W.T. Wooten Floodplain Management Plan

Washington Department of Fish and Wildlife

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TABLE OF CONTENTS

OVERVIEW

INTRODUCTION

The Wooten Wildlife Area Floodplain Management Plan (FMP) was developed by the Washington Department of Fish and Wildlife (WDFW) as an integrated, cross-program effort to improve conditions within the Tucannon floodplain. Over the years the Tucannon River floodplain function has been compromised by certain factors including infrastructure encroachment and deterioration, large wood removal, degradation of riparian habitats, channel straightening, dike building and devastating floods and fires. The goals of the FMP were developed to address these factors: 1) protection and restoration of ecosystem functions of the Tucannon River, floodplain, and riparian habitats, 2) enhancement of fishing, hunting, camping, wildlife viewing and other recreational activities, 3) improvement of habitat conditions for Endangered Species Act (ESA) listed salmonids (as well as other aquatic species), 4) improvement of wildlife habitats, and 5) protection and enhancement of critical infrastructure.

These goals are consistent with the agency mission ("preserve, protect and perpetuate fish, wildlife and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities"), the 2011-17 WDFW Strategic Plan, and will compliment ongoing habitat restoration efforts to recover spring Chinook and other ESA listed stocks within the Tucannon basin. The WDFW Strategic Plan has guiding principles to conserve and restore biodiversity, ensure the health of ecosystems, and ensure sustainable social and economic use of Washington's fish and wildlife and their habitats. It emphasizes both conservation and recreation as equal priorities for WDFW. Goal 1 of the Strategic Plan is to "Conserve and protect native fish and wildlife." This is complimented by Goal 2: "Provide sustainable fishing, hunting and other wildlife-related recreational experiences". The goals of the FMP stated above and the proposed actions following in this document will help the Department meet these two goals in the W.T. Wooten Wildlife Area (Wildlife Area). This FMP addresses issues associated with the Tucannon Lakes and other WDFW infrastructure while seeking to enhance recreational uses and complement the habitat enhancement goals of federal, tribal, state, and other watershed partners. The FMP is a model for the Conservation Initiative approach that has been initiated within WDFW. The Conservation Initiative is an agency-wide commitment to emphasizing conservation and improving how we work

together -- both internally across programs, and externally in cooperation with other governments, organizations and citizens -- to better maintain healthy ecosystems for the benefit of all species, including humans.

The FMP is driven by several factors including the current condition of the Tucannon Lakes and associated infrastructure, and the increased focus on recovery of spring Chinook in the Tucannon River. Large portions of many of the Tucannon Lakes are currently within the floodplain of the Tucannon River. This restriction of the river reduces many important ecological functions of the floodplain. In addition to direct impacts to the floodplain the deteriorated condition of the Tucannon Lakes have other associated issues including: non-compliance with Washington Department of Ecology's (WDOE) Dam Safety regulations, failing surface diversions, continued intake and outlet operation/maintenance or needed upgrades, potential thermal degradation of the river environment, and sedimentation in the lakes that reduces carrying capacity for stocked rainbow trout and recreational fishing. We have separated our proposed actions in this FMP into 6 initiatives: 1) Outreach; 2) Tucannon Lakes; 3) Habitat Enhancement; 4) Campgrounds; 5) Roads, Bridges, Culverts; 6) Camp Wooten.

The Snake River Salmon Recovery Board (SRSRB), Northwest Power Planning Council (NPPC) and Bonneville Power Administration (BPA) will have an increased emphasis in implementing habitat enhancement projects in the Tucannon River over the next 6 years in order to meet obligations to recover spring Chinook as outlined in the Columbia River Power System Biological Opinion. BPA, in cooperation with the SRSRB, is prepared to spend between $6-9 million on river and floodplain habitat enhancement projects in the Tucannon basin before 2018, much of it directed to the Wildlife Area. In addition the SRSRB distributes funds from the State of Washington Salmon Recovery Funding Board (SRFB), much of which is directed to the Tucannon basin to help recover spring Chinook and three other federally listed species (summer steelhead, fall Chinook, and bull trout). This provides a unique opportunity for WDFW, co-managers, partners and interested public to restore habitat conditions, and river and floodplain functions on the Wildlife Area and to build partnerships for restoration off of the Wildlife Area, while at the same time enhancing educational opportunities and recreational experiences.

W.T. WOOTEN WILDLIFE AREA DESCRIPTION

The Wildlife Area was recommended for purchase in 1940 as "Tucannon Deer and Elk Range" and the majority of the purchases took place between 1941 and 1943. The original land purchase (12,000 acres) was intended to minimize conflicts between wildlife and livestock and provide land preserved exclusively for the use of wildlife and outdoor enthusiasts. Since then the total acreage has increased to more than 16,000. The Tucannon River originates on US Forest Service (USFS) lands south of the Wildlife Area. The river flows 17 miles through the Wildlife Area and includes major tributaries such as

Cummings Creek and the Little Tucannon River. The Tucannon River supports a wide variety of aquatic life including four species of ESA listed salmonids (fall and spring Chinook, summer steelhead and Bull trout), all federally designated as threatened. Lands in and around the Tucannon River are historic wintering areas for big game and receive year-round use by a variety of game and non-game species of wildlife. During the 1970's access to the Wildlife Area was improved with modifications to the roadway and public-use increased dramatically. The majority of visitors (75-80 percent) come from the Tri-Cities (Kennewick, Richland and Pasco), with the remainder coming from Spokane, Walla Walla, the Lewiston/Clarkston valley, Dayton, and Pomeroy, etc. (see Appendix A, as an example). The Wildlife Area currently averages 120-140,000 visitor days per year, with each major holiday attracting 3,000 to 5,000 visitors.

Eight artificial lakes were created in the 1950's along with the Tucannon Fish Hatchery. Approximately 88,000 "catchable" sized rainbow trout (~10-12 inches each), and over 2,000 "jumbo" sized rainbow trout (~15-17 inches and 1.5-2 lbs each), are stocked by the Lyons Ferry/Tucannon hatchery complex into the Tucannon Lakes annually to provide popular put-and-take fisheries. In addition, the Tucannon Hatchery serves a valuable role within the Lyon's Ferry Hatchery Complex towards meeting Lower Snake River Compensation Plan (LSRCP) mitigation and ESA recovery goals for steelhead and spring Chinook in the Tucannon River. This hatchery complex spawns adults, incubates eggs, rears juveniles and releases smolts of both species for the Tucannon River, as well as other hatchery production programs for southeast Washington.

THE IMPORTANCE OF FLOODPLAINS

River floodplains are important for a variety of reasons. A floodplain and its associated water body form a complex and dynamic system that supports many ecological functions that benefit the natural system and humans. For example, floodplains may reduce the severity of floods by allowing floodwaters to spread out and slow down. This dissipates floodwater energy which reduces erosion and degradation of stream banks and channels. When floodwaters slow down, sediments settle out on the floodplain - maintaining or improving water quality. These sediments, in turn, provide fertile soils for riparian vegetation growth in the floodplain. Another function is the filtration of nutrients and pollutants from runoff. As floodwaters rise, the nutrients and pollutants they carry are filtered through the vegetation of the floodplain and some are captured for use by plants. Properly functioning floodplains affect stream channel function and fish habitat by improving or maintaining channel sinuosity (meanders), which captures and retains more large woody debris (LWD), and salmon carcasses. Both of these biotic inputs increase productivity of the ecosystem, and LWD and meanders create pools and cover that are favored by many fish life stages and increase abundance and production of salmonids. These floodplain functions also help recharge groundwater by encouraging more rainfall and snowmelt to infiltrate the

floodplain rather than flow overland and be carried downstream. The groundwater is then more slowly filtered to aquifers and streams. This can mean more flow and moderated water temperatures during those times of year (summer *and* winter) when flows and temperatures may reach critical levels in relation to fish life. As stated in the previous paragraph, the sediments that are filtered out of high flows improve the soil quality of the floodplain, making it an area of high plant growth and diversity. This in turn provides habitat for a number of wildlife species. Riparian areas are generally the highest value wildlife habitats on the landscape of southeast Washington and approximately 85% of terrestrial species in Washington use riparian habitats for essential life activities. Riparian habitats support higher diversity and abundance of fish and wildlife than any other habitat, and some species are strongly associated with riparian habitats. Protecting riparian habitat may yield the greatest gains for fish and wildlife across the landscape while involving the least amount of area (Knutson, K. L., and V. L. Naef. 1997).

CAPITAL REQUEST

Funding to implement this FMP is anticipated from a variety of sources. WDFW will seek state capital funding and use those funds to match funding from BPA, SRSRB, and other grant sources. A request for Capital funding has been developed and submitted for consideration in the 2013 legislative session. This Capital Request is a result of this plan, and its funding is the key to accomplishing the goals of the FMP. In particular, matching state capital funds with habitat restoration funds provided by our local and federal partners provides an opportunity to cost share on projects that accomplish conservation, infrastructure and recreation goals. This capital request was divided into 3 phases:

1. **2013-2015, Feasibility** (Development, design and permitting of projects, outreach and early action projects)
    a. Project Design and Permitting
    b. Early Action Projects – Campground Relocation
    c. Habitat Enhancement (Spending Authority-BPA)
    d. Additional Project Development Under Initiatives
2. **2015-2017, Project Implementation**
    a. Rainbow Lake Enhancement
    b. Deer Lake Enhancement
    c. Tucannon Powerline
    d. Habitat Enhancement (Spending Authority-BPA)
    e. Additional Projects Developed Under Phase 1
3. **2017-2019 Project Implementation**
    a. Beaver-Watson Lake Enhancement
    b. Spring Lake Enhancement
    c. Big Four Lake Decommissioning
    d. Camp Wooten Reconfiguration/Relocation
    e. Habitat Enhancement (Spending Authority-BPA)
    f. Additional Projects Developed Under Phase 1

The first biennium is dedicated to feasibility. This includes project development, design and permitting, as well as public outreach and some early action projects. Feasibility and associated public outreach are

described below. The early-action projects currently consist of relocating two campgrounds out of the floodplain. These projects are ready to be conducted and do not require any additional planning or designs.

Lakes Initiative projects are prominent in the second and third biennia (2015-2019). The FMP team has identified lake rehabilitation as a priority, designed to improve and enhance recreation, reduce impacts to ESA listed species, and improve stream and floodplain function for the Tucannon River. The current condition and configuration of most of the 8 Tucannon Lakes is an ecological detriment to Tucannon River floodplain function and causes the need for nearly constant maintenance. All but 2 lakes constrict portions of the Tucannon River floodplain, causing the river to be channelized, incised, and stream habitats to be simplified and degraded. All of the lakes drain back into the river, potentially leading to increased river temperatures. The dams of 6 lakes are in violation of the WDOE Dam Safety regulations. The lakes retain sediment and have to be periodically dredged. Six of the lakes rely on surface diversions from the Tucannon River. The current diversions have had periodic failure issues in recent years impacting both the public fishing availability of the lakes and potentially entraining or impinging ESA listed salmonids. Carrying capacity of these lakes is impacted by the factors mentioned above, threatening the viability of the trout fishery provided as mitigation for construction of the lower Snake River Dams. The WDFW request for funding for state funds for capital projects is $16 million over three biennia, including $1.8 million for 2013-2015.

Habitat Enhancement is a part of all 3 of the biennial requests. BPA has established programmatic funding through the SRSRB to restore spring Chinook habitat in the Tucannon basin. BPA will spend about $1.3 million per year through 2018. Restoration strategies and recommendations were developed based on limiting factors identified in the Tucannon Subbasin Plan (2004), Snake River Salmon Recovery Plan (2006 and 2011), and The Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA, 2011, Appendix D). A list of projects organized into tiered groups was developed; 75 % of the top tiered projects are located on the Wildlife Area. This means that between $6-9 million could be spent on habitat enhancement projects on the Wildlife Area between now and the end of the 2017-2019 biennium. Our Capital Request includes a request for spending authority to utilize up to $2.6 million per biennium ($6.5 million total) to address the habitat enhancement funding that could come from federal sources to WDFW for habitat enhancement work on the Wildlife Area.

WDFW has completed its prioritization of Capital Projects and submitted this list to the Office of Financial Management in preparation for the 2013 legislative session. The Capital Request titled “Wooten Wildlife Area-Improve Floodplain”, was the ranked third project (out of 74) submitted by the agency (Appendix BP). The request is over three biennia and totals $22.5 million. This includes $16 million in state funds and $6.5 million in federal fund spending authority as described above.

FEASIBILITY, PERMITTING AND DESIGN

Much of the success of the FMP depends on the successful relocation or reconfiguration of a majority of the Tucannon Lakes. Several conceptual plans for the lakes have been developed and discussed with WDFW Capital Projects and Asset Management Program (CAMP) staff. There is a great deal of uncertainty and risk (operationally and fiscally) associated with these projects at this stage of development. Most of these plans call for increasing both the surface area and depth of the lakes, as well as identifying alternative water sources to reduce the need and/or amount of surface diversion currently taken from the Tucannon River. The availability of water and the unknown geomorphology of the areas that would need to be excavated contribute to the high risk and uncertain costs of the proposed projects. A feasibility study would alleviate many of these unknowns and solidify the costs for the implementation phases (15-17 and 17-19 biennium). In addition to managing risk, the Tucannon Lakes and the Wildlife Area are a vital part of the local economy and culture, therefore it is incumbent on us to conduct a thorough public outreach at the same time we are designing these projects to gather important public input and increase public awareness. In order to be successful, projects associated with the FMP must be well supported by the public and cooperating agencies.

The focus of the feasibility study would be the Lakes Initiative projects, however, given the interconnectedness of activities within the floodplain all initiatives should be considered as part of the study, whether or not projects identified undergo analysis. Suggested areas to be covered by the feasibility include:

1. Tucannon Lakes
    a. Cost Estimates
    b. Hydro-geology analysis (Geo Tech analysis)
        i. Water supply, water rights
        ii. Geological conditions
    c. Channel Migration Zone Analysis
    d. Full Design-Construction Ready
    e. Permitting
        i. Cultural
        ii. SEPA (on full FMP?)
        iii. Federal Consultation
        iv. County/State
    f. Prioritization/scheduling

2. Campgrounds (*Note: The two Campgrounds remaining in the floodplain are proposed for relocation under the 13-15 Capital Request.) and infrastructure*

a. Explore other improvements to campgrounds, both to improve aesthetics and habitat conditions.
b. Infrastructure-Roads/Crossings/Facilities/other
c. Develop Plan(s)-
d. Synchronize with Lakes Projects - Note: Any plans to reconfigure lakes will potentially affect other infrastructure including roads, bridges and access sites
e. Power Line Plan (burial or alternative energy source, or other?)
f. Hatchery Facilities
g. Develop Long term Recommendations

3. Camp Wooten
    a. Plan (alternatives) to Reduce Floodplain Footprint
    b. Reconfiguration
    c. Relocation
    d. Designs-Costs

4. Habitat Enhancement
    a. Feasibility study will not be necessary for planning and designing Habitat Enhancement Projects. Ongoing planning efforts within the Basin adequately address this need.
    b. Study should consider these efforts and planning documents to ensure that designs and plans are well coordinated.
    c. The development of the study should be in collaboration with coordinating groups already working in the Tucannon basin, including the Tucannon Technical Committee, the Snake River Board RTT, and the SRSRB and staff.

5. Outreach
    a. Develop Outreach Plan – early action
    b. Outreach should be conducted during the Feasibility study
    c. Assist WDFW (WDFW to be the lead) in outreach functions
    d. Assist with materials and handouts

- NOTE: Any feasibility study should take into account, and be consistent with, the Snake River Salmon Recovery Plan and Columbia Conservation District Tucannon Geomorphic Analysis. The consultant should work closely with the WDFW District 3 Team.

INITIATIVES

The balance of the FMP is divided into 2 sections. The Initiatives define the major areas of work that must be completed to make the FMP successful. The Initiatives should serve as the focus of the FMP and will not change (though additional Initiatives could be added). Following the Initiatives, the Projects section outlines discrete projects that will be conducted as part of these Initiatives. Any projects developed for the FMP should be consistent with a listed or newly identified Initiative. The goals of the FMP will be accomplished by developing, designing and implementing projects under 6 Initiatives: 1) Outreach; 2) Tucannon Lakes; 3) Habitat Enhancement; 4) Campgrounds; 5) Roads, Bridges, Culverts; 6) Camp Wooten.

OUTREACH

Outreach is included as an Initiative in the FMP because of the importance of coordinating with watershed co-managers, user groups, the public, and maintaining or building public support for management of the Wildlife Area. The FMP cannot be considered successful without the input, awareness and support of the public and our partners. The Wildlife Area is managed for use by the public for a variety of recreational activities and it is key to salmon habitat improvement efforts. It is important that outreach efforts contact as much of the interested public and as wide a variety of user groups and co-managers as possible.

While development of a specific strategy will identify user groups and organizations to target, there are several organizations that will be the key to outreach efforts. The Wildlife Area has a Citizen's Advisory Group (CAG) that meets annually to review the Management Plan Updates and give input on activities on the Wildlife Area. The CAG consists of local landowners, sportsmen, and stakeholder groups (e.g.. Confederated Tribe of the Umatilla Indian Reservation (CTUIR), Wenaha Game Association, SRSRB, Columbia County commissioner, Last Resort KOA owners). The CAG is a useful tool in obtaining public input, as well as getting the word out about projects we are planning on the Wildlife Area. The SRSRB was formed as a result of the Salmon Recovery Act of 1998. This board is responsible for the implementation of the Snake Region Salmon Recovery Plan and thus has a vested interest in the Tucannon system, which features 4 ESA listed salmonid species. The SRSRB has regional representation including local governments, tribes, citizens and conservation groups. Washington Department of State Parks (State Parks) leases (from WDFW) and operates the Camp Wooten Environmental Learning Center (Camp Wooten) within the Wildlife Area to educate youth about the environment. Camp Wooten is within the floodplain and may be affected by the FMP, and thus discussions with State Parks should occur early in the process. Several sportsmen's organizations (e.g. Tri-state Steelheaders-, Richland Rod

and Gun Club, etc.) will also be contacted by WDFW to discuss concepts and to maintain communications regarding the FMP.

An outline of the major components of the outreach strategy is contained in the Projects section of this document. Some initial outreach by WDFW is currently underway. WDFW staff has met with the SRSRB and the Wildlife Area CAG to present and discuss the FMP. Other stakeholder groups will be contacted in fall and winter of 2012. The formalized outreach strategy will be developed and begin to be implemented during the FMP feasibility study during the 2013-2015 biennium. This will allow 1-2 years for initial outreach prior to major projects being conducted. WDFW will continue to build the relationships with the public and our stakeholder groups during the implementation phase of the FMP. We will hold periodic public meetings to inform the public about the status of ongoing projects and to inform/seek input on any new proposed projects. Similar meetings will involve the watershed habitat restoration partners and fisheries co-managers.

TUCANNON LAKES

The artificial lakes on the Wildlife Area (Figure 1) were mostly constructed between 1953 and 1955. The Tucannon Lakes are some of the most popular fishing lakes in southeast Washington and they are of high value for meeting LSRCP mitigation goals for resident trout fisheries in Washington. The Tucannon Lakes' current recreational purpose is primarily to mitigate for lost fishing opportunities due to the construction and operation of the four lower Snake River Dams. These fisheries are provided via funding from the LSRCP (USFWS) to achieve an annual goal of 67,500 angler days of fishing for resident species. The trout fisheries in just four (Rainbow, Deer, Spring and Blue) of the Tucannon Lakes during the first half of the fishing season in 2003 have been estimated to provide nearly 20,000 angler days, and contribute over $750,000 per year to the economy (Mendel and Trump 2008). The lakes provide very popular fishing for the nearby residents of Columbia, Garfield, Walla Walla, and Asotin Counties, as well as the Tri-cities (Pasco, Kennewick, and Richland, WA (Appendix A).

