GRAYS RIVER
HABITAT RESTORATION TECHNICAL REPORT

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EXECUTIVE SUMMARY

The Grays River is one of seventeen major tributaries to the Lower Columbia River in Southwestern Washington. This watershed historically supported significant populations of several salmon species including: fall Chinook, chum, and coho salmon, winter steelhead and sea-run cutthroat trout. The Grays River is one of only two watersheds where Columbia River chum still spawn in significant numbers. The Grays watershed is critically important to the regional recovery of listed salmon and steelhead. This restoration and project identification study was undertaken with the goal to recover and restore essential salmon and steelhead habitat and to help bring the salmon and steelhead populations in the Grays River Basin to a high level of viability.

The objectives of this study were to identify, evaluate, and provide conceptual level designs for representative habitat restoration projects at high priority locations in the lower Grays River, its floodplain, and portions of key tributaries. These conceptual-level projects were specifically developed to directly address limiting factors and high priority restoration needs identified in the Lower Columbia River Salmon Recovery Plan and Fish and Wildlife Subbasin Plan (LCFRB 2004).

This document is intended to be a tool for project sponsors and willing landowners to use to develop and implement habitat restoration projects in the lower Grays River watershed. Participation in habitat restoration projects is entirely voluntary. No projects can or will be done without a willing landowner. The projects identified in this study are conceptual and must have further engineering analysis and design to evaluate effects on neighboring properties, reach-level conditions, and watershed processes.

The approach used is to build on the previous work conducted by the LCFRB and others in the basin and use that information to document in more detail the restoration needs and opportunities by reaches; identify specific habitat restoration project sites; prioritize the projects based on biological benefits, and then provide conceptual designs and cost estimates for representative types of projects.

This technical report presents the results of this study which identified a total of 63 potential habitat restoration projects. These include: riparian restoration, side channel restoration, floodplain restoration, in-channel enhancement, groundwater fed channels, and the use of wood or other in-stream structures to trap and store sediment upstream of the primary study area. This report does not address actions to restore upland and hillslope processes in the upper watershed, which was beyond the scope of this study. Twenty-eight projects are considered high priority due to their location in high priority reaches, and they address key limiting factors in the basin, and are listed below. Conceptual designs have been prepared for the projects highlighted in yellow.

Table ES-1. High Priority Potential Restoration Projects in the Grays River basin.

Project ID	Project Name	Pop/ Reach Score	PAR Score	Total Benefit Score	Preliminary Cost
14.0B	In-channel enhancement	21	42.00	63.00	$1,600,000
15.0B	In-channel enhancement	21	30.00	51.00	$1,200,000
13.5R	Side channel and floodplain restoration	21	26.04	47.04	$500,000
14.0L	In-channel enhancement	21	24.00	45.00	$750,000
10.5B	Side channel and floodplain restoration	22	22.50	44.50	$300,000
12.5L	In-channel enhancement	21	18.00	39.00	$600,000
SF1	In-channel enhancement	6	30.00	36.00	$1,100,000
CJ2	Groundwater channel	14	20.00	34.00	$250,000
11.8R	Groundwater channel	21	12.02	33.02	$400,000
F2	Riparian restoration	15	15.00	30.00	$125,000
SF2	In-channel enhancement	6	24.00	30.00	$900,000
11.0R	Side channel and floodplain restoration	22	7.50	29.50	$85,000
CJ1	In-channel enhancement	14	15.00	29.00	$200,000
11.5T	Tributary enhancement	9	18	27.00	$225,000
14.0R	Groundwater channel	21	6.00	27.00	$250,000
12.0L	Floodplain restoration	21	6.00	27.00	$750,000
12.0R	Floodplain restoration	21	4.80	25.80	$700,000
15.0L	Connection to wetland	21	4.50	25.50	$250,000
11.2L	Riparian restoration	22	3.02	25.02	$35,000
10.5C	In-channel enhancement	22	3.00	25.00	$225,000
F1	Floodplain restoration	15	9.00	24.00	$80,000
18.0B	In-channel enhancement	6	18.00	24.00	$600,000
12.6R	Reconnect off-channel ponds	21	2.70	23.70	$150,000
10.1L	In-channel enhancement	22	1.50	23.50	$75,000
13.5L	In-channel enhancement	21	1.50	22.50	$100,000
12.3C	In-channel enhancement	21	0.30	21.30	$100,000
SF3	In-channel enhancement	6	15.00	21.00	$300,000
SF4	In-channel enhancement	6	12.00	18.00	$250,000

The high priority projects identified above can provide significant short-term and long term benefits to fish and wildlife in the basin by helping to reduce the rate of transport of sediment, providing in-channel cover and habitat diversity, restoring riparian areas, and providing off-channel and side channel habitats. The restoration of riparian habitats, placement of in-channel wood and floodplain connections will all contribute to the restoration of natural hydrologic and sediment transport processes. Habitat projects can provide incremental benefits to the on-going flooding and sediment issues in the watershed.

A key theme throughout this study is that perhaps the most important issue in the Grays River watershed is the sediment supply and transport in the watershed. Large volumes of sediment are being transported via the river system from the upper watershed to the lower river and this sediment is filling in pools and side channels, and causing channel instability, bank erosion, and increased flooding. This situation is not desirable for either salmon or people. The community is

very concerned about the on-going effects of flooding, channel instability, and heavy sediment loads on their properties. They would like to see action taken to address flooding. Some community members have expressed their concern that this document is too salmon-centric, while other community members support efforts to recover salmon and steelhead populations in the Grays River watershed.

The projects described in this document are intended to begin to address the sediment issues by helping to trap sediment as far up in the watershed as possible. But, without significant actions to reduce erosion on the hillslopes of the upper watershed[1], the sediment will continue to be delivered to the river system for a decade or longer (May & Geist 2007). Thus, in the overall implementation of projects in the basin, it is generally preferable to start as far up in the watershed as possible and work downstream. Riparian restoration is beneficial wherever it occurs in the watershed to provide shading, cover, wildlife migratory corridors, and long-term bank stabilization and wood recruitment. Riparian restoration should be implemented as soon as feasible because it will take more than a decade to achieve the benefits which it will then provide over the long-term. Projects other than riparian restoration, implemented downstream of SR-4 in the near-term would need to be carefully designed to function with the on-going transport and deposition of sediment.

In conclusion, this document is not a regulatory document and none of the potential projects identified herein are required to be implemented. Projects will only be implemented with a willing landowner. However, these potential projects can provide significant benefits to fish and wildlife in the basin and taken together, will significantly contribute to the restoration of salmon habitat and the improved viability of salmon in the basin, concurrent with actions to reduce the long- term input of sediment from the upper watershed.

[1] Hillslope actions could include reforestation with longer harvest rotations, minimizing future cutting on landslide-prone slopes, maintenance of wide buffers near landslide-prone slopes, terracing and soil treatments to reduce erosion, etc.

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SUMMARY OF CHANGES

The Lower Columbia Fish Recovery Board has been addressed by several stakeholders and interested parties with concerns and comments about the draft Grays River Community Habitat Restoration Plan. In response to these concerns and to public comments, the draft plan has been renamed the Grays River Habitat Restoration Technical Report and revised to incorporate and stress the following points:

- The primary goal of habitat projects is to assist in recovering ESA-listed salmon and steelhead. The Board recognizes that such efforts must also work for the people. While a project can be designed to address landowner needs to some degree, the project's primary purpose and value must be habitat restoration.

- The LCFRB remains interested in working with willing landowners to develop, fund, and implement habitat projects. Habitat restoration efforts can and will only be undertaken with willing landowners. Many community members support efforts to recover salmon and steelhead populations in the Grays River. However, while some community members have expressed an interest in doing habitat projects on their property, most are not interested or are concerned over the impact projects may have on their property. A majority of community members do not believe that project sponsors have been responsive to their interests and concerns.

- Community members are concerned about the impact flooding, channel instability, and heavy sediment loads have on their property and community. They want to see action to address flooding. Flooding and sediment problems, however, are results of widespread watershed conditions. Habitat restoration efforts can help to address flooding and channel instability problems, but cannot in themselves solve these problems. Habitat projects can help stabilize channels, and trap sediment and woody debris in areas that will help reduce property impacts.

- The habitat restoration technical report identifies project opportunities and ideas. The project opportunities currently identified are based on biological and habitat considerations. The project opportunities are conceptual. Sponsors and landowners may use these concepts, modify them, or develop new approaches that they believe will be more beneficial in achieving habitat improvements and in meeting landowner interests.

- Habitat projects must be appropriately designed and engineered to address biological and habitat needs, reach-level conditions, watershed processes, and landowner concerns. Habitat projects shall be designed to avoid adverse affects on neighboring properties upstream and downstream. Project sponsors shall consult with neighboring property owners in designing and implementing projects.

- Greater emphasis has been placed biological and habitat objectives for each project opportunity rather than specific methods or approaches. This is intended to allow sponsors and landowners to develop the most appropriate approach to achieve the habitat objectives and address landowner concerns.

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1. Introduction

1.1 Study Background

The Grays River is one of seventeen major tributaries to the Lower Columbia River in Southwestern Washington. This watershed historically supported significant populations of several salmon species including: fall Chinook, chum, and coho salmon, winter steelhead and sea-run cutthroat trout. These salmon populations have declined dramatically in this watershed and the Columbia Basin in general. As a result, several species of salmonids in the Columbia Basin were listed under the Endangered Species Act (ESA) beginning in 1999, including Lower Columbia River Chinook, coho, and steelhead, and Columbia River chum (all listed as Threatened).

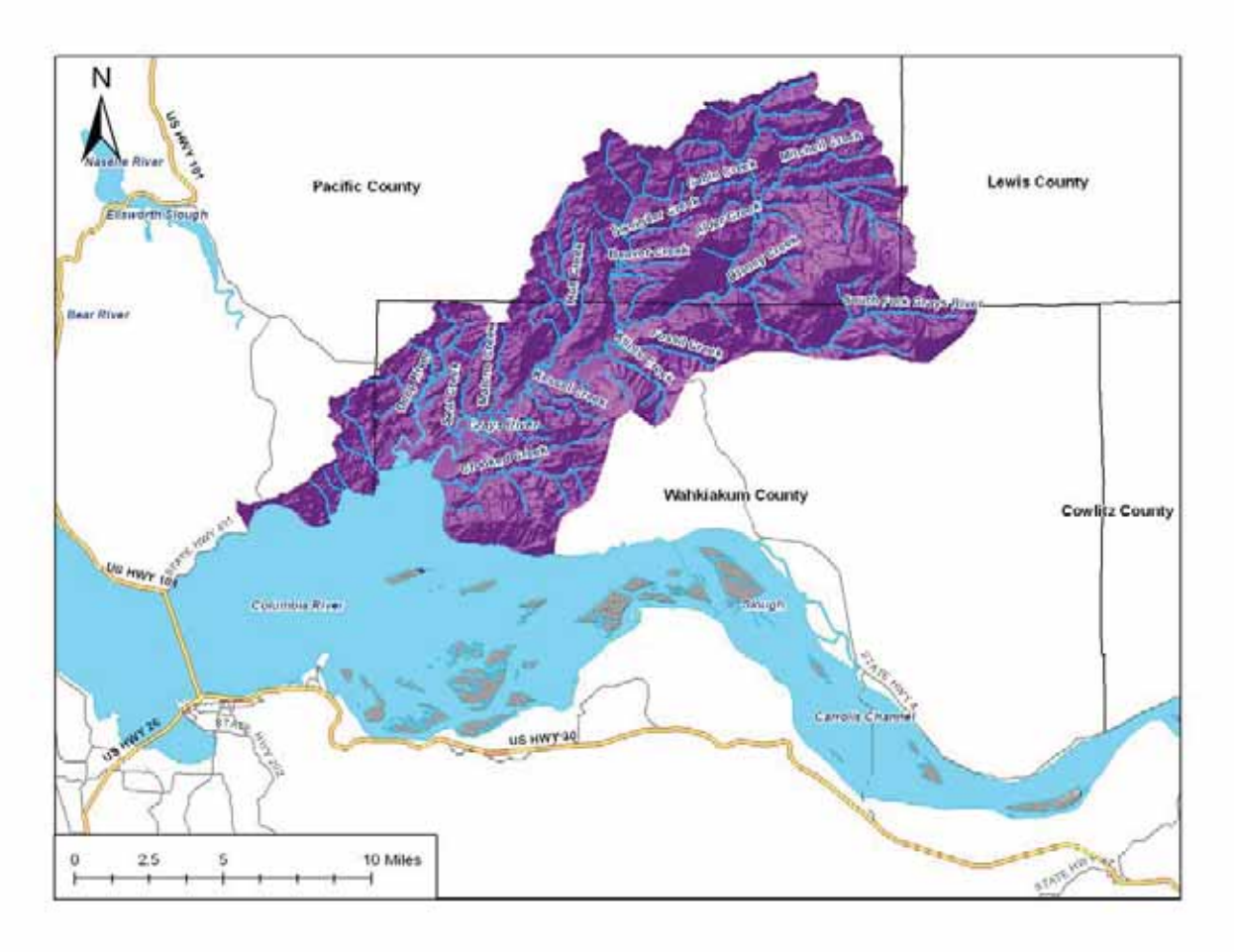

Figure 1. Grays River Watershed Vicinity Map.

The Lower Columbia Fish Recovery Board (LCFRB) and its partners and stakeholders in the Lower Columbia region developed a Salmon Recovery Plan and Subbasin Fish and Wildlife Plan (hereafter called Recovery Plan) in 2004 (LCFRB 2004). The Recovery Plan included a technical

assessment of conditions in each watershed within the overall Lower Columbia subbasin, an inventory of current and past efforts at habitat protection and restoration, and a management plan with objectives and strategies for future actions to protect and recover fish and wildlife populations and their ecosystems. The Recovery Plan was adopted by NOAA Fisheries as an Interim Regional Recovery Plan in February 2006. The Recovery Plan and Six-Year Habitat Work Schedule developed by the LCFRB (LCFRB 2004 and 2008) identified a number of prioritized measures for the Grays River watershed, listed below in order of importance.

1. Protect stream corridor structure and function
2. Protect hillslope processes
3. Restore degraded hillslope processes on forest and agricultural lands with an emphasis on sediment supply conditions
4. Restore floodplain function and channel migration processes in lowland agricultural areas
5. Restore riparian conditions throughout the basin
6. Restore degraded water quality with an emphasis on temperature impairments
7. Create/restore off-channel and side channel habitat
8. Restore channel structure and stability
9. Provide for adequate instream flow during critical periods
10. Restore access to habitat blocked by artificial barriers

These measures provide a solid foundation to move forward to the more detailed planning, identification and development of site-specific plans for habitat restoration that will contribute to the recovery of salmon in the subbasin, which is the purpose of this study. In addition, a more detailed watershed assessment was completed for the Grays River by May and Geist (2007) to compare historic and current watershed conditions and document the loss of habitats that have led to the decline of chum and Chinook in the watershed. May and Geist (2007) also identified overall restoration needs and opportunities, which further provided the basis for the development of this report to identify and develop site-specific restoration plans for the lower Grays River area.

1.2 Implementation of this Technical Report

This report has been developed to provide guidance to project proponents and landowners on opportunities for habitat restoration in the lower Grays River area. It is ***not*** a regulatory document; this report and the potential projects within it are not required or mandatory. The primary goal of the habitat projects identified herein is to assist in the recovery of ESA-listed salmon and steelhead. Flooding and sediment problems are recognized as very serious issues in the Grays watershed, which are the result of historic and on-going watershed activities and land uses. Habitat restoration projects can help to address flooding and channel instability problems, but cannot in themselves solve these problems. Habitat projects can help stabilize channels and trap sediment and woody debris in areas that will help reduce property impacts.

The implementation of any projects identified herein, relies entirely on the willing cooperation of landowners, whether public or private. Habitat restoration efforts can ***only*** be undertaken on properties with willing landowners. Project proponents can be individual landowners, non-profit

groups, local community organizations, or other interested parties that partner with a landowner. The LCFRB is interested in working with willing landowners and project proponents to develop, fund, and implement habitat projects that will contribute to the overall recovery of salmon in the watershed and the broader Columbia basin.

The project opportunities and ideas described in this document have been identified for the purpose of habitat restoration and biological benefits, based on the best available existing information and the experience and best professional judgment of the authors. This document is a tool that project sponsors and willing landowners can use to further develop and then implement projects. The LCFRB and its Technical Advisory Committee (TAC) can use this document to evaluate project proposals. However, it is recognized that additional data collection, analysis, and engineering is required before any of these projects can be implemented.

Over the course of developing this report the LCFRB has held public meetings as an opportunity to hear community comments and concerns. Many community members support efforts to recover salmon and steelhead populations in the Grays River. However, concerns have been voiced over the effects of flooding, channel stability, and heavy sediment loads on private property and the community. The community is very interested in seeing actions taken to address flooding. While some community members have expressed an interest in doing habitat projects on their property, others are not interested or are concerned over the impact that projects on neighboring properties might have on their property. A number of community members also believe that sponsors of past projects have not been responsive to their interests or concerns. Some community members have also expressed their concern that the projects identified in this document are too "salmon-centric."

The LCFRB recognizes that in order for habitat restoration projects to work for fish, they must also work for people. The projects described in this document are intended to provide fish and wildlife habitat benefits within the context of a watershed with a diverse set of problems and needs. All projects identified in this document are currently conceptual. Sponsors and landowners can use these concepts, modify them, or develop new approaches that they believe will be more beneficial in achieving habitat improvements and meeting landowner interests. All projects identified in this document will require further engineering analysis and design to address biological and habitat needs, reach-level conditions, watershed processes, and landowner concerns, prior to actual implementation. Any habitat project should be designed to avoid adverse effects on neighboring properties whether upstream or downstream. Project sponsors must consult with neighboring property owners and appropriate federal, state, and local agencies in designing and implementing projects.

1.3 Study Approach

This report documents the results of a study intended to identify, evaluate, and develop conceptual level designs for representative restoration projects at high priority locations in the lower Grays River, its floodplain, and portions of key tributaries. These projects were specifically identified and conceptualized to directly address the high priority restoration measures listed above (LCFRB 2008) and the habitat restoration needs, particularly in reference to sediment conditions, identified by May and Geist (2007). The approach used in this study is to

build on the previous work and to document restoration opportunities and constraints by reaches; identify specific project sites where it is appropriate to consider restoration actions; prioritize the projects based on biological benefits, as well as cost and engineering feasibility factors; and then provide conceptual designs and cost estimates for representative projects. The conceptual designs and cost estimates can be used as the basis for future grant applications and actions by the LCFRB and other project proponents in the watershed.

A voluntary Working Group was involved in the development of this report, including representatives from Washington Department of Fish and Wildlife (WDFW), U.S. Army Corps of Engineers (Corps), National Marine Fisheries Service (NMFS), Lower Columbia Fish Enhancement Group (LCFEG), LCFRB, Cowlitz Indian Tribe, interested landowners, and technical consultants. The Working Group provided comments on various aspects of this study.

2. Existing Conditions

2.1 Grays River Watershed Conditions

The following watershed description for the Grays River is summarized from the description provided in May and Geist (2007) and a review of current and historic aerial photos (1939, 1966, 2006), unless otherwise referenced. The Grays River is located in the southwestern Coast Range (Willapa Hills) and the lower Columbia River estuary and floodplain in Washington State.

For the purposes of this study, the lower Grays River is defined as the river from the confluence with the Columbia River upstream to the confluence with the South Fork Grays River at approximately river mile (RM) 18. The upper Grays River extends from the South Fork confluence upstream to the headwaters. The named tributaries to the lower Grays River study area are Seal Slough/Seal Creek, Impie, Nikka, Thadbar, Kessel, Hull, King, Klints, Fossil, and Crazy Johnson Creeks and the West Fork Grays River. The Grays River enters the Columbia River at Grays Bay, approximately RM 21. See **Figure 2** for study area map.

Approximately 95% of the Grays River watershed is commercial timberlands (primarily privately owned) in various seral stages, with the remaining 5% a mix of agricultural and residential. Land uses have changed the quantity and quality of both aquatic and terrestrial habitats. The conversion of old-growth forest to various seral stages has modified the hydrology of the watershed; although the effects were most pronounced during periods of intense harvesting (1970s) and the watershed has largely recovered to a natural hydrology (May and Geist 2007). The river is tidally influenced up to approximately RM 10.

2.1.1 Geology and Geomorphology

The Grays River arises from the Willapa Hills in southwestern Washington. The headwaters and tributaries in the upper basin are all generally less than 3000 feet. The Coast Range/Willapa Hills are comprised of both volcanic and sedimentary rocks. Eocene age siltstone and sandstones are intermixed with volcanic basalts. Later Miocene basalt flows occurred in many locations and are generally classified with the Columbia River Basalts. The Pleistocene was generally a period of erosion and slow uplift of the Coast Range (Franklin & Dyrness 1988). Soils derived from the sedimentary rocks are typically unstable and include stony loams, sands, and silty clays.

Herrera (2005) conducted a geomorphic assessment of the upper Grays River watershed that was incorporated into the May and Geist (2007) assessment. The hillslopes in the upper watershed have soils derived either from marine sediments or volcanic basalts. Approximately 37% of the watershed has high soil erosion potential due to steep slopes and poorly indurated (hardened) highly weathered bedrock. Extensive timber harvesting has occurred throughout the watershed over the past several decades, with the most intense and widespread harvesting occurring in the 1960s and 1970s.

Numerous landslides (216 landslides documented on historical photographs) have occurred in the upper watershed on logged areas and associated with roads. Herrera (2005; cited in May and Geist 2007) estimated sediment yields for the basin from documented landslides on aerial photos

from 1970, 1996, and 2003 (**Table 1**). They also estimated that the lag time between timber harvest and landslides was approximately 10 years after harvest and predict that the sediment from landslides will be delivered to the stream channel network 10-30 years after timber harvest. This would result in a maximum delivery of sediment to the stream channel network from the 1970s through present time.

Table 1. Historical Sediment Yield to the Upper Grays Watershed from Landslides.

Aerial Photo Date	*Sediment Yield (tons/year)*
1970	209,000
1996	221,000
2003	238,000

Source: Herrera (2005); Sediment yield for 1970 was extrapolated based on aerial coverage of 76% of the watershed.

Comparing the current sediment yield to the long-term background sediment yield for natural vegetation conditions indicates that the current sediment yield is approximately an order of magnitude greater than the background sediment yield (Table 2).

Table 2. Average Sediment Yield in the Upper Grays River Watershed under Current Conditions and Long-term Background Conditions.

Sediment Source	*Sediment Yield (tons/km^2/year)*
2003 Mass wasting	1032
2003 Roads	41
2003 Soil creep	26
2003 Total	1099
Long-term Background (range)	56-125

Source: Herrera (2005)

The geomorphology of a watershed is a function of its underlying geology, vegetation characteristics, climate, and hydrologic regime. In the Grays River watershed, the steep and erodable hillslopes in the upper watershed provide a significant input of sediment into the stream channel network, which can be readily carried out of the upper watershed (supply reaches) into lower gradient response reaches where sediment deposition occurs. When the watershed was in an old-growth condition, the forested conditions limited the sediment delivery to the channels and the presence of large wood in the streams reduced the transport capacity of the source reaches.

Response reaches of the Grays River and its tributaries tend to have gradients of less than 3% and alluvial valley fills. These reaches were historically characterized by migrating and anabranching channels with high wood loading. Multiple channels were noted in historic Government Land Office (GLO) mapping notes, in the vicinity of the West Fork Grays confluence and on downstream (May and Geist 2007). Historic land use practices including splash damming, channelization and riparian deforestation all resulted in the removal of large quantities of wood and sediment stored in the channels and floodplains of the upper watershed. These actions increased the extent of channel confinement and decreased channel roughness which together increased flood peaks and sediment transport capacity. This resulted in more erosive conditions that further contributed to the sediment being delivered to the Lower Grays River valley. The natural morphology of the lower Grays River was a meandering and

anabranching riffle-pool channel with a wide floodplain and with likely significant quantities of in-stream wood all the way to the confluence with the Columbia River. The channel was characterized as navigable all the way up to the Gorley area in the GLO survey notes (May and Geist 2007), which would indicate that the channels were perhaps narrower and deeper than currently occurs. Such conditions would reflect a well forested floodplain with stable river banks and a relatively small upstream sediment supply which the river was capable of transporting (per the lack of bars and shoals). Bed sediment would have graded from cobble and gravel upstream of the West Fork Grays to sands and silts in the tidal zone.

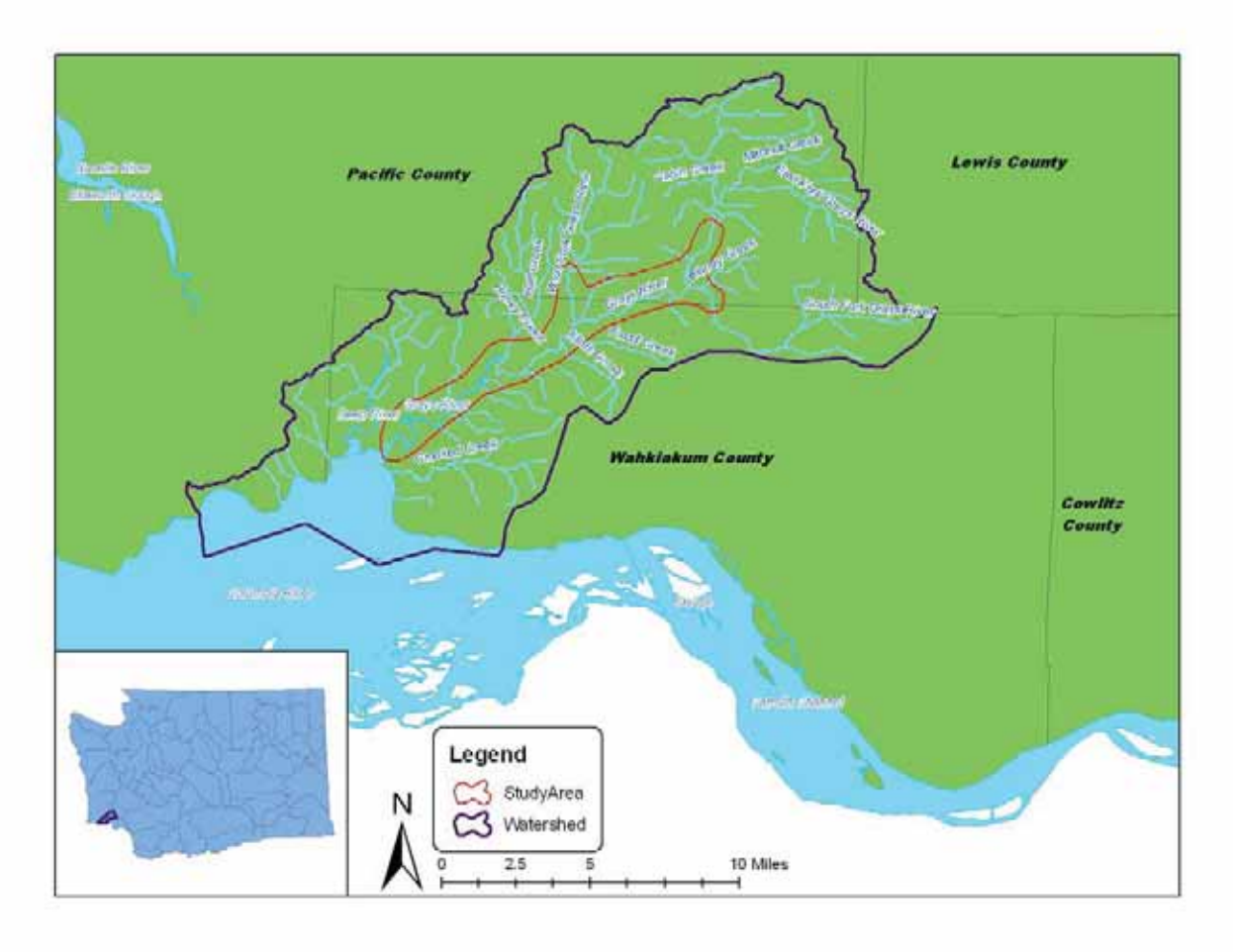

Figure 2. Grays River Study Area.

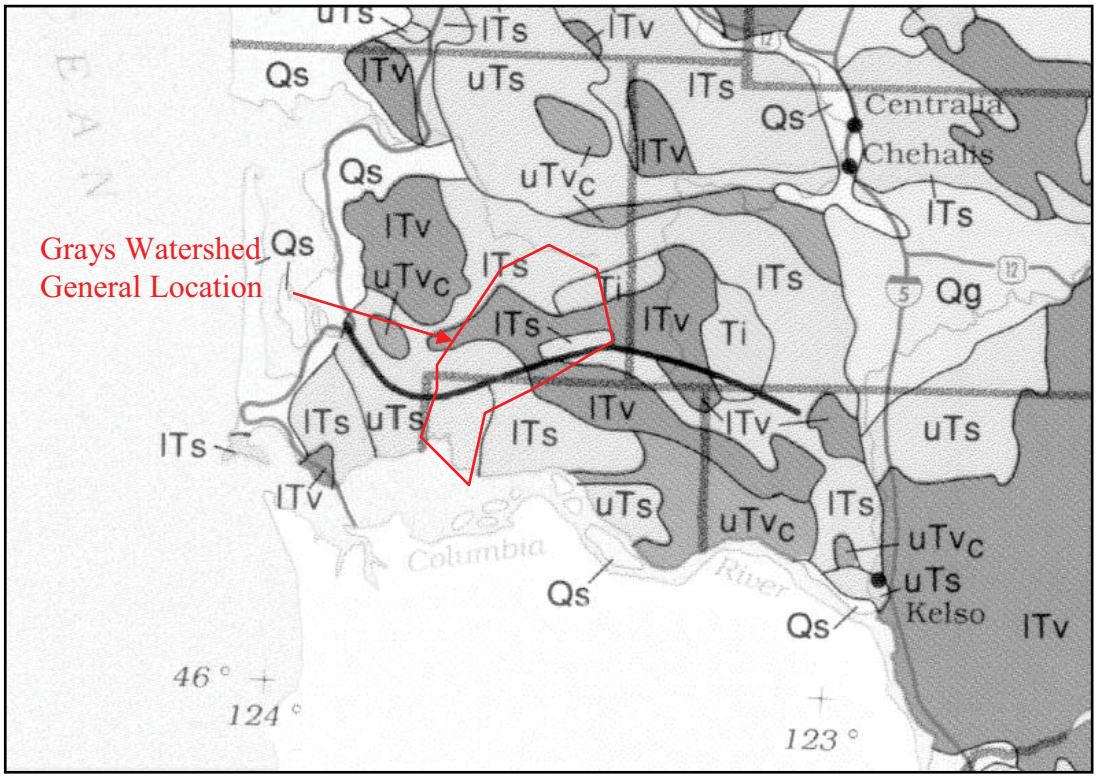

Figure 3. Geologic Map of Southwest Washington Area *(lTs = Lower Tertiary Sedimentary; lTv = Lower Tertiary Volcanic; Ti = Tertiary Intrusive Igneous)*.

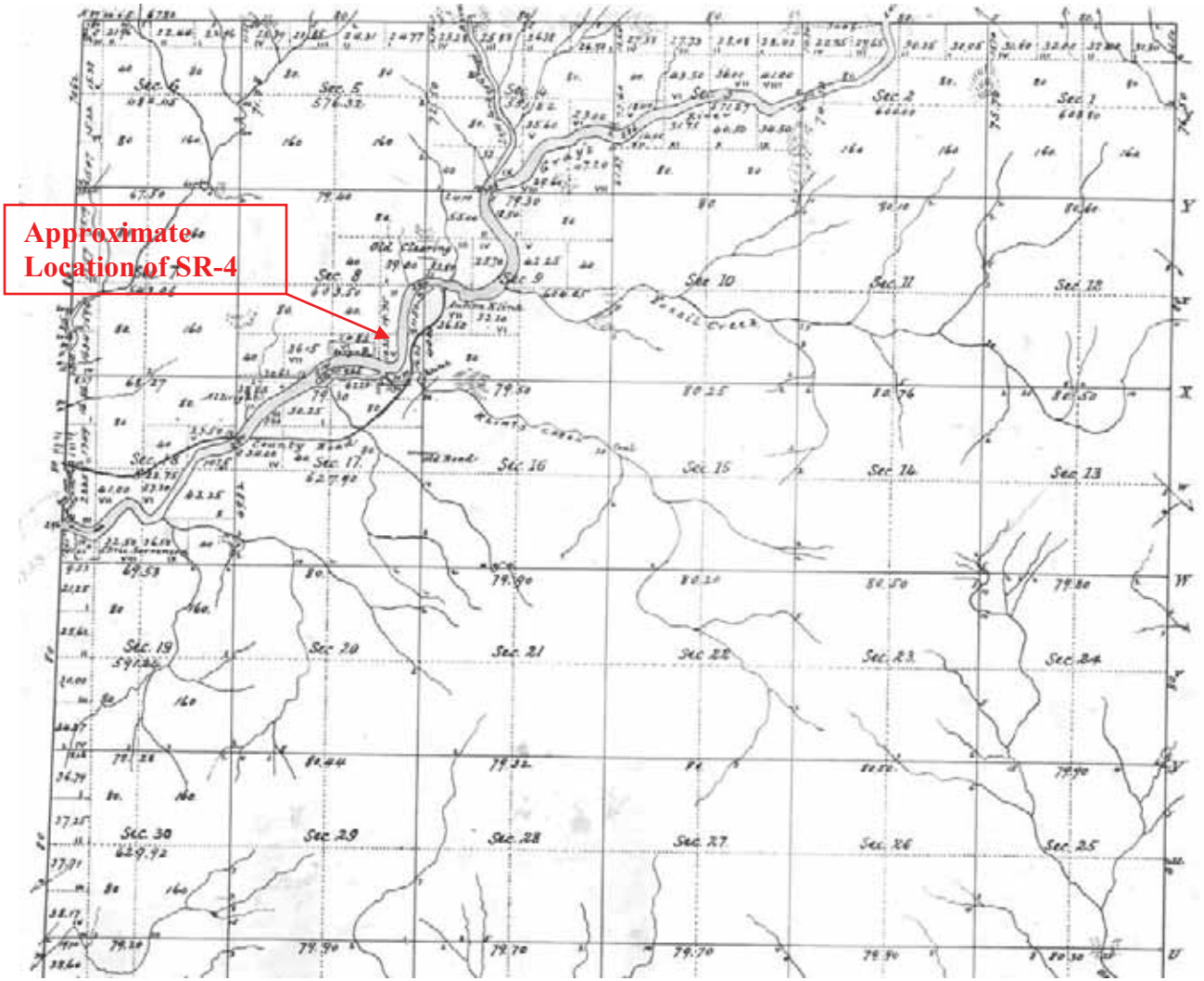

Figure 4. 1884 GLO Map for Upper Study Area (BLM 2008).

