs) | 86% (+5 cfs) | 99% (+5 cfs) | 93% to 95% (+5 to 10 cfs) | 67% to 73% (+5 to 10 cfs) |
| Average flow in September 2015 (drought) | 47 cfs[1] | | 122 cfs[2] | | 86 cfs[1] | | 6.2 cfs[3] | |
| Percent optimal habitat Sept. 2015 | 100% | 88% | 100% | 93% | 90% | 100% | 86% | 39% |
| Percent optimal habitat with water conservation in September 2015 | 98% (+20 cfs) | 97% (+20 cfs) | 100% (+5 cfs) | 93% (+5 cfs) | 88% (+5 cfs) | 99% (+5 cfs) | 90% (+5 cfs) | 54% (+5 cfs) |

[1]ODFW unpublished flow data, [2]OWRD gage data, [3]MFID gage data

**Table 5. Optimal Streamflows for Summer Spawning Species, September Streamflows, & Restoration Scenarios**

| | Spring Chinook | | | Bull Trout |
|---|---|---|---|---|
| | **East Fork Hood River near mouth** | **West Fork Hood River above East Fork Confluence** | **Middle Fork Hood River near mouth** | **Clear Branch upstream of Coe Branch** |
| Optimal flow | 175 cfs | 250 cfs | 60 cfs | 28 cfs |
| Average September flow | 83 cfs[1] | 150 cfs[2] | 91 cfs[1] | 11.8 cfs[3] |
| Percent optimal habitat at average September flow | 75% | 90% | 97% | 85% |
| Percent optimal habitat with water conservation in an average year | 87% (+20 cfs) | 91% (+5 cfs) | n/a- current flow higher than optimal | 95% (+5 cfs) |
| Average flow September 2015 (drought) | 47 cfs[1] (40% of optimal) | 122 cfs[2] (81% of optimal) | 86 cfs[1] | 6.2 cfs[3] (63% of optimal) |
| Percent optimal habitat with water conservation in September 2015 | 62% (+20 cfs) | 83% with additional 5 cfs | n/a- drought flow higher than optimal | 85% (+5 cfs) |

[1]ODFW unpublished flow data, [2]OWRD gage data, [3]MFID gage data

An IFIM study was completed for the mainstem Hood River in 1998 using a different methodology (PacifiCorp 1998). The study determined that optimal spring Chinook spawning occurred at 350 cfs, with 69% of 'preferred habitat' provided at that flow. Average September flows on the mainstem are 317 cfs, which provides 67% preferred habitat. In September of 2015, average streamflow was 251 cfs, which provided 62% of preferred habitat. According to these IFIM results, the percent of preferred spring Chinook spawning habitat does not vary greatly under different streamflows, likely due to the larger volume of water and low intrinsic potential for spring Chinook spawning (regardless of flow) on the mainstem.

Coho, fall Chinook, and steelhead spawn in the winter and spring when average flows are high. On the West Fork Hood River, average monthly flows range from 600 to 800 cfs (November through May), which is higher than optimal spawning and rearing flows for all these species. In addition, average winter flows are predicted to rise in the future, which may negatively impact winter/spring spawning and early juvenile rearing for salmon and steelhead. These conditions highlight the need for more large wood structures and floodplain connectivity in areas with high intrinsic potential, as this is the best way to reduce velocities at higher streamflows.

It should be noted that there is some discrepancy between the flow/habitat benefit models discussed above. Both EDT and IFIM predict lower benefits from flow restoration than ODFW regression analyses, which are based on streamflow and fish data from the Hood River (Simpson *et al*., 2018). IFIM was developed before more sophisticated two-dimensional streamflow models, such as the Hydrologic Engineering Center River Analysis System (HECRAS), were available. In the future, the partnership may use HECRAS to more accurately predict velocity/depth changes as a result of both flow and habitat restoration.

### Timber Harvest Practices and Removal of Large Wood

As described in the section on historical Impacts, early logging practices (e.g., removing all trees, splash damming) and more recent stream 'clean outs' reduced instream wood, eroded streambeds, simplified stream habitat, and disconnected streams from their former floodplains (USFS 1996a & b). Collectively, these practices have led to a significant loss of instream habitat quality. Numerous research studies have documented the effects to the food web and fish habitat from loss of large wood in streams (Salo & Cundy 1987, Naiman & Bilby 1998, Everest & Reeves 2007).

Current timber harvest practices still influence the amount of large wood recruitment to streams. The Oregon Forest Practices Act (OFPA) created and adapted between 1972 and 1994, created riparian setbacks and mandated minimum wood volumes to be left along all perennial streams on privately owned forest lands. The benefits of these practices to large wood recruitment potential will not be realized for at least another 50 years. Although better than previous forest practices, OFPA may not provide a sufficient level of large wood recruitment potential. Recent studies have found that headwater streams play an important role in biodiversity and downstream food webs and are sources of large wood recruitment during large natural events such as landslides and wildfire (Martin & Benda 2001, May & Greswell 2003, Adams 2006, Hassan *et al*. 2005, Olsen 2007, Sweeney 2014). Intermittent headwater streams are not protected by OFPA, so when landslides occur in clear-cut headwaters there is no large wood to accompany the sediment that enters the stream system. The same is true for steep, clear-cut slopes adjacent to streams that fall outside of the riparian buffer.

### Development in Floodplains/Former Stream Channels

Many watershed streams and floodplains have been affected by channel straightening and realignment, fill from roads or other structures, and bank armoring. This has increased stream gradient and water velocities, reduced stream-floodplain interaction, and decreased off-channel habitat that is critical for juvenile salmon and trout survival. The Hood River Watershed Assessment noted that roads and railroads were the most common stream channel modification, affecting a total stream length of 21 miles (Coccoli 1999). The Forest Service observed that the wide valley floor of the upper East Fork dissipated debris flows in the past, but the valley floor was constricted because of the construction of Highway 35. "Both up and down stream of The Narrows the valley floor has evidence of multiple historic channels that are now constrained repeatedly by Highway 35 maintenance operations (USFS 1996b, p. 3-18)."

### Fish Passage Barriers and Unscreened Diversions

Fish passage barriers reduce habitat quantity for migratory fish by limiting access to habitat upstream of a barrier. Resident fish can also be affected if they move downstream through a perched culvert and cannot swim back up it. Most of the known fish passage barriers on tributaries that support salmon and steelhead have been remedied over the past thirty years. Two notable exceptions are upstream passage at Clear Branch Dam and a low head diversion dam near the mouth of Tony Creek. Other barriers still exist on streams containing resident fish.

All major irrigation diversions in the watershed have fish screens, although a few need to be upgraded to meet current ODFW screening standards. These include East Fork Irrigation District's diversion, small

FID diversions on Gate Creek and Cabin Creek, and a private diversion on Tony Creek for the old Dee Mill. It is also possible that small, unscreened diversions exist on private lands.

A new area of concern regards Pacific lamprey ammocoetes, which can pass through modern fish screens. Since the 2010 removal of Powerdale Dam, Pacific lamprey have been recolonizing the basin (**Figure 3**). In 2019, numerous juvenile lamprey (i.e., macropthalmia) were observed in the East Fork Irrigation District main canal (John Buckley pers. comm.). It is thought that the lamprey passed through the canal's fish screen as ammocoetes and settled into the sandy-bottomed canal where they lived for four to six years before maturing into juveniles (Rod French pers. comm.). At this point in their life history, they migrate to the ocean and mature into adults. If there is no passage out of the canal, they cannot survive unless they are rescued and relocated to the river. Ammocoetes also appear to be passing through FID's main diversion fish screen.

Diminished/Altered Riparian Vegetation

Riparian vegetation is an integral element of stream and floodplain habitat complexity and moderates stream temperature with the shade it creates. Large wood recruitment potential and shade have been assessed at various times and locations in the watershed. In 1999, Nelson (2000) and Salminen (1999) assessed riparian conditions and large wood recruitment potential along 170 miles of streams within the lower East Fork Hood River, Middle Fork Hood River, and mainstem Hood River subbasins using aerial photos and spot field verification. They found that shade levels were high along 51%, medium along 21%, and low along 28% of total stream length. [3] Nelson and Salminen also found that large wood recruitment (i.e., supply of big trees with the potential to fall into streams) was unsatisfactory along 64% of the lower Hood River and its tributaries and 54% of the East Fork and Middle Fork Watersheds. Salminen found comparable results in Bear, Tony, Trout, Middle Fork, Lower East Fork, Baldwin, Emil, and Evans Creek.

More recently, CTWS commissioned studies of effective stream shade within the West Fork and East Fork Hood River Subwatersheds. The West Fork Hood River study found that current effective shade values were high except for stream reaches adjacent to recent harvest units, underneath power lines, and along the lower portions of the mainstem West Fork where the active channel is wide and aspect and topography are not favorable for providing shade (Heider *et al*. 2010). Similarly, the East Fork study found that current effective shade values were high except for the mainstem East Fork, recently disturbed glacial headwater streams, and some of the smaller tributaries passing through agricultural and rural residential land (WPN 2013).

Altered Hydrology from Road Networks

Road systems impact water yield and water quality in several ways. Roads act as nearly impervious surfaces, and water and sediment generated from road surfaces are quickly and efficiently transferred to either the outbound slope or to the roadside drainage network. Road cut slopes, particularly those built to access steep forest lands, can further capture shallow groundwater moving downslope thorough the soil profile. Road systems with a high-degree of connectivity between the road drainage and stream networks may experience a much more rapid and efficient transfer of water and sediment to the stream

[3] High shade = >70%, Medium shade= 40 – 70%, Low shade = <40% canopy cover

system, resulting in more early-season removal of water from the system and degraded water quality. The position of roads within the watershed may also influence the magnitude of road drainage impacts, with mid-slope roads possibly having the biggest impacts (Jones *et al*. 2000).

Loss of Beaver Dams

Beavers are a keystone species that provide important ecological functions, most notably creating and maintaining spawning and rearing habitat for native salmon and steelhead. As "ecosystem engineers", their dams can benefit stream habitat in many ways, including moderating stream velocity, increasing summer streamflow, trapping sediment, and creating highly productive environments for juvenile and adult salmonids (Pollack *et al.,* 2004). Unfortunately, beaver and their dams are not as plentiful as they once were in the watershed. Beginning in the 1820's and into the 1850's, beaver were deliberately overhunted by British trading companies south of the Columbia River to stamp out American competition in the Northwest. The Columbia River was a vital route for furs collected east of the Rockies and through the Columbia River Basin, and therefore a target for economic power struggles. Thousands of beavers were killed each year for the fur trade, and by 1900 beavers were nearly extinct. This overharvest and the resulting elimination of their ecosystem benefits is considered the first major human-caused impact on salmon and the beginning of their 150-year decline.

There is minimal historical information on beaver in the Hood River Watershed, but beaver ponds in the West Fork have been noted (Coccoli 1999), and long-time residents along the East Fork Hood River recall a large complex of beaver dams near Baseline Road, which was reportedly a reliable place to catch trout (Rick Ragan pers. comm.). Changes to Highway 35 maintenance, removal of large instream wood, and trapping and killing of beaver to protect orchards have all likely contributed to their decline in the Hood River Watershed.

Estimated Amount of Instream/Floodplain Habitat Restoration to Address Reduced Instream Habitat Quality and Quantity

ODFW's Lower Columbia River Conservation and Recovery Plan (LCRCRP) for Oregon Populations of Salmon and Steelhead set habitat restoration goals for each watershed. These goals were based on a scenario analysis that analyzed total cost and provided restoration targets that would contribute to broad sense recovery of all species in the plan. However, the analysis did not assess whether the quantity of actions was feasible on the landscape. Consequently, an ODFW planning team used alternative scenarios identified in the recovery plan and applied a maximum restoration feasible or delisting scenario to update restoration targets in each watershed (Jim Brick pers. comm.). The resulting restoration targets for the Hood River Watershed are shown in **Table 6**, as well as the quantities completed since 2010 and remaining miles for each restoration type.

**Table 6. LCRCRP Restoration Targets for the Hood River Watershed**

| Restoration Type | Total Target | Completed since 2010 | Remaining Target |
|---|---|---|---|
| Large Wood Placement[1] | 33.6 miles | 10.6 | 23 miles |
| Side channel restoration (includes floodplain reconnection) | 20.1 miles | ~7[2] | ~13 |
| Riparian habitat restoration[3] | 19.2 miles | ~12 | ~7.2 miles |

[1] Assumes a wood volume of 20m$^3$ /100 meters (or 322 m$^3$/mile) of stream made up of key pieces, smaller pieces, and brush; typical key wood piece= 2.4 m$^3$

[2]Side channel reconnection/restoration miles have not been tracked. Partners plan to remedy this by measuring past side channel reconnection length and measuring/tracking for all future projects.

[3]Extends 30 meters on each side of the stream

Need for Conservation Easements in Floodplain, Wetlands, and Large Wood Recruitment Zones

Establishing conservation easements on intact or restored floodplains and wetlands is a need and challenge partners have identified. The primary challenge is finding an entity willing to hold small easements, since there is poor economy of scale for small acreage sites.

Another need for conservation easements is on privately-owned forest lands in critical large wood recruitment zones. Western Rivers Conservancy has been in negotiations with Weyerhaeuser to purchase conservation easements along their riparian corridors but have so far not succeeded.

## Sediment Load

Natural sediment sources include streambank erosion, landslides, glacial runoff, and debris flows originating from the slopes of Mt. Hood. Newton Creek (a tributary of the East Fork Hood River) and the Eliot Branch of the Middle Fork Hood River are especially well known locally for generating significant debris flows on decadal timescales. The flows commonly originate from slumps on steeply sloping glacial moraines that may contain remnants of glacial ice. In November 2006, an especially large debris flow that descended the Eliot Branch buried the Laurance Lake Road and deposited millions of tons of sediment and rock along Eliot Branch and the Middle Fork Hood River. Newton Creek and Clark Creek erode their stream banks each year as these streams migrate back and forth across their floodplains at the base of Mount Hood. These and other glaciated drainages produce highly turbid stream flows during the summer months. Glacial recession and sediment-generating events have been occurring since the last Ice Age, but global warming has increased their degree and frequency (Frans *et al*. 2018). Increased turbidity and debris flows are challenging for fish, although many rivers that drain glaciers in Alaska and Canada are highly productive for salmon. Researchers have found that fish in these systems will feed on midges in the glacially derived sediment and take refuge in smaller, clearwater tributaries where they exist (Bidlack *et al*., 2014).

Major turbidity and sediment inputs from human activities result from runoff from forest roads and recreation use areas, exposed soils in livestock areas adjacent to streams, winter sanding of roads and parking lots, and landslides related to forestry practices or irrigation ditch failures (Coccoli 1999). High levels of fine sediment can create problems for native salmonids in several ways. The interstitial spaces in spawning beds can be plugged by fine sediment, which decreases egg survival. Similarly, coarse-grained substrate can be embedded by fine sediment, which reduces overwintering habitat for juveniles (Coccoli 2004).

On the opposite end of the sediment delivery spectrum is the restriction of sediment transport from dams or undersized culverts. Clear Branch Dam, for example, alters sediment transport from upper Clear Branch and Pinnacle Creek to lower Clear Branch, although observations in Laurance Lake suggest that fine sediment does not accumulate in large amounts (Kleinschmidt 2015).

## Water Quality

### Stream Temperature

Point sources of thermal pollution in the watershed include three domestic wastewater treatment plants, several fruit packing plants, Laurance Lake Reservoir, and industrial/commercial sites. Indirectly, EFID's diversion on the East Fork Hood River may cause warmer stream temperatures because the diversion withdraws approximately 40% of streamflow in mid to late summer, with shallower water warming more quickly. This reduction is enough to effect stream temperatures even in fast-flowing streams. In contrast, over ten years of temperature data collected on the mainstem Hood River up and downstream of FID's diversion do not indicate warming caused by FID's main diversion. Non-point sources of thermal pollution include loss of shade over streams and warming of average air temperatures due to climate change.

Several temperature standards apply to streams in the watershed to protect different fish species and life stages. **Appendix D** lists these standards, and the streams or stream reaches that currently do not meet temperature standards according to the revised Western Hood Subbasin Total Maximum Daily Load (DEQ 2018). These streams make up approximately 35% of fish-bearing stream-miles.

**Appendix D** also shows results of continuous summertime temperature monitoring conducted by CTWS at eleven sites in the watershed (CTWS 2020). Results show average daily temperatures for the summer of 2020 and the 20-year average. The mainstem Hood River, East Fork Hood River, Neal Creek, and Odell Creek consistently do not meet the standard between mid-June to mid-September. In contrast, the West Fork Hood River, Lake Branch, Dog River, Middle Fork Hood River, Rogers Spring, and McGee Creek have usually met the standard over the past 20 years. However, the temperature graphs also show that 2020 average daily water temperatures were higher than the 20-year average at most sites, which is consistent with the rise in average ambient air temperatures.

### Pesticides

Pesticides are used in orchards, residential and commercial properties, forests, roadways, railways, and power line corridors. DEQ monitoring in the late 1990s showed that pesticides, such as chlorpyrifos and azinphos methyl, were above regulatory benchmark levels for the protection of aquatic life. These organophosphate insecticides potentially interfere with normal hormone function in salmonids and alter species composition and abundance of aquatic macroinvertebrates. As part of developing their TMDL for the basin, DEQ initiated a Pesticide Stewardship Partnership program in 1999, which included annual monitoring for 15 pesticides. In 2009, DEQ began analyzing for over 100 pesticides or pesticide degradation products. With the increase in number of pesticide analytes, more have been detected. Nonetheless, pesticide concentrations and detection frequency in the Hood River Watershed have steadily declined over the past two decades, with no pesticides exceeding aquatic benchmark levels over the past three years (AWQMS). There is still some concern that chronic exposure to the mixture of pesticides found in streams could be more deleterious (Temple and Johnson 2011).

Several additional chemicals, including arsenic, beryllium, copper, iron and manganese, found on the current 303(d) list for streams or stream reaches in the Hood River Basin are shown in **Appendix E**. The beryllium and iron listings occur throughout the watershed, including relatively undisturbed areas such as Dog River and West Fork Hood River. These may be naturally occurring. Lenz and Neal Creeks have the most listings of the streams evaluated.

### Cumulative Impact of Limiting Factors in the Watershed

The cumulative effect of limiting factors to threatened salmon and steelhead is ultimately reflected by their reproductive success in the watershed. Although some factors may have a greater impact than others, all of them must be addressed at a certain level. It is also important to implement practices and projects that support all life history stages. **Table 7** provides a summary of salmonid habitat requirements by life stage and how loss of instream habitat quantity/quality, sediment load, and water quality affect them.

### Out of Basin Threats

This action plan is focused on threats and limiting factors that occur in the Hood River Watershed. However, significant threats to salmon and steelhead exist outside the basin, including warmer ocean conditions, commercial fishing, fish passage at Bonneville Dam, summer water temperature on the Columbia River, and the current rate of global carbon emissions and warming (NMFS 2013, EPA 2020, Simpson *et al*. 2017). A study by Frans *et al*. (2018) predicted that by the end of the century, glaciers in the Pacific Northwest could be completely gone. Even if all possible water conservation measures were in place, this would be a severe blow to threatened salmon and steelhead in the Hood River Basin, which are dependent on late summer flow from glacial melt to provide sufficient water quantity and quality for spawning and rearing. It would also have major impacts on local agriculture and human communities in the watershed.

**Table 7. Summary of Habitat Impacts on Salmonid and Lamprey by Life Stage**

| Life Stage | Optimal Habitat | Impact of Lost Habitat Quantity/Quality & Increased Sediment |
|---|---|---|
| Adult Holding (salmon & steelhead) | Deep pools, low velocity, cover: logs, rootwads, undercut banks | Loss of instream large wood has reduced the number of pools and cover in most sub-watersheds. Low summer stream flows, particularly below some irrigation diversions, make existing pools shallower. |
| Adult Holding (Pacific lamprey) | Glides, lateral margins of riffles, boulders for cover | Duration and habitat requirements for Pacific lamprey are not well understood (Ben Clemens pers. comm.). Given their expansion in the watershed since the Powerdale Dam removal, conditions in the Hood River may be adequate for holding. |
| Spawning (salmonids & lamprey) | Medium gravel to small cobble, water 1 - 2 ft. deep, velocity 1 to 2 ft./sec. | Loss of instream wood and channel confinement from splash damming has reduced sorting and deposition of gravels/cobbles, leading to fewer spawning gravel patches. Below some irrigation diversions there is reduced water depth and velocities over spawning gravels in summer and early fall. Gravel and cobbles are also embedded from past debris flows in some stream reaches. |
| Incubation/ Emergence (salmonids & lamprey) | Fry need low velocity, good cover: roots, log jams, undercut banks, overhead vegetation | Glacial recession has led to more debris flows; these events smother redds in their path and provide poorly consolidated substrate and actively shifting channels. Loss of instream large wood and stream-floodplain connection has led to less low-velocity stream area. This is particularly a problem in the winter and spring when fry are emerging. |
| Juvenile Rearing (salmonids) | Pools, glides, off-channel riffles, water depth 1½ to 3 ft., velocity ½ to 1½ ft./sec. (coho - 2.5 – 3 ft. deep & 0.1 – 0.3 ft./sec.) | Loss of stream-floodplain connection and instream large wood has reduced the amount and quality of juvenile rearing habitat in the watershed. Instream wood increases juvenile habitat complexity by creating both pools and riffles, trapping substrates (cobble, twigs, leaves) for aquatic insects, and increasing floodplain connectivity. Floodplain/off-channel habitat provides critical refuge during high-flow events during the winter. Juveniles that cannot get off the main channel get pushed downstream and possibly out of the watershed.<br><br>In the summer, low stream flows reduce the amount of juvenile rearing habitat in some stream reaches.<br><br>Pollutants from agriculture, forestry, rural residences, and transportation corridors have the greatest relative impact on this life stage, as well as resident species like cutthroat and rainbow trout. |

# Chapter 4. Conservation Opportunities

This chapter summarizes conservation opportunities that have been evaluated over the past decade and form the basis of the Strategic Action Plan's strategies, objectives, and actions.

## Water Conservation

During the summer, irrigation water use is twenty times domestic water use and on average diverts one third of the total streamflow in the Hood River. Hence, water conservation strategies mostly focus on agricultural and rural residential land. The five strategies listed in **Table 8** provide the major opportunities for improving streamflow in the future. Other strategies, including managed aquifer recharge, metering with tiered pricing, and forest road management may also be good options but need further evaluation.

**Table 8. Primary Opportunities for Water Conservation**

| Actions | Total Potential Savings | Most Likely in next 20 years |
|---|---|---|
| On-farm irrigation upgrades and water management (total potential: ~10,700 acres; next 20 years: 8,000 acres) | 34 cfs | 23 cfs |
| Conveyance system upgrades | 23 cfs | 23 cfs |
| Hydropower rebalancing (would vary July – mid-October) | ~5 cfs | ~5 cfs |
| Voluntary fallowing of hay/alfalfa (dry years, 20% participate) | ~10 cfs | ~10 cfs |
| Residential water conservation (20% use reduction) | ~6 cfs | ~6 cfs |
| **Total** | **78 cfs** | **67 cfs** |

### On-farm Irrigation Water Management

Efficient on-farm irrigation water management (IWM) requires the use of *both* efficient irrigation equipment and irrigation scheduling. Efficient equipment allows an irrigator to apply water at an appropriate rate for their soils and slopes, while irrigation scheduling optimizes the total amount and frequency of irrigation based on crop need and soil moisture. Older, traditional irrigation systems typically consist of hand or wheel lines with impact sprinklers that, on average, apply 2.4 feet to 3 feet per irrigation season. This can lead to the application of more water than is necessary and result in wasted labor, fertilizer, and water. New, more efficient systems typically consist of fixed poly-tubing with micro or rotator sprinklers. Studies in the Hood River Basin found that, on average, orchards with micro-sprinklers applied 1.53 feet/year, which is a 40 to 50% water savings (HRSWCD 2013, Irrinet 2007). Pear trees, which occupy 62% of the valley's agricultural land, typically need 1.6 feet of irrigation water in an average summer (Agrimet). Thus, they are well suited for irrigation with micro-sprinklers. Crops like alfalfa require more water and mobile irrigation equipment, such as wheel lines, which can be converted to more efficient pods or traveling systems.

#### Lenz Creek Conservation Story

Orchardists on Lenz Creek upgraded their irrigation system with solid-set micro-sprinklers and installed soil moisture sensors at several locations around the orchard, which was a critical component to conserving water. Prior to the upgrade they used approximately 5 million gallons/year on a 7.5-acre block. A post-installation flow meter documented their new water use at approximately 2 million gallons/year, a 60% water savings and the equivalent of over four Olympic-sized swimming pools. In addition, their labor cost was reduced by $2,200/year, they observed improved fruit quality, and eliminated erosion caused by over-watering.

An ongoing challenge to using micro-sprinklers and drip irrigation in the watershed is the glacial sediment in irrigation water. Fine sediment can both clog the small orifices of micro-sprinklers and bore them out over time, which increases the amount of water application. Local irrigation districts are working to remove glacial sediment from their irrigation water to support the use of efficient irrigation systems. MFID has a settling pond to partially remove sediment from Coe and Eliot Branch water, and FID and EFID have a few small locations where they can remove sediment. However, more sediment removal capacity is needed to maximize on-farm water conservation.

Approximately 10,700 acres of agricultural land is still being irrigated with inefficient irrigation systems, based on estimates from irrigation district managers and cost-share funded projects to date. Funding has been available to assist farmers with upgrading irrigation systems through the NRCS Environmental Quality Incentives Program (EQIP) and OWEB small grants. These cost-share programs have helped to upgrade almost 5,000 acres of orchards between 2002 and 2020, an average of 277 acres per year. Many farmers have made use of this funding to upgrade their irrigation systems. However, sometimes EQIP funding allocated to the Hood River Basin has not been fully utilized despite the substantial number of remaining acres with inefficient irrigation systems. Furthermore, the current pace of irrigation upgrades is not in-line with the objective in **Table 8** (*i.e.*, 400 acres per year/8,000 acres in 20 years). An assessment of barriers to upgrading on-farm irrigation systems would help watershed partners address barriers and increase the pace of upgrades.

### Conveyance System Upgrades

EFID has 17.8 miles of open canals and end spills at approximately 25 locations, and FID has 2.5 miles of open canal. If these open canals and end spills were eliminated, approximately 23 cfs could be left instream (FCA 2021, FCA preliminary analysis for FID), a portion of which would be protected with a conserved water allocation. EFID recently partnered with Farmers Conservation Alliance (FCA) and NRCS to complete the EFID Modernization Strategy and the EFID Irrigation Modernization Project Watershed Plan-Environmental Assessment (FCA 2021, FCA 2020). They have also surveyed for cultural resources along most of their remaining canals. This has made EFID's canal to pipeline conversion projects 'shovel-ready' and eligible to receive up to $50 million in federal PL-566 funding. FID is in the process of developing a strategy and environmental assessment with FCA and NRCS, which could result in piping the final 2.45 miles of open canal in the district and other projects to improve water quality and quantity.

### Hydropower Rebalancing

Hydropower water rights in the basin are the same year-round even though streamflow is considerably higher in the winter than the summer. Rebalancing to produce more power in the winter and less in the summer would result in an increase in summer streamflow at no net cost. The goal of rebalancing would be to decrease hydropower water use in the summer when low streamflow is limiting and offset any lost revenue by increasing production during periods of higher streamflow. MFID is interested in pursuing this opportunity.

### Voluntary Fallowing During Dry Years

A feasibility study was recently completed by AMP Insights and Watershed Professionals Network (WPN) to evaluate the potential water savings and community interest in developing a water bank in the Hood River Watershed (Pilz *et al*. 2019). The goals of the water bank would be to increase summer stream flows for fish and provide greater irrigation water reliability for perennial crops like fruit trees, during dry or drought years. This would be achieved by leasing water from people growing irrigated crops that can forgo all or part of their irrigation for the summer, and temporarily dedicating this water to instream flow. Pasture and alfalfa were estimated to cover 4,317 to 8,771 acres based on 2008/2009 aerial photo analysis and 2017 National Agricultural Statistics Service (NASS) data. Target acres were further refined by identifying lands with water rights that are currently irrigating annual crops and selecting parcels that were at least 5 acres. (Larger parcels represent the best targets for water bank supply because it is more efficient to source water from one large parcel instead of several smaller ones due to the fixed transaction costs for each ownership.) A landowner interest survey found that 71% of respondents answered "yes" or "maybe" when asked whether they would consider participating in a voluntary, paid water bank program.

