DRAFT STRATEGY SCOPING: FLOODPLAINS AND HABITAT

Executive Summary

A significant proportion of stream and river miles in the Walla Walla Watershed have been channelized and disconnected from their floodplains, particularly in the parts of the basin impacted by human habitation and development. As a result, many stream reaches across the basin exhibit reduced channel complexity, degraded floodplain and riparian habitat health, and impaired fish passage in certain locations. To address these issues, seven strategies related to floodplains and habitat have been identified as Tier 1 priorities in the Walla Walla Water 2050 Strategic Plan (Strategic Plan). This includes two watershed-scale strategies and five site-specific strategies. The watershed-scale strategies seek to reconnect floodplains and restore channel complexity (Strategy 1.01) and restore and protect riparian habitat (Strategy 1.07) basin-wide. The site-specific strategies primarily focus on improving fish passage in priority reaches and sites across the basin, including the Mill Creek Flood Control Project (Strategy 1.06), Hofer Dam fishway (Strategy 1.12), Gose Street (Strategy 1.19), Bennington Diversion Dam (Strategy 1.23), and Nursery Bridge (Strategy 1.09).

For the two watershed-scale floodplains and habitat strategies, this memo provides detailed descriptions and overviews of implementation approaches, including details on entity and partner roles and implementation phases. The five site-specific strategies are also described, including information on their location in the basin and lead entities and partner roles. For all strategies, this memo highlights potential barriers to implementation, relationships with other Tier 1 strategies, and each strategy's contribution to the Desired Future Conditions outlined in the Strategic Plan. Within each strategy, specific project actions with additional funding needs that have been identified by sponsors within the Basin are described and summarized.

Background

The Walla Walla Water 2050 Strategic Plan (Strategic Plan) was completed in June 2021. This memo is part of Phase 2 of the Walla Walla 2050 Strategic Plan process – an effort to build on the completed Strategic Plan by analyzing and refining implementation details of the Tier 1 strategies. The Strategic plan identified 60 strategies to manage water resources to meet multiple benefits in the Walla Walla watershed. These strategies were prioritized into three tiers; the highest tier, Tier 1, included 23 strategies. This memo, along with a series of subsequent memos will provide additional detail on these Tier 1 strategies to help move these strategies forward to implementation. This memo is focused on priority strategies related to **Floodplains and Habitat.**

Introduction

Strategies scoped in this memo include two high-level watershed scale strategies and four more specific, high-priority project-specific strategies that, in combination will help address floodplain and habitat management challenges in the basin. The watershed-scale strategies discussed here include:

Strategy 1.01: Reconnect floodplains and restore channel complexity basin wide to reduce flood risk and improve habitat.
Strategy 1.07: Restore and protect riparian habitat along tributaries, small streams, and the Walla Walla River basin wide.

The site-specific strategies discussed here include:

Strategy 1.06: Improve fish passage and habitat conditions in weired and concrete channel sections of the flood control project in Mill Creek.
Strategy 1.12: Improve flow and timing of fish passage through the Hofer Dam fishway (Touchet River).
Strategy 1.19: Improve fish passage at Gose Street long term.
Strategy 1.23: Improve fish passage at Bennington Diversion Dam.

One site-specific strategy was scoped in a 2021 memo attached here as an Appendix:

Strategy 1.09: Protect and improve fish passage at Nursery Bridge and implement levee setback projects upstream and downstream of Milton Freewater

The remainder of this memo more fully explains each of these strategies and their components and provides information on status, implementation, potential barriers, and relationships of these and other strategies. For strategy 1.01 and 1.07 the discussion is generalized across the whole basin. The four other strategies involve site-specific projects with accordingly more specific information on status and next steps. The four site-specific projects are grouped based on sub-watershed including projects in the Mill Creek (Strategies 1.06, 1.19, and 1.23) and Touchet River (Strategy 1.12) subbasins.

Current Status

This section describes the health of floodplains, river and stream channels, and riparian habitat across the basin. More specific detail is provided for each of the three main subbasins, the Walla Walla, Touchet River and Mill Creek.

Floodplains and Channel Complexity at the Basin Scale

Floodplain and habitat health are closely related concepts, and they are often addressed together in restoration projects. A river's floodplain is considered healthy when it is connected to the river by periodic inundation caused by high flows. Periodic inundation of floodplains is an important watershed dynamic; it encourages development of off-channel and instream habitat and recharges shallow aquifers, supporting late summer base flows.

The status of floodplain health in the watershed is measured by the degree to which rivers in the basin have been channelized and disconnected from their floodplains. Currently, a significant proportion of stream and river miles in the basin are channelized and cut off from their floodplains.

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Channel complexity describes a range of physical stream characteristics that, considered together, greatly influence habitat quantity and quality. Elements of channel complexity include substrate size and type, presence and characteristics of riffles, runs, pools and other hydraulic features, and the presence, size and distribution of large wood. Many of the same impacts that cause channelization and disconnect rivers from floodplains also reduce channel complexity.

Channels straightened and confined by levees or to make room for farms or urbanization are often conduits for fast moving water which in turn scours deepens channel beds, reinforcing a negative feedback loop that continually degrades important habitat features (Northwest Power and Conservation Council 2004). Pool habitats created by beaver dams and log jams were thought to have historically constituted at least 50% or more of lower-elevation stream channels (Snake River Salmon Recovery Board 2011). Removal of beaver dams and woody debris was common across the basin as cities and farms were developed. These features are critical habitat elements and often form the foundation of a healthy stream channel. As with removal of beaver dams, natural recruitment of large wood into streams from healthy riparian areas is reduced by human land uses like urban development, road building and agriculture (Snake River Salmon Recovery Board 2011).

Channel complexity is lacking in many river and stream reaches across the basin. This is especially true for each of the watershed's rivers and tributaries where they flow through land areas impacted by human habitation and development. While the Walla Walla Basin headwaters generally have more complex channels and better overall fish habitat, channel complexity and, by association habitat quality, are reduced downstream throughout the Walla Walla and Touchet Valleys. Dramatic stream channelization occurred through three Army Corps of Engineers flood control projects in the Basin (in the cities of Walla Walla, Milton Freewater and Dayton/Waitsburg). Channelization on agricultural lands is also significant throughout the agricultural areas of the Basin as streams were straightened and channelized to improve access to farmland. The Strategic Plan noted that there is no current estimate at the basin scale of channel and habitat complexity compared to potential or historic/natural conditions and that instead, these parameters should be determined at specific project sites (Cascadia Consulting 2021).

Riparian Habitat

Healthy riparian habitat includes robust native vegetation growing along the basin's streams and rivers. Functioning riparian habitat plays several important roles including protecting against erosion, shading river surfaces to help mitigate high water temperatures and related impacts and providing habitat for birds and terrestrial species. A functioning riparian zone also contributes to habitat complexity when mature trees die and fall into the river, creating instream habitat (Snake River Salmon Recovery Board 2011).

Across the basin, riparian vegetation has been removed to make way for anthropogenic land uses or has been degraded by poorly managed livestock grazing in the riparian zone. Non-native invasive plants, including cheatgrass, velvet grass, yellow starthistle, barnyard grass, tansy, and rattlegrass, have also supplanted native vegetation in many areas (HDR Engineers, Michael, Barber, WSU, and Steward and Associates, Inc 2005). Riparian health is commonly measured by analyzing the amount (surface area as well as height and density) of riparian vegetation along with the degree to which it is protected from impacts like grazing. Other measures can include maximum potential riparian function, which is defined as the historic function of unaltered riparian habitats, and direct measures of riparian function like the amount of stream surface area that is shaded (Northwest Power and Conservation Council 2004). While there is no basin wide estimate of current riparian function compared to potential or natural conditions, specific goals are described by reach in the following sections covering the three major Walla Walla subbasins.

The next three sections describe the status of floodplains, channel complexity and riparian health in more detail for each of the Walla Walla's three main subbasins.

Walla Walla Subbasin

The Walla Walla Subbasin Plan estimates that cumulative pool area in the Basin's streams has been reduced by approximately 75% across the entire subbasin due to channel straightening, unstable banks, poor riparian conditions (and resulting lack of woody debris recruitment), removal of woody debris from stream channels in developed areas and other dynamics (Northwest Power and Conservation Council 2004). The remainder of this section provides information on specific reaches of the Walla Walla River and its tributaries.

Lower Mainstem Walla Walla River

Floodplain connectivity is low in reaches of the Lower Walla Walla River from river mile 0 to river mile 27.4 according to a 2014 geomorphic study (Tetra Tech 2014). The same study found that the reaches analyzed had low River Complexity Index values indicating low numbers of secondary channels and off-channel habitat and an overall lack of channel complexity. In the Lower Walla Walla, riparian zones have been reduced by 65%-70%, replaced primarily by agricultural use and impacted by the spread of numerous non-native invasive species.

The reach of the Lower Walla Walla from Mill Creek (WA) to Nursery Bridge (OR) flows through agricultural land with some urban, urbanizing and industrial adjacent land uses as well. Floodplain connectivity is generally low throughout this reach; the Subbasin Plan also identified large wood, channel confinement, riparian function and lack of key habitat (pools) as limiting factors with the most impact to key life stages for aquatic species in this reach (Northwest Power and Conservation Council 2004).

Channel, habitat and riparian conditions in the segment of the Lower Walla Walla from Nursery Bridge to the Little Walla Walla River are the subject of a standalone strategy memo attached here as Appendix A and are not covered in the body of this memo.

Little Walla Walla River

The Little Walla Walla River (LWWR) is part of the unique distributary system of the Walla Walla River. The LWWR system includes distributaries and spring branches including the East and West

Little Walla Walla systems, and several spring source creeks including Spring Branch, Mud Creek, Dugger Creek, Lewis-Walsh Creek, Big Spring and others. All these sources enter the mainstem Walla Walla River in Oregon near the border with Washington. What was once a complex of interwoven river channels that likely provided high quality habitat for salmon and other species are now treated alternately as irrigation conveyances and natural streams, depending on location and time of year (Wolcott 2010). Irrigation and urban development, in other words, have largely cut the river system off from its floodplain, reduced channel complexity, and diminished the prevalence of healthy riparian habitat.

A 2004 assessment noted that lack of habitat complexity is an important limiting factor in the LWWR system (Hoverson 2004). The Walla Walla Subbasin Plan listed large wood, channel confinement, riparian function and lack of habitat (pools) as primary limiting factors with the most impact to key life stages of important aquatic species (Northwest Power and Conservation Council 2004).

Upper Walla Walla River Mainstem

Upstream of the LWWR and the town of Milton Freewater, the Upper Mainstem Walla Walla River flows through agricultural land to the confluence of the North and South Forks. This reach lacks consistent connection to its floodplain, having been disconnected by development of irrigated fields and by road and semi-urban development. The Subbasin Plan identified large wood, channel confinement, riparian function and lack of key habitat (pools) as limiting factors with the most impact to key life stages for aquatic species in the Upper Walla Walla (Northwest Power and Conservation Council 2004). Similarly, the Snake River Salmon Recovery Plan noted that encroachment on the floodplain caused by construction of single family dwellings and associated activities threaten floodplain and riparian function (Snake River Salmon Recovery Board 2011). The Recovery Plan also observed that reduced stream channel complexity and floodplain function caused by channel straightening and loss of historic riparian forest/large wood debris sources have reduced key habitats.