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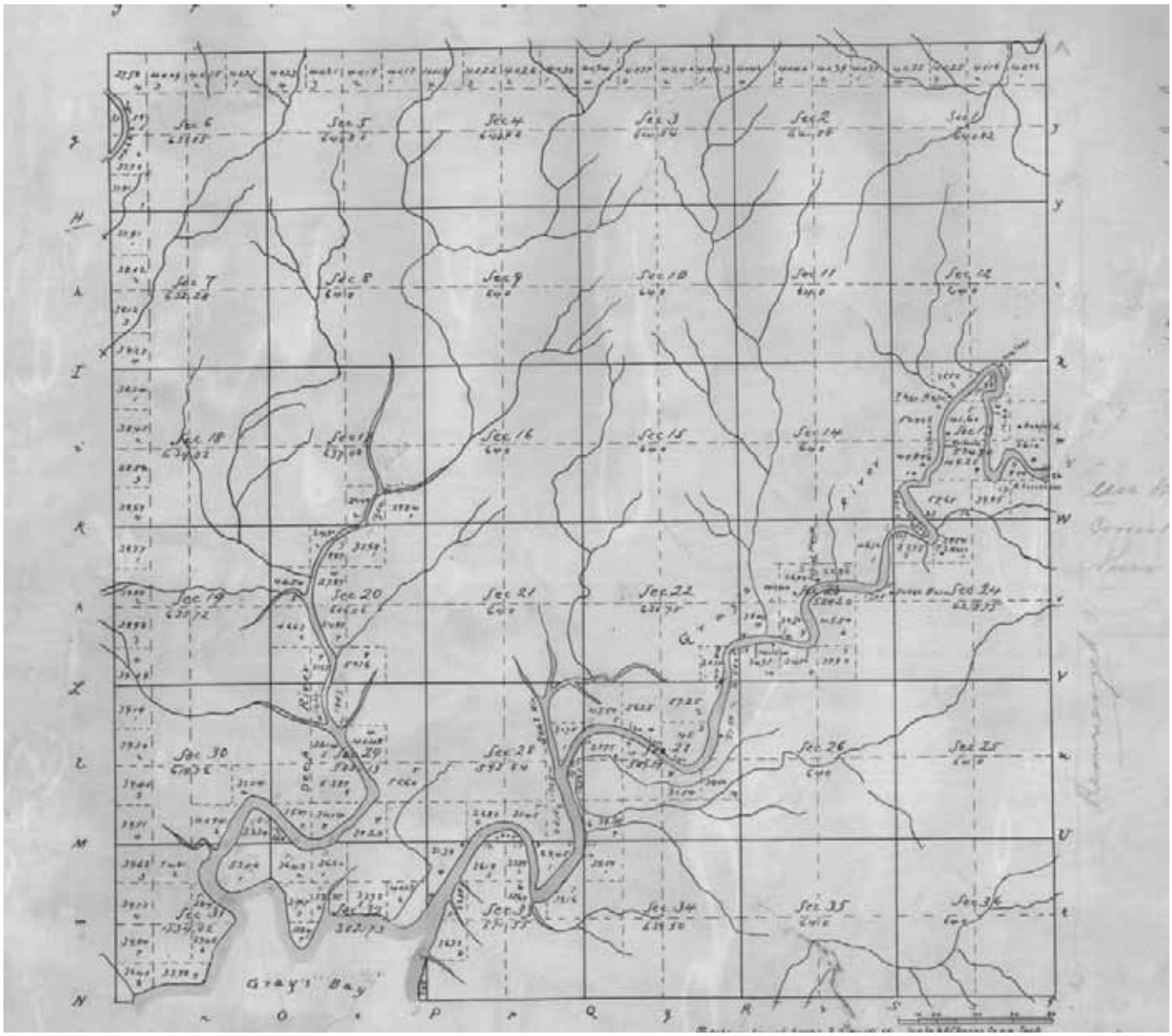

Figure 5. 1884 GLO Map of Lower Study Area (BLM 2008).

Currently, most of the watershed is in an early seral condition characterized by small trees that don't provide functional wood to the channel network (unstable wood that is easily transported downstream and is generally incapable of altering hydraulics or trapping sediment). Any legacy remnants of functional old-growth wood formerly in the channel were cleared or removed in splash damming. The result is a channel network with sparse accumulations of smaller-sized wood that easily transports downstream and limited potential to retain that wood. The loss of wood debris in the channel coupled with the increase in sediment supply has caused a significant increase in sediment delivered downstream of the canyon to the lower river. The dramatic volumes of sediment now being transported into the lower river are a major cause of problems for valley residents (via flooding and bank erosion) and for salmonids (lack of channel stability).

The change in vegetated conditions of the floodplain below the canyon to agricultural uses has removed the stabilizing nature of the historic Sitka spruce and deciduous riparian species, thus making it easier for the channel to migrate in response to sediment deposition and peak flow events. The channel in the lower river is also tending to widen out and become shallower as a result of increased sediment delivery, potentially contributing to water quality issues such as higher temperatures. The magnitude of channel migration has been constrained by historic bank revetments in the lower river which have also precluded the development of valuable habitat formed by side channels and abandoned oxbows that result from periodic channel migration. The natural riffle-pool morphology has largely been filled in by sediment deposition and converted to an unstable riffle or plane-bed dominated channel with infrequent scour pools associated with banks and artificial structures. The riffles scour frequently and the pools fill in with sediment. Only in areas with unique geologic features that cause scour (such as Maki Point adjacent to a diked right bank) do pools persist.

2.1.2 Hydrology

The Grays River watershed has a west coast marine climate with generally dry summers and mild, wet winters. The watershed is generally rain dominant, with only the highest points in the watershed above 2500 feet elevation susceptible to rain on snow events. Mean precipitation averaged over the entire watershed is approximately 88 inches per year (Wade 2002). The typical annual average varies from 80-100 inches per year in the lower portions of the watershed to 120-140 inches per year at the highest elevations (**Figure 6**). Precipitation records kept by WDFW at the Grays River Salmon Hatchery show an annual range in precipitation from 75 to 140 inches since 1962 (WDFW data cited in May and Geist 2007). Rainfall intensity is high, ranging from 8-10 inches per 24-hour period in much of the watershed, up to 10-12 inches per 24-hour period at the highest elevations for the 100-year storm event (OSU 2000).

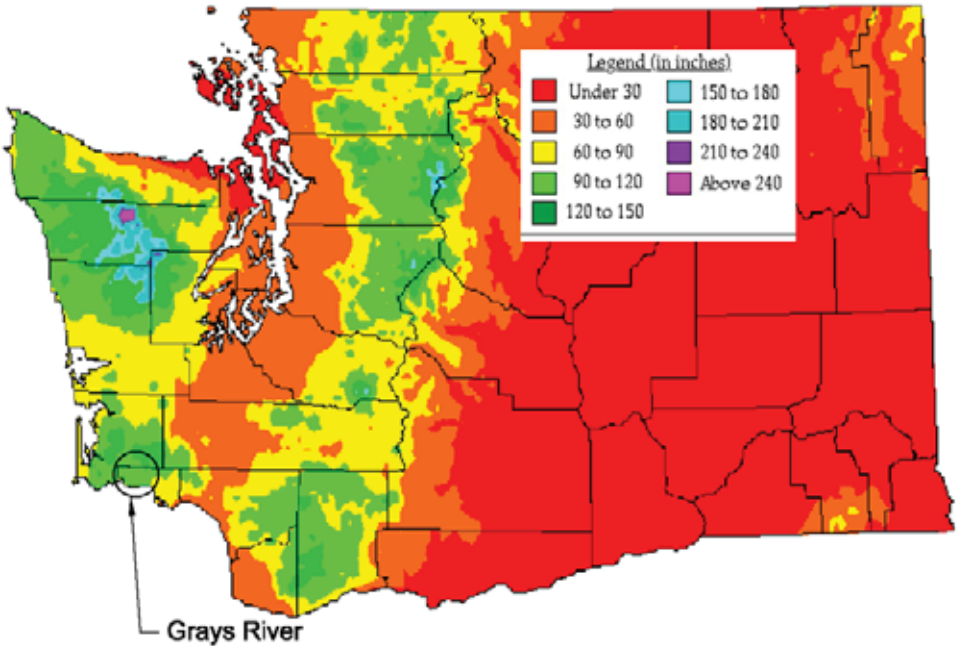

Figure 6. **Mean Annual Precipitation for Western Washington** (OSU 2000).

Using data from a rain gage in Cathlamet, Washington, just east of the Grays River watershed, the annual precipitation totals were plotted as shown in **Figure 7**. Cathlamet is located on the Columbia River and its annual rainfall totals generally fit within the range shown in **Figure 6**. **Figure 8** illustrates the daily average rainfall total for the Cathlamet site, as well as the cumulative average rainfall. The data is shown in relation to the water year, October 1 through September 30. As expected the heaviest average rainfall occurs in the winter months from November through February.

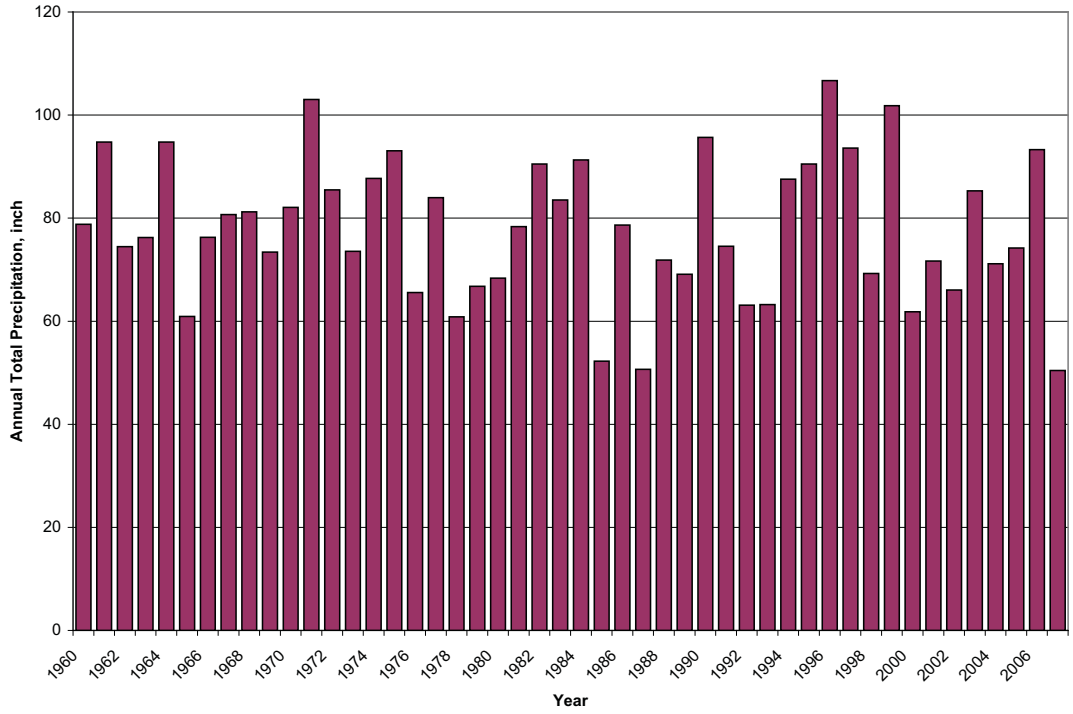

Figure 7. Annual Precipitation Total at Cathlamet, Washington

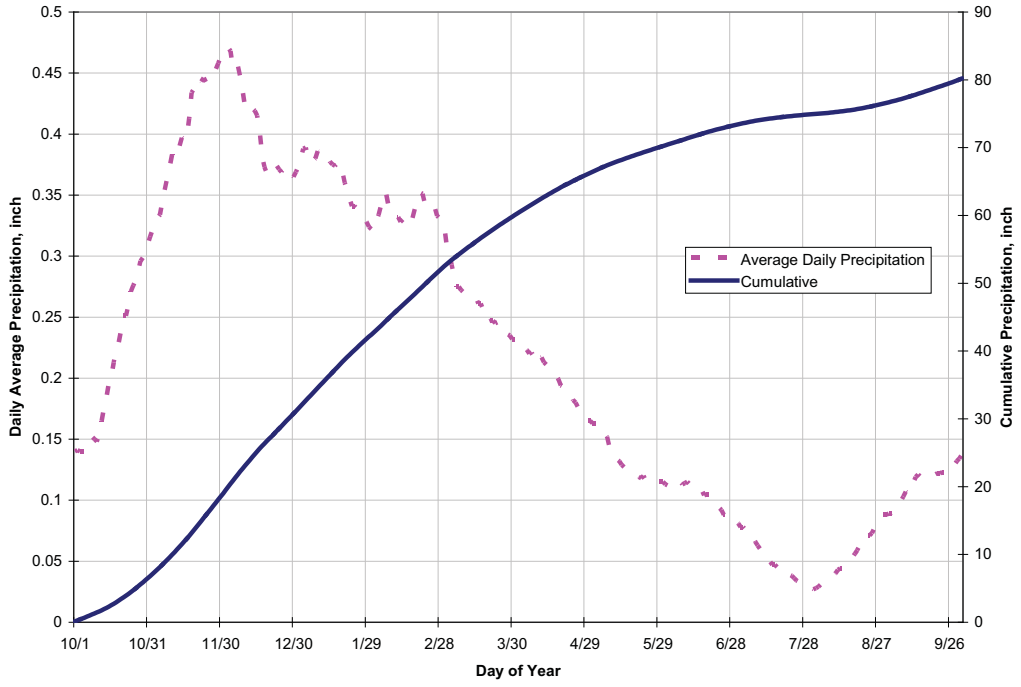

Figure 8. Average Daily and Cumulative Precipitation at Cathlamet, Washington (1971-2000)

Evapotranspiration (ET) - Along with precipitation, evapotranspiration is a major component in the hydrologic budget. Evapotranspiration is the combined process of evaporation from open bodies of water, wetlands, snow cover, and bare soil and the process of transpiration via vegetation. In the coterminous United States, evapotranspiration averages about 67% of the average annual precipitation and ranges from 40% of the precipitation in the Northwest and Northeast to about 100% of the precipitation in the Southwest.

Figure 9 illustrates the annual ET totals for the town of Vernonia, Oregon. This location is the closest available source of ET data, approximately 60 miles south of the Grays River watershed. Based on the data presented in **Figure 7** and **Table 3**, the ET values shown in **Figure 9** fit within the accepted range (40% of annual rainfall) for the Northwest geographic region.

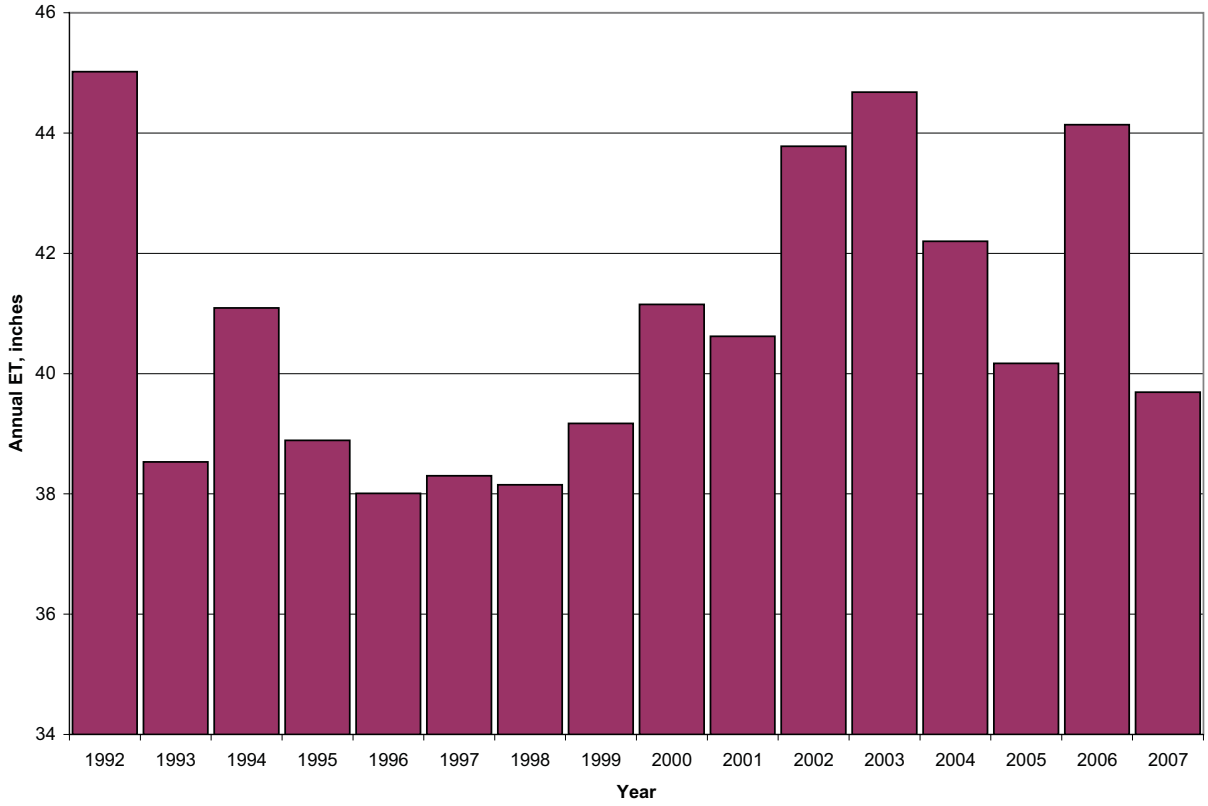

Figure 9. Annual Evapotranspiration at Vernonia, Oregon

Stream flow - The Grays River does not currently have an active river gage measuring stream flows. Historically the USGS has operated gages on the Grays River near the confluence of the South Fork Grays River and also farther downstream. The last recorded stream data was in 1979. Because no recent stream flow data is available for use in directly estimating the flows associated with high flow event, the USGS StreamStat online program was used. This program uses gage analysis and regression equations to estimate peak flow on ungaged rivers.

Figure 10 illustrates the Gray River watershed delineated at SR-4 within the webpage interface; the drainage area is 88 square miles. Based on the known soil, rainfall, and land cover

parameters for the region, the flood flows for the watershed are estimated. **Table 3** contains the hydrologic results of the peak flow analysis and general hydrology.

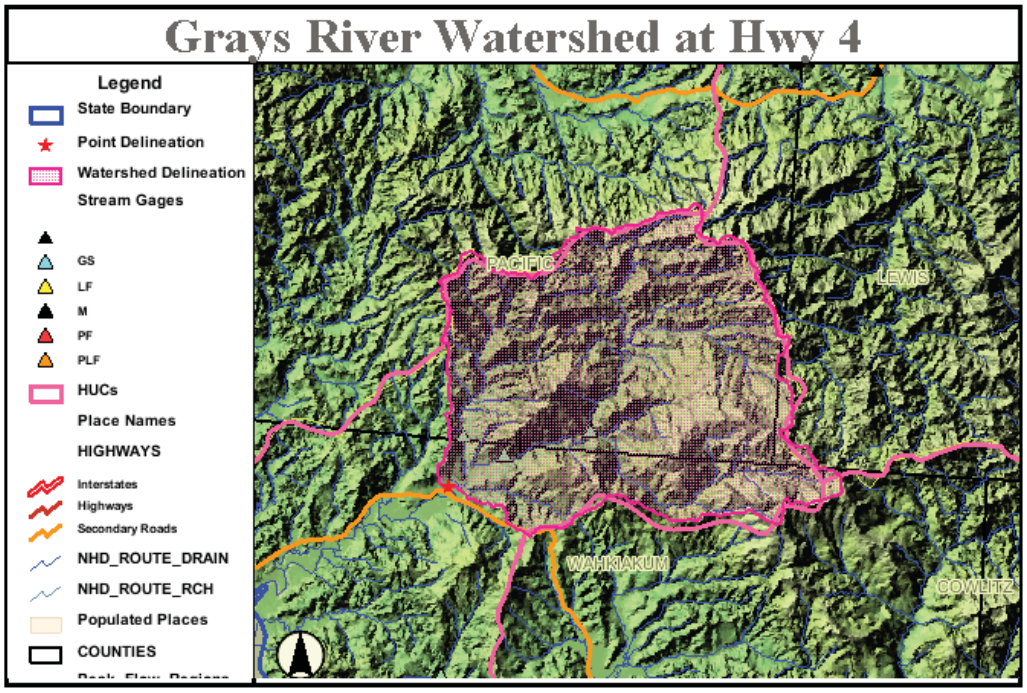

Figure 10. Grays River Watershed Delineation (USGS StreamStat**).**

Table 3. Estimated Peak Flows for Grays River Watershed at SR-4 (USGS StreamStat)

Recurrence Interval	*Estimated Peak Flow (cfs)*
2	5,320
10	9,580
25	11,900
50	13,800
100	15,700
500	20,600

As part of the WRIA 25 hydrologic study, an analysis was conducted that compared the annual precipitation volumes with the estimated stream flow volumes for the entire Grays River watershed (163 square miles). That analysis assumed an average annual rainfall of 103 inches (which is higher than the averaged used by Wade [2002] and is likely more representative of the upper watershed), which results in a precipitation input volume of 898,850 ac-ft. The annual stream flow was estimated to be 907,100 ac-ft. This result indicates there is more stream flow than rainfall and this does not take into account the volume of water loss from ET. The likely explanation for this is that there is a significant component of groundwater in the overall stream flow.

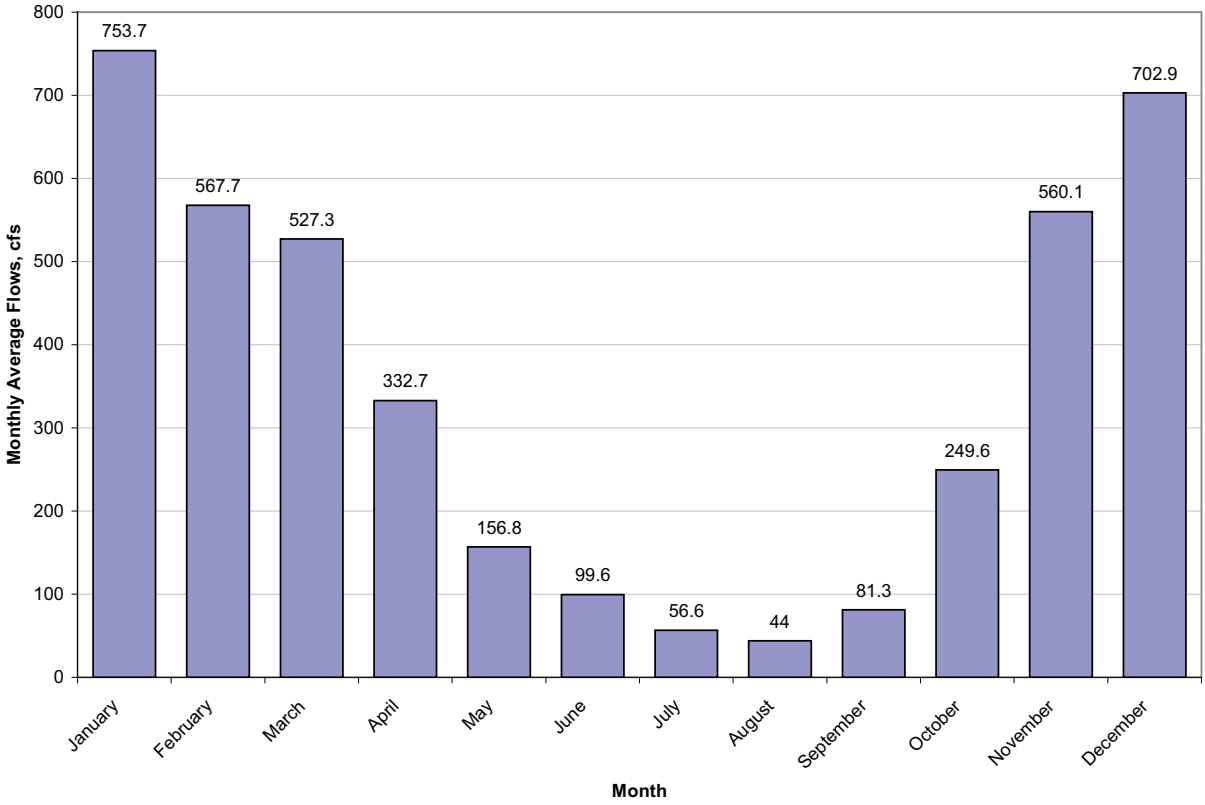

Figure 11. Monthly Average Flows, Grays River above Confluence with South Fork

Other hydrologic studies have been conducted for the Grays River. West Consultants (2004) and Pacific Water Resources (2004) calculated various peak flow events as shown in **Table 4** on the mainstem Grays River above Hull Creek (~RM 10) and at SR-4 (~ RM 12.5). The Pacific Water Resources (2004) study indicates that peak flows have not significantly changed from historic conditions (1-2%). Modeling by May and Geist (2007) provided similar results when evaluating effects of timber harvest on daily, low, and peak flows. Low flows appear to have increased compared to the historic conditions, which is not the expected result since infiltration of precipitation is typically reduced when forested vegetation is removed.

Table 4. Peak Flow Recurrence Events.

Peak Flow Event	Historic above Hull Creek (PWR 2004)	Current at SR-4 (West 2004)	Current above Hull Creek (PWR 2004)
2-year	10,313	8,590	10,505
10-year	15,376	14,300	15,580
100-year	18,835	20,200	19,034

2.1.3 Water Quality

The Grays River is listed on the State of Washington's 303(d) list of impaired waterbodies for high water temperatures that exceed the state standards (WDOE 2004). The listed reaches include the vicinity of SR-4, above the hatchery on the West Fork and near the confluence with the South Fork.

2.1.4 Vegetation and Land Use

The natural vegetation of the Grays River watershed was western hemlock climax forest on the hillslopes and the Sitka spruce zone in the valleys and floodplain/tidal zone (Scott 2001). The floodplain also included areas of deciduous riparian vegetation and emergent and shrub wetlands. The study area for this report is generally within the Sitka spruce zone. Historic information on early settlement compiled by May and Geist (2007) indicate that the early settlers cleared the lower valley for farming over several decades, and that large-scale logging on the hillslopes began in the 1890s. The present route of SR-4 from KM Mountain to the river may follow an old logging railroad alignment.

Approximately 90% of the watershed is privately owned; primarily timberlands and 10% is state owned (Department of Natural Resources). The floodplain in the lower 12-13 miles of the river is primarily in agricultural and rural residential land uses. Approximately 70% of the timberlands are currently in early seral stages (LCFRB 2004).

2.1.5 Wetlands

There are significant areas of wetland in the Lower Grays River (**Figure 12**), predominantly below SR-4, including palustrine emergent, shrub, and forested wetlands, as well as tidally influenced estuarine wetlands at the mouth of the river at Grays Bay. Several areas are mapped as wetlands or riverine associated habitats upstream of SR-4, including a few old oxbows or channels and riverine fringing wetlands.

2.1.6 Fish Distribution

Five species of salmonids are present in the Grays River watershed: fall Chinook, chum, and coho salmon, winter steelhead, and coastal cutthroat trout. Fall Chinook and chum were listed as threatened under the Endangered Species Act in 1999, and coho were listed as threatened in 2005. Grays River winter steelhead are part of the coastal ESU, and are not listed under the ESA. An estimated 29 miles of rivers/streams are accessible to salmonids (Wade 2002). Spring, summer, and up-river bright stocks of Chinook were released in the watershed in the past, but are not sustaining populations.

Fall Chinook are native to the Grays River watershed, but the natural spawning stock is now mixed between wild and hatchery fish due to the Grays River Salmon Hatchery on the West Fork Grays River. Chinook supplementation ended in 1998, but the stock is still considered mixed (WDFW 2002). The historic fall Chinook population for the combined Grays and Chinook Rivers stock has been estimated between 1,500 and 10,000 fish (LCFRB 2004). Recent returns have ranged from 100-300 fish and the population is listed as “depressed” by WDFW (WDFW 2002). Spawning primarily occurs in the mainstem upstream of SR-4 and in the lower West Fork (WDFW 2008 spawning maps).

The Lower Columbia chum salmon population primarily spawns in the Grays River watershed. It is one of the last remaining significant producers of chum. The population is primarily native and

wild, although a small supplementation program at the Grays River Salmon Hatchery began in 1998 (WDFW 2002). The historic chum population for the combined Grays/Chinook stock has been estimated from 8,000 to 14,000 fish (LCFRB 2004). Current returns have ranged from 500 to nearly 10,000 fish (very high return in 2002; PSMFC 2003). The population is listed as "depressed" by WDFW (WDFW 2002). Spawning primarily occurs from below the SR-4 bridge to ½ mile or so upstream of the West Fork confluence, and heavily in the West Fork and Crazy Johnson Creek. The chum spawning channel that was created at Gorley Springs (originally built in 1988 and modified in 1990) was destroyed in the avulsion of the river in 1999.

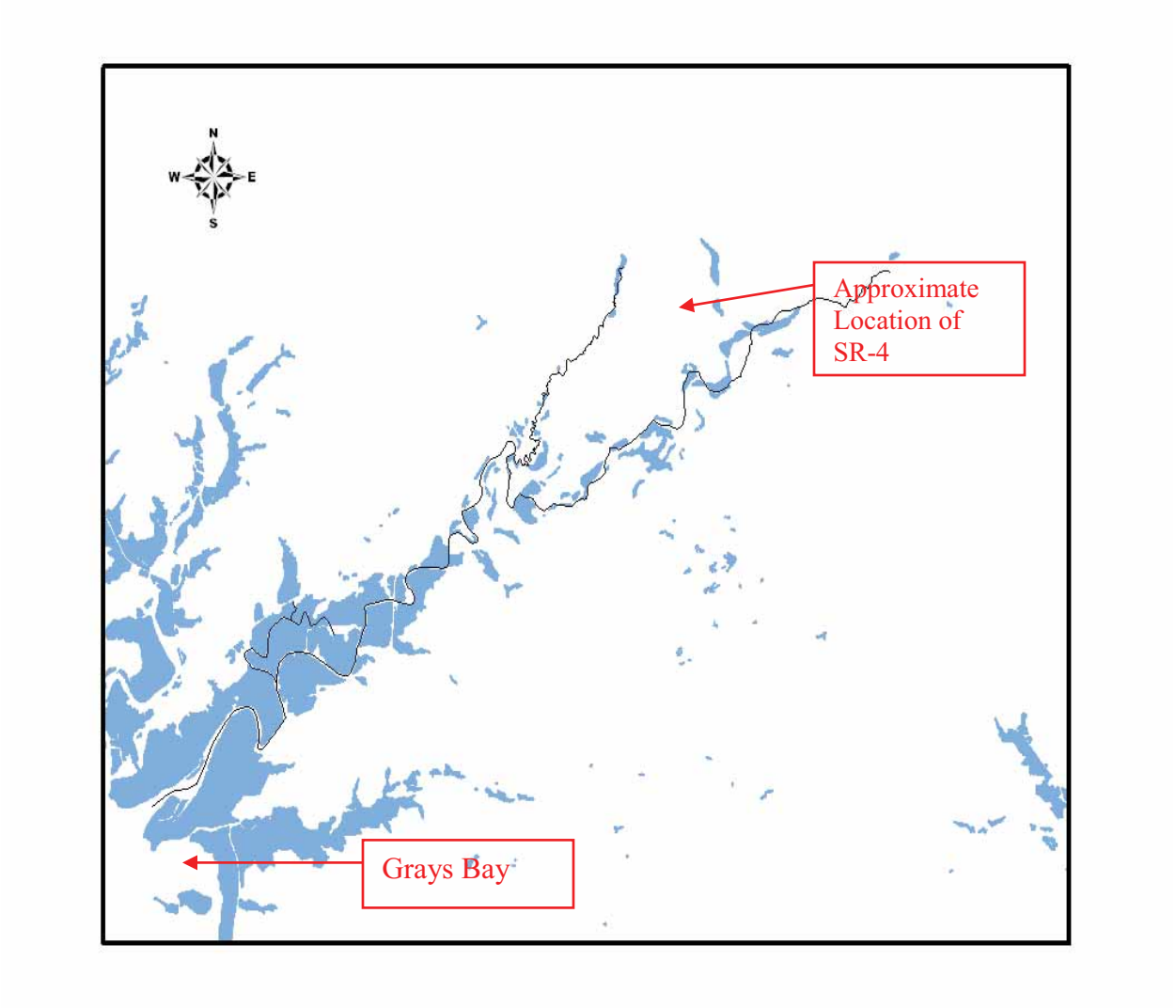

Figure 12. National Wetland Inventory of the Study Area.

Coho salmon are native to the Grays River, but the natural spawners are mixed between wild and hatchery fish from the Grays River Salmon Hatchery. The historic coho population for the combined Grays/Chinook late stock has been estimated from 5,000 to 40,000 fish (LCFRB 2004). Current returns are unknown and the stock is listed as "unknown" by WDFW (WDFW 2002). Spawning primarily occurs in the upper watershed, including major tributaries such as the South, West, East, and North Forks, Crazy Johnson and Hull Creeks.

Winter steelhead are native to the Grays River, and the stock is considered wild from natural production. A small amount of supplementation occurs at the Grays River Salmon Hatchery, but these fish do not significantly contribute to natural spawning. The historic winter steelhead population for the Grays River has been estimated to be approximately 4,500 fish (LCFRB 2004). Current returns have ranged from 400 to 600 fish. The stock is listed as "depressed" by WDFW (WDFW 2002). Spawning occurs throughout the basin, primarily in tributaries such as Hull, Klints, Fossil Creeks, and the West Fork, South Fork and upper basin.

Table 5 shows the EDT reaches developed for the Grays River as part of the Recovery Plan (LCFRB 2004). The mainstem from King Creek to Grays Falls is considered a Tier 1, which is the highest priority for habitat restoration. The lower ends of Klints, Fossil, and Crazy Johnson Creeks are also Tier 1 habitats. The field reconnaissance for this study will evaluate the tier rankings and make recommendations on whether the rankings appear appropriate to the restoration needs and opportunities. In general, the focus of this study is on Tier 1 and 2 reaches.

2.1.7 In-Stream Habitat

In-stream habitat in the Lower Grays River study area is predominantly riffle habitat from approximately RM 10-18, and then sand bed tidal below RM 10. Upstream of SR-4, May and Geist (2007) estimated habitat quality for Chinook and chum spawning. The majority of the habitat is suitable for spawning based on substrate, depth, and velocity criteria, although only about 20% of the habitat available was considered highest quality, which most closely matches preferred substrate/depth/velocities. Chum spawning may also be further limited by the need for hyporheic flow. However, the estimation of redd capacity for each species indicates that the quantity of spawning habitat available should be able to support the historic run sizes of fall Chinook and chum salmon. May and Geist (2007) indicate that other factors, most likely substrate stability and excessive fine sediments, may be the most important limiting factors for salmonid production in the Grays River, as well as the general lack of habitat diversity for various life history stages.

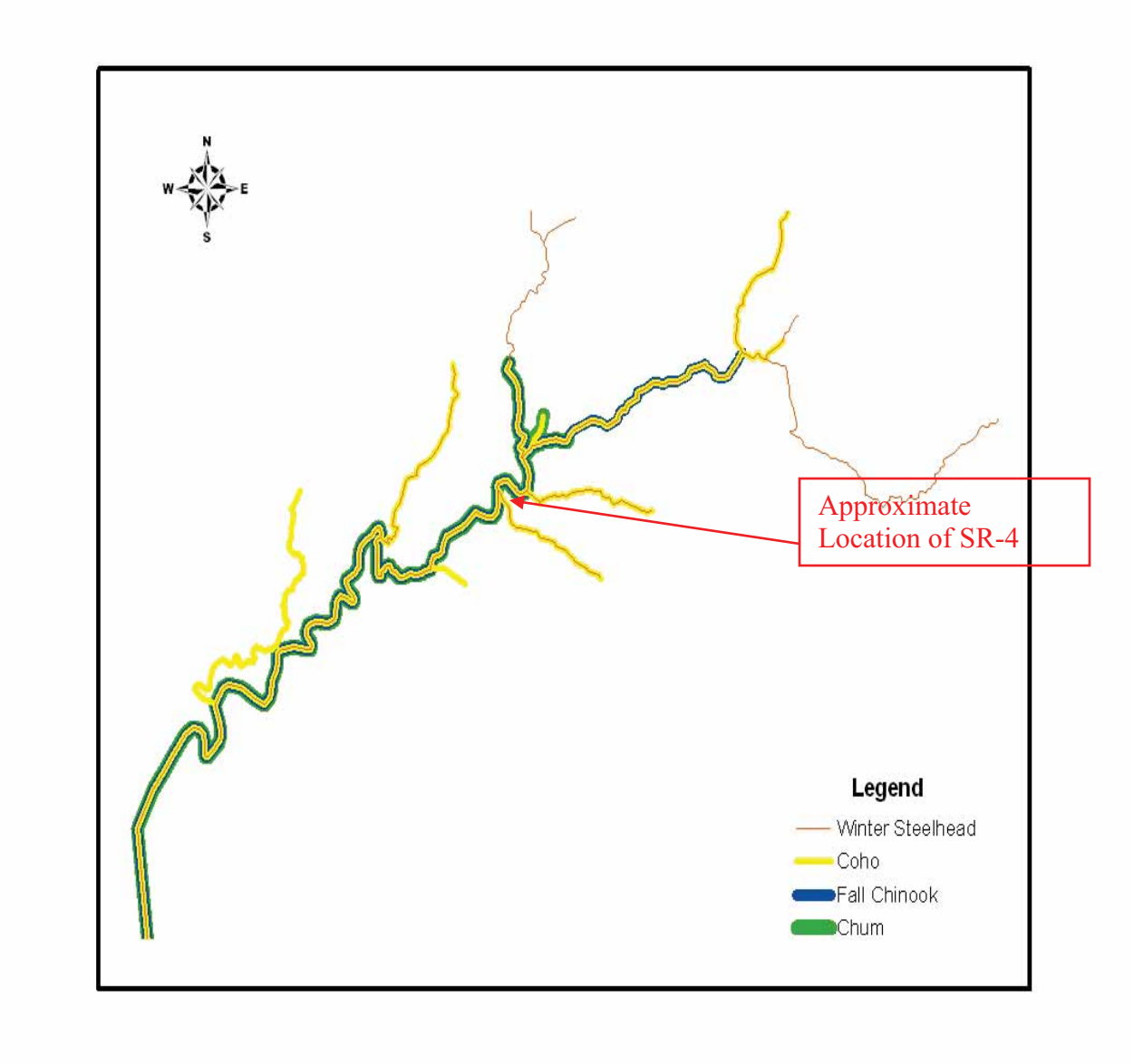

Figure 13. Fish Distribution in the Grays River.