WPN evaluated the water savings and instream flow benefits from a water bank during a dry year (i.e., 80% exceedance flow[4]). The scenario targeted 5,748 acres with different levels of participation, including 5%, 10%, and 20% enrollment of parcels with five or more acres. These success rates were applied to the whole watershed and certain tributaries based on the locations of irrigation district points of diversion. The analysis found that if 20% (1,157 acres) of pastureland was fallowed, the total potential water savings would be approximately 10 cfs for the whole watershed. The next step is to launch a pilot water bank program, which would set up the bank structure, prioritize areas where stream flow augmentation would have the greatest biological benefit (e.g., irrigation water from small, clear water tributaries like Evans Creek and Rogers Spring), and enroll a small number of parcels.

## Residential and Commercial Water Conservation

Outdoor water use accounts for around 30% of all residential use in the United States, about half of which is lost to evaporation and seepage (EPA 2008). Since outdoor use occurs mainly in the summer when stream flow is the lowest, it makes sense to educate and assist residential landowners in conserving water. For example, the City of Portland conducts public outreach campaigns, has water-efficient landscape demonstration projects, and conducts voluntary water audits (Christensen 2013a).

An estimated 32 cfs is diverted for residential irrigation during the summer; 16 cfs via FID, 14 cfs via EFID, and 2 cfs via the City of Hood River (Christensen 2013a). Achieving a 10 to 20% reduction in outdoor water use would yield approximately 3 to 6 cfs in savings. Although smaller than agriculture-related water conservation, it is still enough to be biologically meaningful.

Commercial water use and conservation has received less evaluation. Given the increasing number of breweries and distilleries in the watershed, promoting water conservation has some value, especially since most of them receive water from the City of Hood River's Lake Branch Spring. A good example of the industry's water conservation potential is offered by Full Sail Brewing Company's water conservation measures over the past decade, which have resulted in saving approximately 4.1 million gallons/year. This was largely accomplished by installing a new mash filter, using a hot water recovery system, and changing their production week to four ten-hour days, thereby reducing cleaning water and energy use. As a comparison, most breweries use six to eight gallons of water per gallon of beer produced, whereas Full Sail now uses less than three gallons (Full Sail Brewing 2021).

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[4] 80% exceedance flow means that 80% of the time stream flows are above this level.

## Cumulative Impact of Water Conservation

**Figure 12** shows monthly average summer stream flows under current and predicted future conditions on the East Fork, Middle Fork, and mainstem Hood River (Salminen *et al*. 2016). Future stream flow is based on the median climate change scenario developed by the Bureau of Reclamation (BOR 2015). The conservation scenario includes likely actions in the next 20 years totaling approximately 57 cfs (**Table 8**). (Note that an average year does not include 10 cfs drought-year fallowing.)

Several points should be noted in considering these figures. First, if the climate becomes warmer and drier than the 'median' climate scenario, than stream flows could decrease despite significant water conservation efforts. Second, this set of actions will likely maintain or slightly increase stream flows from current levels (under the median climate scenario). This is good, but not ideal, as current stream flows are a limiting factor to the recovery of listed salmonids in the basin. Third, a major underlying assumption of these strategies and their estimated habitat benefits is that crop irrigation needs will be satisfied, but irrigators will not be applying their full legal water right. Finally, the calculated habitat benefits assume that water saved will be left instream at the point of diversion, as opposed to being applied to new acres or used to generate additional hydropower in the summer.

## Additional Approaches to Increasing Streamflow

A few additional approaches to increasing summer streamflow have been considered but not thoroughly vetted and/or quantified. These include managed aquifer recharge systems (MARS), pumping groundwater from deep, confined aquifers (i.e., not connected to surface water), and changing forest management. A high-level evaluation of the potential for implementing MARS in the watershed was completed by GeoSystems Analysis (Salminen *et al*., 2016) and is described briefly below.

MARS refers to recharging the shallow aquifer system through enhanced surface infiltration. Under this method, water is ponded on the soil surface or applied through shallow perforated pipe during winter and spring months and the infiltrated water percolates through permeable material on its path to the alluvial aquifer and eventually to connected surface waters. In the Hood River Watershed, the best opportunity for MARS is on private land within the MFID where existing pipelines are adjacent to highly permeable soil types. MARS would be performed during the winter and spring when surface water is more plentiful. Specific opportunities to consider include: 1) Designing sediment settling ponds to also function as recharge basins during non-irrigation season; 2) Constructing recharge basins near existing canal networks that can be used to divert water to the recharge basin; 3) Constructing subsurface infiltration galleries (*i.e.,* buried perforated pipe) to recharge water in locations where available surface area is insufficient.

Based on the GeoSystems Analysis, MARS projects implemented on the most permeable soil type could yield 1 cfs return flow for every 2.1 acres inundated, assuming a 7-month inundation period during the winter/early spring and that 55% of the water diverted would enter a downslope stream or river. The next step in moving forward with MARS would be an aquifer recharge feasibility study. This would include initial screening of potential recharge sites based on criteria such as proximity to existing infrastructure, surface conditions, subsurface conditions, and land ownership. Subsequent steps would include detailed site evaluations, shallow aquifer monitoring, and seepage runs to identify gaining and losing stream reaches. A final step, which would also evaluate hydrologic impacts of other restoration actions, would be to develop a calibrated basin-scale surface water groundwater model to quantify the demand and distribution of water resources throughout the watershed and simulate the influence of managed aquifer recharge, instream habitat restoration, and other water management activities (*e.g*., canal piping, water conservation) on stream flows and groundwater resources.

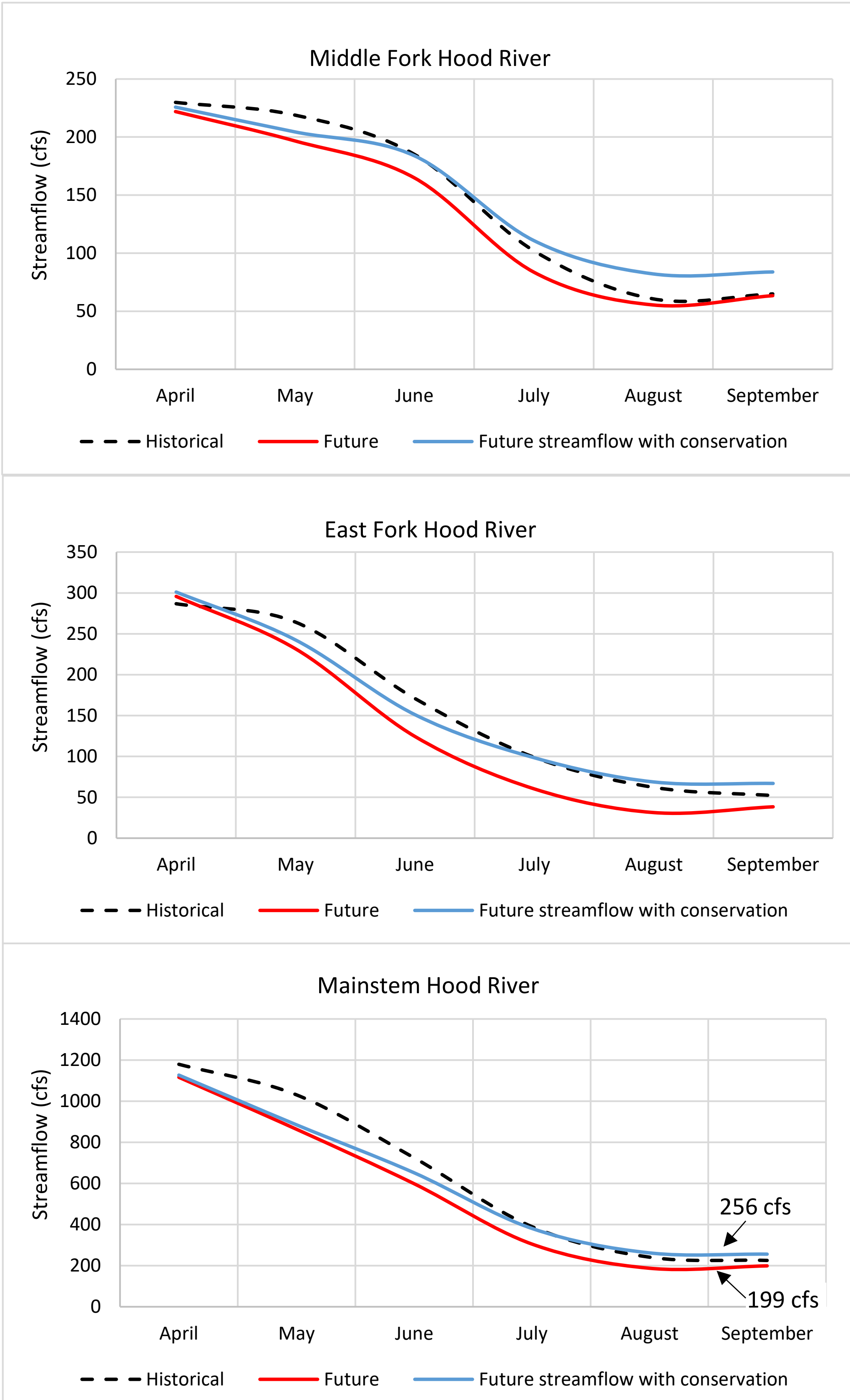



**Figure 12.** Projected future summer flows with and without conservation actions on the East Fork Hood River below EFID diversion, Middle Fork Hood River below MFID diversion, and Hood River at Tucker Bridge.

## Water Quality Protection and Improvement

The best opportunities for protecting and improving water quality in the watershed include:

- Enhancing riparian areas to increase shade and filter pollutants from overland runoff where streamside vegetation has been removed by agricultural or landscaping practices. DEQ shade modeling predicted that daily stream temperatures in the East Fork Hood River, mainstem Hood River, and Neal Creek could be reduced by improving riparian shade (DEQ 2001).
- Increasing streamflow below some irrigation diversions may provide modest stream temperature reductions (see **Figure 13**)
- Continuing to provide education on best practices for pesticide application and promoting integrated pest management
- Converting open canals to pipelines to prevent chemical and thermal pollution from unused irrigation water entering streams at end spills
- Converting open canals to pipelines to prevent canal failures that can send thousands of tons of fine sediment into streams
- Maintaining or decommissioning forest roads that transport sediment to streams, including increasing the number of cross-drains, out-sloping road surfaces, and in some cases eliminating roads

Another future water temperature improvement project is on Clear Branch below Laurance Lake Reservoir. The current proposal is to keep the reservoir and downstream releases cooler by withdrawing irrigation water from the reservoir's surface and sending cold bottom water into Clear Branch.

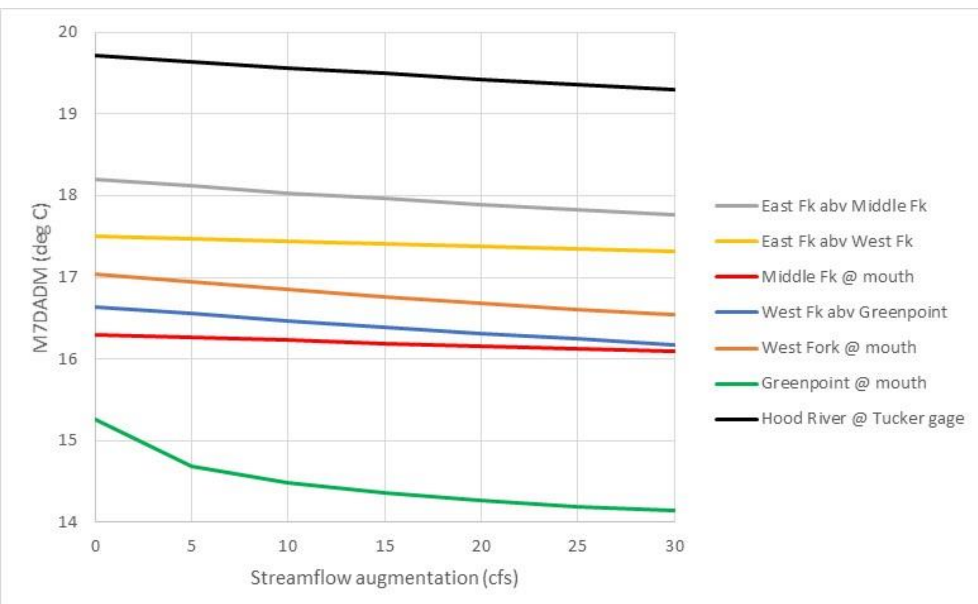



**Figure 13.** Modeled effect of streamflow augmentation on seven-day-average of daily maximum water temperatures at selected locations. Modeled temperature based on summer 2016 data **(**Pilz *et al.* 2019**).**

## Habitat Enhancement Projects

Habitat enhancement projects comprise a variety of techniques, including placement of large wood structures in streams, reconnecting streams with their floodplains, creating favorable conditions for beavers, and restoring fish passage. As noted earlier, large wood structures provide many benefits to all life stages of salmon and steelhead, including cover from predators, stream velocity reduction, deposition of spawning gravels, and pool formation and maintenance (Clark *et al*. 2019, Collins *et al*. 2012, Montgomery *et al*. 2003). Large wood structures can also raise surface water elevations at high flows, helping to reconnect streams with floodplains and side channels. Studies have shown that growth rates of juvenile salmonids foraging on the floodplain are much higher than those on primary stream channels (Corline *et al*. 2013) and that habitat restoration can boost aquatic insect production (Thompson *et al*. 2018). These types of projects have also been shown to raise the summer water table and recharge groundwater.

### Prioritizing Instream Habitat Restoration Areas

The TAC divided the watershed into nine subwatersheds and prioritized them using the Atlas framework, intrinsic potential, fisheries and physical habitat data, and other factors unique to the Hood River Watershed. Intrinsic potential for fish habitat is based on the assumption that landform creates the underlying conditions that control transport and deposition of sediment and large wood, both of which are fundamental elements of good habitat for salmonids (WPN 2020). **Figure 14** and **Figure 15** show maps of intrinsic potential for steelhead and Chinook in the watershed.

Atlas prioritizes subwatersheds into three tiers (*i.e*., Tier 1, 2, 3) based on the number of fish species and life stages present; the number of highly vulnerable life stages; the geomorphic potential to respond to restoration; current habitat conditions; and projected future habitat conditions (primarily stream flow and temperature). Fish species and life stages present make up 50% of the subbasin score, thus the mainstem and lower forks of the Hood River are all Tier 1 subbasins because the greatest number of species and life stages use the lower portion of the watershed. However, three of the four Tier 1 subbasins have low or limited segments of intrinsic potential due to the steep and confined nature of the watershed. Furthermore, important restoration opportunities exist in other subbasins where there is high intrinsic potential, clear water (*i.e*., not glacially influenced), or bull trout presence. **Table 9** lists the subbasins, shows their Atlas ranking, and includes other considerations for working within each subbasin. Partners anticipate that many of the restoration miles will occur in Tier 1 subbasins, particularly the mainstem and lower East Fork Hood River, but other important opportunities exist in Neal Creek, the upper East Fork, upper Middle Fork, and upper West Fork.

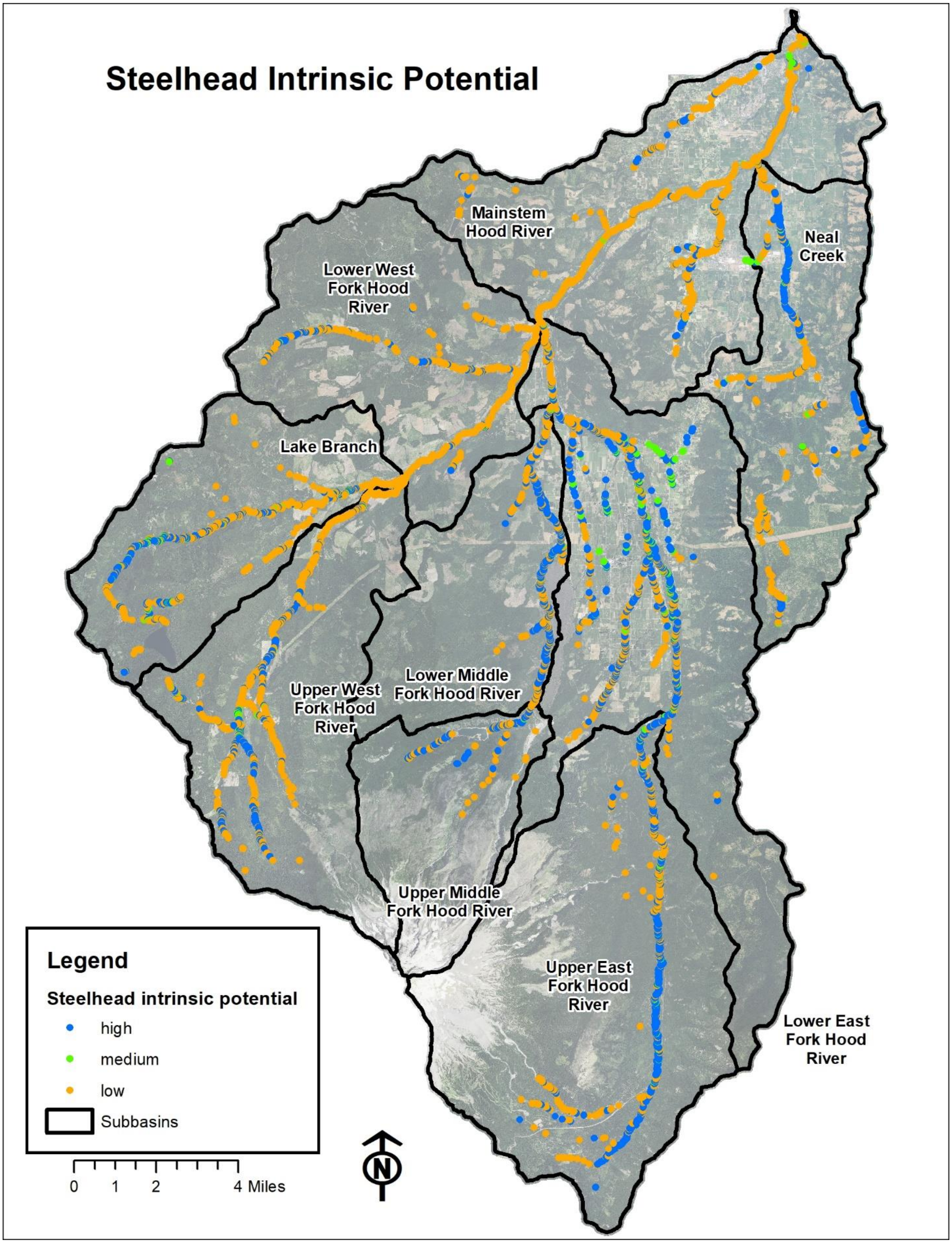



**Figure 14.** Intrinsic Potential for Steelhead Spawning and Rearing (Heider & Salminen 2019; Parameters from Cooney & Holzer 2006).

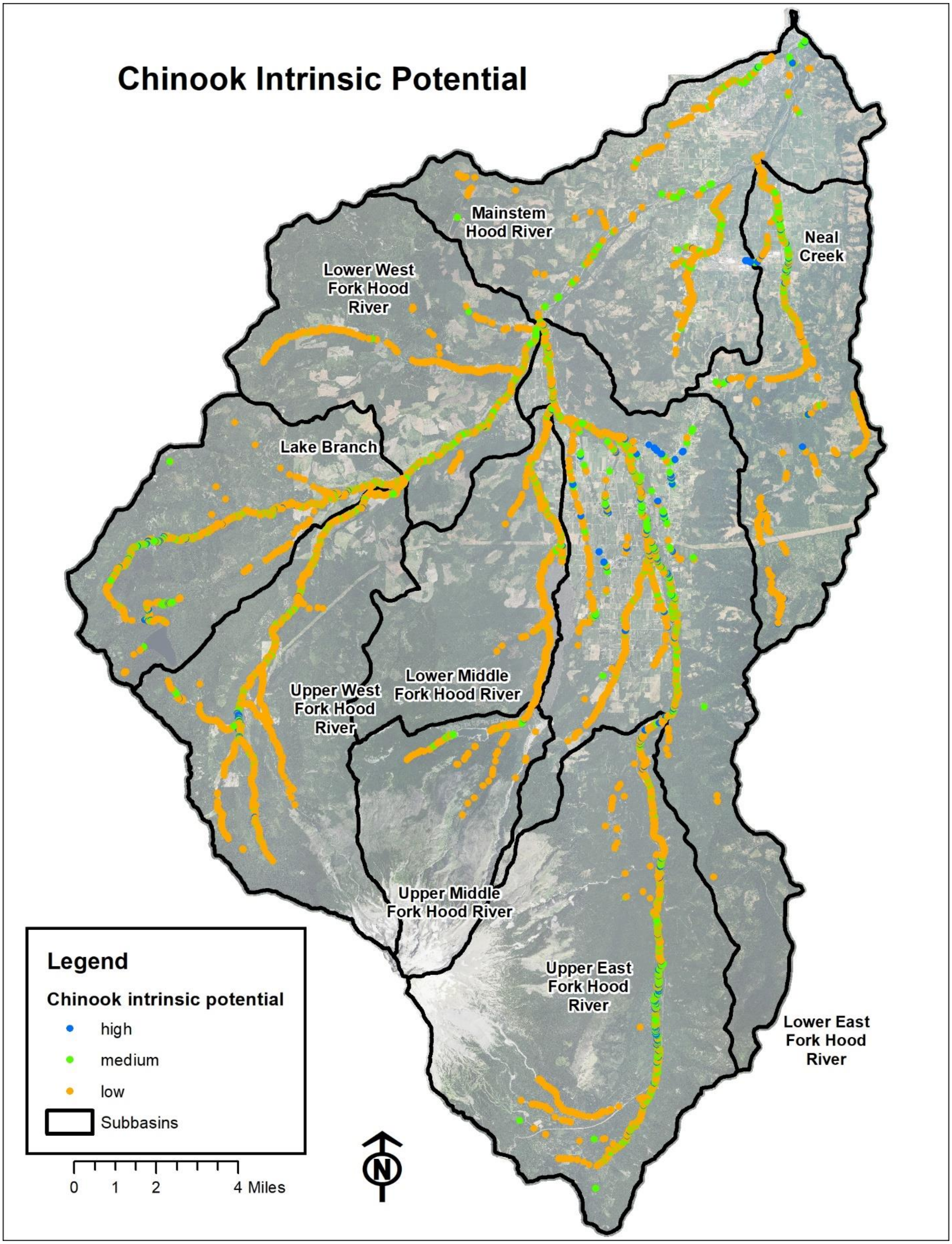



**Figure 15.** Intrinsic Potential for Spring Chinook Spawning and Rearing (Heider & Salminen 2019; Parameters from Cooney & Holzer 2006).

**Table 9. Subwatershed Priorities and Considerations**

| Subwatershed | Atlas Tier | Other Considerations | |
|---|---|---|---|
| | | Pros | Cons |
| Lower East Fork (includes Dog River) | 1 | High intrinsic potential for most of the subbasin; Likely the best potential for winter steelhead recovery; Greatest potential for water conservation | Relatively high glacial turbidity and risk of debris flows from Polallie and Newton Creeks; Numerous private landowners and development within the 100-year floodplain |
| Mainstem Hood River | 1 | High species diversity and number of fish detections; Three to four project opportunities with high biological benefit and technical feasibility; Best potential for fall Chinook habitat restoration in the basin | Low intrinsic potential; Project costs and risk higher than average; Some projects will require a lot of public engagement and support; Difficult access; Uncertainty regarding disposition of Mt. Hood Railroad |
| Lower West Fork | 1 | Lower glacial turbidity; High intrinsic potential reach would benefit spring Chinook and summer steelhead | Most of the subbasin has low intrinsic potential |
| Lower Middle Fork | 1 | Important for bull trout recovery; High intrinsic potential | Relatively high glacial turbidity and semi-regular debris flows from Eliot Branch |
| Neal Creek | 2 | Clearwater habitat; High intrinsic potential; Good potential for coho habitat restoration | Numerous private landowners and development within the 100-year floodplain |
| Upper Middle Fork | 2 | Critical for bull trout recovery; Some high intrinsic potential | Clear Branch Dam prevents upstream migration to Clear Creek and Pinnacle Creek |
| Upper East Fork | 2 | High intrinsic potential; Clear water above Clark Creek | Anadromous fish use is thought to be low |
| Upper West Fork | 3 | Some high intrinsic potential; Clear water above Ladd Creek; Best spring Chinook and summer steelhead spawning habitat in the basin | Many projects have been completed; Restoration need is mostly complete |
| Lake Branch | 3 | Pristine habitat, cold water; Some high intrinsic potential; Good spawning habitat for summer steelhead | Many projects have been completed; Restoration need is mostly complete |

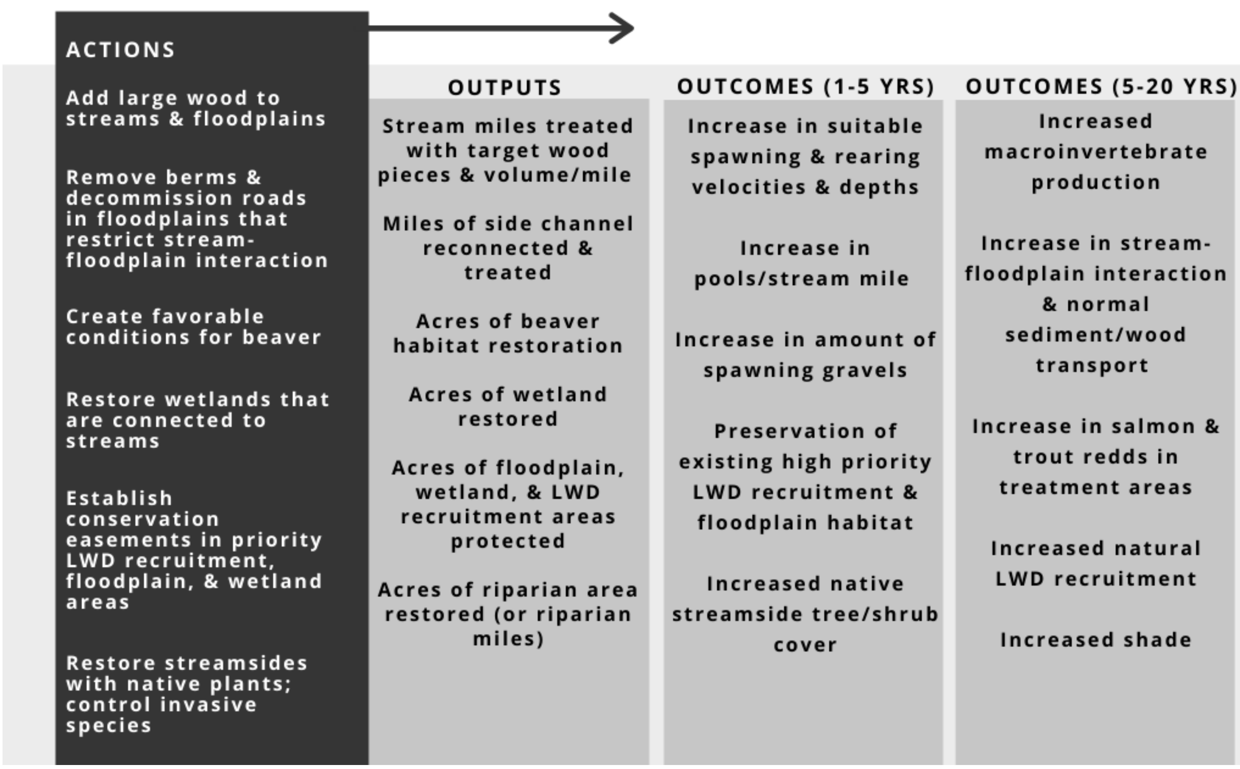
# Chapter 5. Strategies, Actions, and Ecological Outcomes

Drawing from the conservation needs and opportunities described in the previous chapters, the partnership developed a ‘theory of change’ model that illustrates how our selected conservation strategies and actions will lead to desired ecological outcomes. The model was developed by all partners and includes the following components described below:

- **Strategies**: Groups of related actions that reduce limiting factors to salmon and steelhead
- **Actions**: Conservation measures, restoration treatments, management practices, or community engagement that leads to conservation, restoration, and best management practices
- **Outputs**: Immediately measurable results from a project (*e.g.*, miles treated, landowners reached)
- **Intermediate outcomes**: Anticipated changes to physical conditions or human response, within one to five years, that will contribute to a long-term biological response
- **Long-term outcomes**: Anticipated long-term physical or biological response to the strategy

The six strategies shown in the figures below were developed to address the primary limiting factors to salmon and steelhead in the watershed. Each strategy contains the primary set of actions that are intended to achieve specific intermediate and long-term ecological outcomes.

