CONCEPTUAL RESTORATION PLAN, REACH 5
TUCANNON RIVER RM 13.4 TO 20

Prepared For
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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCD</td>
<td>Columbia Conservation District</td>
</tr>
<tr>
<td>CRB</td>
<td>Columbia River Basalt</td>
</tr>
<tr>
<td>CREP</td>
<td>Conservation Restoration Easement Program</td>
</tr>
<tr>
<td>EDT</td>
<td>Ecosystem Diagnosis and Treatment</td>
</tr>
<tr>
<td>ELJ</td>
<td>engineered log jam</td>
</tr>
<tr>
<td>ESA</td>
<td>Endangered Species Act</td>
</tr>
<tr>
<td>ESU</td>
<td>evolutionarily significant unit</td>
</tr>
<tr>
<td>ICTRT</td>
<td>Interior Columbia Technical Recovery Team</td>
</tr>
<tr>
<td>LWD</td>
<td>large woody debris</td>
</tr>
<tr>
<td>MaSA</td>
<td>major spawning area</td>
</tr>
<tr>
<td>mi²</td>
<td>square mile</td>
</tr>
<tr>
<td>MiSA</td>
<td>minor spawning area</td>
</tr>
<tr>
<td>NMFS</td>
<td>National Marine Fisheries Service</td>
</tr>
<tr>
<td>PA</td>
<td>Project area</td>
</tr>
<tr>
<td>PIT</td>
<td>Passive Integrated Transponder</td>
</tr>
<tr>
<td>RM</td>
<td>River Mile</td>
</tr>
<tr>
<td>R/S</td>
<td>return to smolt</td>
</tr>
<tr>
<td>SRSRB</td>
<td>Snake River Salmon Recovery Board</td>
</tr>
<tr>
<td>SRSRP</td>
<td>Snake River Salmon Recovery Plan</td>
</tr>
<tr>
<td>TSP</td>
<td>Tucannon Subbasin Plan</td>
</tr>
<tr>
<td>USACE</td>
<td>U.S. Army Corps of Engineers</td>
</tr>
<tr>
<td>USFS</td>
<td>U.S. Forest Service</td>
</tr>
<tr>
<td>USFWS</td>
<td>U.S. Fish and Wildlife Service</td>
</tr>
<tr>
<td>USGS</td>
<td>U.S. Geological Survey</td>
</tr>
<tr>
<td>VSP</td>
<td>Viable Salmonid Population</td>
</tr>
<tr>
<td>WDFW</td>
<td>Washington Department of Fish and Wildlife</td>
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</table>
1 INTRODUCTION

The Tucannon River is a tributary to the Snake River in southeast Washington (Figure 1). The river supports Endangered Species Act (ESA)-listed summer steelhead, spring Chinook salmon, fall Chinook salmon, and bull trout, which have all been identified as aquatic focal species of concern in the Tucannon Subbasin Plan (TSP; CCD 2004). These species collectively use the entire length of the river at some stage of their lifecycles; at least one species is present in the Tucannon River channel throughout the year.

Anchor QEA, LLC was retained by the Snake River Salmon Recovery Board (SRSRB) to develop conceptual restoration plans for Reach 5 of the Tucannon River, beginning at river mile (RM) 13.4 and continuing upstream to RM 20. This plan builds on the findings from the Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA 2011a). For this study, a basin-scale geomorphic study was used to delineate 10 discrete reaches throughout 50 miles of the river (Figure 2). The geomorphic assessment was prepared to strengthen the technical understanding of existing physical conditions and geomorphic processes in the basin to identify and prioritize habitat restoration opportunities. The assessment included identification of the source, magnitude, and distribution of hydrologic and sediment inputs through the basin; analysis of floodplain connectivity; identification of passage barriers or infrastructure constraints; identification of stressors and features leading to habitat degradation; and a qualitative evaluation of restoration opportunities. Within each reach, potential restoration opportunities and concepts were identified and discussed. The results of that study were used to identify the first of three study areas to follow. The first study area was completed in 2011 for River Mile (RM) 20 to 50, which further refined conceptual projects within the upper basin in Reaches 6 through 10 (Anchor QEA 2011b). This study identifies conceptual projects within the lower basin in Reach 5 (Figure 3), and a third study will identify conceptual-level projects in Reaches 3 and 4 (Anchor QEA 2012).

Preliminary restoration opportunities identified in the geomorphic assessment were developed based on habitat-limiting factors identified in the TSP (CCD 2004) and Snake River Salmon Recovery Plan (SRSRP; SRSRB 2006), salmonid life history and distribution through the river system, and site-specific physical, hydrologic, and geomorphic conditions.
The restoration framework was loosely categorized based on the actions described on Figure 2 from Roni et al. (2002). The initial restoration actions in the geomorphic assessment corresponding to the framework proposed by Roni are listed in Table 1-1.

<table>
<thead>
<tr>
<th></th>
<th>Roni et al. (2002)</th>
<th>Tucannon River Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protect and maintain natural processes</td>
<td>Promote natural hydrologic and sediment routing throughout the system. Allow natural migration and wood recruitment.</td>
</tr>
<tr>
<td>2</td>
<td>Connect isolated habitats</td>
<td>Reconnect floodplains, groundwater channels, wetlands, and former mainstem and side channels.</td>
</tr>
<tr>
<td>3</td>
<td>Address roads, levees, and other human infrastructure-impairing processes</td>
<td>Remove or modify levees, dredge spoils, rock embankments, and grade control structures.</td>
</tr>
<tr>
<td>4</td>
<td>Restore riparian processes</td>
<td>Protect healthy riparian areas. Eradicate invasive species and plant native communities to rehabilitate degraded riparian forests.</td>
</tr>
<tr>
<td>5</td>
<td>Improve instream habitat conditions</td>
<td>Install large individual trees and large woody debris structures in the channel.</td>
</tr>
</tbody>
</table>

1.1 Purpose

The purpose of the current plan is to develop conceptual restoration plans for discrete project areas within Reach 5 that can be implemented to substantially improve habitat conditions for key life stages of ESA-listed and other aquatic species. Five conceptual project areas in Reach 5 were delineated and evaluated for restoration potential. Project evaluation was based in part on:

- Findings in the Geomorphic Assessment (Anchor QEA 2011a);
- Field reconnaissance during summer 2012 that characterized channel, floodplain, and riparian conditions;
- Existing Chinook spawning and juvenile rearing data; and
- Input from the Tucannon Coordinating Committee (a committee comprised of technical representatives from local, state, federal, and tribal government agencies) and the public
Based on the results of our evaluation, project areas were delineated into Tiers 1, 2, and 3, with Tier 1 projects being the highest priority for implementation. Following this plan, 30 percent designs will be developed for selected Tier 1 projects. During the current scope of work, the 2011 conceptual projects in Reaches 6 through 10 were evaluated in an effort to tier projects relative to all projects within the basin. This approach will allow all projects to be grouped in a coordinated manner.
2 BASIN OVERVIEW

2.1 Basin Description

The Tucannon River basin is located in Columbia and Garfield counties in the southeast corner of Washington State (Figure 1). The main channel is approximately 58 miles long and drains approximately 503 square miles (mi²) from its headwaters in the Blue Mountains and Umatilla National Forest to the mouth at the Snake River approximately 3 miles upstream of the Lower Monumental Dam (CCD 2004). Several major tributaries drain into the main channel; the largest (by basin area) is Pataha Creek, which enters the main channel at RM 12.3. Pataha Creek is approximately 52 miles in length with a long, narrow watershed draining 185 mi². The second and third largest tributaries (by basin area) are Kellogg Creek (35 mi²) and Willow Creek (30 mi²).

A majority of the watershed downstream of Tumalum Creek (RM 35.5) is cultivated, primarily with grain crops. The valley floor is occupied primarily by livestock pastures and some cultivated crops downstream of the National Forest boundary at RM 41, except for a vegetated riparian buffer along the margins of the channel. The watershed upstream of Tumalum Creek is typically covered in evergreen forest, with scrub/shrub on the steeper, southwest-facing slopes. The valley floor is forested, with sparse undergrowth in the floodplain until upstream of Panjab Creek (RM 50.2), where tree and undergrowth density increases significantly. The riparian corridor typically contains interspersed evergreen and deciduous trees with dense undergrowth. Large forest fires in 2005 (School Fire), 2006 (Columbia Complex Fire), and 2009 (Hubbard Fire) impacted the upper basin, including portions of the floodplain and riparian corridor.

2.2 Geomorphic Context

2.2.1 Regional Geology

The Tucannon River watershed consists primarily of Miocene-aged Columbia River basalt flows of the Grande Ronde, Wanapum, and Frenchman Springs members with recent Quaternary river alluvium along the valley floor. Basalt is exposed at the surface upstream of Tumalum Creek (RM 35.5) and along the valley walls and gullies down from Tumalum Creek to RM 18. Downstream of RM 18, including within the Pataha and Willow Creek subbasins,
the basalt is overlain by loess deposits (fine sand and silt) of the Palouse Formation. In these areas, bedrock is typically exposed in gullies and along valley slopes. Bedrock sills are also occasionally present in the valley and river bottom of the lower basin downstream of approximately RM 28. The valley walls in much of the lower basin downstream of RM 18 are composed of Quaternary flood outburst deposits consisting of stratified sand, gravel, and cobble, alluvial fan deposits, and bedrock. Alluvial fans line the valley floor at the mouths of tributaries throughout the study area. The fans tend to be large and wide in locations where tributaries drain loess-dominated subbasins (i.e., lower basin), and small and narrow in basins where mainly bedrock is exposed (upper basin). Significant ancient alluvial fan and hillslope deposits are present in many locations that constrict the overall valley and floodplain width.

2.2.2  Channel Patterns and Floodplain

Review of the historic aerial photographic record and traces of active channel positions through time revealed notable trends in channel form and behavior (Anchor QEA 2011a). Channel types include single-thread sections; braided, gravel bar-dominated sections; multi-threaded anastamosing sections, and anabranching sections, which have two or more diverging channels separated by significant lengths of vegetated floodplain. The character of channel movement, or migration, was identified as both relatively steady channel migration of a riverbend through a gravel bar or floodplain, and channel avulsion where the river suddenly changes course, often through historic channels previously abandoned through a similar process.

2.2.3  Channel Confinement and Floodplain Connectivity

Confining features along the banks of the Tucannon River and within the floodplain influence hydraulic conditions during large floods, affecting local and reach-scale geomorphic processes, such as sediment mobility and channel migration. Confining features may be both natural and influenced by anthropogenic activities. However, the presence of anthropogenic features related to land use appears to be the primary factor related to adverse conditions created by channel confinement in the study area, particularly downstream of RM 47. Upstream of this point, natural features such as alluvial fans and overall valley width are more prominent and have a greater effect on channel confinement. Channel migration
within the historic record also appears to be limited in portions of the channel in the lower basin that contain bedrock outcrops.

### 2.2.4 Large Woody Debris

Channel clearing and riparian timber harvesting in the Tucannon River basin have removed large woody debris (LWD) from the system and greatly reduced recruitment of additional LWD, especially large-diameter mature trees that form the core of stable log jams. Previously logged and cleared riparian areas have been regenerating for approximately the past 20 to 50 years in publicly owned and protected riparian forests. While these trees are fairly mature, many (particularly conifers in the upper watershed) may not be large enough to remain stable within the mainstem channel.