Table 5. Grays River Study Area EDT Reaches.

Reach Identifier	River Mileage**	Description	Species of High or Medium Recovery Priority	EDT Tier
Estuary	RM 0.0 – 4.43	Mouth to Seal Slough	N/A	4
Grays 1-Tidal	RM 4.43 – 5.58	Seal Slough to LB Trib 1	N/A	4
G1B-Tidal	RM 5.58 – 5.74	LB Trib 1 to LB Trib 2	N/A	4
G1C - Tidal	RM 5.74 – 6.15	LB Trib 2 to Impie Creek	N/A	4
G1D - Tidal	RM 6.15 – 6.72	Impie Creek to Nikka Creek	N/A	4
G1E - Tidal	RM 6.72 – 8.40	Nikka Creek to Thadbar Creek	N/A	4
G1F - Tidal	RM 8.40 – 8.53	Thadbar Creek to Kessel Creek	N/A	4
G1G - Tidal	RM 8.53 – 10.04	Kessel Creek to Hull Creek	N/A	2
G1H - Tidal	RM 10.04 – 11.77	Hull Creek to King Creek	Chum – Medium Chinook – Medium Coho – Medium	2
G2	RM 11.77 – 12.87	King Creek to Klints Creek	Chum – High Chinook – High Coho – High	1
G2A	RM 12.87 – 14.27	Klints Creek to Fossil Creek	Chum – High Chinook – High Coho – Medium	1
G2B	RM 14.27 – 15.06	Fossil Creek to WF Grays	Chum – High Chinook – Medium Coho – Medium	1
G2C	RM 15.06 – 15.24	WF Grays to Crazy Johnson Creek	Chum - High Chinook – High Steelhead – High Coho – Medium	1
G2D	RM 15.24 – 17.70	Crazy Johnson Creek to Grays Falls	Steelhead – High	1
G3	RM 17.70 – 19.83	Grays Falls to South Fork	Steelhead – High	1
G3A	RM 19.83 – 22.71	South Fork to Alder Creek	Steelhead – Medium	2
Crazy Johnson	RM 0.0 – 0.92	Mouth to fish barrier	Chinook – High	1
Fossil - 1	RM 0.00 – 0.43	Mouth to fish barrier	Chinook – High Coho – Medium	1
Hull – 1A	RM 0.00 – 1.02	Mouth to end of unconfined	N/A	4
Impie – 1	RM 0.00 – 0.83	Mouth to end of unconfined	N/A	4
Kessel – 1	RM 0.00 – 0.46	Mouth to end of unconfined	N/A	4
King	RM 0.00 – 0.8		Chinook – Medium	2
Klints – 1	RM 0.00 – 0.44	Mouth to LB Trib	Chinook – High	1
Nikka – 1	RM 0.00 – 0.32	Mouth to road crossing	Chinook – Medium	2
Nikka – 2	RM 0.32 – 0.8	Road crossing to fish barrier	N/A	4
Seal Slough 1A	RM 0.00 – 1.07	Mouth to RB Trib	N/A	4
Seal Slough 1B	RM 1.07 – 1.36	RB Trib to Seal Creek	N/A	4
Thadbar – 1	RM 0.00 – 0.68	Mouth to end of chum passage	Chinook – Medium	2
SF Grays 1	RM 0.00 – 0.36	Mouth to Blaney Creek	Steelhead – High	1
SF Grays 2	RM 0.36 – 5.23	Blaney Creek to LB Trib	Steelhead – High	1
WFGrays 1A	RM 0.00 – 2.17	Mouth to end of chum passage	Chinook – High Chum – High Steelhead – High	2

*** -- Mileage used in the EDT analysis differs from mileage used in the remainder of this report. Mileage used in the EDT analysis begins with Rivermile (RM) 0.0 at the confluence with the Columbia River channel, whereas RM 0.0 in this report starts approximately 2.0 miles further upstream at the entrance to Grays Bay.*

2.1.8 Floodplain Connectivity

In general, the majority of the floodplain of the mainstem Grays River in the study area is frequently inundated. Flooding regularly affects agricultural fields and residences and may be getting worse due to river bed aggradation resulting from forest practices and sediment delivery from the upper watershed. Many of the natural floodplain habitats such as off-channel habitats and wetlands have been disconnected from the main river channel and/or highly modified. Fish are frequently washed out into the floodplain during floods and then become stranded in fields or disconnected oxbows and swales.

Undeveloped areas, such as upstream of SR-4, are disconnected from normal winter flows by levees and revetments. Floodplain connections are enhanced by geomorphic features that locally raise water elevations such as super-elevation around meanders and backwater upstream of flow obstructions (logjams and bars). These features contribute to the formation and maintenance of side channels and deliver water to floodplain areas at lower discharges than needed in the absence of these features. Bankfull flows in the lower Grays immediately upstream of SR-4 appear to occur at a frequency of approximately once a year, similar to the recurrence found for most Western Washington rivers (Castro 1997). In alluvial channels such as the lower Grays water surface elevation is very sensitive to channel geometry, wood loading and sedimentation. In other words, localized features influence stage-discharge from year to year. Restoration actions can thus be targeted to increase or decrease stage at specific sites. Where increasing stage will not cause harm to landowners, it will benefit downstream landowners by reducing peak discharges and flood wave celerity (speed).

The upstream portion of the study area (Gorley Reach) has been subjected to major fluctuations in sedimentation raising the river channel several feet followed by periods of general scour and incision. **Figure 14** shows the channel migration that has occurred over the past several decades in the Gorley Reach. It was channel aggradation and high flows that led to the major avulsion of the river through the Gorley property. Floodplain inundation within the area of the avulsion occurred frequently and created a storage reservoir for sediment that would have otherwise moved on downstream. Obviously these changes have significant impacts on floodplain connectivity and ecology. Actions to diffuse and mitigate the magnitude of sedimentation within the lower Grays will benefit habitat as well as property and infrastructure. Confinement of a river with a large sediment supply such as the lower Grays increases the potential for catastrophic changes in channel geometry, impacts that can be significantly reduced by improving floodplain connectivity in areas of low risk.

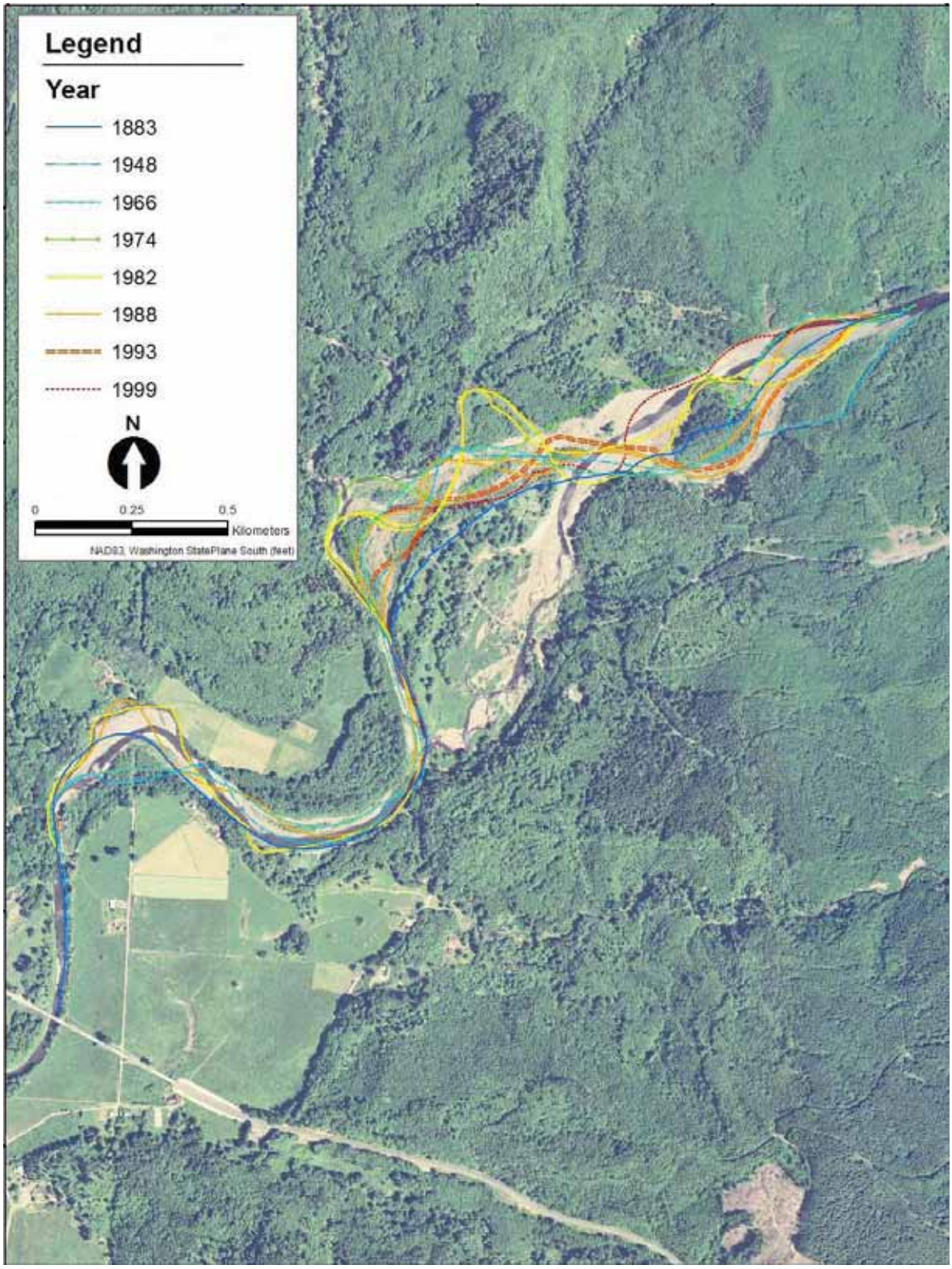

Figure 14. Channel Migration in the Gorley Reach (Reach 4) [May and Geist 2007]**.**

2.2 Study Reaches

The Grays River has several distinct geomorphic features and reaches. The geomorphology and channel form of the Grays River is a function of current and historical landform and geologic structural controls and inputs; basin-scale land use and vegetation characteristics; and climatic, hydrologic and sedimentary inputs to the river. The cumulative effects of inputs and responses over time contribute to the current forms and processes occurring along the river, which are ultimately linked to a variety of habitats and functions. Understanding the geomorphologic functions and processes of the study reach is an important step in evaluating potential habitat restoration opportunities that will function in the Grays River. The following reaches were identified based on field geomorphic and land use characteristics and are used for further reference in this document and are shown in **Figures 15-18**. Mileage is identified based on river miles (RMs) starting at the entrance of the Grays River into Grays Bay.

- Reach 1 (EDT Reaches Grays 1 Tidal to 1C Tidal) RM 0.0 to 2.5, Mouth to Impie Creek – Tidal reach with very low gradient, slough-like conditions, and limited development in floodplain, many forested areas.
- Reach 2 (EDT Reaches Grays 1D Tidal to 1H Tidal). RM 2.5 to 10.2, Impie Creek to King Creek – Tidal reach with more freshwater influence, deposition of sands and small gravels, and more active development or land use in wide floodplain with very limited riparian zone.
- Reach 3 (EDT Reaches Grays 2 to 2B). RM 10.2 to 13.2, King Creek to West Fork Grays River – Above tidal influence, zone of significant sediment deposition of gravels and sands, bank erosion, with more active land uses in wide floodplain with limited riparian zone.
- Reach 4 (EDT Reaches Grays 2C and 2D). RM 13.2 to 15.2, West Fork Grays River to Canyon – Sediment deposition zone immediately below canyon, significant quantities of sediment and wood deposition, virtually no development in somewhat narrower floodplain.
- Reach 5 (EDT Reaches Grays 2D and 3). RM 15.2 to 18.0, Canyon to South Fork Grays River – Confined reach with significant quantities of sediment and wood moving through, no surrounding development.
- West Fork Grays (EDT Reaches West Fork Grays 1A to 3). RM 0.0 to 3.5, Mouth to Beaver Creek – Low gradient with moderate floodplain, significant sediment and wood deposition, with limited floodplain development. Reach includes Crazy Johnson Creek dominated by beaver ponds.
- South Fork Grays (EDT Reaches South Fork Grays 1 and 2). RM 0.0 to 1.0 – Low gradient with moderate floodplain, significant sediment and wood deposition, with no floodplain development.
- Upper Mainstem (EDT Reach Grays 3A). RM 18.0 to 21.0 – Low gradient with pocket floodplains, significant sediment and wood deposition, with no floodplain development.

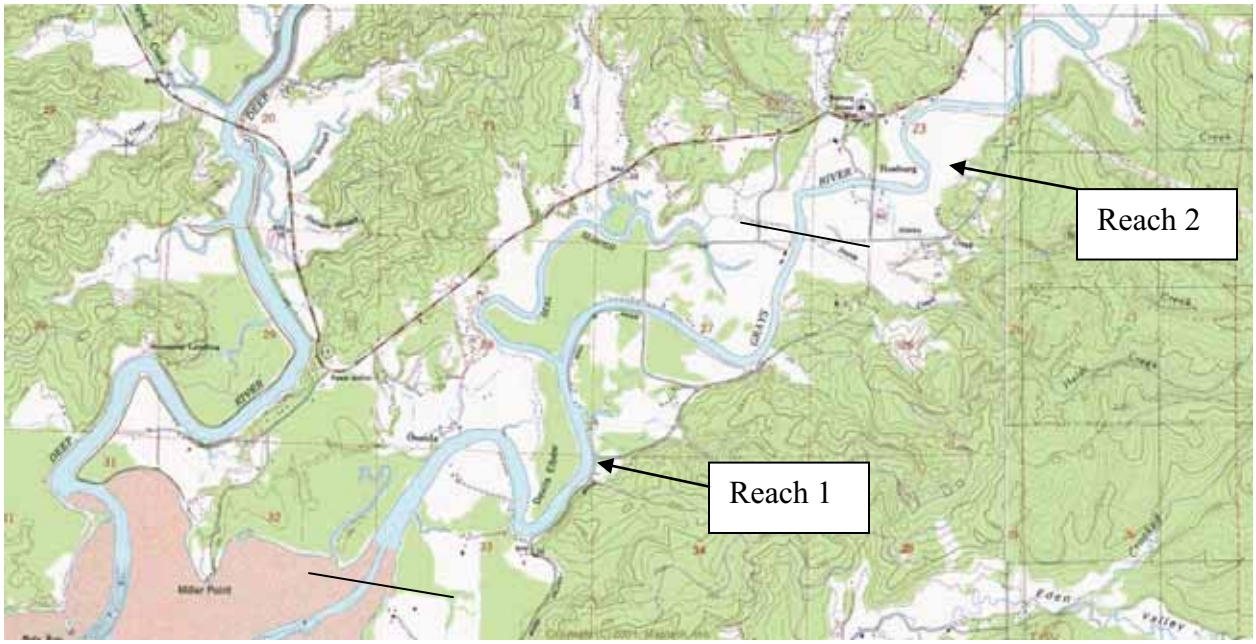

Figure 15. Reach 1.

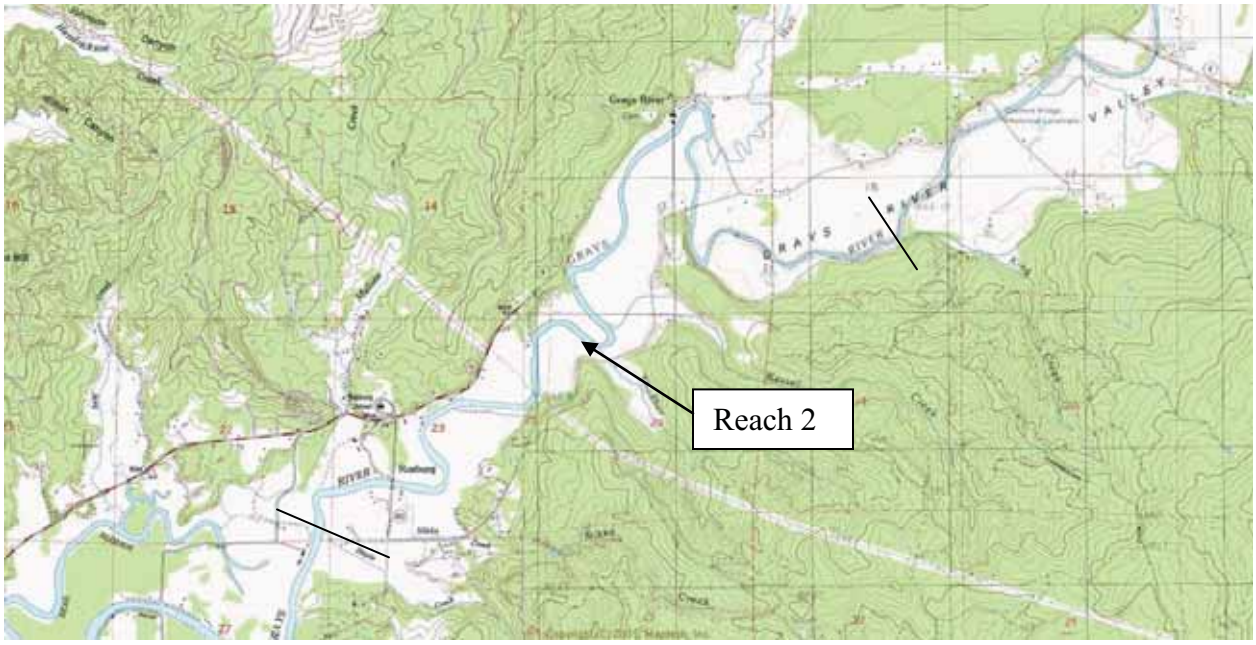

Figure 16. Reach 2.

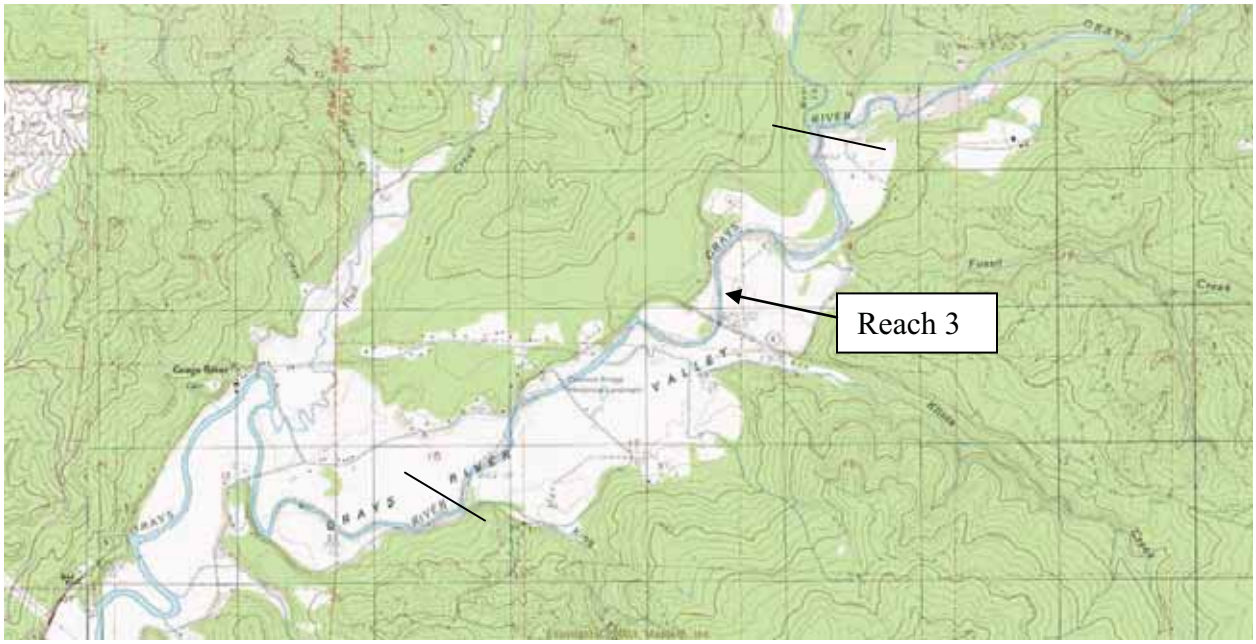

Figure 17. Reach 3.

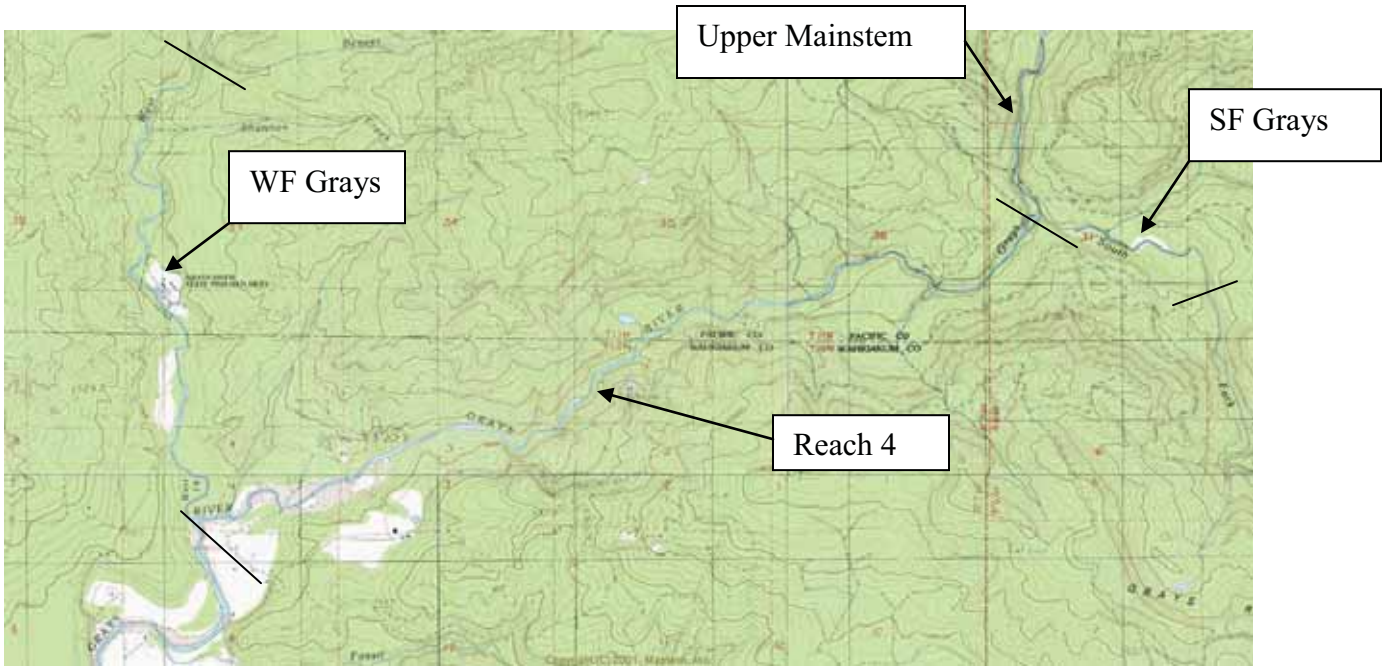

Figure 18. Reach 4, West Fork and South Fork Grays, Upper Mainstem.

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3. Restoration Project Identification and Prioritization

Building on the compilation of historic and existing watershed conditions and factors of decline for salmonids in the basin, the study team then conducted first an aerial reconnaissance of the study area and then a reach-based field reconnaissance to identify restoration needs and opportunities and identify potential locations to conduct various restoration measures. The development of potential site specific restoration measures was specifically designed to address limiting factors for fish and wildlife survival and production while working within the on-going watershed constraints of sediment input and land uses.

The limiting factors that were considered in the development of potential restoration projects are shown in **Table 6)**.

Table 6. Summary of Limiting Factors for the Life Stages of Focal Salmonid Species (from LCFRB 2004)**.**

Species and Lifestage		*Primary factors*	*Secondary factors*	*Tertiary factors*
Grays Fall Chinook				
most critical	Egg incubation	sediment	channel stability, temperature	
second	Spawning	temperature	habitat diversity	harassment, pathogens, predation
third	Prespawning holding	key habitat	flow, temperature	habitat diversity, predation
Grays Chum				
most critical	Egg incubation	sediment	channel stability	key habitat
second	Prespawning holding	key habitat	habitat diversity	flow, harassment
third	Spawning	habitat diversity	key habitat	
Grays Coho				
most critical	Egg incubation	key habitat, sediment	channel stability	
second	0-age summer rearing	key habitat, habitat diversity	flow	food, channel stability
third	0-age winter rearing	key habitat	temperature, habitat diversity, competition (hatch)	predation, pathogens, food, flow, competition (other sp.), channel stability
Grays Winter Steelhead				
most critical	Egg incubation	sediment, temperature, key habitat	channel stabilty	
second	0-age summer rearing	temperature, pathogens, habitat diversity	flow, predation, competition (hatch)	
third	0,1-age winter rearing 1-age summer rearing	habitat diversity competition (hatch), habitat diversity, temperature	flow flow, pathogens, predation	channel stability, sediment

Sediment, key habitat, and habitat diversity were considered to be the primary limiting factors for all species in the Recovery Plan (LCFRB 2004). There is a very significant supply of sediment being delivered to the lower watershed from multiple locations in the upper watershed

as a result of historic timber harvesting. While this study does not specifically address upper watershed or hillslope processes, the rate of transport of sediment into the lower watershed is a major issue and potential restoration projects could not be identified without this major factor being considered at each location. The study team also determined that it was reasonable to include the lower West Fork and South Fork, and a small reach of the upper mainstem Grays above the South Fork in order to help address the sediment issue. The significant volume of sediment being transported from the upper watershed can be partially addressed by investigating the potential for in-channel features and riparian restoration in the upper part of the study area and lower reaches of key tributaries (i.e. lower South Fork).

The ten prioritized measures previously cited in Section 1.1 from the LCFRB's Habitat Work Schedule (LCFRB 2008) were also a key starting point to developing various types of potential restoration projects. The measures we have utilized in this study for the lower basin study area are bolded below. Because the study area is generally the river corridor and floodplain, projects to address hillslope processes were generally not included at this time. It will be extremely important for the long-term restoration of habitats and also to reduce effects on the communities to work with the timber landowners to protect and restore hillslope areas. Additionally, while water quality and flows may benefit from restoration projects in the study area (such as riparian restoration); these will also be highly dependent on the long-term improvements to be made on the hillslopes. Removal of fish passage barriers was also not included because there are no significant barriers within the study area.

1. **Protect stream corridor structure and function;**
2. Protect hillslope processes;
3. Restore degraded hillslope processes on forest and agricultural lands with an emphasis on sediment supply;
4. **Restore floodplain function and channel migration processes in lowland agricultural areas;**
5. **Restore riparian conditions throughout the basin;**
6. Restore degraded water quality with emphasis on temperature impairments;
7. **Create/restore off-channel and side-channel habitat;**
8. **Restore channel structure and stability;**
9. Provide for adequate instream flows during critical periods;
10. Restore access to habitat blocked by artificial barriers.

3.1 Restoration Measures Proposed in Recent Studies

Other recent studies have built further upon the issues and limiting factors identified in the Recovery Plan (LCFRB 2004). These studies include May and Geist (2007) and Streamfix (2004). The May and Geist (2007) study evaluated the hydrologic, geomorphic and sediment processes in the upper watershed and also evaluated the condition of aquatic habitats, particularly chum and Chinook spawning habitats and use. The most significant limiting factors that May and Geist (2007) identified for salmonids in the watershed are channel instability and high loads of fine sediment. The loss of habitat diversity is also a key limiting factor. The recommendations from the study include:

- Protect existing functional refugia habitat (i.e. Crazy Johnson Creek);
- Limit timber harvest on steep slopes and/or in erodable material;
- Decommission inactive forest roads and restore natural drainage ways;
- Construct LWD structures in the upper watershed to trap sediment and improve habitat;
- Riparian and floodplain revegetation;
- Lengthen timber harvest rotation;
- Establish a channel migration zone upstream of SR-4;
- Construct LWD structures in the response reach and CMZ upstream of SR-4;
- Support local efforts to improve watershed conditions.

The Streamfix (2004) study evaluated the lower 14.6 miles of the Grays River for geomorphic conditions and needs/opportunities for channel and bank stability and associated fish habitat benefits. Recommendations from this study include:

- Temperature monitoring
- Riparian corridor establishment
- Monitoring of existing and proposed in-stream and bank structures
- Rehabilitate Gorley reach into single-thread channel with high flow side-channels
- Rehabilitate Middle Ranch reach into single-thread channel
- Place J-hooks downstream of SR-4 for bank protection
- Install W-vane upstream of PUD bar with right bank bench and riparian restoration
- Evaluate chum channel opportunities downstream of PUD bar
- Construct single-thread channel in rock hole reach
- Reconstruct channel near Loop Road with benches and vanes and riparian restoration
- Remove pilings downstream of Loop Road
- Realign channel away from Zimmerman bluff
- Evaluate Covered Bridge Road area for needs for road stability
- Install vane near Barr Road bridge
- Possible channel reconstruction and vanes near confluence of Hull Creek
- Slope back banks and install benches and vanes near Gudmundsen property
- Install wood or other structures downstream of Gudmundsen property near old pilings
- Evaluate tide gates and replace for fish passage as appropriate
- Evaluate other steepened banks for potential bank stability actions
- Evaluate and research stability options for tidal reach

3.2 Restoration Site Identification

The restoration of floodplain and in-channel habitats may begin to address some of the hydrologic and sediment problems, but the impacts of landslides and sediment delivery from upstream timber harvest and on-going land uses in the lower watershed will constrain the future functioning of natural processes and must be considered in the development of restoration projects. It will be extremely important to install wood structures or other roughness elements in the upper watershed to begin to reduce the sediment transport capacity and delivery of sediment to the lower river. The identification of restoration sites in the lower river should focus on locations where restoration can still be functional even with the on-going delivery of sediment.

For example, restoration would be most functional and effective over the long-term by allowing at least some channel migration and floodplain connections. Remnant side channels can be restored, but will need to be designed to include features such as LWD jams to promote continued scour of the openings or be protected by other methods (i.e. chum channels could be protected by upstream structures). By restoring habitats in areas of active channel migration, it is highly likely that the habitats will change over a 10-50 year timeframe, but if the river is given sufficient room it will form new habitats over the long-term, particularly when riparian and floodplain vegetation is restored.

In order to identify specific potential restoration sites, a number of steps were taken and are described in the following sections.

3.2.1 Mapping

Base maps were created for the river and floodplain from RM 0 to 18 using aerial photos and topographic mapping. Aerial photos from 1939, 1965, and 2006 were obtained for as much of the lower Grays as available and were evaluated to identify changes over time to the river and its floodplain and key locations where channel migration continues to occur. The base maps from the 2006 aerial photos are used as the base maps for all project identification and development.

3.2.2 Aerial Reconnaissance

An aerial reconnaissance was conducted prior to conducting the field reconnaissance to videotape the entire study area for use in identification of specific potential project locations.

3.2.3 Field Reconnaissance

A 3-day field reconnaissance was conducted in May 2008 to specifically define restoration needs and constraints by reach, and identify potential project locations and types. This reconnaissance was conducted via boat on the mainstem Grays River with generous support from WDFW. Flows during the field reconnaissance were generally low, in the 300-350 cfs range. Additionally, the study team accessed the upper watershed via car. Photographs and field notes were taken in all reaches and at individual sites as appropriate. In some cases, a site map and conceptual drawing of restoration opportunities were prepared to facilitate conceptual designs.

The overall qualitative impressions made during the field reconnaissance and project identification include:

- Significant quantities of sediment continue to be transported to the Lower Grays River (downstream of the canyon) and coarse sediments are also moving further downstream well into the tidal zone (below Grays River);
- The on-going sediment transport into the Lower Grays River is aggrading the channel bed, which leads to adjustments in channel widths and depths and may be increasing the frequency of overbank flows into the floodplain;
- Historic in-stream structures such as timber pile walls have exceeded their design life and begun to fail and resulting in localized bank erosion in the lower river which is altering channel geometry – particularly channel widening and bar formation. This

physical diversity can enhance habitat but can impact local landowners who have benefited from historic structures for many decades.

- Individual projects undertaken to provide habitat restoration, or flood/erosion control may provide short-term localized benefits, but will not either address nor control the much larger-scale sediment processes currently occurring as a result of past and present timber harvest in the upper watershed;
- Trapping and stabilizing sediment in the upper watershed and in the upper study area (RMs 14-15.5) will slow down the rate of transport into the lower river and cumulatively benefit other projects downstream;
- It makes sense to start with restoration projects and roughness elements higher up in the watershed first, and then move downstream over time in order to help reduce sediment delivery to the lower watershed earlier;
- Based on study team's experience on tributaries to Willapa Bay and Gray's Harbor, the natural channel morphology in the Sitka spruce zone would likely have been a highly meandered channel flowing through a heavily vegetated island and floodplain system with multiple side channels and sloughs;
- There is currently no evidence of coarse sediment deposition below Rosburg, but finer sediments are accumulating in this area and in Grays Bay, over time, coarse sediments will likely move on down to this area;
- An economic evaluation of flood-proofing homes and other structures or relocations that could reduce economic damages likely to occur in the future from flooding, while still allowing agricultural uses of the floodplain would be valuable;
- The implementation of numerous projects identified in this study will provide large scale habitat and sediment control benefits but restoration actions on the hillslopes such as reforestation, creation of buffers, and soil treatments such as terracing, are still absolutely necessary for the long-term sustainability of the habitats and communities.

3.3 Summary of Reach Conditions and Restoration Opportunities

The following is a summary of reach conditions based on the aerial and field observations, preliminary identification of projects, and an analysis of historic and geologic mapping.

3.3.1 Reach 1. RM 0.0 to 2.5 – Mouth to Impie Creek

This reach is tidally influenced and is bordered by forested, shrub, or emergent wetlands along much of its length, along with agricultural lands and a few homes. Daily tidal fluctuations in river stage occur in this river reach, and play a role in channel and floodplain morphology. The substrate is generally fine sands or silts and clays. The mouth of the Grays River and Grays Bay are naturally a deltaic and sedimentary zone. This reach was in the Sitka spruce dominated zone of the lower alluvial valley (Scott 2001). The alignment of the channel in this reach has changed little as shown on the 1882 GLO map shown in **Figure 5** (USBLM 2008). The locations of tributaries may have been changed as two major tributaries or sloughs are shown entering from the left bank across from Seal Slough.

Comparisons between the historical GLO map and the 1939 aerial photograph (**Figure 19**) do not show significant changes in the main channel location and position. However, agricultural and residential development has become established in the valley floor, which is within the 100-year floodplain. A log boom is noticeable immediately downstream of Seal Slough. A number of wetland areas and slough/tidal channels are still present in the delta area of this reach in 1939 that have been since diked or otherwise disconnected from the river channel.