Headwaters Including North and South Forks

The Headwaters reach is defined as both the North and South Fork of the Walla Walla River, above their confluence. In the Headwaters reaches, the Subbasin Plan identified large wood, channel confinement, riparian function and lack of key habitat (pools) as limiting factors with the most impact to key life stages for aquatic species (Northwest Power and Conservation Council 2004). A 2005 study that included twelve river miles of the Walla Walla mainstem and South Fork Walla Walla found that the reach had been straightened and had lost significant length and habitat complexity (Hoverson and Schwartz 2005). The report also noted significant reduction of habitat quantity and quality and observed that most of these deficiencies can be traced to diking and straightening of the river.

Mill Creek Subbasin

The Mill Creek headwaters above the town of Walla Walla's municipal water intake at river mile 26.9 have been a protected watershed since the early 1990s; in this area, the river is in nearly pristine condition (Snake River Salmon Recovery Board 2011). The City of Walla Walla's protected watershed area represents only a small fraction of the total watershed in terms of stream miles. Access to this habitat, however, is limited by conditions in and below the municipal intake.

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Fish barriers and lack of fish habitat in Mill Creek were identified in the Walla Walla Subbasin Plan with recommendations that flood control channel obstructions be considered priorities for restoration (Northwest Power and Conservation Council 2004). Similarly, the Snake River Salmon Recovery Plan for Southeast Washington noted that fish habitat is severely limited in Mill Creek from Gose Street to Bennington Diversion Dam (Snake River Salmon Recovery Board 2011).

The primary focus area for floodplain, habitat and riparian restoration is the lower 15 miles of Mill Creek-from River mile (RM) 0 to approximately RM 15 at 7 Mile Bridge. Conditions in this reach were assessed in the 2017 Lower Mill Creek Habitat and Passage Assessment and Strategic Action Plan; this assessment quantified many different parameters related to floodplain and habitat conditions (Tetra Tech 2017). This reach includes the MCFCP encompassing the Gose Street Bridge (RM 4.8) and Bennington Diversion Dam (RM 11.4) flood control structures as well as the roughly six-mile long concrete Mill Creek Channel through the City of Walla Walla (Tetra Tech 2017). Upstream of river mile 6.7 is the most highly urbanized reach of Mill Creek. Through this reach, the channel is severely constrained, at one point flowing through a buried concrete tunnel. The flood controlling sills in this reach are also fish passage barriers, especially at lower flows (Tetra Tech 2017).

Touchet River Subbasin

Habitat diversity and channel stability are both primary limiting factors for aquatic species in the Touchet River subbasin and lack of key habitat (pools) is a secondary limiting factor (Snake River Salmon Recovery Board 2011; Northwest Power and Conservation Council 2004). Hofer Dam, a diversion structure on the lower Touchet River was also a traditional passage barrier for migrating fish in the river. While Hofer Dam has been rebuilt with fish passage, the new structure is not providing ideal conditions.

As with much of the Walla Walla watershed, channel straightening caused by anthropogenic land uses (single-family dwellings, urban development, roads, agriculture, etc.) is a major driver of loss of floodplain functioning, channel complexity and riparian habitat throughout much of the Touchet River watershed.

Detailed Description of Strategies

This section describes the six Tier 1 floodplain and habitat strategies identified in the Strategic Plan in detail including the strategy itself, lead entities and their roles in implementing the strategy, and high-level details on implementation phases. Because they are often completed together, strategies 1.01 and 1.07 are combined under one strategy.

Strategy 1.01 and 1.07 Basin wide efforts to reconnect floodplains and restore channel complexity to reduce flood risk and improve habitat; and restore and protect riparian habitat along tributaries, small streams, and the Walla Walla River

This section discusses strategies 1.01 and 1.07. Together these strategies focus on floodplain connectivity, channel complexity and riparian habitat across the landscape to address flood risk and improve habitat conditions. Though they are listed as distinct strategies, these two approaches are closely related, often have overlapping benefits and in fact, are often combined as part of one project (Table 1).

For example, projects that are designed to connect or reconnect the river to its floodplain often include instream habitat features like large wood and constructed river features (riffles, pools, others) and removal of invasive riparian species and planting native riparian vegetation. One project like this could address all three approaches outlined in Table 1. The following sections describe how the status of floodplain and habitat health are measured and provide the most up-to-date measurements available in the basin.

Table 1: Strategic Plan Approaches to Restoring Floodplains and Habitat

Approach	Brief Description
Connecting Floodplains	Rivers can be connected to their floodplains by levee setback or removal and building new channels that encourage stream and river over-topping of banks to spread water onto adjacent floodplains; as part of these projects, floodplains may also be manipulated to develop wetlands and ponds and increase groundwater infiltration
Increasing Channel Complexity	Complexity can be restored by decreasing channel confinement caused by levees and other infrastructure and by projects that construct new river channels and add woody debris and other habitat features
Restoring and Protecting Riparian Habitat	Riparian health can be increased by better buffering riparian areas from impacts and by planting additional/new streamside vegetation.

Progress toward increasing floodplain connectivity can be measured as a percent increase in the linear amount of a river or stream channel that can naturally access its floodplain. A less direct measure of floodplain health is groundwater elevation; greater connectivity between rivers and their floodplains will raise the groundwater table in shallow aquifers. However, many other factors influence groundwater levels so drawing specific correlations between this measure and floodplain health is difficult at the watershed scale.

Commonly used measures of complexity include the number, depth and surface area of pools, percentage of stream surface area covered by large wood during base flow, the number of large wood pieces of a specific size within the bankfull and/or wetted channel per 100 meters of stream, and the presence, number, and character of riffles, runs and other river features (Cascadia Consulting 2021).

The targets identified in the Strategic Plan for reducing channel confinement are 20% or less of river miles confined for the Walla Walla River including the North and South Forks, and the same

(20% or less confined) for the Touchet River Mainstem. Floodplain connectivity in Mill Creek is complicated by the MCFCP and is discussed in more detail below.

In general, floodplain reconnection involves removing or setting back levees, setting back channelized banks, reconnecting straightened river reaches to historic channels and constructing new side channels to facilitate natural inundation and connection with the floodplain. These projects can provide multiple benefits for groundwater levels, water quality and aquatic habitat. These benefits need to be carefully weighed against flood risk and land use management goals; flood risk can be managed in project selection and design but is a critical consideration for these project types.

In addition to floodplain reconnection, Strategy 1.01 also involves restoring channel complexity. Floodplain reconnection projects often greatly increase channel complexity, but several other techniques are often paired with floodplain work to enhance the benefits. These include engineering specific river/stream features like pools and riffles and placing large wood in treated and constructed channels.

Strategy 1.07 consists of enhancing and expanding protection of existing high quality riparian habitat and, where needed, creating new or widening existing riparian buffers. Healthy, functioning riparian habitat plays numerous important roles in the watershed including providing shade to rivers and streams to help reduce stream temperatures during the hotter months, anchoring stream banks to help prevent erosion, providing habitat for terrestrial species, especially birds, and serving as a source for recruitment of large wood and other materials that can, over time increase habitat complexity.

Goals for riparian habitat from the Strategic Plan include a general goal of creating new and widening existing riparian buffers across the watershed. More specific goals for the Walla Walla River include:

- Mill Creek to E. Little Walla Walla: At least 62% of max potential riparian function;
- E. Little Walla Walla to Tumalum Bridge: At least 62% of max potential riparian function;
- Tumalum to Nursery Bridge: At least 40% of max potential riparian function;
- Little Walla Walla River to N. and S. Forks: At least 50% of max potential riparian function;
- S. Fork Walla Walla River mouth to Elbow Creek: At least 20% of max potential riparian function;
- N. Fork Walla Walla River mouth to L. Meadows Canyon Creek and L. Meadows: At least 50% of max potential riparian function.

For the Touchet River mainstem the riparian habitat goal for the reach from Coppei to Forks and Whiskey Creek is to restore at least 62% of maximum potential riparian function.

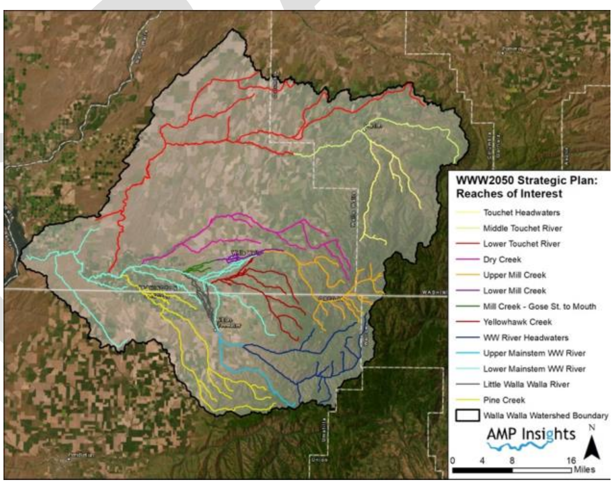
Implementation Phases: Floodplain and Channel Habitat Projects

Implementing floodplain projects and projects that increase channel complexity whether as part of the same or different projects involves the same basic phasing. At a high level, the phases include:

- geographic prioritization to determine where the projects should be implemented for greatest benefit;
- land ownership analysis to determine who owns land where priority projects are identified and determine potential for land access/landowner agreement; identify willing landowners;
- flood risk analysis to determine if projects can be implemented without increasing flood risks to private land, especially in and near urban areas;
- securing funding for priority projects;
- designing specific project parameters, including planning for all necessary permits;
- obtaining permits;
- implementing projects; and
- monitoring and adaptively managing as necessary.

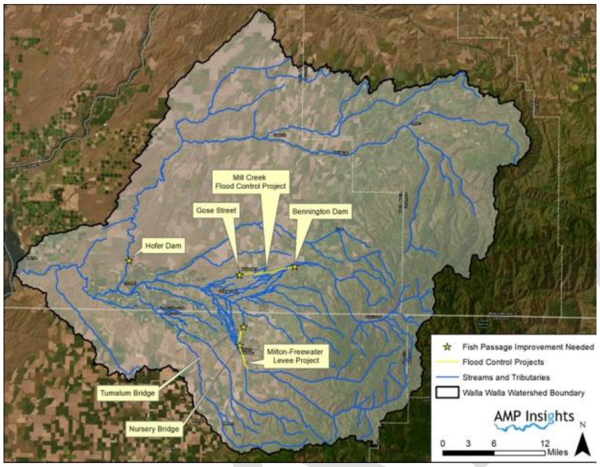
The first step is identifying priority reaches; while many of the basin's river miles are disconnected from their floodplains and/or could benefit from increased channel complexity, prioritization is required to direct limited funds and capacity to projects with the greatest potential to benefit priority aquatic habitat and species goals. All priority reaches as defined in the Strategic Plan are mapped in Figure 1.