### 2.2.5 Future Channel Evolution

The Tucannon River is currently in the process of recovering from anthropogenic disturbance and re-establishing more natural conditions. The river 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 reduce in-channel velocities. Introduction of maturing riparian trees and LWD material will lead to the formation of log jams, which promote sediment deposition in the lee of the structures. Log jams also promote split flow and side channel development, leading to hydraulic conditions that often provide preferred habitat for juvenile salmonids, and distribute sediment load and organic debris across the floodplain. In addition, split flows and side channels reduce the hydraulic energy of the mainstem, increasing the ability for the channel to retain LWD and sediment.

In this manner, the recovery of the system is a feedback loop where channel migration leads to LWD deposition on bars and shallow areas, which leads to log jams and split flow conditions, which reduces hydraulic energy in the channel, leading to additional deposition of LWD and sediment, and the feedback loop continues. The result of this process is an
overall widening of the active channel and better hydraulic connectivity between the river, side channels, and floodplain. The projects identified in this plan are developed to help achieve these desired conditions over time as natural processes are restored in selected areas. Protection is identified in areas with recovering natural processes that are currently creating or leading to desirable habitat conditions.

2.3 Fish Timing and Distribution

The Tucannon River supports four ESA-listed Snake River Basin salmonid populations throughout all or a portion of their life stages. Summer steelhead, spring Chinook salmon, fall Chinook salmon, and bull trout were identified in the TSP as aquatic focal species (CCD 2004). Collectively, these species use the main channel from the mouth to the headwaters, as well as major tributaries, including Pataha Creek. The following information is summarized from the TSP (CCD 2004) and SRSRP (SRSRB 2006) and is revised to include new information from recent data being collected by the Washington State Department of Fish and Wildlife (WDFW) and others in the basin (SRSRB 2011a; Gallinat and Ross 2010).

Table 2-1 shows the spatial distribution of steelhead and Chinook salmon in the mainstem of the Tucannon River, with darker shades of gray indicating higher densities of fish present during their respective life stages. Information on bull trout was not sufficient to provide detailed distribution data as reported for the other focal species.

2.3.1 Steelhead Trout

Steelhead trout in the Tucannon River are part of the Snake River Basin steelhead evolutionarily significant unit (ESU) that was listed as threatened in 1997. Summer steelhead trout enter the Tucannon River in September and begin spawning in late February to early March until mid-May. Spawning occurs in the mainstem from Kellogg Creek (RM 4.8) upstream to the Tucannon headwaters, as well as within Cummings Creek and in the lower portions Panjab and Sheep creeks. The greatest concentration of steelhead spawning is typically found in the mainstem between Tucannon Falls (RM 15.3) and Beaver Lake at approximately RM 42. Juveniles also rear throughout the mainstem but are typically found in the greatest numbers between approximately RM 18 and School Canyon (approximately RM 45).
### Table 2-1

**Distribution of Steelhead, Chinook Salmon, and Bull Trout in the Mainstem Tucannon River**

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>From (RM)</th>
<th>To (RM)</th>
<th>Summer Steelhead</th>
<th>Spring Chinook</th>
<th>Fall Chinook</th>
<th>Bull Trout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spawning</td>
<td>Juvenile</td>
<td>Adult Holding</td>
<td>Spawning</td>
</tr>
<tr>
<td>Mouth</td>
<td>0</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Tucannon</td>
<td>0.7</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.8</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>5.5</td>
<td>8.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.7</td>
<td>12.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pataha-Marengo</td>
<td>12.3</td>
<td>16.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16.5</td>
<td>18.6</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>18.6</td>
<td>22.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>22.8</td>
<td>26.6</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Marengo-Tumalum</td>
<td>26.6</td>
<td>35.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tumalum-Hatchery</td>
<td>35.6</td>
<td>37.8</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>37.8</td>
<td>41.9</td>
<td></td>
<td></td>
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<tr>
<td>Hatchery-Little Tucannon</td>
<td>41.9</td>
<td>44.6</td>
<td></td>
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<td></td>
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<td></td>
<td>44.6</td>
<td>45.6</td>
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<td></td>
<td>45.6</td>
<td>48.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>48.1</td>
<td>50.2</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Notes:**

1. Distribution data are summarized from CCD (2004) and updated based on recent data collected in the basin by WDFW, SRSRB, and others (SRSRB 2011a). Geographic areas and RM sections correspond to Ecosystem Diagnosis and Treatment (EDT) analysis reaches used during subbasin planning.

2. Darker shades of gray indicate higher densities of fish present during their respective life stages.
2.3.2  
**Spring Chinook Salmon**

Spring Chinook salmon in the Tucannon River are of the Snake River spring/summer Chinook salmon ESU that was listed as threatened by the ESA in 1992. Spring Chinook salmon enter the Tucannon River beginning as early as late April and as late as mid-September; spawning occurs from mid-August to the end of September. Spawning occurs almost exclusively in the main channel from approximately King Grade (RM 22.9) to the mouth of Sheep Creek near RM 55 (Gallinat and Ross 2010); the greatest densities are between Marengo and the Little Tucannon River (approximately RM 48.1). Juveniles rear from approximately Tucannon Falls (RM 15.3) to the headwaters, with the highest densities located between Marengo and School Canyon (approximately RM 45).

2.3.3  
**Fall Chinook Salmon**

Fall Chinook salmon are part of the Snake River fall Chinook salmon ESU that was listed as threatened in 1992. Fall Chinook salmon enter the lower Tucannon River beginning in early October and have a brief holding period until spawning begins in mid-October. Fall Chinook salmon use the main channel of the river from the mouth to upstream of Pataha Creek (RM 12.3), with the highest concentration of spawning occurring from the mouth to around the Starbuck Dam near RM 5.5. Juvenile fall Chinook salmon do not overwinter in the Tucannon River and out-migrate shortly after emergence during the late winter to early summer.

2.3.4  
**Bull Trout**

Bull trout in the Columbia Basin were listed as threatened by the ESA in 1998. The Tucannon River bull trout population is part of the Lower Snake River Critical Habitat Unit (USFWS 2010). Bull trout life histories present in the Tucannon River include resident, fluvial, and adfluvial forms. Migratory bull trout move upstream from the Snake River into the upper Tucannon River in the spring and early summer. Critical habitat in the Tucannon Critical Habitat Subunit, as designated by the U.S. Fish and Wildlife Service (USFWS), includes the mainstem Tucannon, Cummings Creek, Hixon Creek, the Little Tucannon River, Panjab Creek, Cold Creek, Sheep Creek, and Bear Creek (USFWS 2010). Juvenile rearing occurs upstream of Tumalum Creek to the headwaters. The lower Tucannon River is
an important migratory corridor to spawning and rearing areas upstream in the watershed, including headwaters and tributary streams.

Historically, the bull trout population in the Tucannon River has been considered healthy; however, recent data suggest some population declines (USFWS 2010). As cited by USFWS, WDFW surveys indicate that the number of redds in the upper Tucannon have dropped from more than 100 in 2002 and 2003 to less than 20 in 2007. This decrease correlates with a decline in the number of adult migratory bull trout captured at the Tucannon Hatchery Trap as they were moving upstream.
3 HABITAT RESTORATION GOALS AND OBJECTIVES

The restoration objective for the Tucannon River is to improve habitat conditions for ESA-listed species for all life history stages within the river. 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.

3.1 Limiting Factors

An Ecosystem Diagnosis and Treatment (EDT) analysis was performed that assessed habitat conditions in the Tucannon River for aquatic focal species (Appendix B in CDD 2004). This analysis allowed watershed planners and stakeholders to identify the primary limiting factors to aquatic focal species in discrete reaches throughout the river. These results are summarized in the SRSRP for summer steelhead and spring Chinook salmon (Tables 3-1 and 3-2); the SRSRP also provides priority habitat objectives for the Upper Tucannon River major spawning area (MaSA). The Lower Tucannon River is a MiSA (minor spawning area) and was not considered for active restoration in the SRSRP (SRSRB 2006); however, the Lower Tucannon River is now considered a priority for restoration actions and, thus, the status was changed to a priority restoration reach beginning in 2010 (SRSRB 2011b). Currently, the egg-parr life history stage is thought to be limiting production in the Tucannon River. Therefore, project evaluation and prioritization considered the potential effects of project implementation on this critical growth stage.
Table 3-1
Factors Limiting the Viability of the Tucannon River Steelhead Population

<table>
<thead>
<tr>
<th>Geographic area</th>
<th>Protection benefit</th>
<th>Restoration benefit</th>
<th>Chemicals</th>
<th>Competition (w/ hatch)</th>
<th>Competition (other sp)</th>
<th>Flow</th>
<th>Food</th>
<th>Habitat diversity</th>
<th>Harassment/poaching</th>
<th>Obstructions</th>
<th>Oxygen</th>
<th>Pathogens</th>
<th>Predation</th>
<th>Sediment load</th>
<th>Temperature</th>
<th>Withdrawals</th>
<th>Key habitat quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tucannon R, Pataha Cr to Marengo</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<td>Tucannon R, Tumalum Cr to Panjab Cr</td>
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<td>Pataha Cr, mouth to Pomeroy</td>
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<td>Tumalum drainage</td>
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<td>Little Tucannon River drainage</td>
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<td>Pataha above Dry Pataha</td>
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<tr>
<td>Smith Hollow Cr</td>
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</tbody>
</table>

Key to strategic priority (corresponding Benefit Category letter also shown)

- **High**
- **Medium**
- **Low**
- **D & E**
- **Indirect or General**

Notes:
Table taken from SRSRB 2006.
3.2 Viable Salmonid Population

To inform habitat restoration actions, spring Chinook in Reach 5 were identified as a species to focus on with the expectation that restoration actions targeted at improving habitat conditions for spring Chinook life stages will also improve conditions for steelhead and other species important to the Tucannon River. Another approach to evaluate the health of Tucannon spring Chinook is to consider how the population is performing compared to the National Marine Fisheries Service (NMFS) standard of a Viable Salmon Population (VSP), a population biology concept. According to the NMFS, a viable salmonid population is an “independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame” (McElhany et al. 2000).

McElhany et al. identified four key population characteristic or parameters for evaluating population viability status:

- Abundance
- Population growth rate or entire life-cycle productivity
Habitat Restoration Goals and Objectives

- Population spatial structure
- Diversity

The following sections present a brief introduction to each of the VSP parameters and how these apply to the Tucannon River habitat conditions and future restoration planning.

It must be emphasized that any change in risk associated with these population parameters is affected by a myriad of factors (including in-basin factors, conditions in the Snake and Columbia rivers, and ocean conditions) and consequently is a long-term proposition. Many of these factors (e.g., ocean conditions and marine survival rates) are largely outside of human control. Moreover, changes expected from the types of actions considered in this report are most likely to occur on a generational scale; the likelihood is low that there would be detectable changes in the near future. Also, there is uncertainty associated with the Tucannon supplemental hatchery program that may affect the spring Chinook salmon population in ways that may not be well understood.

3.2.1 Abundance

Population size is perhaps the most straightforward measure of the VSP parameters and is an important consideration in estimating extinction risk. All other factors being equal, a population at low abundance is intrinsically at greater risk of extinction than is a larger one. The primary drivers of this increased risk are the many processes that regulate population dynamics, particularly those that operate differently on a relatively small population such as Tucannon spring Chinook. Examples include environmental variation and catastrophes, demographic stochasticity (intrinsic random variability in population size), selected genetic processes (e.g., inbreeding depression), and deterministic density effects. Although the negative interaction between abundance and productivity may protect some small populations, there is obviously a point below which a population is unlikely to persist (McElhany et al. 2000).

Tucannon spring Chinook populations spawn almost exclusively in the mainstem Tucannon River with spawning occurring from just above the mouth of Sheep Creek (RM 52) downstream to King Grade (RM 21). Average annual spawning for the past decade (2000 to
2010) is 200 redds, with 53 percent of these being natural spawners and 47 percent hatchery-origin fish (Appendix B in SRSRB 2011c).