The current condition and configuration of most of the lakes is an ecological detriment to the Tucannon River floodplain function and causes the need for nearly constant maintenance. All but Spring and Blue lakes constrict the floodplain of the Tucannon River, causing the river to be channelized and incised. Six of the eight lakes are in violation of the WDOE's Dam Safety regulations. The WDOE Dam Safety regulations and the issues and opportunities for each of the lakes are summarized in Appendix C. WDOE has very strict vegetation restrictions and the dams themselves are visibly leaking in spots. The lakes retain sediment and are losing carrying capacity for maintaining put-and-take trout fisheries, therefore they should periodically be dredged out. At least 6 of the lakes are currently in need of dredging (Curl and Blue Lakes were recently dredged). All of these issues have led to increased

operational expenses. Spring and Blue Lakes are also the only lakes that do not rely on a surface diversion from the Tucannon. The current diversions from the Tucannon River have had periodic failure issues; a condition that will only increase as the floodplain function is restored and the river becomes more dynamic. In recent years the Deer Lake and Beaver-Watson Lake intakes have been particularly problematic impacting both agency financial resources and the availability of these lakes to the fishing public.

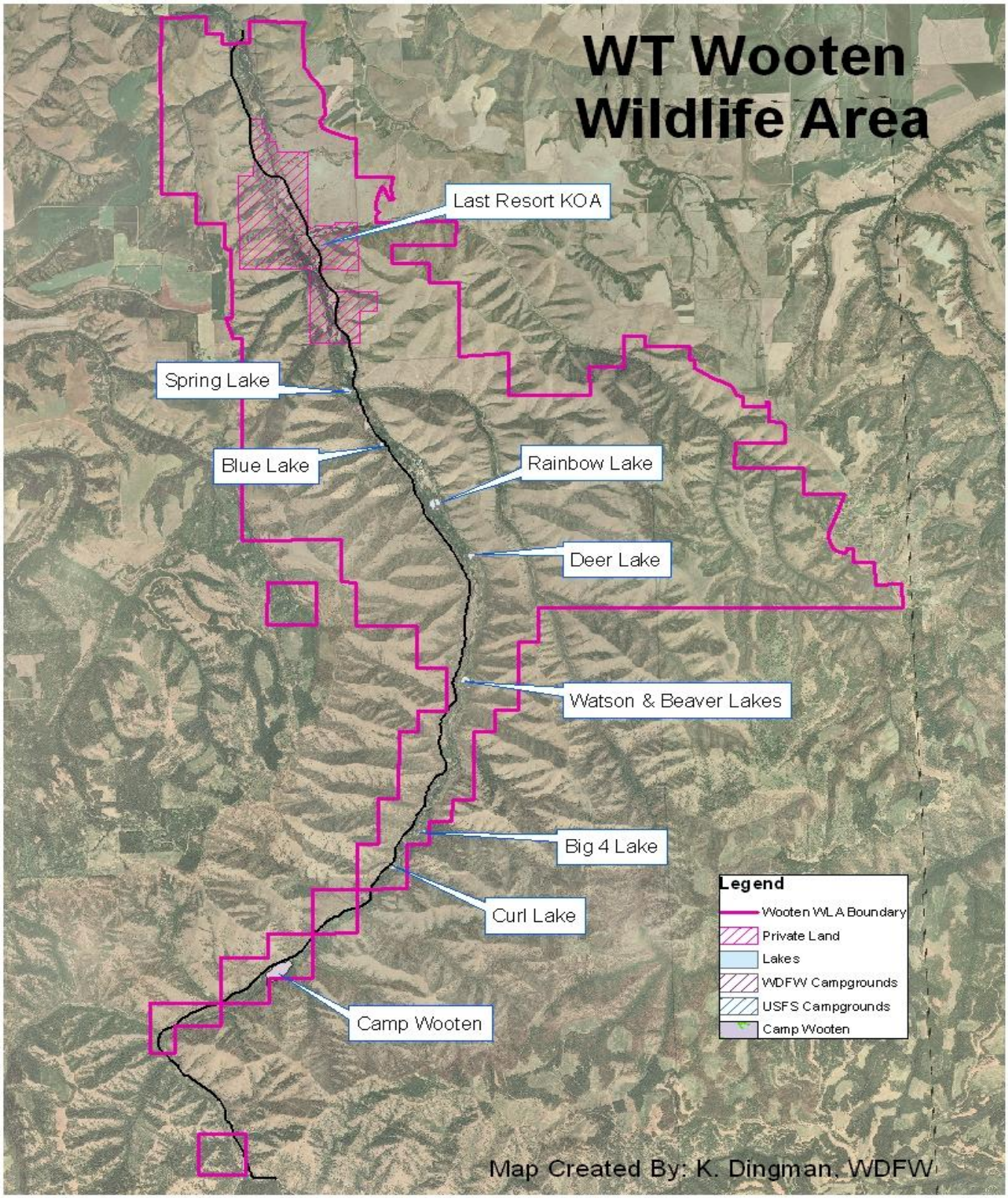

Figure 1: Map of the Tucannon Lakes located on the W.T. Wooten Wildlife Area.

The goals of the Lakes Iinitiative and associated projects are to enhance the Tucannon Lakes to create more fishing opportunity and a more enjoyable fishing experience, comply with WDOE Dam Safety regulations, address reduced carrying capacity and ongoing maintenance issues, and reduce the adverse impacts of the lakes to the Tucannon River and its floodplain. The lakes will be deepened and enlarged to create more usable fish habitat and angler access, improve water temperatures in the lakes and reduce the need for surface diversions, and decrease the water temperature that is flowing back into the Tucannon River. The lakes will also be relocated or reshaped to allow the Tucannon River to have more available floodplain to improve stream channel function and to enhance riparian habitat conditions. With this reconfiguration and relocation the water intake systems will also be modified or replaced to reduce impacts to fish and maintenance costs and to increase reliability. The dams around the lakes will be lowered, if possible, so there is less risk of catastrophic failure and so they would comply with WDOE Dam Safety regulations. These changes in the dams would allow vegetation to be grown on them to provide shade and reduce water temperatures in the lake and to benefit recreationists, as well as enhance habitat for wildlife and aesthetics for the public.

The Tucannon Lakes and associated structures currently have a significant impact on the function of the Tucannon River floodplain within the Wildlife Area. They are also the biggest public draw to this Wildlife Area. Thus the Lakes Initiative's broad proposal for change has the most potential for positively impacting the goals of the FMP.

HABITAT ENHANCEMENT

The restoration objective for the Tucannon River is to improve habitat conditions for ESA listed species for all life history stages. In 2010/2011, a system-wide geomorphic assessment was completed by Anchor QEA (Appendix D) through a contract with the Columbia County Conservation District (CCCD) and the SRSRB. A Conceptual Restoration Plan resulted from the geomorphic assessment for Reaches 6 through 10 (RM 20-50), which were identified as critical habitat for Spring Chinook and Steelhead populations in the Tucannon River. The Wildlife Area encompasses Reaches 7 through 10 in the Restoration Plan, with 19 project sites. The entire process resulted in 28 site specific projects throughout the 30-mile study reach, which were subsequently ranked by priority. The priority ranking utilized four criteria: 1) Expected biological response, 2) Consistency with natural geomorphic processes, 3) Benefit-to-cost ratio, and 4) Reach priority (emphasizing spawning and rearing capacity). The priority projects were grouped as Tier 1 projects to be considered for early implementation, Tier 2 projects are high to moderate priorities for strategic implementation, and Tier 3 projects have lower priority due to considerations such as less certainty of benefit or high cost of implementation. This, along with the Tucannon Subbasin Plan and the Snake River Salmon Recovery Plan, forms the basis for planned habitat enhancement.

LARGE WOODY DEBRIS

Large woody debris (LWD) is a critically important component of streams, fish habitat, and stream function. Historically, streams in this area would have had large amounts of LWD throughout the system. Human activity has removed much of the LWD from the river system. The lack of LWD is a limiting factor for creation and maintenance of pools, providing fish cover, and stream function, and is therefore critical for salmonid recovery. The Tucannon River is currently in the process of recovering from human disturbance and is re-establishing more natural conditions. It has been slowly recovering from clearing and straightening of the channel, although many simplified portions of the channel remain because of confinement by infrastructure. In unconfined areas, the channel is attempting to recover via channel migration, recruitment of LWD, and deposition of LWD and sediment. Through time, additional channel migration will further extend the length of the channel network, increase floodplain connectivity and side channels, and reduce in-channel water velocities (Anchor QEA, 2011, see Appendix D).

Wood collected along the stream bank can redirect or absorb the energy of high stream flow events. This reduces the erosive force of the water and therefore reduces bank erosion. Wood in the stream can also aid in controlling the gradient of the stream by stabilizing the channel or stream bed, developing pools, slowing or stabilizing the movement of fine sediment particles and/or larger bedload material, and retaining salmon carcasses to help fertilize the stream and riparian vegetation and increase primary productivity.

LWD in the stream creates pools that are very important deep water habitats for many life stages of salmonids and other fish species, especially in low flow periods. LWD that is embedded in the bank and protrudes into the stream or sticks out of the stream bed provides valuable cover for fish. These areas provide overhead cover, shelter from high velocity flows, and may provide complexity in the form of many small hiding places among roots or branches (especially for juveniles). LWD also provides critical hiding and resting habitat for adult salmonids. The increased complexity and cover allows for higher densities of salmon, steelhead and trout.

Another function of LWD is the decrease of water velocities and aggradation of gravel, which often raises the water table. This helps create side channels and off channel habitat that is utilized by fish species, particularly juveniles, and all life stages in high water events. These side and off channel areas provide more edge habitat and increased productivity of all aquatic life. The raised water table also provides for vigorous riparian vegetation growth.

LWD is an ideal substrate for algae or periphyton to colonize and for accumulation of other organic material, such as salmon carcasses. These organic materials provide food sources for many invertebrates and some fish species. These invertebrates and small fish are major food components in the diets of many other fish, and wildlife such as dippers, kingfishers, otters, and garter snakes. This highly productive habitat provides food and protection for many aquatic and terrestrial species of insects, fish, and wildlife.

LEVEE REMOVAL/MODIFICATION

There are existing levees and remnants of old levees along reaches of the Tucannon River within the Wildlife Area. Some levees protected farm infrastructure or fields before the Wildlife Area was created by WDFW. These levees constrict the river and prevent the river from having access to the floodplain. Potential projects would be to remove all or portions of levees to promote increased floodplain connectivity over time (See Conceptual Restoration Plan, Reaches 6 to 10 Tucannon River Phase II in Appendix D). Several of the reaches in the Restoration Plan have levee removal projects proposed. Also see Lakes section and Camp Wooten section regarding dams and levees.

POWERLINE RELOCATION, BURIAL OR ALTERNATIVE ENERGY SOURCE

The Columbia Rural Electric Association (REA) transmission line that transects the Wildlife Area supplies electrical power to Camp Wooten (operated by State Parks), the Tucannon Fish Hatchery, and the fish screens at several lakes.

Between August 5 and August 19, 2005, the School Fire burned nearly 52,000 acres of terrain in the Tucannon Valley and adjacent area, causing millions of dollars in damage and firefighting costs. The fire's origin was traced to a dead pine tree falling over power lines, which caused the lines to arc and sent sparks to the ground, thereby igniting dry grass.

The Columbia REA has a maintenance plan that requires clearing an area under and around the power line to prevent trees from falling on the line. This maintenance activity clears a large swath of trees through the Wildlife Area and crosses the river and riparian area several times, resulting in a loss of habitat and riparian cover. Because the 2005 fire was caused by a line damaged by a dead tree or branch, and the Columbia REA was sued by the state for damages, the Columbia REA states they will need to maintain a clear-cut along the power line up to 1-1/2 tree lengths on each side. This will potentially result in a clear-cut about 300 feet wide along the entire 8.5 miles, crossing the river several times, thus destroying large portions of the riparian zone of the Tucannon River, and other terrestrial habitat. This is critical habitat for many species in eastern Washington. The Tucannon River contains four ESA listed salmonid species and high water temperature is an important factor limiting production

of these listed fish. Destroying riparian habitat that shades the stream and provides LWD is detrimental to these fish species. Obviously, other species, both aquatic and terrestrial would be negatively impacted by the loss of this critical riparian habitat. WDFW has been seeking to initiate a project to bury or relocate the power line from at least the Tucannon Fish Hatchery to Camp Wooten since 2006. This project is very important because it would potentially eliminate the problems of overhead power line maintenance, potential fire problems from downed or damaged lines (the cause of the School Fire), and the clear-cutting of wildlife habitat in the power line right of way. Therefore, burying or relocating the power line would increase and improve the riparian canopy and function in those areas currently being cleared. Another option to address the issues associated with powerline would be to examine alternative power sources for the facilities needing electrical power so the power line could be removed or reduced.

STREAM MEANDER RECONSTRUCTION

Properly functioning stream systems of moderate or low gradient typically have a meandering channel, or footprint, and an associated floodplain. The meandering of the stream allows proper dissipation of energy as it slows water flows down. This channel form also causes the formation of pools, deposition of gravel/bedload and LWD, areas of reduced velocities on the inside of bends, and other stream functions. Floodplains also allow dissipation of energy as flows spread out when high water events occur. Many other important functions occur such as deposition of sediments and debris on the floodplain, seed transport and deposition, groundwater retention, etc.

One project being considered is at the Beaver/Watson Lake area of the Tucannon River. The existing parking lot, footbridge, and roadway on the west side of the Tucannon River, and the Watson Lake dam on the east have created a constriction and isolation of the river from its floodplain. The river is forced against the base of the Tucannon Road prism just downstream of the footbridge. A proposed project is to change the physical footprint of Watson Lake by removing the existing dam and moving it eastward to narrow the lake, while the lake would be elongated north to south. This would remove the stream constriction and allow the river access to its floodplain. Once the lake is moved a meander reconstruction is proposed to restore proper stream function and to eliminate the erosive pressure on the Tucannon Road prism.

RIPARIAN ENHANCEMENT OR RESTORATION

Riparian areas are critical components of a healthy stream system and they provide important habitats for terrestrial and avian wildlife species. The trees provide shade, perches, hiding cover, LWD, and food

sources for various organisms in the food chain. Sediment, nutrients, and pollutants are filtered through riparian areas, and these areas have high biological diversity and productivity.

The riparian areas vary in quality throughout the Wildlife Area, from healthy and of high quality, to very poor or nonexistent. The School Fire (mentioned earlier) burned large areas of the riparian habitats reducing or eliminating the riparian trees. Some areas are re-vegetating fairly well while others are not. The Conceptual Restoration Plan developed by Anchor QEA lists several river reaches where riparian restoration is recommended.

CAMPGROUNDS

The Tucannon Campgrounds are a popular place for people from the Tri-Cities, Walla Walla, and elsewhere, to come to recreate. Most of the visitors to the Wildlife Area come to camp in the campgrounds and fish in the lakes, hunt, and/or view wildlife on public lands. There are currently 10 designated campgrounds on the Wildlife Area that are maintained by WDFW. These campgrounds have metal fire rings, outhouses, and a few concrete picnic tables. There are also four USFS designated campgrounds in the Tucannon drainage. All four of the USFS designated campgrounds are located in the floodplain and are experiencing the same riparian damage issues as the WDFW campgrounds.

Campgrounds have been included in the FMP as an Initiative because there are still some campgrounds that are located in the floodplain. Several of the campgrounds were relocated out of the floodplain after the 2005 School Fire and 2006 salvage logging. The campgrounds that are remaining in the floodplain are located in the riparian area and could potentially be in danger of the Tucannon River shifting and damaging or eliminating the campground. The campgrounds in the riparian area also result in the public trampling or removing the riparian vegetation, and garbage being dumped in the river or the riparian area.

The goal of the FMP is to relocate the remaining campgrounds out of the floodplain and allow for the Tucannon River to reconnect with the historic floodplain and reduce damage to the riparian vegetation due to human activity. This will be achieved by constructing new campgrounds in suitable areas on higher ground, closing the campgrounds in the floodplain and restoring these disturbed areas to natural conditions (removing outhouses, replanting, etc.).

The campgrounds that will be relocated are Campgrounds 6 and 9. Campground 6 will be moved to the west side of the road from its current location. Campground 9 will be removed and two smaller campgrounds will be constructed to replace it. The new Campground 9 will be located at a log landing site that was created for the salvage logging project in 2006. The campground will have 4-5 campsites and be located on the west side of the road just north of the mouth of the Little Tucannon River, out of

the floodplain and riparian area. The New Campground 10 will be constructed on higher ground just south of the current Campground 9. The campground will have 4-5 campsites and will have barriers in place to keep the public from driving and/or camping in the riparian area. The current Campground 10 will be renamed as Campground 11. In addition to relocations, opportunities to improve existing campgrounds will be identified during the feasibility study phase of the floodplain management plan.

ROADS, BRIDGES, CULVERTS

Specific projects to address roads and public access will be developed as part of the feasibility study. Potential changes in road infrastructure must take into account the eventual footprint of the Tucannon Lakes and associated access needs. In addition, the needs of the USFS should be considered. The lands in the Wildlife Area are adjacent to, and interspersed with, USFS lands. The USFS owns and manages the main road (USFS Road 47) up the valley and some of the uplands or riparian areas. This road bisects WDFW lands for approximately ten miles.

There are several potential projects that should be considered. The Deer to Watson Lake administrative access road was identified as a "Stream Adjacent Parallel Road" in the Road Management and Abandonment Plan. Portions of the road were moved up slope to avoid the riparian area, however a spring fed stream located near the downstream portion of the road remains a stream ford. Archeological finds in the area prevented a complete solution. This section of roadway should be re-evaluated and possibly moved away from the river, with a crossing structure installed. The footbridge and parking area for public access to Beaver-Watson lakes constricts the river channel and should be relocated. This would be planned as part of the Tucannon Lakes planning process.

The USFS is considering several road improvement projects. We must integrate their actions into our future road planning. One project currently being discussed is moving the USFS Road 47 up slope behind the Tucannon Guard Station. This avoids an area where the existing road is very close to the river.

CAMP WOOTEN

Camp Wooten was originally a Civilian Conservation Corps (CCC) site called Camp Tucannon. State Parks now operates Camp Wooten, which is the largest environmental learning center in eastern Washington, and hosts many educational groups from the spring into fall. The site is historically important because of its use as a CCC camp and because many generations of children have participated in outdoor experiences at Camp Wooten. WDFW owns the land and leases the site to State Parks.

The Tucannon River flows along the western boundary of Camp Wooten (see illustration below), and is constricted between Camp Wooten and the Tucannon Road (USFS Road 47). The east side of the river has a levee to protect Camp Wooten infrastructure from high stream flows. The bridge across the Tucannon to access Camp Wooten also constricts the stream, and past bank protection work just upstream of the bridge, along with a vortex weir, force the river channel to remain under the bridge.

Camp Wooten will be an area of emphasis during the Feasibility Study portion of the Capital Projects process. There are two overarching actions to consider: Reconfiguration of the existing Camp Wooten, and Relocation of Camp Wooten into a newly constructed area outside of the floodplain. Reconfiguration could involve: 1) removal and replacement of the current bridge and road to a new location, 2) moving some infrastructure, such as cabins, away from the river, 3) removing portions of current levees that constrict the river and constructing setback levees to allow the river some access to the floodplain, and 4) re-establishing a pre-existing side channel for off channel rearing.

Relocation of Camp Wooten is, obviously, a more expensive option, but it has the advantage of removing all impacts from the floodplain and modernizing Camp Wooten. Relocation sites would need to be explored during the alternative analysis portion of the plan but would likely be closer to the Wildlife Area Headquarters. This relocation downstream would allow for a reduction in the current infrastructure (powerline, bridges, etc.) needed to support Camp Wooten and may allow for more year-round use of the facility. Specific alternatives for both of these options would be developed and will require collaboration between State Parks and WDFW.