Figure 1. Reaches of interest as defined by WWW2050 Strategic Plan.



It is also important to note that several reaches and individual projects were identified in the Strategic Plan as high enough priority that they are listed as their own Tier 1 priority strategy (including the Nursery Bridge reach below Milton Freewater, and several sites discussed in this memo on Mill Creek and the Touchet River) (**Error! Not a valid bookmark self-reference.**).

Figure 2. Specific reaches and projects where passage, habitat, floodplain and other improvements are needed.



Floodplain and channel complexity projects require access to land. Access and landowner agreements are therefore a critical consideration. The priority stream restoration reaches primarily flow through private land, requiring agreements from private landowners for implementation; access to publicly owned land also requires agreement(s) with the relevant state or federal managers. Land ownership status can be used as part of the prioritization work; once priority reaches or locations are determined for example, projects with the likeliest prospects for successful landowner agreement would naturally rise to the top. In some instances, project proponents may own or be able to acquire riparian land on which floodplain and channel complexity projects can be undertaken.

Another key consideration for these project types is flood risk analysis. Especially in a flood-prone watershed like the Walla Walla, projects need to be selected and designed carefully to avoid exacerbating existing flooding issues. Designing and implementing floodplain and channel complexity projects is technical work that requires specific engineering and hydrologic expertise. Each project has extensive site-specific considerations that need to be incorporated for successful implementation. Project types that will be implemented under this strategy are also diverse. They include levee setbacks and removals, historic channel reconnection, construction of new side channels, increasing channel length and sinuosity, and adding complexity via installation of large wood debris and other structures.

Implementation Phases: Riparian Habitat Projects

Implementing riparian habitat projects proceeds with similar phasing to floodplain and habitat complexity projects. In fact, riparian enhancement and protection is almost always part of floodplain and other habitat projects. When implementing a floodplain project, it is common to plant the newly created riparian area with native vegetation and develop plans and infrastructure (including fences) to protect the riparian area from grazing and other impacts as it is established and into the future thereafter. Occasionally however, riparian restoration and protection projects take place on their own or they occur where other projects were implemented but later in time compared to those projects' completion.

Riparian projects include a range of specific approaches. These include planting new riparian vegetation, installing and maintaining riparian protections like exclusionary fencing and removing invasive species such as knotweed, false indigo, reed canary and kocia using various mechanical or chemical treatments. Part of the overall basin approach to protecting riparian areas can also include incorporating shoreline zoning regulations into planning processes to restrict development in riparian zones (See Strategy 1.16 Increase coordination and enforcement of floodplain and riparian regulations and management between Counties and State water management entities).

At a high level, implementation phases include:

- geographic prioritization to determine where the projects should be implemented for greatest benefit, including balancing between protection of existing healthy riparian areas and establishing new projects;
- land ownership analysis to determine who owns land where priority projects are identified and determine potential for land access/landowner agreement; identify willing landowners;
- securing funding for priority projects;
- designing specific project parameters, including planning for all necessary permits;
- implementing projects; and
- monitoring and adaptively managing as necessary.

Lead Entities and Roles

CTUIR – focused basin wide; WWCD – WA only; Tri-State Steelheaders – not sure if WA only; WWBWC – Oregon mostly; Kooskooskie Commons – WA mostly and focused on urban and suburban riparian restoration; WDFW and ODFW

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Strategies Related to Specific Locations and River Reaches

1.06 Improve fish passage and habitat conditions in weired and concrete channel sections of the flood control project in Mill Creek

Unlike the previous two sections that describe basin-wide strategies, the remaining four sections describe specific projects and/or specific geographies where floodplain reconnection, channel and habitat complexity and riparian habitat projects are planned. Strategy 1.06 is focused on fish passage and habitat quality in the MCFCP.

The MCFCP begins at Gose Street at approximately river mile 4.8. Upstream of Gose Street to approximately river mile 6.7, Mill Creek consists of a channel bounded by levees; the bottom of the channel is constructed with a series of concrete and sheet pile baffles (Tetra Tech 2017). The lower parts of this reach are rural residential with urbanization and development intensity increasing moving upstream from Gose Street. There are opportunities within this reach to eliminate channel confinements and increase channel sinuosity (Tetra Tech 2017). An example project in this reach would be a levee setback and conversion of concrete channel to a naturalized stream corridor.

Recommendations to improve passage in MCFCP include modifying the sills, including notching or installing pool-forming structures in combination with a low-flow channel to increase passage success (Tetra Tech 2017). Other opportunities in this reach include actions to improve the quality of the pools formed by the sills. For example, adding large wood to some of the pools could have important refuge benefits for fish; alternating which side of the river these structures are placed in could help focus flows into a more sinuous patter and encourage growth of aquatic vegetation (Tetra Tech 2017). It is important to note however, that USACE management rules might prevent or restrict installation of large wood in the MCFCP, though it may be possible to obtain variances.

Opportunities to eliminate channel confinement in highly urbanized reach upstream of river mile 6.7 are severely limited, however, the existing channel might be transformed from its current artificial trapezoidal shape to a more naturalized shape that could include boulders and an irregular cross section to mimic natural stream features like pools and riffles (Tetra Tech 2017). Other concepts include removing the tunneled section. It is similarly difficult to improve habitat conditions in this reach without completely renovating the channel.

The Strategic Plan identified high-level goals for floodplains, channel complexity and riparian health:

- Percentage of floodplain disconnected: currently, Mill Creek in the MCFCP is between 50% and 100% disconnected from its floodplain; the minimum goal for the reach ranges between 40% and 90%, with optimal conditions between 30% and 80% (these goals are relatively low in recognition of the urban setting with strict flood control needs).
- River Complexity Index (RCI): Minimal RCI improvements of between 30% and 50% compared to current are recommended.
- Riparian vegetation: Riparian conditions are rated as "not properly functioning" for Mill Creek from its mouth to Bennington Diversion Dam. The percent of canopy coverage for the five segments in the Lower Mill Creek Habitat Assessment range from 0 to a maximum of 75% with most values at or less than 50%.

Lead entities and roles

City of Walla Walla, Tri-State Steelheaders, CTUIR, ACOE, others?

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Strategy 1.19 Improve fish passage at Gose Street

This strategy is focused on designing and completing a permanent fix for the Gose Street fish passage ladder. Gose Street is located at approximately river mile 4.8 on Mill Creek, at the lower end of the flood control channel. While a short-term fix has been installed at the fish ladder, it is not a suitable long-term option because it is was not designed to function at the full range of flows that Mill Creek can experience. The permanent fix at Gose Street may include sediment supplementation and floodplain connection above and below the site to decrease stream power and incision.

Strategy 1.23 (Mill Creek) Improve fish passage at Bennington Diversion Dam

Strategy 1.23 involves complete improvements at the Bennington diversion dam fish ladder on Mill Creek. This project is currently in the design stage now and USACE is in the process of completing preliminary designs. Implementing this strategy requires finalizing design of the improvements and then funding and implementing the design.

Lead entities and roles

ACOE, others?

Strategy 1.12 (Touchet River) Improve flow and timing of fish passage through the Hofer Dam fishway

Located at approximately river mile 5 on the lower mainstem of the Touchet River, Hofer Dam is an irrigation diversion structure diverting water into the Eastside and Westside Irrigation Districts. Prior to reconstruction in 2006, Hofer Dam was a significant passage barrier. In 2006, the Walla Walla Conservation District (WWCD), replaced the old dam with a new, automated structure with fish passage and adequate fish screens. Despite these upgrades, the Strategic Plan identified a need to improve fish passage at the dam and to address sedimentation issues at the diversion site. The Strategic Plan noted the need to work with Touchet Eastside and Westside Irrigation Districts on increasing flow through the fishway and implementing fish ladder improvements.

Lead entities and roles

WDFW, WWCD, Touchet Eastside Westside Irrigation District, others?

Possible Barriers to Implementation

This section discusses possible barriers that can slow or interfere with implementing floodplain, habitat and riparian projects. The barriers addressed here include land access and legal and regulatory issues.

Land Access

Floodplain, habitat and riparian projects require access to riparian land. 90% of the Walla Walla subbasin is privately owned, with public ownership primarily located in the headwaters areas of the basin's streams and rivers (Northwest Power and Conservation Council 2004). This means that access for implementing projects will, in most cases, require private landowner permission. Negotiating access with private landowners can be fraught; access may be withheld for many different reasons. Some landowners may simply be opposed to public agencies and/or to environmental restoration; others may fear legal and other repercussions from having habitat for ESA-listed species on their property; flood control issues are another common concern. Projects that involve creating new riparian areas or dedicating land for constructing new channels or wetlands can require taking agricultural land out of production. Even with compensation for taking land out of production, many landowners will be hesitant.

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Another challenge for implementation related to land ownership is the need for restoration within the urban areas of Milton Freewater and especially Walla Walla. The MCFCP is the most urbanized stream reach in the basin and the presence of city infrastructure (roads, bridges, flood control features, etc.) as well as private homes, businesses, and land all combine to significantly restrict restoration options within and near the city of Walla Walla.

Legal and Regulatory Barriers

Floodplain, habitat and riparian projects can require a broad array of permits and assessments. These include permits to work in streams occupied by ESA-listed species, cultural resources assessments, permits related to the Clean Water Act and permits from both federal and state related to dredging and filling wetlands. Reconnecting rivers to their floodplains in a flood-prone area like the Walla Walla watershed can be complex. Projects within the watershed's numerous floodplains require special permits and assessments to satisfy both state and federal requirements.

By themselves, legal and regulatory requirements need not stop projects from happening; the various entities in the basin that regularly undertake restoration projects are equipped and experienced to meet permitting requirements. However, these requirements can make floodplain, habitat and riparian projects complex and introduce uncertainty and delay to the implementation process.

Relationship to Other Strategies and Discussion of Contribution to Desired Future Conditions (DFCs)

This section discusses how the strategies described above relate to other Strategic Plan priorities and, more specifically, how implementing these strategies contributes to the set of Desired Future Conditions (DFCs) outlined in the Strategic Plan.

Relationship to Other Strategies

The floodplain, habitat and riparian strategies described in this Memo relate to a broad array of other Strategic Plan priorities. At a high level, floodplain and channel habitat projects provide not only habitat benefits, but also water quality and quantity benefits; these projects can help boost late summer base flows and recharge alluvial aquifers. In addition to benefits to rivers and streams, riparian revegetation projects can increase carbon capture and provide habitat for terrestrial bird and other species.

More specifically, the floodplain, habitat and riparian restoration strategies described here relate to Strategy 1.10 (Develop an overarching monitoring strategy) because they will make up a large part of the focus of monitoring work in the basin. Similarly, these projects provide a platform for meeting the goals of strategy 1.16 to increase coordination and enforcement of floodplain and riparian regulations and management between counties and state water management agencies.

Other Tier 1 priority strategies and their relationship to floodplain, habitat and riparian strategies are outlined below in Table 2.