Between 1986 and 2010, the annual returns of natural-origin spring Chinook to the Tucannon River ranged from 0 to 1,500 adults; the high of about 1,500 returning adults occurred in 2010 and the low of 0 returning natural-origin spawners occurred in 1995 and 1999 (Chart 1; Gallinat and Ross 2011). The 10-year geometric mean abundance has varied between approximately 100 and 400 returning adults. The Interior Columbia Technical Recovery Team (ICTRT) estimated that the minimum abundance threshold of returning adults is 750 and the current average is 371 (SRSRB 2011c).

**Chart 1**

Estimated Abundance of Tucannon River Natural-Origin Spring/Summer Chinook Salmon Adults and 10-year Geomean between 1986 and 2010 (Gallinat and Ross 2011)
3.2.2 Life Cycle Productivity

Population growth rate (λ) or productivity over the entire life cycle is a key measure of population performance in a species’ habitat. In simple terms, it describes the degree to which a population is replacing itself. A population growth rate of 1 (λ = 1.0) means that a population is exactly replacing itself (one spawner produces one spawner in the next generation), whereas a λ = 0.71, the λ value determined in the Tucannon for spring Chinook, means that the population is declining at a rate of 29 percent annually—a trend that is obviously not sustainable in the long term (Chart 2). This return to smolt (R/S) value does not account for the nearly 25 percent of returning adults that bypass the Tucannon River upon return, based on Passive Integrated Transponder (PIT)-tag detections, and ascend the Snake River without returning back to the Tucannon River. Nevertheless, recruits per spawner are often less than 1 and documented R/S is nearly always less than 1 for spring Chinook (SRSRB 2011c). The Technical Review Team estimated that an R/S of 1.8 is needed for an extinction risk of less than 5 percent and an R/S of 2.1 is needed for an extinction risk of less than 1 percent (highly viable criteria; SRSRB 2011c).
Note:
1986 to 2003 data from NOAA salmon population summary SPS database:

Chart 2
Estimated Productivity of Natural-origin Spring/Summer Chinook Salmon Adults and 20-year Geomean from the Tucannon River

The causes for the low R/S are not precisely known and likely include multiple factors that are difficult to quantify, such as potential effects from habitat conditions and habitat capacity (Glen Mendel, WDFW, personal communication on 9/7/2011). Hatchery supplementation, the Columbia and Snake rivers, and ocean conditions are also factors of the R/S value.
3.2.3 Spatial Structure

Spatial structure, as the term suggests, refers to the geographic distribution of individuals in a population unit and the processes that generate that distribution. Distributed populations that interact genetically are often referred to as a metapopulation. Although the spatial distribution of a population, and thus its metapopulation structure, is influenced by many factors, none are perhaps as important as the quantity, quality, and distribution of habitat. One way to think about the importance or value of a broad geospatial distribution is to consider that in the presence of such a distribution, a population is less likely to go extinct from a localized catastrophic event or localized environmental perturbations (McElhany et al. 2000).

Spatial distribution (of spawning and summer rearing) of spring Chinook in the Tucannon River is primarily restricted to the area upstream of Marengo (RM 25) to the headwaters, yet historically it is presumed that spring Chinook spawned and reared at least down to Pataha Creek (RM 12.5; Gallinat and Ross 2011). The spring Chinook salmon spawning and rearing distribution is reported in the SRSRP, which is currently being updated (SRSRB 2006). The information from the SRSRP shown in Table 3-3 appears as Table B-3 in Appendix B of the draft 2011 SRSRP (SRSRB 2011c).

### Table 3-3

Spring/Summer Chinook Redd Distribution in the Tucannon River

<table>
<thead>
<tr>
<th>Section</th>
<th>River km (Rkm)</th>
<th>River mile (RM)</th>
<th>Percent of Total Redds</th>
<th>Average Redds</th>
<th>Redds per Rkm</th>
<th>Redds per RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth to Marengo (Lower)</td>
<td>0-20.1</td>
<td>0-13.6</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Marengo</td>
<td>20.1-39.9</td>
<td>13.6-26.9</td>
<td>1.1</td>
<td>2</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hartsock</td>
<td>39.9-55.5</td>
<td>26.9-37.5</td>
<td>19.3</td>
<td>29</td>
<td>1.9</td>
<td>2.7</td>
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<tr>
<td>HMA</td>
<td>55.5-74.5</td>
<td>37.5-50.3</td>
<td>67.4</td>
<td>98</td>
<td>5.2</td>
<td>7.7</td>
</tr>
<tr>
<td>Wilderness</td>
<td>74.5-86.3</td>
<td>50.3-58.3</td>
<td>12.2</td>
<td>18</td>
<td>1.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Upstream of Trap</td>
<td>&gt; 59</td>
<td>&gt; 39.9</td>
<td>60.7</td>
<td>87</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Downstream of Trap</td>
<td>&lt; 59</td>
<td>&lt; 39.9</td>
<td>39.3</td>
<td>56</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note:
1985 to 2009 data from Gallinat and Ross (2009). Rkm and RM differ slightly; RM shown were developed for the current scope of work and have been compared to Rkm primarily based on landmarks (bridges, property boundaries) for consistency.
Per Table 3-3, it is noteworthy that approximately 88 percent of the spring Chinook spawning documented over the past 24 years occurs between RM 22.8 (King Grade) and RM 48.1 (near Cow Camp Bridge), recognizing that spawning near the headwaters may have occurred historically at a higher density than is currently occurring (WDFW 2011).

Data provided in Table 3-3 have been further evaluated by delineating the spawning distribution relative to Reach 5 identified in this report and in the Geomorphic Assessment (Anchor QEA 2011a). This information was used in the project evaluation presented later in this report.

### 3.2.4 Life History Diversity

Biological diversity within and among populations of salmon is generally considered important for three reasons (McElhany et al. 2000):

- Diversity of life histories patterns is associated with a use of a wider array of habitats.
- Diversity protects a species against short-term spatial and temporal changes in the environment.
- Genetic diversity is the so-called raw material for adapting to long-term environmental change.

The latter two reasons are often described as nature’s way of hedging its bets—a mechanism for dealing with the inevitable fluctuations in environmental conditions—in the long and short term. With respect to diversity, more is better to minimize the risk of extinction.

Current life-history diversity of Tucannon River spring Chinook is presumed to reflect historic life-history diversity, with the majority of juveniles emerging from the gravel in spring, rearing for one summer and one winter, and then out-migrating as 1-year-old smolts in the spring. Of interest is the apparent lack of winter rearing habitat and channel complexity (e.g., side channels, back water, and pools) that support juvenile fish. Existing data demonstrate that the largest mortality occurs between egg and smolt, with the majority of the mortality occurring between egg and parr; it is alarming that, from brood year 1983 to brood year 2003, on average less than 6 percent of spring Chinook survived from egg to smolt (Gallinat and Ross 2010).
3.3 Restoration Expectations Related to Viable Salmonid Population Goals

3.3.1 Abundance

Population abundance is a key parameter used to assess the status of a stock and evaluate trends in stock improvement or decline. Abundance is also useful in identifying critical population dynamics that can be used to identify success in restoring a stock or levels at which extinction risk is high and the level of attention given to restoration be increased. Collectively proposed restoration actions in the Tucannon River are intended to improve abundance holistically; hence, no restoration action proposed in this report is targeting abundance specifically.

3.3.2 Life Cycle Productivity

As presented and referenced in this document, previous studies have identified degraded habitat conditions and juvenile carrying capacity as primary causes for the low R/S ratio currently observed in the Tucannon River. Therefore, proposed restoration actions are highly focused on addressing limitations to productivity. The largest mortality occurs between egg and smolt, with the majority of the mortality occurring between egg and parr (SRSRB 2006). In addition, WDFW data indicate that smolt production generally increases with an increase in adult returns in the basin, although a carrying capacity issue may exist above approximately 200 female spawners (Gallinat and Ross 2010). Spawning and incubation for spring Chinook begins in August and continues through March, with fry developing to parr through June. This timeline represents a large range in hydrologic conditions and habitats used by Chinook; prioritizing specific time periods and associated habitats is necessary to target critical life-cycle periods affecting productivity (ISRP 2011a).

The life stage between egg and parr coincides with late summer low flow, winter storm flows, and the spring runoff period. Summer low flows are unpredictable, and other efforts in the basin are focused on improving water quality and quantity. Winter storm events are stochastic and vary greatly in the effect that they may have on growth and productivity. For example, several consecutive years of minor peak flows, where impacts to fish are also minor, may occur between larger, less frequent flood events that have the ability to scour redds, resulting in significant losses to the run. Spring runoff flows occur each year and are relatively predictable in their magnitude and their effect on the habitat types required by
juvenile salmonids; these habitats are currently lacking in the system. Data from smolt trapping in the lower river indicate that parr are arriving in the lower basin throughout the spring runoff period, long before their genetic signal should be initiating movement downstream (WDFW 2011). It is speculated that this may be occurring either because they are being flushed downstream and are not able to find suitable refuge habitat or because juvenile fish are actively seeking out habitats in the lower river because of the lack of refuge areas (carrying capacity) in the preferred rearing areas upstream.

Based on high egg-to-parr mortality and uncertainty related to much of the hydrologic cycle during the egg-to-parr timeline, improving habitat conditions for juveniles during the spring runoff period was determined to be of high priority and to provide the greatest certainty of success with respect to improving growth and productivity. Therefore, restoration actions that will provide hydraulic complexity; will improve or create side channels, alcoves, or hydraulic refuge and cover; or will improve low-lying floodplain connectivity will be considered to have high biological benefit when developing conceptual projects. Installing necessary instream structure to provide adequate cover and complexity while designing within the basin and reach-scale geomorphic context will be critical to achieving both an immediate biological benefit and long-term restoration success. Hydraulic complexity and off-channel habitat projects will provide hydraulic refuge and rearing habitat for juvenile salmonids during moderate to high flows and will also provide more desirable habitat during lower flow conditions. LWD placements will provide refuge and cover and will be used to initiate a geomorphic response in many locations where natural channel development and floodplain connectivity can be achieved. Levee and riprap removal will remove stressors in the system, allowing for more natural geomorphic processes and promoting habitat recovery. See Appendix A for more details on specific restoration actions proposed for the Tucannon River.

Collectively, these improvements can re-establish natural “processes of material and energy transfer across the watershed that enables the formation and maintenance of productive habitat,” identified by the ISRP for the Tucannon River (ISRP 2011b). It is expected that these improvements will promote the re-establishment of natural processes, which will increase habitat diversity and total rearing area available for juveniles and will improve their survival and productivity. The habitat improvements should also increase spawning and
emergence conditions over time through improved energy dissipation from increases in channel complexity, improved temperature conditions, and improved distribution of nutrients and fine sediment across the floodplain.

### 3.3.3 Spatial Structure

Improving the population spatial structure relates to improving habitat conditions throughout the river corridor such that habitat needs are met across the various life stages and hydrologic regimes, and the health of the population is not jeopardized by local environmental effects. While it is known that the majority of the spawning occurs upstream of Marengo and rearing densities decrease downstream of Cummings Creek, valuable existing and potential habitat throughout the basin. The restoration approach for the Tucannon River does not focus exclusively on one reach or segment of the study area, but values both areas of the river currently experiencing high fish use as well as areas with high restoration potential should a “full build out” of restoration opportunity be realized. This approach is further described below and in Section 5 of this report.