### Strategy 1: Restore and Protect Instream and Floodplain Habitat

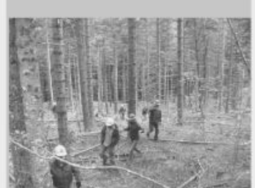


## Strategy 2: Increase and Protect Summer Streamflow

| ACTIONS | OUTPUTS | OUTCOMES (1-5 YRS) | OUTCOMES (5-20 YRS) |
|---|---|---|---|
| Convert irrigation canals to pipeline<br><br>Assess barriers to on-farm irrigation upgrades and identify remaining parcels for irrigation upgrades<br><br>Construct/improve sediment removal infrastructure<br><br>Technical & financial assistance to farmers for on-farm irrigation upgrades & water management<br><br>Set up a water bank to lease water from pasture owners in drought years<br><br>Explore alternative irrigation water sources | Miles of irrigation pipeline installed<br><br>Number of end spills eliminated<br><br>Instream flow protected<br><br>Acres of Onfarm Irrigation Upgrades | Increase in stream flows (3 -10 cfs)<br><br>Improved spawning & rearing depths & velocities below irrigation diversions in summer | Increase in stream flows (10 to 70cfs)<br><br>Improved spawning & rearing depths & velocities below irrigation diversions in summer<br><br>Decrease in summer stream temperatures below some irrigation diversions<br><br>Increase in salmon & trout redds below irrigation diversions |

## Strategy 3: Forest and Road Management that Supports Natural Hydrologic Function

| ACTIONS | OUTPUTS | OUTCOMES (1-5 YRS) | OUTCOMES (5-20 YRS) |
|---|---|---|---|
| Identify key areas for road decommisioning or storm proofing<br><br>Implement best management practices on forest roads (increase cross drains, outslope roads, minimize ditches)<br><br>Promote forest management practices that support normal hydrologic function | Miles of roads decommissioned, storm proofed, & maintained<br><br>Miles of road improvement to disperse water<br><br>Recommendations made to forest managers | Reduction in road/slope failures<br><br>Increase in summer baseflows | Restored hillslope processes (increased colluvial inputs, subsurface flow) |



### Strategy 4: Fish Passage Restoration & Screening

| ACTIONS | OUTPUTS | OUTCOMES (1-5 YRS) | OUTCOMES (5-20 YRS) |
|---|---|---|---|
| Identify & eliminate fish passage barriers<br><br>Install or improve fish screens on diversions | Barriers eliminated & miles of habitat reconnected<br><br>Fish screens installed or improve<br><br>Volume of water screened | Native fish presence above former barriers<br><br>Decreased fish mortality from screens | Increased presence & abundance of native fish above former barriers & decreased mortality |

### Strategy 5: Improve Water Quality

| ACTIONS | OUTPUTS | OUTCOMES (1-5 YRS) | OUTCOMES (5-20 YRS) |
|---|---|---|---|
| Identify high priority reaches for increased streamside vegetation & shade<br><br>Assist streamside landowners with riparian planting, livestock exclusion, & manure management<br><br>Monitor stream pesticide levels & promote best stewardship practices | Livestock exclusion fence installed<br><br>Miles/acres of riparian area planted<br><br>Manure management projects implemented | Increased cover of native riparian trees & shrubs<br><br>Reduction in livestock waste entering streams<br><br>Reduction in streambank degradation<br><br>No increase in stream pesticide levels | Increased shade and riparian buffers on streambanks<br><br>Decrease in summer water temperature on small/medium tributaries<br><br>Decrease in stream pesticide levels |

## Strategy 6: Community Engagement

**ACTIONS**

- Give presentations & develop written materials on critical conservation issues & goals
- Promote efficient irrigation water management; host IWM & technology workshops in English & Spanish
- Tell stories of success: newspaper, website, radio, social media
- Host stream neighborhood gatherings & restoration project tours
- Develop a Homeowner Guide to Water Conservation
- Watershed education for school-aged children

**OUTPUTS**

- Community presentations & written materials/ year
- Tours & targeted mailings/year
- Workshops & trainings/year
- Guidance documents developed
- Media metrics

**OUTCOMES (1-5 YRS)**

- Increased actions by community members to support aquatic habitat and conservation goals
- Increased number of projects with landowners and new partners
- Decrease in amount of water use per acre & per capita for agricultural & residential irrigation

**OUTCOMES (5-20 YRS)**

- Public values and understanding of watershed restoration and conservation reflected in annual engagement numbers, restoration actions, and funding support

# Chapter 6. Restoration and Conservation Projects

Restoration actions shown in the theory of change model were further developed using two parallel processes. One process included the entire partnership and encompassed all the strategies, the results of which are shown in **Table 10**. The other was completed by the TAC using Atlas to identify and prioritize instream and floodplain habitat enhancement projects, which are shown on maps and tables for each subbasin.

**Table 10** shows an expanded list of actions for each strategy, the relative priority of the action, timeframe for implementation, and lead and supporting organizations. For the most part, the additional actions are precursors to implementing the primary actions. For example, partners need to identify the highest priority locations for floodplain easements and large wood recruitment zones before pursuing easement negotiations with land trusts or managers. Similarly, partners need to identify and map remaining parcels for irrigation upgrades and assess landowner implementation barriers to accelerate the rate of on-farm irrigation upgrades.

**Table 10. Actions, Priority, Timeframe, and Lead/Support Organizations**

| | Actions | Priority | Timeframe | Leads (Support) |
|---|---|---|---|---|
| **Restore and Protect Instream and Floodplain Habitat** | | | | |
| **A1.** | Identify high priority areas for floodplain conservation easements or protection | High | 2022-2025 | HRWG, CTWS (USFS, ODFW) |
| **A2.** | Identify current and future large wood recruitment areas that would be a high priority to protect and, in some cases, manage to promote future wood recruitment (i.e., thinning, replanting) | Medium | ongoing | HRWG, CTWS (USFS, County Forest) |
| **A3.** | Identify high priority sites for wetland restoration (including riverine wetlands) | Medium | 2021-2025 | SWCD, HRWG (DSL) |
| **A4.** | Establish conservation easements or other protections in priority riparian, floodplain, and large wood recruitment areas. Potential easement holders include Columbia Land Trust, Western Rivers Conservancy, Ecotrust Forest Management, or Hood River County | High | 2025-2040 | HRWG - identify and coordinate with land trust or manager |
| **A5.** | Provide guidance to county to update Stream Protection Overlay ordinance and floodplain development regulations. Continue to provide guidance on county land use permits to protect floodplains and riparian areas from development | High | 2021-2022 | SWCD, HRWG |
| **A6.** | Support purchase and appropriate management of private commercial timberland by public or conservation entities in priority floodplain and LWD recruitment areas | High | ongoing | HRWG |

| | | | | |
|---|---|---|---|---|
| **A7.** | Instream/floodplain habitat restoration (large wood and boulder additions, reconnect floodplain side channels, decommissioning of roads in floodplain if possible, Stage ‘0’ restoration) | High | 2021-2040 | CTWS, HRWG, USFS (County, Columbia Land Trust) |
| **A8.** | Improve beaver forage and create beaver dam analogs where appropriate | Medium -High | 2022-2030 | HRWG, USFS, CTWS |
| **A9.** | Restore wetlands (removal fill, restore hydrology, enhance vegetation) | Medium | 2022-2040 | HRWG, SWCD |
| **A10.** | Control invasive plants that threaten the establishment of native trees/shrubs | High | 2021-2040 | SWCD, HRWG, USFS |
| **A11.** | Plant and establish native trees and shrubs in riparian areas | High | 2021-2040 | SWCD, HRWG, CTWS (NRCS on ag land) |
| **A12.** | Action Plan Effectiveness Monitoring | High | 2021-2040 | HRWG, CTWS, USFS, ODFW, SWCD |
| **A13.** | Gravel augmentation below Clear Branch Dam | High | ongoing | MFID (USFS) |
| **A14.** | Place carcasses or pellets in stream | Medium | ongoing | CTWS (HRWG, SWCD) |
| **Increase and Protect Summer Streamflow** | | | | |
| **B1.** | Pipe remaining open irrigation canals in EFID and FID | High | 2021-2035 | EFID, FID (NRCS, HRWG, CTWS) |
| **B2.** | Identify parcels with inefficient irrigation equipment and identify significant barriers and solutions to implementing on-farm irrigation upgrades and IWM; prioritize geographic focus of outreach and funding for on-farm water conservation and IWM | High | 2022-2024 | SWCD, irrigation districts (NRCS) |
| **B3.** | Provide technical and financial assistance to farmers for on-farm irrigation upgrades; increase funding availability for on-farm water conservation and IWM | High | 2020-2040 | SWCD, NRCS, irrigation districts |
| **B4.** | Install infrastructure to remove sediment from irrigation water | High | 2022 & beyond | Irrigation districts |
| **B5.** | Implement a water bank pilot project | High | 2024-2026 | SWCD or HRWG |
| **B6.** | Form and operate a water bank to lease water from irrigators in dry years | TBD | 2026 & beyond | SWCD or HRWG |
| **B7.** | Hydropower rebalancing in MFID: reduce summer/increase winter hydropower diversions | High | TBD | MFID |
| **B8.** | Explore managed aquifer recharge | High | TBD | MFID, HRWG |
| **B9.** | Review commercial and industrial water use and conservation potential | Low | TBD | HRWG (City, Port) |

| | | | | |
|---|---|---|---|---|
| **Forest and Road Management that Supports Normal Hydrologic Function** | | | | |
| **C1.** | Identify upland/forest roads and culverts with high potential to negatively affect stream hydrology, water quality, and fish passage | High | 2022-2025 | USFS, County, EFM, HRWG |
| **C2.** | Decommission or storm proof target roads (C1) to reduce hydrologic impacts | High | ongoing | USFS, County Forest |
| **C3.** | Maintain or improve upland/forest roads (Instead of concentrating in ditches, disperse water by outsloping, increasing number of cross drains, etc.) | High | ongoing | USFS, County Forest, private landowners |
| **Fish Passage Restoration and Screening** | | | | |
| **D1.** | Review and update fish barrier map | High | 2022-23 | HRWG (ODFW, USFS) |
| **D2.** | Eliminate fish passage barriers on streams within designated critical habitat for threatened salmon, steelhead, and bull trout with at least 1/4 mile of high-quality upstream habitat | High | 2021-2030 | USFS, HRWG, CTWS, SWCD |
| **D3.** | Eliminate fish passage barriers on 'non-anadromous' streams with at least 1/2 mile of high-quality upstream habitat | Medium | 2021-2040 | USFS, HRWG, SWCD |
| **D4.** | Provide fish passage around Clear Branch Dam | High | 2023-2028 | MFID (NRCS, USFS, ODFW) |
| **D5.** | Install improved fish screens (FCA or other modern criteria screen) at EFID diversion, FID diversions at Gate Cr. and Cabin Cr., MFID diversion at Clear Branch, Tony Creek, and individual PODs | High | ongoing | EFID, FID, ODFW |
| **D6.** | Develop and implement measures to decrease Pacific lamprey larvae from entering irrigation diversions | High | ongoing | ODFW, irrigation districts |
| **Improve Water Quality** | | | | |
| **E1.** | Evaluate water temperature data from past 15 years for trends and attainment of standards | Medium | 2022 | HRWG, DEQ |
| **E2.** | Identify stream segments with poor riparian buffers or other thermal impacts | High | 2020-2040 | SWCD (DEQ) |
| **E3.** | Assist streamside landowners in priority areas to improve riparian buffers or mitigate other pollution sources | High | ongoing | SWCD for ag and non-ag lands; HRWG for non-ag lands (CTWS) |
| **E4.** | Assist landowners with funding and technical assistance to exclude livestock from streams and riparian areas | High | ongoing | SWCD (CTWS, HRWG) |
| **E5.** | Pesticide Stewardship Partnership Program: strategic plan, annual monitoring, pesticide applicator workshops | High | ongoing | SWCD (OSU Extension, CGFG) |

| | | | | |
|---|---|---|---|---|
| **E6.** | Changes to Laurance Lake water diversion (from reservoir surface) and downstream release (from reservoir bottom) | High | 2024-2026 | MFID |
| **Community Engagement** | | | | |
| **F1.** | Give presentations and develop written materials on critical conservation issues and goals in the watershed, including water conservation, conserving energy and reducing personal carbon footprint, riparian restoration, stream habitat restoration, and toxics reduction; provide information in English and Spanish | High | ongoing | HRWG, SWCD |
| **F2.** | Tell stories of success: newspaper, website, radio, other social media | High | ongoing | SWCD, HRWG |
| **F3.** | Host or assist with riparian projects along Indian Creek with community members, schools, and Parks & Recreation | Medium | ongoing | HRWG, HRVHS, HRVPR |
| **F4.** | Host stream neighborhood gatherings and restoration project tours; targeted mailings for presentations | High | ongoing | HRWG |
| **F5.** | Reach out to landowners with known or potential fish passage barriers | High/ Medium | ongoing | HRWG |
| **F6.** | Reach out to landowners with known or potential unscreened diversions or poorly performing screens | Medium | ongoing | ODFW, SWCD, HRWG |
| **F7.** | Reach out to landowners with inefficient irrigation equipment to share information on funding opportunities and technical assistance | High | ongoing | SWCD (NRCS, irrigation districts) |
| **F8.** | Promote efficient irrigation water management on ag lands, including hosting Irrigation Water Management workshops in English and Spanish | High | 2022-2040 | SWCD (NRCS, OSU Extension, irrigation districts) |
| **F9.** | Develop a 'Homeowner Guide to Water Conservation' (provide in English and Spanish) | Medium | 2023-2024 | HRWG (irrigation districts, SWCD) |
| **F10.** | Host residential water conservation workshops (provide in English and Spanish) | Medium | 2024-2040 | HRWG (irrigation districts, SWCD) |
| **F11.** | Provide education on value and functions of wetlands (e.g., workshops to realty and development community); provide in English and Spanish | Medium | 2022-2040 | SWCD (HRWG) |
| **F12.** | Reach out to Port and City about impacts of new, large water users | Medium | 2021-2023 | HRWG |
| **F13.** | Watershed education for school-aged children (Salmon Days and other pre-existing education programs) | Medium | 2022-2040 | CTWS, GEO (HRWG, SWCD) |

| | | | | |
|---|---|---|---|---|
| **F14.** | Promote forest management practices (BMPs) that support normal hydrologic function | Medium | ongoing | Forest Collaborative, USFS, County Forest, HRWG |

Using Atlas, the TAC identified restoration opportunity polygons (*i.e.*, stream segments) within each subbasin, with each polygon containing one or more of 36 potential actions listed in **Appendix F**. Potential actions that would most benefit listed salmonids were identified with the aid of Google Earth, intrinsic potential maps, fish use data, and local knowledge of site conditions and potential. <u>It is important to note that not all the actions identified may be feasible from a social, economic, or logistical standpoint</u>.

The Atlas model generated a score for each restoration opportunity polygon based on the degree to which the type and number of restoration actions addressed limiting habitat factors, decreased the impacts of climate change, and contributed to the restoration of watershed processes (BPA 2015). Polygons with the greatest number of potential actions tend to have the highest scores. Since there are many habitat restoration actions (*e.g.*, channel reconstruction, pool development, levee modification, etc.), the Atlas model is well suited for scoring these polygons. However, for water conservation actions Atlas assumes that water rights are held by individual landowners at numerous points of diversion along a stream instead of irrigation districts with a handful of diversions. In addition, only two of the thirty-six actions are related to water conservation. The model also does not differentiate the relative impact of water conservation based on biological response, as the partnership has done with the IFIM studies discussed in Chapter 4. Consequently, the relative priority of water conservation actions across the watershed are more explicitly addressed by the actions in **Table 10**.

Over one hundred aquatic habitat restoration opportunity polygons were identified for the watershed with scores ranging from one to fifty-two. These scores are based on what the TAC believed was feasible from past projects and professional experience working in the watershed. However, most of these projects have not been examined in the field or discussed with private property owners. The Atlas score may change once landowner interest is confirmed and site evaluations have occurred. Generally, projects receiving scores above twenty-five were prioritized for implementation over the next twenty years. However, there are a few instances of lower-scoring projects making “the cut” if they meet a unique need in the watershed. This is particularly true for water conservation projects, which have low scores in Atlas but have high biological impact for some subbasins. It is also the case for projects benefitting bull trout or that take place in a clearwater tributary. Restoration opportunity maps, tables, and a summary description for each subbasin are below. The tables note the number of landowners and percent public ownership for each polygon; fewer landowners and/or public ownership generally make project logistics easier. The tables also identify polygons that have medium or high intrinsic potential for Chinook and/or steelhead.

## Mainstem Hood River Restoration Opportunities

The Mainstem Hood River Subbasin delineated for the Action Plan includes the Hood River from its mouth to the confluence of the East Fork and Middle Fork Hood River, as well as the watersheds of Indian Creek, Whiskey Creek, and Odell Creek. The high priority projects are all on the mainstem, due to the absence of anadromous species in the tributaries. Indian Creek and Whiskey Creek have cutthroat trout but not anadromous fish, due to barrier falls. Odell Creek has the potential to support steelhead, but they have yet to be documented in the creek. The mouth of Odell Creek is a steep cascade and may limit steelhead passage.

There are several challenges of working on the mainstem river. First, it is mostly confined by steep valley walls, leading to limited floodplain habitat and lower intrinsic potential. One of the largest floodplain areas was cut off by construction of the adjacent railroad in 1906. Second, large wood projects on the main channel could create risks for rafters and kayakers. Third, water velocities and volumes are high, which will make instream habitat projects more expensive. Fourth, access to some segments is not feasible. And finally, projects near the mouth of the Hood River will involve significant planning, funding, public engagement, and collaboration from local, state, and federal regulatory agencies.

Despite these challenges, there are benefits to working on the mainstem. First, the greatest number of native fish species and life stages are present; telemetry studies of adult winter steelhead in the 1990s and 2013/14 showed most detections in the mainstem Hood River and lower East Fork Hood River (ODFW 1996, ODFW unpublished data 2014). Second, the mainstem affords the best opportunity for habitat restoration to benefit fall Chinook recovery within the Columbia Gorge/Hood River ‘population’. Third, restoration at the mouth of the Hood River would benefit juvenile salmon and steelhead from the Hood River, as well as adults migrating up the Columbia since the Hood River is one of fourteen cold water refuges on the lower Columbia River (EPA 2020).

Key restoration opportunities on the mainstem include:

- Mouth of the Hood River (Atlas #1)- This project would take out part of the ‘Spit’ road so that the Hood River could recapture part of its former delta within Nichols Basin. Public access would be maintained with a bridge or culvert.
- Old Powerhouse (Atlas #2)- This project would remove the abandoned powerhouse and create an alcove to create off-channel habitat.
- River Mile 1 (Atlas #4)- This project would relocate the railroad grade to the toe of the valley bottom or create openings for water to enter a side channel. This would restore natural riverine processes and reconnect 13 acres of former floodplain and juvenile rearing habitat.

The overall approach to restoration on the mainstem will be to carefully evaluate potential projects using hydraulic modelling, and to pursue the high-value projects that are deemed feasible. **Table 11** lists the map number, location, Atlas score, and other key attributes for each priority polygon shown on the map in **Figure 16**.

**Table 11. Mainstem Hood River Subbasin: High Priority Habitat Restoration Opportunities**

| Map No. | River Mile | Atlas Score | Potential Actions from Atlas | Other considerations |
|---|---|---|---|---|
| **1** | 0.0 to 0.4 | 27 | Side channel reconnection, levee modification, floodplain/riparian restoration, improve thermal refuge | 93% public<br>5 landowners |
| **2** | 0.4 to 1.5 | 44 | Side channel reconnection, alcove development, levee modification, floodplain/riparian restoration, beaver restoration management, improve thermal refuge | 96% public<br>8 landowners |
| **4** | 1.5 to 1.8 | 44 | Stream/side channel reconstruction and reconnection, LWD placement, levee modification, floodplain/riparian restoration, beaver restoration management, improve thermal refuge | Land Trust property |
| **6** | 2.5 to 3.0 | 44 | Channel reconstruction, levee modification, floodplain/riparian restoration, meander reconnection, beaver restoration management, LWD placement, bank restoration, improve thermal refuge | Land Trust property |
| **7** | 3.6 to 4.1 | 44 | Channel reconstruction, levee modification, floodplain/riparian restoration, meander reconnection, beaver restoration management, LWD placement, bank restoration, improve thermal refuge | 79% public<br>4 landowners |
| **8** | 4.4 to 5.1 | 44 | Channel reconstruction, levee modification, floodplain/riparian restoration, meander reconnection, beaver restoration management, LWD placement, bank restoration, improve thermal refuge | 0% public<br>6 landowners |
| **10** | 5.9 to 7.2 | 47 | Floodplain/riparian restoration, side channel reconnection, beaver restoration management, bank restoration | 29% public<br>11 landowners |
| **11** | 8.9 to 10.6 | 47 | Floodplain/riparian restoration, side channel reconnection, beaver restoration management, bank restoration | 49% public<br>5 landowners |
| **12** | FID Diversion | N/A | Fish screen/bypass installation or improvement, acquire instream flow, irrigation upgrades | 100% |

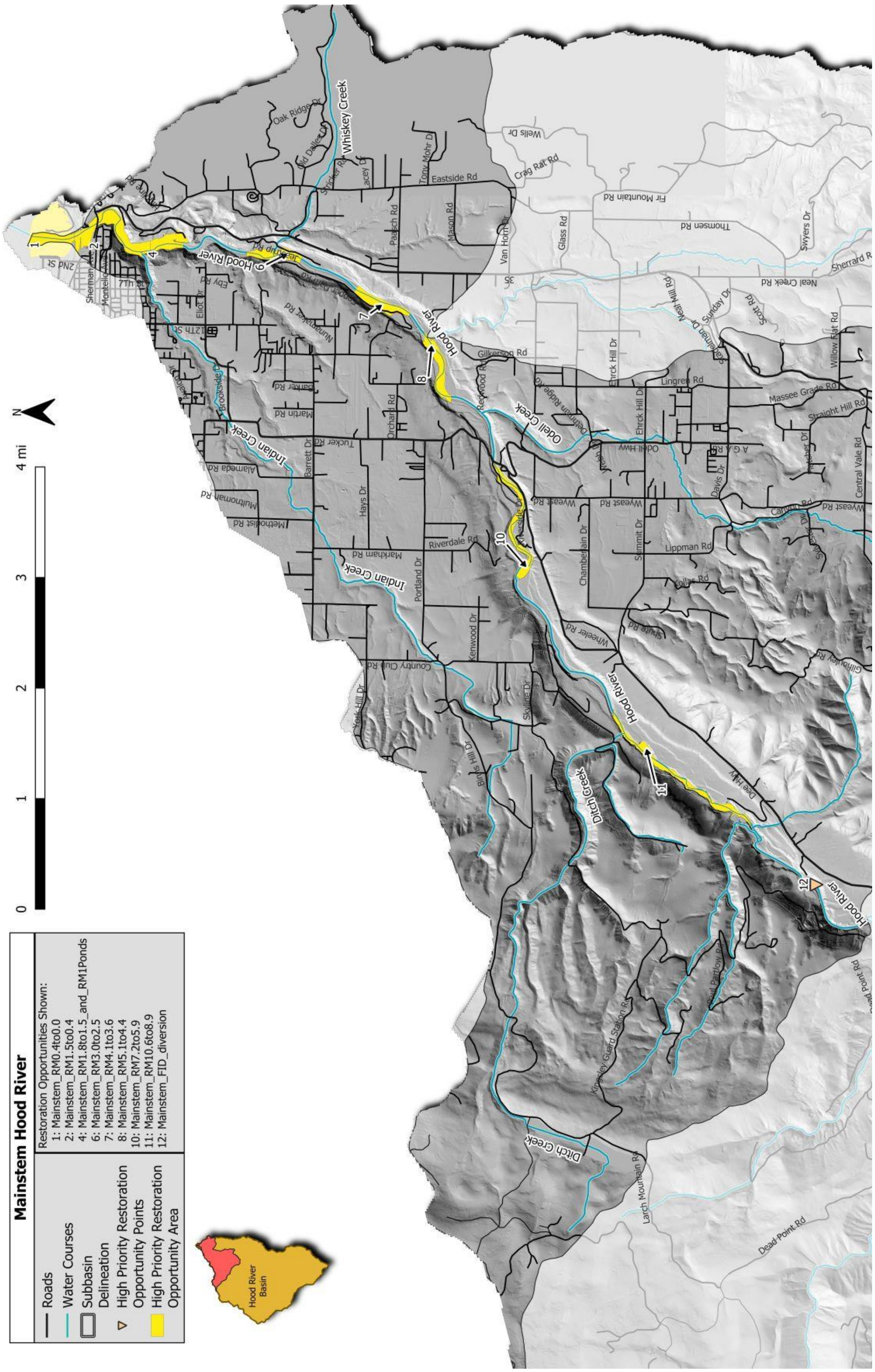



**Figure 16**. Restoration Opportunities on the mainstem Hood River.

## Lower East Fork Hood River Restoration Opportunities

The Lower East Fork Hood River Subbasin delineated for the Action Plan includes the East Fork Hood River and all tributaries from Dog River to its confluence with the Middle Fork Hood River. Important clearwater tributaries include Dog River, Baldwin Creek, and Evans Creek. Challenges to working on the East Fork Hood River include high water velocities and volumes, high glacial sediment deposition, many private landowners, and development within the 100-year floodplain. The benefits to working in this subbasin are long stretches of high intrinsic potential for steelhead habitat and moderate intrinsic potential for spring Chinook. In addition, the reach below the EFID diversion has by far the highest biological benefit from water conservation. This subbasin was ranked first for restoration in the Hood River Aquatic Habitat Restoration Strategy (Shively 2006) but only one large wood project has been implemented to date.

Key instream habitat restoration opportunities in this subbasin are large wood placement projects that reconnect side channels, decrease velocities, increase pool density and maximum depth, and increase spawning gravel area. Key water conservation opportunities include the EFID's Main Canal and Dukes Valley pipeline projects and on-farm water conservation in EFID and parcels in MFID that are irrigated from the Evans Creek diversions. **Table 12** lists the map number, location, Atlas score, and other key attributes for each priority polygon shown on the map in **Figure 17**.