PROJECTS

OUTREACH

Many of the discrete Outreach project(s) will be developed with a consultant during the feasibility portion of the FMP. However, WDFW will begin outreach to discuss the intent, conceptual plans, and the draft FMP with stakeholders. In fact, outreach has already begun on a local basis. This has included briefings to both the SRSRB and the CAG. Outreach for the FMP can be divided into 3 stages: early outreach, feasibility stage outreach, and construction phase outreach.

Early outreach to the community regarding the FMP and associated actions is currently occurring and will continue through the rest of 2012 and into 2013. This outreach is targeted to particular stakeholders, traditional partners, user groups and legislative bodies to inform them of the FMP and the conceptual project plans contained therein. Besides information sharing, the purpose is to gauge the amount of support for our proposed actions; and if not well supported, to gather information on how

the projects could be changed to increase support. This outreach would be developed, coordinated and implemented by WDFW staff.

The feasibility stage outreach will occur approximately from the summer of 2013 through the winter of 2014/2015. While targeted outreach and briefings would continue as described above, the purpose of this outreach would be information sharing and gathering from the general public. The outreach plan for this time period would be developed with the assistance of a consultant, though most of the outreach itself will be conducted with WDFW personnel. The main vehicle of outreach will be a series of public presentations and open houses. Though other work would also be presented, the main focus of this outreach will be the work to be performed on the Tucannon Lakes. The early meetings would have detailed graphics and descriptions of conceptual plans. The emphasis would be to inform and listen to public comment. Later meetings would feature complete plans and would be more informational in nature.

Construction of most of the projects is scheduled to occur from about the summer of 2015 through 2019. It is important to continue to inform the public of the progress of the floodplain management plan. These meetings would likely take the form of open houses, perhaps in the early spring (emphasis on proposed work) and late fall (emphasis on completed work) of each year. The main purpose of this outreach would be information sharing. This would allow the public to be informed of the work to be done that year and how it may impact use of the Wildlife Area, and to track the progress of construction.

The description above should be considered a conceptual framework for outreach. A complete outreach plan will be developed with the assistance of a professional outreach consultant and be presented in a later version of the floodplain management plan.

TUCANNON LAKES

RAINBOW LAKE ENHANCEMENT AND REHABILITATION PROJECT

DESCRIPTION

Rainbow Lake, located just south of the Tucannon Fish Hatchery in Columbia County and adjacent to the Tucannon River, is a 10-acre, off-channel impoundment that was reportedly constructed in 1955. The water supply is directly from the river via an open channel. Water is diverted from the Tucannon River at the Tucannon Fish Hatchery diversion dam (with a recently improved fish ladder). The impoundment serves two important purposes: it provides water (and acts as an ice free supply in winter) to the

Tucannon Fish Hatchery, and supports a very popular put-and-take recreational trout fishery within the Wildlife Area.

Many public camp grounds are located around Rainbow Lake. Campground 3 specifically serves as recreational attractions for Rainbow Lake fishing and other outdoor activities. Statistically, the most fishing effort within the Tucannon Lakes likely occurs at Rainbow Lake (Mendel and Trump 2008), as it is the largest of the eight impoundments knows as the Tucannon Lakes. Up to 15,000 catchable sized, and 325 jumbo sized, rainbow trout are planted annually in Rainbow Lake. The estimated economic value of the fishery in the four northern Tucannon Lakes, including Rainbow Lake, is estimated to be at least $780,000 annually (Mendel and Trump 2008).

The outlet water flow structure is in need of restoration and repair work. The outlet structure consists of a large drop-inlet concrete structure with a revolving drum screen and adjustable stop logs. The mechanically screened outlet structure provides constant water flows back to the river, or through an above ground pipeline that runs north approximately 2,000 feet to the hatchery facility. . This pipeline was replaced in 2005 following the School Fire. It is the sole source of water for the earthen pond that typically is utilized for rearing catchable-sized rainbow trout for the area lakes, including Rainbow Lake. The water supply from Rainbow Lake is not used for hatchery operations during the late spring and summer months due to increased temperatures. During the fall and winter months, the water supply is critical for fish rearing and the reservoir is a vital safety factor for maintaining flows. Icing on the river, and reduced flows at the intake that supplies Rainbow Lake, can impact water availability to the lake and hatchery. In these events, the lake acts as an important reserve for continued water supply to the hatchery.

In recent years, the buildup of sediment and vegetative growth has diminished the capacity of Rainbow Lake and hatchery trout stocking levels have been reduced. Not only has it reduced the amount of water available to the hatchery in low flow events, it is reducing carrying capacity for stocked trout and it may be causing increased water temperatures in the spring and summer months. The shallow water column is not conducive to maintaining a cool environment for the fish or the fishery. Trout that carry over through the winter into the next spring are currently uncommon because of high water temperatures in the lake. Also, any increase in temperature of the river potentially caused by Rainbow Lake outflow is a concern for ESA listed fish in the river because river temperatures are near upper limits of tolerance for salmonids. If the lake was dredged and/or excavated to restore impoundment capacity and improve water quality for fish, it is possible that not only carryover trout would survive to the next year, but water could be used for hatchery rearing year around. This is especially important considering that rearing ESA listed spring Chinook is being tested as a future production option at the Tucannon Fish Hatchery.

Prior to some repair efforts in 2009, the intake structure for the lake was being undermined at the front of the concrete slab (in the fishway), reducing head for flows to the lake and hatchery. In a low flow season, this undermining was potentially harmful to the fish program. With reduced flows and warmer temperatures in the summer months, the potential for pathogen outbreaks increases dramatically. Restoration work is also necessary to resolve current safety issues with various components of the lake impoundment structures, to improve water flows within Rainbow Lake, and water flow from this storage lake to the Tucannon Fish Hatchery.

Figure 2: Current photos of Rainbow Lake at left and inlet channel at right (May 2012).

CONCEPTUAL PLAN

WDFW would like to significantly reconfigure and enhance Rainbow Lake to increase water depth, reduce water temperatures, eliminate dam safety concerns, increase trout stocking capacity, and increase angler opportunity. The lake would be elongated to the south towards the current inlet, the west bank would be moved toward the east, and the lake would be dredged to make a larger, narrower, deeper, irregularly shaped lake and increase the available floodplain to the west of the lake (Figure 3). The inlet canal would be piped and would form a "Y" at the south end of the lake, with the west arm of the "Y" going around the west side of the lake and feeding directly into the pipeline from the lake to the hatchery. The east arm of the "Y" pipeline would feed directly into the lake and the upper end of each arm would have flow control gates. This would increase operational flexibility by allowing the hatchery to pull water from the lake, or directly from the river, to take advantage of the most appropriate water temperatures. Sediment ponds with spits and submerged berms would be built into the south end of

the lake to allow for incoming sediments to settle out and to make it easier and less expensive for future maintenance dredging, as needed.

The dam height is proposed to be reduced, if feasible, to reduce or eliminate safety concerns and remove WDOE Dam Safety regulations that require clearing vegetation from the dam. The lake bottom is proposed to be excavated deeper into the ground to enable us to potentially lower the dam and utilize groundwater to fill and maintain the lake. Two docks or spits should be placed in the lake to allow increased angler access to near the middle of the lake (although docks are preferred for better angling opportunities, water flow patterns, and to maximize the lake volume for fish use). A set-back levee could be constructed to the west to protect the lake from the river, but it would be vegetated with trees. A protective levee would allow for trees on the lake shoreline without being considered a dam safety concern. A forested shoreline is more natural appearing, provides wildlife habitat and shade for anglers, and is consistent with the intent of the Wildlife Area management goals.

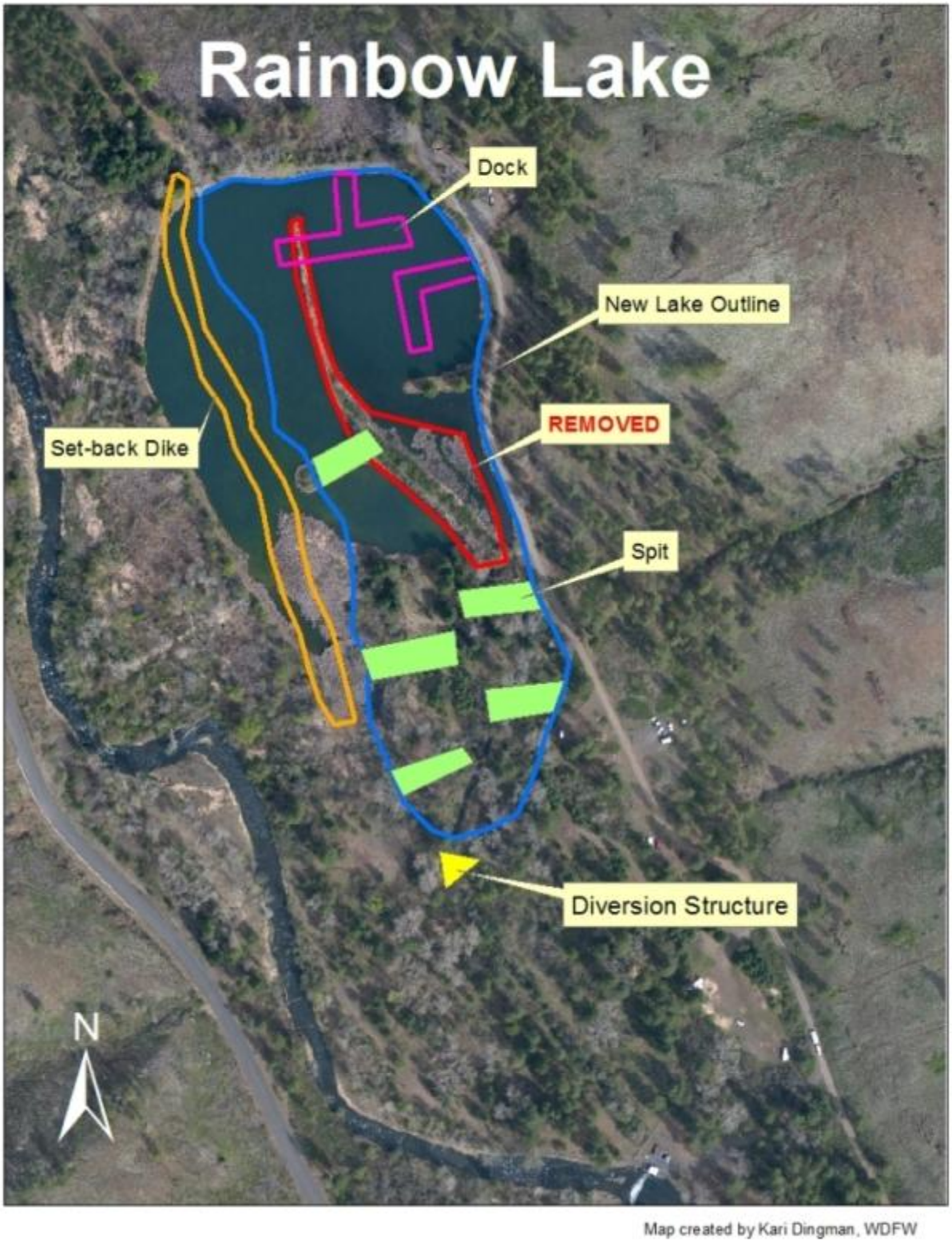

Figure 3: Rainbow Lake Conceptual Design.

DEER LAKE ENHANCEMENT AND REHABILITATION

DESCRIPTION

Deer Lake is approximately 4.4 acres in size and is the fourth lake in the valley traveling north to south. It is a designated as a walk-in only lake and it is located about ¾ of a mile South of Rainbow lake. From a parking area the public must walk ¼ mile south to access the lake. Historically, an aluminum foot bridge was used to access the lake from a nearby campground located on the west side of the Tucannon River. High water and flooding in 1996 and 1997 destroyed the footbridge and campground. The river now flows through the remains of the old campground. Deer Lake is adjacent to the Tucannon River and on the eastern portion of the floodplain.

Figure 4: Deer Lake.

CONCEPTUAL PLAN

Enhancement plans call for enlarging the lake at the southern end to create a larger, deeper, irregularly shaped lake (Figure 5). The existing dam is proposed to be reduced in height, if feasible, to reduce safety concerns and WDOE Dam Safety regulations that require vegetation clearing on the dam. The lake is proposed to be excavated deeper into the water table to help maintain water quantity and quality in the lake. An adjacent spring could be developed to provide another source of water, but water may have to be pumped to the lake. By utilizing spring water and ground water, there should be adequate flow to keep the lake full and of high water quality. Lake outflow would be channeled into a concrete outlet structure at the north end of the lake near the existing drain. The advantage to using

this concept to fill and maintain the lake is elimination of the existing river inlet structure and associated canal between the lake and river. Elimination of the inlet means silt and other debris from the river no longer would enter the lake, which means less need for costly dredging operations to maintain depth and volume in the lake. And, probably most importantly, no river inlet means no more manipulation of the Tucannon River channel to ensure water is flowing into the inlet structure, and the river is then free to move because it does not have to be locked in place at the intake site.

Enhancement of Deer Lake is intended to help offset the eventual loss of Big Four Lake which is proposed for closure and removal. Making Deer lake larger and more attractive to fishermen will provide a better experience for the public. Discussions with the public will occur to consider changing Deer Lake regulations to be more restrictive and allow fly fishing to replace the loss of Big Four Lake, which is the sole "fly fishing only" water in southeast Washington. Other fishing regulation changes will be considered here and at the other Tucannon Lakes. Other enhancements include the addition of two fishing docks or spits to increase angler access to the middle of the lake. The irregular shape and docks mean more shoreline length and places to fish, which is desirable to fishermen. A protective levee is proposed to be constructed to the west to protect the lake from the river during high water events. If this is not a dam used to impound water in the lake, it will be vegetated with trees and other woody vegetation. With a protective levee in place and dam height reduced, trees may be planted or maintained on the lake shoreline without being considered a dam safety concern. A forested shoreline will provide shade for the lake, habitat for wildlife, and a more aesthetically pleasing shoreline area than exists now. It also provides shade for anglers and is consistent with the intent of the Wildlife Area management goals.

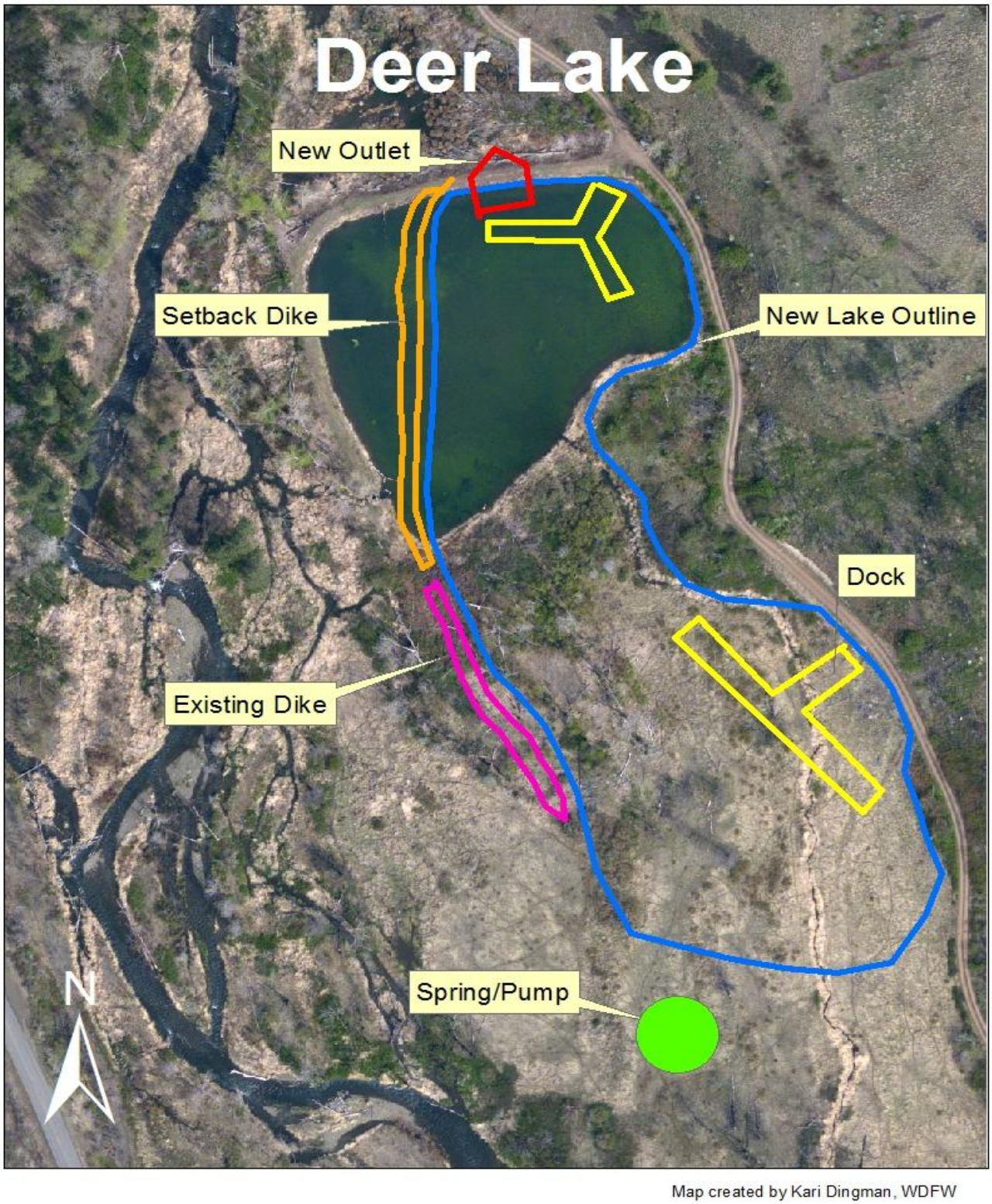

Figure 5: Deer Lake Conceptual Design.

BEAVER-WATSON LAKE ENHANCEMENT AND REHABILITATION

DESCRIPTION

The Watson Lake / Beaver Lake Complex suffers from a variety of problems causing management, maintenance and environmental concerns. Currently the lakes are in the floodplain between the eastern valley hillside and the river to the west. They are located in the historic channel migration zone of the Tucannon River. This location restricts the normal floodplain functions of the river and tends to direct the river towards the roadway, adjacent to the river.

Beaver and Watson lakes were constructed in 1953 and 1954, respectively. Beaver Lake was initially just over 2 acres and Watson was 6.7 acres. These two lakes are grouped together because they have a common intake and inflow channel, and the screened river water passes through Beaver Lake before passing into Watson Lake. Beaver Lake has become filled with sediment and weeds and it is no longer stocked with trout to provide a fishery. Watson Lake also has filled in and become quite shallow.

The impounding dams are covered in woody vegetation, plus Watson Dam has substantial leaks. Both of these dams are in violation of WDOE Dam Safety regulations to protect public safety, and therefore they require substantial and costly repairs.

So little water currently flows into Watson Lake and/or leaks out of the dam that water does not flow out of the lake outlet for a majority of the summer. In 2011, the problem with inflow and outflow was increased because the river channel changed near the intake and very little water was able to be directed into the diversion canal and into these two lakes. A temporary project was constructed in March 2012 to try and improve inflow into these lakes so Watson Lake could be stocked with trout and provide a fishery. Watson Lake normally has a very popular trout fishery because it is one of the larger Tucannon Lakes and it is easily accessible.

Figure 6: Beaver-Watson intake, with the Tucannon River in the left channel.