In general terms, the restoration strategy for the Tucannon River is a holistic basin-scale approach that values both immediate and long-term biological benefits. Implementation of restoration projects will likely occur in high-use areas early to maximize growth and productivity in areas of current use. In addition, projects with high benefit and low cost will be highly recommended regardless of location to maximize the growth and productivity of the segment of the population currently using those areas. Projects implemented on the fringes of the current high-use areas will expand the linear extent of high-quality habitat throughout the river corridor, increasing the distribution and carrying capacity for fish using those areas. Projects removing stressors on habitat will allow for natural recovery of the system and better habitat continuity through the river in the long term.

This restoration strategy will improve the spatial distribution of the stock by improving existing high-use areas, implementing high-benefit/low cost projects in non-high-use areas, expanding the size of high-use areas by implementing projects on the fringes of those areas, and removing stressors affecting natural processes for long-term improvement of quality.
habitat throughout the river corridor production; and improve the spatial distribution of the stock.

### 3.3.4 Life History Diversity

Because the majority of the population of spring Chinook are 1+ fish, and restoration actions will target improving habitat for juvenile fish, none of the proposed restoration actions will specifically target improving life history diversity within the target species.
4 REACH 5 CONCEPTUAL PROJECTS

Reach 5 is located from RM 20 approximately 1.5 miles upstream of the Einrich/Brines Bridge to just upstream of Pataha Creek at RM 13.4 (Figure 2). Highway 12 crosses the river near RM 14.7. Reach 5 is located within a portion of the valley that is privately-owned and occupied largely by irrigated and non-irrigated grain crops, pasture, and riparian forest. Reach 5 is an important reach particularly for steelhead trout. Summer steelhead spawn, hold, and rear in this reach, spring Chinook are also known to hold and rear, and some fall Chinook may also spawn and rear in the reach. The reach is also an important migratory corridor for all ESA-listed species.

The valley is primarily occupied by pasture with a relatively narrow riparian corridor dominated by alders and occasional cottonwoods. Some wider forested buffers exist up to approximately 1,000 feet. Willow Creek enters Reach 5 near RM 14.85. The area was identified as a gaining reach upstream of RM 18.4 and as a losing reach to its downstream extent. Field observations supported this evaluation – groundwater seepage from bedrock and a greater area of wet portions of the floodplain were observed in the upper reach.

Reach 5 has a moderate amount of both natural and anthropogenic confinement. The channel is typically a straight, single-thread channel with local deep bedrock-forced pools where it is positioned along the toe of the valley slope. Infrastructure, particularly angular rock bank armoring, confines the river throughout much of these areas. Bedrock grade controls are present in many areas that contribute to holding the bed elevation of the river; in particular, two significant bedrock falls are located near RM 16.5 and 15.3. The amount of low-lying floodplain is relatively small and floodplain connectivity is typically poor. Some portions of Reach 5 are relatively unconfined and have significantly wider floodplains with better connectivity and recovering processes (i.e., RM 18.6 to 17.6). These areas typically contain a more diverse channel network, active LWD recruitment, and relatively good habitat conditions.

Five conceptual project areas (PAs) were identified in Reach 5 (PA-29, PA-30, PA-31, PA-32, and PA-33). The primary restoration strategy presented within Reach 5 focuses on levee removal and setback and adding LWD. Levee setback would promote restoration of natural
channel and floodplain processes, as well as promote the development of off-channel habitat areas. LWD is proposed in areas where channel complexity is lacking and pool quantity and LWD are limited. The addition of LWD is consistent with the limiting factors identified in the EDT analysis for Chinook and steelhead of key habitat quantity, sediment load, key habitat diversity, and temperature (CCD 2004, Appendix J). LWD will provide a greater quantity of holding areas by initiating pools and will contribute to reversing the incised condition of much of the channel, which will eventually lead to better connectivity of riparian vegetation with water table and bank overtopping.
4.1  Project Area 29 (River Mile 20 to 18.6)

PA-29 is located within the active channel and floodplain from RM 20 to Einrich/Brines Bridge (RM 18.6).

Table 4-1

<table>
<thead>
<tr>
<th>Restoration Framework Actions</th>
<th>Project Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect and maintain natural processes</td>
<td>Natural processes are impaired in this project area.</td>
</tr>
<tr>
<td>2. Reconnect isolated habitats</td>
<td>No significant isolated habitats were identified in this project area. The wetland area near RM 18.7 will become better connected to the river by removing spoils near RM 18.7. Create downstream connection to pond at RM 18.9 (right bank).</td>
</tr>
<tr>
<td>3. Address roads, levees, and other anthropogenic infrastructure impairing processes</td>
<td>Remove approximately 847 feet of bank armoring and spoils in the upper portion of the reach to allow the channel to migrate and evolve. Modify existing LWD and Rock Barb at RM 18.7 (left bank)</td>
</tr>
<tr>
<td>4. Restore riparian processes</td>
<td>Restore riparian areas as needed when associated with other restoration actions in the project area.</td>
</tr>
<tr>
<td>5. Improve instream habitat conditions</td>
<td>Place LWD throughout RM 18.6 to RM 20.</td>
</tr>
</tbody>
</table>

4.1.1  Site Description

4.1.1.1  Channel Characterization

The river through PA-29 is primarily characterized by a low-sinuosity, single-thread, plane-bed channel, with local areas of split flow and LWD or bedrock-forced pools. The upstream portion of the project area between RM 20 and 19.1 is highly influenced by bedrock outcrops along the left bank and in the channel bed. The bedrock maintains the grade of the channel and creates local rapid sections and deep pools. Boulders eroded from the hillside that also create rapid conditions are present in much of the channel where it flows along the toe of the valley wall. Short plane-bed sections are located between the bedrock-dominated portions of the channel that generally contain sparse LWD and an armored substrate conditions. A forested island with split flow is located at RM 19.6, which appears to be maintained for irrigation purposes. The channel on the right side contains armor rock in the
bed and banks at the head of the island and additional armoring along the length of the right bank. Another short split flow section is located near RM 19.4 adjacent to an armored bank that restricts channel migration. Downstream of RM 19.1, the channel is dominantly plane-bed with little complexity. A local aggrading section with a braided channel pattern is located between RM 19.1 and 19 where the channel is migrating to the left bank. Evidence of recent migration along the right bank between 19 and 18.75 was observed; cabled LWD toe stabilization has been placed near RM 18.95 and a concrete block wall in the floodplain protects a residence and driveway. Downstream of RM 18.8, the Tucannon Road and Einrich/Brines Bridge abutments are armored with angular riprap. Spoils are located in the left floodplain near RM 18.7 near a constructed rock/LWD barb feature. A low-lying wetland area between RM 18.7 and Einrich/Brines Bridge is connected at the downstream end and contains flowing water and juvenile fish.

Photograph 4-1
Typical Channel Conditions in the Upper Portion of PA-29; Bedrock Outcrop in Foreground on Right Side of Image, near RM 19.5 (photo by Anchor QEA, August 17, 2012)
Instream habitat conditions are generally characterized by a lack of LWD and cover, low hydraulic complexity, and poor bedload sediment distribution. Bedrock pools in the upper reach provide good adult holding habitat but the bedrock-dominated and plane-bed channel have a low amount of potential spawning area. Potential spawning is better suited to the lower reach; however, the confined and plane-bed conditions likely result in high velocities during high flows and the channel lacks hydraulic refuge.

4.1.1.2 Floodplain Characterization

This project area is characterized by low to moderate floodplain connectivity. Although the upper project area contains a small area of low-lying floodplain, it is not disconnected by any significant infrastructure. The lower project area contains a large area of low-lying floodplain that is primarily irrigated and non-irrigated fields. There is no apparent infrastructure that prevents flooding of these areas except for minor features such as the spoil berm near RM 18.7.

The riparian zone is in generally poor to moderate health. Overall, the riparian corridor is relatively narrow and flanked by fields and pastures. Riparian trees are predominantly mature alders with few cottonwoods. The alders provide good shading in some portions of the project area, particularly along the channel margins. Understory vegetation is dominated by invasive groundcover and several areas of thick reed canarygrass.

4.1.2 Conceptual Project Actions

PA-29 conceptual project actions include removing segments of levees to improve floodplain connectivity and adding LWD throughout the entire project area to add hydraulic and habitat complexity. Specific actions include removing an approximately 200-foot segment of rock at RM 19.4 to allow migration into the right bank. Additional rock removal at RM 19 (left bank) and removal and setback of a spoils pile at RM 18.7 (right bank). In addition, modification of previously constructed rock and wood bank structure along the left bank is proposed that is located at RM 18.65.
### 4.1.2.1 Geomorphic Implications

Levee setback would help restore natural channel migration processes throughout the project area. Natural migration would promote wood and sediment recruitment, improving hydraulic and habitat complexity. Over time, floodplain connectivity should improve as natural processes are restored. Large wood placement would increase cover, create pools, and create localized areas of hydraulic and habitat complexity.

### 4.1.2.2 Biological Benefits

Wood placement throughout the channel would create hydraulic and habitat diversity. LWD would increase roughness, create pools and cover, and promote sediment retention throughout the project area. Levee setback and rock removal would allow increased floodplain connectivity and improvement of off-channel habitats as lateral channel migration increases in the project area.

### 4.1.2.3 Potential Challenges

Project actions would require landowner permission and construction access throughout the project reach. Large wood placement may require in-water work. Limiting construction and channel access disturbance in healthy riparian areas would be a construction consideration.
4.2 Project Area 30 (River Mile 18.6 to 17.6)

Project Area 30 (PA-30) is located in the active channel and floodplain from the Einrich/Brines Bridge (RM 18.6) to the property boundary near RM 17.6.

<table>
<thead>
<tr>
<th>Restoration Framework Actions</th>
<th>Project Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect and maintain natural processes</td>
<td>Natural processes are impaired throughout most of this project area.</td>
</tr>
<tr>
<td>2. Reconnect isolated habitats</td>
<td>Old channels are located throughout the right bank floodplain. Removal and setback of right bank rock revetment at RM 17.8 and 17.9 would reconnect to one of these old channels.</td>
</tr>
<tr>
<td>3. Address roads, levees, and other anthropogenic infrastructure-imparing processes</td>
<td>Remove and setback the revetment along the right bank between RM 17.8 and 17.9. Revetment setback would require modification of landowner’s pump withdrawal system from the river. Implement measures to prevent cattle grazing in and near the river.</td>
</tr>
<tr>
<td>4. Restore riparian processes</td>
<td>Restore riparian areas as needed when associated with other restoration actions in the project area.</td>
</tr>
<tr>
<td>5. Improve instream habitat conditions</td>
<td>Instream habitat conditions would improve with removal of grazing access to the river and by instream gravel bar stabilization and floodplain revegetation.</td>
</tr>
</tbody>
</table>

4.2.1 Site Description

4.2.1.1 Channel Characterization

Within a majority of PA-30, the channel has a wide, active channel with braided channel pattern and forced pool-riffle configuration associated with LWD. The channel contains a high volume of temporary sediment storage in the form of large gravel bars and low-lying floodplain areas, including recently-mobilized and unvegetated bars (Photograph 4-2). Active channel migration and recent recruitment of riparian trees was observed throughout the project area, most recruited trees and LWD accumulations were associated with deep, well-covered scour pools. In the lower half of the project area, an armored rock and LWD revetment confines the channel on the right bank between approximately RM 18.0 and 17.8. Deep pools are located along the structure associated with large angular rock and placed...
rock/LWD barb features. At RM 17.85, a side channel opening appears to be annually maintained for irrigation purposes. The side channel contained approximately 10 percent of the river flow during field observation. The middle portion of the side channel contains armor along the right bank adjacent to a private residence on the floodplain. An additional side channel in the right floodplain between RM 18.3 to 18.1 contains several deep pools and ample LWD.