Table 2: Relationship Between Tier 1 Priority Strategies

Floodplains, Habitat and Riparian Strategies		Related Tier 1 Priority Strategies		
Strategy Numbers	**Strategy**	**Category**	**Strategy Number**	**Strategy Name**
1.01, 1.06, 1.07, 1.12, 1.19, 1.23	Reconnect floodplains and restore channel complexity and riparian areas basin wide	Streamflow & Groundwater	1.03	Direct additional winter flow down the Little Walla Walla River to support alluvial aquifer recharge and stream function
			1.04	Water rights acquisitions to restore streamflows
			1.05	Improve and expand managed aquifer recharge (MAR)
		Water Quality	1.17	Increase infiltration of stormwater rather than discharge to surface water bodies and improve coordination and management

In addition to relationships to other strategies, floodplain, habitat and riparian restoration also help the basin meet DFCs that were outlined in the Strategic Plan. Table 3 below outlines specific DFCs influenced by the strategies outlined in this Memo.

Table 3: Specific Strategy Contributions to DFCs

Desired Future Condition	Connection with Strategies 1.01, 1.06, 1.07, 1.12, 1.19 and 1.23
Floodplains, Critical Species, Habitat, & Water Quality	
Achieve healthy, natural floodplain function	Floodplain, channel habitat and riparian restoration strategies directly address all these DFCs.
Increase access to quality habitat	
Increase riparian cover	
Increase river channel complexity and naturalize channelized streams	
Restore a natural sediment transport regime	
Meet TMDL targets	
Increase critical fish species populations and abundance levels necessary to meet delisting criteria, support sustainable natural production, and provide a fishery for Tribes and the public	Reconnecting floodplains can help increase water quality when water is stored and released from alluvial aquifers; habitat complexity also helps decrease flow velocities and reduces sedimentation and helps to lower stream temperatures; enhancing riparian

Desired Future Condition	Connection with Strategies 1.01, 1.06, 1.07, 1.12, 1.19 and 1.23
	vegetation can help lower stream temperatures
Water Supply, Streamflows, & Groundwater	
Stabilize aquifer levels to support water resources and water for people and farms	Reconnecting floodplains can increase late summer base flows and enhance alluvial aquifer storage
Enhance instream flows to meet instream flow targets for critical species	
Increased natural infiltration, acreage, and duration of inundation	
Land Use & Flood Control	
Reduce flood risk for people and cities	Increased floodplain storage can help reduce the magnitude of flood flows
Create climate resilience for basin water resources	Reconnecting floodplains can increase late summer base flows and enhance alluvial aquifer storage; enhancing riparian vegetation can help increase carbon capture
Quality of Life	
Sustain and improve quality of life in the Walla Walla Valley by supporting community health with clean and reliable domestic water supply as well as opportunities for outdoor recreation and sustainable tourism	Improving floodplain connectivity and riparian habitat supports clean water supply and enhances the overall health of the watershed's rivers and streams; all of this boosts quality of life for people in the Walla Walla Valley

Future Work and Funding Needs

Future Implementation and Budget Needs

Table 4 below provides a list of high priority specific projects and funding needs for the strategies discussed in this memo.

Table 4: Priority Projects and Funding Needs Identified in Strategic Planning Process

Strategy	Floodplains & Habitat Action	Sponsor	Funding Needed ($)
1.01	Touchet Mainstem-15 Restoration Project Design	CCD	$75,000
1.01	Walla Walla River Restoration Design RM 30-25	WWCCD	$37,500
1.01	Cottonwood Creek Habitat Improvement Phase 2	WWCCD	$22,500
1.01	Touchet River Mile 42 Restoration Phase 1	WWCCD	$75,000
1.01	Touchet River Mile 42 Restoration Phase 2	WWCCD	$150,000
1.01	Touchet Main Stem Gailey Property Design	CTUIR	$65,000
1.01	Touchet Main Stem Gailey Property Restoration	CTUIR	$75,000
1.01	Touchet Main Stem Gailey Property Restoration Phase 2	CTUIR	$75,000
1.01	Yellowhawk Creek Fish Passage Improvement	CTUIR	$50,000
1.01	Walla Walla River Frenchtown Floodplain Reconnection and Habitat Improvements	CTUIR	$90,000
1.01	Smyth-Paup Mill Creek Habitat Improvements	CTUIR	$90,000
1.01	Walla Walla River Bridge to Bridge Phase 3	TSS	$99,750
1.01	Walla Walla River Bridge to Bridge Phase 4 Design	TSS	$10,000
1.01	Touchet River Mainstem Project 14 Design	CCD	$97,500
1.01	Touchet River Mainstem Project 10 Restoration	CCD	$75,000
1.01	Mill Creek FbD Implementation- Phase 2	WWCCD	TBD
1.01	Mill Creek FbD Implementation- Phase 3	WWCCD	TBD
1.01	McNary Wildlife Refuge Habitat Design	CTUIR	$15,000

Strategy	Floodplains & Habitat Action	Sponsor	Funding Needed ($)
1.01	North Fork Walla Walla River Flood Plain and Habitat Restoration Project RM 3.6-4.3	WWBWC	$296,462
1.01	Couse Creek Low-Tech Process-Based Habitat and Floodplain Restoration Project	WWBWC	$0
1.01	Coppei Creek Project Area C-7 Implementation	WWCCD	$100,000
1.01	Mill Creek Floodplains by Design Assessment	WWCCD	$100,000
1.06	Mill Creek Fish Passage 5th and 6th Ave Bridges	City of WW, TSS	$3,000,000
1.06	Mill Creek Passage - Division to Roosevelt	TSS	$2,000,000
1.06	Mill Creek Passage - 6th Ave Extension	TSS	$206,000
1.06	Mill Creek Passage - Spokane to Park	TSS	$206,000
1.06	Mill Creek Passage Design - 3rd to Colville	TSS	$195,760
1.06	WDFW Mill Creek project implementor (0.5 FTE)	WDFW	$175,806
1.06	Mill Creek Low Flow Channel	Corps of Engineers	$0
1.07	Capacity to assist implementor groups and decision makers: Assumes 2.5 FTE/year for facilitation, education, outreach	WWCCD, WWBWC, Snake River Salmon Recovery, TSS, Kooskooskie Commons, Lower WW River Group, Touchet Levee Group	$200,000
1.07	Developing Programs to Address Riparian Habitat in Urban Locations	WWCCD, Kooskooskie Commons	$160,000
1.09	Feasibility Study for WWRID Eastside POD change	WWRID, CTUIR	TBD
1.19	Mill Creek Gose Street Assessment and Design	TSS	$182,112
1.19	Mill Creek Gose Street Passage Implementation	TSS	$2,500,000

Strategy	Floodplains & Habitat Action	Sponsor	Funding Needed ($)
1.23	Bennington Dam Fish Ladder	Corps of Engineers	$0
		Total:	**$10,424,390**

Future Implementation and Budget Needs

- Add additional detail on gaps/needs for implementation into the future reference funding memo

- General description of funding source(s) reference funding memo

Future Considerations and Potential Next Steps

To be drafted once feedback is incorporated from the Implementation Work Group

References

Cascadia Consulting. 2021. "Walla Walla Water 2050 Strategic Plan." 20-12–003. Department of Ecology, State of Washington.

HDR Engineers, Michael, Barber, WSU, and Steward and Associates, Inc. 2005. "Walla Walla Watershed Plan."

Hoverson, Eric. 2004. "Habitat and Fisheries Assessment of the Mainstem, East and West Fork LWWR Systems." Milton-Freewater, OR: Confederated Tribes of the Umatilla Indian Reservation.

Hoverson, Eric, and Jesse Schwartz. 2005. "HABITAT ASSESSMENT OF THE SOUTH FORK AND MAINSTEM WALLA WALLA RIVER: WALLA WALLA BASIN NATURAL PRODUCTION MONITORING AND EVALUATION PROJECT." Pendleton, OR: Confederated Tribes of the Umatilla Indian Reservation.

Northwest Power and Conservation Council. 2004. "Walla Walla Subbasin Plan." Northwest Power and Conservation Council.

Snake River Salmon Recovery Board. 2011. "Snake River Salmon Recovery Plan for SE Washington." Washington Governor's Salmon Recovery Office.

Tetra Tech. 2014. "Lower Walla Walla River Geomorphic Assessment and Action Plan." Confederated Tribes of the Umatilla Indian Reservation.

———. 2017. "Lower Mill Creek Final Habitat and Passage Assessment and Strategic Action Plan." Confederated Tribes of the Umatilla Indian Reservation.

Wolcott, Brian. 2010. "Little Walla Walla River Assessment and Initial Action Plan." Walla Walla Basin Watershed Council.

Appendix A – Nursery Bridge Milton-Freewater Levee Reach Memo

Commented [AE10]: Reviewers: are there any updates you would like to make to this memo since its release in 2021?

TECHNICAL MEMORANDUM

To: Ecology, CTUIR and OWRD and the Walla Walla Implementation Work Group

From: Amanda Cronin and Davíd Pilz, AMP Insights and Jim Mathieu, Northwest Land & Water

Date: November 2021

Subject: Nursery Bridge-Milton-Freewater Levee System Strategy Scoping

The Walla Walla Water 2050 Strategic Plan was completed in June of 2021 and included 60 strategies to manage water resources to meet multiple benefits that were prioritized into three tiers. Tier 1 included 23 strategies, including Strategy 1.09 to "Protect and improve fish passage at Nursery Bridge and implement levee setback projects upstream and downstream of Milton-Freewater". This memo recognizes that there is a long history of efforts to address the habitat and flood managements challenges associated with this reach of the river, that work on this strategy has already begun and that the Confederated Tribes of the Umatilla Indian Reservation's Department of Natural Resources (CTUIR) in particular has taken recent leadership for summarizing the completed work and future phases of the work.

1. Background

The habitat, fish passage and flood management issues associated with the Milton-Freewater Levee system and Nursery Bridge drop structure are complex and addressing these issues is critical to overall salmonid recovery in the Walla Walla Basin (see Figures 1 and 2). CTUIR has been a leader in working toward solutions to address this multifaceted habitat challenge. This section summarizes a factsheet on the levee system developed by CTUIR in August of 2020 (Department of Natural Resources Fisheries Program 2020).

Below the town of Milton-Freewater in Oregon, the mainstem Walla Walla River flows through the five-mile-long Milton-Freewater Levee Project (referred to as "the Flood Control Project") see Figure 2. Constructed in 1951, the levee system constrained what was formerly a physically diverse, unconstrained river network flowing across a five-mile-wide alluvial fan to its current width of approximately two hundred to three hundred feet (NOAA Fisheries, Pacific Coastal Salmon Recovery Fund 2021). Habitat for the watershed's two ESA listed species (Middle Columbia River summer steelhead and Bull Trout) and reintroduced Spring Chinook, along with other culturally and economically important species has been severely impacted by the Flood Control Project.