CONCEPTUAL PLAN

Beaver Lake may be combined with Watson Lake and the new lake would be elongated, with a north-south orientation against the east hillside. This configuration should provide a similar, or larger, surface acreage, more lake volume, and enhanced fishing opportunities for the public. Habitat for salmon, steelhead and bull trout, plus river and floodplain functions, will be improved, and roadway maintenance and flood risk will likely be reduced by opening up the floodplain and removing the constrictions caused by the current dams, parking lot, and short span footbridge (Figure 7). Because of differences in elevation between the two lakes, a stair step configuration may be necessary. In this case the upper lake (Beaver Lake) may serve as a settling basin for the main, lower lake (Watson Lake).

The new lake is proposed to be extended into the wet area north of the current Watson Lake and excavated deep enough to use groundwater for maintaining the water levels. The lake enhancement goals will be to increase water depth and reduce water temperatures, eliminate dam safety concerns, increase trout stocking and carrying capacity, and increase angler opportunity. The lake will be

narrowed and the west bank will be moved toward the east to make a larger, deeper, irregularly shaped lake and increase the available floodplain to the west of the lake (Figure 8).

Depending on the elevation difference, it may be necessary to have two distinct lakes. This may require a connection between the two lakes. A constructed riffle may be used. In this case the existing Beaver Lake outlet structure would be replaced with a more natural looking structure.

The inlet and diversion canal will hopefully be eliminated and springs from the east will be piped into the new lake to help maintain the water level and provide water inflow. If surface water from the river is no longer needed, the lake should receive less sediment and therefore need less maintenance dredging in the future, and the river would not have to be manipulated to maintain the inflow for the lake. The outlet will be moved to provide a better flow pattern in the lake and improve the connection with the river. The dam height is proposed to be substantially reduced to eliminate safety concerns and remove it from WDOE Dam Safety regulations that require clearing vegetation from the dam. Two docks or spits may be constructed in the lake to allow increased angler access to the middle of the lake (although docks are preferred for better angling opportunities, improve flow patterns within the lakes, and to maximize the lake volume for fish use). A set-back levee will be constructed to the west to protect the lake from the river and it will be vegetated with trees. The protective levee will allow for trees on the lake shoreline without being considered a dam safety concern. A forested shoreline is more appealing as a natural setting, provides wildlife habitat, provides shade for anglers, and is consistent with the intent of the Wildlife Area management goals.

Figure 7: Access Bridge to Beaver Watson.

Some major infrastructure will need to be changed in this proposed plan. The current footbridge will probably be replaced with a suspension bridge in a different location with a much longer span so the river does not have to remain in its current constrained channel. The current parking lot will be removed and a new parking lot will be constructed on higher ground next to the new footbridge. The administrative access road (from Deer Lake) on the east side of the river will be moved towards the east to reduce its footprint in the floodplain to allow the river to meander.

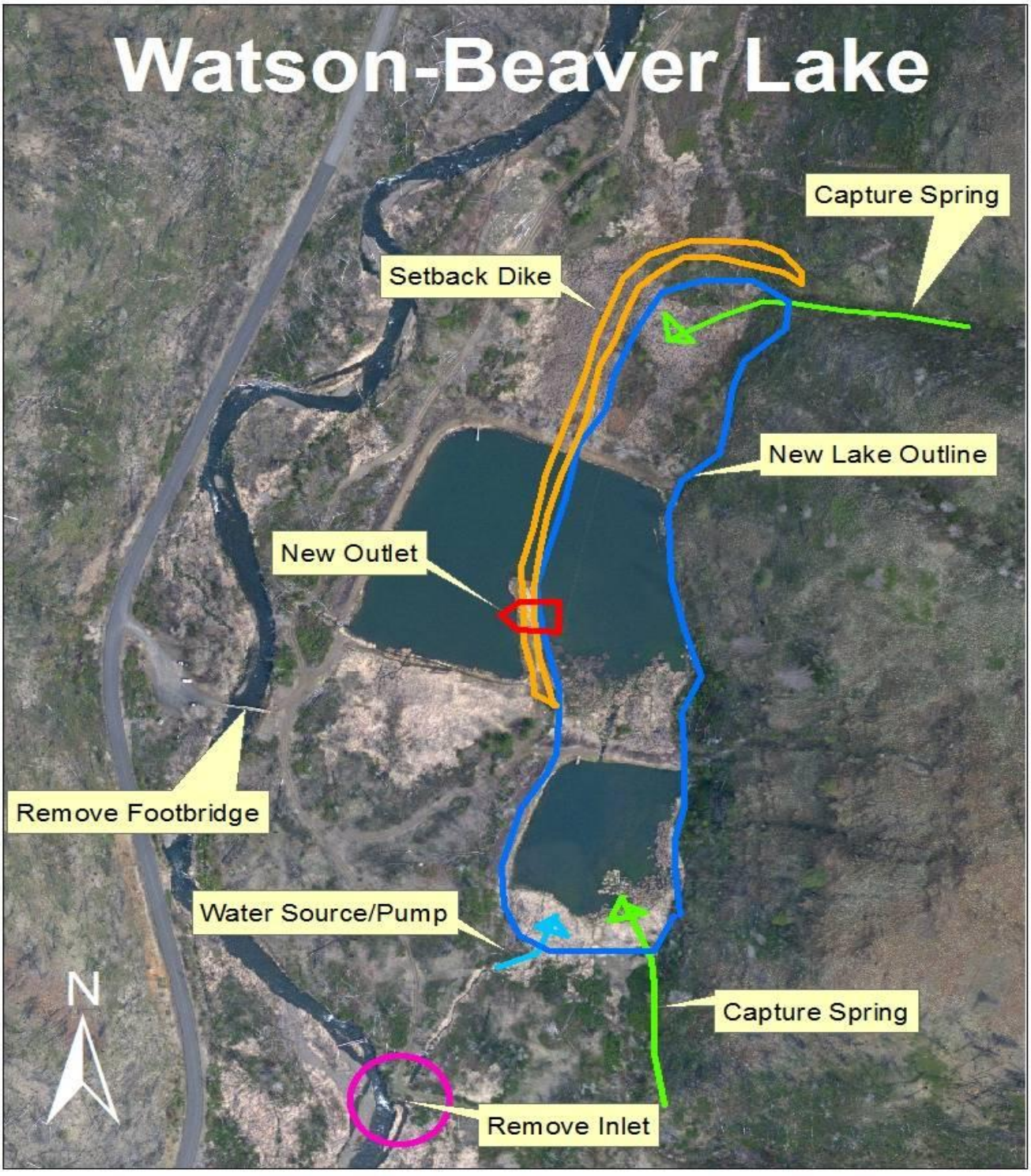

Figure 8: Beaver-Watson Conceptual Design.

BIG 4 LAKE CLOSURE AND REMOVAL

DESCRIPTION

Big 4 Lake was constructed in 1954 at about 2.1 acres. It is need of substantial work to maintain the dam, lake volume, and the outlet structure. This lake is unique because it is currently the one designated "fly fishing only" water that exists in southeast Washington (stream or lake). It has two spits that make access and fly casting easier in this lake because of minimal woody vegetation obstructing casting. The lake is secluded and requires foot access across the Tucannon River, which can be dangerous during high spring river flows.

CONCEPTUAL PLAN

Big 4 Lake is proposed by WDFW to be closed and removed because of its need for substantial maintenance and the difficulty in repairing and maintaining this lake. There are no roads for vehicle access for maintenance, repair, or fish stocking in this lake. The lake has become shallow and weedy because of sediment and vegetation accumulating over the years, resulting in reduced trout stocking rates and frequency of stocking. The dam is overgrown by woody and herbaceous vegetation and it leaks substantially, violating the WDOE Dam Safety regulations. The lake is very difficult to stock with fish and requires a temporary pipeline across the river when flows are low enough in February or March so fish can be planted, and therefore it is only stocked once per year. A beaver dam has blocked the outlet of the lake in the past. The Tucannon River has been threatening to erode the west dam and potentially capture the lake. The lake would need to be dredged, the dams repaired, and protection from the river, if it were to be maintained.

Removal of this impoundment will consist of breaching and/or removal of much of the dam material, including the intake and outlet structures. Some portions of the dams or spit structures near the east side of the floodplain will be left to reduce costs and promote wetland development with some ponding of water. Permits, timing, and manner of heavy equipment access to decommission this lake will be sensitive because of potential adverse effects on ESA listed fish and their habitats.

It is our intent to enhance one of the other lakes before closure and removal of this lake to mitigate for the loss of Big 4 Lake. Changes to regulations on one of the other lakes (possibly Deer Lake) to require more restrictive gear types (such as fly fishing only) will be considered to compensate for the loss of this unique fishing opportunity in southeast Washington.

Figure 9: Big 4 Lake Conceptual Design.

SPRING LAKE ENHANCEMENT AND REHABILITATION PROJECT

DESCRIPTION

Spring Lake is located approximately a mile north of the Tucannon Fish Hatchery in Columbia County, and adjacent to the Tucannon River. It was constructed around 1955 and is 6-acres in size. The water supply for Spring Lake comes from runoff and springs, hence it's name. This impoundment supports a very popular put-and-take recreational trout fishery. Over the years the lake has filled in with sediment and vegetation, resulting in a loss of volume or carrying capacity for hatchery stocked "catchable-sized" and "jumbo-sized" rainbow trout. The overgrowth of vegetation is also limiting the open fishing area available to anglers. Thus, trout stocking and angler opportunities have decreased.

As with all eight of the Tucannon Lakes, many public campgrounds are located near Spring Lake. Campground 1, specifically, serves as a recreational attraction for Spring Lake fishing and other outdoor activities. Up to 11,000 catchable sized and 325 jumbo sized rainbow trout are planted annually into Spring Lake. The relative economic value of the fishery in the northern four Tucannon Lakes, including Spring Lake, is estimated as at least $780,895 annually (Mendel and Trump 2008).

CONCEPTUAL PLAN

The proposed lake rehabilitation would primarily include dredging and/or excavation to restore its depth and carrying capacity. That would provide a more enjoyable experience to the recreational public (e.g. better access, more open water etc.) and better fish and wildlife habitat because it would include deeper water and a more diverse environment. The lake would also be more accessible. To allow for handicap accessibility and improved fishing in deeper waters, a dock could be installed which would also provide more fishing access, and better fishing success. The lake currently does not have full access from all sides.

With a deeper lake, it is expected that the water temperatures would likely decrease and potentially extend the fishing season into the summer and minimize the release of elevated water temperature into the river. The dam also needs to be repaired or reconstructed to prevent leakage or seepage. It should also be increased to the recommended width of 12 feet; thereby reducing dam safety concerns and violation of WDOE Dam Safety regulations, and future dam maintenance costs.

A screened bottom draw outlet should be installed to reduce thermal loading into the river that currently contributes to reduced habitat quality for ESA listed salmonids. Spring Chinook, summer steelhead and bull trout in the Tucannon River are genetically unique, geographically isolated, and critical for recovery of the Snake River Basin ESUs or DPSs for these species. An emergency spillway

may be added if deemed necessary by the engineering analysis. The access trail around the lake would be improved to allow for greater angling opportunity on the south and west sides of the lake.

The future of fisheries in this lake are dependent upon these improvements for sustaining recreational opportunities and maintaining a stable environment for the species in the Tucannon River.

Figure 10: Spring Lake with direction of flow towards the outlet shown.

Figure 11: Spring Lake Conceptual Design.

HABITAT ENHANCEMENT

The Tucannon Large Wood Restoration Projects section below describes some recently implemented projects. Immediately below are some other projects that have been completed on the Wildlife Area since 2005 that benefit the floodplain and ecosystem.

1. **Campgrounds:** After the 2005 School Fire and the 2006 Columbia Complex Fire, several campgrounds were moved out of the floodplain and relocated to higher ground farther from the river. There were also several fords that had been used to access campgrounds that were across the river from the main Tucannon Road, and those fords were eliminated. The infrastructure associated with the campgrounds that were moved was also removed from the floodplain, including outhouses and campfire rings, and the areas were planted with grass seed to reduce erosion.

2. **Tree Plantings:** In 2008, 1.5 million tree seedlings were planted in the areas on the Wildlife Area that had been salvaged logged after the 2005 fire. The hillsides were planted to help establish trees and vegetation on the slopes to reduce the erosion down into the floodplain and the Tucannon River. The old campgrounds and some floodplain areas were also planted to help establish vegetation growth.

3. **Spring Branch Restoration/Russell Unit:** In 2010, WDFW partnered with the CTUIR to improve and reconnect a spring channel on the Russell Unit of the Wildlife Area that feeds into the Tucannon River. This spring branch historically had spring Chinook spawn in it, but over time it had been straightened out and had become overgrown with reed canary grass. The spring channel was altered to create meanders and small logs were placed in it to create pools and riffles. Approximately 24 car bodies were removed, along with about 40 cubic yards of miscellaneous household and farming trash. An engineered log jam (ELJ) was constructed near the mouth of the spring channel to create a fish holding pool and to protect adjacent property.

4. **Spring Branch Restoration/Hartsock Unit:** In 2011, WDFW partnered with the CTUIR to do some channel reconstruction work on a spring channel on the Hartsock Unit of the Wildlife Area, near the sediment catchment basins, to improve fish access to these off-channel habitats. This spring branch feeds into the Tucannon River and had become very shallow and choked with reed canary grass. The project included the channel being deepened, some meanders constructed, logs placed in the channel to create pools and riffles, matting laid along the banks to control the reed canary grass, and willow whips planted along the channel. An existing stream ford was removed and replaced by an ATV bridge.

5. **Infrastructure Removal**: In 2012, WDFW utilized a grant from BPA to remove the metal Quonset hut and the cinderblock bunkhouse from the Hartsock Unit of the Wildlife Area. During spring flows the Tucannon River tended to overflow its banks and flood the structures. The buildings and all associated infrastructure (power line, well, foundations, concrete pads and several culverts) were removed from the floodplain. The area will be leveled and reseeded into natural grasses in the near future. The Tucannon River is now free to access the floodplain on the Hartsock Unit.

6. **Remnant Fish Weir Removal:** The remaining sheet piling in the river channel was removed in 2010 from the old fish trap weir site at the Tucannon Fish Hatchery outlet.

TUCANNON RIVER LARGE WOOD RESTORATION PROJECTS

COMPLETED LWD PROJECTS

LWD restoration efforts for the Wildlife Area started in 2006 following the 2005 School Fire. Fires have historically played a major role in LWD recruitment to rivers, and subsequently, WDFW staff concluded that the event was a natural starting point for LWD restoration for the Tucannon River and its tributaries on the Wildlife Area. Two small scale LWD projects were conducted (2006, 2008), one in Cummings Creek and the other in the Tucannon River. Both projects were successful at meeting project objectives and goals, most noteworthy the enhancement to instream habitat complexity and reconnecting the river and its floodplain (Figure 12).

Figure 12: Habitat complexity resulting from LW restoration in the Tucannon River (site treated 2006, 2008), photo 2011.

The August 2012 Large Wood Project (Area 10 from Anchor Geomorphic Assessment) was completed based on the conceptual design that was developed in 2010 and 2011 by a technical team of collaborating partners from the SRSRB Regional Technical Team (RTT) and the Tucannon River Coordination Committee (TCC) with WDFW serving as the project lead. Approximately 260-270 large trees, most with root balls, 25 boulders (10K-15K lbs.), and 600-700 smaller "racking" trees (4-10" dbh, 30ft, with root) were placed by design with a S64 Sky Crane Helicopter in the Tucannon River between Big 4 Lake and Beaver Lake (river miles 42-44). The helicopter makes it possible to treat large reaches that have poor accessibility with minimal impact to the riparian area. Additionally, the helicopter provided an opportunity to use whole trees with the root ball and branches intact. Utilizing whole trees is a major design feature intended to enhance the longevity and stability of the LWD structures. The helicopter phase of the project followed construction of 4 ELJs at the downstream end of the project. The location of the constructed ELJs is a natural narrow reach of the river valley and it was chosen as an area where multiple large log jams would have naturally occurred. The ELJs are to function as control structures at the downstream end of the treated reach. Collectively, the project installed 60 separate structures in the roughly 2 mile reach. This project was funded for construction by the SRSRB and BPA.

TUCANNON RIVER RESTORATION PROJECT AREA 14

DESCRIPTION

Project Area 14 is located on the Tucannon River starting at the Tucannon Fish Hatchery bridge (RM 39.2) downstream to near Spring Lake (RM 37.15). Project Area 14 is one of the 28 site specific projects identified by the Conceptual Restoration Plan in the Tucannon Geomorphic Assessment. The project is a Tier 1 priority and was the first project selected for implementation by the TCC, CCCD, and SRSRB.

CONCEPTUAL PLAN

The majority of the restoration action proposed is construction of 8 types of ELJs designed to function in various ways, including; localized scour to develop pools and gravel bars, improve pool frequency, improve habitat complexity and cover, decrease channel confinement through aggradation of bed-load, restore conditions or activate secondary channels currently isolated on the floodplain, increase inundation frequency within the riparian zone, and restore seasonal off channel habitat. The Project Area 14 design includes more than 60 individual ELJ structures within the 2 mile reach. The proposed design is intended to function collectively throughout the reach to achieve a reach scale geomorphic response. Another key feature to the proposed project is a cobble or gravel augmentation program. Spoil piles located in the floodplain, possibly historically dredged from the river, will be used for the gravel source. The recommendation is to implement the gravel augmentation over the course of 5-10 years until the existing spoil piles are depleted. Approximately 1,000 cubic yards of gravel will be placed at 3 key locations throughout the project reach. The main site for augmentation is below the Tucannon Fish Hatchery bridge, designed to increase bed-load at the upper extent of the project to stop an existing head-cut adjacent to the hatchery. The project proposal also includes removal of floodplain infrastructure such as dredge spoil dikes, removal of bank armoring downstream from the hatchery, removal of an old fish intake, and the removal of an obsolete bridge (referred to as the “foot bridge”), located just downstream from the main road bridge near Spring Lake. The removal of the old bridge will reduce a constricted area below the Tucannon Road bridge and relieve hydraulic impacts to the bridge during flood conditions. Many of the ELJs are designed to capture channels that are currently isolated on the floodplain to increase surface water habitat availability and improve habitat diversity and linkages between those habitats. The 60% design report is located in Appendix E. The design continues downstream to the WDFW property line at the downstream end, however, the river section below Spring Lake will not be completed as part of this implementation.

Tucannon River LWD restoration efforts have developed into a cooperative partnership involving WDFW, USFS, the SRFB, SRSRB, BPA, CCCD, CTUIR, and the Nez Perce Tribe. Additional projects on the Wildlife Area will be developed and designed utilizing these partners.

POWER LINE BURIAL PROJECT

Note: The project detailed below is the current proposal. The Power Line Burial Project will be a topic of the Feasibility portion of the FMP process. The final solution to this issue is dependent on the outcome of the feasibility study and could be different then what is outlined below.

The School Fire of 2005 damaged much of the Wildlife Area, burning and destroying large areas of timber, and some of the electrical power lines and poles crossing the area. It was the largest fire of 2005 in the lower 48 states at about 52,000 acres. The cause of the fire was determined to be a tree or tree branch falling on the power line and damaging the line near the Tucannon Guard Station at the mouth of School Canyon. Burying the power line would preclude this from happening again, and reduce required maintenance of the line, and prevent habitat degradation from the power line maintenance activities.

This project consists of working with the Columbia REA to bury the electrical power line that serves the Wildlife Area, Tucannon Fish Hatchery and associated infrastructure, Tucannon Lakes' fish screens, USFS Guard Station, and Camp Wooten. This project would eliminate the main overhead power line and associated poles and replace it with a buried line across the Wildlife Area from at least the Tucannon Fish Hatchery to its terminal end at Camp Wooten, approximately 7 miles. If buried along its current route, the line would cross approximately 12 small tributary streams to the Tucannon River, and cross the river once on the Camp Wooten bridge (tentatively). Most, if not all, of these tributaries are non-fish bearing. There may still possibly be 4 or 5 overhead lateral lines that service the lakes' fish screens, however, under the Tucannon Lakes Projects, most of these fish screens and river withdrawals would be removed.