Reach 1 encompasses the EDT reaches of Estuary Tidal and Grays 1, 1B, and 1C Tidal. These reaches were all ranked Tier 4 reaches due to the expected limited benefits to chinook, coho, chum, or steelhead from restoration measures; and the expected limited declines from habitat degradation in these reaches. Chum were the only species considered vulnerable to habitat degradation in these reaches. Seal Slough was also considered a Tier 4 reach. Restoration priorities for Reach 1 are shown in **Table 7**.

Table 7. Reach 1 Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Chum	Prespawning holding Spawning	Key habitat Habitat diversity	Oct-Jan	51/49	Low
Fall Chinook	-	-	-	-	Low
Coho	-	-	-	-	Low
Steelhead	-	-	-	-	Low

** -- Restoration/preservation value averaged over all EDT reaches within reach*

The observations made in this reach during the field reconnaissance are that the habitat is of good to high quality due to still large pockets of forested and emergent wetlands and riparian vegetation, limited development, and the fairly natural shoreline. Pilings are present in the channel in several areas and have riparian vegetation associated with them, and some agricultural and residential uses occur in the floodplain. The main degradation that has occurred is the disconnection of the river from wetlands, tidal sloughs, and distributary channels and the clearing of Sitka spruce forested swamps. The presence of dikes has isolated the river from frequent connections to the tidal surge floodplain. However, considering that the elevation of the mean higher high water (MHHW) at Altoona datum is 8.4 feet (NAVD 88), and the floodplain in this reach is generally around 5 feet in elevation (from LIDAR), the floodplain experiences groundwater and surface water connections frequently from tidal effects alone. The entire valley floor is within the 100-year floodplain and can experience occasional flooding from the river. There are no obvious sediment deposits in this reach, but fine materials are transported into and through this reach and on into Grays Bay. The lower river was occasionally dredged in the past to facilitate navigation, but has not been dredged recently. The banks are generally stable, particularly where vegetated, but may experience toe erosion or slumping as a result of tidal action.

Habitat restoration opportunities in this reach are moderate due to the good to high quality habitat that currently exists in the reach. Opportunities include riparian restoration, reconnection of tidal/floodplain habitats, restoration of tidal channels near the mouth of the river at Grays Bay, and placement of wood within and along the channel to provide cover for juvenile fish.

The primary importance of this reach of the river is that it provides shallow water tidal rearing habitat for juvenile salmonids from the Grays River and may provide rearing habitat for other salmonid stocks from the Columbia Basin. Ongoing research by the Columbia River Estuary Taskforce, Columbia Land Trust, University of Washington and others is focused on characterizing this use. The lower Grays River and Grays Bay was a historically complex zone of tidal channels and wetlands. The habitat complexity has been reduced. The Columbia Land Trust has purchased several parcels for habitat protection and restoration in this reach.

Possible projects identified in this reach include: 1) 0.0L, reconnection of historic tidal sloughs; 2) 1.0C, placement of wood interwoven with existing pilings and/or creation of islands; 3) 3.0L, reconnect tidal floodplain; 4) 3.0R, riparian restoration; and 5) 4.5L, tributary enhancement. Existing protected properties would benefit from vegetation management to ensure development of Sitka spruce or shrub swamp or native marsh vegetation communities over time. The projects at RM 0.0L, 1.0C, 3.0L, and 3.0R, would primarily benefit 0-age Chinook and chum that rear extensively in shallow water tidal areas by providing cover and a greater quantity of habitat. There may be coho spawning in Impie Creek. Riparian restoration and channel enhancement in the lower end of Impie Creek would improve rearing habitat for coho and Chinook and provide shading and long-term recruitment of wood and food web support. The residences in the low floodplain areas are currently subject to flooding from the river and high tides. Flood-proofing structures would allow continued use of the properties but reduce economic damages that are likely to occur in the future, particularly with likely sea level rise.

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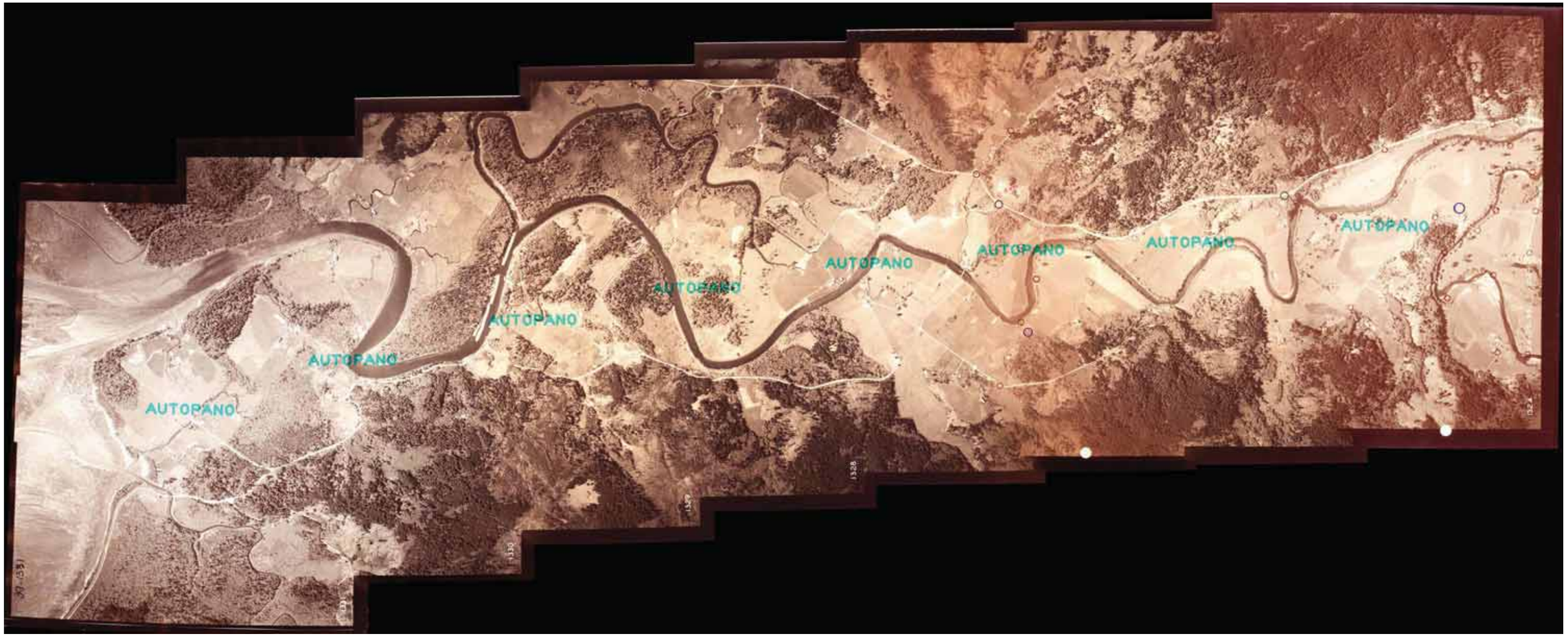

Figure 19. 1939 Aerial of the Lower Grays River.

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Figure 20. Marsh and Spruce near RM 0.5 Right Bank.

Figure 21. Right Bank Seal Slough with Clay Substrate and Overhanging Vegetation.

3.3.2 Reach 2. RM 4.2 to 10.2 – Impie Creek to King Creek

Reach 2 is still generally within the tidal zone depending on river flows, but this reach has experienced significant sediment deposition in recent years, primarily sands and small gravels transported from upstream reaches. The primary land uses in this reach are agricultural and residential. This reach was also historically within the Sitka spruce zone (Scott 2001). The entire reach generally has limited riparian zone and thus the banks are susceptible to erosion during high flows and from tidal action. The substrate ranges from fine sands/silts at the lower end of the reach to small gravels and sands at the upper end of the reach.

The 1882 GLO map indicates that Reach 2 is also of similar alignment currently and very few changes have occurred (**Figure 5**). A comparison to the 1939 photo (**Figure 19**) indicates that by 1939 most of the agricultural and residential development in the valley floor had occurred, although old channels or meander scars are more visible such as near Rosburg and upstream of Barr Road. Malone Creek formerly entered the Grays River at the Rosburg bridge, but has since been diverted to Seal Slough. Point bars are evident on the insides of meander bends upstream of RM 6. Limited riparian was present in 1939 similar to existing conditions.

Reach 2 encompasses the Grays 1D, 1E, 1F, 1G, 1H Tidal reaches used in the EDT analysis. Reaches 1D, 1E, 1F Tidal were ranked as Tier 4 reaches due to the expected limited benefits to chinook, coho, chum, or steelhead from restoration measures; and the expected limited declines from habitat degradation in these reaches. Reaches 1G and 1H Tidal were ranked as Tier 2 reaches due to moderate declines expected in abundance and productivity for chinook, coho, and chum if further degradation were to occur in these reaches. Coho was expected to benefit moderately from restoration of habitat in these reaches. Steelhead were not considered to be affected by either restoration or degradation. Restoration priorities for Reach 2 are shown in **Table 8.**

Table 8. Reach 2 Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Chum	Egg incubation Prespawning holding Spawning	Sediment Key habitat Habitat diversity	Dec-Mar Oct-Jan	41/59	Low
Fall Chinook	Prespawning holding	Key habitat	Aug-Nov	41/59	Low
Coho	0-age winter rearing	Key habitat	Nov-Mar	41/59	Low
Steelhead	-	-	-	-	Low

** -- Restoration/preservation value averaged over all EDT reaches within reach*

The observations made in this reach during the field reconnaissance are that the habitat is of generally poor quality due to a lack of riparian zone, uniform channel habitat, lack of in-stream cover, and lack of quality floodplain habitat. Pilings are present along the banks in several areas and have riparian vegetation associated with them; some of the better riparian areas are associated with pilings. There is a moderate quantity of wood that came down in the 2007 flooding, but it is primarily on the fields and floodplain and only limited quantities are in the channel. Informal levees/dikes are present on some properties to reduce flooding frequency. The majority of the valley floor is within the 100-year floodplain and can experience frequent

flooding from the river. However, there are no flood storage areas distinct from the agricultural floodplain. Sediment deposition in the channel may be increasing the frequency at which the valley floods. The deposition of sediment has also placed pressure on the river banks that have virtually no stabilizing riparian vegetation and eroding banks are present in many locations. There are a variety of bank stabilization measures both historic and more recent in many locations.

Habitat restoration opportunities in this reach include riparian restoration (to include possible sloping back and stabilization of banks), reconnection of low floodplain habitats to allow some channel migration and take the erosive pressure off of other banks, restoration of the lower ends of tributaries, and placement of in-stream structures within and along the channel to provide cover for juvenile fish and diversity of habitats.

The primary importance of this reach of the river is that it provides freshwater tidal rearing habitat for juvenile salmonids and could provide adult prespawning holding habitat. The lower Grays River was likely very closely connected to its floodplain historically and had multiple freshwater tidal sloughs and channels. The habitat complexity has been significantly reduced for a lengthy period of time (since before 1939).

Possible projects identified in this reach include: 1) 4.7R, reconnection of floodplain; 2) 5.0B, reconnect floodplain and create secondary channel; 3) 5.0L, tributary enhancement; 4) 5.5L, floodplain reconnection and anabranching channel; 5) 5.0-6.0, riparian restoration and instream wood; 6) 6.7B, reconnect floodplain and create secondary channel along with tributary enhancement at the lower ends of Thadbar and Kessel Creeks; 7) 7.5B, restore low floodplain to allow for continued channel branching; 8) 7.5C, bar apex logjam; 9) 7.0-8.0C, place wood interwoven with existing pilings; 10) 8.0B, reconnect floodplain and create secondary channel; 11) 8.2R, tributary enhancement; 12) 9.5R, reconnect oxbows in floodplain; 13) 9.0-10.0B, riparian restoration; 14) 9.7R, reconnect low floodplain; 15) 10.0R, side-channels in area of high sediment deposition. Invasive species management and riparian restoration is a key component throughout the reach, along with the placement of in-stream structures at key locations such as bar apexes to stabilize bars.

The projects in Reach 2 would primarily benefit 0-age Chinook and chum that rear extensively in shallow water tidal areas by providing cover and a greater quantity of habitat. Coho from tributary streams would also utilize improved lower tributary habitat and additional mainstem habitat for rearing. Riparian restoration and channel enhancement in the lower ends of tributaries would improve rearing habitat for coho and Chinook and increase shading and provide long-term recruitment of wood and food web support. There may be needs or opportunities for flood-proofing structures that would allow continued use of the agricultural properties but reduce economic damages that are likely to occur in the future.

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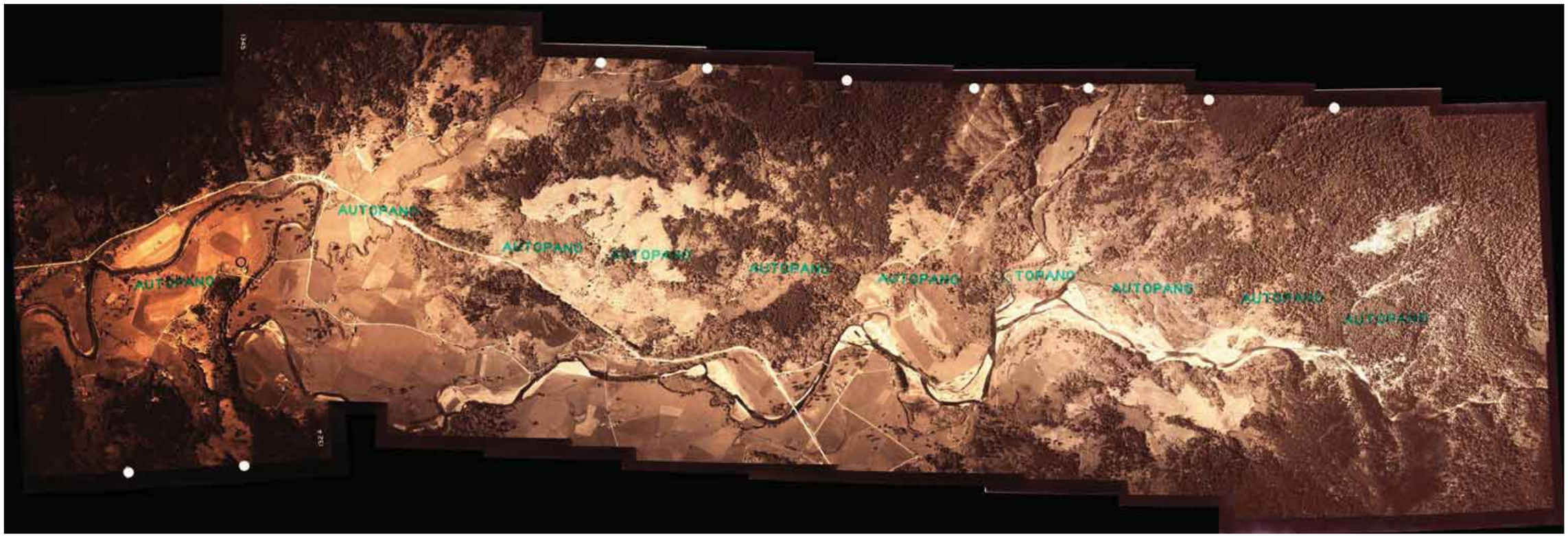

Figure 22. 1939 Aerial of the Middle Grays River.

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Figure 23. Bank in Reach 2 with Limited Riparian and Recently Deposited Wood.

Figure 24. Eroding Bank with Limited Riparian Vegetation.

3.3.3 Reach 3. RM 10.2 to 13.2 – King Creek to West Fork Grays River

Reach 3 is reach is above the tidal zone and has also experienced even more significant sediment deposition in recent years; cobbles, gravels and sands transported from upstream reaches. The primary land uses in this reach are also agricultural and residential. This reach was also historically within the Sitka spruce zone (Scott 2001). The entire reach generally has limited riparian zone and thus the banks are susceptible to erosion during high flows and from sediment deposition and channel widening. The substrate ranges from sands and small gravels at the lower end of the reach to gravel and cobbles at the upper end of the reach.

The 1882 GLO map indicates that Reach 3 is also of similar alignment currently and very few changes have occurred (**Figure 5**). A comparison to the 1939 photo (**Figure 22**) shows that some meander shapes and lengths are slightly different, typically sharper bends, although generally in the similar configuration as current. Limited riparian vegetation was present in 1939 similar to existing conditions. Exposed gravel bars and scour zones are present throughout the reach even in 1939. Several side channels were present, such as at the WDFW bar and near RM 13.

Reach 3 encompasses the Grays 2, 2A, and 2B reaches used in the EDT analysis, all ranked as Tier 1 due to the expected significant benefits to chinook, coho, and chum from restoration measures; and the expected declines from potential habitat degradation in these reaches. Steelhead were not considered to be affected significantly by either restoration or degradation. Restoration priorities for Reach 3 are shown in **Table 9**.

Table 9. Reach 3 Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Chum	Egg incubation Prespawning holding Spawning	Sediment Key habitat Habitat diversity	Dec-Mar Oct-Jan	55/45	High
Fall Chinook	Egg incubation Spawning Prespawning holding	Sediment Temperature Key habitat	Oct-Mar Oct-Dec Aug-Dec	55/45	High
Coho	0-age winter rearing	Key habitat	Nov-Mar	55/45	High
Steelhead	0,1-age winter rearing	Habitat diversity	Nov-Mar	55/45	Low

** -- Restoration/preservation value averaged over all EDT reaches within reach*

The observations made in this reach during the field reconnaissance are that the habitat is of generally poor quality due to a lack of riparian zone, channel instability, uniform channel habitat (predominantly riffles), lack of in-stream cover, and lack of quality off-channel and floodplain habitat. There are significant cobble/gravel/sand bars present from several recent years of deposition. Chinook and chum spawning begins in this reach. There is a moderate quantity of wood that came down in the 2007 flooding, present on bars and a few pieces in channel. The majority of the valley floor is within the 100-year floodplain and can experience frequent flooding from the river. However, there are no flood storage areas distinct from the agricultural floodplain. Sediment deposition in the channel may be increasing the frequency at which the valley floods. The deposition of sediment has also placed pressure on the river banks that have

limited stabilizing riparian vegetation and eroding banks are present in several locations. However, bank erosion and limited channel migration appear to have occurred fairly frequently historically. There are a variety of bank stabilization measures both historic and more recent in many locations, including groins, rock, wood, and vanes.

Habitat restoration opportunities in this reach include riparian restoration (including sloping back banks for stabilization), reconnection of low floodplain habitats to allow for channel migration and reduce pressure on other banks, restoration of the lower ends of tributaries, and placement of in-stream structures to provide cover for juvenile fish, habitat diversity and some bank protection. Flood-proofing of structures in the floodplain would reduce economic damages from future flooding.

The primary importance of this reach of the river to fish is for salmon spawning and juvenile rearing. The lower Grays River was likely very closely connected to its floodplain and had multiple side channels, pools, and in-stream diversity prior to settlement. The habitat complexity has been significantly reduced for a lengthy period of time (since before 1939).

Possible projects identified in this reach include: 1) 10.3T, tributary enhancement at Kings Creek; 2) 10.5C, reconnection of floodplain and create secondary channel; 3) 11.0R, reconnection of floodplain and create secondary channel; 4) 11.2L, riparian restoration; 5) 11.8R, create secondary channel or chum channel; 6) 12.0R, reconnection of floodplain and create secondary channel; 7) 12.0L, riparian restoration and reconnect low floodplain; 8) 12.3C, evaluate and monitor mid-channel snag; 9) 12.5C, stabilize bar and create secondary channel; 10) 12.6R, reconnect off-channel pond; 11) 13.5R, create secondary channel or chum channel. Invasive species management and riparian restoration is a key component throughout the reach, along with the placement of in-stream structures at key locations such as bar apexes to stabilize bars to reduce further downstream transport.

The projects in Reach 3 would primarily benefit adult Chinook and chum for spawning by stabilizing the substrate and 0-age Chinook and 0-age and 1-age coho by providing cover and habitat diversity for rearing. Riparian restoration and channel enhancement in the lower ends of tributaries would improve rearing habitat for coho and Chinook and increase shading and long-term recruitment of wood and food web support. There may be needs or opportunities for flood-proofing structures that would allow continued use of the properties but reduce economic damages that are likely to occur in the future.

Figure 25. Bedload Deposition and Bar Formation in Reach 3.

Figure 26. Groins and Vegetation along Left Bank in Reach 3.

Figure 27. Eroding Bank in Reach 3 with Recruitment of Non-functional (small) Wood that is easily Transported Downstream.

3.3.4 Reach 4. RM 13.2 to 15.2 – West Fork Grays River to Canyon

Reach 4 includes the Gorley Reach up to the canyon and has experienced very significant sediment deposition in recent years; cobbles, gravels and sands transported from upstream reaches. The primary land uses in this reach are open space and timberland. This reach was also historically within the Sitka spruce zone (Scott 2001). This reach is naturally a depositional area for sediments transported through the canyon from the upper watershed and there has been sustained meandering and braiding in this reach for decades. However, the high sediment load that is currently coming out of the upper watershed has caused more dramatic channel changes in recent years. The substrate ranges from large cobbles to gravels to sands.

The 1882 GLO map indicates that Reach 4 was more similar to its current alignment (Gorley Reach alignment more to the south and east portion of the floodplain than to pattern that had persisted in the previous several decades (**Figure 4**). A comparison to the 1939 photo (**Figure 22**) shows that the 1939 alignment was more to the south in the upper half of the reach and more to the north and west in the Gorley reach. Limited riparian was present in 1939 similar to existing conditions. Exposed gravel bars and scour zones are present throughout the reach in the 1939 photo similar to today's conditions. The only major side channel in 1939 was near the Crazy Johnson confluence.

Reach 3 encompasses the Grays 2C and 2D reaches used in the EDT analysis, ranked as Tier 1 due to the expected significant benefits to Chinook, coho, and chum from restoration measures in

Reach 2C and the benefits to steelhead in Reach 2D. Restoration priorities for Reach 4 are shown in **Table 10**.

Table 10. Reach 4 Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Chum	Egg incubation Prespawning holding Spawning	Sediment Key habitat Habitat diversity	Dec-Mar Oct-Jan	62/38	High
Fall Chinook	Egg incubation Spawning Prespawning holding	Sediment Temperature Key habitat	Oct-Mar Oct-Dec Aug-Dec	62/38	High**
Coho	0-age winter rearing	Key habitat	Nov-Mar	62/38	Medium
Steelhead	0,1-age winter rearing	Habitat diversity	Nov-Mar	62/38	High

** -- Restoration/preservation value averaged over all EDT reaches within reach*
*** -- Reach potential high based on WDFW past few years of spawner surveys and high level of use by fall Chinook*

The observations made in this reach during the field reconnaissance are that the habitat is of moderate quality due to a lack of riparian zone, significant channel instability, uniform channel habitat (i.e. lack of pools), lack of in-stream cover, and continued high sediment deposition. There are significant cobble/gravel/sand bars present from several recent years of deposition. Chinook and chum spawning occurs in this reach. There is a significant quantity of wood that came down in the recent years of flooding, present on bars and a few pieces in channel. The entire valley floor is generally within the frequently connected floodplain and has been a part of the channel at various points in the past. The deposition of sediment has also placed pressure on both high and low banks and there are many areas of erosion. However, bank erosion and channel migration occurred fairly frequently historically, as indicated by historic photos.

Habitat restoration opportunities in this reach include placement of wood structures to trap and stabilize sediment, placement of wood for habitat diversity, riparian restoration, reconnection/restoration of additional channels to allow stabilization of pool and riffle habitats while storing gravel on bars and islands. Fortunately, there will be limited economic damages from channel migration in this reach. The one area of concern for bank protection is Fossil Creek Road, but placement of in-stream structures to deflect flows away from the roadway and stabilize sediment would be effective in reducing erosion along that bank.

The primary importance of this reach of the river to fish is for salmon spawning and juvenile rearing. This reach of the river likely had wood in significant quantities in the channel prior to settlement, as well as multiple channels. The habitat complexity has been reduced for a lengthy period of time (since before 1939). A key need is to trap sediment in this reach to prevent significant quantities from moving further downstream.

Possible projects identified in this reach primarily apply throughout the reach. 1) placement of wood structures to trap and stabilize sediment (14.0B, 14.0L, 15.0B, etc.); 2) placement of wood to create habitat diversity (i.e. pools), 3) riparian and floodplain revegetation; 4) restoration of additional secondary channels, including chum channels; 5) 15.0L, reconnection to south bank wetland for off-channel rearing.

The projects in Reach 4 would primarily benefit adult Chinook, chum, and steelhead for spawning by stabilizing the habitats, and 0-age Chinook and 0-age and 1-age coho and steelhead by providing cover and habitat diversity for rearing.

Figure 28. Gravel Bars and Secondary Channel in Gorley Reach *(groundwater upwelling was observed)***.**

Figure 29. Looking Upstream at Cobble Bar in Upper End of Reach 4. *(Note eroding right bank in left of photo.)*

3.3.5 Reach 5. RM 15.2 to 18.0 – Canyon to South Fork Grays River

This reach encompasses a portion of EDT reaches Grays 2D and 3. The canyon is highly confined, although occasional bars are present wherever the channel widens slightly. The canyon was not investigated during the field reconnaissance other than by observations via the aerial flight due to the difficulty of access. There are limited restoration opportunities in the canyon. However, there is an opportunity to trap sediment and stabilize bars and islands at the confluence with the South Fork Grays River to limit delivery of sediment to Reach 4 downstream. Restoration priorities for Reach 5 are shown in **Table 11**.

Table 11. Reach 5 Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Steelhead	1-age summer rearing 0,1-age winter rearing	Habitat diversity	Year-round	61/39	High

** -- Restoration/preservation value averaged over all EDT reaches within reach*

3.3.6 West Fork Grays River

The West Fork Grays River is extensively used for chum and Chinook spawning in the lower few miles. However, the habitat is generally uniform riffles with limited pools. The West Fork contributes a moderate quantity of sediment to the mainstem. The substrate is generally gravels

and sands. There is extensive evidence above the hatchery diversion of historic wood jams and stable islands and floodplains that are now eroding (extensive large wood in eroding banks). Restoration priorities for the lower West Fork Grays are shown in Table 12.

Table 12. West Fork Grays Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value	Reach Potential
Chum	Egg incubation Prespawning holding Spawning	Sediment Key habitat Habitat diversity	Dec-Mar Oct-Jan	66/34	Medium
Fall Chinook	Egg incubation Spawning	Sediment Temperature	Oct-Mar Oct-Jan	66/34	Medium**
Coho	Egg incubation 0-age summer rearing	Sediment Key habitat, habitat diversity	Oct-Mar Mar-Oct	66/34	Medium
Steelhead	Egg incubation 0-age summer rearing	Sediment, key habitat Habitat diversity	Dec-Jun May-Oct	66/34	High

** -- Restoration/preservation value averaged over all EDT reaches within reach*

*** -- Although not listed as present or priority for West Fork in EDT analysis; recent WDFW spawner surveys indicate moderate use*

Possible projects identified in the West Fork include 1) repair and update hatchery diversion dam and provide screening to ensure fish passage and reduce stranding; 2) remove old road grade and berms (or breach) upstream of hatchery diversion to reconnect floodplain; 3) place wood structures upstream of hatchery diversion for 1-2 miles to trap sediment and stabilize bars; 4) place in-stream structures in lower mile to trap sediment and stabilize bars, as well as providing habitat diversity.

Figure 30. Channel Aggradation in Lower West Fork.

Figure 31. Buried Wood Exposed in Bank of West Fork Upstream of Hatchery Intake.

3.3.7 South Fork Grays River

The South Fork Grays River is extensively used by steelhead for spawning and rearing. The South Fork is also one of the major contributors of sediment to the mainstem. The lower mile of the South Fork has a broad floodplain with an extensively braided channel and significant sediment and wood deposition. The only land use is timberland. The lower mile of the South Fork is a key area to trap and stabilize sediment before it enters the mainstem because the majority of the sediment that enters the mainstem at this point is transported through the canyon and into Reach 4. This reach encompasses the EDT reaches SF Grays 1 and the lower portion of SF Grays 2, which are both Tier 1 reaches. Restoration priorities for the lower South Fork are shown in **Table 13**.

Table 13. South Fork Grays Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value*	Reach Potential
Steelhead	Egg incubation 0-age summer rearing 0,1-age winter rearing	Sediment, key habitat Habitat diversity	Dec-June May-Oct Nov-Mar	49/51	High

** -- Restoration/preservation value averaged over all EDT reaches within reach*

Possible projects identified in the South Fork are to place wood structures in multiple locations to trap and stabilize sediment and facilitate the formation of stable bars and islands, and pools. Restoration of stable secondary channels would further stabilize spawning and rearing habitats.

Figure 32. Wide, Shallow Channel in Lower South Fork

3.3.8 Mainstem Upstream of Canyon

This reach encompasses EDT reach Grays 3A. The only areas investigated during the field reconnaissance for this study upstream of the canyon were at the South Fork confluence and then near RM 21 and Alder Creek. There are significant quantities of sediment moving through this reach from the upper watershed. There are moderate "pocket" floodplain areas where sediment could be trapped and stabilized and to also help stabilize the channel bed. Similar to the West Fork and South Fork, placement of stable wood structures would trap sediment and stabilize existing bars and promote the formation of stable bars and islands. The rearing pond at Alder Creek could be reconnected to provide steelhead rearing opportunities. Restoration priorities for the upper mainstem are shown in **Table 14**.

Table 14. Upper Mainstem Grays Restoration Priorities.

Species Present	Life Stage (primary)	Limiting Factor (primary)	Relevant Months	Restoration/ Preservation Value	Reach Potential
Steelhead	Egg incubation 0-age summer rearing 0,1-age winter rearing	Sediment, key habitat Habitat diversity	Dec-June May-Oct Nov-Mar	63/37	Medium

Figure 33. Mainstem Grays River Immediately Downstream of South Fork Confluence.

Figure 34. Alder Creek Pond in Grays River Floodplain.

3.4 Restoration Approaches

There are several approaches to consider in fish habitat and river restoration that can be used to develop the type and scale of restoration that is appropriate at a specific site.

Conservation and Protection
The most sustainable approach in river restoration is protecting existing river systems, their natural processes and subsequent functioning habitats. This typically involves acquiring and dedicating conservation easements and channel migration zone and floodplain setbacks, especially in critical areas that have extremely valuable habitat benefits, frequent flooding and/or the potential for significant channel migration. This is especially useful in locations at high risk of development or other degradation.

Watershed and Land Use Management
Within the context of existing and future land uses, it is inevitable that conservation easements and full protection of aquatic and riverine resources are not feasible. Therefore, land use planning and management can be used to prevent further degradation of habitats. While management is not explicitly considered in this report as a site-specific restoration action, it is worthwhile for stakeholders to invest effort land use management approaches. Some examples include:

- Floodplain, channel migration and critical area zoning and restrictions
- Land use planning and management of resource industries such as mining, forestry and agriculture to provide buffers along waterways and wetlands

Process Based Restoration
Process based river restoration focuses on restoring physical, biological and chemical processes and the connective linkages that may have been lost due to anthropogenic influences (Kondolf 2006). The underlying approach is based on restoring natural riverine hydrologic and biologic processes and not simply fixing specific symptoms, like an eroding bank. The following are a few examples of process based restoration.

- Riparian plantings along river banks and floodplains to restore long-term bank stabilization and natural recruitment of wood to the system.
- Levee notching, removal or setback to restore floodplain connections and allow habitats to form naturally while protecting more critical infrastructure further from the channel.
- Fish passage barrier removal or modification.
- Revetment removal to allow natural channel bank erosion and migration processes.

Engineered and Constructed Restoration
Engineered and constructed restoration involves physical manipulation of the river and floodplain to promote, enhance or augment river processes related to fish habitat conditions. Typically, restoration features of this scale and type involve some type of installation of a hydraulic structure or channel manipulation to a desired condition. Engineering analysis and design is needed to support construction. Typically, an engineered and constructed restoration plan can attain results in the short term very efficiently. However there is a higher risk of not being sustainable over the long term, unless the project is designed to accommodate on-going natural processes over the long-term. The following are a few examples of engineered restoration:

- Design and construction of rock or large wood structures to provide in-channel scour and cover.
- Reconnection or reconfiguration of floodplain side channels, backwaters, and wetlands using excavation.
- Bioengineered bank enhancement to reduce impacts from past or future bank stabilization activities.

3.5. Restoration Measure Types

The key restoration approaches used in this study are process based restoration and engineered and constructed restoration. The following types of restoration measures have been identified in this study:

Channel Migration Zone Easements
This type of project would involve acquiring conservation easements on properties that are in naturally active channel migration zones to potentially provide multiple benefits to fish habitat,

flood and sediment storage. Project sponsors will work with landowners to determine if there is an opportunity for an acquisition or conservation easement. In general, this type of project will involve only minor engineering and construction (such as riparian plantings) and primarily let the river continue to migrate within a specific area. A setback revetment or levee could also be constructed to protect other lands behind the easement where channel migration is not desired.

Floodplain Restoration and Enhancement
This type of project would involve enhancing or reconnecting existing floodplain areas that may include side channels, backwaters, or wetlands. Floodplain enhancement can include excavation to create channels and/or provide incremental additional frequent flood storage, placement of in-stream structures to promote scour or stabilize bars, and planting of riparian vegetation. Floodplain restoration can range from passive to significantly engineered and is a function of adjacent land uses and the risk and the level of disturbance that may have occurred on-site. For example, simple reconnection of a side channel through notching of a bank or excavation of a bar in an undeveloped area could be relatively passive, whereas removal and setback of a revetment could require more significant engineering.

Riparian Restoration and Non-native Vegetation Removal
These projects are for river bank, tributary, floodplain, and bar areas that either lack riparian vegetation or have significant non-native vegetation populations. In many cases, riparian plantings and non-native vegetation removal will be part of other project feature types. However, there are instances when it may be the only proposed treatment, and will be identified in this manner. Fencing may be included in this type of project if necessary to keep livestock out of a newly restored riparian area. To achieve the maximum fish and wildlife benefits from riparian restoration it would involve planting native tree and shrub species up to the maximum tree height potential immediately adjacent to the mainstem or tributaries (150 feet wide); however, this is not always feasible, and narrower riparian restoration is also considered. In some locations, banks may need to be sloped back to provide a suitable area for planting or revetments may need to be modified through rock removal and replacement with bioengineered materials and riparian plantings. Riparian restoration could also occur integrated into the existing pilings parallel to the banks in some locations.

Side Channel Restoration and Enhancement
This type of project would involve restoring and/or reconnecting side channel features, or enhancing an existing side channel. Side channel enhancement may be part of other project types. The scale and restoration approach may also vary from project to project. The simplest type of project would involve excavation to remove deposited materials to reconnect a remnant side channel. However, because of the heavy sediment load in the river, it will be absolutely necessary to analyze and design a side channel to maintain an opening. A side channel reconnection that is associated with a levee setback or located near adjacent floodplain infrastructure (bridges, houses, pipelines) could require significant engineering and construction work. Restoration can involve restoring historic overflow connections that are currently blocked and enhancement involves placement of cover and riparian plantings. Other types of side channel enhancement include creation of more stable groundwater fed channels for chum and coho spawning and rearing. These channels are typically designed to be protected from a 20-year flood and engineered. They can turn into active channels over time and have multiple functions.

In-Stream Structures
These projects could involve the placement of varying sizes of wood structures, log jams, or rock/boulders structures to create habitat complexity, trap sediment to increase channel stability, scour pools, sort spawning gravel and provide cover. These structures would require engineering to ensure they do not raise flood elevations or cause undesired effects on adjacent properties.

Tributary Enhancement
Tributary enhancement projects focus on the lower ends of tributaries and their deltas along the mainstem river. Typically these areas provide a range of habitats for migrating fish. For juveniles, the tributary floodplain deltas provide refuge, cover and foraging areas during downstream migration. Typically, alluvial tributary confluence areas are dynamic and complex floodplain environments with active sedimentation and channel dynamics that can provide an array of features including side channels, sloughs, and wetlands. Enhancement features could include placement of in-stream structures, setback of banks to create benches, riparian plantings or bioengineering of banks.