Photograph 4-2  
Braided Channel Pattern in PA-30 with Wide, Exposed Gravel Deposits and Multiple Flow Paths throughout the Active Channel, near RM 18.35 (photo by Anchor QEA, August 17, 2012)

Instream habitat conditions are relatively good in the dynamic portion of the project area, due to the complex channel pattern that maintains hydraulic diversity and a high volume of potential spawning substrate. The numerous flow paths and backwater areas provide variable habitat conditions for juvenile fish during a range of flows. Log jams and recently recruited trees appear to be retaining additional mobile wood and maintaining deep pools; however, the volume of LWD in the project area is not adequate for habitat purposes.
Temperature and lack of cover are also potential concerns in the project area where the wide, braided active channel is exposed. Cattle grazing also degrades water quality, bank stability, and floodplain vegetation.

4.2.1.2 Floodplain Characterization

The floodplain in this project area is well-connected and contains a large quantity of low-lying floodplain relative to adjacent projects areas. An exception is the low-lying floodplain that is disconnected from the river by the bank armoring between RM 18.0 and 17.8.

Riparian trees are predominantly mature to moderately mature alders and some locust trees. The alders provide good shading in the existing side channels but shade is lacking in much of the main channel. The armored levee contains primarily dry weedy species and does not provide adequate shading in the main channel adjacent to the feature. Throughout the project area the understory is highly disturbed by cattle grazing and contains a high density of invasive plants. The disconnected right bank floodplain area near RM 17.9 is dominated by reed canarygrass and contains sparse shrubs and young deciduous trees.

4.2.2 Conceptual Project Actions

PA-30 conceptual project actions include one segment of revetment removal and setback between 17.8 and 17.9 (right bank). This setback would require reconfiguration of a pump withdrawal system from the river (right bank). Additional proposed project actions include stabilizing in-channel bars and promoting floodplain vegetation development where it is poorly developed; preventing cattle access to the river and floodplain areas; and preventing cattle grazing in the river, riparian, and floodplain areas.

4.2.2.1 Geomorphic Implications

Removal and setback of the rock revetment between RM 17.8 and 17.9 would restore floodplain processes and improve connectivity to this historical channel area. Stabilization of the gravel bars and restoration of vegetation in the floodplain would promote the development of a stable multi-thread channel within the active channel and floodplain.
4.2.2.2  **Biological Benefits**

Areas of revetment setback and rock removal would allow for increased floodplain connectivity and improvement of off-channel habitats as lateral channel migration in the project area. Bar stabilization would promote long-term habitat features such as stable pool riffle habitats that are key so spawning and rearing life cycles.

4.2.2.3  **Potential Challenges**

Project actions would require landowner permission for construction access throughout the project reach. Modification or relocation of the water withdrawal pump system from the river would be necessary as part of the proposed revetment removal and setback proposed between RM 17.8 and 17.9. Landowner cooperation would be necessary to limit or prevent the grazing access to the river.
4.3 Project Area 31 (River Mile 17.6 to 16.1)

Project Area 31 (PA-31) is located in the active channel and floodplain from RM 17.6 to RM 16.1.

Table 4-3

<table>
<thead>
<tr>
<th>Restoration Framework Actions</th>
<th>Project Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect and maintain natural processes</td>
<td>Natural processes are impaired throughout most of this project area in localized areas where functioning, enhancement proposed.</td>
</tr>
<tr>
<td>2. Reconnect isolated habitats</td>
<td>Improve reconnection at side channel located between RM 17.2 and 17.1 along the right bank.</td>
</tr>
<tr>
<td>3. Address roads, levees, and other anthropogenic infrastructure-imparing processes</td>
<td>Remove rock levee from approximately RM 17.6 to 17.5 (right bank). Remove sugar dike at and downstream of RM 15.5 (right bank). Remove culvert at RM 17.05 and remove access road over side channel.</td>
</tr>
<tr>
<td>4. Restore riparian processes</td>
<td>Restore riparian areas as needed when associated with other restoration actions in the project area.</td>
</tr>
<tr>
<td>5. Improve instream habitat conditions</td>
<td>Place LWD from RM 17.6 to 17.2 (plane-bed segment). Increase roughness from RM 16.5 to 16.1 by LWD placement.</td>
</tr>
</tbody>
</table>

4.3.1 Site Description

4.3.1.1 Channel Characterization

The river through PA-31 is primarily characterized by a low-sinuosity, single-thread, plane-bed channel, with local areas of split flow, LWD or bedrock-forced pools, and depositional areas. In places, the project area is highly influenced by bedrock outcrops along the left bank and in the channel bed. Bedrock maintains the grade of the channel and controls the left bank along the valley wall. Pools are found throughout the project area and are associated with bedrock, armored banks, and locally recruited LWD. In the upper extent of the project area, between RM 17.6 and RM 17.1, the channel is highly confined between the valley wall (along the left bank) and levees and revetments along the right bank. Minimal bedrock is exposed along the channel bed in this confined segment. Downstream of RM 17.2, the channel widens and deposition is occurring with an unvegetated gravel bar developing in the channel. In this area, an active side channel is located along the right bank, with its
upstream inlet at approximately RM 17.2. In the lower segment of the project area, bedrock controls the channel grade. Grazing in the channel was noted at RM 16. At RM 16.5, there is a small falls (identified as DeRuwe Falls) with a large, deep pool at the bottom. Downstream of the falls, the channel is moderately to highly confined between the valley wall on the left bank and rock levees along the right bank, with deposition in the less confined areas.

Photograph 4-3
View of Plane-bed Channel with Bedrock Bank Looking Downstream in PA-31 near RM 16.1 (photo by Anchor QEA, August 18, 2012)

4.3.1.2 Floodplain Characterization
Throughout PA-31, the channel is moderately to highly confined with some areas of floodplain connectivity. The bedrock valley wall limits floodplain development along the left bank and the right bank is mostly confined by rock levees and revetments to limit flooding and channel migration into the adjacent agricultural fields. The channel is incised
through much of the project area, with overbank flooding in areas that are less confined (i.e., between RM 17.2 and RM 16.9 at the right bank side channel).

The riparian zone is in generally poor to moderate health. Overall, the riparian corridor is relatively narrow and flanked by fields and pastures along the right bank. Riparian trees are predominantly mature alders with few cottonwoods with moderate density. The riparian vegetation provides shading along the channel margins. Stands of riparian trees are lacking in places along the left bank where the river is adjacent to the valley wall, which is composed of bedrock along much of the project area. Understory consists of sparse coverage of invasive species.

4.3.2 Conceptual Project Actions

PA-31 conceptual project actions include adding LWD in the plane-bed reach between RM 17.6 and 17.2; removing rock along the right bank at RM 17.5; improving the connection to the side channel and removing a road crossing and culvert to improve side channel connectivity at RM 17.2; and adding LWD and floodplain roughness between RM 16.5 and 16.1.

4.3.2.1 Geomorphic Implications

The plane-bed portions of the channel are subject to high velocities during peak flows, which prohibit sediment deposition and promote overall channel incision. The addition of in-channel wood would help reduce velocities and promote localized sediment aggradation to help limit the ongoing channel incision.

4.3.2.2 Biological Benefits

Wood placement throughout the channel would create hydraulic and habitat diversity. LWD would increase roughness, create pools and cover, and promote sediment retention throughout the project area. In addition, these features would slow water velocities, potentially reducing channel incision by promoting aggradation and stabilized bar development.
4.3.2.3  Potential Challenges

Project actions would require landowner permission and construction access throughout the project reach. Large wood placement may require in-water work. Limiting construction and channel access disturbance in healthy riparian areas would be a priority. Landowner cooperation would be necessary to limit or prevent grazing access to the river.
4.4  **Project Area 32 (River Mile 16.1 to 14.65)**

Project Area 32 (PA-32) is located in the active channel and floodplain from RM 16.1 to RM 14.65 (Hwy 12 Bridge).

### Table 4-4

**Restoration Recommendations for Project Area 32**

<table>
<thead>
<tr>
<th>Restoration Framework Actions</th>
<th>Project Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect and maintain natural processes</td>
<td>Protect and maintain natural processes between RM 16 and RM 15.65. Natural processes are impaired throughout the remainder of this project area.</td>
</tr>
<tr>
<td>2. Reconnect isolated habitats</td>
<td>Reconnect right bank floodplain area by constructing a setback levee from RM 15.8 to RM 14.8 (right bank).</td>
</tr>
<tr>
<td>3. Address roads, levees, and other anthropogenic infrastructure</td>
<td>Construct a setback levee (right bank) between RM 15.8 and RM 14.85. Setback right bank levee at RM 16.1 and RM 16 (and excavate right bank to widen channel). Setback levee at RM 15.1 (right bank) and RM 14.8 (left bank). Reconfigure pumping withdrawal locations with landowners.</td>
</tr>
<tr>
<td>4. Restore riparian processes</td>
<td>Restore riparian areas as needed when associated with other restoration actions in the project area.</td>
</tr>
<tr>
<td>5. Improve instream habitat conditions</td>
<td>Strategically place wood to jumpstart processes between RM 15.65 and RM 15.1.</td>
</tr>
</tbody>
</table>

#### 4.4.1  Site Description

##### 4.4.1.1  Channel Characterization

The PA-32 channel characteristics range from a single-thread incised channel to a wider braided channel supporting large unvegetated gravel bars. Bedrock controls the left bank and channel grade throughout much of the project area. In the upper section of the project area (RM 16.1 to RM 15.65), the channel has a wide, active channel with braided channel pattern and forced pool-riffle configuration associated with LWD. This area is depositional and contains numerous large gravel bars. Localized LWD recruitment has created numerous scour pools. Downstream of RM 15.65, the channel narrows and is confined by the valley wall along the left bank and by a levee along the right bank. Tucannon Falls is located at RM 15.3 and is a bedrock feature that drops approximately 5 to 6 feet. A large, deep pool is located at the foot of the falls. Downstream of the falls to the Highway 12 bridge, the
channel widens and is no longer confined on the left bank by bedrock. Evidence of overbank flows and off-channel connectivity are evident throughout the right bank floodplain. Willow Creek flows into the river along the left bank at RM 14.8.

Photograph 4-4
View Looking Downstream at Approximately RM 15.6 with the Bedrock-controlled Left Bank and Riprap along a Section of the Right Bank (photo by Anchor QEA, August 18, 2012)

4.4.1.2 Floodplain Characterization
Throughout PA-32, the channel is unconfined to highly confined. The bedrock valley wall generally limits floodplain development along the left bank and the right bank is mostly confined by rock levees and revetments to limit flooding and channel migration into the adjacent agricultural fields. The downstream segment from approximately RM 15.2 to the downstream boundary is generally unconfined.

The riparian zone is generally poor to moderate health with mature alder trees with a moderately sparse understory consisting of mostly invasive species. A well-established
riparian zone is generally lacking downstream of RM 15.0 where overall shading of the river channel is poor. The floodplain widens in this section, as it is no longer confined on the left bank by the bedrock valley wall. Floodplain vegetation in this area is mostly understory vegetation such as reed canarygrass. Wetlands exist within both the right bank and left bank floodplains downstream of RM 15. Wetland vegetation includes reed canarygrass, rushes, and cattails. Some of the wetlands have direct hydraulic connections to the main channel.