In 2006, Qwest was contacted to learn how they buried their telephone line in the same area, and how they avoided environmental issues and concerns. Their representative stated that Qwest buried their phone line in the road prism, under the shoulder. At any of the tributary crossings, they were able to bore under, or over the culverts and avoid any stream crossings needing permits, or causing any environmental concerns. Their representative did mention that the power line could be placed near the phone line, but said power companies needed to dig a trench to place the line in conduit. Utilizing the existing road prism is an alternative that should be explored. It avoids many environmental concerns during construction and may reduce the cost of installation. Columbia REA has stated that burial costs are approximately $70,000 per mile over "average" ground.

Figure 13: (Left) Power line crossing Tucannon River to Camp Wooten. (Right) Power line within cleared riparian area.

CAMPGROUNDS

CAMPGROUND 6 RELOCATION

The current Campground 6 is located in the floodplain of the Tucannon River. Some of the campsites are located very near the edge of the river, resulting in soil compaction along the banks, trash in the river, and damaged or removed riparian vegetation. WDFW is currently working on several projects to reconnect the floodplain of the Tucannon River, and one of those projects is located adjacent to, and north of, the current Campground 6.

A new campground will be constructed across the Tucannon Road from the existing campground. The new campground will be out of the floodplain and in an area with trees to provide shade. A driveway into the campground will be built and graveled. A new concrete outhouse will be installed, 8 camp sites

will be leveled, gravel will be placed on the parking pads, a concrete picnic table will be placed, and campfire rings will be set in concrete.

The current Campground 6 will be removed and the site restored. The fiberglass outhouses will be removed. The campfire rings and concrete picnic table will be removed and used in the new campground. The riparian area will be rehabilitated and replanted with native riparian vegetation. The campground will be planted into native grasses and shrubs. The area will be closed to vehicle entry and will be allowed to return to floodplain.

This project is necessary to the success of the floodplain management plans' ultimate goals of restoring floodplain function for the benefit of fish and wildlife and improving the recreational experience of the public on the Wildlife Area.

CAMPGROUND 9 RELOCATION

The current Campground 9 is located in the floodplain of the Tucannon River and it will be relocated outside the floodplain. Some of the campsites are located very near the edge of the river, resulting in soil compaction along the banks, trash in the river, and damaged or removed riparian vegetation. The current Campground 9 will be replaced with 2 smaller campgrounds that are located outside of the floodplain.

One of the new campgrounds will be located just south of the current Campground 9 on a little rise (Figure 14). One of the concrete outhouses from the current Campground 9 will be moved to the new campground. Four to five camp sites will be constructed in the new campground with gravel placed on the parking pads and the campfire rings set in concrete. The perimeter of the new campground will be lined with boulders to keep campers from driving vehicles down to the river or camping outside of the designated campground. A driveway into the new campground will be constructed and graveled. The new campground will be named Campground 10 and the current Campground 10 will be renamed Campground 11.

The second replacement campground will be located in the log landing site located northeast of the mouth of the Little Tucannon River, across the Tucannon Road from a previous WDFW campground that was closed because it was located in the floodplain. This new campground will give the public another campground that is near the section of the Tucannon River that is open to fishing. The driveway into the new campground will be improved and graveled. The second concrete outhouse from the current Campground 9 will be moved and installed in the new campground. Four campsites will be constructed in the campground with gravel placed on the parking pads and the campfire rings set in concrete. Trees

will be planted in the new campground to provide future shade trees for the campground. The new campground will be named Campground 9.

The current Campground 9 will be closed and the habitat restored. The outhouses and campfire rings will be removed and used in the 2 new campgrounds. The riparian area will be cleaned up of garbage. The campground will be replanted with native grasses and shrubs. The riparian area will be rehabilitated and replanted with willows and riparian vegetation. The area will be closed off to all vehicle entry and allowed to return to floodplain. The boulders lining the current Campground 9 will be used to line the new Campground 10 and to close the current Campground 9 to vehicle access. Some riparian enhancement will be done along the south bank of the Tucannon River along the north edge of Campground 11.

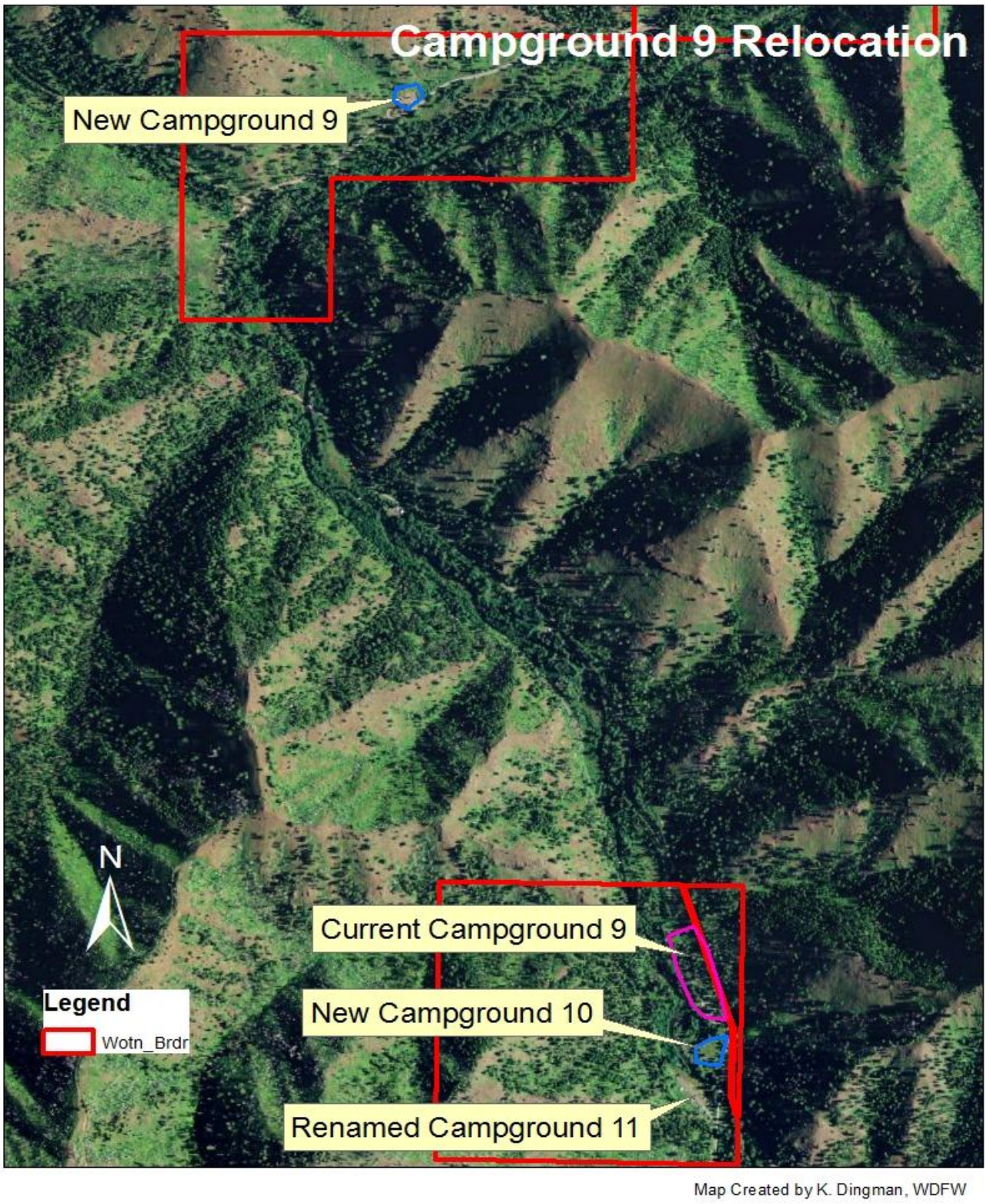

Figure 14: Campground relocations aerial view.

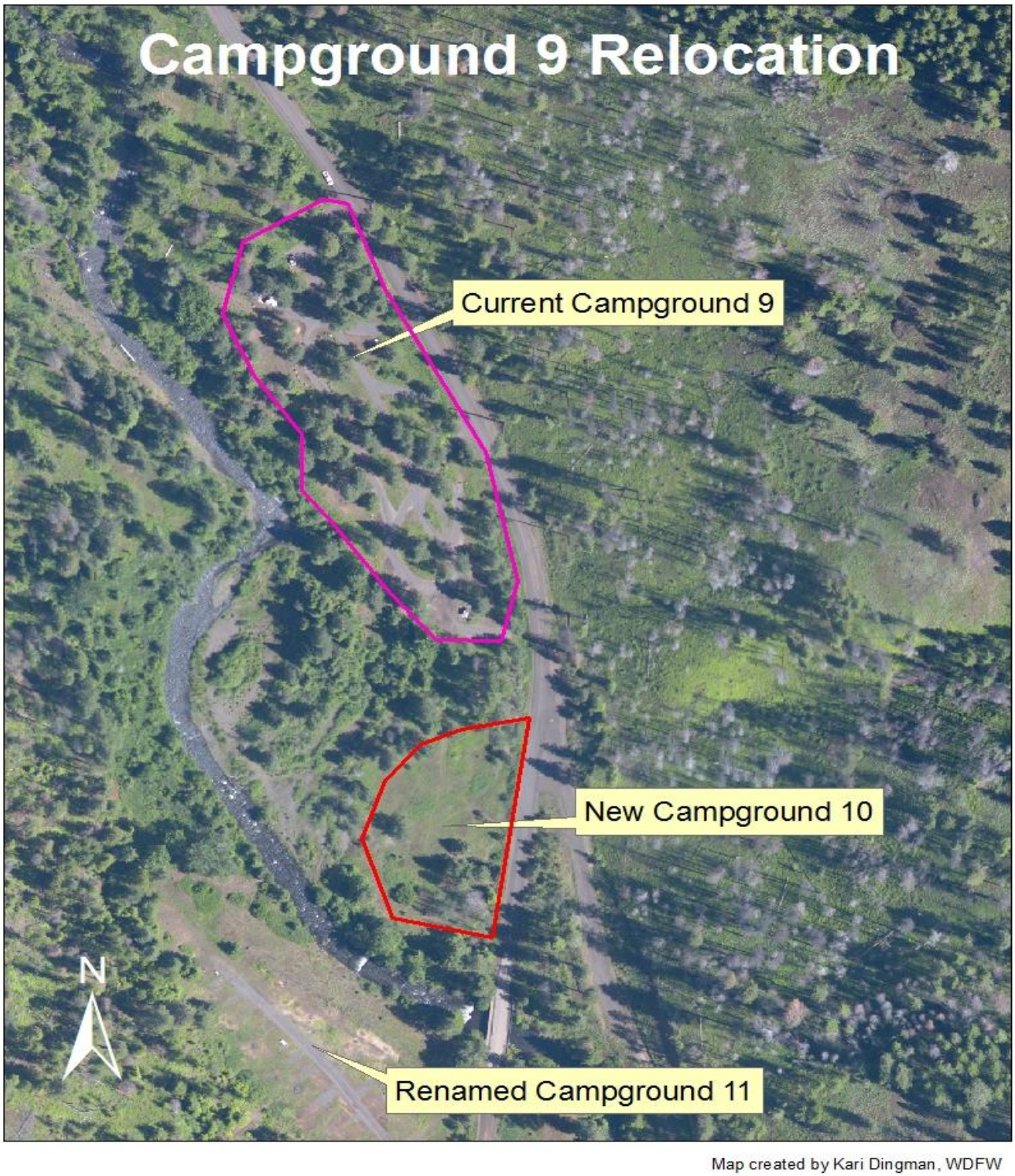

Figure 15: Campground 9 location and the new Campground 10 location.

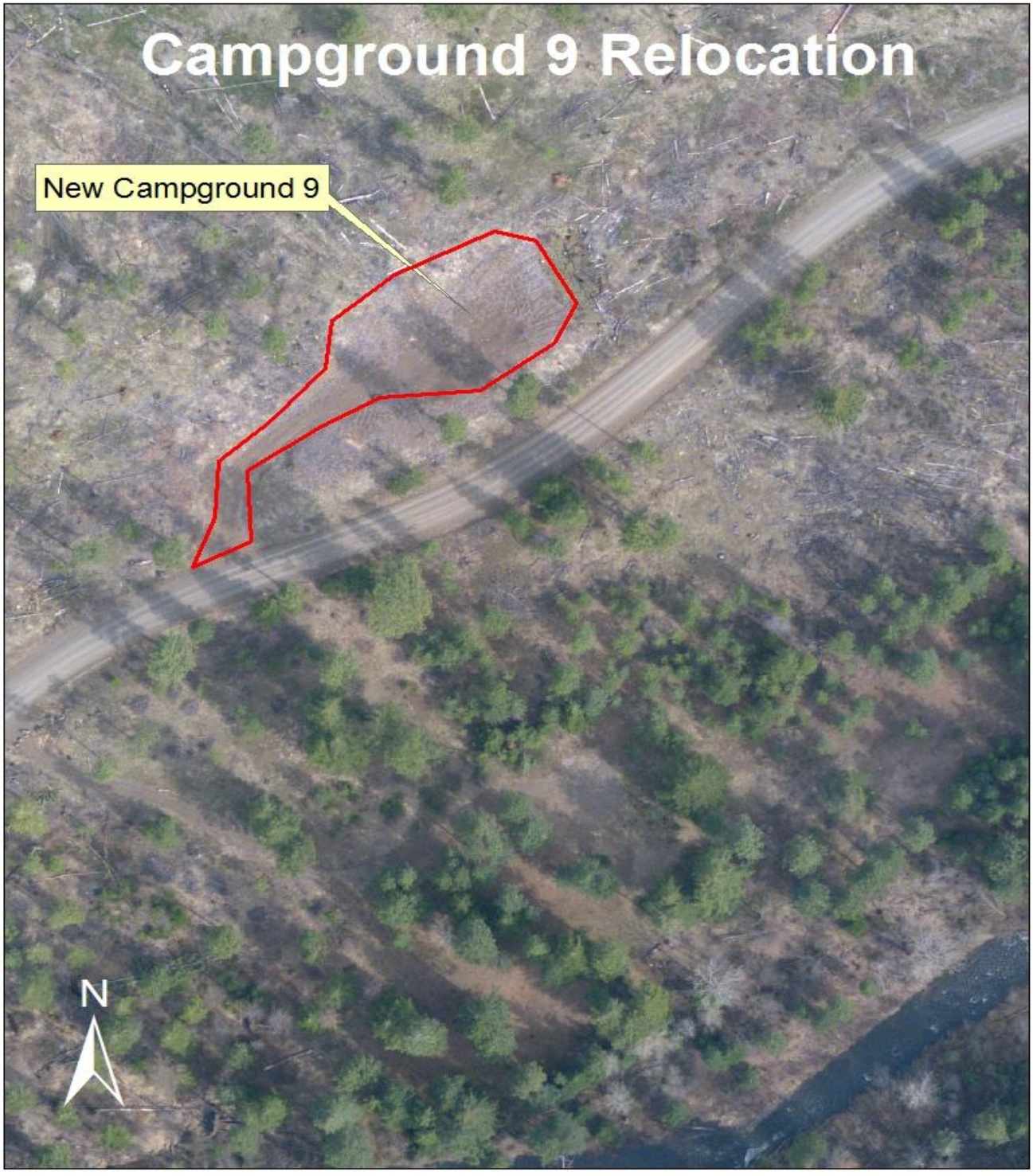

Figure 16: New Campground 9 Location.

ROADS, BRIDGES, CULVERTS

No specific projects are currently proposed for roads, bridges and culverts except for those that are associated with the conceptual Tucannon Lakes projects (e.g Beaver-Watson lakes). Projects for roads, bridges and culverts are dependent upon the Feasibility Study portion of this floodplain management plan scheduled for implementation in 2013-2015.

CAMP WOOTEN

No specific projects are currently proposed for Camp Wooten. Projects for reconfiguration or relocation are dependent upon the Feasibility portion of the FMP scheduled for 2013-2105.

REFERENCES

Anchor QEA. 2011. Tucannon River Geomorphic Assessment and Habitat Restoration. Prepared for the Columbia Conservation District and the Snake River Salmon Recovery Board.

Knutson, K. L., and V. L. Naef. 1997. Management recommendations for Washington's priority habitats: Riparian. WDFW, Olympia. 181pp.

Mendel, G., and J. Trump. 2008. Tucannon Lakes Fishery Monitoring Report for 2003. WDFW Project Report FPA 08-02. 22 pp, plus appendices.

Columbia County Conservation District. 2004. Tucannon Subbasin Plan. Submitted to NPCC.

Snake River Salmon Recovery Board. 2006 and 2011. Snake River Salmon Recovery Plan. Prepared for the Governor's Salmon Recovery Office.

APPENDIX- AVAILABLE AT:
HTTP://WDFW.WA.GOV/LANDS/WILDLIFE_AREAS/WT_WOOTEN/

APPENDIX A: SOURCES OF ANGLERS SAMPLED AT THE FOUR NORTHERN TUCANNON LAKES IN 2003.

APPENDIX B: CAPITAL REQUEST WOOTEN WILDLIFE AREA IMPROVE FLOOD PLAIN.

APPENDIX C: TUCANNON LAKES SUMMARY OF ISSUES AND OPPORTUNITIES.

APPENDIX D: TUCANNON RIVER GEOMORPHIC ASSESSMENT AND HABITAT RESTORATION STUDY FLOODPLAIN MAPS.

APPENDIX E: PROJECT AREA 14 60% DESIGNS

Appendix A: Angler residence data from all interviews conducted during the sampling season for the Tucannon Lakes creel surveys, 2003 **(from Mendel and Trump 2010).**

Residence	Number of Anglers	% of Anglers
Washington State Anglers		
Columbia and Garfield County Anglers		
Blind Grade	4	0.11
Dayton	170	4.64
Lyons Ferry	5	0.14
Pomeroy	136	3.71
Starbuck	7	0.19
Tucannon	3	0.08
Columbia and Garfield County Totals	**325**	**8.87**
Walla Walla and Asotin County Anglers		
Asotin	2	0.05
Burbank	35	0.96
Clarkston	32	0.87
College Place	19	0.52
Dixie	12	0.33
Prescott	18	0.49
Touchet	38	1.04
Waitsburg	92	2.51
Walla Walla	537	14.66
Wallula	8	0.22
Walla Walla and Asotin County Totals	**793**	**21.65**
Other Cities in Washington State		
Arlington	1	0.03
Bellevue	1	0.03
Benton City	42	1.15
Chehalis	1	0.03
Cheney	5	0.14
Cle-Elum	2	0.05
Colfax	8	0.22
Connell	29	0.79
Ellensburg	6	0.16
Eltopia	4	0.11
Finley	5	0.14
Gig Harbor	13	0.35
Goldendale	3	0.08
Grandview	54	1.47
Hoquiam	1	0.03
Ione	2	0.05
Kahlotus	21	0.57
Lind	14	0.38
Mesa	6	0.16
Moses Lake	13	0.35
Olympia	1	0.03
Othello	27	0.74
Prosser	68	1.86
Pullman	23	0.63
Puyallup	5	0.14
Reardon	1	0.03
Redman	3	0.08
Ridgefield	4	0.11
Ritzville	1	0.03
Sammamish	1	0.03
Seattle	16	0.44
Silverdale	1	0.03
Snohomish	1	0.03
Soap Lake	2	0.05
Spokane	38	1.04
Sunnyside	3	0.08
Tri-Cities	1,928	52.63
Union Town	1	0.03
Vancouver	10	0.27
Washtucna	7	0.19
Wenatchee	1	0.03
Whidbey Island	4	0.11
Yakima	39	1.06
Zillah	2	0.05
Washington Totals	**3536**	**96.53**
Oregon State Anglers		
Glide, OR	2	0.05
Hermiston, OR	8	0.22
Irrigon, OR	11	0.30
Medford, OR	3	0.08
Milton-Freewater, OR	33	0.90
Portland, OR	3	0.08
Salem, OR	2	0.05
Wallowa, OR	1	0.03
Oregon Totals	**63**	**1.72**
Idaho State Anglers		
Bothell, ID	4	0.11
Lewiston, ID	9	0.25
Peck, ID	7	0.19
Pocatello, ID	3	0.08
Whinchester, ID	12	0.33
Idaho Totals	**35**	**0.96**
Anglers from other U.S. Cities and States		
Alabama	1	0.03
Arizona	3	0.08
Mesa, AZ	2	0.05
California	1	0.03
Sacramento, CA	2	0.05
Florida	1	0.03
Michigan	1	0.03
Missouri	1	0.03
Nebraska	5	0.14
Las Vegas, NV	6	0.16
Carson City, NV	1	0.03
Texas	1	0.03
Salt Lake City, UT	1	0.03
Wisconsin	3	0.08
Other Totals	**29**	**0.79**

Project Number: **30000481**
Project Title: **Wooten Wildlife Area Improve Flood Plain**

Description

Project Phase Title: Design and Permitting
Starting Fiscal Year: 2014
Project Class: Preservation
Agency Priority: 3

Project Summary

The Department will renovate the flood plain in the Wooten Wildlife Area to improve spawning and rearing habitat for ESA listed fish, protect private and public property, improve recreational fishing opportunities and increase revenue to the local economies.