3.6 Project List

An initial list of potential project sites was developed from the review of the previous studies, aerial photos, and suggestions from the technical working group. This list was refined after the aerial and field reconnaissance trips to produce a final project list. This list has also been revised somewhat based upon comments from the working group and others, and additional evaluation of project elements and costs. The resulting potential project list is shown in **Table 15**. These sites are shown on the project site maps (**Figures 35 - 39**) and are identified based on their approximate River mile location. More details on each project are provided in Appendix A.

Table 15. Draft Potential Restoration Project List

Location ID	River Mile	Restoration Intent and Needs	Potential Features	Notes/Status
1.0C	0.0 to 1.5	Provide cover for juvenile salmonids; increase complexity without compromising navigation; riparian restoration for long-term cover, food web support, wood recruitment	Work with existing pilings to increase complexity and cover along shoreline; riparian revegetation	Pilings parallel along bankline are providing cover and protecting bank to some extent while also creating undercut banks/holes for refuge/rearing habitat
1.0C Alt	0.0 to 1.5	Provide channel complexity and cover for juvenile salmonid rearing and refuge, without compromising navigation;	Create deeper channels, with stable islands, riparian restoration	Tidal delta would have had distributary channels with extensive cover; Sitka spruce transitioning to brackish marsh and sloughs
0.0L	0	Reconnect historic tidal channels to provide estuary rearing opportunities for juvenile salmonids, riparian restoration	Setback levees, modify tide gates, riparian restoration	Reconnect and restore historic tidal slough channels for estuarine rearing
3.0L	3	Reconnect floodplain and side-channels to provide tidal slough rearing and detrital and primary production to estuary	Setback levees, modify tide gates, riparian restoration	CLT currently doing this project
3.0R	3	Riparian restoration to provide cover, bank stability, and long-term wood recruitment to channel	Riparian plantings suitable to elevation; possible slope back banks if needed	CLT land, supplement on-going restoration
3.1T	3.1	Create habitat node at lower end of MS LB Trib 1; riparian restoration, bank sloping, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, and long-term LWD	Enhance lower end of trib
4.5T	4.5	Create habitat node at lower end and delta of Impie Creek; riparian restoration, bank sloping for stability, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, and long-term LWD.	Lack of riparian trees is exaggerating erosion problems in addition to lack of cover
4.7T	4.7	Create habitat node at lower end and delta of Malone Creek; riparian restoration, bank sloping for stability, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, and long-term LWD	Lack of riparian trees is exaggerating erosion problems in addition to lack of cover
4.7R	4.7 - 4.9	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Excavate banks and side channel; key to keep channel open is to place structure in-stream at both ends to promote scour. Because this is still tidal, need to be able to scour sands and small gravel	excellent site downstream of bridge for local floodplain restoration, incorporating above
5.0B	5	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Excavate banks and side channel; key to keep channel open is to place structure in-stream at both ends to promote scour. Because this is still tidal, need to be able to scour sands and small gravel	Opportunity to reduce erosive forces on sharp bend while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
5.0T	5	Create habitat node at lower end and delta of Nikka Creek; riparian restoration, bank sloping for stability, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, and long-term LWD	Lack of riparian zone
5.5L	5.5	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Increase total quantity of perennial and ephemeral aquatic refugia and reduce bank erosion	Opportunity to reduce erosive forces and accommodate future sediment deposition by allow annual floodplain connections.
5.0-6.0B	5 -6	Riparian restoration along mile long reach with limited riparian zone; place in-stream structures as appropriate to provide cover for juvenile salmonids and create stable bars/islands	Provide long-term cover and enhance stability of banks with riparian zone; provide structures to stabilize bars/islands and deepen flow-through channels	Provide cover and rearing habitat for chinook and coho in upper end of tidal range. Lower bank is armored with riprap, large alders are falling into channel which will further destabilize banks.
6.5L	6.0-6.5 L	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Increase total quantity of perennial and ephemeral aquatic refugia and reduce bank erosion	Excellent site for restoration of an anabranching channel that could increase extent and quality of aquatic & riparian habitat several fold.
6.7B	6.7	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Provide cover, habitat diversity, and reduce erosive forces on sharp bend	Opportunity to reduce erosive forces on sharp bend while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
6.7T	6.7	Create habitat node at lower end and delta of Thadbar Creek; riparian restoration, bank sloping for stability, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, and long-term LWD	Lack of riparian zone
7.5B	7.5	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	EXISTING PROBLEM SITE: Sedimentation has formed a mid-channel bar which is becoming a vegetated island and contributing to erosion of river banks on either side - a condition that will likely continue. Floodplain easement would allow channel migration to proceed within specific bounds determined by landowners	Right bank actively eroding into field lacking trees. Current depositional zone and eroding banks;opportunity to widen channel to allow river to restore an anabranching morphology (its natural tendency) with setback protection from erosion. Continued deposition at this site could raise flood stages and continued erosion will contribute more sediment to downstream reaches. Channel deformation will proceed upstream and downstream without some sort of action.
7.5 C	7.5	Bar Apex Logjam	Create pool, refugia, and enhance floodplain restoration	This option will be excellent addition only if some version of floodplain restoration at RM 7.5 can be undertaken or stabilization of right and left banks.
7.0-8.0C	7-8 L, R	Provide cover for juvenile salmonids; increase complexity without compromising navigation; riparian restoration for long-term cover, food web support, wood recruitment	Work with existing pilings to increase complexity and cover along shoreline; riparian revegetation	Existing pilings located parallel to bank along much of lower river offer potential means of low-cost LWD placement that could enhance aquatic habitat and improve bank stability.
8.0B	8	Floodplain/side-channel restoration	Provide cover, habitat diversity, and reduce erosive forces on sharp bend	Opportunity to reduce erosive forces on sharp bend while creating side-channel and riparian restoration, also reduce in-channel sediment deposition. Reforestation of floodplain on left bank within sharp bend would provide improve overall benefits but design will need to carefully consider development on right bank.
8.2T	8.2	Riparian restoration and tributary enhancement, lower mile of Hull Creek	Control invasive species. Provide cover, bank stability, and long-term LWD recruitment to important tributary habitat for coho and steelhead	Lack of riparian zone; reed canary grass occupying channel
9.5R	9.3	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Reconnect existing oxbow(s); excavate connection to channel. Key is to place structures to cause continued scour at entrance and exit	Remenant oxbow wetland located about 700 ft off right bank offers excellent floodplain restoration opportunity.
9.0-10.0B	9.0-10.0	Riparian reforestation	Slope banks back as feasible, replant, place anchored wood for cover along shoreline or integrate with pilings as present	Reach lacking riparian buffer
9.0-10.0C	9.0-10.0	Provide cover for juvenile salmonids; increase complexity without compromising navigation; riparian restoration for long-term cover, food web support, wood recruitment	Work with existing pilings to increase complexity and cover along shoreline; riparian revegetation	Existing pilings located up and down much of lower river offer potential means of low-cost LWD placement that could enhance aquatic habitat and improve bank stability.
9.7R	9.7	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Provide cover, habitat diversity, and reduce erosive forces	Opportunity to reduce erosive forces while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
10.0R	10	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Provide cover, habitat diversity, and potential chum channel	Opportunity to reduce erosive forces while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
10.1L	10.1	In-stream structures at confluence of Kings Creek	Trap gravel from Kings Creek for chum spawning	Stabilize sediment and provide spawning habitat and cover; need to ensure doesn't cause bank erosion on opposite bank
10.1T	10.1	Riparian restoration and tributary enhancement, lower end of Kings Creek	Provide cover, bank stability, long-term LWD	
10.5C	10.5	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Provide cover, habitat diversity, and reduce erosive forces	Provide in-channel habitat, excavate gravel from large bar to provide side-channels
10.5C	10.5	Bar Apex Logjam	Create pool, refugia, and enhance floodplain restoration	This option will be excellent addition to if some version of floodplain restoration at RM 10.5 can be undertaken or stabilization of right and left banks.

Table 15 (continued)

Location ID	River Mile	Restoration Intent and Needs	Potential Features	Notes/Status
11.0R	11	Side channel and floodplain restoration to create off-channel rearing habitat for juveniles and take pressure off of eroding banks on mainstem	Provide cover, habitat diversity, and reduce erosive forces	Opportunity to reduce erosive forces on sharp bend while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
11.2L	11.2	Riparian restoration	Provide cover and bank stability upstream and downstream of covered bridge	Erosion occurring at left bank bridge abutments
11.5T	11.5	Create habitat node at lower end and delta of Klints Creek; riparian restoration, bank sloping for stability, place cover and structures in-stream to create pools and cover for adult holding and juvenile rearing	Provide cover, bank stability, long-term LWD	
11.8R	11.8	Off-channel habitat	Investigate if groundwater sufficient to water channel or if flow-through channel more appropriate	Opportunity to reduce erosive forces while creating side-channel and riparian restoration, also reduce in-channel sediment deposition; investigate chum channel potential
12.0R	12	Floodplain reconnection	Provide cover, habitat diversity, and potential chum channel	Opportunity to provide sediment deposition and off-channel habitat in fallow field; currently floods, but investigate if excavation to lower floodplain warranted or feasible
12.0L	12	Floodplain reconnection	Off-channel habitat, sediment deposition, flood storage	This floodplain is very low and easily lowered further for incremental flood storage and refuge habitat
12.3C	12.3	Evaluate and monitor mid-channel snag, possibly re-locate.	Large snag was deposited in center of channel and providing good local habitat. Snag should be monitored for movement, formation of logjam. If location poses unacceptable risk, snag can be moved to more appropriate location (~RM 12.6)	excellent opportunity to evaluate the role of natural wood recruitment and channel response, developing restoration strategy that works with natural processes
12.5L	12.5	In-channel enhancement: side channel creation (excavation and gravel removal combined with strategic wood placement)	Provide cover, habitat diversity and off-channel rearing and refuge	Opportunity to reduce erosive forces on sharp bend while creating side-channel and riparian restoration, also reduce in-channel sediment deposition
12.6R	12.6	Reconnect off-channel pond	Off-channel habitat and reduce stranding	LCFEG observed fish stranding after two recent floods; is old meander scar
13.5R	12.5 - 13.5	Side-channel and floodplain restoration; potential for groundwater fed channel due to steep slope adjacent	Off-channel habitat, habitat diversity, and cover. Reconnection of right bank floodplain would provide incremental flood storage for downstream communities	Excellent opportunity to restore historic side-channel and also provide sediment storage and reduce erosive forces on main channel. This is a site where sedimentation is already becoming a significant problem and will only continue to get worse. It is a priority site already identified in the sediment budget.
13.5L	13.5	Add in-stream deflectors along road to establish riparian buffer and prevent future riprap placement as has occurred recently	Habitat restoration and prevention of emergency road protection that has degraded habitat.	Relatively easy application to stabilize existing wood and add structure and deflection to improve buffer along road and improve aquatic and riparian habitat.
14.0B	14	In-channel enhancement (bar scalping and wood placement)	Create anabranching section for habitat diversity, restore riparian, provide LWD for sediment trapping, and reconnect old channel	Gorley reach currently actions being designed with BPA funding. Can supplement CREST project by reconnecting old channel for overflow, add'l placement of LWD, riparian restoration, etc.
14.0R	14	Groundwater channel, floodplain fencing, and riparian restoration	Chum spawning and coho rearing channel	Potential to feed via groundwater/hyporheic flow from Grays River and outlet into Crazy Johnson which will also increase Crazy Johnson outlet flow and reduce stranding. A key component will be floodplain roughness and riparian plantings to protect Crazy Johnson from avulsions.
14.0L	14.5	Place in-stream structures and reconnect historic channel south of vegetated island	Habitat diversity, sediment trapping and reconnect old channel for spawning and rearing	
15.0B	15	In-channel enhancement (bar scalping and wood placement)	Create anabranching section for habitat diversity and provide LWD for cover and sediment trapping	Potential to trap some sediment and create off-channel habitats above Gorley reach. Logjams are recommended for Gorely reach to improve development of anabranching channel, sediment storage, sustain pools and side channels.
15.0L	15	Channel connection to wetland	Off-channel rearing and refuge	Needs more investigation to determine elevations and possible connections
18.0B	18.5	In-channel enhancement (bar scalping and wood placement)	Create anabranching section for habitat diversity	Potential to trap some sediment and create diverse confluence habitat above mainstem.
18-21	18-21	Place wood structures to trap sediment	Increase habitat diversity and stabilize channel substrate; retain and trap sediment	Have not identified locations
21C	21	Place wood structures to trap sediment and direct flows. Stabilize existing logjams and construct new logjams	Increase habitat diversity and stabilize channel substrate; retain and trap sediment	
21R	21	Reconnect/restore Alder Creek ponds for off-channel rearing	Steelhead rearing	Provide flow-through or other frequent connection; likely need to maintain ability to use pond for water supplies.
Crazy Johnson 1	Lower mile	Provide in-channel and riparian restoration	Protect and enhance high quality spawning habitat	Potential for limited side-channel development, but do not want to disturb existing high quality habitat
Crazy Johnson 2	Upper area	Create groundwater channel to springs on hillslope to increase flows and provide additional chum spawning habitat	Investigate if groundwater sufficient to water channel; possibility to protect from avulsions	Ground is high floodplain, less susceptible to avulsions, but need to protect to prevent sedimentation of Crazy Johnson Creek
West Fork 2	Lower mile	Floodplain reconnection and placement of wood structures to stabilize sediment	Increase pool habitat in groundwater fed areas which has a high density of spawners and improve channel diversity and trap sediment	
West Fork 1	Lower mile	Remove levees to reconnect former floodplain		
West Fork 3	2.5	Modify hatchery intake to allow unhindered passage	Fish access, rearing, and spawning	Side-channel could be reconnected for juvenile access and reduce stranding
West Fork 4	2.5-3.5	Place wood structures to trap sediment and stabilize bars/islands	Provide cover, channel stability, trap sediment	Extensive old wood buried in floodplain, evidence of effectiveness at trapping sediment
West Fork 5	2.5-3.5	Breach or remove old road grade	Reconnect floodplain and side-channels for rearing and refuge; trap sediment	Close to 50% of floodplain is disconnected at frequent high flows
Fossil Creek 1	0-1	Realign to former channel and riparian restoration	Provide rearing habitat and natural formation of habitats	Floodplain in this area is very low and could provide flood storage and sediment trapping
Fossil Creek 2	Further upstrea	Riparian restoration	Provide cover, bank stability, and long-term LWD	
South Fork 1	0-0.5	Enhance and restore side channels and install wood structures to maintain scour	Provide off-channel habitat, stability and sediment retention.	
South Fork 2	0.5-1	Enhance and restore side channels and install wood structures to maintain scour	Provide off-channel habitat, stability and sediment retention.	
South Fork 3	0-0.5	Place wood structures to trap sediment and provide cover and pool scouring	Provide cover, enhance stability and sediment retention	
South Fork 4	0.5-1	Place wood structures to trap sediment and provide cover and pool scouring	Provide cover, enhance stability and sediment retention	

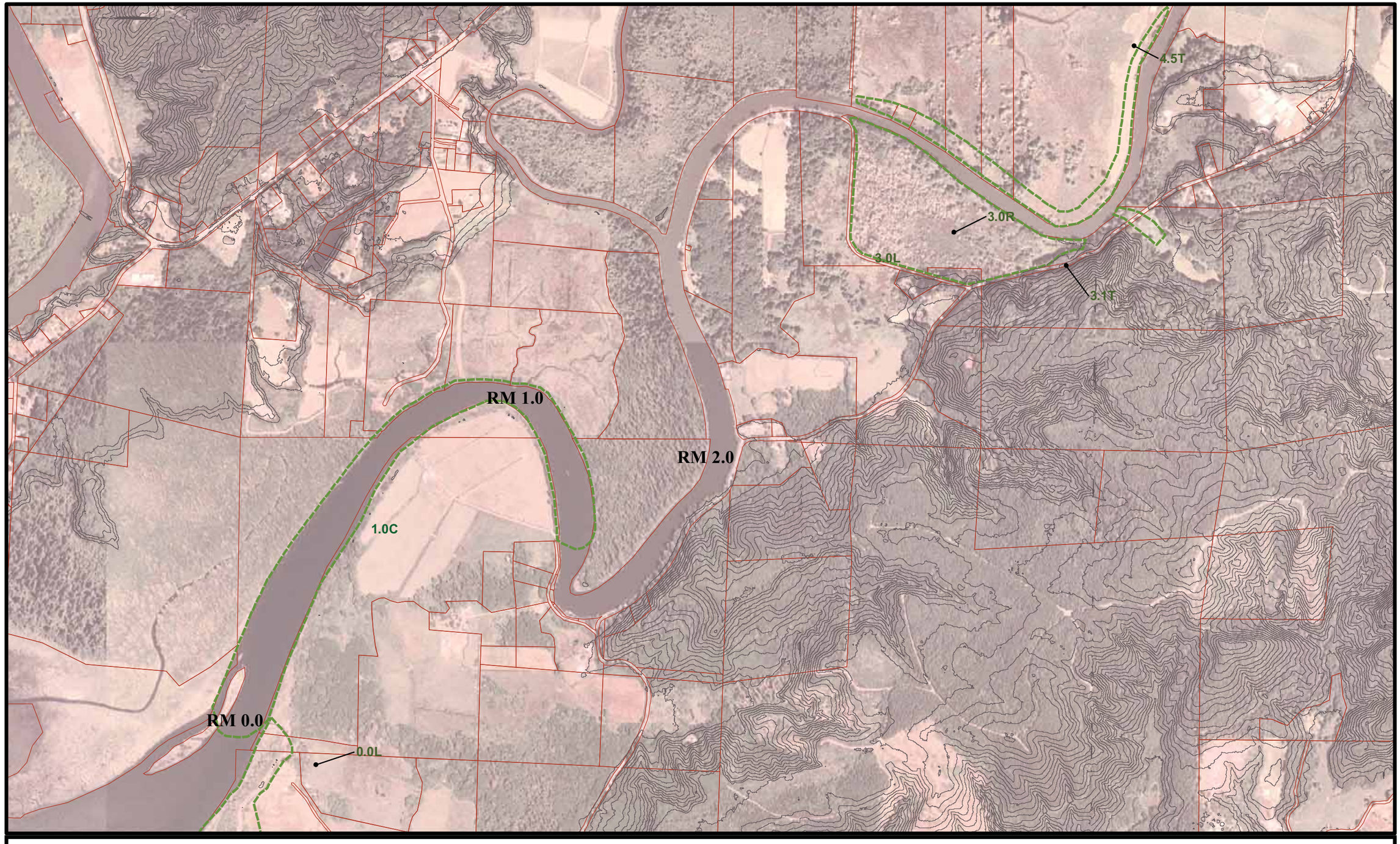

Figure 35. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Reach 1

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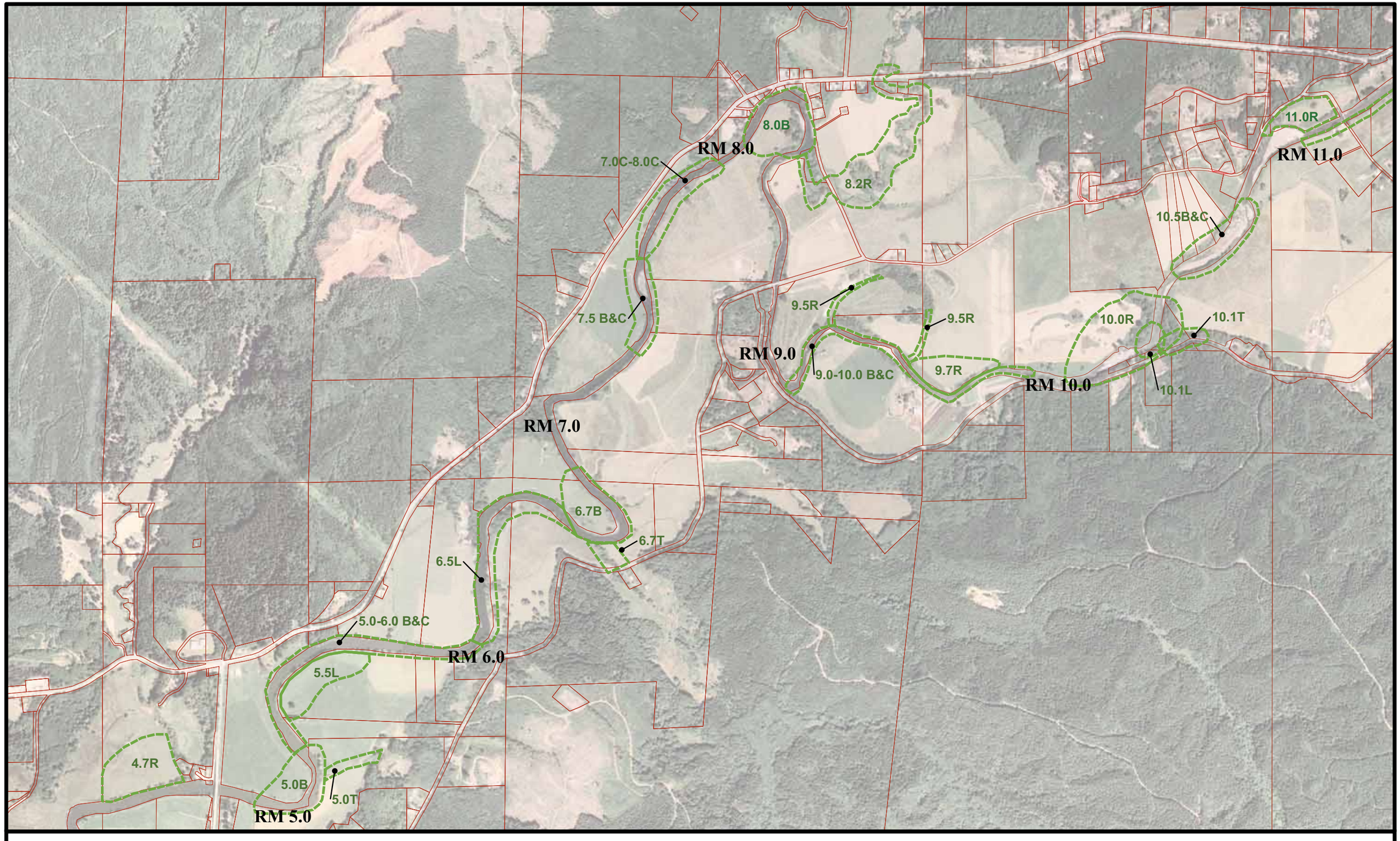

Figure 36. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Reach 2

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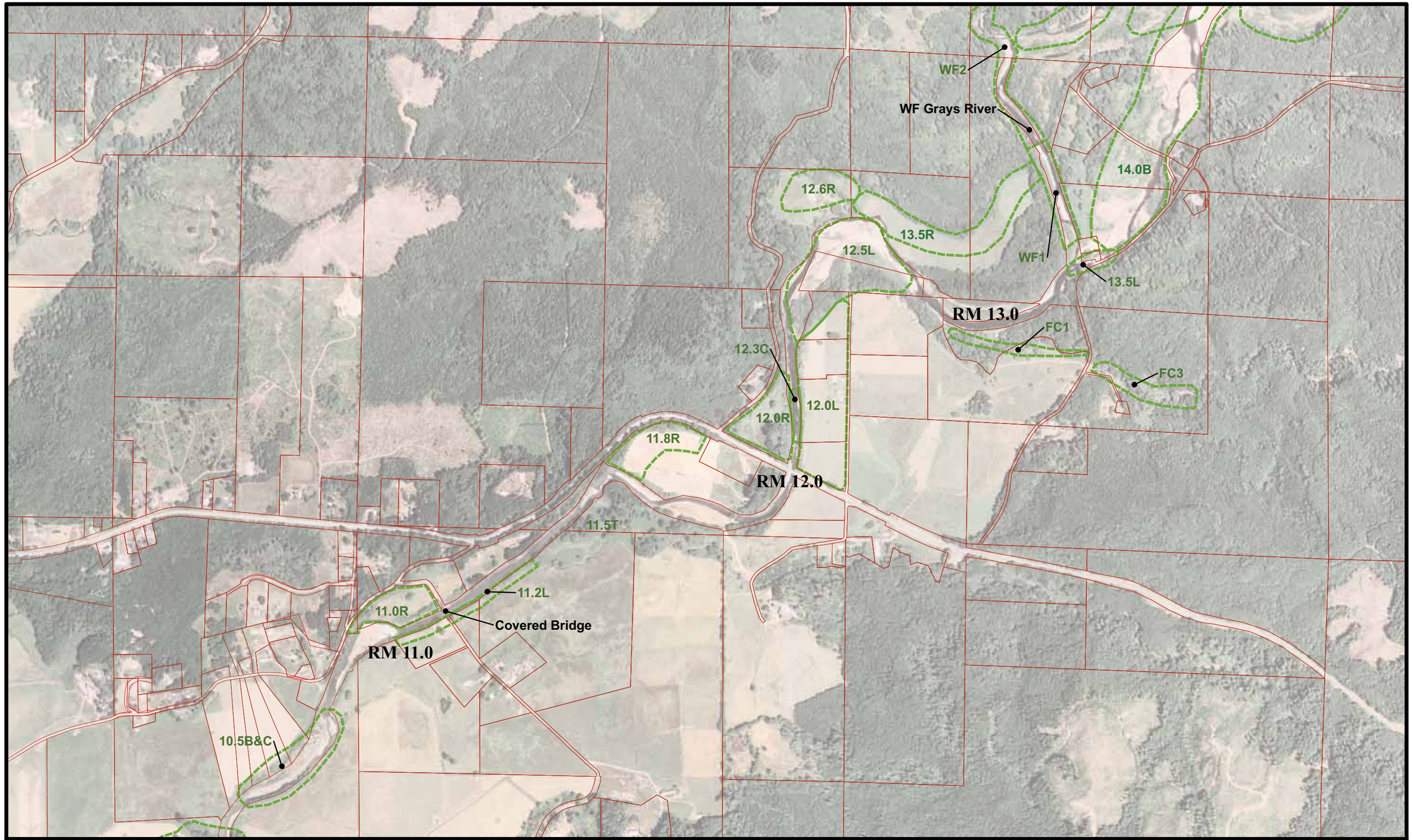

Figure 37. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Reach 3

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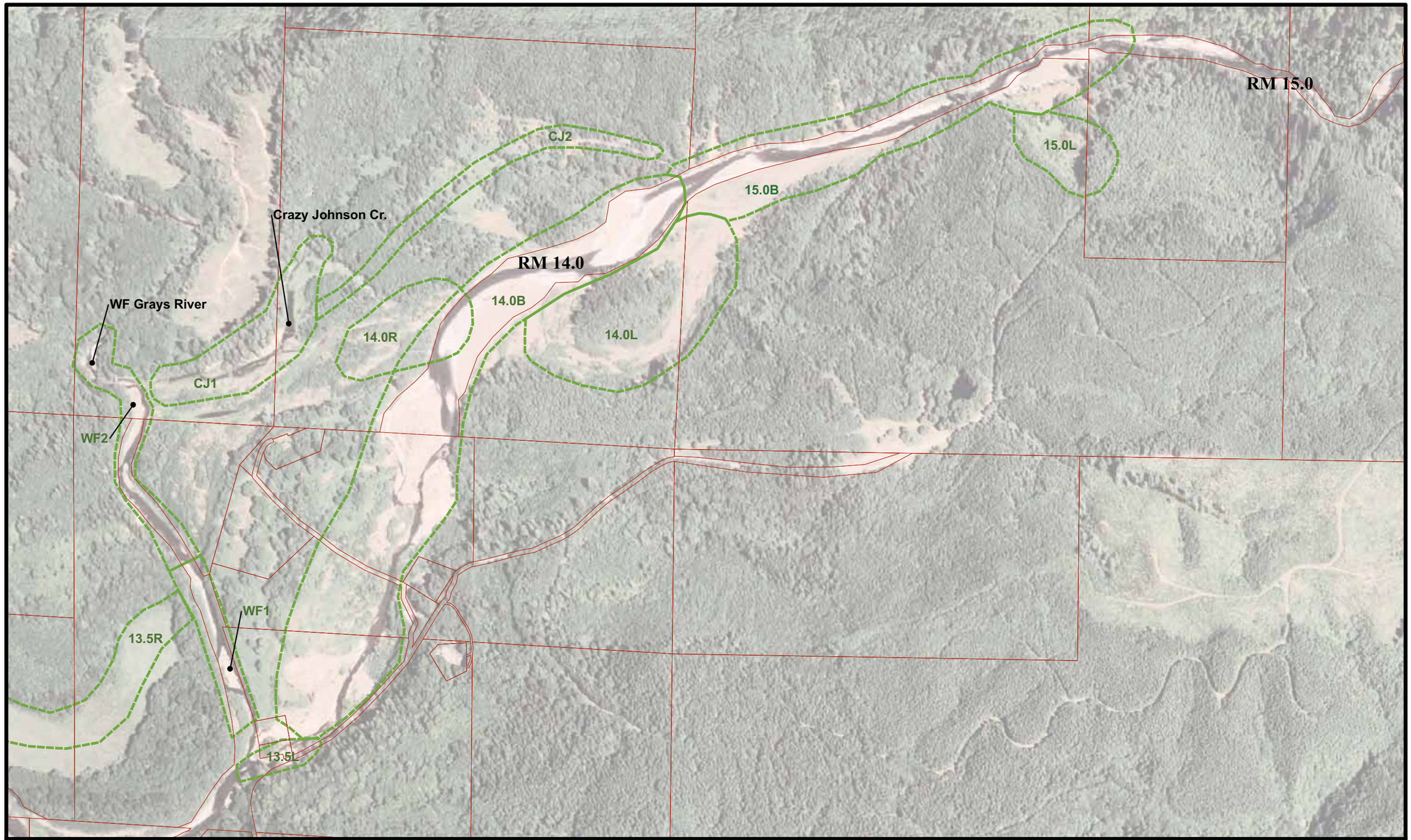

Figure 38. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Reach 4

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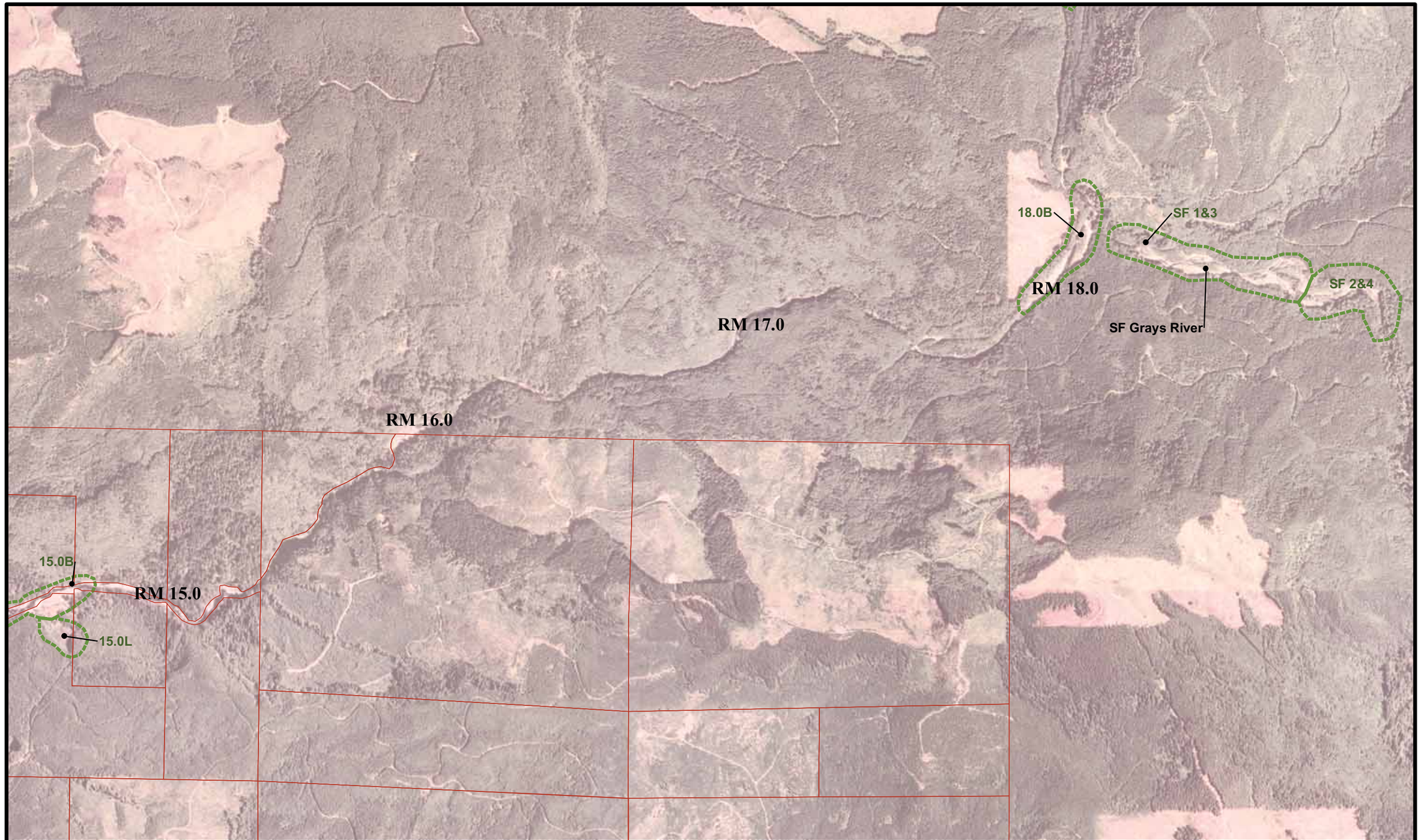

Figure 39. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Reach 5

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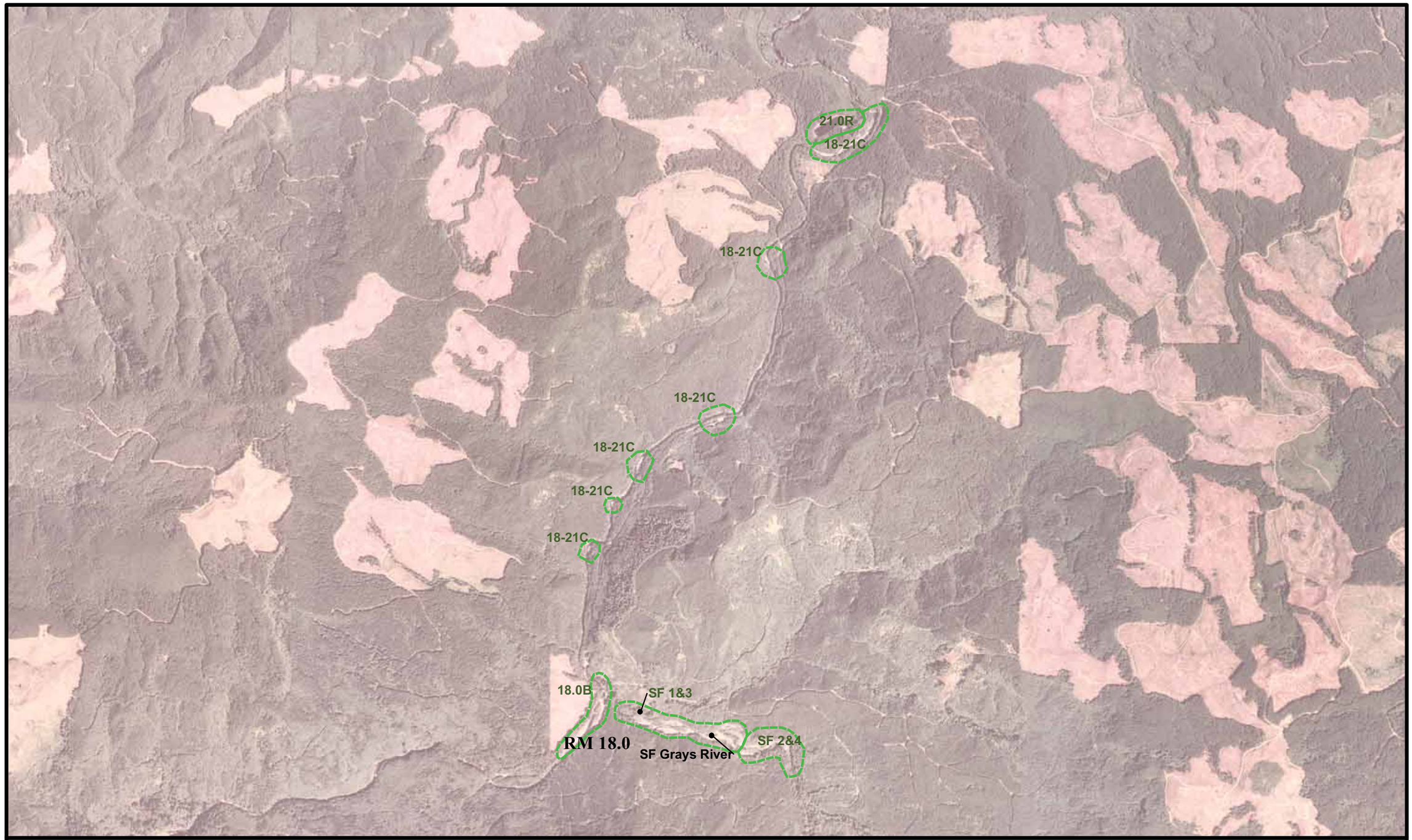