The Project was constructed from 1949-1952 in response to frequent flooding. The levees were breached for the first time in flood events in 1964-1965. In 1967, the US Army Corps of Engineers (USACE) repaired the levees and constructed a 14-foot-tall drop structure downstream of Nursery Bridge to help stabilize the bridge. Constraining the river and installing the drop structure have caused numerous problems for fish and aquatic habitat. Despite several iterations of installation and repair of fish passage around the drop structure, fish are only able to pass upstream today thanks to an emergency grade-controlled channel that allows access to what is known as the east fishway. In addition to fish passage problems at the drop structure, the Walla Walla River through the Flood Control Project has experienced significant downcutting (incision), and general channel degradation; the river is no longer connected to its floodplain, has very little riparian vegetation and shading, and limited channel complexity to support aquatic habitat.

The goal of the Milton-Freewater Levee system floodplain restoration project (Strategy 1.09 in the Walla Walla 2050 Strategic Plan) is to address these ongoing issues; to improve floodplain-riverine processes and decrease channel incision, enhance fish passage and rearing habitat, and decrease surface water seepage (losses) while maintaining the flood risk management features of the Flood Control Project. Meeting this goal requires a complex, large, multi-phased project. The remainder of this memo briefly describes work completed to date on the reach of the Walla Walla River just upstream of Nursery Bridge in Milton-Freewater to the Stateline, planned additional phases of work and project needs, how the Flood Control Project integrates with other priority projects in the watershed and the potential benefits and impacts of the project at the site and watershed levels. Appendix A provides a more in-depth summary of the seepage studies that have been done to date in the reach and briefly discusses the implications of these on future restoration work in this reach.

Figure 1. Nursery Bridge Drop Structure Detail (US Army Corps of Engineers 2019)

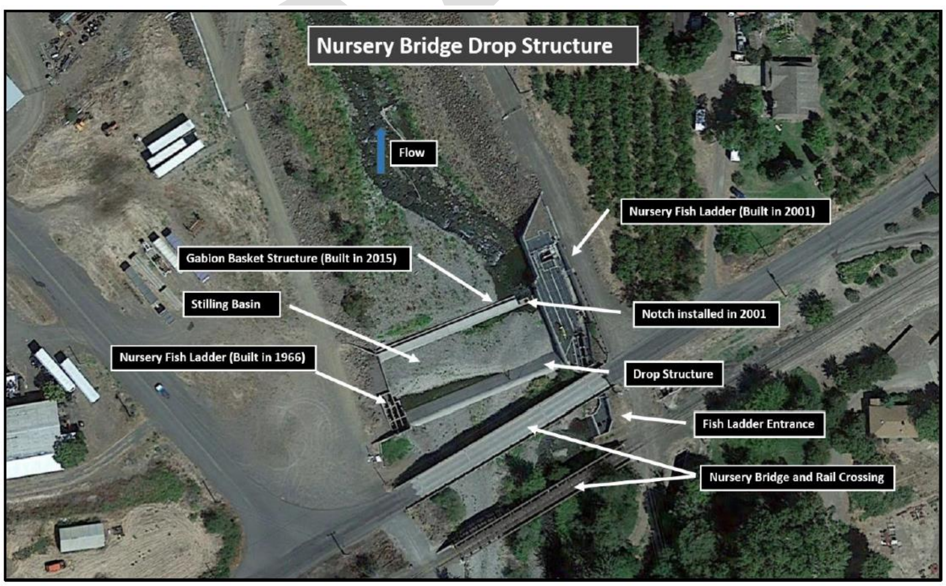
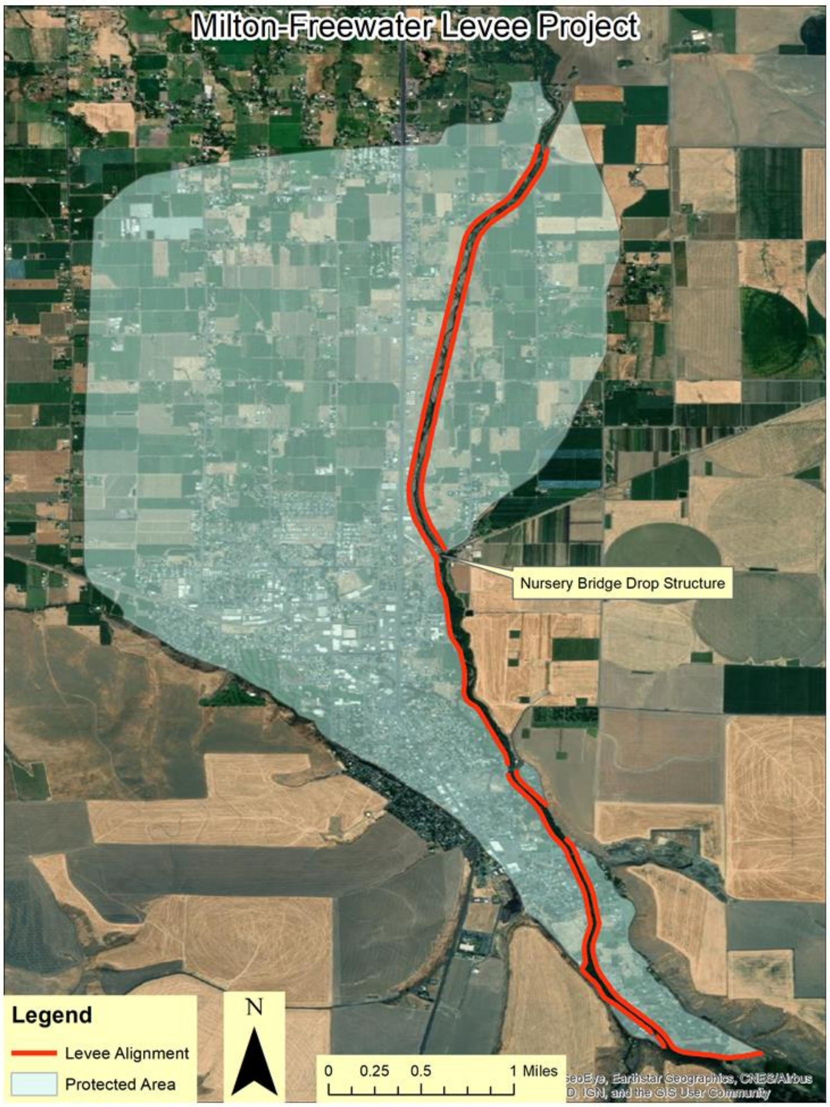


Figure 2. Milton-Freewater Levee Reach Project (Department of Natural Resources Fisheries Program 2020)



2. Work Completed to Date

There is a long history of planning for various management alternatives in this reach of the Walla Walla River and this memo does not attempt to describe all the work completed to date.

This memo focuses on recent efforts to organize the work into a three-phase effort currently lead by CTUIR.

In 2016, CTUIR and partners began a design effort to develop long-term fish passage solutions and address downcutting below the Nursery Bridge drop structure. A key takeaway of this process was the conclusion that hydraulic conditions downstream of the structure will not be improved by placing structures in the channel; sufficiently improving conditions will require increasing the flood-prone width of the river and riparian corridor through the flood control project from 200 feet to a minimum of 400 feet. There is also an ongoing process to address fish passage at the drop structure.

The current plan for the Nursery Bridge project envisions three phases. Phase I included construction of the emergency grade control structure in 2014 along with planning of additional phases. Phase II is focused on addressing channel erosion and deposition impacting fish passage, and operation of the east fishway and the Eastside irrigation diversion (provides irrigation water to the Walla Walla River Irrigation District, WWRID, in Oregon). To date, completed work on Phase II includes initial design work and scoping of options, including notching the Nursery Bridge Drop Structure/ Dam and moving the WWRID's Eastside point of diversion to the Little Walla Walla River (LWWR) from the Nursery Bridge location. Finally, Phase III will involve restoring a more natural channel to the river for approximately five miles below the Nursery Bridge Drop Structure.

3. Moving Forward

This section outlines key next steps (primarily as described by CTUIR) as well as roles and responsibilities for these steps and funding and timing considerations.

4. Next Steps

The project/strategy is organized into three phases.

Phase I (Complete 2014): Phase I of the project is largely complete and involved a temporary fix for reconnecting the fishway with the channel which had become disconnected due to flooding and channel downcutting. Ongoing needs for Phase I include monitoring project effectiveness, and ongoing operations and maintenance as needed. Phase 1 of the project also included Section 216 Initial Appraisal Report was completed in 2019 for the Nursery Bridge reach. This study concluded that "Based on the project's history of repeated failures and increasing risk of a major failure. . . there is sufficient federal interest investigating the feasibility of modifying the Walla Walla River Flood Control Project." The 2019 Initial Appraisal report also concluded that the Flood Control Project did not account for the sediment transport issues through the reach and recommended additional study which is being initiated in Phase II (Boen 2021; US Army Corps of Engineers 2019).

Phase II (Address habitat needs immediately above and below Nursery Bridge): The focus of Phase II is to address the impact of erosion and deposition on fish passage at Nursery Bridge Drop Structure in the quarter mile reaches above and below the Drop Structure. The project engineer (hired by CTUIR) and project team are currently discussing options for proceeding. The current favored approach involves notching the Nursery Bridge Drop Structure and moving the

WWRID's Eastside point of diversion upstream to the LWWR (where the primary WRRID and Hudson Bay diversion is located). Moving the Eastside diversion would also require figuring out a way to convey irrigation water back across the river to serve water users on the Eastside and one potential solution for this is to run a pipeline across the 8th Street Bridge or run a pipeline through the levee from west to east. A final memorandum of agreement (MOA) solidifying the conceptual approach is the most immediate need/next step. Additional steps required in the short-term include:

- Complete designs for modifications at Nursery Bridge and the WWRID diversion (funded by Bonneville Power Administration) (2022)
- Obtain USACE funding for an Aquatic Ecosystem Restoration Feasibility Study under Section 206 (2022)
- Obtain permitting clearance (2022)
- Secure cost share (2022).

Construction of Phase II is currently estimated to total $2 million or more; if desired timelines are met, construction is anticipated to begin in 2023. CTUIR has submitted a letter to USACE to request an Aquatic Ecosystem Restoration General Investigation Study.

Phase III (Address habitat needs in the 5-mile reach downstream of Nursery Bridge): Phase III work includes conceptual designs and construction to set-back levees in the five-mile reach downstream of Nursery Bridge. The goal of Phase III is to restore a more natural floodplain to address downcutting, erosion, fish habitat and passage, and streamflow seepage losses. Even though Phase II is not complete, work on Phase III has begun and can proceed in parallel to Phase II and ongoing Phase I activities. Conceptual designs for the five-mile reach below the Nursery Bridge Drop Structure are ongoing. CTUIR and the project team are coordinating to secure commitment for non-federal cost share for a USACE Aquatic Ecosystem Restoration General Investigation (under Section 206 of Public Law 104-303) to develop restoration and design alternatives for the five mile reach downstream of Nursery Bridge. Agreement on design and approach is anticipated by 2023 with designs and funding secured in 2024. Construction of Phase III could then begin in 2025 and would last for several years. Current project cost estimates are $10 million.