Project Description

What is the proposed project?

An agency-wide, cross-program committee is currently engaged in writing the Wooten Floodplain Management Plan (FMP) for the 17 miles of Tucannon River that is located within the boundaries of the Wooten Wildlife Area. The Department has a unique opportunity to possibly obtain federal funding to help with implementation of this plan. The projects will improve spawning and rearing habitat for ESA listed fish in the Tucannon River, protects private and public property, improves recreational lake fishing opportunities, and extends the number of lake fishing days, increasing revenue to the local economies. The Department would like to phase this project out over three biennia to accommodate the possible funding from the BPA. The cost estimate associated with this project could change once the Department completes a predesign.

Phase 1 (2013-2015): Feasibility (Development, design and permitting of projects, outreach and early action projects)
Project Design and Permitting
Early Action Projects – Campground Relocation out of the floodplain
Habitat Enhancement (Spending Authority: BPA)
Additional Project Development under Initiatives

Phase 2 (2015-2017): Project Implementation Part 1
Rainbow Lake Enhancement
Deer Lake Enhancement
Tucannon Power line
Habitat Enhancement (Spending Authority: BPA)
Additional Projects Developed Under Phase 1

Phase 3 (2017-2019): Project Implementation Part 2
Beaver-Watson Lake Enhancement
Spring Lake Enhancement
Big Four Lake Decommissioning
Camp Wooten Reconfiguration/Relocation
Habitat Enhancement (Spending Authority: BPA)
Additional Projects Developed Under Phase 1

What opportunity or problem is driving this request?

The BPA may fund up to $1,300,000 a year until 2018 to support restoration projects in the Tucannon. Much of the work identified is on the Wooten Wildlife Area. The Department will need to compete for these funds and we are optimistic that we may receive funding if we can contribute funding to a portion of these projects.

The W.T. Wooten Wildlife Area covers approximately 16,000 acres in Columbia and Garfield counties and features eight lakes located along the Tucannon River. The Wooten Floodplain Management Plan has been driven by several factors, primary among which are the deteriorating condition of the Tucannon Lakes and associated infrastructure and the Bonneville Power Administration and the Snake River Salmon Recovery Board focus of spring Chinook recovery in the Tucannon River. The

Version: 11 13-15 DFW Capital Budget

Report Number: CBS002
Date Run: 9/10/2012 11:25AM

Project Number: 30000481
Project Title: Wooten Wildlife Area Improve Flood Plain

Description

FMP team has identified lake rehabilitation as a priority, designed to improve and enhance recreation, reduce impacts to ESA listed species, and improve stream and floodplain function for the Tucannon River.

The current condition and configuration of most of the Tucannon Lakes is an ecological detriment to the Tucannon River floodplain function and drives constant maintenance needs. All but two lakes constrict the floodplain of the Tucannon River, causing the river to be channelized and incised. All of the lakes drain back into the river, leading to increased water temperatures. The dikes/levees of all eight lakes are in violation of the Department of Ecology's Dam Safety requirements. The lakes retain sediment and have to be periodically dredged out. Six of the lakes rely on surface diversions from the Tucannon River. The current diversions have had periodic failure issues in recent years impacting both the fishing availability of the lakes to the public and potentially endangering listed salmonids.

Bonneville Power Administration (BPA) has established funding through the Snake River Salmon Recovery Board to restore Spring Chinook habitat in the Tucannon River Basin. BPA will spend about 1.3 million dollars per year through 2018. Restoration strategies and recommendations were developed based on limiting factors identified in the Tucannon Sub basin Plan, Snake River Salmon Recovery Plan, and the Tucannon River Geomorphic Assessment and Habitat Restoration Study. Of a prioritized list of projects developed from this review, 75 percent of the top tiered projects are located on the Wooten Wildlife Area. This means that between six and nine million BPA dollars could be spent on habitat enhancement projects on the Wildlife Area between now and the end of the 2017-2019 Biennium.

How does the project support the agency and statewide results?
This project supports the agency's strategic plan by enhancing fish rearing habitat for ESA listed fish. This project also enhances fishing opportunities by increasing the number of fishing days in this area.

Goal 1: Conserve and protect native fish and wildlife
Objective C: Enhance and improve land and water stewardship to meet conservation goals
Strategies
Ensure department lands, fishways, screening structures, water intakes, dams and dikes are compliant with regulations

Goal 2: Provide sustainable fishing, hunting and other wildlife-related recreational experiences
Objective A: Increase the economic benefits and public participation derived from sustainable fish and wildlife opportunities
Strategies
Increase access to private lands to enhance hunting and wildlife viewing opportunities

This project supports the statewide results:

Improve the quality of Washington's natural resources
This project will protect the natural resources by protecting fish and wildlife, and their habitats. This project will also preserve, maintain and restore natural systems and landscapes.

Improve the economic vitality of businesses and individuals
Fish and wildlife activities bring in revenue to Washington communities. This project can help develop markets by promoting fishing and hunting opportunities. By improving and repairing infrastructure and restoring and acquiring natural habitats, this project will ensure healthy, diverse and sustainable fish and wildlife populations for the residents in Washington State for social and economic benefit.

Improve the safety of people and property
This project will reduce the potential of flooding and could protect private and public property. This project could also prevent human and wildlife conflict making highways safer and protecting Washington State's resources. By improving and repairing

Version: 11 13-15 DFW Capital Budget

Report Number: CBS002
Date Run: 9/10/2012 11:25AM

Project Number: 30000481
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Description

infrastructures and structures, the Department will preserve and protect existing state property.

What are the specific benefits of this project?
This request if funded will enhance fishing, camping and other recreational uses on the Wooten Wildlife Area while improving habitat for fish and wildlife by reducing the impounded lakes' impact to the floodplain. The Wooten Floodplain Management Plan (FMP) team has identified lake rehabilitation as a priority, designed to improve and enhance recreation, reduce impacts to ESA listed species, and improve stream and floodplain function for the Tucannon River. This Capital Request will help to accomplish this goal by developing, designing and implementing projects under the six initiatives identified in the plan: 1) Lakes; 2) Campgrounds; 3) Roads/Water Crossings/infrastructure; 4) Camp Wooten; 5) Habitat Enhancement; and 6) Outreach.

How will clients be affected and services change if this project is funded?
This request if funded will enhance fishing, camping and other recreational uses on the Wooten.

How will other state programs or units of government be affected if this project is funded?
The dams currently are in violation can be removed from Department of Ecology's list.

What is the impact on the state operating budget?
The project will renovate and existing asset and is not expected to have any additional impacts to the operating budget.

Why is this the best option or alternative?
The Wooten Wildlife Area Floodplain Improvement Capital Request was developed to as a result of cross-program, agency-wide coordination on the Wooten Floodplain Management Plan (FMP). The goal of the FMP is to enhance fishing, camping and other recreational uses on the Wooten while improving habitat for fish and wildlife by reducing floodplain impacts.

What is the agency's proposed funding strategy for the project?
The Department requests State Building Construction Funds for this project. The Department has an opportunity to compete for federal funding and could receive up to $2.6 million per biennium until 2018.

How does this impact the economy?
This project is expected to extend the fishing seasons within the Tucannon and directly benefit the local economies. When feasible, the Department will use contract services for this project, thus helping to create jobs in the private sector.

Location
City: Dayton **County:** Columbia **Legislative District:** 016

Project Type
Infrastructure (Major Projects)

Growth Management impacts
This project is not expected to impact growth management.

Funding

Acct Code	Account Title	Estimated Total	Expenditures Prior Biennium	Current Biennium	2013-15 Fiscal Period Reapprops	New Approps
001-2	General Fund-Federal	6,500,000				2,600,000

477 - Department of Fish and Wildlife

Capital Project Request

2013-15 Biennium

Version: 11 13-15 DFW Capital Budget

Report Number: CBS002
Date Run: 9/10/2012 11:25AM

Project Number: 30000481
Project Title: Wooten Wildlife Area Improve Flood Plain

Funding

Acct Code	Account Title	Estimated Total	Expenditures Prior Biennium	Current Biennium	2013-15 Fiscal Period Reapprops	2013-15 Fiscal Period New Approps
057-1	State Bldg Constr-State	16,097,000				1,800,000
	Total	**22,597,000**	**0**	**0**	**0**	**4,400,000**

		Future Fiscal Periods 2015-17	2017-19	2019-21	2021-23
001-2	General Fund-Federal	2,600,000	1,300,000		
057-1	State Bldg Constr-State	8,297,000	6,000,000		
	Total	**10,897,000**	**7,300,000**	**0**	**0**

Schedule and Statistics

	Start Date	End Date
Predesign	09/01/2013	06/01/2014
Design	7/1/2014	2/1/2018
Construction	3/1/2015	10/1/2019

	Total
Gross Square Feet:	3
Usable Square Feet:	0
Efficiency:	0.0%
Escalated MACC Cost per Sq. Ft.:	5,578,193
Construction Type:	Other Schedule A Projects
Is this a remodel?	No
A/E Fee Class:	A
A/E Fee Percentage:	Varies

Cost Summary

	Escalated Cost	% of Project
Acquisition Costs Total	**0**	**0.0%**
Consultant Services		
Pre-Schematic Design Services	184,730	0.8%
Construction Documents	1,106,260	4.9%
Extra Services	213,034	0.9%
Other Services	497,015	2.2%
Design Services Contingency	40,667	0.2%
Consultant Services Total	**2,041,706**	**9.0%**

Maximum Allowable Construction Cost(MACC) **16,734,580**

477 - Department of Fish and Wildlife
Capital Project Request
2013-15 Biennium

Version: 11 13-15 DFW Capital Budget

Report Number: CBS002
Date Run: 9/10/2012 11:25AM

Project Number: 30000481
Project Title: Wooten Wildlife Area Improve Flood Plain

Cost Summary

	Escalated Cost	% of Project
Construction Contracts		
Site work	0	0.0%
Related Project Costs	0	0.0%
Facility Construction	16,734,580	74.1%
GCCM Risk Contingency	0	0.0%
GCCM or Design Build Costs	0	0.0%
Construction Contingencies	1,673,458	7.4%
Non Taxable Items	0	0.0%
Sales Tax	1,435,828	6.4%
Construction Contracts Total	**19,843,866**	**87.8%**
Equipment		
Equipment	0	0.0%
Non Taxable Items	0	0.0%
Sales Tax	0	0.0%
Equipment Total	**0**	**0.0%**
Art Work Total	**0**	**0.0%**
Other Costs Total	**0**	**0.0%**
Project Management Total	**711,889**	**3.2%**
Grand Total Escalated Costs	**22,597,461**	
Rounded Grand Total Escalated Costs	**22,597,000**	

Operating Impacts

No Operating Impact

Tucannon Lakes Management

9/7/11

DOE Dam Safety Criteria – summary of applicability (see WAC 173-175-020)

- *Applies to dam which can impound a volume of 10 acre ft or more as measured at dam crest elevation which could be released by a dam failure (excluding the volume below natural ground level)*
- *For a dam of 6 ft high or less, which meets the conditions of subsection 1 of this section, DOE may elect to exempt the dam from these regulations.*
- *These regulations do not apply to dams that are owned by an agency of the federal government which has oversight on operation and maintenance and has its own dam safety program for inspection and repair of safety deficiencies of completed projects.*
- *These regulations do not apply to dikes and levees constructed along a water course for protection from flooding or for purposes of floodplain management.*

Issues

1. Dam Safety- in violation of DOE legal requirements for dams
2. Loss of depth and volume in lakes and consequential reduction of fish stocking and fishing access or success
3. Some lakes have river intakes to be maintained (Rainbow, Deer, Beaver/Watson, Big Four and Curl) and others have spring or ground water sources
4. Thermal inputs into the Tucannon River and ESA fish habitat issues
5. Too many lakes to manage and maintain?
6. Maintenance and Operation of facilities
    a. screens and intakes,
    b. dams and vegetation
    c. footbridge at Watson Lake - maintenance
    d. General repair/maintenance costs and man-power
7. Loss of Floodplain and constriction of the Tucannon River by lakes and dams
8. Resident trout angling and LSRCP mitigation goals (trout stocking to replace expected loss of angling days because of damming the Snake River)
9. Other resident Trout Fishing opportunities are limited (no natural lakes and only small ponds, streams no longer stocked, maintenance of the jumbo trout program)
10. Further restrictions to fishing in the Tucannon River to protect ESA listed fish likely in the near future

Opportunities

1. Repairs and restructuring could provide more fishing opportunity/recreation and more disabled angler access
2. Reexamine angling regulations and restrictions – could possibly relax some regulations and provide some use of float tubes, etc. in some locations
3. Could possibly enhance fish habitat for ESA listed fish and other wildlife
    a. Construct side channels and improve riparian vegetation
    b. Reduce river constriction and expand river access to floodplain
    c. Reduce thermal inputs from lakes
4. Reduce long term costs

5. The vegetation clearing by Screen Shop staff in January 2009 was for inspection purposes only and little money expected for statewide dam work by WDFW in new biennium ($150,000 total for 65 dams)
6. Capital Budget may receive $30 million of the $60 million requested, but includes design only for Rainbow and Spring Lakes, no construction funds available.

A. Spring Lake (built in 1955, 6.0 acres) – **High Priority for Repairs (repair and maintain dam, dredge to increase volume and depth)**

1. WDFW District Team identified this several years ago as a high priority for repair
2. Serious dam problems and this could have a catastrophic failure and severe impacts to habitat in the Tucannon River for ESA listed fish
3. very shallow and weedy now – lack of capacity
4. Angler access is limited because of weeds and overgrowth
5. Needs a bottom draw outlet and screen system to reduce thermal inputs into the river and to keep fish in the lake
6. has little constriction of the river
7. 2008 proposal to RCO for rehab. By WDFW??
8. stocking plans for 2009 were for 11,000 catchables and 300 jumbos
9. Outlet pipe replacement in 1997
10. 2003 estimated costs for repair: $544,000 for full repairs and $43,000 for decommissioning,
11. Over 8,000 angler hrs of use and 4,700 fish harvested in 2003

B. Blue Lake (built 1955, 5.0 acres) – **Needs Few Repairs**

1. Most dam safety issues already addressed, least cost for repairs
2. Already has a screened, bottom draw outlet
3. doesn't need to be dredged – was dredged about 8years ago
4. Has high angler use (nearly 14,000 angler hrs in 2003, and about 12,000 fish caught)
5. this lake does not draw from the river and has no constriction of the floodplain
6. this lake is classified as a fish passage barrier by the WDFW assessment of this spring fed tributary
7. stocking plans for 2009 were for 23,300 catchables and 400 jumbos
8. Rebuilt, dredged and new outlet in 1997
9. 2003 estimated costs for repair: $58,500 for dam repair

C. Rainbow Lake (built 1955, 10 acres) **– High Priority for Repair (major dam repairs, dredging to improve volume and depth – could fill or isolate the SW corner)**

1. Unique lake, as its intake is included with the intake for the hatchery (and the lake acts as a reservoir for the hatchery). The intake is owned by USFWS as part of LSRCP- it is part of the hatchery facility.
2. fills in with sediment quickly because it withdraws water year round

3. largest of the 8 lakes
4. the size of the lake could be reduced and the water circulation improved during dredging (e.g. fill the sw corner and breach or remove some of the spits)
5. the sediment trap section of the lake near the inflow could be expanded
6. docks could be added for better access and improved water flow patterns
7. another, separate issue is the constraining dike along the river downstream of the intake dam. This dike directs the river to the base of the hill and reduces floodplain and maintains channelization of the river
8. WDFW Region 1 staff compiled a proposal to RCO for funding lake rehab. In 2008
9. this lake used to be heavily stocked, but loss of capacity and volume has caused reduced stocking – the lake must be dredged to add depth/volume
10. Lake has high angler use (nearly 15,000 angler hrs in 2003, and about 10,000 fish caught)
11. stocking plans for 2009 were for 15,000 catchables and 300 jumbos
12. 2003 estimated costs for repair: $858,400 and $140,400 for decommissioning
13. Consultant's narrative in 2005 for proposed rehabilitation/reconstruction and drawings

D. Deer Lake (built 1955, 4.4 acres) **– could use alternative plans to decommission (e.g. breach dam and dismantle intake) and turn into a wetland, or reconfigure/relocate?**

1. no road access for anglers- secluded
2. small, shallow and weedy lake
3. low dam?
4. Tucannon River is close by
5. outlet does not have a functioning screen
6. intake structure controls the river location and is difficult to maintain or operate
7. the dam leaks
8. could decommission and leave the intake open but there may be risks to river damage to infrastructure such as the road and old dam.
9. could decommission and block the intake, and breach, or remove the dam
10. this lake could be used to replace loss of Big 4 as a fly fishing only lake
11. beaver problems in 2008
12. Has relatively low angler use (nearly 1,100 angler hrs in 2003, and about 700 fish caught – partial survey that missed first two weeks of the season)
13. stocking plans for 2009 were for 3,300 catchables and 25 jumbos
14. 2003 estimated costs for repair: $456,100 and $35,400 for decommissioning

E. **Watson Lake** (built 1954, 6.7 acres) – **repair/maintain dam, dredge and reconfigure/relocate to combine with Beaver Lk and open up floodplain**

1. This lake has lots of angler use (Easy access for the public and very popular)
2. This lake causes maintenance costs because or recent relocation and rebuilding of a separate access administrative road
3. This lake also requires a separate power line and maintenance costs
4. The river is channelized and has a sharp corner that is a risk to the footbridge, lake, road and parking lot, and reduces floodplain (Watson and Beaver lakes severely constricts the river and floodplain)
5. leaky dam that is covered with brush and trees
6. Parking lot is dangerous to exit
7. Bridge over river requires maintenance
8. Lake is not holding enough water to exit through the outflow screen now
9. stocking plans for 2009 were for 20,000 catchables and 300 jumbos
10. 2003 estimated costs for repair: $606,000 for repair and $43,900 for decommissioning

F. **Beaver Lake** (built 1953, 2.1 acres) **– decommission or combine with Watson**

1. This lake is very small, shallow, weedy and overgrown
2. little angler use and reduced stocking with hatchery fish
3. easy access
4. difficult to get water flow during the summer
5. could be used as a sediment trap for Watson Lake (terminated stocking in 2011)
6. stocking plans for 2009 were for 500 catchables and 0 jumbos
7. could consolidate with Watson with new lake configuration that would open up floodplain
8. 2003 estimated costs for repair: $246,800 for repair and $26,900 for decommissioning