4.4.2 Conceptual Project Actions

PA-32 conceptual project actions include designating RM 16 to RM 15.65 as a protection area. Downstream of the protection area, a setback levee is proposed along the right bank, extending from approximately RM 15.9 to RM 14.8. A small segment of levee proposed for removal extents from RM 16.1 to RM 16. In addition, levee setbacks are proposed at RM 15.1 (right bank) and 14.8 (left bank).

4.4.2.1 Geomorphic Implications

Ongoing geomorphic processes would continue in the designated protection area between RM 16 and RM 15.65. Levee setback would help restore natural channel migration processes throughout the project area. Natural migration would promote wood and sediment recruitment, improving channel complexity. Over time, floodplain connectivity should improve. Large wood placement would increase cover, create pools, and create localized areas of hydraulic and habitat complexity.

4.4.2.2 Biological Benefits

Wood placement between RM 15.65 to RM 15 would create hydraulic and habitat diversity. LWD would increase roughness, create pools and cover, and promote sediment retention. LWD would also slow water velocities and reduce channel incision by promoting aggradation and stable bar development. Levee setback throughout much of the project area would improve the development of off-channel habitat areas.
4.4.2.3  Potential Challenges

Project actions would require landowner permission and construction access through private property. Large wood placement may require in-water work. Limiting construction and channel access disturbance in healthy riparian areas would be a priority. Landowner cooperation would be necessary to modify or relocate pumping and water withdrawal systems.
4.5 Project Area 33 (River Mile 14.65 to 13.4)

Project Area 33 (PA-33) is located between the Highway 12 bridge (RM 14.65) and the Territorial Road bridge (RM 13.4).

<table>
<thead>
<tr>
<th>Restoration Framework Actions</th>
<th>Project Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect and maintain natural processes</td>
<td>Natural processes are impaired in this project area.</td>
</tr>
<tr>
<td>2. Reconnect isolated habitats</td>
<td>Potential off-channel habitat areas are located along the right bank in the areas proposed for levee removal.</td>
</tr>
<tr>
<td>3. Address roads, levees, and other anthropogenic infrastructure impairing processes</td>
<td>Remove right bank levees between approximately RM 14.4 and RM 14.6. Remove levee at RM 14.3 (right bank). Remove levee between RM 13.5 and 13.65 (right bank).</td>
</tr>
<tr>
<td>4. Restore riparian processes</td>
<td>Restore riparian areas as needed when associated with other restoration actions in the project area.</td>
</tr>
<tr>
<td>5. Improve instream habitat conditions</td>
<td>Strategically place wood to add channel complexity between RM 14.65 to RM 13.4.</td>
</tr>
</tbody>
</table>

4.5.1 Site Description

4.5.1.1 Channel Characterization

Within PA-33, the river is largely confined and incised within a relatively straight, single-thread channel. In some portions of the channel, the channel has cut down to expose historic compacted alluvium along the banks and LWD has been unburied. The channel is primarily a transport reach with a low volume of temporary sediment storage and low volume of LWD. In the upper project area between RM 14.65 and 14.15, occasional bedrock outcrops are located in the channel bed which forces local pools and rapids and likely contributes to holding the channel grade. A majority of the upper reach is confined by riprap and unarmored levees. A significant bedrock sill is located along the left bank and in the channel between RM 14.25 and 14.15. The bedrock sill area contains split flow, a large log jam, and active migration of the channel into the right floodplain (currently a field). The lower portion of the project reach is primarily a plane bed channel with local forced pools where the channel is located along the toe of the bedrock valley wall, and sporadic LWD
pools. The right bank contains sporadic riprap between RM 14.05 and 13.4, and an armored and unarmored access road prism at a decommissioned pump and ditch site.

Photograph 4-5
A Bedrock Sill (Left) and Plane-bed Channel Conditions in PA-33 near RM 14.4
(photo by Anchor QEA, August 16, 2012)

Instream habitat conditions are generally characterized by a lack of LWD and cover, low hydraulic complexity, and poor bedload sediment distribution. The existing bedrock pools likely provide good adult holding habitat but the overall quantity of pools is low. In general there is a low amount of potential spawning area. No significant side channels or off-channel areas for high flow refuge or juvenile rearing areas were observed.

4.5.1.2 Floodplain Characterization
This project area is characterized by low floodplain connectivity. Overall, the project area contains a very small area of low-lying floodplain. Slightly higher elevation areas that may have been activated in the 1996 flood are located near RM 14.5 and at the decommissioned
ditch site at RM 13.6. Armored and un-armored levees disconnect these areas from the river. The infrastructure in the reach also prevents migration of the channel into the floodplain, which is currently occupied by an irrigated field, orchard, and an RV camp site.

The riparian zone is in generally poor health. The riparian corridor is very narrow and not well connected to the water table. Riparian trees are predominantly mature alders and cottonwoods. Some exposed sections of the channel exist where regenerating locusts or other invasive plants are dominant. Shade is poor to moderate. Understory vegetation is dominated by invasive groundcover including several thick patches of poison hemlock.

4.5.2 Conceptual Project Actions

PA-33 conceptual project actions include removing levees in select locations and placing LWD throughout the project area. Levee removal is proposed along the right bank between approximately RM 14.4 and RM 15.6, at RM 14.3 (right bank), and between RM 13.5 and 13.65 (right bank).

4.5.2.1 Geomorphic Implications
Levee removal would help restore natural channel migration processes throughout the project area. Natural migration would promote wood and sediment recruitment, creating a more complex channel pattern. Over time, floodplain connectivity should improve as the available floodplain width increases. Rates of channel migration may increase as the channel becomes more dynamic and erodes through previous levee bank portions. Large wood placement would promote sediment aggradation and scour pool development. More pool-riffle bed morphology should result throughout the project area.

4.5.2.2 Biological Benefits
Large wood placement throughout the project area would create hydraulic and habitat diversity. LWD would increase roughness, create pools and cover, and promote sediment retention. LWD would also slow water velocities and reduce channel incision by promoting aggradation and stable bar development. Levee setback throughout much of the project area would improve the development of off-channel habitat areas.
4.5.2.3 Potential Challenges

Project actions would require landowner permission and construction access through private property. Large wood placement may require in-water work. Limiting construction and channel access disturbance in healthy riparian areas would be a priority. Landowner cooperation would be necessary to modify or relocate any pumping and water withdrawal systems.
5 PROJECT EVALUATION

Projects were evaluated and placed into implementation tiers based on four criteria: expected biological response, consistency with natural processes, benefit-to-cost, and reach priority. Biologic and geomorphic criteria were assigned qualitative values of high, moderate, or low value and benefit-to-cost was given a qualitative ratio using high, moderate, or low values. Reaches were prioritized into three levels of relative importance. The following sections of this report describe the prioritization criteria and process. As projects are implemented, it may be appropriate to revisit projects and re-evaluate tier levels. This evaluation does not consider feasibility in terms of landowner willingness to participate. The information presented in this report is intended to provide an objective look at the conceptual projects that would most benefit target species based on biological benefit and physical effects.

5.1 Evaluation Criteria

5.1.1 Expected Biologic Response

The expected biological benefit was scored based on the expected magnitude of benefits and the likelihood that project objectives would be met. Those projects that most directly address limiting factors and critical life stages, while creating the greatest volume of quantifiable habitat, received the highest scoring. The diversity of existing habitat and the functionality of the existing and proposed habitat during target life stages were included in the evaluation. The juvenile life history stage (egg to parr) was identified as critical to improving spring Chinook populations in the Tucannon River. In particular, the persistent lack of adequate juvenile rearing habitat during winter and spring runoff (post-emergence to parr), bed scour during stochastic winter/spring flows, and summer water temperature have been identified as limiting to juvenile populations. Therefore, projects that improve the quality and quantity of juvenile habitat during these periods or create rearing habitat in areas where it does not currently exist received a higher rating.

The expected biologic response of each project was evaluated within the following categories:

- Provides immediate habitat benefits for critical life history stages
- Reconnects isolated habitats or improves existing habitats and promotes floodplain connectivity
- Provides diversity throughout the active channel and low-lying floodplain for all life history stages

5.1.2 Consistency with Natural Geomorphic Process

Natural geomorphic processes are the primary factor in creating and maintaining high-quality habitat in properly functioning rivers and streams. Designing for geomorphic process or removing inhibitors to geomorphic processes are important considerations in project prioritization. The sustainability and functionality of the project is highly dependent on consistency with geomorphic processes, and it is the restoration of these processes that will create and maintain habitat features in the long term. The projects that are expected to most effectively address the rehabilitation of natural processes will receive the highest qualitative rating.

For each project, consistency with natural geomorphic processes was evaluated within the following categories:

- Removes stressors that promote habitat degradation or inhibit natural channel and floodplain processes
- Promotes reach-scale geomorphic response consistent with natural processes
- Promotes the retention of LWD and sediment and forces pool-riffle morphology and complex channel planform

5.1.3 Benefit-to-Cost Ratio

A qualitative evaluation of the magnitude of biological and physical benefits of the project was determined, as was a rough opinion of the probable implementation cost. The result of this estimate is a qualitative ranking of the benefit-to-cost ratio. Those projects that achieve the greatest benefit for the least amount of money received the highest ratings. This criterion also considers whether the benefit is achieved on a short-term or long-term timeline.
5.1.4 Reach Priority

Reaches were prioritized using a variety of biologic and physical data (Table 5-1). High priority was given to reaches where existing fish use is high and the restoration potential has also been determined to be high. Physical characteristics included the area of low-lying floodplain, the amount of disconnected low-lying floodplain, and the percent of the reach that is a gaining reach versus a losing reach. Biological data included redd surveys (Gallinat and Ross 2010) and juvenile distribution (SRSRB 2006) that provide a relative density of spawning and juvenile presence in each reach.

Table 5-1
Summary of Physical Reach Characteristics, Reach 5

<table>
<thead>
<tr>
<th>Reach</th>
<th>Length (mi)</th>
<th>Low-lying Floodplain Area (acres)</th>
<th>Low Floodplain per River Mile (acres/mi)</th>
<th>Degree of Confinement (%)</th>
<th>Disconnected Low Floodplain (acres/RM)</th>
<th>Groundwater Input (%)</th>
<th>Gaining</th>
<th>Losing</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>6.6</td>
<td>325</td>
<td>48</td>
<td>58</td>
<td>18.0</td>
<td>25</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-2
Summary of Biological Reach Characteristics, Reach 5

<table>
<thead>
<tr>
<th>Reach</th>
<th>Length (mi)</th>
<th>Spawning Use (redds/RM)</th>
<th>Spawning Presence (qualitative)</th>
<th>Juvenile Density (per/100 m²)</th>
<th>Juvenile Presence (qualitative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>6.6</td>
<td>0.2</td>
<td>None</td>
<td>3.2</td>
<td>Low</td>
</tr>
</tbody>
</table>

Sources:
Spawning data from Gallinat and Ross (2010).
Juvenile data from SRSRB (2006), Table 3-9.

Four of the above characteristics were chosen to collectively represent the relative restoration potential of the reaches and achieve watershed-scale restoration objectives:

- **Available low-lying floodplain**: The total amount of low-lying floodplain within the reach represents the maximum habitat that could be available if a “full build-out” condition with respect to restoration actions were realized. Hence, those reaches with naturally wider low-lying floodplain areas were scored higher than reaches with floodplains that are higher and naturally confined. Low-lying floodplain was
calculated by determining an average height of the 5-year flood elevation within each reach using the basin-scale hydraulic model (Anchor QEA 2011a). This elevation value was projected out across the LiDAR surface to create a floodplain polygon. These areas were then calculated for each reach and compared to the length of the reach in RM. The low-lying floodplain area was refined and updated from the values presented in the Geomorphic Assessment (Anchor QEA 2011a).