**Table 12. Lower East Fork Hood River Subbasin: High Priority Habitat Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **66** | Mainstem 13.3 to 12.8 | 22 | Conservation easement/acquisition, side channel reconnection, floodplain restoration, LWD placement, acquire instream flow | 2% public<br>5 landowners<br>Med sthd IP |
| **68** | Mainstem 14.6 to 13.9 | 22 | Conservation easement/acquisition, meander/side channel reconnection, floodplain restoration, dam removal, LWD placement, acquire instream flow | 1% public<br>5 landowners<br>Med sthd IP |
| **69** | Lower EF 0.6 to 0.1 | 42 | Conservation easement/acquisition, channel reconstruction, meander/side channel reconnection, floodplain/riparian restoration, instream structure placement, bank restoration, road decomm./grading | 93% public<br>4 landowners<br>Med sthd IP |
| **71** | Lower EF 1.4 to 1.0 | 42 | Conservation easement/acquisition, channel reconstruction, meander/side channel reconnection, floodplain/riparian restoration, instream structure placement, bank restoration, road decomm./grading | 100% public<br>3 landowners<br>High sthd IP |
| **72** | Lower EF 1.8 to 1.4 | 42 | Conservation easement/acquisition, channel reconstruction, meander/side channel reconnection, floodplain/riparian restoration, instream structure placement, bank restoration, road decomm./grading | 6% public<br>2 landowners<br>Med sthd IP |
| **73** | Lower EF 2.25 to 2.1 | 42 | Conservation easement/acquisition, channel reconstruction, meander/side channel reconnection, floodplain/riparian restoration, instream structure placement, bank restoration, road decomm./grading | 0% public<br>4 landowners |
| **74** | Baldwin 1.1 to 0.5 | 33 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, riparian fencing/off-stream cattle water source, fish barrier removal, LWD placement | 0% public<br>5 landowners |
| **77** | Lower EF 2.8 to 2.25 | 33 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 0% public<br>3 landowners |

| | | | | |
|---|---|---|---|---|
| **82** | Lower EF 3.8 to 2.8 | 32 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 0% public<br>8 landowners<br>Med sthd IP |
| **83** | Lower EF 4.4 to 3.8 | 34 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 0% public<br>7 landowners<br>Med sthd IP |
| **84** | Lower EF 5.1 to 4.4 | 46 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 0% public<br>9 landowners<br>High sthd IP |
| **85** | Lower EF 5.6 to 5.1 | 35 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 10% public<br>9 landowners<br>Med sthd IP |
| **88** | Lower EF 6.3 to 5.6 | 44 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, instream structure placement, bank restoration, road decommission/grading | 86% public<br>6 landowners<br>Med chnk IP<br>Med sthd IP |
| **89** | Lower EF 6.9 to 6.3 | 34 | Conservation easement/acquisition, channel reconstruction, meander/side channel reconnection, floodplain/riparian restoration, instream structure placement, bank restoration | 39% public<br>12 landowners<br>High sthd IP |
| **90** | EFID Diversion | 6 | Fish screen/bypass improvement, acquire instream flow, irrigation upgrades, reduce/mitigate point source impacts<br>Key projects: Main Canal & Dukes Valley pipeline projects; Fish-screen upgrade; sediment settling basin; on-farm irrigation upgrades | 100% public<br>1 landowner |
| **91** | Lower EF 7.9 to 7.0 | 32 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 38% public<br>15 landowners<br>Med sthd IP |
| **92** | Lower EF 8.5 to 7.9 | 32 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration | 35% public<br>9 landowners<br>Med sthd IP |
| **93** | Lower EF 9.6 to 8.5 | 31 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 100% public<br>2 landowners<br>Med sthd IP |
| **94** | Lower EF 10.5 - 9.6 | 31 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 86% public<br>4 landowners<br>Med sthd IP |
| **95** | Dog River Hwy 35 to mouth | 7 | Barrier/culvert removal or replacement, instream structure placement | 100% public<br>1 landowner |
| **97** | Dog River Dalles Diversion | 3 | Acquire instream flow, irrigation upgrades | 100% public<br>1 landowner |

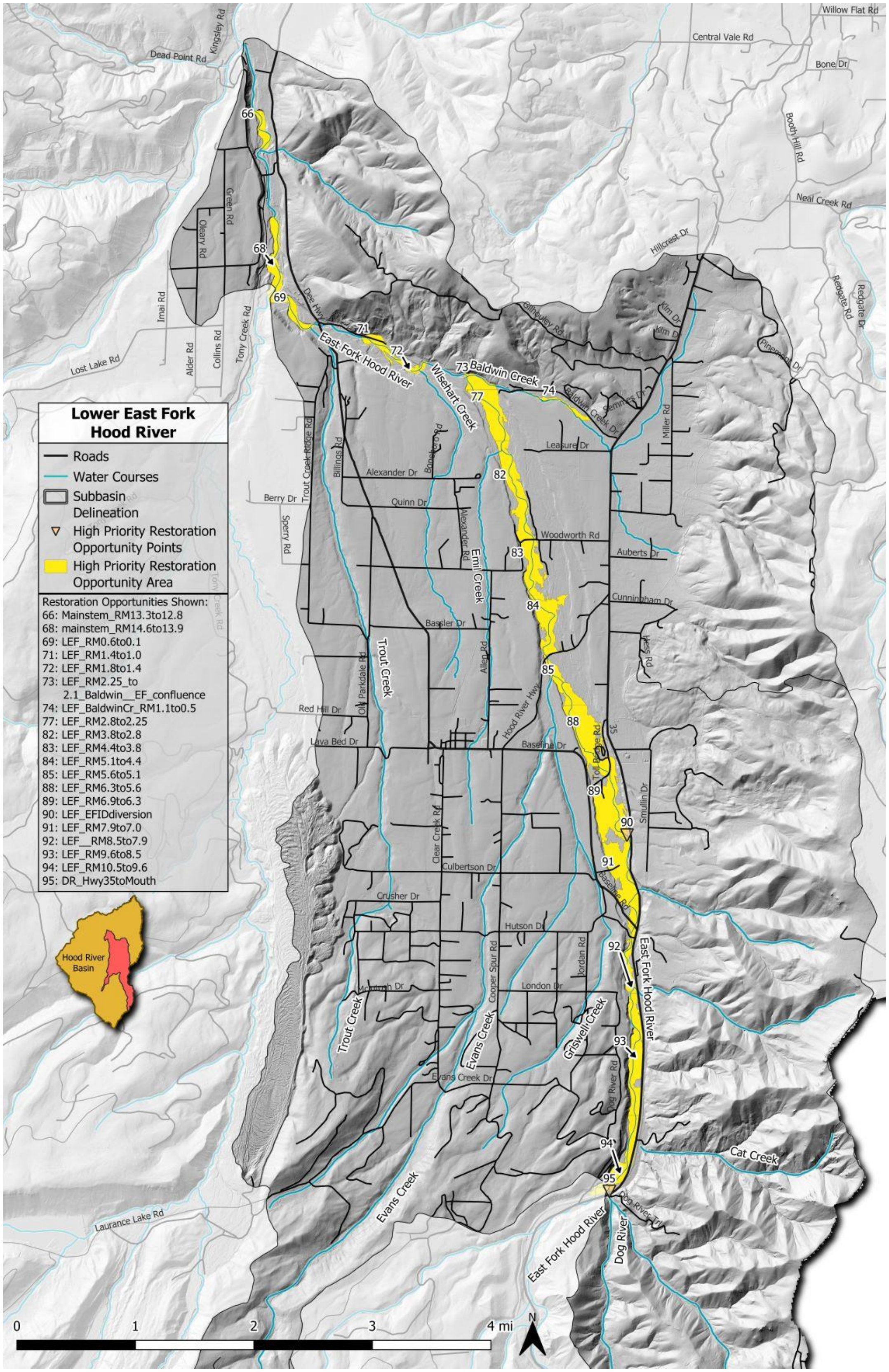



**Figure 17**. Restoration opportunities on the lower East Fork Hood River.

## Upper East Fork Hood River Restoration Opportunities

The Upper East Fork Hood River Subbasin delineated for the Action Plan includes the East Fork Hood River and all tributaries upstream of Dog River, including Tilly Jane Creek, Polallie Creek, Cold Spring Creek, Robinhood Creek, Newton Creek, Clark Creek, and Meadows Creek. Challenges to working on the Upper East Fork Hood River include high water velocities and glacial sediment deposition downstream of Clark Creek. In the past, the wide valley floor of the Upper East Fork dissipated debris torrents, but the construction of Highway 35 disrupted this process (USFS 1996b). Fish surveys on the upper East Fork Hood River have generally not found anadromous fish, although rainbow and cutthroat trout are present (Ryan Gerstenberger, pers. comm.). The benefits to working in this subbasin are high intrinsic potential for steelhead habitat, clear water tributaries, and potential to capture large wood and sediment from future wildfires.

Key restoration opportunities in this subbasin are large wood placement projects that reconnect side channels, increase pool number, and increase spawning gravel area. Above the Clark Creek confluence, there may be opportunities to install beaver dam analogs to encourage dam building and channel aggradation. **Table 13** lists the map number, location, Atlas score, and other key attributes for each priority polygon shown on the map in **Figure 18**.

**Table 13. Upper East Fork Hood River Subbasin: High Priority Habitat Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **98** | Upper EF 11.7 to 10.5 | 24 | Pool/riffle construction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 100% public<br>1 landowner<br>Med sthd IP |
| **100** | Upper EF 18.9 to 17.2 | 28 | Pool/riffle construction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 100% public<br>1 landowner<br>Med chnk IP<br>High sthd IP |
| **101** | Upper EF 19.9 to 18.9 | 28 | Pool/riffle construction, floodplain/riparian restoration, side channel reconnection, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 100% public<br>1 landowner<br>Med chnk IP<br>High sthd IP |
| **103** | Upper EF 26.5 to 23.3 | 7 | Beaver restoration management, LWD placement, road decommission/grading | 100% public<br>1 landowner |
| **106** | Upper EF 28.5 | 3 | Acquire instream flow, improve thermal refuge, reduce/mitigate point source impacts | 100% public<br>1 landowner |

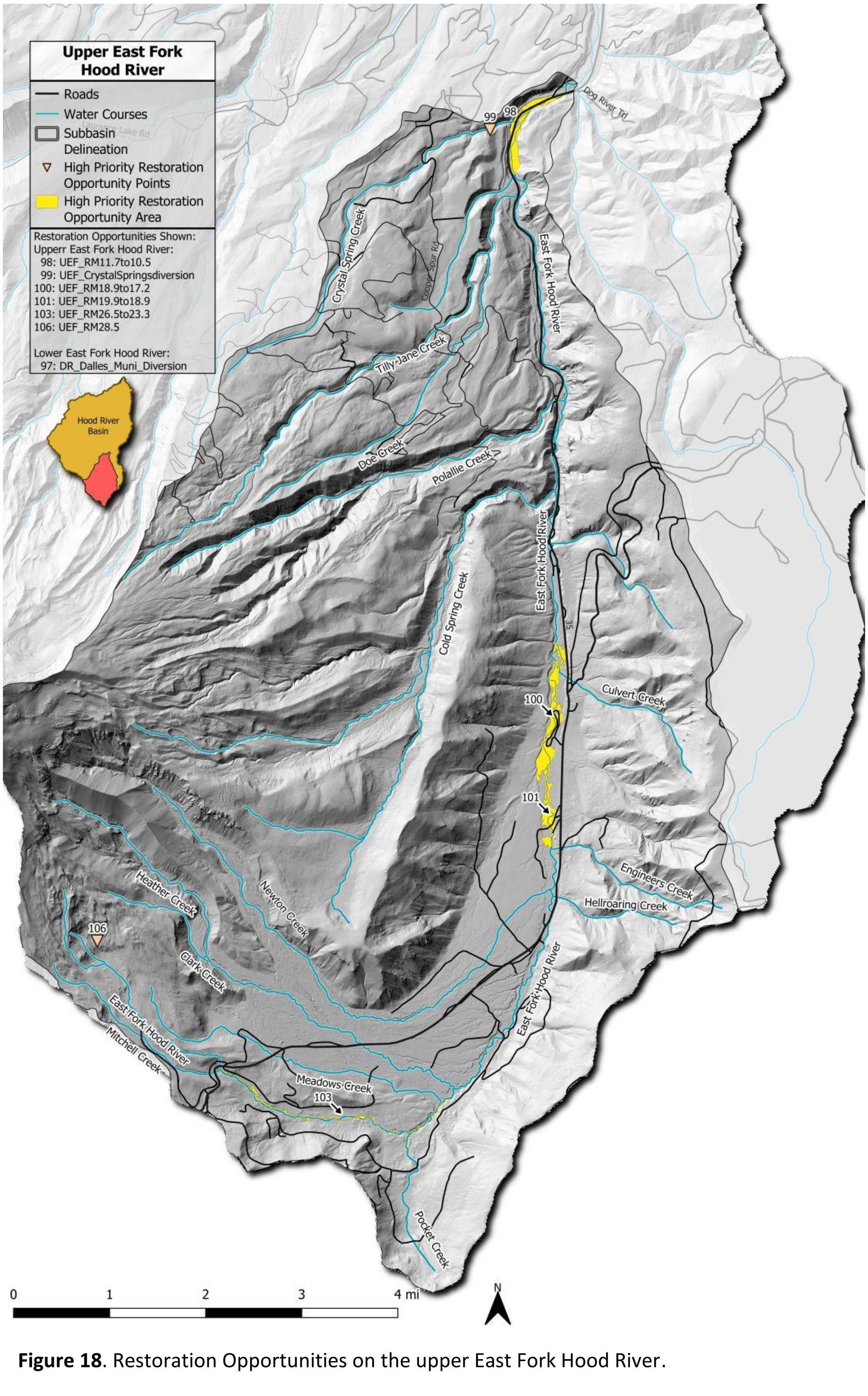



**Figure 18**. Restoration Opportunities on the upper East Fork Hood River.

## Neal Creek Restoration Opportunities

Neal Creek is a clearwater tributary that enters the mainstem Hood River at river mile 4. Challenges to working on Neal Creek include numerous private land holdings and development within the 100-year floodplain. The benefits to working in this subbasin are high intrinsic potential for winter steelhead and coho habitat and its proximity to the mouth of the Hood River. HRWG has received positive responses from a high percentage of landowners within high-priority polygons. Key restoration opportunities in this subbasin are large wood placement projects that reconnect side channels, create off-channel pools, increase pool number and depth, and increase spawning gravel area. In addition, completion of EFID's main canal pipeline project will completely eliminate overflow of East Fork Hood River water into Neal Creek during the summer. **Table 14** lists the map number, location, Atlas score, and other key attributes for each priority polygon shown on the map in **Figure 19**.

**Table 14. Neal Creek Subbasin: High Priority Habitat Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **14** | 1.7 to 1.5 | 48 | Conservation easement/acquisition, pool/riffle construction, levee modification, floodplain/riparian restoration, side channel reconnection, beaver restoration management, riparian fencing/off-stream cattle water source, instream structure placement, bank restoration, improve thermal refuge | 0% public<br>1 landowner<br>Med chnk IP<br>Med sthd IP |
| **17** | 2.3 to 2.0 | 41 | Pool/riffle construction, floodplain/riparian restoration, beaver restoration management, riparian fencing/off-stream cattle water source, instream structure placement, bank restoration, improve thermal refuge | 0% public<br>2 landowners<br>Med sthd IP |
| **19** | 3.5 to 3.2 | 41 | Pool/riffle construction, floodplain/riparian restoration, beaver restoration management, riparian fencing/off-stream cattle water source, instream structure placement, bank restoration, improve thermal refuge | 0% public<br>6 landowners<br>Med chnk IP<br>High sthd IP |
| **20** | 4.3 to 3.5 | 34 | Pool/riffle construction, meander/side channel reconnection, floodplain/riparian restoration, barrier/culvert replacement or removal, instream structure placement, bank restoration | 0% public<br>13 landowners<br>High sthd IP |
| **22** | 5.7 to 5.6 | 31 | Channel reconstruction, floodplain/riparian restoration, side channel reconnection, instream structure placement | 100% public<br>1 landowner |

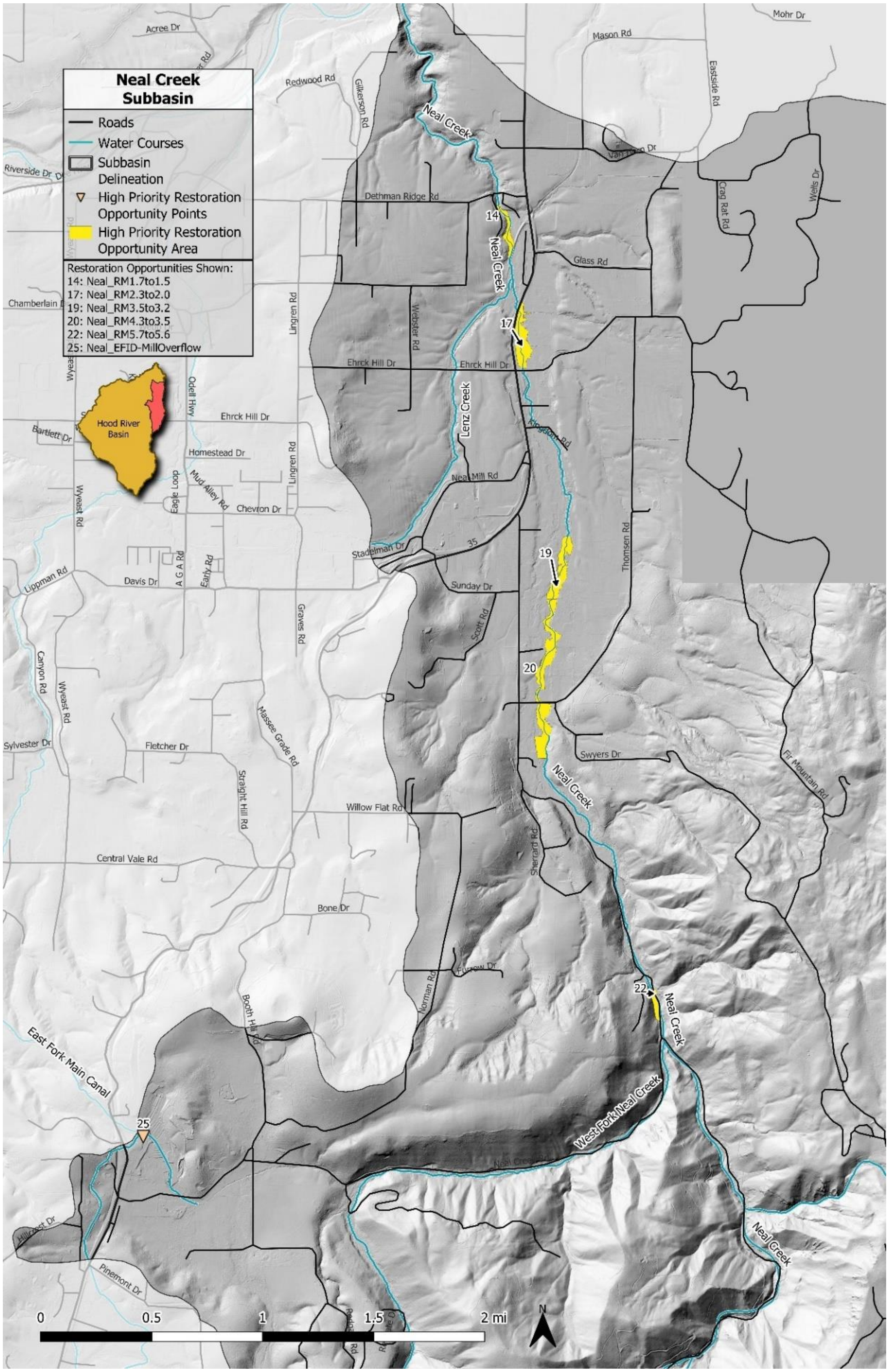



**Figure 19**. Restoration Opportunities on Neal Creek.

## Lower West Fork Hood River Restoration Opportunities

The Lower West Fork Hood River Subbasin delineated for the Action Plan includes Green Point Creek, Dead Point Creek, and the West Fork Hood River from Lake Branch down to its confluence with the mainstem Hood River. Challenges to working on the West Fork Hood River include high water velocities and volumes and low intrinsic potential since most of this reach is confined by valley walls. The only high priority polygon is #35 (**Figure 20**), from river mile 4.3 to 3.1 with an Atlas score of 29. Potential actions for this polygon include conservation easement acquisition, instream habitat restoration (*e.g.*, pool development, side channel reconnection, large wood and boulder placement), and riparian restoration across four private properties. The benefits to improving instream habitat here are relatively high summer streamflow and cold water.

## Upper West Fork Hood River Restoration Opportunities

The Upper West Fork Hood River Subbasin delineated for the Action Plan includes the West Fork Hood River and tributaries upstream of Lake Branch, including Marco Creek, Redhill Creek, Ladd Creek, Jones Creek, Elk Creek, and McGee Creek. This is a 'Tier 3' Atlas subbasin primarily because it has fewer anadromous species. However, it is generally thought to be the most important spawning habitat for spring Chinook and summer steelhead in the watershed and several large-scale instream large wood and floodplain reconnection projects have been implemented to date. The benefits of continuing to improve instream habitat in this subbasin include clearwater habitat above Ladd Creek and areas of high intrinsic potential for steelhead and Chinook. In addition, most of the land is on Mt. Hood National Forest, with the remainder owned by Ecotrust Forest Management who has supported past habitat enhancement projects on their land. **Table 15** and **Figure 21** show the remaining high priority projects in the subbasin.

**Table 15. Upper West Fork Hood River Subbasin: High Priority Habitat Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **38** | Upper WF 9.4 to 8.7 | 42 | Conservation easement/acquisition, pool/riffle construction, floodplain/riparian restoration, side channel reconnection, off-channel habitat, instream structure placement, bank restoration, improve thermal refuge, road decommission/grading | 0% public<br>2 landowners |
| **39** | Upper WF 12.8 to 12.3 | 52 | Conservation easement/acquisition, pool/riffle construction, levee modification, floodplain/riparian restoration, side channel reconnection, off-channel habitat, barrier/culvert replacement or removal, instream structure placement, bank restoration, improve thermal refuge, road decommission/grading | 0% public<br>1 landowner<br>Med sthd IP |
| **42** | Upper WF Big Eddy 14.7 to 14.3 | 51 | Conservation easement/acquisition, channel reconstruction, levee modification, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, barrier/culvert replacement or removal, instream structure placement, improve thermal refuge, road decommission/grading | 1% public<br>2 landowners<br>High sthd IP |
| **43** | Elk Creek 1.3 to Mouth | 40 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, understory thinning, barrier/culvert replacement or removal, instream structure placement, improve thermal refuge, reduce/mitigate point source impacts, road decommission/grading | 0% public<br>1 landowner |

| | | | | |
|---|---|---|---|---|
| **44** | Elk Creek 3.6 to 2.4 | 40 | Conservation easement/acquisition, channel reconstruction, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, understory thinning, barrier/culvert replacement or removal, instream structure placement, improve thermal refuge, reduce/mitigate point source impacts, road decommission/grading | 100% public<br>1 landowner |
| **45** | McGee Cr 1.4 to Mouth | 26 | Conservation easement/acquisition, channel reconstruction, levee modification, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, understory thinning, barrier/culvert replacement or removal, instream structure placement, bank restoration, improve thermal refuge, road decommission/grading | 24% public<br>2 landowners<br>Med sthd IP |
| **46** | McGee Cr 2.2 to 1.4 | 26 | Conservation easement/acquisition, channel reconstruction, levee modification, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, understory thinning, barrier/culvert replacement or removal, instream structure placement, bank restoration, improve thermal refuge, road decommission/grading | 100% public<br>1 landowner |
| **47** | McGee Cr 3.8 to 2.2 | 26 | Conservation easement/acquisition, channel reconstruction, levee modification, floodplain/riparian restoration, meander/side channel reconnection, off-channel habitat, beaver restoration management, understory thinning, barrier/culvert replacement or removal, instream structure placement, bank restoration, improve thermal refuge, road decommission/grading | 100% public<br>1 landowner<br>Med sthd IP |