Figure 40. Draft Potential Projects
Grays River Community Habitat Restoration Plan
Upper Mainstem Grays / South Fork

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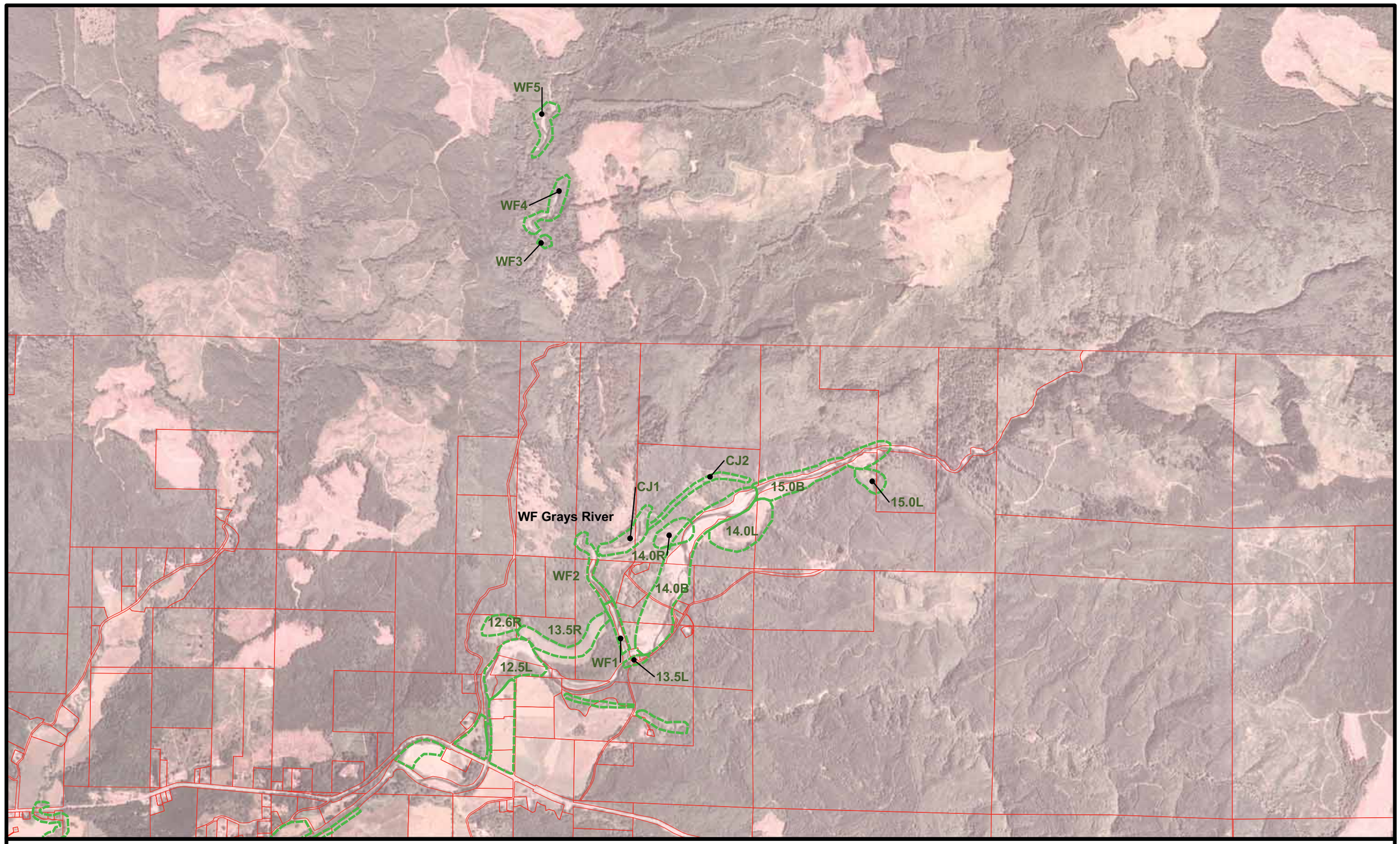

Figure 41. Draft Potential Projects
Grays River Community Habitat Restoration Plan
West Fork

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3.7 Project Cost Estimates

Preliminary cost estimates were developed for each potential project in **Table 14** using standard unit costs and conceptual level estimates of project lengths, widths, and potential volumes of excavation required based on the field reconnaissance. Potential feasibility of construction was evaluated to escalate the unit costs, such as when access is difficult to the site. These cost estimates are intended to be at a conceptual level to allow comparisons between projects and do not include costs to acquire easements. **Table 16** shows the unit costs used in the cost estimates and Appendix B contains the conceptual costs for each potential project.

Table 16. Unit Cost Assumptions.

Feature Type	Costs	Source
1. Riparian plantings	$10,000 per acre	Evergreen Funding Consultants 2003; Tetra Tech unpublished data
2. Excavate and haul sediment	$15-20/CY	Tetra Tech unpublished data; does not include escalation for future years fuel increases (assume 10% increase in fuel charges per year in future)
3. Bioengineer levee or bank protection	$400/linear foot	Evergreen Funding Consultants 2003; Tetra Tech unpublished data
4. Install piece of LWD	$1000/ea	Tetra Tech unpublished data
5. Import and place soil, substrate, rock	$50 - $70/CY	Waterfall Engineering and Tetra Tech unpublished data
6. Install large scale wood structure	$100k per structure	Evergreen Funding Consultants 2003; Tetra Tech unpublished data

3.8 Project Ranking and Prioritization

The ranking and prioritization of the Restoration Project Site List was conducted using the first step of a two step method developed by the LCFRB to rank grant applications for the Salmon Recovery Funding Board (SRFB). This method (LCFRB 2007) is briefly explained in this section. The first step ranks the projects primarily based on their expected benefits to salmonids and consistency with the Recovery Plan (LCFRB 2004). The two key components of the fish benefit evaluation are: 1) the importance of the fish populations, key life history stages, and associated limiting factors targeted by the project; and 2) the extent to which the project will address the targeted limiting factors. Costs were not included in this ranking, but are shown for comparison.

The second step of the evaluation considers the certainty of success of a project. This evaluation is primarily concerned with how likely it is that a project will achieve its proposed benefits or can actually be implemented. Because the projects described in this document are not at the point where a grant application would be submitted to construct them, the certainty of success evaluation was not included in this ranking. The key elements of the certainty of success evaluation are: 1) project scope – is the scope tied directly to the stated goals and objectives and does it account for the causes of the limiting factors in the project reach? 2) project approach – does the project approach utilize proven and accepted technologies and does it account for potential risk of failure? 3) coordination and sequencing – is the project logically sequenced with other habitat projects completed, underway or planned in the subbasin and coordinated with other plans or programs? 4) uncertainties and constraints – does the project account for physical, legal, technical or other uncertainties or constraints such as future development? 5) sponsor qualifications – is the sponsor qualified to design and construct a project? 6) community and

landowner support – is the landowner willing? and are affected members of the community supportive? and 7) stewardship – who will perform monitoring and maintenance over time?
Benefit to fish ratings and scores are the product of:

- A population/reach rating and score
- A benefit rating and score;
- A cost reasonability score (not included in this document)

Population/reach ratings and scores reflect the degree to which a project targets priority populations and reaches, and is based on the Tier of the reach in which a project is located. Tier 1 reaches are ranked high, Tier 2 reaches are ranked medium, and Tier 4 reaches are ranked low. In addition to the reach rating, each project receives a score based on the populations of salmonids in the reach (Primary = 3, Contributing = 2, Stabilizing = 1) plus the species reach potential (high, medium, low) for each population using the reach. All salmonid populations in the Grays River are Primary populations.

Benefit ratings and scores reflect whether a project targets priority habitat project needs and the extent to which a project would address those needs. Scores are derived from the protection/access/restoration scores. For the projects in this document, only the restoration scores are used. The restoration rating is based on the EDT-derived multiple species restoration type ratings (high, medium, low) provided in the Habitat Work Schedule (LCFRB 2008). The benefit score is the product of the restoration type rating times the number of habitat units time an effectiveness factor. A habitat unit equals:

- 500 linear feet on both sides of the stream or 1000 feet on one side of the stream for riparian and floodplain projects; or
- 500 feet of stream length for instream project types.

The effectiveness factor reflects a percentage estimate of the extent to which the project would address the project type within a targeted habitat unit. For example, a riparian restoration project would be considered fully effective if it was designed to achieve the maximum tree height potential (150 feet) on each bank where restoration occurred (100% effectiveness). If the riparian restoration was proposed to be only 100 feet in width it would be 2/3 effective (67% effective).

Based on the above benefit evaluation, the detailed scoring sheet is shown in Appendix C, and the draft ranking is shown in **Table 17**. Concept designs for the yellow highlighted projects are provided in Appendix D.

Table 17. Draft Ranking of Potential Projects.

Project ID	Project Name	Pop/ Reach Score	PAR Score	Total Benefit Score	Preliminary Cost	Pop/Reach Rank	PAR Rank	Overall Priority Grouping
14.0B	In-channel enhancement	21	42.00	63.00	$1,600,000	H	H	1
15.0B	In-channel enhancement	21	30.00	51.00	$1,200,000	H	H	1
13.5R	Side channel and floodplain restoration	21	26.04	47.04	$500,000	H	H	1
14.0L	In-channel enhancement	21	24.00	45.00	$750,000	H	H	1
10.5B	Side channel and floodplain restoration	22	22.50	44.50	$300,000	H	H	1
12.5L	In-channel enhancement	21	18.00	39.00	$600,000	H	H	1
SF1	In-channel enhancement	6	30.00	36.00	$1,100,000	H	H	1
CJ2	Groundwater channel	14	20.00	34.00	$250,000	H	H	1
11.8R	Groundwater channel	21	12.02	33.02	$400,000	H	H	1
F2	Riparian restoration	15	15.00	30.00	$125,000	H	H	1
SF2	In-channel enhancement	6	24.00	30.00	$900,000	H	H	1
11.0R	Side channel and floodplain restoration	22	7.50	29.50	$85,000	H	H	1
CJ1	In-channel enhancement	14	15.00	29.00	$200,000	H	H	1
11.5T	Tributary enhancement	9	18	27.00	$225,000	H	H	1
14.0R	Groundwater channel	21	6.00	27.00	$250,000	H	H	1
12.0L	Floodplain restoration	21	6.00	27.00	$750,000	H	H	1
12.0R	Floodplain restoration	21	4.80	25.80	$700,000	H	H	1
15.0L	Connection to wetland	21	4.50	25.50	$250,000	H	H	1
11.2L	Riparian restoration	22	3.02	25.02	$35,000	H	H	1
10.5C	In-channel enhancement	22	3.00	25.00	$225,000	H	H	1
F1	Floodplain restoration	15	9.00	24.00	$80,000	H	H	1
18.0B	In-channel enhancement	6	18.00	24.00	$600,000	H	H	1
12.6R	Reconnect off-channel ponds	21	2.70	23.70	$150,000	H	H	1
10.1L	In-channel enhancement	22	1.50	23.50	$75,000	H	H	1
13.5L	In-channel enhancement	21	1.50	22.50	$100,000	H	H	1
12.3C	In-channel enhancement	21	0.30	21.30	$100,000	H	H	1
SF3	In-channel enhancement	6	15.00	21.00	$300,000	H	H	1
SF4	In-channel enhancement	6	12.00	18.00	$250,000	H	H	1
9.5R	Side channel and floodplain restoration	19	27.00	46.00	$200,000	M	H	3
7.0-8.0C	In-channel enhancement	16	30.00	46.00	$250,000	M	H	3
10.0R	Side channel and floodplain restoration	19	27.00	46.00	$400,000	M	H	3
7.5B	Side channel and floodplain restoration	16	26.00	42.00	$900,000	M	H	3
9.0-10.0B	Riparian restoration	19	20.10	39.10	$1,000,000	M	H	3
9.7R	Side channel and floodplain restoration	19	15.00	34.00	$250,000	M	H	3
18-21	In-channel enhancement	4	30.00	34.00	$1,500,000	M	H	3
9.0-10.0C	In-channel enhancement	19	7.50	26.50	$125,000	M	H	3
8.0B	Side channel and floodplain restoration	16	9.75	25.75	$350,000	M	H	3
10.1T	Tributary enhancement	13	10.02	23.02	$200,000	M	H	3
6.7T	Tributary enhancement	13	10.02	23.02	$200,000	M	H	3
3.1T	Tributary enhancement	14	7.01	21.01	$110,000	M	H	3
7.5C	In-channel enhancement	16	3.00	19.00	$225,000	M	H	3
21C	In-channel enhancement	4	15.00	19.00	$750,000	M	H	3
21R	Restore Alder Creek pond	4	6.00	10.00	$250,000	M	H	3
WF2	In-channel enhancement	15	30.00	45.00	$700,000	M	M	4
WF4	In-channel enhancement	15	30.00	45.00	$900,000	M	M	4
WF1	Floodplain restoration	15	18.00	33.00	$250,000	M	M	4
WF5	Floodplain restoration	15	12.00	27.00	$150,000	M	M	4
WF3	Modify hatchery intake	15	12.00	27.00	$250,000	M	M	4
0.0L	Restore tidal slough	17	40.00	57.00	$400,000	L	M	5
3.0L	Reconnect floodplain and sloughs	21	26.40	47.40	$500,000	L	H	5
3.0R	Riparian restoration	21	22.50	43.50	$250,000	L	H	5
8.2R	Tributary enhancement	12	25.05	37.05	$400,000	L	H	5
1.0C	Pilings and LWD	17	20.00	37.00	$250,000	L	M	5
1.0C Alt	In-channel enhancement	17	16.00	33.00	$500,000	L	M	5
5.0B	Side channel and floodplain restoration	21	10.50	31.50	$500,000	L	M	5
5.0-6.0B	Riparian restoration	16	13.40	29.40	$1,000,000	L	H	5
4.7R	Side channel and floodplain restoration	21	7.00	28.00	$225,000	L	M	5
6.5L	Side channel and floodplain restoration	16	11.70	27.70	$300,000	L	H	5
4.5T	Tributary enhancement	12	13.02	25.02	$225,000	L	M	5
5.5L	Floodplain restoration	16	7.50	23.50	$250,000	L	H	5
5.0T	Tributary enhancement	13	10.02	23.02	$200,000	L	H	5
6.7B	Side channel and floodplain restoration	16	5.20	21.20	$250,000	L	H	5
4.7T	Tributary enhancement	4	6.01	10.01	$250,000	L	L	5

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3.9 Overall Sequencing of Projects

In general, implementation of projects higher up in the watershed, first, will be more beneficial because of the need to reduce the sediment load entering the lower basin prior to undertaking projects in the lower basin. The installation of wood structures designed specifically to trap sediment and create stable bars/islands and pools in the upper mainstem, South Fork, and West Fork are of high priority. Work is currently on-going to design and implement wood structures in Reach 4. However, riparian restoration projects throughout the study area are likely to have benefits and take a number of years to realize those benefits, so conducting riparian restoration projects sooner will help to realize the benefits more quickly.

Implementation of the major elements of this report, along with hillslope actions in the upper watershed, will significantly assist in the restoration of natural processes in the basin. The implementation of individual projects designed to stabilize and restore fish habitat will provide key habitat elements in the near-term to benefit and stabilize fish populations, now, while longer term projects such as sediment control and riparian restoration are developing and contributing to the restoration of the natural processes and providing the basis for the longer term recovery of salmonid populations.

Because the implementation of these restoration projects still does not fully address the underlying major problem of sediment erosion and deposition in the watershed, it is recommended that an evaluation of the potential to acquire or restore steep slopes and wide stream corridor buffers in the upper basin for restoration purposes should be undertaken with the timberland landowners. It will be beneficial to timber owners to reduce the erosion of topsoil and roads in order to maintain long-term forest rotation viability and access. Also, because the Grays River watershed is so important for salmon recovery in the Lower Columbia region, addressing the sediment problems at their source appears not only feasible, but highly important to the fish recovery goals of a variety of state and federal agencies.

In addition, an evaluation of the potential to floodproof or remove flood prone structures from the floodplain in the lower valley to reduce economic damages would also be highly beneficial. Considering that the total price of implementing these identified restoration projects will likely exceed $40,000,000, spending funds to reduce economic damages will make it more viable to actually implement restoration projects in the watershed.

Also, an assessment of invasive species throughout the basin could help prioritize areas to remove invasives and replant native species (particularly remove Japanese knotweed, etc. along Hull Creek).

A proposed sequence of actions is shown below for integration into the Six-Year Habitat Work Schedule developed by the LCFRB.

Action	2010	2011	2012	2013	2014	2015
Upper Watershed Assessment						
Floodproofing Assessment						
Invasive Species Assessment						
Riparian Restoration						
Structures to Trap Sediment above SR-4						
Floodplain and Side Channel Restoration						
In-Stream Structures in Lower River						

4. Conclusions

The assessment of potential habitat restoration projects conducted in this study identified sixty-three projects that could potentially be implemented in the lower Grays River watershed; ***if there are willing landowners***. This document is not a regulatory document and does not mandate the implementation of any projects. Rather, it provides guidance to potential project sponsors on projects which initially appear feasible to pursue and to landowners of the habitat restoration opportunities within the reaches that they live. This document will be most useful if it is updated over time as projects are implemented in the basin and lessons are learned on how projects have functioned, or as landowners and stakeholders identify further projects.

The potential projects identified in this assessment will address critical limiting factors for salmonids in the Grays River watershed, including habitat diversity, key habitats, and channel stability. Placement of structures in the upper study area will help reduce sediment loading to the lower river and allow any restoration measures undertaken in the lower river to function more effectively over time. Restoration of floodplain and off-channel and side channel habitats, placement of in-stream structures, and riparian restoration will significantly improve habitat diversity in the mainstem and restore many of the key habitats that historically existed and provided spawning, rearing, and refuge. This will improve egg incubation, fry colonization, 0-age summer and winter rearing, 1-age summer rearing, prespawning holding, migration, and improve spawning habitats. In the near term, restoration of key habitats for salmonids will assist in the stabilization of the populations and help to increase survival and viability. Over the long-term, it is important to restore natural processes that create and sustain habitats over time.

Implementation of the potential projects identified in this assessment will likely take many years and should be accomplished in a phased approach, to reduce sediment loading and restore riparian zones both beginning early and continuing for the long-term, and then move towards implementing floodplain, and side channel projects moving downstream. It should be recognized that all potential projects identified in this document have only been evaluated at a conceptual level. At many sites, more detailed designs and engineering analyses are needed. Some areas are unconfined without infrastructure and project implementation could proceed with a lesser level of engineering.

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APPENDIX A

PROJECT DESCRIPTIONS

Site 0.0L – Tidal Slough Restoration

Project Description

The intent of this project concept is to reconnect a remnant tidal slough/distributary channel near the entrance to Gray's Bay that is currently diked. This channel could be reopened to river/tidal flows and excavated to connect down into Gray's Bay. The remnant channel would cross up to 5 parcels that are privately owned, so could not accomplish without landowner agreement and easement.

Preliminary Costs

The preliminary construction cost estimate for this site is $400,000, and the design cost estimate is $125,000. Preliminary costs were based on an estimated 2,500 foot length channel and approximately 20 acres of associated riparian. An estimated removal of 10,000 CY was based on excavation of the 2,500 foot channel to average 5 feet in depth with a 40 foot width. An in-stream structure would be placed at the entrance and approximately 100 pieces of wood would be placed in and along the channel. Does not include costs for acquisition of real estate or easement.

Elements for Fish Benefit Scoring

- **EDT Reach**: Grays Estuary Tidal, Tier 2[1].
- **Populations**: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- **Limiting Factors Addressed:**
    - Off-channel and side-channel habitat (create approximately 2,500 feet)
    - Floodplain function (provide additional distribution of flows)
    - Riparian conditions and function (restore 20 acres of riparian along length of channel)
    - Breach or lower dikes and levees to improve access to off-channel habitats (reconnect remnant channel that is currently not connected)
- Current habitat conditions are degraded because remnant channel/slough has been disconnected from the river and Gray's Bay. Riparian zone has been diminished due to adjacent land uses (pasture, etc.). Sediment is moving into this lower reach from upstream; need to place wood to promote scouring to keep channel open.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of channel, with riparian for 150 feet wide on both banks, assumes 100% effective for 2.5 and 5 HUs, respectively.
- **Primary Species /Life History Stages to Benefit:**
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, evaluation of reference tidal slough(s), detailed engineering. Need to evaluate setback dike behind this area to protect other land uses.

[1] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 1.0C – In-Channel Enhancement

Project Description

The intent of this project concept is to increase cover and channel diversity that would likely have existed historically in the estuary by working with the existing pilings located parallel to the banks and interweaving wood, etc. to provide a significant component of cover. It is likely that this would also facilitate sediment deposition behind and within the structures. Prior to dredging of the lower river for navigational purposes, it is likely there were significant quantities of stable wood and multiple channels and distributary channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both in-basin and out-of-basin stocks. This project should be phased to allow monitoring and redesign of future structures as appropriate to work with on-going sediment regime. Wood currently passes through this reach of the river, and/or is intercepted and removed upstream.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $90,000. The preliminary costs were based on an estimated 5,000 foot length of the main channel that would be treated. Included placement of 200 pieces of large wood in with and along the pilings. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Elements for Fish Benefit Scoring

- **EDT Reach**: Grays Estuary Tidal, Tier 2[2].
- **Populations**: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- **Limiting Factors Addressed:**
  - Stream channel habitat structure
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation.
- Effectiveness was based on assumptions:
  - Restoration of 5,000 feet of main channel habitat structure, assumes 100% effective for 10 HUs.
- Species and Life History Stages to Benefit:
  - Chinook and chum 0-age rearing
  - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, survey of piling locations and bathymetry, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

[2] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 1.0C Alt – In-Channel Enhancement

Project Description

The intent of this project concept is to increase channel diversity by creating additional channels in areas where feasible by creating a stable island to split the flow. Prior to dredging of the lower river for navigational purposes, it is likely there were significant quantities of stable wood and multiple channels and distributary channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both in-basin and out-of-basin stocks. This project should be phased by conducting a demonstration project initially to allow monitoring and redesign of future features as appropriate to work with on-going sediment regime.

Preliminary Costs

The preliminary construction cost estimate for this site is $500,000, and the design cost estimate is $100,000. The preliminary costs were based on an estimated 4,000 foot length of the main channel that could be treated. Includes placement of 4 in-stream structures with islands. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Elements for Fish Benefit Scoring

- **EDT Reach**: Grays Estuary Tidal, Tier 2[3].
- **Populations**: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- **Limiting Factors Addressed:**
  - Stream channel habitat structure
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation.
- Effectiveness was based on assumptions:
  - Restoration of 4,000 feet of main channel habitat structure, assumes 100% effective for 8 HUs.
- Species and Life History Stages to Benefit:
  - Chinook and chum 0-age rearing
  - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, bathymetric survey, hydrologic/hydraulic analysis, sediment evaluation, evaluation of reference tidal channels, detailed engineering.

[3] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 3.0L – Reconnect Floodplain and Sloughs

Project Description

This project is currently being implemented by the Columbia Land Trust. The intent of this project concept is to reconnect a large floodplain area that is currently partially isolated behind a berm. Reopening this floodplain would allow the natural formation of sloughs and off-channel habitats. Riparian and floodplain revegetation would also occur, along with raising Mill Road to prevent flooding of adjacent parcels. This habitat would be utilized by juvenile salmonids for rearing habitat. This benefit would be provided to both in-basin and out-of-basin stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $500,000, and the design cost estimate is $125,000. The preliminary costs were based on an estimated 2,200 feet along the mainstem, with excavation of approximately 10,000 CY of berm material, placement of two in-channel structures, and an additional 100 pieces of large wood in the tidal floodplain. The property is owned by the Columbia Land Trust.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1 Tidal, Tier 2[4].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore floodplain and tidal slough habitats.
- Limiting Factors Addressed:
    - Off-channel and side-channel habitats
    - Breach or lower dikes and levees to improve access to off-channel habitats (reconnect remnant channel that is currently not connected)
- Current habitat conditions are degraded because site has been logged and largely disconnected from the river.
- Effectiveness was based on assumptions:
    - Restoration of floodplain along 2,200 feet of main channel, assumes 100% effective for 2.2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Need topographic survey, hydrologic/hydraulic analysis, sediment evaluation, evaluation of reference tidal slough(s), detailed engineering.

[4] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 3.0R – Riparian Restoration

Project Description

The intent of this project concept is to restore a minimum 150 foot wide riparian zone along nearly one mile of the right bank of the main channel. This property is primarily owned by the Columbia Land Trust and was former pastureland with virtually no forested riparian cover remaining.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $50,000. The preliminary costs were based on an estimated 4,500 foot length of riparian restoration along the main channel. Includes placement of 50 pieces of large wood. This estimate does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1 Tidal, Tier 2[5].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would provide cover, large wood recruitment, and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because riparian zone was logged and has been in agricultural uses for many decades.
- Effectiveness was based on assumptions:
    - Restoration of 4,500 feet of riparian zone on right bank only to 150 feet in width, assumes 100% effective for 4.5 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Need topographic survey, evaluation of reference tidal riparian, revegetation designs.

[5] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 3.1T – Tributary Enhancement – LB Trib 1

Project Description

The intent of this project concept is to enhance the lower end of Mainstem LB Tributary 1 by riparian restoration, placement of large wood, and some excavation to create a riparian bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $110,000, and the design cost estimate is $40,000. The preliminary costs were based on an estimated 700 foot length of the tributary that would be enhanced. Includes excavation of approximately 3,000 CY of soils and placement of 20 pieces of large wood, along with 4 acres of riparian revegetation. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Mainstem LB Trib 1, Tier 2.
- Populations: winter steelhead (P), chum (P)
- Project would restore complex cover and habitat diversity to the lower end of this tributary.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because there is limited riparian zone, no wood and an incised narrow channel with limited floodplain.
- Effectiveness was based on assumptions:
    - Restoration of 700 feet of stream habitat structure, and riparian on both banks to a width of 100 feet, assumes 100% and 67% effective for 1.4. HUs each.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 4.5T – Tributary Enhancement – Impie Creek

Project Description

The intent of this project concept is to enhance the lower end of Impie Creek by riparian restoration, placement of large wood, and some excavation to create a riparian bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $225,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,500 foot length of the tributary that would be enhanced. Includes excavation of approximately 8,000 CY of soils and placement of 50 pieces of large wood, along with 7 acres of riparian revegetation. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Impie Creek 1, Tier 4.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the lower end of Impie Creek.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded due to channelization and lack of riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of stream channel habitat structure and riparian zone on both banks, assumes 100% and 67% effective, respectively, for 3 HUs each.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

4.7T – Tributary Enhancement – Malone Creek

Project Description

The intent of this project concept is to enhance the lower end of Malone Creek by riparian restoration, placement of large wood, and some excavation to create a riparian bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both stream and mainstem stocks. Unclear at this point if Malone Creek enters both Seal Slough and mainstem Grays, multiple drainage channels through ag field. Historic photos show it entering mainstem Grays. Also need to investigate fish passability of SR-4 crossing.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,800 foot length of the tributary that would be enhanced. Includes excavation of approximately 10,000 CY of soils and placement of 50 pieces of large wood, along with 8 acres of riparian revegetation. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Malone Creek 1, Tier 4.
- Populations: coho (P)
- Project would restore complex cover and habitat diversity to lower Malone Creek.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has been moved and channelized and there is limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,800 feet of stream channel habitat structure and riparian restoration to width of 100 feet on both banks, assumes 100% and 67% effective, respectively, for 3.6 HUs each.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to investigate if SR-4 crossing is fish passable and identify needs for setback levees to protect adjacent land uses.

Site 4.7R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses downstream of the Rosburg bridge, as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This benefit would be provided to both in-basin and out-of-basin stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $225,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,000 foot length of side-channel that would be excavated, placement of approximately 20 pieces of large wood, along with up to 12 acres of riparian and floodplain restoration. Cost does not currently include land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1D Tidal, Tier 2[6].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore a side-channel, riparian zone, and provide complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has uniform habitat, limited riparian zone, and complete lack of side channels in the lower river.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of side channel and riparian restoration, assumes 100% effective for 2 and 1 HU, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering to design to maintain channel without filling in. Need to evaluate need for a setback levee or similar to protect lands behind potential project.

[6] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 5.0B – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This benefit would be provided to both in-basin and out-of-basin stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $500,000, and the design cost estimate is $125,000. The preliminary costs were based on an estimated 1,500 foot length of side-channel that would be excavated (approx. 5,000 CY), placement of 2 in-channel structures and approximately 20 pieces of large wood, along with up to 18 acres of riparian/floodplain restoration. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1D Tidal, Tier 2[7].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore a side-channel, riparian zone, and provide complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has uniform habitat, limited riparian zone, and complete lack of side channels in the lower river.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of side channel and riparian restoration, assumes 100% effective for 3 HUs each.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering to design to maintain channel opening without filling in. Identify if setback levees are needed to protect adjacent land uses.

[7] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 5.0T – Tributary Enhancement – Nikka Creek

Project Description

The intent of this project concept is to enhance the lower end of Nikka Creek by riparian restoration, placement of large wood, and some excavation to create a riparian/floodplain bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $200,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,000 foot length of the tributary that would be enhanced. Includes excavation of approximately 6,000 CY of soils and placement of 25 pieces of large wood, along with 6 acres of riparian revegetation. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Nikka Creek 1, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore riparian, complex cover and habitat diversity to the lower end of Nikka Creek.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has been moved, channelized and there is limited riparian.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of stream channel habitat structure and riparian restoration to a width of 100 feet, assumes 100% and 67% effective, respectively, for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

A tidegate, considered a fish passage barrier by WDFW, is currently in use onsite, and should be addressed either prior to or concurrently with any habitat enhancement.

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 5.5L – Floodplain Restoration

Project Description

The intent of this project concept is to excavate back to create an inset and frequently connected floodplain. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses as well as providing habitat diversity and cover. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $87,500. The preliminary costs were based on an estimated 1,500 foot linear length of floodplain to be restored (10,000 CY). Includes placement of 20 pieces of large wood and 10 acres of riparian restoration. Does not include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1E Tidal, Tier 2[8].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain function and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel is uniform with higher floodplain terrace in agricultural land use and limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 linear feet of floodplain and riparian restoration, assumes 100% effective for 1.5 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Identify if setback levees are needed to protect adjacent land uses.

[8] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 5.0-6.0B – Riparian Restoration

Project Description

The intent of this project concept is to restore the riparian zone on both banks, as feasible, and availability of willing landowners. Banks would be sloped back as necessary to provide further bank stability and wood or rock could be placed at the toe if necessary. The riparian restoration is estimated to be a maximum of 100 feet in width on either bank to preserve farmable area.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,000,000, and the design cost estimate is $150,000. The preliminary costs were based on an estimated 5,000 foot length of the main channel that would be treated. Includes placement of up to 500 pieces of wood or similar at the toe, and approximately 30,000 CY of excavation to slope back the banks. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1E Tidal, Tier 2[9].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore riparian function along the main channel.
- Limiting Factors Addressed:
    - Riparian conditions and function
- Current habitat conditions are degraded because there is virtually no riparian zone for cover, shading, or long-term wood recruitment.
- Effectiveness was based on assumptions:
    - Restoration of 5,000 feet of riparian along both banks, assumes 67% effective for 10 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, engineering design and revegetation plans.

[9] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 6.5L – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $300,000, and the design cost estimate is $100,000. The preliminary costs were based on an estimated 900 foot length of side channel to be created. Includes placement of 1 in-stream structure, and 20 additional pieces of large wood, plus approximately 10 acres of riparian and floodplain restoration. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1E Tidal, Tier 2[10].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain function
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat, and there are essentially no side channels in the lower river. Sediment is moving into this lower reach from upstream; need to design features to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 900 feet of side channel habitat and riparian restoration, assumes 100% effective for 1.8 and 0.9 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering to design to maintain channel opening without filling in. Identify if setback levees are needed to protect adjacent land uses.

[10] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 6.7B – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $87,500. The preliminary costs were based on an estimated 400 foot length side channel to be excavated. Includes placement of 1 in-channel structure, and 10 pieces of large wood, plus approximately 5 acres of riparian and floodplain restoration. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1F Tidal, Tier 2[11].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain functions
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat, and there are virtually no side channels in the lower river. Sediment is moving into this lower reach from upstream; need to design features to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 400 feet of side channel habitat and riparian restoration, assumes 100% effective for 0.8 and 0.4 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

[11] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering to design to maintain opening. Identify if setback levees are needed.

Site 6.7T – Tributary Enhancement – Thadbar Creek

Project Description

The intent of this project concept is to enhance the lower end of Thadbar Creek by riparian restoration, placement of large wood, and some excavation to create a riparian/floodplain bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $200,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,000 foot length of the creek channel that would be enhanced. Includes placement of 25 pieces of large wood, riparian restoration on 5 acres and removal of 4, 5 00 CY of bank material. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Thadbar Creek 1, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the lower creek channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because the creek has virtually no wood and very uniform habitat, and limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of creek channel habitat structure and riparian zone, assumes 100% and 67% effective, respectively, for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, detailed engineering.

Site 7.5B – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $900,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 2,000 foot length of side channel to be restored. Includes placement of 2 in-channel structures, and 50 pieces of large wood, plus removal of approximately 35,000 CY of bank material and 20 acres of riparian restoration. Does not include costs for land acquisition and easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1G Tidal, Tier 2[12].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain functions
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has uniform habitat and limited riparian zone. Sediment has deposited in this area as an island and is causing bank erosion. Need to design features to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 linear feet of side channel habitat and riparian restoration, assumes 100% and 67% effective, respectively for 4 and 2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering

[12] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

to design to maintain opening and not fill in. Need to identify if setback levees are needed to protect adjacent land uses.

Site 7.5C – Bar Apex Logjam

Project Description

The intent of this project concept is to stabilize the existing bar and create deeper channels on both sides to enhance the split flow channel. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. Needs to occur in conjunction with bank/floodplain restoration at 7.5B.

Preliminary Costs

The preliminary construction cost estimate for this site is $225,000, and the design cost estimate is $78,750. The preliminary costs were based on an estimated 500 foot length of the main channel that would be treated. Includes placement of 2 wood structures. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1G Tidal, Tier 2[13].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 500 feet of main channel habitat structure, assumes 100% effective for 1 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, bathymetric and topographic surveys, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

[13] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 7.0-8.0C – In-Channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically in the lower river by interweaving wood with the existing pilings that are located parallel to the banks. Prior to dredging of the lower river for navigational purposes, it is likely there were significant quantities of stable wood and multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary. This project should be phased to allow monitoring of initial installations of wood to ensure it is providing effective habitat and to determine sediment deposition rate, etc.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $90,000. The preliminary costs were based on an estimated 5,000 foot length of the main channel that would be treated. Includes placement of 200 pieces of large wood. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1G Tidal, Tier 2[14].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P); out-of-basin stocks (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 5,000 feet of main channel habitat structure, assumes 50% effective for 10 HUs. Because wood placement does not bring stream habitat to properly functioning condition, effectiveness estimate was reduced.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, bathymetric and topographic surveys, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

[14] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 8.0B – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses at a sharp meander as well as providing habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $350,000, and the design cost estimate is $120,000. The preliminary costs were based on an estimated 750 foot linear length of side channel that would be restored. Includes placement of 1 in-channel structure, and placement of 20 pieces of large wood in the groundwater channel, with approximately 9 acres of riparian restoration. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1G Tidal, Tier 2[15].
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel and riparian zone.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has very uniform habitat, along with a limited riparian zone. Sediment is moving into this lower reach from upstream; need to design opening to not become buried.
- Effectiveness was based on assumptions:
    - Restoration of 750 feet of side channel habitat and riparian restoration, assumes 100% effective for 1.5 and 0.75 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to identify if setback levees are needed to protect adjacent land uses.