5. Roles and Responsibilities

CTUIR is currently the project lead for securing funding, providing technical input, and coordinating other key partners which include the following entities.

Walla Walla River Irrigation District and **Hudson Bay District Irrigation Company** currently divert from the Walla Walla River at Cemetery Bridge at the Little Walla Walla River headgate. WWRID also has a small diversion of about 5.5 cfs at Nursery Bridge called the Eastside diversion and consideration is being given to moving their point of diversion upstream to the Little Walla Walla River headgate which would eliminate irrigation diversion from the Walla Walla River. WWRID will need to be closely involved with design and construction work as it relates to any change in their Eastside diversion.

Milton-Freewater Water Control District (MFWCD) currently owns the levees and has responsibility for managing and maintaining the Milton-Freewater Levee system. MFWCD will need to be involved in any proposed changes to the levee system. In the past they have collaborated on various studies and planning processes to explore management changes that take into account flood control and habitat needs (GeoEngineers 2012).

Oregon Water Resources Department will need to be involved in any water rights permitting issues especially pertaining to the potential move of the Eastside diversion upstream to the Little Walla Walla Diversion.

Walla Walla Basin Watershed Council is also a key leader in the Basin on habitat restoration and has worked to improve conditions in the reach in the past through restoration projects and feasibility studies/reports (GeoEngineers 2012). The watershed council will likely be a strong partner on various elements of Phase II and III.

NOAA/NMFS will also need to be involved in management changes as they relate to ESA-listed fish habitat issues as will **ODFW**. Currently, NMFS has been participating by reviewing Phase II designs. Overall, their goals are to decrease infrastructure in the channel and decrease harden streambanks through the reach.

The **USACE** built the levees and the Nursery Bridge Drop Structure and has requested funding for an Aquatic Ecosystem Restoration Feasibility Study under Section 206 and if this request is granted the USACE will take the lead on a Feasibility Study for Aquatic Ecosystem Restoration. USACE participation as the lead for the Feasibility Study and congressional authorization of possible design and construction under Phase III is crucial to the success of this project.

Leadership from **Umatilla County, OR** will also be important to moving forward with any major changes to the management of the Levee system as well as support in securing federal or state funds for upgrades. The City of Milton-Freewater and local property owners will also be key partners in managing the reach in the future. If levees setbacks are to occur it will likely mean acquiring land from willing private landowners along the leveed reach.

6. Funding and Timing

Addressing all of the challenges in this reach of the river will take many years. Table 1 below summarizes timing and estimated funding needs in the context of the 2023-2025 fiscal year and beyond, based on estimates provided by CTUIR (Department of Natural Resources Fisheries Program 2020). The actual budget will be driven by the completed designed for Phase II and Phase III construction activities which will also need to include land acquisition, engineering, design and permitting costs. Given these complexities, Table 1 estimates are likely lower than actual costs.

Table 1. Timing and Rough Budget Estimates

Timing	Activity	Estimated Budget Need
2021-2022	Complete Designs for Phase II work	Funding secured
FY 2023-2025	Complete Construction for Phase II	$2m
2025-2027	Construct Phase III	$10m

Moving forward, the additional phases of the Nursery Bridge project will require an additional study in partnership with the USACE. The study requested of USACE by CTUIR is an Aquatic

Ecosystem Restoration General Investigation (GI) Study under Section 206 of the Water Resources Development Act of 1996. GI studies are done in situations where the ongoing need for the project is not in question and the 2019 Appraisal report completed in Phase 1 established this need (US Army Corps of Engineers 2019).

USACE has included this study in their request for funding from the U.S. Congress, but funding has not yet been secured. USACE operates on a 3-year budget cycle and anticipates also including the request for the Ecosystem Restoration Study in their FY23 budget. However, this request would have to compete on a national level and against other request for Ecosystem Restoration Feasibility Studies. The recently completed Mill Creek General investigation study took 5 years to complete which was relatively fast for this type of study and was credited to broad community support (Boen 2021). If the conclusion of the Feasibility Study is that ecosystem restoration is justified and feasible then the project would move forward to design and construction. The design and construction phase would require the non-Federal sponsor to sign a coast share agreement with USACE (costs split 65% Federal and 45% sponsor). Furthermore, the non-Federal sponsor would need to provide all of the real estate required to complete the project and would be responsible for all operation and maintenance when the project is completed.

7. Implementation Barriers

Differing perspectives on future water management: One significant challenge to making habitat improvements in this reach is coming to agreement with the MFWCD and the USACE on physical alterations to the flood control system. As mentioned, the MFWCD has authority for managing the levee system and as such their approval will be needed to make changes to the system. Currently, MFWCD is completing the minimal amount of maintenance required by the USACE and receives USACE assistance in the case of major flood events that require significant repairs (Boen, 2021). There could be resistance from MFWCD to changing the current management of the project, so working closely with MFWCD to understand current and future management needs will be important. It may be possible to design solutions that result in less maintenance for MFWCD and more security for flood management while also achieving the goals of CTUIR and other partners.

The USACE also has very specific management directives and the pace of change can be slow. For example, there has been frustration expressed with current polices related to vegetation management on the levees with the USACE recommending and often requiring vegetation removal (US Army Corps of Engineers 2019) and CTUIR and others preferring to leave vegetation on the levees to support riparian and aquatic habitat. Larger scale changes to the Nursery Bridge, drop structure, and levee system will require cooperation with the USACE and agreement on management changes as well as securing USACE funding for future work.

Funding Availability: Aside from the proposed major infrastructure investment being considered as an "anchor project" under the Bi-State Flow Study(Walla Walla Watershed Flow Study Steering Committee 2019), upgrading this reach to meet all the multiple objectives is among the most expensive projects in the Basin. Yet the Nursery Bridge reach represents the largest bottleneck for critical species due to inadequate fish passage, streamflow, and floodplain and riparian habitat. As such, significant funding will be needed to complete Phase II and Phase III and any subsequent work and multiple funding sources will be required to achieve success. A secure source of revenue would also be needed for long-term operation and maintenance.

Landowner willingness: Phase III of the project envisions significant levee setback projects and floodplain and riparian restoration work which will primarily need to occur on land that is currently privately held. This will require purchasing land and potentially conservation and other easements from willing landowners. Given the high number of private landowners in this reach, the task of reaching out, coordinating, and negotiating with many individual landowners will be significant.

Water rights changes in Oregon: Switching WWRID's diversion from the Nursery Bridge Drop Structure to the LWWR would require a formal water right change approved by OWRD. The change will be analyzed to determine whether it might impact instream flows and other water rights on the LWWR and if legal injury might occur, that could prevent the change from being approved or require modifications of the proposed change. However, initial conversations with ODWR have indicated that this proposed change would not be a significant barrier to the project, particularly since WWRID already has an established point of diversion at the Little Walla Walla Diversion.

8. Relationship to Other Strategies

Walla Walla 2050 aims to advance a coordinated and strategic package of strategies for healthy water management into the future. The Strategic Plan identified 60 strategies of which 23 were ranked as Tier 1 (highest priority) strategies(Cascadia Consulting 2021). However, implementation of this package of strategies is complex and understanding the relationships between strategies is a crucial part of achieving the goals of the 2050 Strategic Plan. This section provides a framework for assessing the relationships between *Strategy 1.09* (Protect and improve fish passage at Nursery Bridge and implement levee setback projects upstream and downstream of Milton-Freewater) and the other Tier 1 strategies. Table 2 provides a quick snapshot of the relationship between the strategies and categorizes them as one of the following;

- *Directly complimentary-helps achieve the same goals*: full implementation of Strategy 1.09 will directly compliment another strategy by helping achieve the same desired future conditions.
- *Complimentary-but not directly related*: full implementation of Strategy 1.09 will compliment another strategy by helping achieve many of the same desired future conditions.
- *Co-dependent strategy*: benefits of implementing Strategy 1.09 would be significantly reduced without full implementation of the co-dependent strategy.
- *Potential conflict or complicating issues*: there is a possibility for the implementation of Strategy 1.09 to contradict or be out of sync with a potentially conflicting or complicating strategy.

One significant caveat to these categorizations, is that the relationship with other strategies depends on a thorough implementation of Strategy 1.09. Meaning that if only Phase II is implemented for example, and the floodplain restoration work envisioned in Phase III is not implemented, the Strategy may not be complimentary to other Strategies in the WWW2050 Plan.

Table 2: Relationship with Other Strategies if Strategy 1.09 is Implemented at Scale

Relationship	Strategy Number	Strategy Name	Narrative Description
Directly complimentary - helps achieve the same goals	1.01	Reconnect floodplain and restore channel complexity Basin wide to reduce flood risk and improve habitat	Phase III will be designed to meet these objectives within the Milton Freewater Flood Control Project.
	1.07	Restore and protect riparian habitat along tributaries, small streams, and the Walla Walla River Basin wide	Phase III will be designed to meet these objectives within the Milton Freewater Flood Control Project.
	1.17	Increase infiltration of stormwater rather than discharge to surface water bodies and improve coordination and management	Protecting water quality will insure that habitat and other benefits of the NB project are not degraded or undermined
Complimentary - but not directly related	1.02	Support the ongoing analyses of the Bi-State Flow Study and work toward a recommendation on implementation of the preferred alternative	Increased flow through this reach will enhance habitat and floodplain restoration envisioned by the NB project
	1.04	Work to acquire senior water rights from willing sellers basin-wide and transfer water rights instream	Both strategies seek to improve streamflow to support critical species.
	1.06	Improve fish passage and habitat conditions in weired and concrete channel sections of flood control project in Mill Creek	Similar project type, different location' addresses similar limiting factors for critical species
	1.08	Decrease surface water diversions or substitute for basalt wells during low flow periods	Any effort to decrease reliance on surface flows could potentially benefit streamflow in this reach or other reaches across the Basin.
	1.12	Improve flow and timing of fish passage through the Hofer Dam fishway	Similar project type, different location' addresses similar limiting factors for critical species
	1.13	Expand and support Aquifer Storage and Recovery (ASR) to maintain groundwater quality and capacity	Enhancing groundwater quantity in the basin will contribute to overall species and watershed health
	1.14	Improve coordination and response to drought management Basin-wide	The strategy will improve fish passage and habitat conditions at all flow levels including low flows exacerbated by drought
	1.18	Upgrade Dayton wastewater treatment plant to meet Ecology requirements and watershed community environmental goals	Enhancing and protecting water quality anywhere in the basin will contribute to overall species and watershed health
	1.19	Improve fish passage at Gose Street long term	Similar project type, different location' addresses similar limiting factors for critical species
	1.20	Improve agricultural irrigation water use metering and reporting programs in WA and OR by installing telemetry and improving data use by agencies and water users	The proposed WWRID Eastside POD change offers chance to install enhanced metering/monitoring if needed
	1.21	Additional Bi-State coordination on groundwater regulation	Increased coordinatrion on groundwater regulation will help address further stress on gorundwater supplies that support the river and out of stream users.
	1.22	Implement conservation tillage and soil erosion BMPs to decrease nonpoint source pollution	Protecting water quality via conservation tillage help imporve water quality basin wide
	1.23	Improve fish passage at Bennington Diversion Dam	Similar project type, different location' addresses similar limiting factors for critical species
Co-dependent strategy	1.11	Address legal implications of Bi-State surface water management and protection of instream flow across the state border and protection of instream flow within States	Finding a solution to protecting flow downstream of the leveed reach is crucial to overall flow improvements in the mainstem Walla Walla River.
	1.15	Expand and fund streamflow gages throughout the Basin	A new streamflow gauge at the Stateline is a recommendation of Phase III of the Strategy.
	1.16	Increase coordination and enforcement of floodplain and riparian regulations and management between Counties and State water management entities	Existing regulation related to the levee system will need to be addressed to achieve the goals of this strategy in coordination with the County, the State, the Flood Control District and the ACOE.
	1.10	Develop an overarching monitoring strategy and adaptive management plan for fish, habitat, and water to inform actions and evaluate effectiveness	An overarching monitoring strategy should be developed with this Strategy in mind, both in terms of ensuring any monitoring strategy can capture benefits from the strategy and adaptively managing for the project work in this reach.
Potential conflict or complicating issues	1.05	Improve and expand managed aquifer recharge (MAR)	Depending on the locations and goals of MAR sites they could positively or negatively impact flow through the Milton-Freewater Leveed reach. Additional analysis may be needed to understand the complexity of recharged water and benefit to stream flow and groundwater users.
	1.03	Direct additional winter flow down the Little Walla Walla River to support alluvial aquifer recharge and stream function	Directing winter flow down the Walla Walla could be compatible with this Strategy if all parties agree on the details of the diversion quantity and timing and beneficiaries.