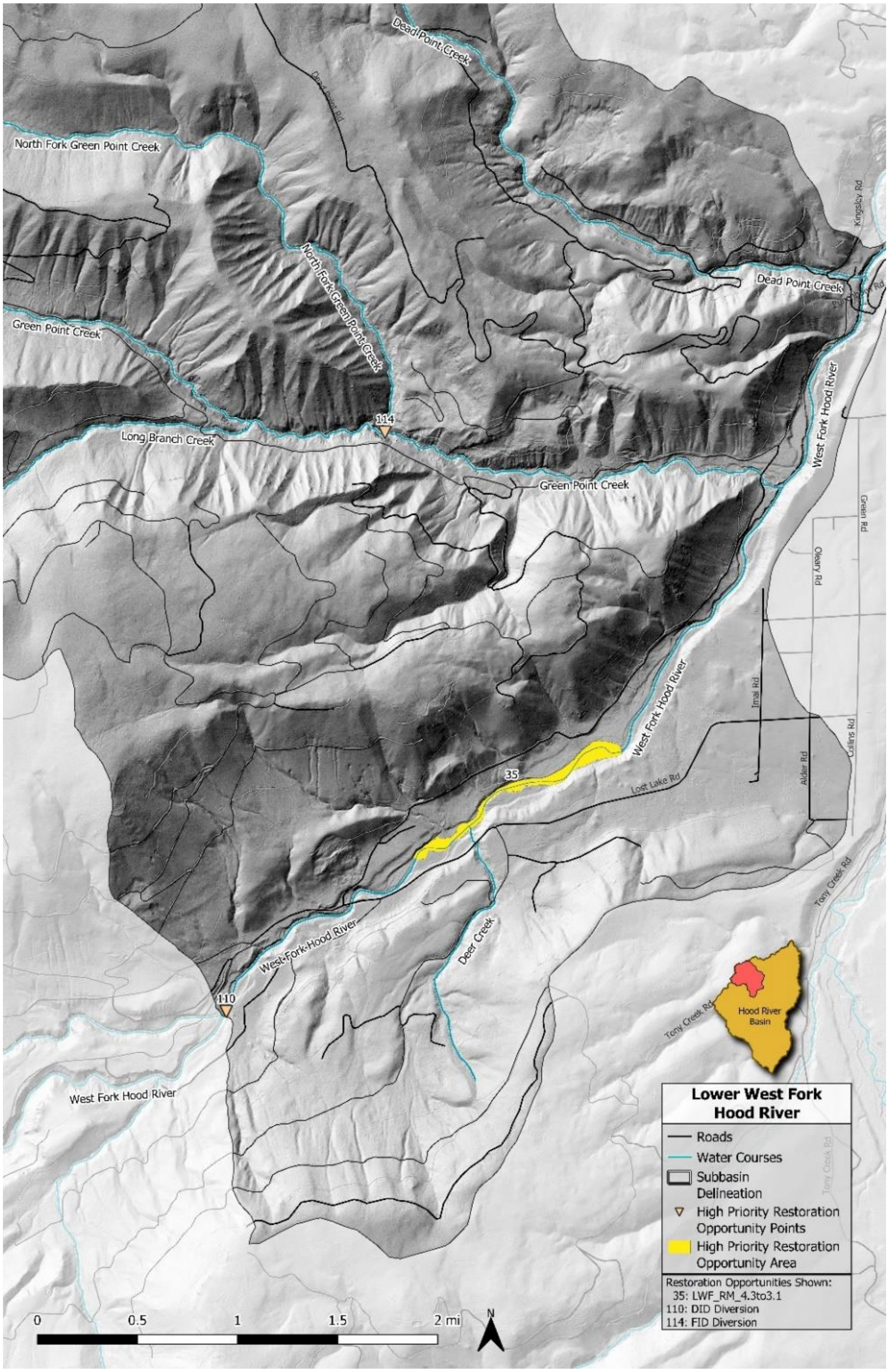



**Figure 20**. Restoration Opportunity on the Lower West Fork Hood River.

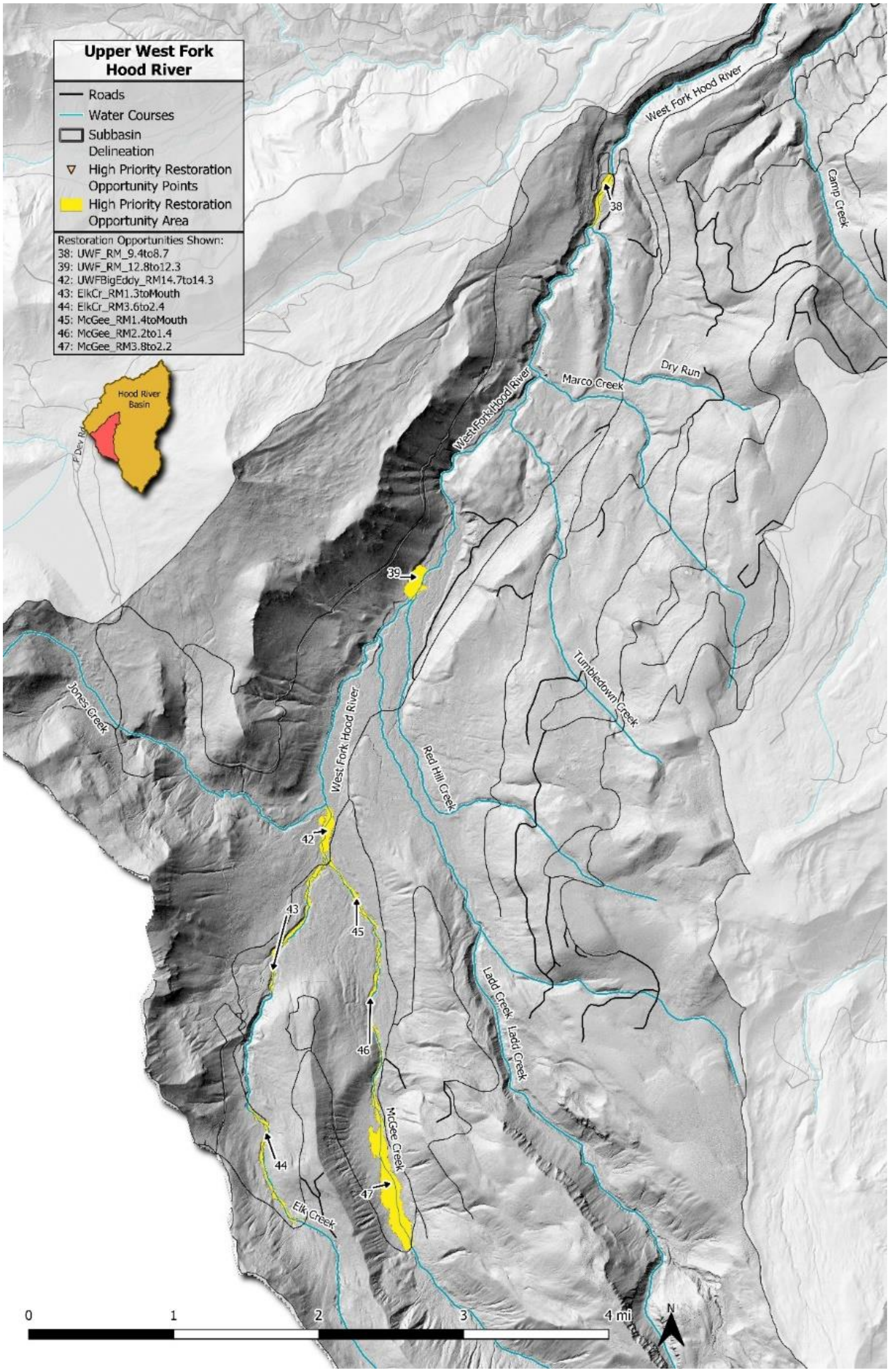



**Figure 21**. Restoration Opportunities on the Upper West Fork Hood River.

## Lower Middle Fork Hood River Restoration Opportunities

The Lower Middle Fork Hood River Subbasin delineated for the Action Plan includes the Middle Fork Hood River from Eliot Branch to its confluence with the East Fork Hood River. Important clearwater tributaries include Bear Creek, Tony Creek, and Rogers Spring. The downsides of working on the lower Middle Fork are the prevalence of debris flows associated with the retreat of Eliot Glacier and the relatively high levels of stream turbidity caused by glacial melt in the summer. However, the Middle Fork Hood River Subbasin is home to the watershed's bull trout population and has high intrinsic potential for steelhead habitat. The TAC believed the best potential project centered around the lower half-mile of Rogers Spring, which enters the Middle Fork at river mile 4.3. At this site, it may be possible to reconstruct the lower half-mile of Rogers Creek to increase the amount of clearwater habitat it provides, and pipe return-flow from MFID's hydropower plant '3' directly to the Middle Fork instead of mixing with Rogers Spring water. Some partners were also interested in continuing to discuss improving fish passage conditions at river mile 1.5, where a natural barrier has limited fish passage for some species and life stages in the past. A key water conservation opportunity in this subbasin is on-farm irrigation upgrades on parcels that are irrigated from Rogers Spring. **Table 16** lists the map number, location, Atlas score, and other key attributes for each polygon shown on the map in **Figure 22**.

**Table 16. Lower Middle Fork Hood River: High Priority Habitat Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **53** | Lower MF 4.4 to 0.0 | 14 | Conservation easement/acquisition, riparian restoration, road grading | 2% public<br>15 landowners<br>Med sthd IP |
| **55** | Ice Fountain Diversion | 2 | Irrigation upgrades | 0% public<br>1 landowner |
| **56** | Tony Cr 2.5 to 0.0 | 20 | Conservation easement/acquisition, pool/riffle construction, floodplain/riparian restoration, side channel reconnection, off-channel habitat, beaver restoration management, instream structure placement, bank restoration, road decommission/grading | 0% public<br>1 landowner |
| **57** | Tony Cr Diversion | 0 | Channel reconstruction, dam/barrier replacement or removal, fish screen/bypass installation or improvement, acquire instream flow | 0% public<br>1 landowner |
| **58** | Roger Springs 0.5 to 0.0 | 34 | Channel reconstruction, floodplain/riparian restoration, side channel reconnection, alcove construction, beaver restoration management, barrier/culvert replacement or removal, fish screen/bypass installation or improvement, instream structure placement, irrigation upgrades | 50% public<br>3 landowners |
| **60** | Bear Creek Culvert | 6 | Barrier/culvert replacement or removal, road decommission/grading | 100% public<br>1 landowner |

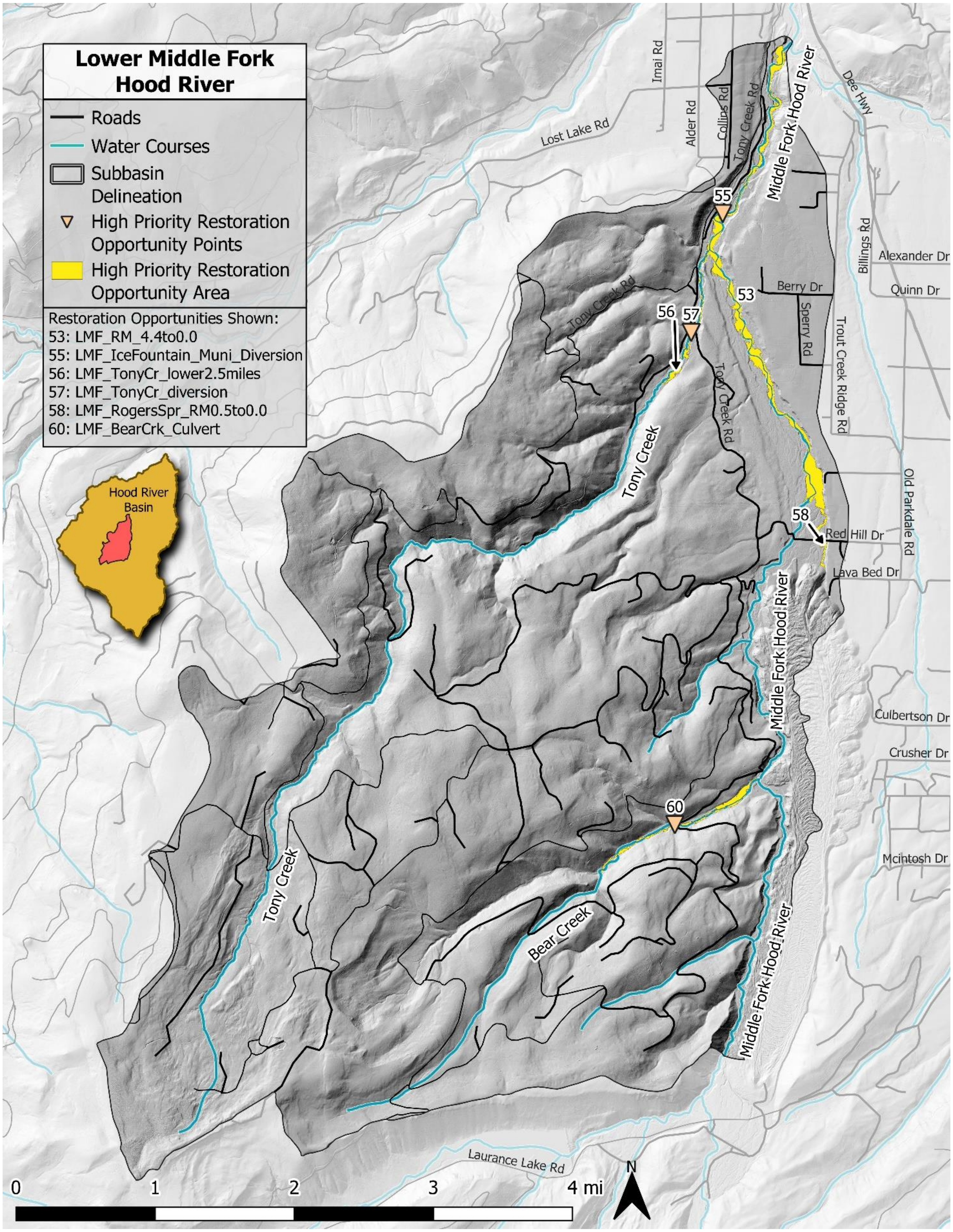



**Figure 22**. Restoration Opportunities on the Lower Middle Fork Hood River.

## Upper Middle Fork Hood River Restoration Opportunities

The Upper Middle Fork Hood River Subbasin delineated for the Action Plan includes Pinnacle Creek, Clear Branch, Coe Branch, and Eliot Branch. Clear Branch and Pinnacle Creek are important clearwater tributaries and provide the core spawning and rearing habitat for the watershed's bull trout population. Both streams are captured by Laurance Lake Reservoir, which was built by the Soil Conservation Service in 1968 to provide irrigation water for MFID. Clear Branch continues below the dam for ¾-mile before it is joined by glacier-fed Coe Branch.

A significant challenge to improving conditions for bull trout and steelhead in the Upper Middle Fork Subbasin is the reservoir, which lacks upstream fish passage year-round and downstream fish passage during the summer when the reservoir is not spilling. The reservoir appears to increase downstream water temperature during the summer and reduces the amount of streamflow that would naturally occur due to MFID irrigation and hydropower water rights on Clear Branch. Finally, ODFW stocks the reservoir with rainbow trout. While this might provide a food source for larger bull trout, it also attracts anglers throughout the summer. Despite regulations that require barbless hooks and prohibit bait, bycatch of bull trout does occur, as documented through creel surveys and personal observation.

Key restoration opportunities in this subbasin center on decreasing impacts to water quality and habitat caused by the reservoir and providing fish passage up and downstream. Since 2005, MFID has been working with a committee that includes USFS, ODFW, DEQ, CTWS, U.S. Fish and Wildlife Service, and National Marine Fisheries Service. Several major capital improvement projects to improve downstream water temperature, fish passage, and streamflow are currently under design development and regulatory review with partial funding from NRCS. These include:

- Intakes to divert warm water at the reservoir's surface for irrigation and a siphon to send cold-water from the reservoir's bottom into lower Clear Branch to improve downstream water temperature
- A new spillway with improved downstream passage and a descending weir that allows downstream passage over a greater range of reservoir levels when the reservoir spills (typically October through June)
- A new stilling basin at the base of the dam, which includes a fish trap and haul system to provide upstream fish passage
- Potentially eliminating stocking and fishing

Extensive large wood placement has occurred on upper Clear Branch over the past twenty years and Pinnacle Creek has sufficient amounts of instream wood. Hence, the best opportunity to improve instream habitat structure in this subbasin is on Clear Branch below the dam (polygon 64), including gravel augmentation, removal/modification of an old USFS gaging station weir, and large wood placement. Streamflow augmentation will be supported by on-farm irrigation upgrades on parcels that are irrigated from Clear, Coe, and Eliot Branches and hydropower rebalancing. **Table 17** lists the map number, location, Atlas score, and other key attributes for each polygon shown on the map in **Figure 23**.

**Table 17. Upper Middle Fork Hood River: High Priority Restoration Opportunities**

| Map No. | River mile | Atlas score | Potential Actions from Atlas | Other Considerations |
|---|---|---|---|---|
| **62** | Upper MF 10.0 to 9.3 | 3 | Reduce/mitigate point source impacts | 100% public<br>1 landowner<br>Med sthd IP |
| **64** | Upper MF 11.0 to 10.0 | 16 | Spawning gravel placement, LWD placement, improve thermal refuge, improve instream flow, irrigation upgrades, reduce/mitigate point source impacts | 100% public<br>1 landowner<br>Med sthd IP |
| **107** | 11 | n/a | Cold water siphon, spillway improvements, irrigation upgrades, fish trap/haul system | 100% public<br>1 landowner |
| **108, 109** | Coe, Eliot diversions | 2 | Improve instream flow, irrigation upgrades | Many landowners<br>Med sthd IP |

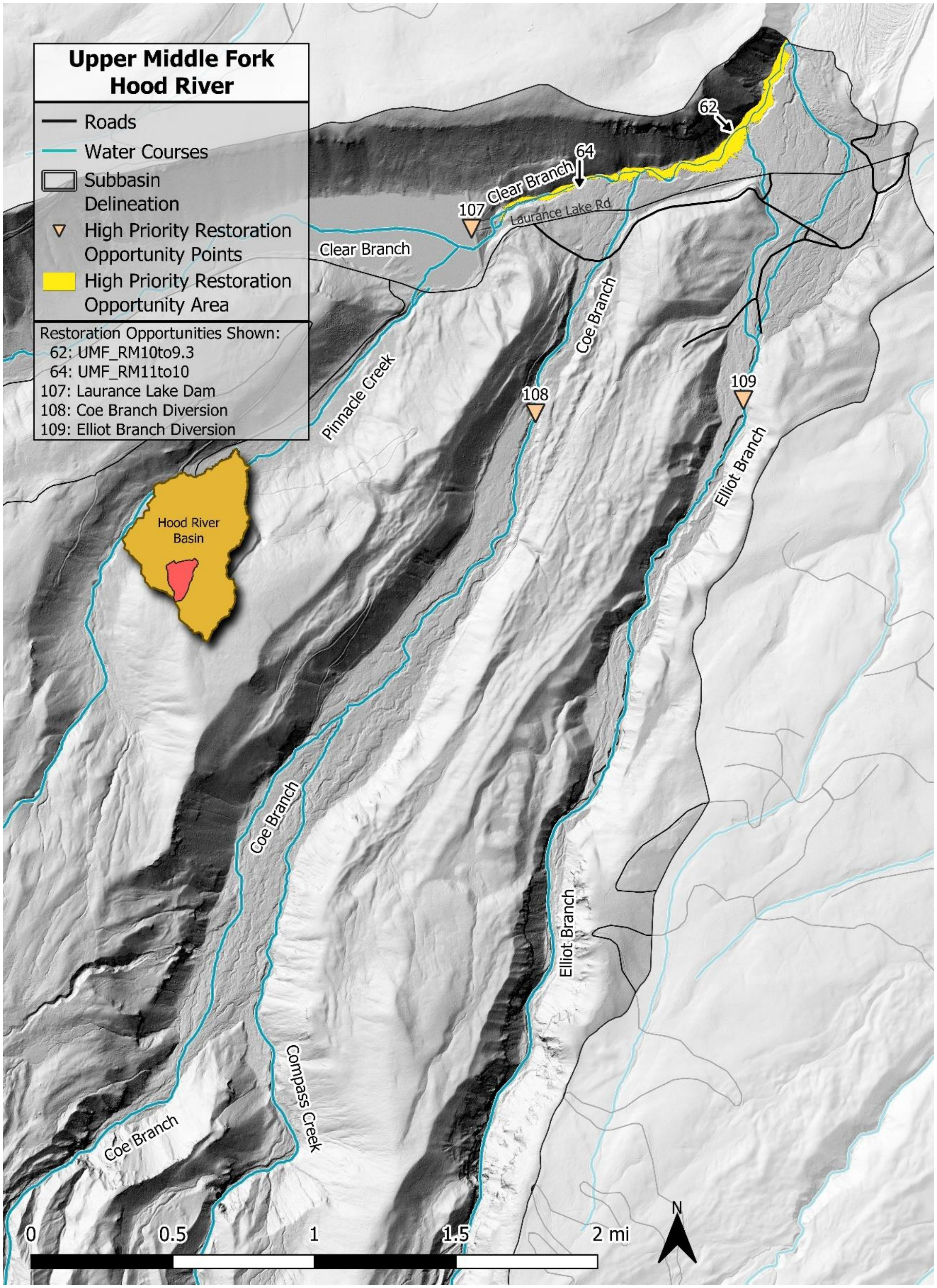


**Figure 23.** Restoration opportunities in the Upper Middle Fork Hood River Subbasin**.**

# Chapter 7. Monitoring Progress and Adaptive Management

## Progress Monitoring Framework

The intent of the Progress Monitoring Framework is to 1) track progress in achieving implementation objectives, 2) evaluate the effectiveness of actions in achieving intermediate and long-term ecological outcomes, and 3) utilize monitoring results to adjust actions or methodology. As outlined in **Figure 25**, the framework includes a subset of outputs from the action plan's theory of change that will be monitored to measure progress towards implementation objectives and ecological outcomes. For each selected output, SMART (i.e., specific, measurable, achievable, results-oriented, time-based) objectives were developed with accompanying actions. Finally, monitoring metrics were identified to track progress towards implementation objectives and ecological outcomes.

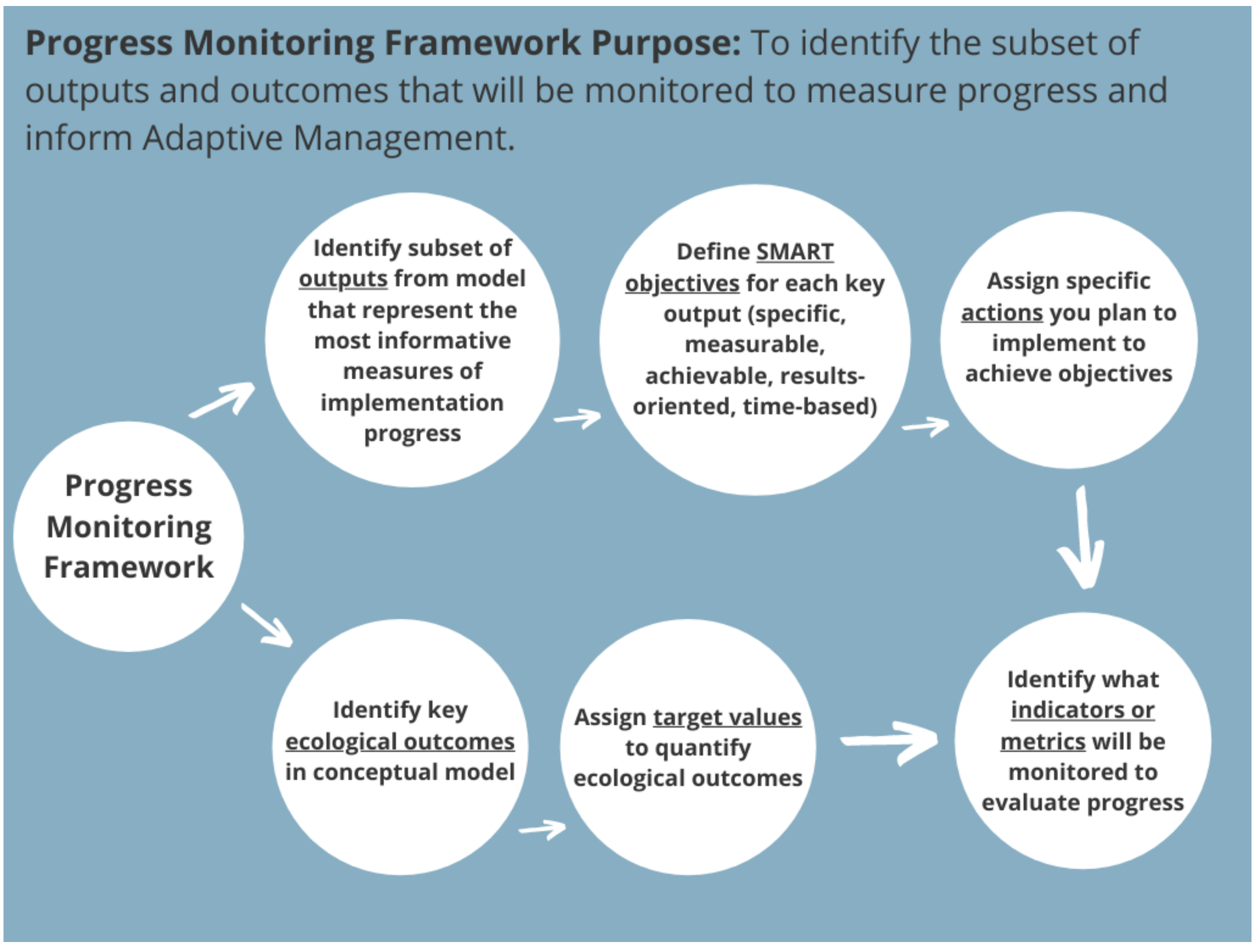



**Figure 25.** Schematic of Progress Monitoring Framework.

## Selected Outputs and SMART Objectives

A subset of outputs from Strategies 1, 2, and 5 in the theory of change (Chapter 5) were selected for inclusion in the Progress Monitoring Framework. Under each strategy are the corresponding goals for selected outputs and a table that lists the outputs, SMART objectives, and actions. **SMART Objectives and actions cover eight years, from 2022-2030.**

### Strategy 1: Stream and Floodplain Habitat Restoration and Protection

**Goal:** By 2040, there will be enough habitat complexity and floodplain connectivity in the Hood River Watershed to meet the freshwater life history needs of all returning salmon, steelhead, and Pacific lamprey, as well as the local bull trout population and resident fish species. This goal will be supported by adding large wood to 25 miles of perennial stream channels and reconnecting 15 miles of side channels.

**Goal:** By 2040, large wood recruitment potential will have increased in the Hood River Watershed. This goal will be supported by protecting steep headwater areas from intensive timber harvest and managing for larger trees in high priority wood recruitment areas.

**Table 19. Outputs, Objectives, & Actions for Stream and Floodplain Habitat Restoration & Protection**

| Output 1a: Large wood placed in streams and floodplains AND Floodplain and side channels are reconnected |
|---|
| **Objective 1a1: By 2030, restore 1.5 miles of Neal Creek by installing large wood structures in the stream and floodplain and reconnecting side channels.** |
| **Actions:**<br>1. Design and install an average of 1 in-stream restoration project every 2 years for a total of 1.5 miles of restoration along Neal Creek by 2030. |
| **Objective 1a2: By 2030, restore 1 mile of the Mainstem Hood River by reconnecting the floodplain and historic side channels and installing large wood structures where appropriate.** |
| **Actions:**<br>1. Gain a better understanding of water temperature profile and fish use of cold-water refuge at Hood River-Columbia confluence by 2023.<br>2. Evaluate feasibility and benefits of habitat restoration projects at mouth of Hood River, including Nichols Basin, by 2023.<br>3. If feasible, develop design for high priority habitat restoration project(s) at mouth of Hood River by 2025.<br>4. If feasible, implement habitat restoration project(s) at mouth of Hood River by 2030.<br>5. If feasible, design restoration project for Rivermile 1 Ponds by 2024.<br>6. If feasible, implement habitat restoration project at Rivermile 1 Ponds by 2026. |
| **Objective 1a3: By 2030, restore 4 miles of the Lower East Fork Hood River by installing large wood structures in the stream and floodplain and reconnecting side channels.** |
| **Actions**:<br>1. Identify and reach out to private landowners to develop 2 to 3 instream/floodplain projects by 2023. |

| |
|---|
| 2. Design and install an average of 1 in-stream restoration project every 2 years for a total of 4 miles of restoration along the Lower East Fork by 2030. |
| **Objective 1a4: By 2030, restore 2 miles of the Upper West Fork Hood River by installing large wood structures in the stream and floodplain and reconnecting side channels and floodplain habitat.** |
| **Actions**:<br>1. Identify 2 to 3 instream/floodplain projects by 2023.<br>2. Design and install an average of 1 in-stream restoration project every 3 years for a total of 2 miles of restoration along the Upper West Fork by 2030. |
| **Objective 1a5: By 2030, restore 1.5 miles of the Upper East Fork Hood River by installing large wood structures in the stream and floodplain and reconnecting side channels.** |
| **Actions**:<br>1. Identify 2 to 3 instream/floodplain projects by 2023.<br>2. Design and install an average of 1 in-stream restoration project every 3 years for a total of 1.5 miles of restoration along the Upper East Fork by 2030. |

## Strategy 2: Increase and Protect Summer Streamflow

**Goal:** By 2040, average monthly summer stream flows below some irrigation diversions will remain at current levels or increase. This goal will be supported by piping all remaining canals and eliminating end spills, providing cost-share to upgrade approximately 8,000 acres of on-farm irrigation equipment across the Hood River Watershed, and promoting efficient irrigation water management for agricultural and rural residential lands.

**Table 20. Outputs, Objectives, & Actions to Increase and Protect Summer Streamflow**

| ***Output 2a: Irrigation water conveyance improved, including piping/eliminating end spills*** |
|---|
| **Objective 2a1: By 2023, the Eastside Lateral main canal and sub-laterals are piped and pressurized.** |
| **Actions:**<br>1. By 2023, complete construction of Eastside Lateral Canal Pipeline Project.<br>2. By 2023, complete piping or replacing non-pressure pipe on all unpressurized Eastside Lateral sub-laterals. |
| **Objective 2a2: By 2028, a portion of EFID's Main Canal pipeline or Dukes Valley pipeline project is complete.** |
| **Actions:**<br>1. By 2024, complete design for the Main Canal or Dukes Valley pipeline project.<br>2. By 2028, complete construction of a portion of the Main Canal or the Dukes Valley pipeline project. |
| **Objective 2a3: By 2028, the Farmers Irrigation District's Famers Canal pipeline project is complete.** |
| **Actions:**<br>1. By 2024, complete design for the Farmers Canal pipeline project.<br>2. By 2028, complete construction of the Farmers Canal pipeline project |

| Objective 2a4: By 2030, Central Lateral Pipeline sublaterals are piped and pressurized. |
|---|
| **Actions**:<br>1. By 2025, complete design for pressurizing sub-laterals.<br>2. By 2030, complete piping or replacing non-pressure pipe on all unpressurized Eastside Lateral sub-laterals. |

| *Output 2b: Instream flow protected* |
|---|
| **Objective 2b1: By 2026, 3 water rights transactions are completed to restore 15 cfs along 5 miles of the East Fork Hood River and mainstem Hood River.** |
| **Actions:**<br>1. By 2023, application for 3 cfs Conserved Water Allocation is finalized for the Eastside Lateral pipeline project<br>2. By 2030, application for 6 cfs Conserved Water Allocation is finalized for the Main Canal or Dukes Valley pipeline project<br>3. By 2030, application for 6 cfs Conserved Water Allocation is finalized for the Farmers Canal pipeline project |

| *Output 2c: On-Farm Irrigation Upgrades Implemented* |
|---|
| **Objective 2c1: By 2030, 4,000 acres of irrigated farmland are converted to microsprinklers, accompanied by soil moisture monitoring and other IWM practices.** |
| **Actions**:<br>1. By 2023, develop a strategy for prioritizing geographic focus of funding and support for on-farm water conservation and increasing funding availability for on-farm water conservation and irrigation water management<br>2. By 2024, conduct a barrier assessment for on-farm irrigation upgrades.<br>3. Implement approximately 400 acres of on-farm irrigation upgrades each year through 2030. |

**Strategy 5: Improve Water Quality**

**Goal:** By 2040, summertime water temperature on 303(d) listed stream reaches will be trending towards state standards for salmon and steelhead spawning. This goal will be supported by increasing shade along streams, eliminating spills from open canals, and potentially changing reservoir management.