[15] Reach was rated as a Tier 4 reach in Grays EDT analysis, but because of the presence of out-of-basin stocks, for the purposes of rating, we have called it a Tier 2 reach.

Site 8.2T – Tributary Enhancement – Hull Creek

Project Description

The intent of this project concept is to enhance the lower end of Hull Creek by removal of invasive species, riparian restoration, placement of large wood, and excavation to create a riparian/floodplain bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $400,000, and the design cost estimate is $100,000. The preliminary costs were based on an estimated 2,500 foot length of the creek channel that would be enhanced. Includes placement of 50 pieces of large wood, excavation of 10,000 CY of material and riparian restoration on 12 acres. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Hull Creek 1A, Tier 4.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the creek channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because channel is incised and has virtually no wood and very uniform habitat and limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of creek channel habitat structure and riparian zone, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, detailed engineering.

Site 9.5R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to reconnect remnant oxbows for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide additional flow paths to relieve sheer stresses as well as providing off-channel habitat diversity and cover. Prior to dredging of the lower river for navigational purposes, it is likely there were multiple channels in the lower river. It will also reduce fish stranding by providing an outlet from these existing ponds/oxbows back to the river to reduce fish stranding following flood events. They key element of design is to keep the openings scoured open.

Preliminary Costs

The preliminary construction cost estimate for this site is $200,000, and the design cost estimate is $60,000. The preliminary costs were based on an estimated 1,800 foot length of side channel. Includes placement of 10 pieces of wood and riparian restoration on 8 acres. Cost does not currently include costs for land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1H Tidal, Tier 2.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore off channel habitat and provide return path to river to reduce stranding.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Floodplain functions
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because oxbows are isolated from the river with limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,800 feet of side channel habitat and riparian restoration, assumes 100% effective for 3.6 and 1.8 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to identify if setback levees are needed to protect adjacent land uses.

Site 9.0-10.0B – Riparian Restoration

Project Description

The intent of this project concept is to restore a minimum 100 foot wide riparian zone along nearly one mile of both banks of the main channel. This property is all agricultural land with limited forested riparian cover remaining. Also includes sloping back banks to provide more stability and could include placement of wood or rock at the toe. The riparian width has been reduced from the typically proposed 150 foot width for properly functioning conditions to reduce effects on farmland.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,000,000, and the design cost estimate is $150,000. The preliminary costs were based on an estimated 5,000 foot length of the main channel for riparian restoration. Includes placement of up to 500 pieces of large wood, and excavation to slope banks back to a more stable slope and provide a low floodplain bench. Cost does not currently include costs for land acquisition or easement that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1H Tidal, Tier 2.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore riparian habitats along the main channel and over time contribute wood to the channel.
- Limiting Factors Addressed:
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because there is very limited riparian zone and steep vertical banks.
- Effectiveness was based on assumptions:
    - Restoration of 5,000 linear feet of riparian zone, assumes 67% effective for 10 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, revegetation and slope designs.

Site 9.0-10.0C – In-Channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure by interweaving wood with existing pilings that are located parallel to the banks. Prior to settlement, it is likely there were significant quantities of stable wood and multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This project should be phased to allow monitoring of initial installations of wood to ensure it is providing effective habitat and to monitor effects on sediment transport and deposition.

Preliminary Costs

The preliminary construction cost estimate for this site is $125,000, and the design cost estimate is $40,000. The preliminary costs were based on an estimated 1,000 foot length of the main channel that would be treated. Included placement of 100 pieces of large wood. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1H Tidal, Tier 2.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has uniform habitat and virtually no wood. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of main channel habitat structure, assumes 50% effective for 1 HUs. Because wood placement is not bringing wood loading to properly functioning conditions, effectiveness estimate was reduced.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, bathymetric survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 9.7R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide a widened area for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to settlement, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,000 foot length of side channel. Includes placement of 1 in-channel structure, and 20 pieces of large wood, plus riparian restoration on 6 acres. Does not include costs for land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1H Tidal, Tier 2.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore side channel habitat and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Floodplain functions
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
- Current habitat conditions are degraded because channel has uniform habitat, limited wood and virtually no side channels in the lower river. Sediment is moving into this lower reach from upstream; need to design ELJ feature to keep side channel scoured open.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of side channel habitat and riparian restoration, assumes 100% effective for 1 HU.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to identify if setback levees are needed to protect adjacent land uses.

Site 10.0R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide an alternate flow path for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to settlement, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $400,000, and the design cost estimate is $125,000. The preliminary costs were based on an estimated 1,800 foot length of side channel that would be restored. Includes placement of 1 in-channel structure, and 10 pieces of large wood and riparian restoration on up to 10 acres. Does not include costs for land acquisition or easement that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 1H Tidal, Tier2.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P), out-of-basin stocks (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain function
    - Protect intact riparian areas in estuary and restore riparian areas that are degraded
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has limited wood and uniform habitat. This site has one of the better riparian zones along the river. Sediment is moving into this lower reach from upstream; need to design ELJ to keep side channel scoured open.
- Effectiveness was based on assumptions:
    - Restoration of 1,800 feet of side channel habitat and riparian restoration, assumes 100% effective for 3.6 and 1.8 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge
    - Out-of-basin stocks estuary rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to identify if setback levees are needed to protect adjacent land uses.

Site 10.1T – Tributary Enhancement – King Creek

Project Description

The intent of this project concept is to enhance the lower end of King Creek by riparian restoration, placement of large wood, and excavation to create a riparian/floodplain bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $200,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,000 foot length of the creek channel that would be enhanced. Includes placement of 25 pieces of large wood, and riparian restoration on 5 acres. Costs do not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: King Creek, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the creek channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because channel is incised with a narrow riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of creek channel habitat structure and riparian restoration, assumes 100% and 67% effective, respectively, for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 10.1L – In-Channel Enhancement

Project Description

The intent of this project concept is to place in-channel structures at the delta confluence of King Creek to create cover, and a node of habitat at the confluence. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. Need to investigate potential for creating chum spawning habitat.

Preliminary Costs

The preliminary construction cost estimate for this site is $75,000, and the design cost estimate is $26,250. The preliminary costs were based on an estimated 250 foot length of mainstem that would be enhanced. Includes placement of 10 pieces of large wood or other in-channel structures. Costs do not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat and function
- Current habitat conditions are degraded because channel has uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to stabilize sediment.
- Effectiveness was based on assumptions:
    - Restoration of 250 feet of mainstem habitat, assumes 100% effective for 0.6 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, bathymetric and topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to investigate potential for chum spawning at this location.

Site 10.5B – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander at this location. This type of project would provide an alternate flow path for the river to relieve sheer stresses as well as providing habitat diversity and cover. Prior to settlement, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $300,000, and the design cost estimate is $100,000. The preliminary costs were based on an estimated 1,500 foot length of side channel to be restored. Includes placement of 10 pieces of large wood and riparian restoration on 10 acres, plus excavation of 6,000 CY. Cost does not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain functions
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to promote scour at opening of side channel.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of side channel habitat and riparian restoration, assumes 100% effective for 3 and 1.5 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Need to investigate setback levee to protect adjacent land uses. Need to identify if setback levees are needed to protect adjacent land uses.

Site 10.5C – Bar Apex Logjam

Project Description

The intent of this project concept is to stabilize an existing bar by placement of in-channel structures. This project should be done in conjunction with 10.5B. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear in the estuary.

Preliminary Costs

The preliminary construction cost estimate for this site is $225,000, and the design cost estimate is $78,750. The preliminary costs were based on an estimated 500 foot length of the main channel that would be treated. Includes placement of 2 wood structures. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or promote undesired channel migration.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of main channel habitat structure, assumes 100% effective for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 11.0R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to provide off-channel habitat and an inset floodplain for very frequent connections to the mainstem river. As sediment accumulates in the main channel, it is causing the channel to migrate and meander. This type of project would provide an alternate flow path for the river to relieve sheer stresses at a meander as well as providing habitat diversity and cover. Prior to settlement, it is likely there were multiple channels in the lower river. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $85,000, and the design cost estimate is $30,000. The preliminary costs were based on an estimated 500 foot length of side channel and floodplain/riparian restoration. Includes placement of 10 pieces of large wood and riparian restoration on 3 acres. Cost does not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
    - Floodplain functions
- Current habitat conditions are degraded because there is limited riparian zone on vertical banks. Sediment is moving into this lower reach from upstream; need to design placement of wood to promote scour at opening of side channel.
- Effectiveness was based on assumptions:
    - Restoration of 500 feet of side channel habitat and riparian restoration, assumes 100% effective for 1 and 0.5 HUs, respectively.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Identify if setback levees are needed to protect adjacent land uses.

Site 11.2L – Riparian Restoration

Project Description

The intent of this project concept is to restore the riparian zone along the covered bridge area to promote additional bank stability and provide cover and long-term recruitment of wood. A 100-foot width riparian zone is proposed to minimize effects on farmland.

Preliminary Costs

The preliminary construction cost estimate for this site is $35,000, and the design cost estimate is $12,250. The preliminary costs were based on an estimated 1,500 foot length of riparian zone restored, plus some bank sloping. Costs do not include land acquisition or easements. After conceptual designs were prepared (Appendix D), it is likely that bank sloping and placement of wood or rock at the toe would be beneficial as well, thus the construction cost is more in the range of $150,000, with a design cost of $50,000.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore riparian zone along the main channel.
- Limiting Factors Addressed:
    - Riparian conditions and function
- Current habitat conditions are degraded because there is limited riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of riparian restoration to a 100-foot width, assumes 67% effective for 1.5 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, revegetation and bank slope designs.

Site 11.5T – Tributary Enhancement – Klints Creek

Project Description

The intent of this project concept is to enhance the lower end of Klints Creek by riparian restoration, placement of large wood, and excavation to create a floodplain bench for high flow refuge. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This benefit would be provided to both stream and mainstem stocks.

Preliminary Costs

The preliminary construction cost estimate for this site is $225,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,500 foot length of the creek channel that would be enhanced. Includes placement of 35 pieces of large wood and riparian restoration on 10 acres. Costs do not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Klints Creek 1, Tier 1.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the lower creek channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has uniform habitat. There is a moderate amount of riparian, but it could be enhanced.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of creek channel habitat structure and riparian restoration, assumes 100% effective for 3 HUs.
- Species and Life History Stages to Benefit:
    - Chum 0-age rearing; coho 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 11.8R – Groundwater or Side Channel

Project Description

The intent of this project concept is to create a groundwater fed channel in an area that is protected from upstream connection and sediment deposition. This channel could be protected by Highway 4. Previous investigations into groundwater at this site need to be reviewed, so there needs to be additional investigation before a channel is designed.

Preliminary Costs

The preliminary construction cost estimate for this site is $400,000, and the design cost estimate is $125,000. The preliminary costs were based on an estimated 1,200 foot length of groundwater channel that would be created. Includes placement of 1 ELJ, and 20 pieces of large wood, and riparian restoration on 20 acres. Cost does not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore off channel spawning and rearing habitat
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Riparian conditions and function
- Current site is partially agriculture higher floodplain with limited riparian zone
- Effectiveness was based on assumptions:
    - Restoration of 1,200 feet of groundwater channel habitat and riparian restoration, assumes 100% effective for 1.2 HUs.
- Species and Life History Stages to Benefit:
    - Chum spawning
    - Chinook and chum 0-age rearing; coho and steelhead juvenile refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, investigate groundwater potential, conduct topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 12.0R – Floodplain Restoration

Project Description

The intent of this project concept is to restore even more frequent flood connections to a relatively low existing floodplain that is currently not actively farmed. Plantings and high flow channels would be investigated. This would allow sediment deposition on the floodplain and frequent refuge for salmonids during high flows. It would also facilitate return flows back to the river after flood events to reduce stranding.

Preliminary Costs

The preliminary construction cost estimate for this site is $700,000, and the design cost estimate is $175,000. The preliminary costs were based on an estimated 800 linear foot length of floodplain restoration and removal of 30,000 CY of material. Includes placement of 1 ELJ, and 20 pieces of large wood and riparian restoration on 10 acres. Cost does not currently include land acquisition or easements that may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain functioning.
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
- Current habitat conditions are degraded because there is limited riparian and floodplain vegetation and habitat.
- Effectiveness was based on assumptions:
    - Restoration of 800 linear feet of floodplain and riparian restoration, assumes 100% effective for 0.8 HUs.
- Species and Life History Stages to Benefit:
    - Chinook, chum, coho, and steelhead refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Identify if setback levees are required to protect adjacent land uses.

Site 12.0L – Floodplain Restoration

Project Description

The intent of this project concept is to reconnect this lower floodplain for more frequent connections and facilitate return back to the river for salmonids after flood events to reduce stranding.

Preliminary Costs

The preliminary construction cost estimate for this site is $750,000, and the design cost estimate is $175,000. The preliminary costs were based on an estimated 1,000 linear foot length of floodplain restoration and removal of 30,000 CY of material. Includes placement of 1 ELJs, and 20 pieces of large wood, and riparian restoration on 15 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain functions and reduce stranding
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has been dredged in the past and has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried or obstruct navigation by small boats.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of floodplain and riparian, assumes 100% effective for 1 HU.
- Species and Life History Stages to Benefit:
    - Chinook, chum, coho, and steelhead refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 12.3C – In-channel Enhancement

Project Description

The intent of this project concept is to monitor and potentially enhance the existing wood and bar upstream of the Highway 4 bridge to ensure better stability of the large wood and provide a location for some sediment trapping and stabilization. Additional wood would be placed as a bar apex jam with the existing wood, if appropriate.

Preliminary Costs

The preliminary construction cost estimate for this site is $100,000, and the design cost estimate is $35,000. The preliminary costs were based on placement of 1 ELJ. In-channel work would be on DNR lands, does not include costs for DNR permit or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to not become buried, or if it is to continue to stabilize sediment in this reach.
- Effectiveness was based on assumptions:
    - Restoration of 200 feet of main channel habitat structure, assumes 100% effective for 0.2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 12.5L – In-channel Enhancement

Project Description

The intent of this project concept is to restore an existing side channel by excavating down to split the flows at the WDFW bar and provide in-channel structures to keep the channel scoured open and provide diverse cover and channel structure that would likely have existed historically.

Preliminary Costs

The preliminary construction cost estimate for this site is $600,000, and the design cost estimate is $150,000. The preliminary costs were based on an estimated 2,000 foot length of the side and main channel that would be treated. Includes excavation of 5,000 CY of material, placement of in-channel structures, and 20 additional pieces of large wood and riparian restoration on 7 acres. This work would be conducted on WDFW or DNR lands.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat, complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Off channel and side channel habitat
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has been filling in with sediment and side channel is only occasionally connected. Overall area has general lack of wood, except for recent project on right bank. Riparian habitat is young and dominated with many non-native species.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of side channel and main channel habitat structure, assumes 100% effective for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 12.6R – Floodplain Restoration

Project Description

The intent of this project concept is to reconnect an existing low swale that ponds water during high flows, but has been a recurring fish stranding area. This project would create a flow-through side channel/oxbow with riparian restoration.

Preliminary Costs

The preliminary construction cost estimate for this site is $150,000, and the design cost estimate is $52,500. The preliminary costs were based on an estimated 300 foot length of side channel/oxbow habitat. Includes placement of 50 pieces of large wood and riparian restoration on 5 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2A, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat and reduce stranding.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain function
- Current habitat conditions are degraded because remnant oxbow is disconnected and has been farmed and smoothed out. Causes fish stranding after high flows.
- Effectiveness was based on assumptions:
    - Restoration of 300 feet of side channel and floodplain, assumes 100% effective for 0.3 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Identify if setback levees are needed to protect adjacent land uses.

Site 13.5R – Side-channel and Floodplain Restoration

Project Description

The intent of this project concept is to create either a flow-through or groundwater fed side channel and restore floodplain and riparian habitats. This project could be fed by hyporheic flows from the West Fork Grays or if there is sufficient groundwater at the base of the steep bluff, could be a groundwater fed channel. Additional investigation is warranted prior to developing more detailed designs to determine if a flow-through or groundwater channel is most likely to succeed.

Preliminary Costs

The preliminary construction cost estimate for this site is $500,000, and the design cost estimate is $150,000. The preliminary costs were based on an estimated 2,000 foot length of side channel. Includes placement of 2 ELJs, and 50 additional pieces of large wood and riparian restoration on 12 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2B, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat and riparian function
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Floodplain functions
- Current site is not connected except at high flows and is farmed.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of off channel habitat and floodplain, assumes 100% effective for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum 0-age rearing; coho and steelhead 0-age and 1-age rearing
    - Chum spawning if groundwater fed

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, investigate groundwater, conduct topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 13.5L – In-channel Enhancement

Project Description

The intent of this project concept is to place in-channel structures along the left bank near Fossil Creek Road to replace end dumped riprap and other bank protection materials and provide complex cover to reduce velocities and scour pools. This project is likely to be part of the Gorley project in order to protect the road.

Preliminary Costs

The preliminary construction cost estimate for this site is $100,000, and the design cost estimate is $35,000. The preliminary costs were based on an estimated 500 foot length of the main channel that would be treated. Includes placement of 60 pieces of large wood or similar. Does not include costs for easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2C, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because of placement of rock on multiple occasions that has typically fallen in and moved downstream and continually eroding road embankment
- Effectiveness was based on assumptions:
    - Restoration of 500 feet of main channel habitat structure, assumes 100% effective for 1 HU.
- Species and Life History Stages to Benefit:
    - Chinook, coho, steelhead refuge and rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 14.0B – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing LWD jams and wood islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This project includes the current Gorley project and could be expanded into multiple phases to allow monitoring and adaptive management of wood placement to provide the most habitat benefits and stabilization of sediment.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,600,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 3,500 foot length of the main channel that would be treated. Includes placement of 6 ELJs, and 100 additional pieces of large wood and excavation of multiple channels. Work is on Gorley and timber company lands.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2D, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel and create multiple channels.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Off channel and side channel habitat
- Current habitat conditions are degraded because channel has been filling in with large volumes of sediment and is a wide shallow channel. While wood is present, it is typically not interacting with low flows.
- Effectiveness was based on assumptions:
    - Restoration of 3,500 feet of main channel habitat structure and side channels, assumes 100% effective for 7 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum spawning and 0-age rearing; coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 14.0R – Groundwater Channel

Project Description

The intent of this project concept is to create a groundwater fed channel either in association with CJ2 or near the old mainstem Grays channel. The key would be to protect this channel from being destroyed in an avulsion similar to the 1999 avulsion. The floodplain fencing and placement of large wood associated with the Gorley project and 14.0B could provide sufficient protection to develop a channel near the old main channel.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $80,000. The preliminary costs were based on an estimated 1,000 foot length of groundwater fed channel. Includes placement of 1 ELJ, and 25 additional pieces of large wood, and additional riparian restoration on 4 acres. Project would be located on Gorley or DNR lands.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2D, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore groundwater fed channel habitat.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
- Currently, there are some channels with groundwater upwelling, but the rapid sediment deposition and channel movement does not allow these features to persist.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of groundwater channel habitat, assumes 100% effective for 2 HUs.
- Species and Life History Stages to Benefit:
    - Chum spawning and rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 14.0L – In-channel Enhancement

Project Description

The intent of this project concept is to restore the side channel around the large vegetated island at RM 14. This channel is activated at high flows, but not regularly engaged, and may also cause stranding currently. Placement of complex wood will help to stabilize sediments and provide longer term scouring of the opening of the side channel.

Preliminary Costs

The preliminary construction cost estimate for this site is $750,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 2,000 foot length of side channel. Includes placement of in-channel structures, and 60 additional pieces of large wood and riparian restoration on 10 acres. Cost does not currently include easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2D, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat and complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
    - Stream channel habitat structure
- Current habitat conditions are degraded because side channel has become disconnected and filled with sediment.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of side channel habitat and riparian restoration, assumes 100% effective for 4 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum spawning and 0-age rearing; coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 15.0B – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing in-channel wood structures to stabilize bars and islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear and can stabilize spawning sediments. This project should be phased similar to the Gorley project to allow for monitoring and adaptive management of wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,200,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 2,500 foot length of the main channel that would be treated. Includes placement of 6 wood structures, multiple channels excavated and 14 acres of floodplain/riparian restoration. Cost does not currently include easements.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2D, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Off channel and side channel habitats
- Current habitat conditions are degraded because channel has been filling in with sediment and is very wide and unstable.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of main channel habitat structure and side channels, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Chinook and chum spawning and 0-age rearing; coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 15.0L – Connection to Off-channel Wetland

Project Description

The intent of this project concept is to provide a connection to an off-channel wetland that could provide steelhead and coho rearing habitat. The key will be to provide in-channel structures to keep connection channel scoured open, but minimize sediment inputs into the channel and wetland.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 500 foot connection channel to the wetland. Includes placement of 1 in-channel structure, and 20 additional pieces of large wood and riparian enhancement on 3 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 2D, Tier 1.
- Populations: Fall Chinook (P), winter steelhead (P), coho (P), chum (P)
- Project would provide connection to off-channel wetland
- Limiting Factors Addressed:
    - Off channel and side channel habitat
- Currently wetland is not connected to mainstem.
- Effectiveness was based on assumptions:
    - Restoration of 500 feet of off channel habitat, assumes 100% effective for 0.5 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 18.0B – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing in-channel wood structures to stabilize islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $600,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 1,500 foot length of the main channel that would be treated. Includes placement of 4 in-channel wood structures, and excavation of multiple channels. Cost does not currently include land acquisition or easement which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 3, Tier 1.
- Populations: winter steelhead (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to function with current sediment regime.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of main channel habitat structure, assumes 100% effective for 3 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 18-21C – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing in-channel wood structures to stabilize bars and islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This project should be phased to allow monitoring of sediment trapping, habitat creation, and channel stability, and to facilitate adaptive management of wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,500,000, and the design cost estimate is $250,000. The preliminary costs were based on an estimated 5,000 foot length of the main channel that would be treated. Includes placement of 12 in-channel wood structures. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 3A, Tier 2.
- Populations: winter steelhead (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this reach from upstream; need to design placement of wood to function in existing sediment regime.
- Effectiveness was based on assumptions:
    - Restoration of 5,000 feet of main channel habitat structure, assumes 100% effective for 10 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 21C – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing in-channel wood structures to stabilize bars and islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This project should be phased to allow monitoring and adaptive management or further wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $750,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 2,500 foot length of the main channel that would be treated. Included placement of 6 in-channel wood structures. Cost does not currently include land acquisition or easement which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Grays 3A, Tier 2.
- Populations: winter steelhead (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this reach from upstream; need to design placement of wood to function with existing sediment regime.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of main channel habitat structure, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site 21R – Restore Alder Creek Pond

Project Description

The intent of this project concept is to restore a good connection to Alder Creek Pond to provide off channel steelhead rearing habitat. Since landowner is likely to need to continue to use the pond for both water supply and recreation, need to ensure pond does not drain.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,000 foot connection to Alder Creek pond. Includes placement of 1 wood structure, and 50 additional pieces of large wood and riparian restoration on 10 acres. Cost does not currently include land acquisition or easement.

Assumptions for Fish Benefit Scoring

- Reach: Grays 3A, Tier 2.
- Populations: winter steelhead (P)
- Project would restore off channel rearing habitat.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
- Current connections are diffuse and stranding can occur
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of side channel habitat, assumes 100% effective for 1 HU.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering. Ensure design can accommodate water supply and other uses.

Site CJ1 – In-channel Enhancement

Project Description

The intent of this project concept is to enhance the lower end of Crazy Johnson Creek by placing wood and riparian/floodplain restoration. Currently, the lower end of Crazy Johnson is a series of beaver ponds. The intent would be to work with existing beaver activity, but create flow through conditions.

Preliminary Costs

The preliminary construction cost estimate for this site is $200,000, and the design cost estimate is $70,000. The preliminary costs were based on an estimated 1,500 foot length of the main channel that would be treated. Included placement of 50 pieces of large wood and 10 acres of riparian restoration. Project would occur on Columbia Land Trust property.

Assumptions for Fish Benefit Scoring

- Reach: Crazy Johnson, Tier 1.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Riparian conditions and function
- Current habitat conditions are degraded because of lack of outflow and concentration of beavers in only remaining riparian zone.
- Effectiveness was based on assumptions:
    - Restoration of 1,500 feet of channel habitat structure, assumes 100% effective for 1.5 HUs.
- Species and Life History Stages to Benefit:
    - Chum spawning and 0-age rearing

Design Needs

This project is located on a highly sensitive spawning and rearing site for chum salmon. Designs should be coordinated with WDFW Fish and Habitat Program staff.

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site CJ2 – Groundwater Channel

Project Description

The intent of this project concept is to create a protected groundwater channel in the higher floodplain to the upstream end of Crazy Johnson Creek. There is significant spring flow from the hill slopes that could be channeled into a spring and groundwater fed channel that outlets to Crazy Johnson Creek.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 2,000 foot length of groundwater fed channel. Includes placement of 25 pieces of large wood and riparian restoration on 7 acres. May need to install wood structures at key locations to prevent mainstem from avulsing into this channel. Need to confirm if this is located on Columbia Land Trust property. If large wood structures are installed, the construction cost increases to $500,000-600,000.

Assumptions for Fish Benefit Scoring

- Reach: Crazy Johnson Creek, Tier 1.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore groundwater channel
- Limiting Factors Addressed:
    - Off channel and side channel habitat
- Currently this is a high floodplain terrace
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of groundwater channel habitat and riparian, assumes 100% effective for 4 HUs.
- Species and Life History Stages to Benefit:
    - Chum spawning and 0-age rearing

Design Needs

This project is located on a highly sensitive spawning and rearing site for chum salmon. Designs should be coordinated with WDFW Fish and Habitat Program staff.

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site F1 – Floodplain Restoration

Project Description

The intent of this project concept is to remove the levee placed along the lower reach and restore the riparian zone. This project is an alternative of project F2.

Preliminary Costs

The preliminary construction cost estimate for this site is $80,000, and the design cost estimate is $28,000. The preliminary costs were based on an estimated 1,200 foot length of floodplain and riparian to be restored. Includes placement of 20 pieces of large wood and riparian restoration of 2 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Fossil Creek 1, Tier 1.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain function and riparian zone
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has been channelized into a narrow corridor and large quantities of sediment have built up in the channel and downstream areas
- Effectiveness was based on assumptions:
    - Restoration of 1,200 feet of floodplain and riparian, assumes 100% effective for 1.2 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age refuge and rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site F2 – Riparian Restoration

Project Description

The intent of this project concept is to restore riparian along the reach of Fossil Creek upstream of Fossil Creek Road to properly functioning conditions.

Preliminary Costs

The preliminary construction cost estimate for this site is $125,000, and the design cost estimate is $40,000. The preliminary costs were based on an estimated 2,500 foot length of riparian to be restored. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: Fossil Creek 1, Tier 1.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore riparian functions.
- Limiting Factors Addressed:
    - Riparian conditions and function
- Current habitat conditions are degraded due to past logging and other land uses.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of riparian on both banks, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site SF1 – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing wood structures and excavating multiple channels. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear, and may stabilize spawning beds. This project has been broken into the four separate projects that could be conducted in a phased manner to allow monitoring and adaptive management of future wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $1,100,000, and the design cost estimate is $250,000. The preliminary costs were based on an estimated 2,500 foot length of the main channel that would be treated. Included placement of 6 wood structures, channel excavation, and riparian restoration on up to 14 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: South Fork Grays 1, Tier 1.
- Populations: winter steelhead (P)
- Project would restore multiple channels, complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Off channel and side channel habitat
- Current habitat conditions are degraded because of significant sediment deposition and channel widening.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of main channel habitat structure, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge; stabilization of spawning beds

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site SF2 – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically by placing wood structures and excavating multiple channels. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear and may stabilize spawning beds. This project should be phased with the other 4 South Fork projects to allow monitoring and adaptive management of future wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $900,000, and the design cost estimate is $250,000. The preliminary costs were based on an estimated 2,000 foot length of the main channel that would be treated. Included placement of 5 wood structures, channel excavation, and up to 12 acres of riparian restoration. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: South Fork Grays, Tier 1.
- Populations: winter steelhead (P)
- Project would restore multiple channels, complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Off channel and side channel habitat
- Current habitat conditions are degraded because of significant sediment deposition and channel widening.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of main channel habitat structure and riparian restoration, assumes 100% effective for 4 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge, may also stabilize spawning beds.

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site SF3 – In-channel Enhancement

Project Description

The intent of this project concept is to create stable vegetated islands using jacks or other structures to create bar deposition.

Preliminary Costs

The preliminary construction cost estimate for this site is $300,000, and the design cost estimate is $105,000. The preliminary costs were based on an estimated 2,500 foot length of the main channel that would be treated. Includes placement of jacks[16] or other structures and vegetation on up to 14 acres. Cost does not currently include land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: South Fork Grays, Tier 1.
- Populations: winter steelhead (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because of significant sediment deposition and channel widening.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of main channel habitat structure, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge and stabilization of spawning beds.

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

[16] Jacks are concrete structures that trap sediment (shaped similarly to "jacks" from the game).

Site SF4 – In-channel Enhancement

Project Description

The intent of this project concept is to create stable vegetated islands using jacks or other structures to promote bar deposition and braiding channels. This should be phased with the other South Fork projects to allow monitoring and adaptive management.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $87,500. The preliminary costs were based on an estimated 2,000 foot length of the main channel that would be treated. Includes vegetation of up to 12 acres and placement of jacks and other structures.

Assumptions for Fish Benefit Scoring

- Reach: South Fork Grays, Tier 1.
- Populations: winter steelhead (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because of significant sediment deposition and channel widening.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of main channel habitat structure, assumes 100% effective for 4 HUs.
- Species and Life History Stages to Benefit:
    - Steelhead rearing and refuge and stabilization of spawning beds.

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site WF1 – Floodplain Restoration

Project Description

The intent of this project concept is to breach dikes as appropriate and enhance the floodplain associated with the lower West Fork and lower Crazy Johnson Creek to provide complex wood and riparian/floodplain revegetation.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,000 foot length of the floodplain to be enhanced. Includes placement of 50 pieces of large wood and riparian restoration on 1 acre. Cost does not currently include land acquisition or easements.

Assumptions for Fish Benefit Scoring

- Reach: West Fork Grays 1A, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain functions
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
- Currently there are berms and remnants of berms that isolate the floodplain on a sporadic basis and significant sediment deposition.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of floodplain and riparian, assumes 100% effective for 2 HU.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age refuge and rearing

Design Needs

This project is located on a highly sensitive spawning and rearing site for chum salmon. Designs should be coordinated with WDFW Fish and Habitat Program staff.

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site WF2 – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically in the West Fork by placing wood structures. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear.

Preliminary Costs

The preliminary construction cost estimate for this site is $700,000, and the design cost estimate is $200,000. The preliminary costs were based on an estimated 2,000 foot length of the main channel that would be treated. Includes placement of 5 wood structures, and 50 additional pieces of large wood. Cost does not currently include land acquisition or easements which may be required. This project will be partially constructed by the LCFEG.

Assumptions for Fish Benefit Scoring

- Reach: West Fork Grays 1A, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
    - Floodplain functions
    - Riparian conditions and function
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to function in on-going sediment regime.
- Effectiveness was based on assumptions:
    - Restoration of 2,000 feet of main channel habitat structure, assumes 100% effective for 4 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age refuge and rearing

Design Needs

This project is located on a highly sensitive spawning and rearing site for chum salmon. Designs should be coordinated with WDFW Fish and Habitat Program staff.

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site WF3 – Modify Hatchery Intake

Project Description

The intent of this project concept is to facilitate the on-going investigation of altering or changing the hatchery intake to allow fish use of the outflow channel and prevent any fish stranding issues. WDFW and NOAA are currently investigating; this project should build on that effort and create habitat opportunities for the downstream side channel.

Preliminary Costs

The preliminary construction cost estimate for this site is $250,000, and the design cost estimate is $75,000. The preliminary costs were based on an estimated 1,000 foot length of side channel habitat. Includes placement of 1 wood structure, and 50 additional pieces of large wood and riparian restoration on 2 acres.

Assumptions for Fish Benefit Scoring

- Reach: West Fork Grays 1A, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore side channel habitat.
- Limiting Factors Addressed:
    - Off channel and side channel habitat
- Current intake may cause fish stranding and restricts access to outflow side channel
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of side channel habitat and riparian restoration, assumes 100% effective for 2 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site WF4 – In-channel Enhancement

Project Description

The intent of this project concept is to restore the diverse cover and channel structure that would likely have existed historically in the West Fork by placing wood structures to stabilize bars and islands. It is likely that this wood would further facilitate creation of islands due to sediment deposition behind and within the structures. This cover and channel structure provides complex habitat for juvenile fish to find refuge and rear. This project should be phased to allow monitoring and adaptive management of future wood placement.

Preliminary Costs

The preliminary construction cost estimate for this site is $900,000, and the design cost estimate is $250,000. The preliminary costs were based on an estimated 2,500 foot length of the main channel that would be treated. Includes placement of 6 wood structures, and 100 additional pieces of large wood and riparian restoration on 15 acres. Cost does not currently include land acquisition or easements which may be required.

Assumptions for Fish Benefit Scoring

- Reach: West Fork Grays 1A, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore complex cover and habitat diversity to the main channel.
- Limiting Factors Addressed:
    - Stream channel habitat structure
- Current habitat conditions are degraded because channel has virtually no wood and very uniform habitat. Sediment is moving into this lower reach from upstream; need to design placement of wood to function in on-going sediment regime.
- Effectiveness was based on assumptions:
    - Restoration of 2,500 feet of main channel habitat structure and riparian, assumes 100% effective for 5 HUs.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age refuge and rearing

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

Site WF5 – Floodplain Restoration

Project Description

The intent of this project concept is to remove or breach the abandoned road bed that is currently isolating about half of the floodplain from the West Fork Grays.

Preliminary Costs

The preliminary construction cost estimate for this site is $150,000, and the design cost estimate is $52,500. The preliminary costs were based on an estimated 1,000 foot length of floodplain to be reconnected. Includes placement of 50 pieces of large wood and restoration of 2 acres of riparian zone. Cost does not currently include land acquisition or easements which would be required.

Assumptions for Fish Benefit Scoring

- Reach: West Fork Grays 1A, Tier 2.
- Populations: winter steelhead (P), coho (P), chum (P)
- Project would restore floodplain functions.
- Limiting Factors Addressed:
    - Floodplain functions
    - Riparian conditions and function
- Current habitat is isolated.
- Effectiveness was based on assumptions:
    - Restoration of 1,000 feet of floodplain and riparian, assumes 100% effective for 1 HU.
- Species and Life History Stages to Benefit:
    - Coho and steelhead 0-age and 1-age rearing and refuge

Design Needs

Conduct landowner outreach to determine if there are any willing landowner(s) and level of interest in restoration, topographic survey, hydrologic/hydraulic analysis, sediment evaluation, detailed engineering.