G. **Big 4 Lake** (built 1954, 5.0 acres) **– Major issue – decommission or repair lake and protect it from the river – no access for stocking or repair except across river**

1. Unique fishing area because it is the **only <u>fly fishing only</u> area in SE WA**
2. it is secluded and access requires wading the river (can be difficult or dangerous in early spring during high flows)
3. dam is overgrown and leaks badly
4. this lake is difficult to stock because of no road access, and it is only stocked once per year
5. a beaver dam was blocking the outlet in 2008
6. the Tucannon River is threatening to erode the dam and capture the lake
7. the lake is shallow and needs to be dredged and it needs protection from the river
8. repairs will be expensive and difficult because there is no road access (all heavy equipment will have to cross the river)
9. stocking plans for 2009 were for 2,000 catchables and 300 jumbos

10. 2003 estimated costs for repair: $644,700 to repair and $123,100 for decommissioning

H. **Curl Lake** (built 1955, 2.5 acres) – **Few or NO repairs Needed – planned for dredging in 2011**

1. This lake is part of the USFWS ownership and part of the LSRCP hatchery program. It is used primarily as an acclimation pond for spring Chinook and later stocked with catchable trout for fishing.
2. The lake has very easy access
3. This lake opens for fishing the last Sat. in April, after use as an acclimation pond
4. Relatively few repairs are needed
5. Could likely get cost share from LSRCP, or possibly full costs paid by LSRCP
6. stocking plans for 2009 were for 12,000 catchables and 300 jumbos
7. 2003 estimated costs for repair: $214,600 for repairs and $42,900 to decommission. Could reduce volume to below DOE threshold for $30,000.
8. this lake is constricting the river channel and reducing floodplain
9. the intake was repaired to provide adequate fish passage in 2008, but it has been repaired several times in the past 10-12 yrs.
10. Installed a clay core in dam to reduce seepage in 2005, so this dam should be compliant with DOE regulations now, or nearly so

REPORT

60 PERCENT DESIGN REPORT
PROJECT AREA 14
TUCANNON RIVER

Prepared for

Snake River Salmon Recovery Board

410 B East Main

Dayton, Washington 99328

Prepared by

Anchor QEA, LLC

1605 Cornwall Avenue

Bellingham, Washington 98225

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TABLE OF CONTENTS

List of Tables

List of Accompanying Documents

60% Design Drawings (20 sheets)

Engineer's Quantity and Cost Opinion

List of Acronyms and Abbreviations

%	percent
CCD	Columbia Conservation District
ELJ	engineered log jam
ESA	Endangered Species Act
GPS	global positioning system
LWD	large woody debris
PA	project area
RM	river mile
WDFW	Washington Department of Fish and Wildlife

1 INTRODUCTION

Anchor QEA, LLC, was retained by the Snake River Salmon Recovery Board (SRSRB) to develop 60 percent (%) designs for restoration within Project Area (PA) 14 of the Tucannon River as delineated in the Conceptual Restoration Plan (Anchor QEA 2011a) from approximately river mile (RM) 39.2 to 37.15. The Tucannon River basin is located in Southeast Washington State in Columbia and Garfield counties (Drawing T-01). Enhancing and restoring instream habitat in this project area will be accomplished through a variety of treatment actions in the main channel, along the banks, and within the floodplain. This report describes the project areas as well as the function, design, and construction of restoration treatments that are proposed for implementation. These treatments include construction of large woody debris (LWD) features, engineered log jam (ELJ) structures, removal of infrastructure such as dredge spoils, and riparian plantings. In addition a gravel augmentation program is proposed to place former dredge spoils back into the river to help treat incision and arrest an existing headcut moving through the reach near the upstream extent of PA-14. A description of the project area with respect to existing natural processes and habitat conditions is provided in the 30% design report (Anchor QEA 2011d), along with the specific physical and biological objectives that the proposed restoration features are expected to achieve (Appendix A, Anchor QEA 2011d). In addition, the project's contribution to the overall watershed-scale restoration plan is described in the 30% design report. Construction considerations and best management practices are included in the 30% design report for the proposed treatment actions.

1.1 Previously Completed Studies

Previous studies completed in support of restoration within PA-14 are presented below in chronological order:

- Tucannon Subbasin Plan (CCD 2004)
- Snake River Recovery Plan for SE Washington (SRSRB 2006)
- Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA 2011a)
- Draft Conceptual Restoration Plan, River Miles 20 to 50 (Anchor QEA 2011b)
- Conceptual Restoration Plan, Reaches 6 to 10 (Anchor QEA 2011c)
- 30 Percent Design Report (Anchor QEA 2011d)

2 PROJECT PURPOSE AND OBJECTIVES

The system-wide restoration objective for the Tucannon River is to improve habitat conditions for Endangered Species Act- (ESA-) listed species for all life history stages. Improving habitat conditions will lead to an increase in the abundance of listed species returning to the river. Increasing abundance will lead to delisting of the species, which is the overall recovery goal for the system. Previous efforts (CCD 2004; SRSRB 2006) have identified the habitat-limiting factors associated with the decline of ESA-listed populations. A geomorphic assessment synthesized and updated this information and identified 10 geomorphic reaches between the river mouth and Panjab Creek (RM 50). Reach-scale restoration actions based on this basin-scale assessment were provided at a preliminary level in the Conceptual Restoration Plan described below.

2.1 Conceptual Restoration Plan, Reaches 6 to 10

In 2011, a Conceptual Restoration Plan was created for Reaches 6 through 10 (RM 20 to 50), which were identified as critical for spring Chinook and steelhead populations in the system (Anchor QEA 2011a). This assessment included the development of 28 site-specific restoration projects throughout the 30 miles of the study area. As part of this effort, meetings and discussions with local stakeholders and scientific experts in the Tucannon basin were held to identify the critical life history stages to target in prioritizing the implementation of the 28 projects. Four criteria were identified:

1. **Expected biologic response:** How well the project is expected to benefit listed fish populations, particularly spring Chinook. For Reaches 6 through 10, projects expected to benefit the juvenile life history stage, or contribute to habitat complexity and pool quantity, typically received the highest rank.
2. **Consistency with natural geomorphic processes:** How well the project is expected to contribute to rehabilitation of natural processes on a project and reach scale.
3. **Benefit-to-cost ratio:** The ratio of the magnitude of expected physical and biologic benefit versus the relative cost.
4. **Reach priority:** A relative ranking between Priority 1 (highest) and Priority 3 (lowest) based on existing biologic and physical data that describes the restoration potential of the geomorphic reach.
    - Priority 1: Reaches 8 and 9 (RM 32.1 to 44.0)

- Priority 2: Reaches 6 and 7 (RM 20.0 to 32.1)
- Priority 3: Reach 10 (RM 44.0 to 50.0)

The conceptual project areas were qualitatively ranked based on the four criteria and placed into three relative tier levels. The tier levels are representative of the implementation priority for projects. Tier 1 projects should be considered for early implementation within basin restoration planning, Tier 2 projects are moderate to high priority to be considered for strategic implementation, and Tier 3 projects have a lower priority due to considerations such as less certainty of benefit, high cost of implementation, or contingencies of benefit on the construction of other projects.

2.2 Project Selection

Nine Tier 1 projects were identified in the Conceptual Restoration Plan for early implementation. Six of these projects are located within Reaches 8 and 9, which were identified as the highest priority reaches based on the criteria used in the evaluation. These two reaches have the greatest existing use by adult and juvenile fish, and a high/moderate level of restoration potential based on physical characteristics and impaired geomorphic process. PA-14 was selected for early implementation by the Columbia Conservation District (CCD) and the SRSRB, leading to the development of this 60% design package. The project addresses existing incision and ongoing headcut with the placement of ELJ structures and other LWD features. Project elements target retention of mobile wood and sediment, promotion of side channel development, and overall increased connectivity between the river and its adjacent floodplain. A summary of PA-14 in regards to the four evaluation criteria from the Conceptual Restoration Plan is provided in Table 1; additional details of the project prioritization and discussion of the evaluation criteria are available in the Conceptual Restoration Plan (Anchor QEA 2011a).

Table 1

PA-14 Evaluation Criteria Rationale

Criteria	Rationale
Expected biologic response	In the short term, the LWD features will provide high-flow refuge, low-flow cover, and additional pools in the project area. In the long term, the project actions are expected to initiate the formation of more complex and diverse habitats for juvenile and adult fish. Increased floodplain connectivity will contribute to the recovery of ecological riparian processes.
Consistency with natural geomorphic processes	The proposed restoration actions will promote the retention of LWD and sediment, which will contribute to the recovery of natural processes in the project area. In the long term, the project actions are expected to initiate increased floodplain connectivity and the development of a more complex channel network with diverse hydraulic conditions.
Benefit-to-cost ratio	The project is expected to have a moderate benefit and a moderate relative cost. The restoration treatments should provide some immediate benefit from the placement of LWD features in the channel; however, the desired geomorphic response will likely take place on a longer time line.
Reach priority	The project area is located in Reach 8, which is a priority 1 reach.

Source: Anchor QEA 2011a

The Conceptual Restoration Plan was intended to provide an objective look at which conceptual projects would be most beneficial to target species based on the above criteria. The assessment did not consider feasibility in terms of landowner willingness to participate or other potential challenges such as site access. PA-14 covers just over 2 RMs, which are located on property owned by the Washington Department of Fish and Wildlife (WDFW). Therefore, the potential challenges associated with landowner permission are low. While several access routes will be required to access the length of the project area, disturbance to existing vegetation will be minimized by observing best management practices during construction. Any trees disturbed may be incorporated into the project design to add additional complexity to the proposed LWD features.

3 DESIGN DEVELOPMENT

For purposes of discussion, the project area was divided into four discrete subareas with similar existing conditions, restoration objectives, and suites of treatment actions (Table 2). For an overview of the proposed conditions in the project area, see Drawings C-03 and C-04.

Table 2
PA-14 Subareas

Subarea	River Miles	Project Stationing	Length (ft)
1	39.2 to 38.8	108+00 to 88+00	2,000 ft
2	38.8 to 38.45	88+00 to 60+00	2,800 ft
3	38.45 to 37.75	60+00 to 30+00	3,000 ft
4	37.75 to 37.15	30+00 to 0+00	3,000 ft

RM rounded to nearest 0.05 mile

The proposed restoration actions are described within each subarea, including the physical description and construction details, as well the expected biological and physical benefits. Design details for LWD features and ELJ structures are shown in Drawings C-11 through C-17. For the purposes of describing the specific benefits of the design elements, the subareas have been further subdivided into groups of one or more features. However, the proposed design is intended to function collectively throughout the overall project area in order to achieve a reach-scale geomorphic response and optimum biological benefit in the long term. Therefore, the subareas and feature groups are not independent from one another. However, construction may spread out over a number of years depending on funding.

3.1 Subarea 1, Stations 108+00 to 88+00

Subarea 1 is located between the hatchery bridge near Station 108+00 to just upstream of the outlet of the hatchery outfall channel, Station 88+00. The proposed restoration features within this subarea are summarized in Table 3 and shown in Drawings C-05 and C-06.

Table 3

Summary of Proposed Restoration Actions and Expected Benefits, Subarea 1

Feature Group	Approx. Station	Action(s)	Expected Benefit
A	107+50 to 102+00	Spoil pile removal and gravel bedload augmentation	Works collectively with downstream LWD features and ELJ structures to raise the bed elevation of incised portions of the project area, contributing to channel complexity and floodplain connectivity.
B	103+50 to 98+50	Construction of two BA ELJ structures, 5 TH LWD features in the left split channel, and intensive riparian planting on the right bank	Address the active headcut by directing the majority of flow into the left-hand split flow channel and add LWD to the left bank to promote disturbance and roughen the channel; roughen the floodplain adjacent to the hatchery levee to minimize avulsion risk. Promote retention of wood and sediment to smooth out the headcut and steepened elevation in the subarea.
C	98+50 to 95+00	Construction of 3 TH LWD features on the left bank and one BA ELJ structure on the right bank	Provide hydraulic complexity and cover, promote gravel deposition, and encourage upstream connectivity to the hatchery outfall flow path at high flows.
D	94+00 to 92+00	Construction of two BA ELJ structures at the heads of existing islands	Maintain the existing split flow/island configuration and promote the development of additional channel complexity through the adjacent floodplain.
E	90+50 to 89+50	Construction of four TH LWD features along the left bank	Create hydraulic diversity, initiate meander bend development, and promote floodplain connectivity.
F	90+50 to 86+50	Spoil pile removal and in channel gravel placement during construction, placement of eight S LWD features in the hatchery outfall channel	Spoil pile removal and channel gravel placement is intended to promote increased floodplain connectivity and increase the local channel bed elevation to improve accessibility to the hatchery outfall channel. S LWD features are intended to provide cover and complexity at the downstream end of the existing hatchery outfall channel.

3.2 Subarea 2, Stations 88+00 to 60+00

Subarea 2 is located from Station 88+00 to Station 60+00. The proposed restoration features within this subarea are summarized in Table 4 and shown in Drawings C-06 and C-07.

Table 4

Summary of Proposed Restoration Actions and Expected Benefits, Subarea 2

Feature Group	Approx. Station	Action(s)	Expected Benefit
A	88+00 to 84+00	Construction of three TH LWD features, one BA ELJ structure and one CS ELJ structure	Improve low-flow connectivity to the existing side channel. Retain mobile LWD and bedload to raise the bed elevation along the valley wall over time.
B	84+00 to 80+50	Construction of two SR LWD features and one BA ELJ structure	Add instream complexity and promote floodplain connectivity and evolution of a channel network through the adjacent floodplain.
C	79+00 to 77+00	Construction of four TH LWD features and two SR LWD features	Initiate development of the meander bend and point bar. Promote right bank floodplain connectivity.
D	74+00 to 67+00	Construction of one BA ELJ structure and one CG ELJ structure	Split flow to enhance flow into the existing floodplain flow paths, increase floodplain connectivity, and promote side channel development in the long term.
E	66+00 to 62+050	Construction of three SR LWD features and two TH LWD features	Create hydraulic diversity, initiate development of the meander bend and point bar. Promote right bank floodplain connectivity.

3.3 Subarea 3, Stations 60+00 to 29+00

Subarea 3 is located from Station 60+00 to 29+00. The proposed restoration features within this subarea are summarized in Table 5 and shown in Drawings C-07 through C-09.

Table 5

Summary of Proposed Restoration Actions and Expected Benefits, Subarea 3

Feature Group	Approx. Station	Action(s)	Expected Benefit
A	59+00 to 55+50	Construction of three BA ELJ structures, two TH LWD features and multiple single LWD that will be incorporated into a natural log jam; gravel augmentation program	Create cover and refuge in the main channel short term, retain wood and sediment to increase floodplain connectivity and reverse the incised channel condition over time. Gravel augmentation will jump start this process by adding gravel from spoil piles removed from the floodplain upstream.
B	51+00 to	Construction of two BB	Add instream complexity, promote development of

	48+00	ELJ structures and four TH LWD features	more complex channel configuration, and raise the bed elevation over time.
C	47+00 to 41+00	Construction of two CS ELJ structures and two SR LWD features	Provide diverse hydraulic conditions in the short term. Retain mobile LWD and bedload to raise the bed elevation of the incised channel over time.
D	36+50 to 29+00	Construction of four CG ELJ structures	Provide cover and complexity in the short term. Retain mobile LWD and bedload over time to promote floodplain connectivity.

3.3.1 Bridge Removal

Removal of the bridge at Station 31+00 is proposed as part of this project (the bridge is located across the former Tucannon Road crossing). This process will involve demolition and removal of two concrete abutments, four cast-in-place piers, and the bridge deck and railings. The fill on the left bank flood plain leading up to the bridge will also be regarded to more closely match the natural floodplain grade. The bridge opening currently represents a significant channel constriction that likely causes a backwater effect and accelerated velocities during flood flows that may affect fish passage, particularly juveniles. In addition to creating better instream conditions, removal of this constriction will allow the presently straight channel to evolve to a more natural configuration over time. See Drawing C-09 for bridge and approach removal extents.

3.4 Subarea 4, Stations 29+00 to 0+00

Subarea 4 is from Station 29+00 to the downstream end of the project subarea at Station 0+00. To limit riparian disturbance, features and structures in this subarea are designed to be constructible using helicopters to place material in conjunction with a ground crew. The proposed restoration features within this subarea are summarized in Table 6 and shown in Drawings C-09 and C-10.

Table 6

Summary of Proposed Restoration Actions and Expected Benefits, Subarea 4

Feature Group	Approx. Station	Action(s)	Expected Benefit
A	29+00 to 10+50	Construction of multiple LWD features	Diversify hydraulics and add cover in the plane-bed channel; promote floodplain connectivity and side channel development over time.

B	10+00	Construction of one CS ELJ structure	Provide diverse hydraulic conditions in the short term. Retain mobile LWD and bedload to raise the bed elevation of the channel over time.
C	8+50 to 4+00	Construction of multiple LWD features in the main channels and in the active side channel	Increase hydraulic complexity in the main channel; maintain the existing side channel outlet and provide additional cover, complexity, and high-flow refuge in the side channel.
D	1+50	Construction of one CS ELJ structure	Provide diverse hydraulic conditions in the short term. Retain mobile LWD and bedload to raise the bed elevation of the channel over time and prevent mobile wood from being distributed in privately owned portions of the river downstream.

3.5 Key Modifications to the 30% Design

Anchor QEA refined the 30% design to accommodate comments provided by WDFW, increase habitat and geomorphic benefits, and improve constructability. The following design changes were made to the LWD features and ELJ structures:

- **S LWD Feature** (Type S LWD at 30%): No significant design changes were made to the single log LWD feature for the 60% design.
- **TH LWD Feature** (Type L LWD at 30%): No significant design changes were made to the toe habitat LWD feature for the 60% design.
- **TH2 LWD Feature:** This feature type is new for 60%. It is a variation of the toe habitat feature and is designed to be held in place using boulders for ballast or simply placed on the bank with the two logs secured together. This design variation is intended for use in portions of the project where machinery access would cause an unacceptable amount of riparian damage. The elements of this feature type could be placed with helicopters and secured together by a ground crew.
- **SR LWD Feature** (Type Z LWD at 30%): Rootwad log pile embedment depth was increased by 2 feet to account for refinements in probable scour depth and the expected hydraulic conditions. The distance between the rootwad ends and the nearest rootwad log piles was increased to improve habitat benefit and reduce scour potential near the rootwad log piles.
- **SR2 LWD Feature:** This feature type is new for 60%. It is a variation of the sediment retention feature and is designed to be held in place using boulders or additional LWD layers for ballast. This design variation is intended for use in portions of the

project where machinery access would cause an unacceptable amount of riparian damage. The elements of this feature type could be placed with helicopters and secured together by a ground crew.

- **BA ELJ Structure** (Type A ELJ at 30%): The layer layback was increased to allow the use of fuller rootwads while improving constructability. The inner two rootwad logs on the top layer were removed to reduce construction costs without a reduction in habitat and geomorphic benefit or structural stability.
- **CG ELJ Structure** (Type M ELJ at 30%): No significant design changes were made to the Channel Grade ELJ structure for the 60% design.
- **BB ELJ Structure** (Type B ELJ at 30%): No significant design changes were made to the Bank Barb ELJ structure for the 60% design.
- **CS ELJ Structure** (Type C ELJ at 30%): The diameter and length of the three large rootwad logs was reduced by 1 foot and 20 feet respectively. The reduction in size will allow the rootwad logs to be placed using smaller machinery with less riparian impact. The reduced size will also allow a helicopter to lift and place the logs for the two structure locations downstream of the Tucannon River Road bridge. The size of the largest boulders was also reduced to allow placement with smaller machinery or by a helicopter.