**Table 21. Outputs, Objectives, & Actions to Improve Water Quality**

| *Output 3a: Miles/acres of riparian area planted* |
|---|
| **Objective 3a1: By 2030, plant up to 2 miles of fencing &/or riparian restoration projects and sustain and monitor projects for five years post-planting.** |
| **Actions:**<br>1. Assess riparian shade and reach out to target landowners.<br>2. Plant an average of 0.25 miles of riparian area each year through 2030. |

## Monitoring

The Partnership is developing a restoration program effectiveness monitoring plan that incorporates existing and future monitoring actions and protocols across all partners. The intent of monitoring is to provide information on whether restoration measures were designed and implemented properly, evaluate whether objectives were met, and provide new insights into processes that can be used in adaptive management of subsequent restoration actions. The monitoring approach aims to maximize efficiency through collaboration and provide a centralized database for results. The plan is expected to be complete by 2022.

The monitoring plan relies upon a series of steps to be successful. Clear documentation on project prioritization is important to set expectations and assumptions regarding the intent of the project from the beginning. Prioritization assumptions and decisions will be documented (e.g., projects with high feasibility and ecological value will fall into the highest priority category). Once projects have been identified, monitoring begins with setting up an agreed upon schedule to manage expectations for project implementation. Monitoring the performance of the adopted schedule helps set expectations within the partnership, as well as funding entities, and helps in project management. As the projects move through the funding cycle and to construction, schedule and costs associated with the project will be monitored. When the project is completed, documenting whether the as-built condition is what was expected at the beginning will occur. The selected monitoring metrics will be calculated for communication within and outside of the partnership. Partners responsible for monitoring and communicating progress will share results on their projects. A database will be developed to compile both effectiveness and implementation data for analysis and reporting.

To assess the outputs and ecological outcomes from the implemented restoration and conservation actions, partners identified metrics that will be measured before and after implementation (implementation monitoring). Project outcomes, as a reflection of long-term ecological goals, will be measured on a longer timeframe (effectiveness monitoring). Implementation monitoring determines if the activities and recommendations proposed in the action plan are being implemented through individual projects according to initial direction, requirements, and standards. Effectiveness monitoring determines if activities and recommendations are achieving, or moving towards, the desired ecological outcomes. The tables below show the framework, metrics, and targets for both implementation and effectiveness monitoring for the same sub-set of strategies and outputs for which SMART objectives were developed. Note that implementation monitoring is linked to outputs, whereas effectiveness monitoring is linked to desired ecological outcomes.

**Strategy 1: Stream and Floodplain Habitat Restoration and Protection**

*Limiting Factor: Impaired habitat complexity and diversity, including access to off-channel habitat*

**Table 22. Implementation Monitoring of Stream and Floodplain Habitat Restoration Projects**

| **Output 1a: Large wood placed in streams and floodplains AND Floodplain and side channels are reconnected** | | |
|---|---|---|
| **Objectives** | **Implementation Metrics** | **Monitoring Plan/ Responsible Party** |
| **Objectives 1a1, 2, 3, 4, 5:** By 2030, restore 1.5 miles of Neal Creek, 1 mile of the mainstem, 4 miles of the Lower East Fork, 2 miles of the Upper West Fork, and 1.5 miles of Upper East Fork by installing large wood structures in the stream and floodplain and reconnecting side channels | • Number of key pieces of wood and volume placed per distance (#/mile)<br>• Total volume of wood placed per distance (m3/mile)<br>• Change in number of pools in project footprint (# pools)<br>• Length of reconnected or constructed side channels<br>• Modeled stream velocity for project reach | CTWS, USFS, HRWG: Pre- and Post-Restoration project monitoring based on USFS Stream Inventory (Hankin & Reeves) |

**Table 23. Effectiveness Monitoring of Stream and Floodplain Habitat Restoration Projects**

| ***Outcome 1: Increase the physical habitat conditions necessary to support all life stages of salmon, steelhead, and Pacific lamprey along 25 river miles in the Hood River by 2040 by protecting and restoring watershed processes and function, cold-water refugia, and diverse, complex in-stream and floodplain habitats*** | | |
|---|---|---|
| **Ecological Outcomes** | **Effectiveness Metrics** | **Monitoring Plan/ Responsible Party** |
| • Increased macroinvertebrate production<br>• Increase in stream-floodplain interaction and normal sediment/wood transport<br>• Increase in salmon and trout redds in treatment areas<br>• Increased pool depth and frequency<br>• Increased spawning habitat | • Pool density (#/mile)<br>• Macroinvertebrate diversity and/or abundance<br>• Pool area, frequency, and maximum depth<br>• Change in D50 gravel/cobble<br>• Total area of spawning gravels | HRWG, USFS, CTWS: Physical habitat surveys, Wollman Pebble Counts, macroinvertebrate sampling, velocity surveys<br><br>CTWS: Spawning Surveys (at selective sites) |

**Strategy 2: Increase and Protect Summer Streamflow**

*Limiting Factor: Reduced habitat quantity*

**Table 24. Implementation Monitoring of Streamflow Enhancement Projects**

| *Output 2a: Irrigation water conveyance improved, including piping/eliminating end spills* | | |
|---|---|---|
| **Objectives** | **Implementation Metrics** | **Monitoring Plan/ Responsible Party** |
| • **Objective 2a1:** By 2023, the Eastside Lateral main canal and sub-laterals are piped and pressurized<br>• **Objective 2a2:** By 2028, the East Fork Irrigation District Dukes Valley or Main canal pipeline Phase 1 construction is complete<br>• **Objective 2a3**: By 2028, complete construction of the Farmers Canal pipeline project<br>• **Objective 2a4:** By 2030, Central Lateral Pipeline sublaterals are piped and pressurized | • Miles of pipe installed/replaced<br>• Change in the number of end spills | HRWG, EFID |
| *Output 2b: Instream flow protected* | | |
| **Objectives** | **Implementation Metrics** | **Monitoring Plan/ Responsible Party** |
| **Objective 2b1:** By 2030, 3 water rights transactions are completed to restore 15 cfs along 5 miles of the East Fork Hood River and the mainstem Hood River | Transaction completion | EFID, FID |

| *Output 2c: On-Farm Irrigation Upgrades Implemented* | | |
|---|---|---|
| **Objectives** | **Implementation Metrics** | **Monitoring Plan/ Responsible Party** |
| **Objective 2c1:** By 2030, 4,000 acres of irrigated farmland are converted to microsprinklers, accompanied by soil moisture monitoring and other IWM practices | • Total reduction in water use<br>• Percent change property owners needing upgraded irrigation systems<br>• Acres upgraded<br>• Proportion of volume used vs. conserved | SWCD, NRCS, irrigation districts |

**Table 25. Effectiveness Monitoring of Streamflow Enhancement Projects**

| *Outcome 2: Restore stream flow sufficient to support successful spawning and rearing of salmon, steelhead, and Pacific lamprey in the Hood River Watershed by 2040* | | |
|---|---|---|
| **Ecological Outcomes** | **Effectiveness Metrics** | **Monitoring Plan/ Responsible Party** |
| • Increase in stream flows and suitable spawning & rearing depths and velocities below irrigation diversions in summer<br>• Decrease in summer stream temperatures below EFID diversion<br>• Increase in salmon and trout redds below irrigation diversions | • 60-minute average instantaneous stream flow<br>• Difference in summer stream flow down versus upstream<br>• Habitat surveys below diversions<br>• Temperature monitoring<br>• Wetted width and average depth increase | HRWG, EFID, CTWS, ODFW |

## Strategy 5: Improve Water Quality

*Limiting Factor: Elevated water temperature; toxins in water; fine sediment*

**Table 26. Implementation Monitoring of Water Quality Enhancement Projects**

| *Output 3a: Miles/acres of riparian area planted* | | |
|---|---|---|
| **Objectives** | **Implementation Metrics** | **Monitoring Plan/ Responsible Party** |
| **Objective 3a1:** By 2030, plant up to 2 miles of riparian and fencing projects and sustain and monitor projects for five years post-planting | • Acres and length of riparian area treated<br>• Proportion of riparian plantings that survive through the first summer<br>• Acres of non-native plants removed<br>• Number of tree shelters/tubes/fencing installed to protect plantings | SWCD, HRWG |

**Table 27. Effectiveness Monitoring of Water Quality Enhancement Projects**

| *Outcome 3: Restore water quality sufficient to support successful spawning and rearing of salmon, steelhead, and Pacific lamprey in the Hood River by 2040* | | |
|---|---|---|
| **Ecological Outcomes** | **Effectiveness Metrics** | **Monitoring Plan/ Responsible Party** |
| • Increased shade and riparian buffers on streambanks | • % increase in acres of riparian vegetation from GIS polygons<br>• Temperature monitoring | HRWG, SWCD |

| | | |
|---|---|---|
| • Decrease in summer water temperature on small/medium tributaries<br>• Decrease in stream pesticide levels | • Increased shade | Pesticide Stewardship Partnership |

**Communicating Progress**

Partners identified in the monitoring plan for specific actions and outcomes will be the lead on determining the monitoring details for a particular project, and then collecting, analyzing, and reporting on the data. The TAC will review monitoring plans and provide input and support. When data has been compiled and analyzed, it will be reviewed by the TAC at an annual one-day meeting (see Adaptive Management).

## Adaptive Management

Implementation and effectiveness monitoring and the data collected and analyzed from the database will highlight the areas where restoration and conservation projects may or may not be having the desired effects. The monitoring plan includes specific metrics and a diversity of data points that will allow for the identification of varying methods and actions that produce the greatest benefits, and those that are falling short of implementation and effectiveness goals.

The TAC will participate in an annual one-day meeting to review monitoring data and emerging research related to stream habitat project effectiveness and lessons learned from implementing current or past-year projects. Project implementation and effectiveness monitoring data will be presented in a format that allows for comparison with previous years' data. Projects that have not yielded expected ecological outcomes will be discussed in detail, with suggestions for alternative implementation strategies documented in the meeting minutes. Meetings will be convened and recorded by the HRWG.

An advisory committee will also be developed to review and assess monitoring data and emerging research related to irrigation efficiency and water quality program effectiveness and lessons learned from implementing current or past-year projects. As with the habitat TAC, projects that have not yielded expected implementation or ecological outcomes will be discussed in detail, with suggestions for alternative implementation strategies documented in the meeting minutes. Meetings will be convened and recorded by the SWCD and may be combined with the biennial review of the Hood River Agricultural Water Quality Management Area Plan.

Some uncertainties identified in the partnership's theory of change may need to be addressed through adaptive management over time. This may include the feasibility of small-scale easements or land purchase, the amount of wood needed for a particular project reach, climate change impacts, and other unforeseeable issues. These uncertainties will be discussed at the annual TAC meeting considering emerging research, project-specific details, and lessons learned from previously implemented projects. The partnership may consider developing a Climate Adaptation Plan in future years to address the uncertainties that are certain to impact projects in the coming years.

# Chapter 8. Sustainability and Community Engagement

The long-term sustainability of the restoration and conservation priorities outlined in this action plan, as well as the partnership itself, is a critical component of its overall success. This includes the sustainability of the implemented projects and outcomes, project funding, and the partnership's function over time. Sustainability will be considered in the planning, implementation, and monitoring of each project.

## Project and Outcomes Sustainability

Sustainability at the project-level will promote restoration and conservation actions that will continue to deliver the ecological outcomes laid out in the action plan. Project prioritization has laid the groundwork for each project's likelihood of success and final actions will be evaluated through the lens of feasibility, funding potential, site-specific characteristics/risks, and the potential to deliver ecological benefits. Long-term sustainability will also be supported by designs that restore natural processes whenever possible. The diversity of partner perspectives and expertise in project planning and implementation will also increase project success. Finally, monitoring and adaptive management will allow the partnership to track and assess progress towards ecological goals, and then capitalize on partner expertise and the sharing of knowledge to improve and sustain projects over time.

## Funding and Sustainability Plan

Restoration and conservation projects in the watershed have been supported by several consistent streams of funding to date. Water conservation projects, including on-farm irrigation upgrades and irrigation conveyance infrastructure upgrades, have received millions of dollars from NRCS. Additionally, CTWS has utilized annual Bonneville Power Administration (BPA) funds for restoration and conservation projects for the last 20 years. BPA funding has been leveraged with other sources including OWEB funds and USFS funds and in-kind contributions. BPA, as one of the Biological Opinion Action Agencies, is obligated to support restoration work to restore habitat and ESA-listed species, and for this reason, funding is expected to continue. However, the Columbia Basin Fish Accords are set to be renegotiated in 2022 and funding allocations may change. For this reason and others, it is important for the partnership to consider a diversity of funding opportunities and cast a wider funding net.

To launch the action plan and begin work on prioritized projects, the partnership determined that a correlating Funding and Sustainability Plan (FSP) would be necessary to expand revenue options and tap into current and future funding possibilities across all sectors. The plan is needed to understand current and long-term opportunities, identify a diversity of possible funding channels, address barriers, assess capacity, and determine necessary actions.

In November 2019, the partnership hired a consultant to conduct research for the development of the FSP. The consultant reviewed reports, websites, communications plans, and other materials related to the partnership. Additionally, they conducted interviews with community stakeholders, foundations, the staff from partnership organizations, and others with a stake in the Hood River Watershed.

Through the course of these interviews, it was agreed that the goal of developing a FSP is to identify new funding sources and revenue strategies that support action plan project implementation, and to build partnership capacity to match its long-term goals. The FSP was developed with a diversified revenue approach to fit the overall mission and goals of the partnership. Over the course of the 20-year arc laid out for Hood River Watershed conservation and restoration projects, priorities may shift, needs may change, and new opportunities will emerge. The FSP will serve as a roadmap to guide the planning of and preparation for funding of long-term goals and will be reviewed and updated to remain aligned with the action plan.

The FSP considers the capacity necessary to fully fund and operate the action plan as well as the infrastructure needed to support the long-term pursuit and coordination of revenue and community building opportunities that support the partnership's shared goals. Government investment will remain the cornerstone of much of the work outlined in the action plan. To pursue innovation and have some degree of flexibility, investment from the private sector must be increased significantly. This requires a focused and consistent effort that engages the local community as well as a broader funding community.

Key elements of the FSP include:

*Capacity:* Adequate staffing will be required to not only sustain current partnership activities but also accommodate the additional responsibilities of coordinating the action plan and identifying and managing strategies to meet the resulting funding needs. The partnership will identify capacity needs as they align with the action plan goals and seek funding for needed support that can be sustained over time.

*Infrastructure:* Infrastructure that provides effective and efficient tools and systems to support the partnership goals are vital. This may include everything from data management systems for monitoring, to contracted outsourcing of certain functions that require specialized knowledge or skills.

*Access:* Each partner organization connects with the community in unique ways. These connections will be important in identifying new and creative opportunities to build bridges with the watershed community. This effort may include farmers, local businesses, environmental specialists, or committed advocates. Centralized coordination of points of access and resulting relationships is critical to a cohesive approach and can be critical to building momentum and achieving milestones.

*Engagement:* As with any undertaking that benefits the community and has the potential to encourage deeper involvement and support, a well-planned communication and outreach strategy is important. Strong messaging, a broad network, and compelling connectivity can result in greater awareness of the partnership and its contributions to the watershed, as well as higher community prioritization of action plan projects and partner initiatives. This interaction requires dedicated staff with the skill set to develop and maintain these activities and an understanding of the unique and complex synergy of the partnership.

The FSP includes a tool for reporting and tracking aligned funding and engagement opportunities. The HRWG and other partners will utilize this tool to develop annual funding plans for prioritized projects identified in the action plan.

**Table 28** lists the estimated costs for the high priority projects deemed essential for recovering salmon, steelhead, and bull trout populations in the Hood River Basin, as well as supporting resident native fish populations. Although this is a significant amount, a combination of funding sources could realistically provide it. Key sources include NRCS (PL566 and EQIP), Bureau of Reclamation (WaterSMART), CTWS, USFS, OWRD, OWEB, and local irrigation districts. Other potential funding sources include private foundations.

**Table 28. Estimated Costs for Implementing High Priority Projects Over 20 Years**

| Project Type | Quantity | Average Unit Cost | Total Cost | Potential Funders |
|---|---|---|---|---|
| On-farm Irrigation Efficiency (i.e., sprinkler upgrades) | 8,000 acres; water savings = 23 cfs | $1,200/acre or $0.4 million/cfs | $9.6 million[1] | NRCS, OWEB, Irrigation Districts |
| Delivery & Distribution Pipelines (EFID; FID canal) | Pipe up to 23.5 miles open canal; Replace up to 38 miles sub-laterals; est. water savings = 22.6 cfs | ~$2 million/cfs | Up to $45[2] million | NRCS, CTWS, OWEB, OWRD, Irrigation Districts |
| Water Bank Pilot Project | 1,160 acres; est. water savings=10 cfs | $400/acre; $46,400/cfs each drought year | $464,000[3] per drought year | OWEB, OWRD, CBWPT, Irrigation Districts |
| Hydropower Rebalance | ~ 5 cfs | $0 | $0 | N/A |
| Instream Habitat Restoration: Large Wood Placement | 25 miles | $200,000/mile | $5 million[4] | OWEB, CTWS, USFS, PP Blue Sky |
| Instream Habitat Restoration: Side Channels/Floodplain Enhancement | 15 miles | $250,000/mile | $3.75 million[4] | OWEB, CTWS, USFS, PP Blue Sky |
| Riparian Habitat Restoration | ~5 miles/~35 acres | $10,000/acre | $350,000[4] | OWEB, CTWS, PP Blue Sky, BEF Tree Credits |
| Livestock Fencing | ~5 miles | $ 11/foot | $290,400[4] | NRCS, OWEB |
| Road Decommissioning & Storm-proofing | 35 miles | $25 K/mile | $875,000[5] | USFS, County |
| Alternate Surface Water Outlet System at Laurance Lake | | Lump sum | ~$6 million[6] | NRCS, MFID, OWRD |
| Fish Passage- road crossings | ~5 barriers | $300,000-500,00 each | ~$2 million[6] | ODOT, USFS, OWEB |
| Clear Branch Fish Passage | Trap and haul infrastructure | Lump sum | ~$2 million[6] | NRCS, MFID, OWRD |
| Conservation Easement or Purchase | TBD | Market value | TBD | OWEB, CTWS, CLT, WRC |
| Action Plan Effectiveness Monitoring | Annual average | ~$50,000/year | $1 million[7] | OWEB, USFS, CTWS, ODFW |
| | | **Grand Total** | **~$76,329,400 million** | |

Sources for cost estimates: [1] Material costs for currently funded projects; landowner provides labor for installation (SWCD).[2]EFID Irrigation Modernization Plan (FCA 2020) & draft FID Irrigation Modernization estimates;[3]Hood River Water Bank Feasibility Study (Pilz *et al.* 2018); [4]Average material & labor costs for recently funded projects (HRWG & SWCD). [5]Average construction costs for recent projects (USFS). [6]Clear Branch Dam Rehabilitation plans (MFID). [7] Average annual personnel costs and occasional contractor costs for project effectiveness monitoring.

## Community Engagement

Engaging with watershed residents, interest groups, and partners will play a critical role in the partnership's ability to meet its goals and objectives. Continuous community learning and engagement provides a range of opportunities for people to connect to and better understand the watershed in which they live. The driving principal is the notion that a community well-informed about the benefits generated by a dynamic watershed will be more willing to protect and restore the natural systems inherent to the watershed. As more community members are engaged in restoration and conservation in the watershed, the partnership will be prepared to offer programs and support opportunities that help encourage the development of projects and other actions. For example, the partnership may consider developing a program that makes it desirable, easy, and cost-effective for residential landowners to implement water-saving irrigation and landscaping techniques and practices, or programs that inspire habitat restoration (e.g., backyard wildlife habitat, riparian planting program) or water quality improvement (e.g., pesticide use reduction, hazardous waste disposal, stormwater management).

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## Appendix A. Optimal Habitat Characteristics and Seasonality for the Freshwater Life Stages of Chinook, Steelhead, Coho, and Bull Trout

Sources: Hood River Watershed IFIM Studies (WPN *et al*. 2013, Normandeau 2014) and ODFW fish monitoring data

| | Life Stage | **Optimal Water Depth (ft.)** | **Optimal Velocity (ft./sec.)** | **Optimal Streambed Substrate or Habitat Type** | **Time of Year (peak)** |
|---|---|---|---|---|---|
| **Chinook** (spring & fall runs) | Adult holding | $\geq$ 6.5 | 0 – 2.4 | Pools | April – July (spr. Ch.)<br>No holding (fall Ch.) |
| | Spawning | 1- 1.2 | 1.4- 2.8 | Pool tail crest; Medium gravel to small cobble | Aug. – Sept. (spr. Ch.)<br>Oct. - Nov. (fall Ch.) |
| | Fry | 0.3 – 1.5 | 0 – 0.3 | Channel margins, low velocity & good cover | Late fall (spr. Ch)<br>Early spring (fall Ch) |
| | Juvenile Rearing | 1.5- 3 | 0.3 - 1.1 | Pools and glides | 1+ Years (spr. Ch.)<br>March – Nov. (fall Ch) |
| **Steelhead** (winter & summer runs) | Adult holding | $\geq$ 6.5 | 0 - 2.4 | | Feb.-April (winter run)<br>Summer – following spring (summer run) |
| | Spawning | 1.1 – 1.6 | 2 – 3 | Medium gravel to small cobble | March – May (both runs) |
| | Fry | 0.2 - 1 | 0.1 - 0.5 | Channel margins, low velocity & good cover | Early summer (both runs) |
| | Juvenile Rearing | 1.6 - 3 | 0.7- 1.6 | | Year round for 2- 3 yrs. |
| **Coho** | Adult holding | $\geq$ 6.5 | 0 to 2.4 | Deep pools | No holding |
| | Spawning | 2.1 | 1.1 | Medium gravel to small cobble | Nov. – Dec. |
| | Fry | 0.5 - 2 | 0 - 0.5 | Channel margins, low velocity & good cover | Emerge early spring |
| | Juvenile Rearing | 2.5 – 3.3 | 0.15 - 0.3 | Slow moving off-channel or pools | 1 Year |
| **Bull trout** | Spawning | 0.5- 1.2 | 0.7- 1.5 | Medium gravel to small cobble | Sept.- Oct. |
| | Fry | Not available | | | |
| | Juvenile Rearing | 1 - 2 | 0.1 – 0.4 | | |

## Appendix B. Limiting Life Stages and Threats by Sub-basin Completed for Atlas Prioritization

**H**= High priority life stage in need of short-term action, 1 - 5 years, to improve population productivity, abundance, and distribution
**M**= Medium priority life stage in need of medium-term action, 5 - 10 years, to improve population productivity, abundance, and distribution
**L**= Low priority life stage in need of long-term action, 10 - 20 years, to improve population productivity, abundance, and distribution

### Middle Fork Hood River Subbasin (Upper/Lower)

| Limiting Life Stage | Spring Chinook | | Winter Steelhead | | Bull Trout | | Coho |
|---|---|---|---|---|---|---|---|
| | **Upper** | **Lower** | **Upper** | **Lower** | **Upper** | **Lower** | **Lower** |
| **Adult Immigration** | **H** | **M** | **H** | **M** | **H (fluvial)** | **M** | **M** |
| **Adult Holding** | **H** | **H** | **H** | **H** | **H** | **N/A** | **H** |
| **Spawning** | **H** | **H** | **H** | **H** | **M** | **H** | **H** |
| **Incubation/Emergence** | **H** | **H** | **H** | **H** | **M** | **H** | **H** |
| **Summer Rearing** | **H** | **H** | **H** | **H** | **M (adult)** | **H (adult)** | **H** |
| **Winter Rearing** | **H** | **M** | **H** | **M** | **M (juv.)** | **H (juv.)** | **M** |
| **Juvenile Emigration** | **H** | **L** | **H** | **L** | **H** | **L** | **L** |
| **Adult Emigration** | **N/A** | **N/A** | **H** | **L** | **H** | **L** | **L** |

**Threat Severity: H**= high; **M**= moderate**; L=**low; **- =** threat not present

| Threats/Limiting Factors | Upper | Lower | Comments |
|---|---|---|---|
| Anthropogenic Barriers | **H** | **H** | Clear Branch Dam; some diversions may be partial barriers |
| Natural Barriers | **-** | **M** | Mainstem falls |
| HQ-Competition | **M** | **L** | Small amount of hatchery fish present; Rainbow trout stocked from lake, hatchery stray steelhead and spring Chinook |
| Predation | **M** | **L** | Introduced small mouth bass from the lake in the past, Laurance Lake management exposes bull trout for longer time periods, beaver dams in Laurance Lake increase predation challenges |
| Pathogens | **L** | **L** | Hatchery fish have relatively low pathogen levels |
| Mechanical Injury | **H** | **M** | Entrainment in unscreened penstock, abrasions |
| Contaminated Food | **L** | **M** | Pesticides and herbicides (lower) |
| Altered Primary Productivity | **H** | **H** | Loss of marine derived nutrients from returning adults |
| Food-Competition | **M** | **L** | Small amount of hatchery fish present |

| | | | |
|---|---|---|---|
| Altered Prey Species Composition and Diversity | **H** | **M** | Many species can't access upper subwatershed due to Clear Branch Dam |
| Riparian Vegetation | **L** | **M** | Logging in tributaries, Weyerhaeuser land on mainstem |
| LWD Recruitment | **L** | **M** | Based on habitat surveys |
| Side Channel and Wetland Conditions | **L** | **M** | Based on habitat surveys |
| Floodplain Condition | **L** | **M** | Based on habitat surveys |
| Nearshore Conditions | **H** | **H** | Upper: impact from reservoir; Lower: loss of shallow water and low velocity habitat |
| Bed and Channel Form | **H** | **H** | Upper: reservoir impact; Lower: channel incision |
| Instream Structural Complexity | **M** | **H** | Upper: good in tributaries, poor in reservoir; Lower: High velocity and lack of pools |
| Decreased Sediment Quantity | **H** | **M** | Reservoir sediment transport disruption; some compensation from Coe and Elliot glacial streams with sediment |
| Increased Sediment Quantity | **M** | **H** | Glacial sedimentation increases expected with climate change, logging impacts |
| Temperature | **H** | **H** | DEQ listed for bull trout standard |
| Oxygen | **L** | **L** | |
| Gas Saturation | **M** | **N/A** | In settling basin below Clear Branch Dam |
| Turbidity | **M** | **H** | Glacial sources |
| pH | **L** | **L** | |
| Toxic Contaminants | **L** | **M** | |
| Increased Water Quantity | **M** | **H** | Flashiness |
| Decreased Water Quantity | **H** | **H** | Multiple diversions |
| Altered Flow Timing | **H** | **H** | Multiple diversions, reservoir |
| Reduced Genetic Adaptiveness | **H** | **H** | |
| Small Population Effects | **H** | **H** | |
| Demographic Changes | **H** | **H** | |
| Life History Changes | **H** | **H** | |