This reach of the river is critical for instream and out-of-stream water resources and supports multiple benefits including: irrigation diversions, flood management for the City of Milton-Freewater, fish passage and habitat for critical species all of which are integrated into the strategies categorized as "directly complimentary or "complimentary" in Table 2. Given the multifaceted nature of this project, any work to improve upon this reach has the potential to overlap with many other strategies under the WWW2050 Plan.

For example, two specific areas of overlap are managed aquifer recharge and irrigation efficiency. The WWRID is currently working with Farmer's Conservation Alliance on considerations for upgrading their delivery system which currently utilizes the natural channel of the Little Walla Walla River through the town of Milton-Freewater. One concept currently under discussion is the idea of a dual delivery system to convey irrigation water through a leaky natural channel (to maximize recharge) in the winter and a nonleaky pipeline in the summer when flows are lower and conservation is desired (Teresa Kilmer, 2021). WWBWC and CTUIR are currently analyzing the LLLWR system to best understand losing and gaining reaches and the implications for future managed aquifer recharge. Given the complications associated with tracking benefits of MAR and locating MAR sites for out of stream and or instream benefit, this strategy is categorized as having potentially complicating issues.

There are four strategies that are considered co-dependent, meaning that success of each strategy is tied to the implementation of the other strategy. For example, finding a solution to legal protection of water instream in Oregon across the state line is critical to improving flows downstream of the Milton-Freewater reach and a new streamflow gauge at the state line may need to be established to measure and manage those flows. Similarly, a comprehensive monitoring strategy will also be crucial to tracking and understanding the changes in habitat as a result of floodplain restoration work in the Milton Freewater reach of the river.

9. Potential Benefits of Strategy 1.09

Once Phase III is implemented this strategy will provide multiple ecological, social, and cultural benefits that are briefly described in narrative form below. Once restoration designs are completed for Phase I and II these benefits can be further articulated and quantified to estimate the potential impact.

Improved Fish Passage: Fish passage through the Flood Control Project and past Nursery Bridge is crucial for Bull trout, Steelhead and Spring Chinook and this project seeks to achieve unimpeded passage for these and other critical species.

Floodplain and riparian habitat restoration: Phase III will achieve significant habitat improvement in the reach from Nursery Bridge to the Stateline. Given the current poor state of habitat, setting levees back to allow for improved floodplain function and riparian vegetation has the potential to dramatically improve habitat conditions to benefit critical species.

Retention of flood management capacity for the City of Milton-Freewater and Umatilla County: Any changes made to the flood control project including levee setbacks will be designed to maintain or even improve on the original flood management goals of the Flood Control Project.

Decreased seepage loss during low flows and improve sediment transport: There is a current estimate of about 50% seepage loss from around Nursery Bridge to the Tumalum Bridge, this project would seek to decrease seepage losses by restoring a more natural sediment transport regime by allowing finer particles to move past the Nursery Bridge Drop Structure and widening the floodplain to slow the streamflow and allow for sediment deposition.

Improved irrigation diversion infrastructure: Phase II of the project will improve the Eastside irrigation diversion which will eliminate the need for the Irrigation District to physically alter the channel in order to divert water down the Eastside ditch improving operations for the district and avoiding further in-channel disturbance.

Enhanced recreational and aesthetic value of Walla Walla River through the Milton-Freewater: This reach of the Walla Walla River runs right through the town of Milton-Freewater, Oregon. The focus of the community in the past has been primarily on flood control however in the future in addition to flood management the town would benefit from a more naturalized stream channel in many ways. A healthy flowing river through town could provide significantly improved aesthetic value. There may be opportunities to improve recreational access to the river which could be used in promoting, tourism and nature-based economic development in the fast-growing town.

9.1 Discussion of Contribution to Desired Future Conditions

Strategy 1.09 to "Protect and improve fish passage at Nursery Bridge and implement levee setback projects upstream and downstream of Milton-Freewater" contributes to 13 out of the 16 Desired Future Conditions (DFCs) incorporated into the Walla Walla Strategic Plan (Cascadia Consulting, 2021). Table 3 summarizes the DFCs that are most likely to have positive benefit as a result of improving fish passage and floodplain habitat with Strategy 1.09.

Table 3: Intersection of Nursery Bridge Strategy and Desired Future Conditions

Desired Future Condition	Water Acquisition for Instream Flows
Achieve healthy, natural floodplain function.	One of the explicit goals of this strategy is to improve floodplain function through a five mile reach of the Walla Walla River
Increase access to quality habitat by addressing human caused fish passage barriers	Providing adequate fish passage and healthier riverine conditions through this reach is critical to allowing all three critical species to access the more intact upper headwater for spawning and rearing.
Increase riparian cover	Phase II of this project will seek amore naturalized stream channel including more areas with riparian vegetation.
Increase river channel complexity and naturalize channelized streams.	The project will seek to add in channel complexity by adding root wads and other materials instream setting back levees and encouraging the restoration of riparian vegetation
Increase critical fish species population and abundance levels necessary to meet delisting criteria, support sustainable natural production, and provide a fishery for Tribes and the community	The fish passage and habitat benefits of this project are necessary to achieve recovery and fisheries goals given the migratory importance of this reach to access to upstream spawning areas
Reduced flood risk for people and cities	The project will seek to maintain or increase the current level of flood protection for the City of Milton Freewater
Restore a natural sediment transport regime	The project seeks to allow for more movement of sediment past Nursery Bridge as well as increased deposition in the floodplain downstream of the drop structure
Meet TMDL targets	Improved riparian and in channel conditions will positively impact temperature, flow and sediment
Create climate resilience	Water acquisition to help enhance low flows helps create climate resilience for streams that that are expected to experience lower streamflows due to less snowpack and a changing precipitation regime.
Increased natural infiltration, acreage, and duration of inundation	Phase II of this project will widen the floodplain to slow the flow and increase natural infiltration.
Enhance instream flows to meet instream flow targets for critical species	While specific contributions due to this strategy are unknown, the goal of this strategy is for floodplain restoration and improved sediment transport to improve baseflows in the summer time
Sustain and improve quality of life in the Walla Walla Valley	Maintaining the flood management benefits of the reach while providing an enhanced recreational resource through the town of Milton-Freewater will improve the quality of life for the broader community
Increase streamflow, habitat, and water use monitoring to support better water resource management and adaptive management	Monitoring water quality, streamflow, habitat conditions and sediment transport will be an important aspect of understanding the benefits of this project and future management

10. Potential Next Steps and Future Considerations

As discussed, addressing habitat and flood control needs in the Nursery Bridge Milton-Freewater Levee Reach is incredibly complex particularly, given the multitude of habitat related challenges facing this critically important reach of the river. In their 2020 factsheet on the project, CTUIR listed several next steps and these are integrated in the following headings along with some observations from the Walla Walla 2050 Implementation Working Group for future consideration by the Tri-Sovereign and the Walla Walla 2050 stakeholder process.

Phase II

Establish framework for collaboration amongst key partners for Phase II: There is an immediate need under Phase II to organize stakeholders and arrange for formal agreement via a memorandum of understanding on the preferred alternative for fish passage rectification at the Nursery Bridge drop structure (Department of Natural Resources Fisheries Program, 2020). As mentioned previously, this design work may also include moving the WWRID's Eastside point of diversion upstream to the Little Walla Walla River diversion at Cemetery Bridge. Potential parties to an MOA would include, CTUIR, WWRID, the Milton-Freewater Water Control District and USACE.

Confirm the project as a high priority through the WW2050 process: This reach of the river is the gateway to headwater spawning habitat for the three critical fish species and a viable restoration will be necessary to achieve the goals of the Walla Walla 2050 Strategic Plan. This project was selected as a Tier 1 priority in the Strategic Plan along with 23 other priority strategies. Phase II of the Strategic Plan will require further refinement of the Tier 1 priorities and a funding request package of the most shovel-ready priority projects. The Tri-Sovereigns and the WWW2050 Stakeholders have expressed a strong interest in prioritizing action in this reach in Phase II of the Walla Walla 2050 work.

Complete design and construction for improvements at Nursery Bridge: Funding has been secured for a redesign at the Nursery Bridge Drop Structure to allow for full fish passage and address downcutting but the final design needs to be selected. Once a design is complete, regulatory approval for construction will be needed and construction can be completed in 2023 (Department of Natural Resources Fisheries Program 2020).

Phase III

Obtain USACE approval for Phase III work: CTUIR has submitted a letter to USACE to request an Aquatic Ecosystem Restoration General Investigation Study. A broad coalition of support will help expedite obtaining approval and funding for the study from the USACE (Boen, 2021). The results of the study will guide the development of designs that address impaired floodplain-riverine processes within the Project reach.

Complete design and construction for floodplain restoration work: Construction of Phase III will be very significant and span multiple years and will require the project sponsor to acquire a real estate interest in any properties involved in the levee setbacks or floodplain restoration projects. Permitting requirement of all in-channel and adjacent construction activities will also need to be acquired. There may also be a need for remedial investigation and possibly cleanup of gravel pits or industrial sites that are incorporated into floodplain restoration work.

Build broad community support: This project is complex and includes various potential benefits including flood control, irrigation infrastructure improvements habitat restoration, fish passage improvements, and recreational and aesthetic resources in the town of Milton-Freewater. Crafting a strong partnership between multiple interests for a broad coalition of support will help expedite funding for the USACE study and design funding as well attract other essential funding sources.