4 HYDRAULIC ANALYSIS

4.1 HEC-RAS Model

A reach-based, one-dimensional (1-D) Hydraulic Engineering Center-River Analysis System (HEC-RAS) hydraulic model (Brunner 2010a, 2010b) was developed by Anchor QEA for a portion of Project Area 14 (Station 94+50 to 111+00). The results of this HEC–RAS model were used to support the structure and feature design calculations and scour calculations presented in this report. The model was run for the design hydrology shown in Table 7. The design hydrology provided a thorough understanding of hydraulic conditions over a wide range of discharges.

Table 7
Design Hydrology, Project Area 14, Tucannon River

Discharge (cfs)	Return Period
245	1-year
664	2-year
1,481	5-year
2,276	10-year
3,627	25-year
4,923	50-year
6,498	100-year

Note:
1. Hydrology was developed by Anchor QEA as part of the geomorphic assessment and habitat restoration study (Anchor QEA 2011a).

The detailed hydraulic model was only developed for the portion of the project area where concerns related existing infrastructure (WDFW hatchery) are the greatest. All structure and feature design analyses were completed using the hydraulic results of this model.

The HEC-RAS cross-section station elevation data was taken from a 3-dimensional (3-D) existing conditions surface developed by Anchor QEA for the portion of the project area adjacent to the WDFW hatchery. The 3-D surface used the bare earth data from 2010 aerial Light Detection and Ranging (LiDAR) survey (provided by the CCD) merged with ground survey data (cross-sections) collected in 2012 by the Pomeroy Conservation District (Ausman 2011). Cross-sections and other model geometries were drawn in ESRI ArcGIS® and

exported using HEC-GeoRAS (Ackerman 2011) and imported into the 1-D HEC-RAS model. Cross-sections in the model were located to capture significant changes in channel and floodplain planform, as well as changes in channel gradient, with the spacing of cross-sections varying in proportion to planform complexity of the channel and floodplain. Channel and floodplain roughness values were estimated using typical values for the land use and channel condition observed in the field and as identified from 2010 aerial photography. The bridge at project Station 107+50 was surveyed (Ausman 2011) and incorporated into the model. Existing levee features and known ineffective flow areas were also added to the model to appropriately confine and restrict flow.

A proposed conditions model was not developed as part of this design phase. The design analysis for features and structures only requires information on existing conditions hydraulics. However, a proposed conditions model may be developed in subsequent design phases to further evaluate project impacts near existing infrastructure.

5 DESIGN ANALYSES

The design analyses completed for the proposed features and structures include scour, stability, and pile analyses. Forces considered in these analyses include log buoyancy, log weight, upstream and downstream hydrostatic forces, friction, velocity, drag, ballast, and the resisting forces of the substrate. These design calculations were used to set footprint elevations, determine the stability of each of the structures and the resulting factors of safety that apply to the structure. The factor of safety can generally be defined as a ratio of the structure's holding strength to the actual applied load.

5.1 Scour Analysis

Bed scour at the BB ELJ structures and SR LWD features placed along existing banks was estimated using an equation originally presented by Liu et al. (1961) for scour at bridge abutments. This equation has since been recommended by others, including Drury (1999) for use in calculating scour at ELJ structures. The equation relates flow conditions (i.e., flow depth and velocity), obstruction dimensions, and Froude number to maximum scour depth below existing grade. Approach velocity, water depth, and Froude number were obtained from the hydraulic output of a HEC-RAS steady-state model completed by Anchor QEA.

Bed scour at the BA and CG ELJ structures was estimated using the simplified Chinese equation (Landers and Mueller 1996) developed for bridge piers in coarse bed rivers. The equation relates flow conditions (i.e., flow depth and velocity), obstruction dimensions, and sediment grain size distribution to maximum scour depth below existing grade. Values for the required hydraulic parameters were obtained from output of the HEC-RAS steady-state model completed by Anchor QEA. Estimates of the of the channel bed grain size distribution were made based on site visit observations.

Results of this analysis were used to determine the maximum probable depths of bed scour that could potentially undercut the structures. However, final footprint elevations and log pile installation depths will be determined based on scour estimates and professional judgment.

5.1.1 Scour Equation (Liu et al. 1961)

The Liu et al. (1961) scour equation was selected for use at bank barb ELJ structures and sediment retention LWD features. This equation was originally intended to estimate scour at abutments where the groins are placed perpendicular to the flow. The equation was developed from laboratory tests in a flume and prototype measurements, and was subsequently verified with field experiments. Results of the study indicated that the contraction ratio and approach flow depths are the critical parameters. This equation is recommended for when the ratio of effective length (L_e) of the ELJ protruding into the flow divided by the upstream hydraulic depth (d_1) is less than 25.

$$d_s = 1.1 \cdot \frac{L_e}{d_1}^{0.4} \cdot Fr^{0.33} \cdot d_1$$

where:

d_s = Scour Depth (predicted)

L_e = Length (effective)

d_1 = Upstream Hydraulic Depth

Fr = Froude Number (dimensionless number), where

$$Fr = \frac{V}{\sqrt{g \cdot d}}$$

V = Flow velocity

g = gravitational acceleration

d = flow depth

5.1.2 Simplified Chinese Equation (Landers and Mueller 1996)

The simplified Chinese pier-scour equation was used to estimate scour for the bar apex (BA) and channel grade (CG) ELJ structures. This equation is applicable to coarse-bed rivers and is based on laboratory and field data from China (Landers and Mueller 1996, as cited in Chase and Holnbeck 2004). The equation accommodates clear-water scour and live-bed scour.

$$y_s = 0.95 \cdot K_s \cdot b^{0.6} \cdot y_o^{0.15} \cdot D_{50}^{-0.07} \left(\frac{V_o - V_{ic}}{V_c - V_{ic}} \right)^c$$ for live-bed scour ($V_o > V_c$)

where:

y_s = depth of scour below bed, feet

K_s = Pier shape coefficient

b = pier width, feet

y_o = existing depth in channel before contraction scour, feet

V_o = approach velocity upstream of the pier, feet/second

$$c = \left(\frac{V_C}{V_o} \right)^{8.20 + 2.23 \cdot \log D_{50}}$$

D_{50} = median particle size, feet

V_c = critical velocity (incipient motion) for the D_{50}-sized particle, feet/second

$$V_c = 3.28 \left(\frac{y_0}{D_{50}} \right)^{0.14} \cdot \left[8.85 \cdot D_{50} + 6.05 \cdot 10^{-7} \left(\frac{10 + 0.3048 \cdot y_o}{(0.3048 \cdot D_{50})^{0.72}} \right) \right]^{0.5}$$

V_{ic} = Approach velocity corresponding to critical velocity at the pier, feet/second

$$V_{ic} = 0.645 \left(\frac{D_{50}}{a} \right)^{0.053} V_c$$

5.1.3 Results

The maximum probable scour was estimated for the BA, CG, and bank barb ELJ structures over a range of flows up to the 100-year event. The maximum probable scour was estimated for the Sediment Retention features over a range of flows up to the 10-year event. Table 1 presents probable scour depths based on both the results of this analysis and professional judgment.

Table 8

Probable Maximum Scour Depths for Features and Structures

Feature or Structure[1]	Flow Event	Scour Depth (feet)
Bar Apex (BA)	100-year	8.5
Channel Grade (CG)	100-year	8.5
Bank Barb (BB)	100-year	7.4
Sediment Retention (SR)	10-year	3.5

Notes:
1. Results are reported for the feature or structure location with the highest calculated scour depth (for that feature or structure). A common structure design was used even though scour may be less at other locations.

The probable maximum scour depth for the BA and CG ELJ structures are essentially identical as their width (*b*), at the channel grade, is nearly the same. The major difference between these two ELJ structures is how they are designed to handle to scour.

- The BA ELJ structure is emended into the channel bed to a depth just above the probable maximum scour depth. Embedding the structure into the bed reduces the likelihood of scour under the structure would result in differential settling, thereby compromising the stability of the structure.
- The CG ELJ structure is essentially placed at the existing channel grade with only minor excavation for the rootwad mass to allow good ground contact along the length of the logs in the bottom layer. The front of the structure, where maximum scour depth is anticipated, is set forward of the enclosed portion of the structure containing the ballast material. This configuration limits the likelihood that scour would undermine the structure and cause differential settling. Additionally, the enclosed portion of structure is backfilled with large boulders rather than native material. The size of the boulders greatly improves the retention of the ballast required for stability even if the structure experiences deferential settling and distortion. Furthermore, many locations where the CG ELJ structure is proposed have a significantly coarser bed material than what was assumed in the calculations.

Scour was not evaluated at the CS ELJ structures. These structures are designed to be flexible and settle into any scour local to the rootwad logs and boulders. Additionally, because the structures span the entire channel flow contraction and acceleration is expected to be

primarily in the vertical direction and result in material deposition upstream of the structure rather than scour.

The probable maximum scour depth for the BB ELJ structure is slightly less than the scour for the BA and CG ELJ structures as its effective length (L_e) into the flow presents less of an obstruction to flow than the wider BA and CG ELJ structures. The embedment depth of the BB ELJ structure is designed to handle scour a similar way to the BA ELJ structure. The footer log along the leading edge of the structure is intended to help retain the backfill required for structure stability in the event that scour begins to undercut the front of the structure.

The probable maximum scour depth for the SR LWD feature is considerably less than the other structures for the following reasons:

- The design discharge is the 10-year flow event
- The features low profile causes the effective length (L_e) into the flow used in the calculations to be reduced as the structure becomes further submerged at higher discharges
- Similar to the CS ELJ structure the flow contraction and acceleration is expected to be both horizontal and vertical for discharges overtopping the feature.

The probable maximum scour depth for the SR LWD feature is used to determine the unsupported length of the log piles (see Section 5.3)

5.2 Stability of Ballasted Features and Structures

The ballasted features and structures stability analysis evaluates the sum of all the forces acting on the feature or structure to determine the horizontal and vertical factor of safety against displacement. The forces driving and resisting structure displacement are:

- The upward vertical force on the structure from the buoyancy of the submerged wood
- Downward vertical forces from the weight of the any un-submerged wood and the ballast material secured to or within the feature/structure

- Driving horizontal forces from drag and differential hydrostatic pressure acting on the structure
- The resisting horizontal force caused by friction between the bottom of the structure and the river bed

The factors of safety presented in Table 2 (for both vertical and horizontal forces) are for features and structures just after construction. Calculations assume that the LWD density is equal to the average green weight of wood and bark for the lowest density species allowed in construction. Over time, much of the wood within the structure can become saturated, thereby increasing the log's density and increasing the overall weight and resisting force of the structure. Calculations also assume the bulk porosity of the backfill material placed as ballast is 0.30. For structures where boulders are used as ballast the rock mass, specific gravity is assumed to be 2.5 to account for variability in rock type density.

Table 9
Gravity Structure Stability Factors of Safety

	Representative of Moderate Discharge Events		Representative of 100-year Discharge Events		Fully Submerged
Feature or Structure	Approach Velocity, V (fps)	Horizontal Factor of Safety[1]	Approach Velocity, V (fps)	Horizontal Factor of Safety[1]	Vertical Factor of Safety[2]
Bar Apex (BA)	9.0	2.0	12.8	1.0	2.9
Channel Grade (CG)	10.5	2.0	14.5	1.0	6.1
Bank Barb (BB)	5.6	2.0	7.8	1.0	2.3
Channel Spanning (CS)	7.5	2.0	10.5	1.0	2.2
Toe Habitat (TH2) w/Boulders	5.2	2.0	7.2	1.0	3.6
Sediment Retention (SR2) w/Boulders	7.1	2.0	9.8	1.0	6.5

Notes:
1. Horizontal factor of safety is the friction force divided by the drag force.
2. Vertical factor of safety is the downward vertical force of the ballast and logs divided by the upward vertical force of the submerged wood logs.

Horizontal and vertical factors of safety were not calculated for the TH2 and SR2 features not secured using boulders. These feature types are expected to experience some movement depending on placement location, channel migration and local water depth. Structure buoyancy calculations were not completed for the pile-supported structures. See Section 5.3 for pile-supported feature stability calculations.

5.3 Pile-supported Feature Stability

Pile stability analyses were completed for the sediment retention features. The pile stability analyses examined the size of the feature, the number of log piles, the depth of the log piles, and the hydraulic load applied to the feature. The number of log piles needed for each feature is based on the feature length and width (feature geometry) and the hydraulic load applied to the feature. The hydraulic load is transferred from the above grade rootwad logs to the log piles. Results of the log pile analyses are presented in Table 3.

A resulting factor of safety was determined for the pile-supported features. The factor of safety is the ratio of the structural capacity of the pile system to the design load. The factor of safety increases as the number of piles or the pile diameter increases because the structural capacity of the pile system is increasing as the load remains constant.

Table 10

Pile-supported Feature Design Summary and Resulting Factors of Safety

LWD Feature [1]	Sediment Retention (SR)
Design Event	10-year
Velocity[2], V (fps)	5.6
Scour Depth (ft)	3.5
Log Pile Embedment[3], L (feet)	3.5
Pile Depth BEGS (ft)	7.0
Log Pile Diameter[4], B (inches)	12
Number of Log Piles, n	4
Min. Pile Bending Stress Cap.[5] (psi)	475
F.S. Log Pile Overturning	1.2
F.S. Log Pile Bending Strength	2.7

Notes:
1. See design plans for additional details regarding LWD feature design and construction.
2. Velocity is determined using the HEC-RAS hydraulic model for the indicated design event.

3. Log pile embedment is the depth below the design analysis scour depth (see Section 5.1) and does not include the extreme fibers of the rootwad.
4. Log pile diameter is measured at a distance equal to three times the pile diameter from the butt end of the log pile. Diameter does not include bark.
5. Specified minimum bending stress is the starting design value before strength reduction factors are applied per timber pile design methods.

BEGS = below existing ground surface, fps = feet per second, psi = pounds per square inch

5.3.1 Soil Strength

The soil strength resisting pile overturning was calculated for the sediment retention features. These calculations represent the condition where the soils (substrate) supporting the log piles fails and the log piles overturn before the pile strength is exceeded (Section 5.3.2) resulting in feature deformation. The soil strength is calculated using published methods for estimating ultimate lateral soil resistance to timber piles in cohesion-less soils. The soil strength calculations assume the design maximum scour depth for effective pile embedment depth and also assume the features are subject to the highest modeled channel velocity in the vicinity of the feature. Furthermore, calculations assume a homogenous channel substrate.

Soil strength sensitivity analysis included varying embedment lengths, log pile diameter, log pile quantity, substrate characteristics, and varying velocities in the channel.

5.3.2 Pile Bending Strength

The pile bending strength was calculated for the sediment retention features. These calculations represent the condition where the log piles yield and break in bending under the applied load. These calculations assess each log pile as a cantilevered beam subject to the hydraulic loads of the design flow event. The calculations assume the probable maximum scour depth for determination of the unsupported pile length. The pile bending strength factor of safety was evaluated to exceed the soil strength for each feature. Pile bending strength sensitivity analysis included varying the diameter and bending stress capacity of the log piles.

6 LIMITATIONS

This report was prepared for the SRSRB for use in documenting design analysis for the 60% design phase of the PA-14 geomorphic and habitat improvements. Further development of the 60% designs described in this document will require additional evaluation and design. The Drawings and Technical Specifications accompanying this report may require additional refinement prior to use in construction or contract bidding. Conditions within the project are may change both spatially and with time and as additional scientific and engineering data may become available. Significant changes in project area conditions or the available information may require reassessment of both existing and proposed project conditions. Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted scientific and engineering practices in this area at the time this report was prepared.

Engineered log jams and other large wood structures are designed and intended to emulate the large, natural wood accumulations historically found in forested river systems. These accumulations have long been a part of most forested rivers in the Columbia River Basin and are a vital component of healthy ecological systems. Engineered log jams are intended to modify the hydraulic function of river systems and to create improved habitat for aquatic species. Localized scour pools are expected to form adjacent to and beneath portions of the log jam structures after several flood events. These scour pools are desirable as key components of aquatic habitat improvement.

Rivers are dynamic systems and experience major seasonal changes in flow. Flood events will result in localized scour and deposition of bed sediment near the log jams. Cyclic periods of accumulation and depletion of logs on, and adjacent to, log jam structures are expected during conditions of high flow as part of natural river dynamics.

Like their natural counterparts, constructed log jams can pose unique risks to property and to persons who access the river or stream. Log jam structures may be partially or completely destroyed in extreme floods, carrying the logs downstream for accumulation in other areas. This potential downstream accumulation of logs could cause changes in channel position or unintended damage to improved and unimproved property on or near the river.

During periods of low to moderate flow, the river's flow may converge on the deep-water areas adjacent to and beneath the ELJs. The changes in flow patterns and the flow convergence near ELJs can pose significant risks for people using the river for general recreation, boating, rafting, fishing, swimming, wading, or other purposes. Bodily injury or death could result from people being trapped within or under the ELJs. Walking on or over the ELJs also involves risk of falling and injury.

These risks are similar to those posed by natural log jams. However, the structures contemplated by this design and report will be man-made. This may create unique risks for the owner, designer, and builder of this project. Accordingly, we specifically recommend that permanent warning signs be posted and maintained along all publicly accessible areas of the river containing ELJs. These signs, at a minimum, should warn river users of the presence and potential hazards associated with natural and artificial log jams in the river.

The following key points should be noted:

1. The ELJ structures are a response to the ESA and are designed to improve fish habitat as a matter of public policy.
2. All structures in the river, including ELJs, represent a potential hazard to boaters and swimmers.

Because some **known** risk is inherent in building an ELJ, the design of such structures does not represent engineering negligence. If the risks were **not** known, considered, and communicated to interested parties, then potential negligence could be an issue.

7 REFERENCES

Anchor QEA, LLC, 2011a. *Tucannon River Geomorphic Assessment and Habitat Restoration Study*. Prepared for Columbia Conservation District. April 2011.

Anchor QEA, 2011b. *Draft Conceptual Restoration Plan, River Miles 20 to 50 Tucannon River Phase II*. Prepared for Columbia Conservation District, Dayton, Washington.

Anchor QEA, LLC, 2011c. *Conceptual Restoration Plan, Reaches 6 to 10.* Prepared for the Columbia Conservation District. November 2011.

Anchor QEA, LLC, 2011d. *30 Percent Design Report Project Area 14.* Prepared for the Columbia Conservation District. December 2011.Ausman, Gary, P.E. 2011. Tucannon Area 14 Survey Cross Sections. Pomeroy Conservation District. December 2011.

Brunner, G.W., 2010a. *HEC-RAS River Analysis Systems User's Manual Version 4.1.* CDP-68. U.S. Army Corps of Engineers. Hydrologic Engineering Center. Davis, California.

Brunner, G.W., 2010b. *HEC-RAS River Analysis Systems Hydraulic Reference Manual.* CDP-69. U.S. Army Corps of Engineers. Hydrologic Engineering Center. Davis, CA.

Drury, T., 1999. *Stability and pool scour of engineered log jam structures in the North Fork Stillaguamish River, Washington*. M.S. Thesis University of Washington.

CCD (Columbia Conservation District), 2004. *Tucannon Subbasin Plan*. Prepared for Northwest Power and Conservation Council. May 2004.

Liu, M.K., F.M. Chang, and M.M. Skinner, 1961. *Effect of Bridge Construction on Scour and Backwater*, Dept. of Civil Engineering, Colorado State University, Report No. CER60-HKL22. February 1961.

SRSRB (Snake River Salmon Recovery Board), 2006. *Snake River Recovery Plan for SE Washington*. Prepared for Washington Governor's Salmon Recovery Office. December 2006.

ACCOMPANYING DOCUMENTS