### West Fork Hood River Subbasin (Upper/Lower)

| **Limiting Life Stage** | **Spring Chinook** | | **Fall Chinook** | **Summer Steelhead** | | **Winter Steelhead** | **Bull Trout** | **Coho** | **Pac. lamprey** |
|---|---|---|---|---|---|---|---|---|---|
| | **Upper** | **Lower** | **Lower** | **Upper** | **Lower** | **Lower** | **Lower** | **Lower** | **Lower** |
| **Adult Immigration** | **L** | **L** | **L** | **L** | **L** | **L** | | **L** | **L** |
| **Adult Holding** | **M** | **M** | **L** | **M** | **M** | **M** | **L** | **L** | **L** |
| **Spawning** | **H** | **H** | **L** | **H** | **M** | **M** | | **H** | **M** |
| **Incubation/ Emergence** | **H** | **H** | **M** | **H** | **H** | **M** | | **M** | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Summer Rearing** | **M** | **M** | **L** | **M** | **M** | **M** | **L** | **M** | **M-**larval rearing |
| **Winter Rearing** | **H** | **H** | **L** | **H** | **H** | **M** | | **M** | |
| **Juvenile Emigration** | **L** | **L** | **L** | **L** | **L** | **L** | | **L** | **L** |
| **Adult Emigration** | **N/A** | **N/A** | **N/A** | **L** | **L** | **L** | | **N/A** | **N/A** |

| **Threats/Limiting Factors** | **Upper** | **Lower** | **Comments** |
|---|---|---|---|
| Anthropogenic Barriers | **M** | **M** | Dee Irrigation diversion |
| Natural Barriers | **-** | **L** | |
| HQ-Competition | **M** | **M** | Hatchery fish have already moved |
| Predation | **L** | **L** | No bull trout; avian predation |
| Pathogens | **L** | **L** | |
| Mechanical Injury | **-** | **L** | Handling at Moving Falls trap |
| Contaminated Food | **L** | **L** | Pesticides at low levels |
| Altered Primary Productivity | **H** | **H** | Cumulative land use impacts (logging, powerlines) |
| Food-Competition | **M** | **M** | Lots of hatchery fish |
| Altered Prey Species Composition and Diversity | **H** | **H** | Land use impacts |
| Riparian Vegetation | **H** | **H** | Lack of mature forest |
| LWD Recruitment | **H** | **H** | Lack of mature forest |
| Side Channel and Wetland Conditions | **H** | **H** | Not enough present |
| Floodplain Condition | **H** | **H** | Very little floodplain habitat |
| Nearshore Conditions | **H** | **H** | Lack of shallow low-velocity habitat (ODFW AQI) |
| Bed and Channel Form | **H** | **M** | Base habitat surveys |
| Instream Structural Complexity | **H** | **H** | |
| Decreased Sediment Quantity | **L** | **L** | |
| Increased Sediment Quantity | **M** | **H** | |
| Temperature | **L** | **M** | |
| Oxygen | **L** | **L** | |
| Gas Saturation | **L** | **L** | |
| Turbidity | **L** | **L** | |
| pH | **L** | **L** | DEQ listing for pH (lower) |
| Toxic Contaminants | **L** | **L** | Trace pesticides/herbicides |
| Increased Water Quantity | **M** | **M** | Flashiness; climate change; deforestation |
| Decreased Water Quantity | **M** | **H** | Dee Irrigation diversion |
| Altered Flow Timing | **M** | **M** | Earlier snow melt |
| Reduced Genetic Adaptiveness | **H** | **H** | Small population effects |
| Small Population Effects | **H** | **H** | Small population effects |
| Demographic Changes | **M** | **M** | Traps |

| | | | |
|---|---|---|---|
| Life History Changes | **M** | **M** | Lack of species diversity; small population effects; hatchery influence; future climate change |

**East Fork Hood River Subbasin (Upper/Lower)**

| **Limiting Life Stage** | **Spring Chinook** | | **Winter Steelhead** | | **Coho** | **Pac. lamprey** | **Bull trout** |
|---|---|---|---|---|---|---|---|
| | **Upper** | **Lower** | **Upper** | **Lower** | **Lower** | **Lower** | **Lower** |
| **Adult Immigration** | **L** | **H** | **L** | **L** | **M** | **M** | **L** (fluvial) |
| **Adult Holding** | **L** | **H** | **L** | **L** | **M** | **M** | **-** |
| **Spawning** | **M** | **H** | **M** | **M** | **M** | **M** | **-** |
| **Incubation/Emergence** | **H** | **H** | **H** | **M** | **M** | **-** | **-** |
| **Summer Rearing** | **M** | **H** | **M** | **H** | **H** | **-** | - |
| **Winter Rearing** | **M** | **M** | **M** | **M** | **M** | **M** larval | **L** (adult) |
| **Juvenile Emigration** | **L** | **L** | **L** | **L** | **L** | **L** | **-** |
| **Adult Emigration** | **N/A** | **N/A** | **L** | **M** | **N/A** | **N/A** | **-** |

| **Threats/Limiting Factors** | **Upper** | **Lower** | **Comments** |
|---|---|---|---|
| Anthropogenic Barriers | **M** | **H** | Diversions, weirs, culverts; dependent on season and flow |
| Natural Barriers | **L** | **M** | Several tributary entrances, insufficient water in EF bypass channel |
| HQ-Competition | **L** | **H** | Hatchery and other salmonid species present in greater numbers than other sub-watersheds |
| Predation | **L** | **L** | |
| Pathogens | **L** | **L** | |
| Mechanical Injury | **L** | **M** | Weirs, diversions, and culverts |
| Contaminated Food | **L** | **M** | |
| Altered Primary Productivity | **H** | **H** | Loss of marine derived nutrients |
| Food-Competition | **L** | **M** | Based on screw traps and pit tag data |
| Altered Prey Species Composition and Diversity | **L** | **M** | |
| Riparian Vegetation | **M** | **M** | Glacial flows, highway 35 impact |
| LWD Recruitment | **M** | **H** | Glacial outburst debris, highway 35 impact, loss of large wood in riparian zones/floodplains |
| Side Channel and Wetland Conditions | **H** | **H** | Highway 35 impact, intrinsic potential for steelhead high |
| Floodplain Condition | **H** | **H** | |
| Nearshore Conditions | **H** | **H** | |
| Bed and Channel Form | **H** | **H** | |
| Instream Structural Complexity | **M** | **H** | |
| Decreased Sediment Quantity | **-** | **-** | |
| Increased Sediment Quantity | **H** | **M** | Glacial influence expected to increase due to climate change |

| | | | |
|---|---|---|---|
| Temperature | **L** | **M** | Norwest current model |
| Oxygen | **L** | **L** | |
| Gas Saturation | **-** | **-** | |
| Turbidity | **M** | **M** | EFID sand flushing |
| pH | **L** | **L** | |
| Toxic Contaminants | **M** | **M** | Highway 35; ag, forestry, RR, and rural residential fertilizers and pesticides |
| Increased Water Quantity | **M** | **M** | Glacial influence, flashiness |
| Decreased Water Quantity | **L** | **H** | Multiple irrigation diversions |
| Altered Flow Timing | **M** | **H** | Glacial influence expected to increase with climate change |
| Reduced Genetic Adaptiveness | **M** | **H** | Small population effects |
| Small Population Effects | **M** | **H** | Small population effects |
| Demographic Changes | **L** | **M** | Small population effects |
| Life History Changes | **L** | **M** | Small population effects |

| **Threats/Limiting Factors** | | **Comments** |
|---|---|---|
| Anthropogenic Barriers | **-** | |
| Natural Barriers | **M** | Few barriers, cataract on Lake Branch is a partial barrier at certain flows |
| HQ-Competition | **M** | Introduced brown and brook trout, and naturalized sockeye run |
| Predation | **L** | Due to introduced species |
| Pathogens | **L** | |
| Mechanical Injury | **L** | |
| Contaminated Food | **L** | |
| Altered Primary Productivity | **H** | Loss of marine derived nutrients |
| Food-Competition | **L** | Low density of brown and brook trout |
| Altered Prey Species Composition and Diversity | **M** | Due to competition from introduced species |
| Riparian Vegetation | **L** | Surveys |
| LWD Recruitment | **L** | Mature forests, especially in upper area |
| Side Channel and Wetland Conditions | **L** | Habitat surveys |
| Floodplain Condition | **L** | Habitat surveys |
| Nearshore Conditions | **H** | Habitat surveys |
| Bed and Channel Form | **L** | Habitat surveys |
| Instream Structural Complexity | **L** | Wood and pools present |
| Decreased Sediment Quantity | **L** | |
| Increased Sediment Quantity | **M** | Logging in lower area |
| Temperature | **L** | Norwest current model, TMDL listing |
| Oxygen | **L** | |
| Gas Saturation | **L** | |
| Turbidity | **L** | |
| pH | **L** | |

| | | |
|---|---|---|
| Toxic Contaminants | **L** | |
| Increased Water Quantity | **M** | No glacial influence, logging impacts |
| Decreased Water Quantity | **M** | Flow data |
| Altered Flow Timing | **M** | Logging, flow gauges |
| Reduced Genetic Adaptiveness | **H** | Small population effects |
| Small Population Effects | **H** | Small population effects |
| Demographic Changes | **M** | Small population effects |
| Life History Changes | **M** | Small population effects |

**Neal Creek**

| Limiting Life Stage | Winter Steelhead | Coho |
|---|---|---|
| **Adult Immigration** | **L** | **M** |
| **Adult Holding** | **M** | **M** |
| **Spawning** | **M** | **H** |
| **Incubation/Emergence** | **M** | **H** |
| **Summer Rearing** | **H** | **H** |
| **Winter Rearing** | **M** | **M** |
| **Juvenile Emigration** | **L** | **L** |
| **Adult Emigration** | **L** | **N/A** |

| Threats/Limiting Factors | | Comments |
|---|---|---|
| Anthropogenic Barriers | **L** | Few barriers |
| Natural Barriers | **L** | River mile 1, confluence with Hood River |
| HQ-Competition | **M** | Hatchery steelhead and coho strays (weir data) |
| Predation | **L** | |
| Pathogens | **L** | |
| Mechanical Injury | **L** | Some diversions and rip rap |
| Contaminated Food | **M** | Pesticides and herbicides |
| Altered Primary Productivity | **H** | Loss of marine derived nutrients |
| Food-Competition | **M** | Hatchery steelhead and coho stray |
| Altered Prey Species Composition and Diversity | **H** | |
| Riparian Vegetation | **M** | |
| LWD Recruitment | **H** | |
| Side Channel and Wetland Conditions | **H** | |
| Floodplain Condition | **H** | |
| Nearshore Conditions | **H** | |
| Bed and Channel Form | **H** | |
| Instream Structural Complexity | **H** | |
| Decreased Sediment Quantity | **L** | |
| Increased Sediment Quantity | **H** | Upper Neal Creek has been heavily logged; some East Fork water still spills into Neal Creek during the summer |

| | | |
|---|---|---|
| Temperature | **M** | |
| Oxygen | **M** | |
| Gas Saturation | **N/A** | |
| Turbidity | **M** | Glacial water from EFID overflow |
| pH | **M** | DEQ data set |
| Toxic Contaminants | **H** | DEQ data set |
| Increased Water Quantity | **L** | |
| Decreased Water Quantity | **M** | Multiple irrigation diversions |
| Altered Flow Timing | **L** | Change to rain dominated area |
| Reduced Genetic Adaptiveness | **H** | |
| Small Population Effects | **H** | Spawning surveys, snorkel surveys, weir counts |
| Demographic Changes | **M** | |
| Life History Changes | **M** | |

**Mainstem**

| Limiting Life Stage | Spring Chinook | Fall Chinook | Winter Steelhead | Summer Steelhead | Coho | Pacific lamprey | Bull Trout |
|---|---|---|---|---|---|---|---|
| **Adult Immigration** | **L** | **L** | **L** | **L** | **L** | **L** | **L** |
| **Adult Holding** | **L** | **L** | **L** | **L** | **L** | **L** | **N/A** |
| **Spawning** | **L** | **M** | **L** | **M** | **M** | **M** | **N/A** |
| **Incubation/Emergence** | **L** | **M** | **L** | **M** | **M** | **N/A** | **N/A** |
| **Summer Rearing** | **M** | **M** | **M** | **M** | **M** | **M**-larval | N/A |
| **Winter Rearing** | **H** | **H** | **H** | **H** | **H** | **M**-larval | **N/A** |
| **Juvenile Emigration** | **L** | **L** | **L** | **L** | **L** | **L** | **L** |
| **Adult Emigration** | **N/A** | **N/A** | **L** | **L** | **N/A** | **N/A** | **L** |

| **Threats/Limiting Factors** | | **Comments** |
|---|---|---|
| Anthropogenic Barriers | **L** | Few known barriers |
| Natural Barriers | **L** | |
| HQ-Competition | **L** | Hatchery coho and fall Chinook presence |
| Predation | **L** | |
| Pathogens | **L** | |
| Mechanical Injury | **L** | |
| Contaminated Food | **M** | |
| Altered Primary Productivity | **H** | Loss of marine derived nutrients |
| Food-Competition | **M** | |
| Altered Prey Species Composition and Diversity | **M** | |
| Riparian Vegetation | **M** | |
| LWD Recruitment | **M** | |
| Side Channel and Wetland Conditions | **H** | Habitat surveys |
| Floodplain Condition | **H** | |

| | | |
|---|---|---|
| Nearshore Conditions | **H** | Loss of shallow, low velocity habitat |
| Bed and Channel Form | **H** | Lack of deep, low velocity pools |
| Instream Structural Complexity | **H** | |
| Decreased Sediment Quantity | **L** | |
| Increased Sediment Quantity | **M** | |
| Temperature | **M** | |
| Oxygen | **L** | DEQ data set |
| Gas Saturation | **N/A** | |
| Turbidity | **M** | DEQ data set |
| pH | **L** | |
| Toxic Contaminants | **M** | |
| Increased Water Quantity | **M** | Flashiness, glacial influence upstream, transition to rain dominated system |
| Decreased Water Quantity | **H** | Multiple irrigation diversions |
| Altered Flow Timing | **M** | |
| Reduced Genetic Adaptiveness | **H** | Small population effects |
| Small Population Effects | **H** | Small population effects |
| Demographic Changes | **M** | Small population effects |
| Life History Changes | **M** | Small population effects |

# Appendix C. Instream Water Rights in the Hood River Watershed vs. Mean Monthly Flow

(OWRD/USGS: https://apps.wrd.state.or.us/apps/sw/hydro_report/Default.aspx, ODFW unpublished estimated flow data, CTWS unpublished estimated flow data)

Red= mean flow does not meet instream water right

| Location/Dates/Source | Jan | Feb | Mar. | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hood River at Powerdale IWR | 170 | 270 | 270 | 270 | 250 | 250 | 250 | 250 | 250 | 220 | 100 | 170 |
| Average:1996-2018 (USGS) | 1565 | 1411 | 1411 | 1359 | 1279 | 898 | 522 | 358 | 328 | 542 | 983 | 1328 |
| East Fork Hood River, above Middle Fork IWR | 100 | 100 | 100 | 150 | 150 | 150 | 100 | 100 | 100 | 150 | 150 | 150 |
| Average: 1996-2019 (ODFW) | | | | 221 | 242 | 201 | 132 | 83 | 83 | 141 | | |
| Middle Fork Hood River, Eliot Branch to Mouth IWR | 150 | 150 | 150 | 255 | 255 | 255 | 150 | 150 | 100 | 255 | 255 | 150 |
| Average: 1996-2019 (ODFW) | | | | 193 | 198 | 172 | 139 | 110 | 91 | 104 | | |
| Lake Branch at Mouth IWR | 67 | 67 | 67 | 168 | 113 | 66.9 | 44.8 | 38.6 | 37.1 | 35.7 | 67 | 67 |
| Average: 1996-2019 (ODFW) | | | | 173 | 160 | 110 | 57 | 41 | 40 | 77 | | |
| West Fork Hood River, Lake Branch to Mouth IWR | 150 | 150 | 150 | 255 | 255 | 255 | 150 | 180 | 176 | 195 | 255 | 180 |
| Average: 1996-2018 (OWRD) | 864 | 764 | 795 | 772 | 673 | 438 | 237 | 166 | 150 | 271 | 607 | 788 |
| Neal Creek at Mouth IWR | 13 | 13 | 13 | 20 | 20 | 20 | 13 | 13 | 5 | 20 | 20 | 13 |
| Average: 2010- 2019 (CTWS) | 32.3 | 42.6 | 58.2 | 50 | 35.2 | 28 | 21.3 | 21.1 | 21.9 | 21 | 16.2 | 25.5 |
| Dog River at Mouth IWR | 12 | 12 | 20 | 20 | 20 | 20 | 12 | 7.01 | 6.05 | 7.79 | 14.7 | 12 |
| Average: 2016- 2019 (CTWS) | 7.9 | 9.4 | 10.3 | 20.9 | 19.4 | 12 | 7.9 | 7.1 | 6.6 | 6.5 | 7.8 | 5.4 |

# Appendix D. Streams Listed as Water Quality Limited for Temperature, Applicable Temperature Standard and Beneficial Use, and Temperature Data for Select Sites in the Hood River Watershed

(DEQ 2018, CTWS 2020b)

**Stream Temperature Standards Applied to Category 4A Streams in the Hood River Watershed**

| Stream | River Miles | Standard/Time Period | Beneficial Use |
|---|---|---|---|
| Hood River | 1.5 to 14.6 | 16°/June 16-September 30 | Core cold water habitat |
| Hood River | 1.5 to 14.6 | 13°/October 1 – June 15 | Salmon & steelhead spawning |
| Indian Creek | 0 to 7.8 | 18°/year-round | Salmon & trout rearing & migration |
| Whiskey Creek | 0 to 2.5 | 18°/year-round | Salmon & trout rearing & migration |
| Neal Creek | 0 to 5.6 | 18°/May 16-October 14 | Salmon & trout rearing & migration |
| Neal Creek | 0 to 5.6 | 13°/October 15-May 15 | Salmon & steelhead spawning |
| Lenz Creek | | 18°/year-round | Salmon & trout rearing & migration |
| West Fork Neal Creek | | 18°/year-round | Salmon & trout rearing & migration |
| Unnamed West Fork Neal Cr. tributary | | 18°/year-round | Salmon & trout rearing & migration |
| Unnamed Pine Grove creek | | 18°/year-round | Salmon & trout rearing & migration |
| Odell Creek | | 16°/May 16-December 31 | Core cold water habitat |
| Odell Creek | | 13°/January 1 – May 15 | Salmon & steelhead spawning |
| East Fork Hood River | 0 to 27.4 | 18°/May 16-October 14 | Salmon & trout rearing & migration |
| East Fork Hood River | 0 to 27.4 | 13°/October 15-May 15 | Salmon & steelhead spawning |
| Robinhood Creek | 0 to 1.7 | 18°/ May 16-October 14 | Salmon & trout rearing & migration |
| Middle Fork Hood River | 0 to 9.5 | 12°C/year-round | Bull trout spawning & juvenile rearing |
| Clear Branch | 0 to 0.3 | 12°C/year-round | Bull trout spawning & juvenile rearing |
| West Fork Hood River | 0 to 14.4 | 16°/year-round | Core cold water habitat |
| Lake Branch | 0 to 11.1 | 16°/year-round | Core cold water habitat |

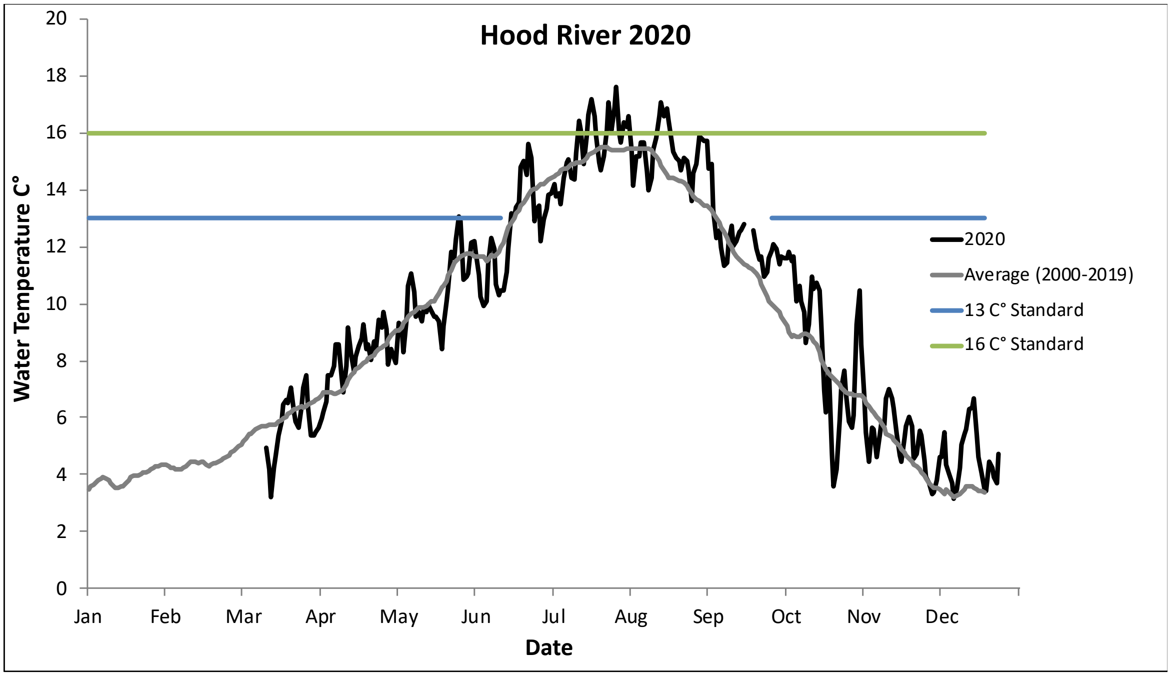


**Figure D1.** Average daily water temperature (°C) recorded for the mainstem Hood River near the former Powerdale Dam (dam was removed in 2010), RKM 6.76, UTM 10T 0615125E; 5057981N

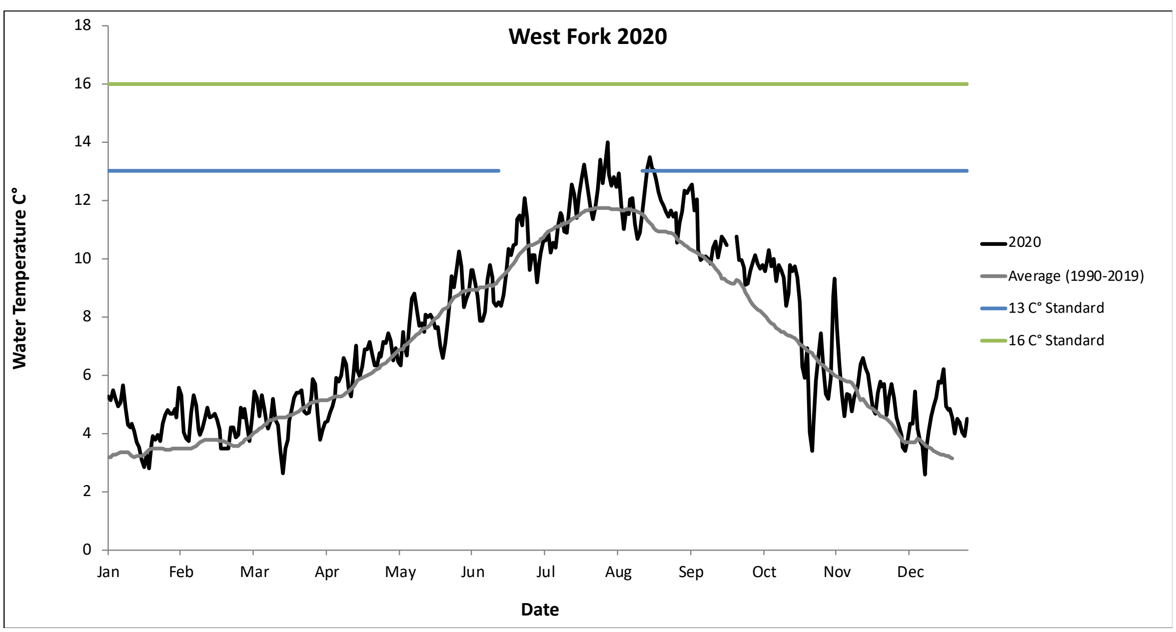


**Figure D2.** Average daily water temperature (°C) recorded in the West Fork Hood River at the Lost Lake Road bridge, RKM 7.56, UTM 10T 0602437E; 5045687N

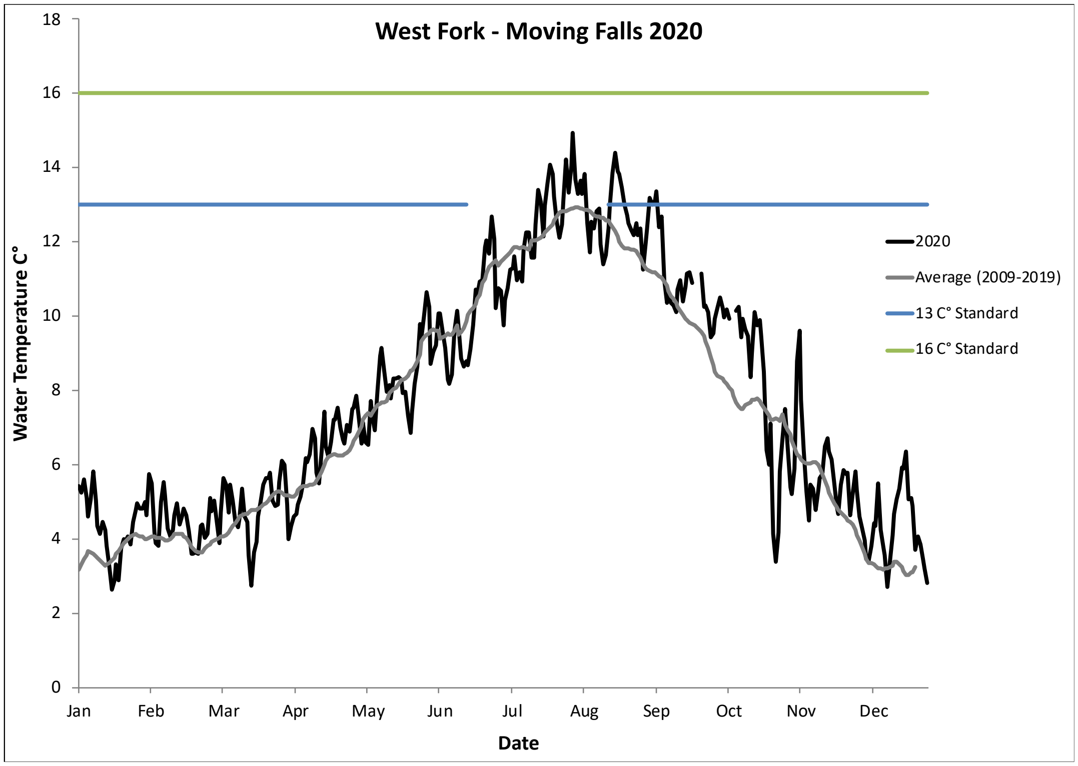


**Figure D3.** Average daily water temperature (°C) recorded in the West Fork Hood River downstream of Moving Falls, RKM 4.02, UTM 10T 0604882E; 5047632N

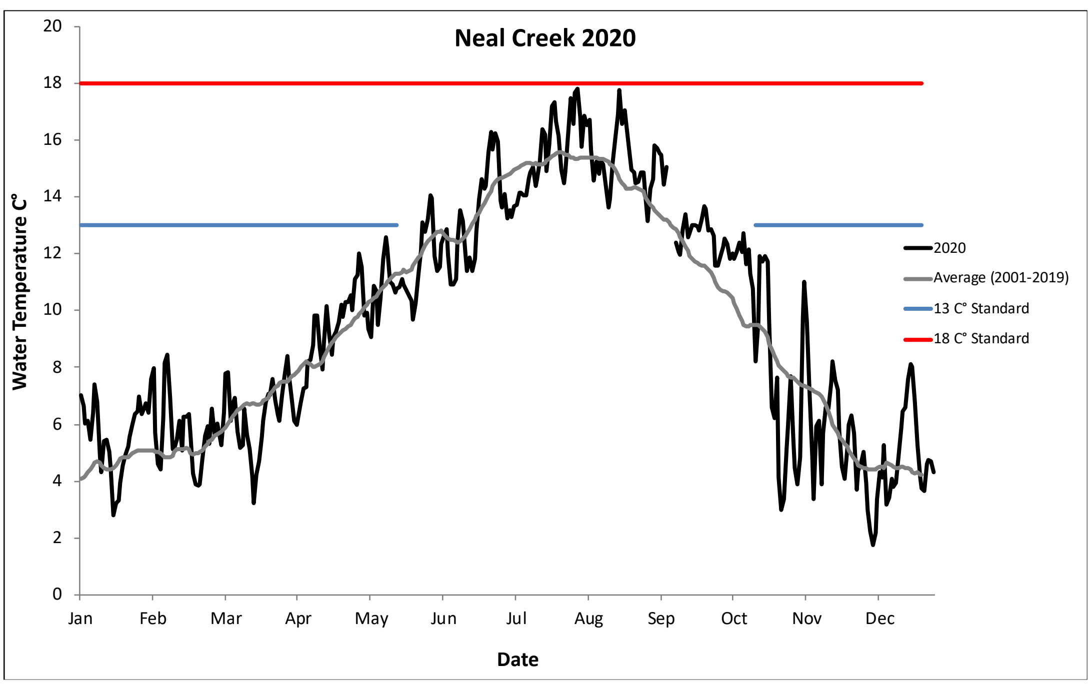


**Figure D4.** Average daily water temperature (°C) recorded in Neal Creek near its confluence, RKM 0.32, UTM 10T 0614871E; 5057591N