Many of these next steps could be supported and receive cost-share from the Walla Walla 2050 process. The Tri-Sovereigns and the 2022 Advisory Committee will need to review this suggested list for accuracy and make suggestions for next steps in the context of the larger portfolio of Walla Walla 2050 Phase II work beginning in 2022.

11. References

Boen, Cindy. 2021. Personal Communication, Army Corps of Engineers.

Cascadia Consulting. 2021. "Walla Walla Water 2050 Strategic Plan." 20-12–003. Department of Ecology, State of Washington.

Department of Natural Resources Fisheries Program. 2020. "Fact Sheet Milton Freewater Levee System." CTUIR.

GeoEngineers. 2012. "Alternatives Analysis & Conceptual Design Milton-Freewater Levee and Habitat." Walla Walla Basin Watershed Council.

NOAA Fisheries, Pacific Coastal Salmon Recovery Fund. 2021. "Nursery Bridge Reach Phase II Fish Passage and In-Stream Habitat Enhancement II." NOAA Fisheries. https://www.webapps.nwfsc.noaa.gov/apex/f?p=309:19:::::P19_PROJECTID:48461176.

Teresa Kilmer. 2021. Personal Communication, Walla Walla River Irrigation District.

US Army Corps of Engineers. 2019. "Initial Appraisal Report Walla Walla River Flood Control Project."

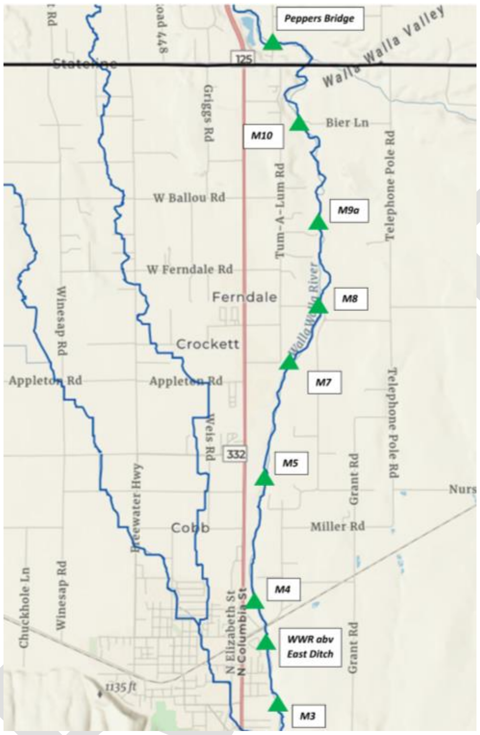
Walla Walla Watershed Flow Study Steering Committee. 2019. "Walla Walla River Bi-State Flow Study: 2019 Flow Study Update." Office of Columbia River, Washington State Department of Ecology.

Appendix A-1. Seepage Loss Summary

Seepage investigations have been conducted along the WWR by both OWRD/USGS/Ecology (in August 2020 and August 2021) and the WWBWC (since 2000). WWBWC has worked collaboratively with CTUIR, OWRD, and Ecology on these investigations to understand the hydraulic conditions of the WWR — specifically, to identify gaining and losing reaches. Gaining reaches are fed by the underlying aquifer system; in losing reaches, river flows move into the subsurface.

Seepage stations have been established to measure discharge (flow) in the river, tributary inflow to the river, and diversion outflow from the river. **Figure 1** shows the locations of WWBWC seepage stations, which have provided measurements for studies conducted between 2011–2016 (WWBWC, 2012a; WWBWC, 2012b; WWBWC, 2013; WWBWC, 2014; WWBWC, 2015; WWBWC, 2017). OWRD measures seepage at many established WWR stations and has also added some of its own. One such station, "WWR abv (above) East Ditch" (**Figure 1**), is located just above the Eastside Milton-Freewater diversion (the "Eastside ditch"), about 0.1 mile above Nursery Bridge, the river drop (dam) structure, and the fish ladder.

Figure 1: Select Seepage Stations for WWR Flow Measurements (locations are approximate)



1. Results

1.1 Seepage Loss as a Percentage of Flow

OWRD is currently processing 2020–2021 seepage data; however, preliminary calculations show that approximately 50 percent of WWR flow moves from the riverbed into the subsurface between the "WWR above East Ditch" (upstream) and Tum-A-Lum Bridge (Birch Creek Road; downstream) on August 12, 2020 and on August 24, 2021 (pers. comm., OWRD/USGS, 11/29/21). River flow was approximately 40 cubic feet per second (cfs) at the "WWR above East Ditch station" on each of these dates. This information indicates losing conditions for this reach on each date in August.

The OWRD results were compared to prior seepage measurements made by WWBWC and its collaborators using data from both M3 and M4 to Tum-A-Lum Bridge. M3 and M4 are located just upstream and downstream of "WWR above East Ditch." The comparison uses 20 seepage loss calculations based on WWBWC measurements from June, July, August, and/or September for years 2011–2016 (WWBWC, 2012a; WWBWC, 2012b; WWBWC, 2013; WWBWC, 2014; WWBWC, 2015; WWBWC, 2017).

The average seepage loss as a percent of the flow at stations M3 (0.5 mile upstream of Nursery Bridge) and M4 (immediately downstream of Nursery Bridge) is 55 percent, a finding that is consistent with OWRD's calculations. It is also generally consistent with river – alluvial fan settings throughout the arid western U.S., where flowing rivers at the apex of an alluvial fan are often perched above a deeper water-table aquifer and lose water to the aquifer through the riverbed. Exacerbating this condition is the presence of the flood-control levees along this reach and the drop (dam) structure at Nursery Bridge, which have likely contributed to greater river losses. Such seepage losses — and the resulting instream flow reductions — are a limiting factor for fish passage, particularly during seasonal low flows.

1.2 Seepage Loss/Gain Variation by Reach and Year-to-Year

Table 1 shows select 2011–2016 seepage measurements made by the WWBWC between Peppers Bridge Road and 0.5 mile upstream of Nursery Bridge. Values were normalized by dividing the flow loss or gain by the length of the reach to obtain seepage per mile of reach. Both seepage losses and gains occur on the lower four downstream reaches bounded by stations M7 and M10. Seepage loss is dominant in the three upstream reaches bounded by stations M3 and M7.

Table 1: Seepage per Mile, from Station Peppers Bridge to M3, for Six Seepage Runs, 2011-2016

	River Mile		Reach Length	Seepage per Mile of Reach (cfs/mile) on...							
Walla Walla River Reach	From	To	(miles)	*6/29/2016*	*7/30/2015*	*7/24/2014*	*7/16/2013*	*7/24/2012*	*7/21/2011*	Average[3] (cfs/mile)	Standard Deviation
Pepper Bridge to M10 [1]	41.90	42.94	1.04	0.88	-1.47	5.04	-0.97	-2.25	3.55	0.80	2.9
M10 to Mauer Lane (M9a)	42.94	43.76	0.82	0.50	4.22	1.31	3.97	2.65	2.99	2.61	1.5
Mauer Lane (M9a) to Tum-A-Lum Bridge (M8)	43.76	44.43	0.67	1.52	-4.18	0.24	-1.66	-0.26	1.67	-0.45	2.2
Tum-A-Lum Bridge (M8) to M7	44.43	44.87	0.44	-3.14	-0.23	-3.43	-2.56	2.65	-5.73	-2.07	2.9
M7 to M5	44.87	45.96	1.09	-9.66	-13.43	-1.79	-15.09	-8.67	-10.77	-9.90	4.6
M5 to Nursery Bridge (M4)	45.96	46.62	0.66	-14.91	-0.54	-27.79	-9.78	-7.6	-7.61	-11.37	9.3
Nursery Bridge (M4) to M3 [2]	46.62	47.26	0.64	-25.77	-4.08	-16.4	-7.94	-8.23	-18.23	-13.44	8.1

Notes:
[1] WA-OR Stateline is within this reach at approximate River Mile 42.1
[2] Nursery Bridge Dam and Fish Ladder are within this reach at approximate River Mile 46.7
"-" seepage indicate loss from WWR to subsurface
"+" seepage indicates flow gain from subsurface to WWR
[3] "Average' and 'Standard Deviation' statistics for 6 seepage runs (2011 - 2016) by reach

Table 2 also shows the variation in river flow losses ("–") and gains ("+") from the Nursery Bridge vicinity to the Washington – Oregon state line. Seepage variation is highest in the three upstream reaches bounded by stations M3 and M7 (green background), as indicated by their larger standard deviation values.

Several factors may play a role in reach loss/gain averages and year-to-year variation observed from the Nursery Bridge vicinity to the Washington – Oregon state line (M3 downstream to M10). Understanding these factors and their interdependence would inform future restoration approaches. Factors may include:

- Hydraulics of the river at Nursery Bridge drop (dam) structure, fish ladder, and adjacent levees which creates high-energy flow conditions immediately downstream.
- Lack of relatively fine sediments downstream of Nursery Bridge that favors higher riverbed permeability.
- Subsurface sediment texture and spatial distribution beneath and adjacent to the current river channel.
- Presence of historic gravel mining where gravel pits are directly hydraulically connected to the river.
- Variation in the longitudinal river gradient.
- Measurement uncertainty.

2. Focus Area for Floodplain Restoration Work

To reduce seepage loss between the Nursery Bridge vicinity downstream to Tum-A-Lum Bridge (Birch Creek Road), levee setbacks and Nursery Bridge dam modifications have been proposed. These modifications would create a larger meander area for the river thereby reducing flow velocities; they would also allow downstream movement of finer sediments that would potentially accumulate and form a less permeable riverbed. **Table 1** suggests that future floodplain restoration work should focus on the upstream reaches from M3 (just upstream of Nursery Bridge) to M8 (Tum-A-Lum Bridge), where efforts for retaining instream flows (via reduction in losses) may be most impactful in terms of instream flow. However, a range of restoration approaches should be considered, and contingency plans should be developed to adapt to constructed restoration outcomes. Note that reduction in reach losses through an engineered project(s) means a reduction in recharge to the underlying aquifer; analysis of this recharge reduction impact would be worthwhile.

Prior to restoration work, detailed studies will be needed to characterize the hydrogeologic conditions and the texture and distribution of sediment in this reach—longitudinally, laterally, and at depth. The 'lateral' characterization should include sufficient data around gravel pits to understand the current and future influence these pits have, or could have, on river flow. For example, levee setback work should consider permeability of the sediments that are incorporated into the new channel or restored floodplain areas. Further study and potentially modeling of reach specific sediment transport and hydraulic movement under various floodplain restoration scenarios would help to understand potential future seepage and impact on streamflow.

References

Walla Walla Basin Watershed Council, 2012. 2011 Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.

_____________________________, 2012. 2012 Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.

_____________________________, 2013. 2013 Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.

_____________________________, 2014. 2014 Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.

_____________________________, 2015. 2015 Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.

_____________________________, 2017. Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, Touchet River, and Yellowhawk Creek. Includes results for 2016 and 2017. Accessed online at http://www.wwbwc.org/images/Monitoring/Reports/.