- **Disconnected low-lying floodplain:** The potential for additional floodplain connection is represented by the relative amount of disconnected low-lying floodplain in a reach. The channel alignment was broken out into sections that are disconnected from the low-lying floodplain by infrastructure and sections that are not influenced by infrastructure. A percent length within each category was calculated and compared to acres of available low-lying floodplain per RM as described above. These values were refined and updated from the values presented in the Geomorphic Assessment (Anchor QEA 2011a); revisions were based on field observations and refined spatial analysis.

- **Distribution of spring Chinook spawning areas:** Redd distribution for spring Chinook, as presented in Gallinat and Ross (2010), was compared to the Tucannon River geomorphic reaches. A relative weight was assigned to each reach to represent the density of existing spawning.

- **Distribution of spring Chinook juveniles:** Estimates of juvenile Chinook distribution for spring Chinook, as presented in the Snake River Salmon Recovery Plan (2006), was compared to the Tucannon River geomorphic reaches. A relative weight was assigned to each reach to represent the density of existing juvenile use.

Based on the quantitative values shown in Tables 5-1 and 5-2, the reaches were assigned a relative value between 1 and 5 for each of the four criteria above. The higher values represent a greater potential for restoration benefit. Low-lying floodplain was assumed to be slightly less beneficial in the near-term relative to the presence of spring Chinook in a reach. Therefore, the physical and biological values were weighted at 40 percent and 60 percent, respectively; Table 5-3 summarizes these values and provides the reach priorities. As a result of this methodology, Reach 5 has the highest priority. Fish use is low throughout the lower Tucannon River (Reaches 3 through 5). Floodplain connectivity is the driving factor in
ranking reach priority. Of these lower Tucannon reaches, Reach 5 has higher fish use and a large area of low-lying floodplain per mile.

Table 5-3

<table>
<thead>
<tr>
<th>Physical Characteristics weight = 40%</th>
<th>Biological Characteristics weight = 60%</th>
<th>Reach Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-lying Floodplain</td>
<td>Relative Spring Chinook Spawning Use</td>
<td></td>
</tr>
<tr>
<td>Disconnected Low-lying Floodplain</td>
<td>Relative Spring Chinook Juvenile Rearing Use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Weighted Total</td>
</tr>
<tr>
<td>Reach</td>
<td></td>
<td>Reach Priority</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Weighted Total</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Reach Priority</td>
<td>P3</td>
</tr>
</tbody>
</table>

Note: Relative values between 1 and 5 are based on the quantities provided in Tables 5-1 and 5-2

5.2 Project Prioritization

Table 5-4 summarizes the ratings assigned to each project within the four evaluation criteria categories: Expected Biologic Response, Consistency with Natural Geomorphic Processes, Benefit-to-Cost Ratio, and Reach Priority. Table 5-5 provides the relevant quantities of reconnected floodplain area, levee removals, and other project actions that were considered in developing the qualitative ranking for each project. This information was used to place each project within one of three tier levels that reflect the relative priority of project implementation (where P1 is the highest priority ranking and P3 is the lowest priority ranking). The following sections describe the general attributes of each tier level and how the tier levels should be considered within the overall restoration planning process, as well as providing the tier level of the 11 conceptual project areas.
## Table 5-4

**Reach 5 Project Prioritization**

<table>
<thead>
<tr>
<th>Project</th>
<th>Reach</th>
<th>Expected Biologic Response</th>
<th>Consistency with Natural Geomorphic Processes</th>
<th>Benefit-to-Cost Ratio</th>
<th>Reach Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Provides immediate benefit for critical life history stages</td>
<td>Removes stressors that promote degradation or inhibit natural channel processes</td>
<td>Promotes retention of LWD and sediment; forces pool-riffle morphology and complex planform</td>
<td>Magnitude of benefit vs. cost of implementation</td>
</tr>
<tr>
<td>29</td>
<td>5</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M/M</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>M</td>
<td>M</td>
<td>L</td>
<td>M/M</td>
</tr>
<tr>
<td>31</td>
<td>5</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M/M</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>M/H</td>
</tr>
<tr>
<td>33</td>
<td>5</td>
<td>M</td>
<td>H</td>
<td>M</td>
<td>M/M</td>
</tr>
</tbody>
</table>
Table 5-5
Approximate Physical and Habitat Quantities for Reach 5 Conceptual Projects

<table>
<thead>
<tr>
<th>Reach</th>
<th>Project Area</th>
<th>RM From</th>
<th>RM To</th>
<th>LWD Addition</th>
<th>Levees/Riprap</th>
<th>Side Channels</th>
<th>Roads</th>
<th>Reconnected Low Floodplain (in acres)</th>
<th>Riparian Enhancement (in acres)</th>
<th>Protection Area (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>29</td>
<td>20</td>
<td>18.6</td>
<td>7433.52</td>
<td>847.93</td>
<td>411.48</td>
<td></td>
<td>730.39</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>18.6</td>
<td>17.6</td>
<td>1053.73</td>
<td>1075.84</td>
<td>-</td>
<td></td>
<td>-</td>
<td>4.63</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>17.6</td>
<td>16.1</td>
<td>4248.07</td>
<td>634.47</td>
<td>-</td>
<td></td>
<td>1346.45</td>
<td>31.70</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>16.1</td>
<td>14.65</td>
<td>2882.31</td>
<td>1574.03</td>
<td>6137.80</td>
<td></td>
<td>-</td>
<td>2.05</td>
<td>16.1-15.6</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>14.65</td>
<td>13.4</td>
<td>6703.35</td>
<td>2285.66</td>
<td>-</td>
<td></td>
<td>-</td>
<td>0.73</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The levee setback calculation includes the road realignment; this section of road is located on top of the levee embankment.
5.2.1 Tier 1 Projects

Tier 1 projects are those projects that would be considered for early implementation within basin restoration planning. In general, the actions recommended in these projects are expected to provide an immediate biological response for the identified critical life history stages within a relatively large area of impact. Using a ranking system based on the parameters presented in Table 5-4, no Tier 1 projects were identified within Reach 5.

5.2.2 Tier 2 Projects

Tier 2 projects are moderate- to high-priority projects that should be considered for strategic implementation as funding and other opportunities arise. These projects are expected to achieve relatively high biologic and physical benefits for target life stages; however, it may take time for the benefits to be fully realized or achieving the results may be contingent upon other actions or have potential challenges that have been identified by local stakeholders. Three Tier 2 projects were identified in Reach 5 (Table 5-6).

<table>
<thead>
<tr>
<th>Project</th>
<th>Reach</th>
<th>River Miles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>5</td>
<td>17.6 to 16.1</td>
<td>Improve connection to right bank side channel at RM 17.2. Remove right bank rock levee (17.6 to 17.5). Remove sugar dike (RM 15.5 (right bank)). Remove access road and culvert (RM 17.05). Add LWD in main channel between RM 17.6 and 17.2.</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>16.1 to 14.65</td>
<td>Construct right bank setback levee from RM 15.8 to RM 14.8. Setback levee at RM 16.1 excavate channel at RM 16.0 to ease confinement. Setback levees at RM 15.1 (right bank) and RM 14.8 (left bank). Add LWD to main channel between RM 15.65 and 15.1. Protection area designation between RM 16.1 and 15.6.</td>
</tr>
<tr>
<td>33</td>
<td>5</td>
<td>14.65 to 13.4</td>
<td>Remove right bank levees between approximately RM 14.4 and 15.6. Remove levee at RM 14.3 (right bank). Remove levee between RM 13.65 and 13.5 (right bank). Strategically place LWD to add channel complexity between RM 14.65 and RM 13.4.</td>
</tr>
</tbody>
</table>
5.2.3 **Tier 3 Projects**

The Tier 3 group represents those projects that are appropriate for long-term strategic implementation. The biological and physical response may have less impact or be less certain, or the expected benefit of the project is low compared to the relative cost. Achieving the full benefits of a Tier 3 project may depend on implementing other actions, or it may take place on a relatively long time scale. Two Tier 3 projects were identified throughout the area of study (Table 5-7). Both of these Tier 3 projects are expected to provide moderate habitat benefits and have a moderate implementation costs.

<table>
<thead>
<tr>
<th>Project</th>
<th>Reach</th>
<th>River Miles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>5</td>
<td>20.0 to 18.6</td>
<td>Remove 922 feet of bank armoring and place LWD throughout the entire project area (RM 20.0 to 18.6). Reconnect an off-channel wetland near RM 18.7.</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>18.6 to 17.6</td>
<td>Setback right bank revetment at RM 17.9 to 17.8 to reconnect the main channel to an old channel area. Limit cattle grazing access (via fencing) to the river to improve channel habitat conditions between RM 17.8 to 18.0.</td>
</tr>
</tbody>
</table>
6 LIMITATIONS

We have prepared this report for use by the SRSRB to evaluate existing physical conditions in the Tucannon River and to identify appropriate potential restoration opportunities in the study reach. The information presented in this report is based on available data and limited site reconnaissance at the time of report development. Conditions within the study reach may change both spatially and with time, and additional scientific data may become available. Significant changes in site conditions or the available information may require re-evaluation. 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.
7 REFERENCES


FIGURES
NOTES:
1. Horizontal Datum: WA State Plane South Zone, NAD 83, Feet.
2. Public lands data provided by Washington State Dept. of Natural Resources.
Figure 2
Assessment Reaches
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board

NOTES:
1. Horizontal Datum: WA State Plane South Zone, NAD 83, Feet.
2. Sub-basins are based on USGS HUC areas.
Figure 3
Study Area
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board

NOTES:
1. Horizontal Datum: WA State Plane South Zone, NAD 83, Feet.
2. Sub-basins are based on USGS HUC areas.
APPENDIX A
CONCEPTUAL RESTORATION ACTIONS
CONCEPTUAL PROJECT ACTIONS

Enhancing instream habitat and initiating the recovery of natural watershed processes will involve a variety of treatment actions within the main channel, along the banks, and within the riparian zone and floodplain. The restoration actions proposed address key restoration objectives identified for the Tucannon River that address limiting factors for focal species and promote long-term recovery of the system.

Passive Restoration and Protection

Passive restoration is recommended for areas of the system where natural processes are actively recovering and habitat conditions are adequate to support critical life history stages. In these locations, processes such as channel migration, wood recruitment, and side channel development are actively creating and maintaining habitat complexity. Although these areas are not fully recovered, it is expected that they are on a positive trajectory and passive means are appropriate. Wood removal, cattle grazing, and other detrimental practices should be prevented by implementing fencing or conservation easements. In some project areas, riparian development or other minor restoration actions may be recommended to address local habitat degradation.

Reconnect Isolated Habitat

Off-channel habitat provides critical holding and rearing habitat for juvenile salmonids during moderate to high flows and often provides preferred habitat conditions to main channel habitat at lower flows. Several isolated features were identified throughout the study extent, including flowing channels, stagnant channels and pools, wetlands, and un-wetted areas within the low-lying floodplain. Some isolated features such as cut-off meander bends are naturally isolated, but many of the areas identified are disconnected from the main channel by infrastructure. Other areas have poor floodplain connectivity and hyporheic exchange with the channel due to incision and channel modification.

Encouraging reconnection of isolated features will increase habitat complexity by providing off-channel habitat and increased floodplain connectivity. Reconnecting these areas will provide additional juvenile carrying capacity and enhance water quality conditions in stagnant areas, particularly during late summer and early fall low flows.
Actions for reactivating disconnected habitat may include earthwork to establish hydraulic connections with the main channel and installation of LWD to provide cover or assist in keeping pathways to the main channel accessible. A perennial surface-water connection at the downstream end of off-channel features will help lessen the possibility of entrapment of fish.