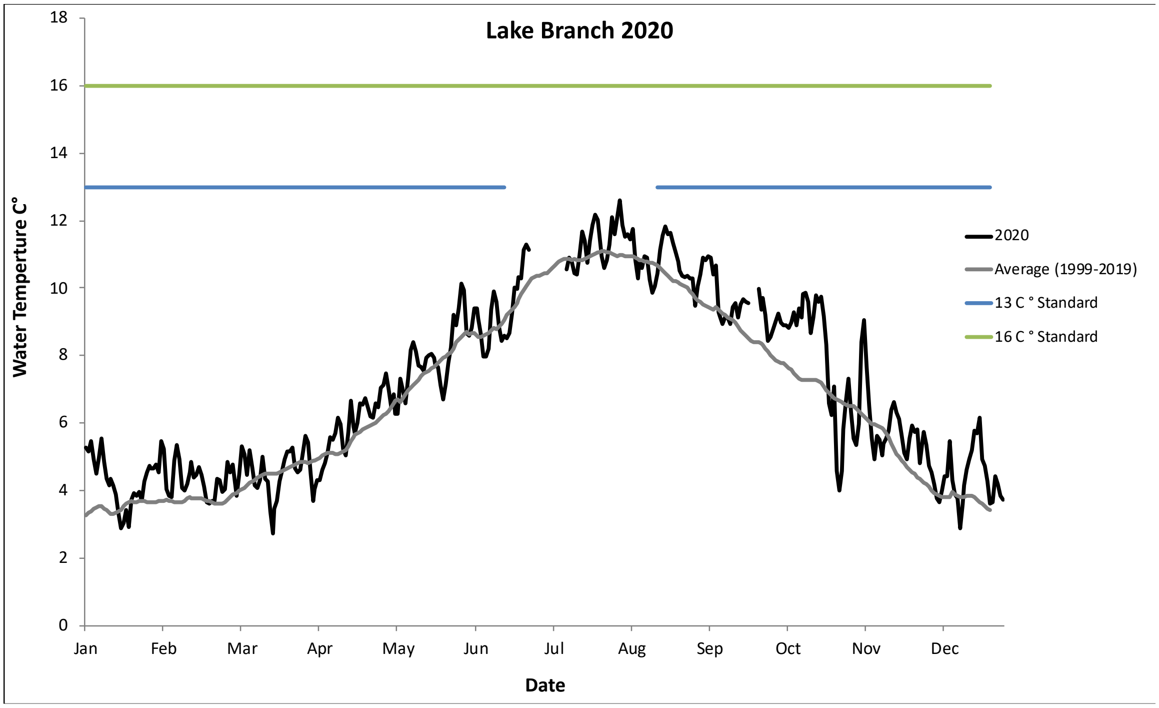


**Figure D5.** Average daily water temperature (°C) recorded in Lake Branch near its confluence, RKM 0.16, UTM, 10T 0601323E; 5044692N

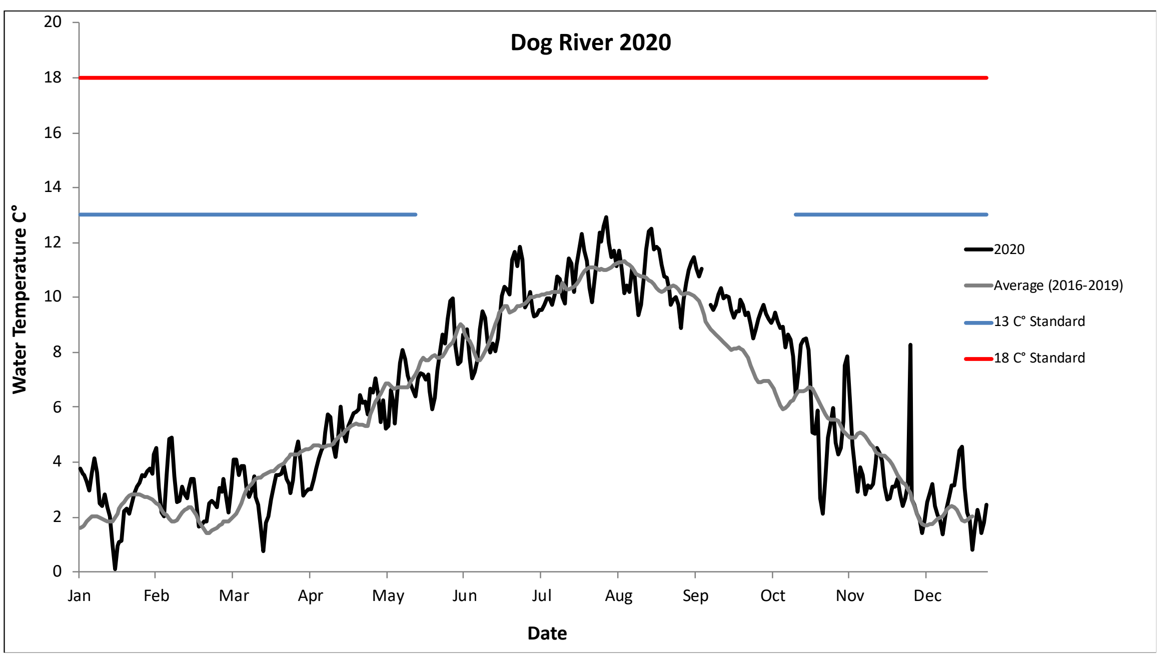


**Figure D6.** Average daily water temperature (°C) recorded in Dog River downstream of the Highway 35 culvert, RKM 0.16, UTM, 10T 0612077E; 5035720N

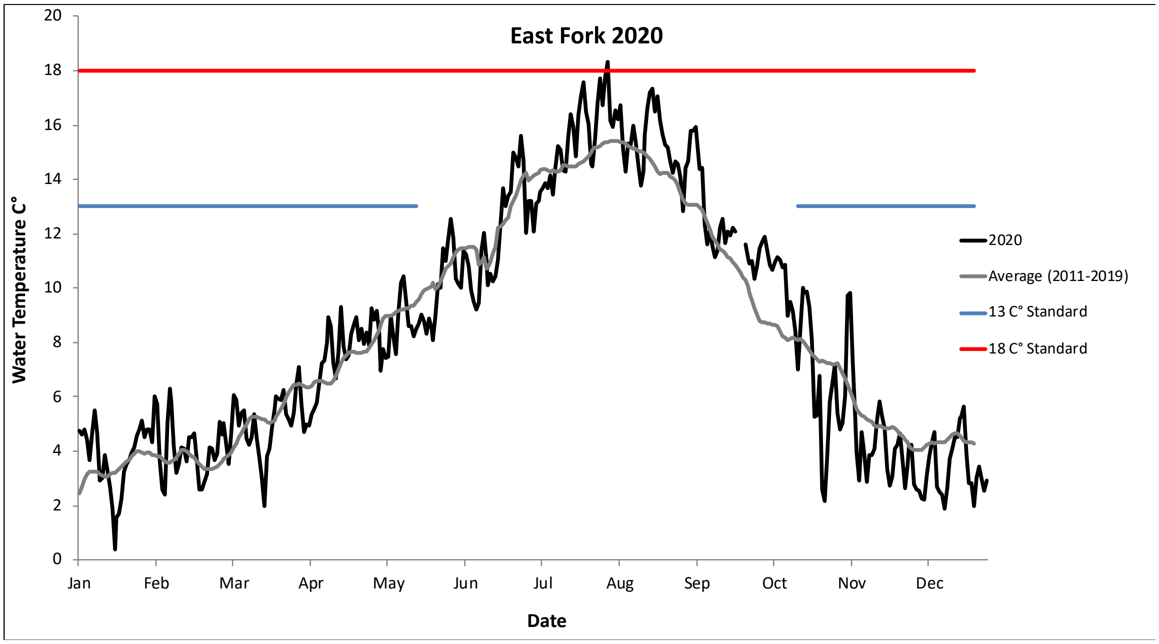


**Figure D7.** Average daily water temperature (°C) recorded in the East Fork Hood River at the County Gravel Pit off Dee Highway, RKM 1.45, UTM 10T 0607969E; 5047272N

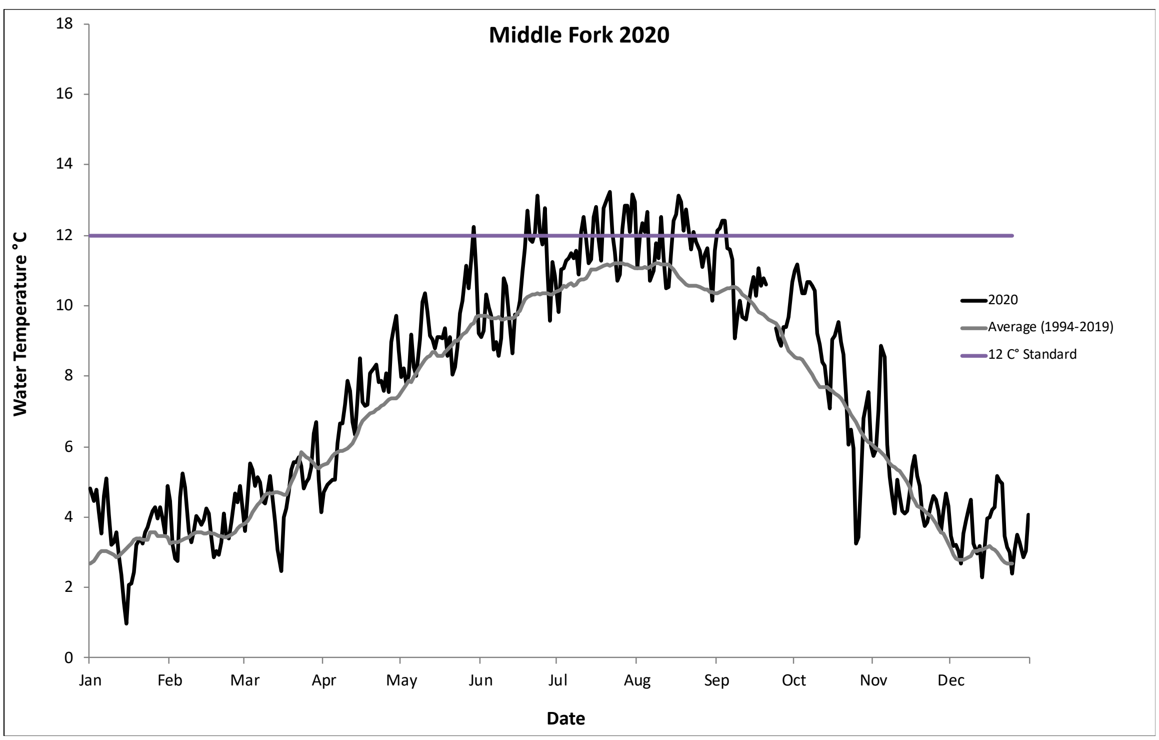


**Figure D8.** Average daily water temperature (°C) recorded in the Middle Fork Hood River at Red Hill Drive bridge, RKM 7.56, UTM 10T 0607385E; 5042101N

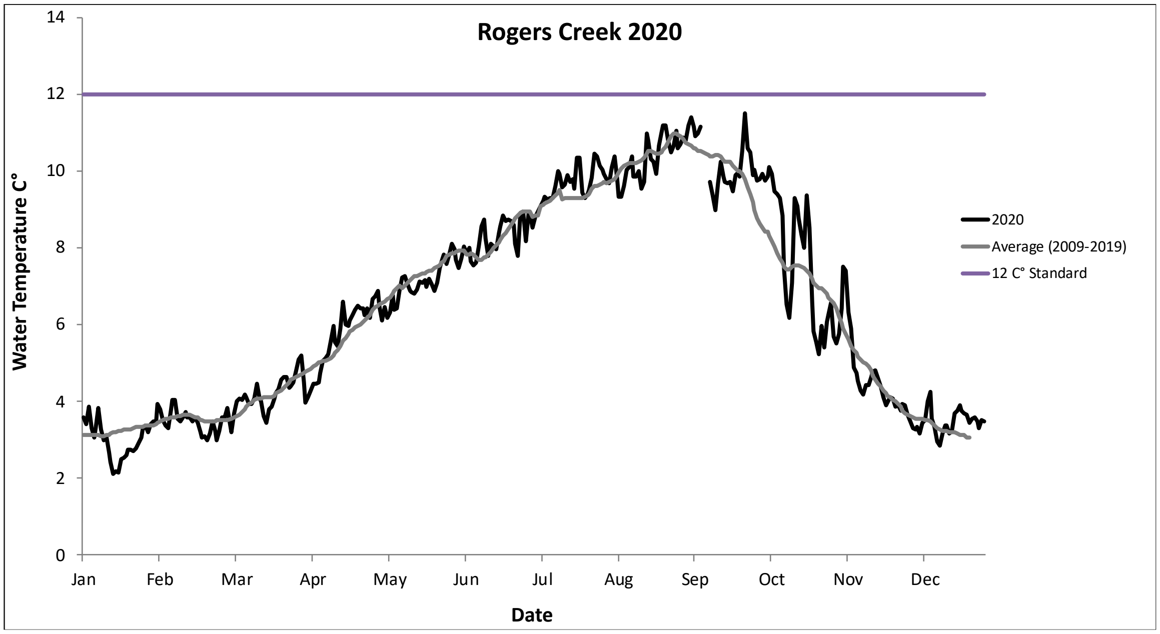


**Figure D9.** Average daily water temperature (°C) recorded in Rogers Creek downstream of the hatchery, RKM 0.16, UTM 10T 0607643E; 5042318N

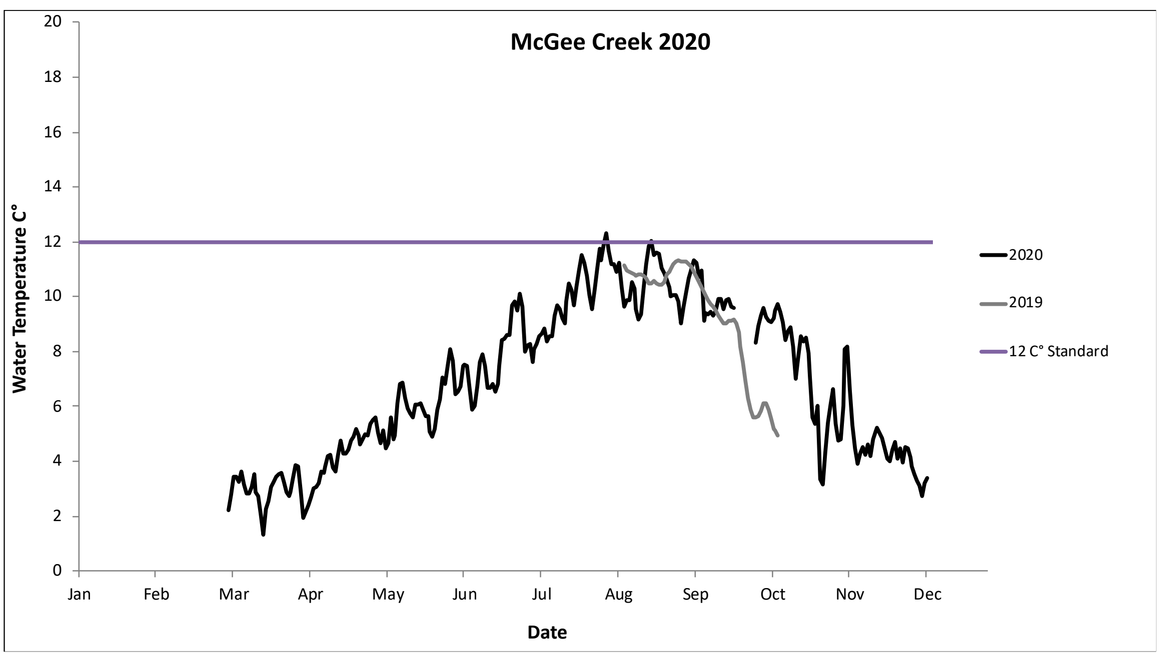


**Figure D10.** Average daily water temperature (°C) recorded in McGee Creek near confluence with Elk Creek, RKM 0.01 UTM 10T 0595260E; 5034383N

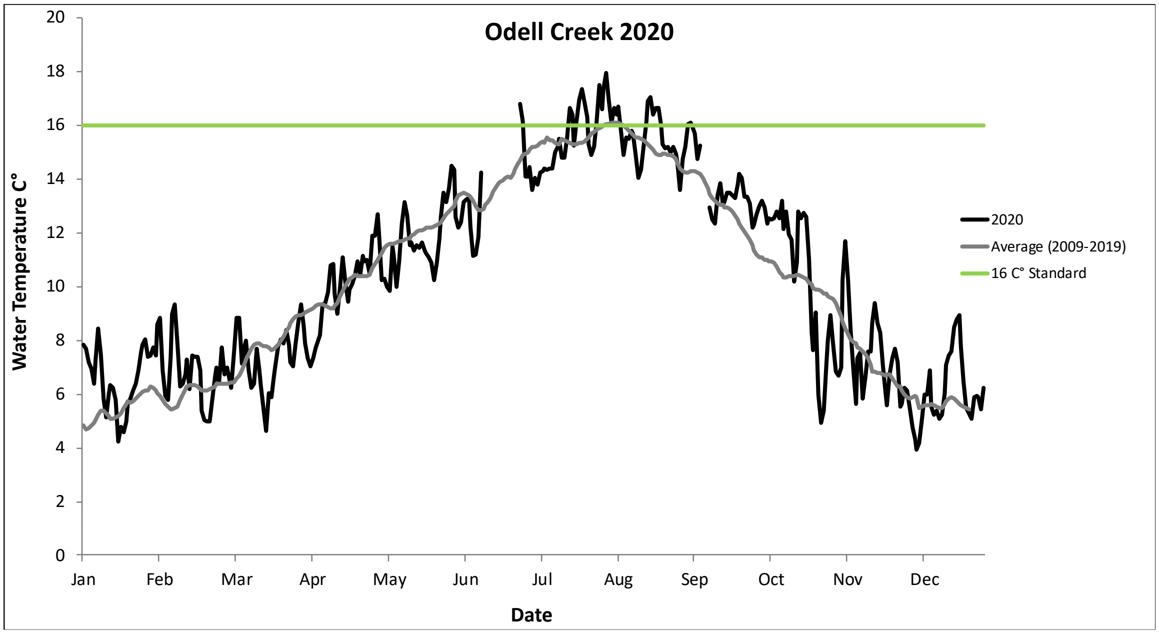


**Figure D11.** Average daily water temperature (°C) recorded in Odell Creek near confluence, RKM 0.2 UTM 10T 0613806E; 5056680N°

# Appendix E. Hood River Watershed 303(d) Listings

| Waterbody Name | Boundaries | Year | Parameter | Current Status |
|---|---|---|---|---|
| Clear Branch Hood River | Mouth to Laurance Lake | 2002 | Temperature (bull trout) | TMDL Plan Approved by EPA. De-listed 2002. |
| Cold Spring Creek | Mouth to Rivermile 4.7 | 2010 | Biological Criteria | Water Quality Limited (303d) |
| Dog River | Mouth to Headwaters | 2004 | Beryllium, Iron | Water Quality Limited (303d). |
| Evans Creek | Mouth to Rivermile 8.0 | 2004 | Beryllium, Copper, Iron | Water Quality Limited (303d). |
| | | 2010 | Biological Criteria | Water Quality Limited (303d) |
| Hood River | PacifiCorp Powerhouse to East Fork Hood River | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |
| | | 2004 | Copper | Water Quality Limited (303d). |
| | Mouth to East Fork Hood River | 2004 | Beryllium, Iron | Water Quality Limited (303d). |
| | | 2010 | Thallium | Water Quality Limited (303d). |
| Hood River, East Fork | Mouth to Headwaters | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |
| | | 2004 | Beryllium, Copper, Iron | Water Quality Limited (303d). |
| | | 2010 | Biological Criteria, Thallium | Water Quality Limited (303d). |
| Hood River, Middle Fork | Mouth to Clear Branch | 2002 | Temperature (bull trout) | TMDL Plan Approved by EPA. De-listed 2002. |
| | | 2004 | Beryllium, Iron | Water Quality Limited (303d). |
| | | 2010 | Biological Criteria | Water Quality Limited (303d). |
| Tributary to Middle Fork Hood River | Mouth to Rivermile 1.4 | 2010 | Biological Criteria | Water Quality Limited (303d). |
| Hood River, West Fork | Mouth to Headwaters | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |
| | | 2004 | Beryllium | Water Quality Limited (303d). |
| | | 2010 | pH | Water Quality Limited (303d). |

| | | | | |
|---|---|---|---|---|
| | Mouth to Lake Branch | 2010 | Thallium | Water Quality Limited (303d). |
| Indian Creek | Mouth to Headwaters | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |
| | | 2004 | Chlorpyrifos | Water Quality Limited (303d). |
| | | 2010 | *E. coli* (fall, winter, spring, summer) | Water Quality Limited (303d). |
| Tributary #1 to Indian Creek | Mouth | 2010 | *E. coli* (fall, winter, spring) | Water Quality Limited (303d). |
| Tributary #2 to Indian Creek | Mouth | 2010 | *E. coli* (fall, winter, spring) | Water Quality Limited (303d). |
| Lake Branch | Mouth to Lost Lake | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |
| Lenz Creek | Mouth to Rivermile 1.5 | 2004 | Arsenic, Beryllium, Chlorpyrifos, Iron, Manganese, pH | Water Quality Limited (303d). |
| | | 2010 | Biological Criteria, Guthion | Water Quality Limited (303d). |
| McGuire Creek | Mouth to Rivermile 0.9 (Headwaters | 2010 | Guthion | Water Quality Limited (303d). |
| Mitchell Creek | Mouth to Headwaters | 2004 | Zinc | Water Quality Limited (303d). |
| Neal Creek | Mouth to East Fork/West Fork Confluence | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002 |
| | | 2004 | Arsenic, Beryllium, Chlorpyrifos, Guthion, Iron, Manganese | Water Quality Limited (303d). |
| | | 2010 | Biological Criteria, Dissolved Oxygen (spawning) | Water Quality Limited (303d). |
| Neal Creek, East Fork | Mouth to Headwaters | 2004 | Beryllium, Iron | Water Quality Limited (303d). |
| Neal Creek, West Fork | Mouth to Headwaters | 2010 | Dissolved Oxygen (spawning) | Water Quality Limited (303d). |
| Tributary to Polallie Creek | Mouth to Rivermile 2.7 | 2010 | Biological Criteria | Water Quality Limited (303d). |
| Unnamed drainage | Near Fir Mountain Rd. & Neal Cr./Hwy. 35 crossing | 2010 | Guthion | Water Quality Limited (303d). |
| Whiskey Creek | Mouth to Headwaters | 2002 | Temperature (rearing) | TMDL Plan Approved by EPA. De-listed 2002. |

## Appendix F. Atlas Restoration Actions and Definitions

| # | Action/Definition |
|---|---|
| 1 | Protect Land and Water: Includes various types of easements, leases, or land acquisitions. May also include land management plans if they are protective and long term. |
| | **Channel Modification** (This category generally involves active construction with heavy equipment.) |
| 2 | Channel Reconstruction: Includes excavation, often in a former floodplain or channel, and placement of streambed material |
| 3 | Pool Development: Includes pool construction, or actions to deepen pools (not just LWD placement). |
| 4 | Riffle Construction: Includes placement of stream bed material |
| 5 | Meander (Oxbow) Reconnection – Reconstruction: reconnect may include less aggressive approaches such as excavating the inlet of remnant channels. |
| 6 | Spawning Gravel Cleaning and Placement |
| | **Floodplain Reconnection** |
| 7 | Levee Modification: Removal, Setback, Breach |
| 8 | Remove - Relocate Floodplain Infrastructure |
| 9 | Restoration of Floodplain Topography and Vegetation: this action increases flood inundation which likely leads to more riparian vegetation. |
| 10 | Excavation of floodplain benches either in existing or new channels |
| | **Side Channel/Off-channel Habitat Restoration** |
| 11 | Perennial Side Channel: may include constructing, restoring connectivity, or enhancing existing channels. |
| 12 | Secondary Channel (non-perennial) |
| 13 | Floodplain Pond – Wetland: ponds are usually constructed, whereas wetlands may either be enhanced or constructed, to retain water and encourage ground water recharge |
| 14 | Alcove |
| 15 | Hyporheic Off-Channel Habitat (Groundwater) |
| 16 | Beaver Restoration Management |
| | **Riparian Restoration and Management** |
| 17 | Riparian Fencing: usually is interpreted to mean fencing to exclude livestock |
| 18 | Riparian Buffer Strip, Planting |
| 19 | Install off-stream water source to exclude cattle from riparian areas |
| 20 | Thinning or removal of understory |
| 21 | Remove non-native plants |
| | **Fish Passage Restoration** |
| 22 | Dam removal or breaching includes associated channel width, depth and flow restoration. |
| 23 | Barrier or culvert replacement/removal includes associated channel width, depth and flow restoration. |
| 24 | Structural Passage (Diversions): Installation and improvement of fish screens and bypass systems (entrainment reduction). |

| | |
|---|---|
| | **Nutrient Supplementation** |
| **25** | Addition of organic and inorganic nutrients via fish carcasses. |
| | **Instream Structures** |
| **26** | Rock Weirs (Generally considered an "old school" technique, but they can still be a tool to restore gradient where avulsions or incision occur.) |
| **27** | Boulder Placement |
| **28** | LWD Placement**:** includes all types and may be soft placed or engineered, with multiple objectives (enhance or create pools, bank stability, cover, etc.) |
| | **Bank Restoration, Modification, Removal** |
| **29** | Modification or Removal of Bank Armoring |
| **30** | Restore Banklines with LWD - Bioengineering |
| | **Water Quality-Quantity Impacts** |
| **31** | Acquire Instream Flow (Lease- Purchase) |
| **32** | Improve Thermal Refugia (spring reconnect, other): Could include cold water seeps (without a surface water connection), channel reconnection. |
| **33** | Irrigation System Upgrades -Water Management: Includes consumptive use. |
| **34** | Reduce - Mitigate Point Source Impacts |
| **35** | Road Decommissioning or Abandonment: May involve regrading to natural contours. |
| **36** | Road Grading - Drainage Improvements: Refers to activities primarily related to sediment reduction and return flow in channels. |

## Partnership Certification Page

### Hood River Basin Partnership Strategic Action Plan

**Hood River Watershed Group**

_____________________________________________ Date: ______________

Chuck Gehling, Chair

**Hood River Soil and Water Conservation District**

_____________________________________________ Date: ______________

Brian Nakamura, Board Chair

**Confederated Tribes of the Warm Springs Reservation**

_____________________________________________ Date: ______________

Robert Brunoe, BNR General Manager

**East Fork Irrigation District**

_____________________________________________ Date: ______________

Steve Pappas, District Manager

**Farmers Irrigation District**

_____________________________________________ Date: ______________

Les Perkins, District Manager

**Middle Fork Irrigation District**

_____________________________________________ Date: ______________

Craig DeHart, District Manager

**Oregon Department of Fish and Wildlife**

_____________________________________________ Date: _______________

Rod French, District Fish Biologist

**USDA Forest Service, Hood River Ranger District**

_____________________________________________ Date: _______________

Kameron Sam, District Ranger

**Oregon Department of Environmental Quality**

_____________________________________________ Date: ______________

Linda Hayes-Gorman, ER Division Administrator