**Side Channel Development**

Side channels provide preferred rearing habitat during low flows and provide hydraulic refuge and cover during high flows. Encouraging multiple flow paths will increase habitat complexity by diversifying the planform, dissipating stream energy, distributing sediment load, and providing hydraulic complexity. Diverse floodplain and side channel networks often have multiple flow paths at various elevations across the valley bottom. Therefore, different channels are accessed at different water surface elevations. In this manner, off-channel habitat is accessed in different areas of the channel network under changing flow regimes providing a multitude of habitat during a large range of flow conditions.

**Infrastructure Removal or Setback**

Tens of thousands of linear feet of levees, spoil piles, and armored banks confine the mainstem Tucannon River and prevent or limit floodplain connectivity. In these areas, infrastructure removal or setback may be used to increase the active floodplain area, thereby promoting floodplain and side channel connectivity, and allow for more natural channel migration and planform complexity. In many of the locations identified, widening the floodplain corridor may occur without significant changes to agricultural practice or other private land use.

Removing levees and promoting floodplain connectivity encourages geomorphic processes while dissipating velocities during high flows as floodwaters are distributed onto the floodplain. This also allows fine sediment to deposit on the floodplain, promoting ecological processes. Decreased channel velocities may also lessen erosive energy along the banks in areas of concern for landowners. Allowing the channel to migrate throughout a wider corridor will encourage development of complex channel and planform geometry, distributing energy and sediment load. It will be important to consider the reach-scale
effects of widening the floodplain, particularly at the downstream end of confined reaches. For example, an unconfined floodplain below a tightly confined section will likely result in a large amount of sediment deposition and channel migration.

**Develop Instream Habitat Complexity**

Instream habitat complexity is correlated to hydraulic complexity created by the channel geometry, bedforms such as gravel bars and pools, hardpoints such as bedrock, and perhaps most importantly to the presence of LWD. The primary biological function of LWD in rivers and streams is to provide complexity that creates hydraulic refuge and cover for adult and juvenile salmonids. Geomorphically, LWD also plays a major role in influencing the channel form.

In natural systems, riparian trees often enter a watercourse as the result of erosion, windfall, disease, beaver activity, or natural mortality. However, in most Pacific Northwest river systems, including the Tucannon River, LWD has been removed from the river channels and cleared from riparian areas. In addition, a significant quantity of natural LWD that would otherwise be recruited from riparian areas has been removed by logging and agricultural practices. Anthropogenic activities in the basin have been detrimental to the system, leading to a decrease in the number, size, and volume of LWD being introduced to the river through natural processes. Therefore, installing LWD is necessary to supplement existing conditions, recognizing that it will take decades of riparian planting and development to begin to provide natural replenishment rates.

In the long term, the added channel and bank roughness created by wood structures will help retain additional mobile wood and sediment, diversifying hydraulic and bedform complexity and contributing to increased floodplain connectivity and functionality of floodplain processes over time. For the Upper Tucannon River MSA, the SRSRP recommended at least one piece of LWD per channel width (2006). Supplementing existing rock structures such as weirs and barbs with LWD is also recommended to add instream complexity and to provide refuge for juvenile fish.
Large Woody Debris Placements

LWD placements that are suitable for placement in the Tucannon River include single-log placements or multiple-log assemblies with rootwads that are installed in the channel bed or bank to create beneficial fish habitat and desired geomorphic effects. These features emulate natural tree fall of mature riparian trees and provide a base for mobile wood to accumulate. In the Tucannon River, a variety of natural trees and log jams were observed, from small accumulations of mobile wood to large, channel-spanning log jams. In almost every location that LWD was observed, whether a single rootwad or a log jam, the feature forced a deep scour pool. In addition, the LWD observed in the Tucannon River was often consistent with the presence of a more complex channel network. The different types of engineered LWD placements have varying levels of design and construction effort and also range in magnitude of physical and biological benefit.

Engineered Log Jams

Engineered log jams (ELJs) are large wood structures that can be placed in the main channel that emulate naturally occurring, stable log jams. Historically, several log jams per mile were likely present in the main channel, but they have either been cleared or are no longer able to become established due to a lack of mature riparian trees being recruited to the system, particularly in reaches were the local riparian conditions are poor. ELJs are typically placed along the bank or mid-channel with the bottom of the structure at the anticipated scour depth and the top built to the approximate height of the 100-year flood water surface elevation. The structure is backfilled with streambed materials for stability, and a gravel bar deposit may be placed in the lee of the structure that emulates the natural sediment deposit that would occur in the lee of this type of structure.

ELJs can create large flow stagnation areas upstream and downstream of the structure and contain a substantial amount of void space within the logs and root masses, providing considerable area for fish refuge. During high flows, the rootwads interact with hydraulic forces from the river and scour large, deep pools that provide holding areas for adults while the void space within the face of the structure is used by juveniles. In addition, these structures are able to retain mobile wood debris. Because of the hydraulic conditions and
hard points created by ELJs, they may also be used as “deflectors” to influence flow direction to promote channel expansion or activation of side channels.

On a reach or subreach scale, installation of multiple ELJs can influence gravel movement and deposition to create localized pool-riffle sequences, increased hydraulic complexity, and a more stable channel profile. Sediment storage and deposition adjacent to the ELJs can create large gravel bars in the active channel allowing for colonization of riparian vegetation and eventually the development of forested islands. The overall roughening of the active channel and aggrading of the riverbed promotes rehabilitation of natural processes by increasing floodplain connectivity and promoting channel migration.

**Supplement Existing Rock Structures**

Rock structures such as rock weirs and barbs are located throughout the area of study. Rock weirs observed ranged from large structures with deep pools on the downstream side, to perpendicular boulders with a relatively low profile across the channel. Many of the existing rock barbs observed contained a rootwad log, and others were constructed of large angular rock with no cover. Supplementing existing rock structures with LWD is recommended to add complexity and cover to rock features. Although large rock weirs provide holding areas for adult salmonids, juveniles do not have adequate places to hide around these structures, which are typically located in straight and simplified reaches of the channel with little off-channel habitat availability. Addition of LWD to some weirs may also create better passage conditions for both juvenile and adult fish.

**Riparian Zone Enhancement**

Riparian habitat enhancement involves removal of undesirable vegetation and planting of native riparian communities on the channel banks, on higher elevation gravel bars, and in the floodplain. However, establishment of the ideal riparian buffer width may be limited by the location of agricultural fields, infrastructure, and the feasibility of irrigating and maintaining plantings. Riparian planting may also be conducted in conjunction with LWD structure placement, including ELJs. In areas such as highly incised reaches, the hyporheic connection to the riparian zone is poor and only sparse vegetation is able to grow. In these
areas, it may be more appropriate to conduct riparian planting efforts once better groundwater availability has been established.

The riparian zone provides several habitat and physical process benefits including increased bank and floodplain roughness, cover, and nutrients for instream species and wildlife. Increased roughness encourages sediment deposition and decreased channel and overbank velocities during floods. Additionally, fully developed mature riparian areas are a source of LWD to the river over time. Riparian restoration should begin with protection of existing healthy riparian areas through programs such as Conservation Reserve Enhancement Program (CREP). Where riparian habitat has been degraded, removal of invasive plants and vegetation and replacing with native species in appropriate environments should be performed. Monitoring and maintenance of plantings for at least the first few years after planting, which will greatly contribute to the success of the restoration effort, may be required for permitting approval. Eradication of invasive species will likely require a longer and more involved maintenance and monitoring effort.
APPENDIX B
PROJECT AREA FIGURES
Modify existing LWD rock barb and setback spoil berm, reconnect low area

Remove berm

Remove levee to create downstream connection to existing pond

Remove riprap and incorporate into structures (allow migration)

Incorporate left bank rock into LWD structures

Add LWD throughout Project Area 29 R.M. 20-18.6

NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND
- River Mile
- Wetted Channel Alignment (2010)
- Tributary
- Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Levee Setback
- Remove Road
- Protection Areas
- Approx. elevation of 5 year flood elevation
- Existing Levee or Spoil Pile
- Remove Infrastructure
- Dam
- Agricultural Feature (e.g. Pivot)
- Diversion (Intake/Return)
- Weir or Dam

Figure B-1
Project Area 29, River Mile 20.0 - 18.6
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board
Stabilize bars and promote recovery of riparian vegetation between R.M. 18.6-18.0

Set back levees to reconnect disconnected floodplain

Cattle fencing placement between R.M. 17.8-18.0

Remove rock

NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND

- River Mile
- Wetted Channel Alignment (2010)
- Tributary
- Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Levee Setback
- Remove Road
- Remove Infrastructure
- Project Area Extent
- Approx. elevation of 5 year flood elevation
- Existing Levee or Spoil Pile
- Agricultural Feature (e.g. Pivot)
- Diversion (Intake/Return)
- Weir or Dam

Figure B-2
Project Area 30, River Mile 18.6 - 17.6
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board
NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND

+ River Mile
+ Wetted Channel Alignment (2010)
+ Tributary
+ Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Levee Setback
- Removal of road
- Protection Areas
- Approx. elevation of 5 year flood elevation

Agricultural Feature (e.g. Pivot)
Diversion (Intake/Return)
Weir or Dam

Figure B-3A
Project Area 31, River Mile 17.6 - 16.1
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board
Add LWD between R.M. 16.5-16.1 to increase channel roughness

NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND
+ River Mile
- Wetted Channel Alignment (2010)
- Tributary
- Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Remove Road
- Levee Setback
- Project Area Extent
- Approx. elevation of 5 year flood elevation

- Existing Levee or Spoil Pile
- Remove Infrastructure
- Protection Areas
- Agricultural Feature (e.g. Pivot)
- Diversion (Intake/Return)
- Weir or Dam
Remove rock setback along toe of left terrace (edge of forested area)

Construct setback levee to promote connectivity and channel recovery

Setback levee

Protect recovering channel processes between R.M. 16.0-15.6

Roughen mainstem with LWD and promote split flow between R.M. 15.65-15.1

Excavate right bank flood channel through floodplain to ease confinement and remove rock

NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND
- River Mile
- Wetted Channel Alignment (2010)
- Tributary
- Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Levee Setback
- Remove Road
- Existing Levee or Spoil Pile
- Remove Infrastructure
- Protection Areas
- Agricultural Feature (e.g. Pivot)
- Diversion (Intake/Return)
- Weir or Dam
- Approx. elevation of 5 year flood elevation

Figure B-4
Project Area 32, River Mile 16.1 - 14.65
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board
Rock to remain

Remove levees to reconnect floodplain and promote migration

Add LWD to mainstem to add complexity in confined channel between R.M. 14.65-13.4

NOTES:
1. Aerial photo collected in 2010 provided by CCD.
2. Roads acquired from WA DNR.
3. Tributary alignments acquired from DOE.
4. Locations of mapped features are approximate.
5. This figure is to be used for conceptual purposes only.

LEGEND
- River Mile
- Wetted Channel Alignment (2010)
- Tributary
- Reconnected Side Channel
- LWD
- Paved Road
- Unpaved Road
- New Bridge
- Remove Road
- Levee Setback
- Protection Areas
- Approx. elevation of 5 year flood elevation
- Existing Levee or Spoil Pile
- Remove Infrastructure
- Agricultural Feature (e.g. Pivot)
- Diversion (Intake/Return)
- Weir or Dam

Figure B-5
Project Area 33, River Mile 14.65 - 13.4
Conceptual Restoration Plan, Reach 5 Tucannon River RM 13.4 to 20
Snake River Salmon Recovery Board