APPENDIX B

DRAFT POTENTIAL PROJECT COSTS

Conceptual Level Cost Estimate Table for Grays Potential Restoration Projects

Project ID (RM)	Restoration Project Type	Project Description	Length (lf)	Area (ac)	Volume (cy)	LWD (ea)	No. ELJ Units (ea)	Estimated Construction Cost	Design/ Permitting/ Costs*	Easement/ Land Costs**	Site Access and Construction Feasibility	# of Parcels
1.0C	In-channel enhancement	Work with existing pilings to increase complexity and cover alon shoreline; riparian revegetation	5000	1		200		$ 250,000	$ 90,000		Accessible via barge	6
1.0C Alt	In-channel enhancement alternativ	Create deeper channels with stable islands, riparian revegetatic	4000	1	10,000		4	$ 500,000	$ 100,000		Accessible via barge	1
0.0L	Restore tidal slough	Restore former tidal slough along left bank, possible distributary channe	2500	3	10,000	100	1	$ 400,000	$ 125,000		Accessible via road, would need to acquire easement o portions of 3 parcels	3
3.0L	Reconnect floodplain and sloughs	Reconnect floodplain and side channels	2200	40	10,000	100	2	$ 500,000	$ 125,000		Accessible via Altoona Road and Mill Road; will require setback levee along Mill Road alignment	1
3.0R	Riparian restoration	Riparian restoratior	4500	15		50		$250,000	$ 50,000			4
3.1T	Tributary enhancement	Restore riparian zone and enhance channel	700	4	3,000	20		$110,000	$ 40,000		Accessible via Altoona Road; would requiremen easement along stream	2
4.5T	Tributary enhancement	Restore riparian zone and enhance channel	1500	7	8,000	50		$ 225,000	$ 75,000		Accessible via farm roads; would require easemen along stream	2
4.7T	Tributary enhancement	Restore riparian zone and enhance channel	1800	8	10,000	50		$ 250,000	$ 75,000		Accessible from Hwy 4, Rosburg community center; would require easement along stream	2
4.7R	Side channel and floodplain restoration	Create side-channel and floodplain zone	1000	12	4,500	20		$ 225,000	$ 75,000		Accessible via farm roads; would require easement to construct/maintain	2
5.0B	Side channel and floodplain restoration	Excavate side-channel at meander bend; slope banks back, an enhance floodplain and riparian	1500	18	5,000	20	2	$ 500,000	$ 125,000		Accessible via farm roads; would require easement to construct/maintain	2
5.0T	Tributary enhancement	Restore riparian zone and enhance channel, Nikka Creek	1000	6	6,000	25		$ 200,000	$ 70,000		Accessible via farm roads; would require easemen along stream	1
5.5L	Side channel and floodplain restoration	Lower floodplain and revegetate for frequent connections	1500	10	10,000	20		$ 250,000	$ 87,500		Accessible via farm roads; would require easement to construct/maintain	1
5.0-6.0B	Riparian restoration	Riparian restoration, slope back banks as feasible, place wood or rock a toe	5000	12	30,000	500		$1,000,000	$ 150,000		Accessible via farm roads and Hwy 4; includes sloping banks back, riparian	2
6.5L	Side channel and floodplain restoration	Excavate side-channel at meander bend and enhance floodplain an riparian	900	10	4,500	20	1	$ 300,000	$ 100,000		Accessible via farm roads; would require easement to construct/maintain	2
6.7B	Side channel and floodplain restoration	Excavate side-channel at meander bend and enhance floodplain an riparian	400	5	2,000	10	1	$250,000	$ 87,500		Accessible via farm roads; would require easement to construct/maintain	2
6.7T	Tributary enhancement	Restore riparian zone and enhance channel, Thadbar Creek	1000	5	4,500	25		$200,000	$ 70,000		Access via Barr Road; would requirement easement to construction/maintain	2
7.5B	Side channel and floodplain restoration	Floodplain easement/acquisition, side-channel restoration and riparia restoration	2000	20	35,000	50	2	$ 900,000	$ 200,000		Accessible via farm roads; would require easement to construct/maintain	3
7.5C	Bar apex logjam	Create pool, refugia, and enhance with 7.5B	500				2	$ 225,000	$ 78,750		Accessible via farm roads; would require easement to construct/maintain	1
7.0-8.0C	In-stream enhancement	Work with existing pilings to increase complexity and cover alon shoreline; riparian revegetation	5000	1		200		$ 250,000	$ 90,000		Accessible via farm roads; would require easement to construct/maintain	4
8.0B	Side channel and floodplain restoration	Excavate side-channel at meander bend and enhance floodplain an riparian	750	9	3,000	20	1	$ 350,000	$ 120,000		Accessible via farm roads; would require easement to construct/maintain	1
8.2R	Tributary enhancement	Restore riparian zone and enhance channel	2500	12	10,000	50		$ 400,000	$ 100,000		Accessible via farm roads; would require easemen along stream	2
9.5R	Side channel and floodplain restoration	Restore/reconnect remnant side-channels to river	1800	8	5,000	10		$ 200,000	$ 60,000		Accessible via farm roads; would require easement to construct/maintain	3
9.0-10.0B	Riparian restoration	Riparian restoration	5000	12	30,000	500		$ 1,000,000	$ 150,000		Accessible via farm roads; would require easement for riparian zone	missing coverage
9.0-10.0C	In-stream enhancement	Work with existing pilings to increase complexity and cover alon shoreline; riparian revegetation	1000			100		$ 125,000	$ 40,000		Accessible via farm roads	2
9.7R	Side channel and floodplain restoration	Floodplain easement/acquisition, side-channel restoration and riparia restoration	1000	6	4,500	20	1	$ 250,000	$ 70,000		Accessible via farm roads	2
10.0R	Side channel and floodplain restoration	Floodplain easement/acquisition, side-channel restoration and riparia restoration	1800	10	8,000	20	1	$ 400,000	$ 125,000		Accessible via farm roads; would require easement to construct/maintain	1
10.1T	Tributary enhancement	Restore riparian zone and enhance channel	1000	5	4,500	25		$ 200,000	$ 70,000		Accessible via farm roads; would require easement to construct/maintain	2
10.1L	In-channel enhancement	Place wood or rock structures at delta of Kings Creek to trap gravel provide hydraulic diversity	250		1,000	10		$ 75,000	$ 26,250		Accessible via farm roads; would require easement to construct/maintain	1
10.5C	Bar apex logjam	Bar apex logjam	500				2	$ 225,000	$ 78,750		Accessible via farm roads	1
10.5B	Side channel and floodplain restoration	Floodplain easement/acquisition, side-channel restoration and riparia restoration	1500	10	6,000	10	1	$300,000	$ 100,000		Accessible via farm roads; would require easement to construct/maintain	2
11.0R	Side channel and floodplain restoration	Excavate side-channel at meander bend and enhance floodplain an riparian	500	3	2,500	10		$85,000	$ 30,000		Accessible via farm roads; would require easement to construct/maintain	2
11.2L	Riparian restoration	Riparian restoration	1500	3				$35,000	$ 12,250		Along shoreline adjacent to Covered Bridge; assume 100 feet wide	2
11.5T	Tributary enhancement	Restore riparian zone and enhance channel, Klints Creek	1500	7	5,000	25		$225,000	$ 70,000		Accessible via farm roads; would require easement to construct/maintain	2
11.8R	Off-channel habitat	Determine if sufficient groundwater for groundwater channel, otherwise provide backwater or side channel	1200	6	5,500	20	1	$400,000	$ 125,000		Accessible via PUD road and farm roads; would require easement to construct/maintain	2
12.0R	Floodplain restoration	Lower floodplain and revegetate for frequent connections	800	10	30,000	20	1	$ 700,000	$ 175,000		Accessible via Hwy 4; would require easement to construct/maintain, need to protect bridge with logjam	1
12.0L	Floodplain restoration	Lower floodplain and revegetate for frequent connections	1000	15	30,000	20	1	$ 750,000	$ 175,000		Accessible via county road; would require acquisition to construct/maintain; need to protect bridge	3
12.3C	In-channel enhancemen	Monitor snag and relocate or attach wood t	100				1	$ 100,000	$ 35,000		Would require construction access via farm road	1
12.5L	In-channel enhancement	Excavate side-channel at meander bend and place wood to maintai channel	1000	7	5,000	20	4	$ 600,000	$ 150,000		Accessible and largely located on WDFW land	1
12.6R	Floodplain restoration	Connection channel to pond and floodplain, riparian restoration	300	5	1,000	20		$ 150,000	$ 52,500		Accessible via private driveway; would require easemen to construct/maintain	1
13.5R	Side channel and floodplain restoration	Excavate groundwater or flow-through channel, restore floodplain an riparian	2000	12	9,000	50	2	$ 500,000	$ 150,000		Accessible via private driveway; would require easemen to construct/maintain	1
13.5L	In-channel enhancemen	Place wood for bank stabilization and cove	500			60		$ 100,000	$ 35,000		Access from Fossil Creek Roac	1
14.0B	In-channel enhancement	Create anabranching section, restore riparian, provide LWD for sedimer trapping and reconnect old channels	3500	20	40,000		8	$1,600,000	$ 200,000		Access via Gorley	1
14.0R	Groundwater channel	Create groundwater fed channel with connection to river for chum spawning, riparian restoration	1000	4	2,500	20	1	$ 250,000	$ 80,000		Accessible via Gorley; need to complete 14.0B prior to this project to provide more protection/stabilization	1
14.0L	In-channel enhancement	Place in-stream structures and reconnect historic channel south c vegetated island	2000	10	7,000	50	4	$ 750,000	$ 200,000		Difficult to access; may be possible to come down from above via old logging road	1
15.0B	In-channel enhancement	Create anabranching section as feasible, restore riparian, place ELJ and LWD for cover, scour and sediment trapping and reconnect old channels	2500	14	20,000		6	$ 1,200,000	$ 200,000		Difficult to access; may be possible to come down from above via old logging road	1
15.0L	Connection to wetland	Needs more investigation to determine elevations and possible connections for off-channel rearing and refuge	500	3	2,500	20	1	$ 250,000	$ 75,000		Difficult to access; may be possible to come down from above via old logging road	1
18.0B	In-channel enhancement	Create anabranching section, restore riparian, provide LWD for sedimer trapping and reconnect old channels	1500	6	12,000		4	$600,000	$ 200,000		Access from logging roads	1
18-21	In-channel enhancement	Place in-channel structures to trap sediment and create scour pools	5000				12	$ 1,500,000	$ 250,000		Difficult to access; may be possible to come down from above via old logging road	1
21C	In-channel enhancement	Place in-channel structures to trap sediment and create scour pools	2500				6	$ 750,000	$ 200,000		May be most accessible via Alder Creek	1
21R	Restore Alder Creek pond	Enhance connection to pond, place wood, restore riparia	1000	6	1,000	50	1	$ 250,000	$ 75,000		Accessible; need easement to construct/maintai	1
CJ1	In-channel enhancement	Place wood in floodplain and riparian restoration; remove key beave dams	1500	10	500	50		$200,000	$ 70,000		Access from logging roads	1
CJ2	Groundwater channel	Excavate groundwater fed channel from higher floodplain to northwest t flow into Crazy Johnson near outlet	2000	7	5,000	25		$250,000	$ 75,000		Access from logging roads	1
WF1	Floodplain restoration	Remove dikes to allow floodplain reconnections	1000	1	8,500	50		$250,000	$ 75,000		Difficult to access; come down from above via old logging road	1
WF2	In-channel enhancement	Place in-channel structures to trap sediment and create scour pools riparian restoration	2000	10	2,000		5	$700,000	$ 200,000		Difficult to access; come down from above via old logging road	
WF3	Modify hatchery intake	Reconnect river to side-channel downstream of intake; modify intake (NOAA already doing?)	1000	2	500	50	1	$250,000	$ 75,000		Accessible via hatchery road	1
WF4	In-channel enhancement	Create anabranching section, restore riparian, provide in-channe structures for sediment trapping and reconnect old channels	3000		15,000		6	$ 900,000	$ 250,000		Accessible via logging roads	1
WF5	Floodplain restoration	Remove or breach abandoned road, place wood in floodplain, riparian restoration	1000	2	5,000	50		$ 150,000	$ 52,500		Accessible via logging roads	1
F1	Floodplain restoration	Remove levee along lower reach, riparian restoration	1200	2	2,000	20		$ 80,000	$ 28,000		Access via Fossil Creek Road; would require easement to construct/maintain	3
F2	Riparian restoration	Riparian restoratior	2500	12				$125,000	$ 40,000			2
SF1	In-channel enhancement	Create anabranching section, restore riparian, providein-channe structures for cover, scour, and sediment trapping and reconnect old channels	2500	14	5,500	100	6	$1,100,000	$ 250,000		Difficult to access; may be possible to come down from above via old logging road	1
SF2	In-channel enhancement	Create anabranching section, restore riparian, provide in-channe structures for cover, scour, and sediment trapping and reconnect old channels	2000	12	4,500	100	5	$900,000	$ 250,000		Difficult to access; may be possible to come down from above via old logging road	1
SF3	In-channel enhancement	Place jacks and other structures to stabilize existing wood, vegetate an stabilize islands	2500	5			5	$300,000	$ 105,000		Difficult to access; may be possible to come down from above via old logging road	1
SF4	In-channel enhancement	Place jacks and other structures to stabilize existing wood, vegetate an stabilize islands	2000	4			4	$250,000	$ 87,500		Difficult to access; may be possible to come down from above via old logging road	1

* Used 25-35% of construction cost as baseline depending on magnitude of cost

** Not included at this time

APPENDIX C

PROJECT BENEFIT SCORING

Project ID	Project Description	Reach/Population								Protection			Restoration						Total Score
		Affected Reaches	Tier	Species	Pop Class		SRP		Reach/Pop Score	Protection Potential	Habitat Units	Protection Score	Restoration Type	Restoration Ranking		Habitat Units	Effectiveness Factor	Restoration Score	
1.0C	In-channel enhancement	Estuary Tidal	4	FC	P	3	L	1	4			N/A	Stream channel habitat structure	M	2	10	1	20.00	
				WS	P	3	L	1	4										
				CO	P	3	L	1	4										
				OBS	P	3	M	2	5										
									17									20.00	37.00
1.0C Alt	In-channel enhancement alternative	Estuary Tidal	4	FC	P	3	L	1	4				Stream channel habitat structure	M	2	8	1	16.00	
				WS	P	3	L	1	4										
				CO	P	3	L	1	4										
				OBS	P	3	M	2	5										
									17									16.00	33.00
0.0L	Restore tidal slough	Estuary Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habitat	M	2	5	1	10.00	
				WS	P	3	L	1	4				Floodplain function	M	2	2.5	1	5.00	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	5	1	10.00	
				OBS	P	3	M	2	5				Breach dikes/levees	H	3	5	1	15.00	
									17									40.00	57.00
3.0L	Reconnect floodplain and slough	Grays 1 Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habita	H	3	4.4	1	13.20	
				WS	P	3	L	1	4				Breach dikes/levees	H	3	4.4	1	13.20	
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
				OBS	P	3	M	2	5										
									21									26.40	47.40
3.0R	Riparian restoration	Grays 1 Tidal	4	FC	P	3	L	1	4			N/A	Riparian conditions and function	M	2	4.5	1	9.00	
				WS	P	3	L	1	4				Restore riparian in estuary area	H	3	4.5	1	13.50	
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
				OBS	P	3	M	2	5										
									21									22.50	43.50
3.1T	Tributary enhancement	Mainstem LB Trib 1	2	WS	P	3	L	1	4			N/A	Riparian conditions and function	H	3	1.4	0.67	2.81	
				CH	P	3	M	2	5				Stream channel habitat structure	H	3	1.4	1	4.20	
									9									7.01	16.01
4.5T	Tributary enhancement	Impie Creek 1	4	WS	P	3	L	1	4			N/A	Riparian conditions and function	M	2	3	0.67	4.02	
				CO	P	3	L	1	4				Stream channel habitat structure	H	3	3	1	9.00	
				CH	P	3	L	1	4										
									12									13.02	25.02
4.7T	Tributary enhancement	Malone Creek 1	4	CO	P	3	L	1	4			N/A	Stream channel habitat structure	L	1	3.6	1	3.60	
													Riparian conditions and function	L	1	3.6	0.67	2.41	
									4									6.01	10.01
4.7R	Side channel and floodplain restoration	Grays 1D Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habitat	M	2	1	1	2.00	
				WS	P	3	L	1	4				Riparian conditions and function	M	2	1	1	2.00	
				CO	P	3	L	1	4				Restore riparian in estuary area	H	3	1	1	3.00	
				CH	P	3	L	1	4										
				OBS	P	3	M	2	5										
									21									7.00	28.00
5.0B	Side channel and floodplain restoration	Grays 1D Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habitat	M	2	1.5	1	3.00	
				WS	P	3	L	1	4				Riparian conditions and function	M	2	1.5	1	3.00	
				CO	P	3	L	1	4				Restore riparian in estuary area	H	3	1.5	1	4.50	
				CH	P	3	L	1	4										
				OBS	P	3	M	2	5										
									21									10.50	31.50
5.0T	Tributary enhancement	Nikka Creek1	2	WS	P	3	L	1	4			N/A	Stream channel habitat structure	H	3	2	1	6.00	
				CO	P	3	L	1	4				Riparian conditions and function	H	3	2	0.67	4.02	
				CH	P	3	M	2	5										
									13									10.02	23.02
5.5L	Floodplain restoratio	Grays 1E Tidal	4	FC	P	3	L	1	4			N/A	Floodplain functio	H	3	1.5	1	4.50	
				WS	P	3	L	1	4				Riparian conditions and functio	M	2	1.5	1	3.00	
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
									16									7.50	23.50
5.0-6.0B	Riparian restoratio	Grays 1E Tidal	4	FC	P	3	L	1	4			N/A	Riparian conditions and functio	M	2	10	0.67	13.40	
				WS	P	3	L	1	4										
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
									16									13.40	29.40
6.5L	Side channel and floodplain restoratic	Grays 1E Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habita	H	3	1.8	1	5.40	
				WS	P	3	L	1	4				Floodplain function	H	3	0.9	1	2.70	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	1.8	1	3.60	
				CH	P	3	L	1	4										
									16									11.70	27.70
6.7B	Side channel and floodplain restoratic	Grays 1F Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habita	H	3	0.8	1	2.40	
				WS	P	3	L	1	4				Floodplain functio	H	3	0.4	1	1.20	
				CO	P	3	L	1	4				Riparian conditions and functio	M	2	0.8	1	1.60	
				CH	P	3	L	1	4										
									16									5.20	21.20
6.7T	Tributary enhancement	Thadbar Cr 1	2	WS	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	2	1	6.00	
				CO	P	3	L	1	4				Riparian conditions and functio	H	3	2	0.67	4.02	
				CH	P	3	M	2	5										
									13									10.02	23.02
7.5B	Side channel and floodplain restoratic	Grays 1G Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habita	H	3	4	1	12.00	
				WS	P	3	L	1	4				Floodplain function	H	3	2	1	6.00	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	4	1	8.00	
				CH	P	3	L	1	4										
									16									26.00	42.00
7.5C	Bar apex logjam	Grays 1G Tidal	4	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	1	1	3.00	
				WS	P	3	L	1	4										
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
									16									3.00	19.00
7.0-8.0C	In-channel enhancement	Grays 1G Tidal	4	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	10	1	30.00	
				WS	P	3	L	1	4										
				CO	P	3	L	1	4										
				CH	P	3	L	1	4										
									16									30.00	46.00
8.0B	Side channel and floodplain restoratic	Grays 1G Tidal	4	FC	P	3	L	1	4			N/A	Off channel & side channel habita	H	3	1.5	1	4.50	
				WS	P	3	L	1	4				Floodplain function	H	3	0.75	1	2.25	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	1.5	1	3.00	
				CH	P	3	L	1	4										
									16									9.75	25.75
8.2R	Tributary enhancement	Hull Creek 1A	4	WS	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	5	1	15.00	
				CO	P	3	L	1	4				Riparian conditions and function	H	3	5	0.67	10.05	
				CH	P	3	L	1	4										
									12									25.05	37.05
9.5R	Side channel and floodplain restoratic	Grays 1H Tidal	2	FC	P	3	M	2	5			N/A	Off channel & side channel Habita	H	3	3.6	1	10.80	
				WS	P	3	L	1	4				Riparian conditions and function	H	3	3.6	1	10.80	
				CO	P	3	M	2	5				Floodplain function	H	3	1.8	1	5.40	
				CH	P	3	M	2	5										
									19									27.00	46.00
9.0-10.0B	Riparian restoratio	Grays 1H Tidal	2	FC	P	3	M	2	5			N/A	Riparian conditions and functio	H	3	10	0.67	20.10	
				WS	P	3	L	1	4										
				CO	P	3	M	2	5										
				CH	P	3	M	2	5										
									19									20.10	39.10
9.0-10.0C	In-channel enhancement	Grays 1H Tidal	2	FC	P	3	M	2	5			N/A	Stream channel habitat structur	H	3	2	1	6.00	
				WS	P	3	L	1	4				Riparian conditions and function	H	3	1	0.5	1.50	
				CO	P	3	M	2	5										
				CH	P	3	M	2	5										
									19									7.50	26.50
9.7R	Side channel and floodplain restoratic	Grays 1H Tidal	2	FC	P	3	M	2	5			N/A	Off channel & side channel habita	H	3	2	1	6.00	
				WS	P	3	L	1	4				Floodplain function	H	3	1	1	3.00	
				CO	P	3	M	2	5				Riparian conditions and function	H	3	2	1	6.00	
				CH	P	3	M	2	5										
									19									15.00	34.00
10.0R	Side channel and floodplain restoratic	Grays 1H Tidal	2	FC	P	3	M	2	5			N/A	Off channel & side channel habita	H	3	3.6	1	10.80	
				WS	P	3	L	1	4				Floodplain function	H	3	1.8	1	5.40	
				CO	P	3	M	2	5				Riparian conditions and function	H	3	3.6	1	10.80	
				CH	P	3	M	2	5										
									19									27.00	46.00
10.1T	Tributary enhancement	King Creek	2	WS	P	3	L	1	4			N/A	Stream channel habitat structure	H	3	2	1	6.00	
				CO	P	3	L	1	4				Riparian conditions and function	H	3	2	0.67	4.02	
				CH	P	3	M	2	5										
									13									10.02	23.02
10.1L	In-channel enhancement	Grays 2	1	FC	P	3	H	3	6				Stream channel habitat structure	H	3	0.5	1	1.50	
				WS	P	3	L	1	4										
				CO	P	3	H	3	6										
				CH	P	3	H	3	6										
									22									1.50	23.50
10.5B	Side channel and floodplain restoratic	Grays 2	1	FC	P	3	H	3	6			N/A	Off channel & side channel habita	H	3	3	1	9.00	
				WS	P	3	L	1	4				Floodplain functio	H	3	1.5	1	4.50	
				CO	P	3	H	3	6				Riparian conditions and functio	H	3	3	1	9.00	
				CH	P	3	H	3	6										
									22									22.50	44.50
10.5C	Bar apex logjam	Grays 2	1	FC	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	1	1	3.00	
				WS	P	3	L	1	4										
				CO	P	3	H	3	6										
				CH	P	3	H	3	6										
									22									3.00	25.00
11.0R	Side channel and floodplain restoratic	Grays 2	1	FC	P	3	H	3	6			N/A	Off channel & side channel habita	H	3	1	1	3.00	
				WS	P	3	L	1	4				Riparian conditions and functio	H	3	1	1	3.00	
				CO	P	3	H	3	6				Floodplain functio	H	3	0.5	1	1.50	
				CH	P	3	H	3	6										

Project ID	Project Description	Reach/Population								Protection			Restoration						Total Score
		Affected Reaches	Tier	Species	Pop Class		SRP		Reach/Pop Score	Protection Potential	Habitat Units	Protection Score	Restoration Type	Restoration Ranking		Habitat Units	Effectiveness Factor	Restoration Score	
									22									7.50	29.50
11.2L	Riparian restoratio	Grays 2	1	FC	P	3	H	3	6			N/A	Riparian conditions and functio	H	3	1.5	0.67	3.02	
				WS	P	3	L	1	4										
				CO	P	3	H	3	6										
				CH	P	3	H	3	6										
									22									3.02	25.02
11.5T	Tributary enhancemen	Klints Cr 1	1	WS	P	3	L	1	4			N/A	Riparian conditions and functio	H	3	3	1	9.00	
				CO	P	3	L	1	4				Stream channel habitat structure	H	3	3	1	9.00	
				CH	P	3	H	3	6										
									14									18.00	32.00
11.8R	Groundwater channel	Grays 2A	1	FC	P	3	H	3	6			N/A	Off channel & side channel habitat	H	3	2.4	1	7.20	
				WS	P	3	L	1	4				Riparian conditions and function	H	3	2.4	0.67	4.82	
				CO	P	3	H	3	6										
				CH	P	3	M	2	5										
									21									12.02	33.02
12.0R	Floodplain restoratio	Grays 2A	1	FC	P	3	H	3	6			N/A	Floodplain functio	H	3	0.8	1	2.40	
				WS	P	3	L	1	4				Riparian conditions and function	H	3	0.8	1	2.40	
				CO	P	3	H	3	6										
				CH	P	3	M	2	5										
									21									4.80	25.80
12.0L	Floodplain restoratio	Grays 2A	1	FC	P	3	H	3	6			N/A	Riparian conditions and functio	H	3	1	1	3.00	
				WS	P	3	L	1	4				Floodplain function	H	3	1	1	3.00	
				CO	P	3	H	3	6										
				CH	P	3	M	2	5										
									21									6.00	27.00
12.3C	In-channel enhancement	Grays 2A	1	FC	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	0.1	1	0.30	
				WS	P	3	L	1	4										
				CO	P	3	H	3	6										
				CH	P	3	M	2	5										
									21									0.30	21.30
12.5L	In-channel enhancement	Grays 2A	1	FC	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	2	1	6.00	
				WS	P	3	L	1	4				Off channel & side channel habitat	H	3	2	1	6.00	
				CO	P	3	H	3	6				Riparian conditions and function	H	3	2	1	6.00	
				CH	P	3	M	2	5										
									21									18.00	39.00
12.6R	Floodplain restoratio	Grays 2A	1	FC	P	3	H	3	6			N/A	Off channel & side channel habita	H	3	0.6	1	1.80	
				WS	P	3	L	1	4				Floodplain function	H	3	0.3	1	0.90	
				CO	P	3	H	3	6										
				CH	P	3	M	2	5										
									21									2.70	23.70
13.5R	Side channel or groundwater chann	Grays 2B	1	FC	P	3	M	2	5			N/A	Off channel & side channel habita	H	3	4	1	12.00	
				WS	P	3	L	1	4				Floodplain functio	H	3	2	1	6.00	
				CO	P	3	H	3	6				Riparian conditions and functio	H	3	4	0.67	8.04	
				CH	P	3	H	3	6										
									21									26.04	47.04
13.5L	In-channel enhancement	Grays 2C	1	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	1	0.5	1.50	
				WS	P	3	H	3	6										
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									1.50	22.50
14.0B	In-channel enhancement	Grays 2D	1	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	7	1	21.00	
				WS	P	3	H	3	6				Off channel & side channel habitat	H	3	7	1	21.00	
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									42.00	63.00
14.0R	Groundwater channe	Grays 2D	1	FC	P	3	L	1	4			N/A	Off channel and side-channel habita	H	3	2	1	6.00	
				WS	P	3	H	3	6										
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									6.00	27.00
14.0L	In-channel enhancement	Grays 2D	1	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	4	1	12.00	
				WS	P	3	H	3	6				Off channel & side channel habitat	H	3	4	1	12.00	
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									24.00	45.00
15.0B	In-channel enhancement	Grays 2D	1	FC	P	3	L	1	4			N/A	Stream channel habitat structur	H	3	5	1	15.00	
				WS	P	3	H	3	6				Off channel and side channel habitat	H	3	5	1	15.00	
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									30.00	51.00
15.0L	Connection to wetlan	Grays 2D	1	FC	P	3	L	1	4			N/A	Off channel and side channel habita	H	3	1	1	3.00	
				WS	P	3	H	3	6				Floodplain function	H	3	0.5	1	1.50	
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									21									4.50	25.50
18.0B	In-channel enhancement	Grays 3	1	WS	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	3	1	9.00	
													Off channel and side channel habitat	H	3	3	1	9.00	
									6									18.00	24.00
18-21	In-channel enhancement	Grays 3A	2	WS	P	2	M	2	4			N/A	Stream channel habitat structure	H	3	10	1	30.00	
									4									30.00	34.00
21C	In-channel enhancement	Grays 3A	2	WS	P	2	M	2	4			N/A	Stream channel habitat structure	H	3	5	1	15.00	
									4									15.00	19.00
21R	Restore Alder Creek pond	Grays 3A	2	WS	P	2	M	2	4			N/A	Off channel & side channel habitat	H	3	2	1	6.00	
									4									6.00	10.00
CJ1	In-channel enhancement	Crazy Johnson Cr	1	WS	P	3	L	1	4			NA	Stream channel habitat structur	H	3	3	1	9.00	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	3	1	6.00	
				CH	P	3	H	3	6										
									14									15.00	29.00
CJ2	Groundwater channel	Crazy Johnson Cr	1	WS	P	3	L	1	4			N/A	Off channel and side channel habitat	H	3	4	1	12.00	
				CO	P	3	L	1	4				Riparian conditions and function	M	2	4	1	8.00	
				CH	P	3	H	3	6										
									14									20.00	34.00
WF1	Floodplain restoratio	WF Grays 1A	2	WS	P	3	M	2	5			N/A	Floodplain functio	H	3	2	1	6.00	
				CO	P	3	M	2	5				Riparian conditions and function	H	3	4	1	12.00	
				CH	P	3	M	2	5										
									15									18.00	33.00
WF2	In-channel enhancement	WF Grays 1A	2	WS	P	3	M	2	5			N/A	Stream channel habitat structure	H	3	4	1	12.00	
				CO	P	3	M	2	5				Floodplain function	H	3	2	1	6.00	
				CH	P	3	M	2	5				Riparian conditions and function	H	3	4	1	12.00	
									15									30.00	45.00
WF3	Modify hatchery intak	WF Grays 1A	2	WS	P	3	M	2	5			N/A	Stream channel habitat structur	H	3	2	1	6.00	
				CO	P	3	M	2	5				Off channel & side channel habitat	H	3	2	1	6.00	
				CH	P	3	M	2	5										
									15									12.00	27.00
WF4	In-channel enhancement	WF Grays 1A	2	WS	P	3	M	2	5			N/A	Stream channel habitat structur	H	3	5	1	15.00	
				CO	P	3	M	2	5				Off channel & side channel habitat	H	3	5	1	15.00	
				CH	P	3	M	2	5										
									15									30.00	45.00
WF5	Floodplain restoratio	WF Grays 1A	2	WS	P	3	M	2	5			N/A	Floodplain function and CM2	H	3	1	1	3.00	
				CO	P	3	M	2	5				Off channel & side channel habitat	H	3	2	1	6.00	
				CH	P	3	M	2	5				Riparian conditions and function	H	3	1	1	3.00	
									15									12.00	27.00
F1	Floodplain restoratio	Fossil Cr 1	1	WS	P	3	L	1	4			N/A	Stream channel habitat structure and bank	H	3	1.2	1	3.60	
				CO	P	3	M	2	5				Floodplain functio	H	3	1.2	0.5	1.80	
				CH	P	3	H	3	6				Riparian conditions and function	H	3	1.2	1	3.60	
									15									9.00	24.00
F2	Riparian restoratio	Fossil Cr 1	1	WS	P	3	L	1	4			N/A	Riparian conditions and functio	H	3	5	1	15.00	
				CO	P	3	M	2	5										
				CH	P	3	H	3	6										
									15									15.00	30.00
SF1	In-channel enhancement	SF Grays 1	1	WS	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	5	1	15.00	
													Off channel & side channel habitat	H	3	5	1	15.00	
									6									30.00	36.00
SF2	In-channel enhancement	SF Grays 1	1	WS	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	4	1	12.00	
													Off channel & side channel habitat	H	3	4	1	12.00	
									6									24.00	30.00
SF3	In-channel enhancement	SF Grays 1	1	WS	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	5	1	15.00	
									6									15.00	21.00
SF4	In-channel enhancement	SF Grays 1	1	WS	P	3	H	3	6			N/A	Stream channel habitat structur	H	3	4	1	12.00	
									6									12.00	18.00

APPENDIX D

DRAFT CONCEPT DESIGNS FOR REPRESENTATIVE PROJECTS

Grays River

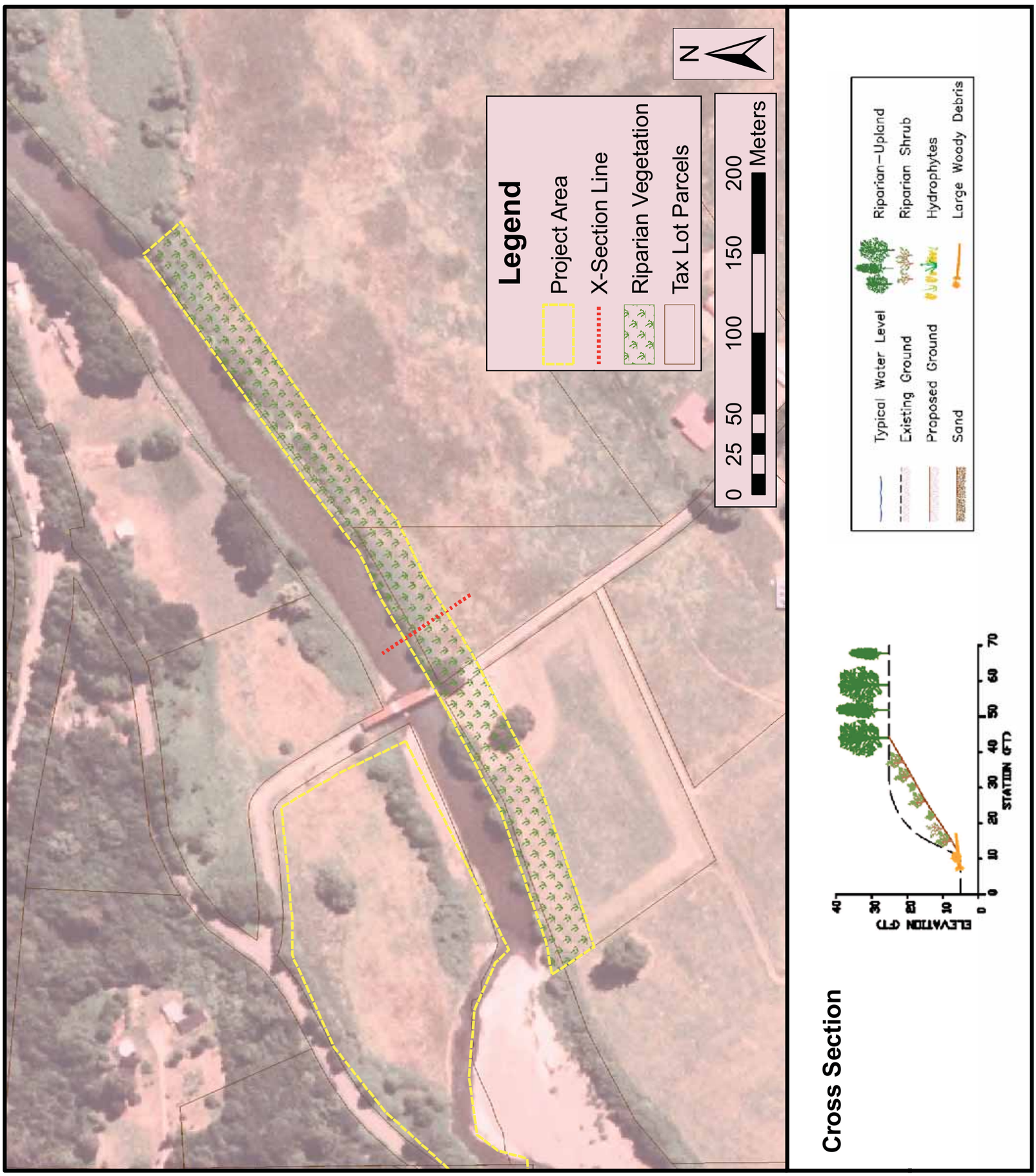
Habitat Restoration Technical Report

Project RM 11.2L Concept Design

Cost Estimate

Cost Estimate Summary Project RM 11.2L

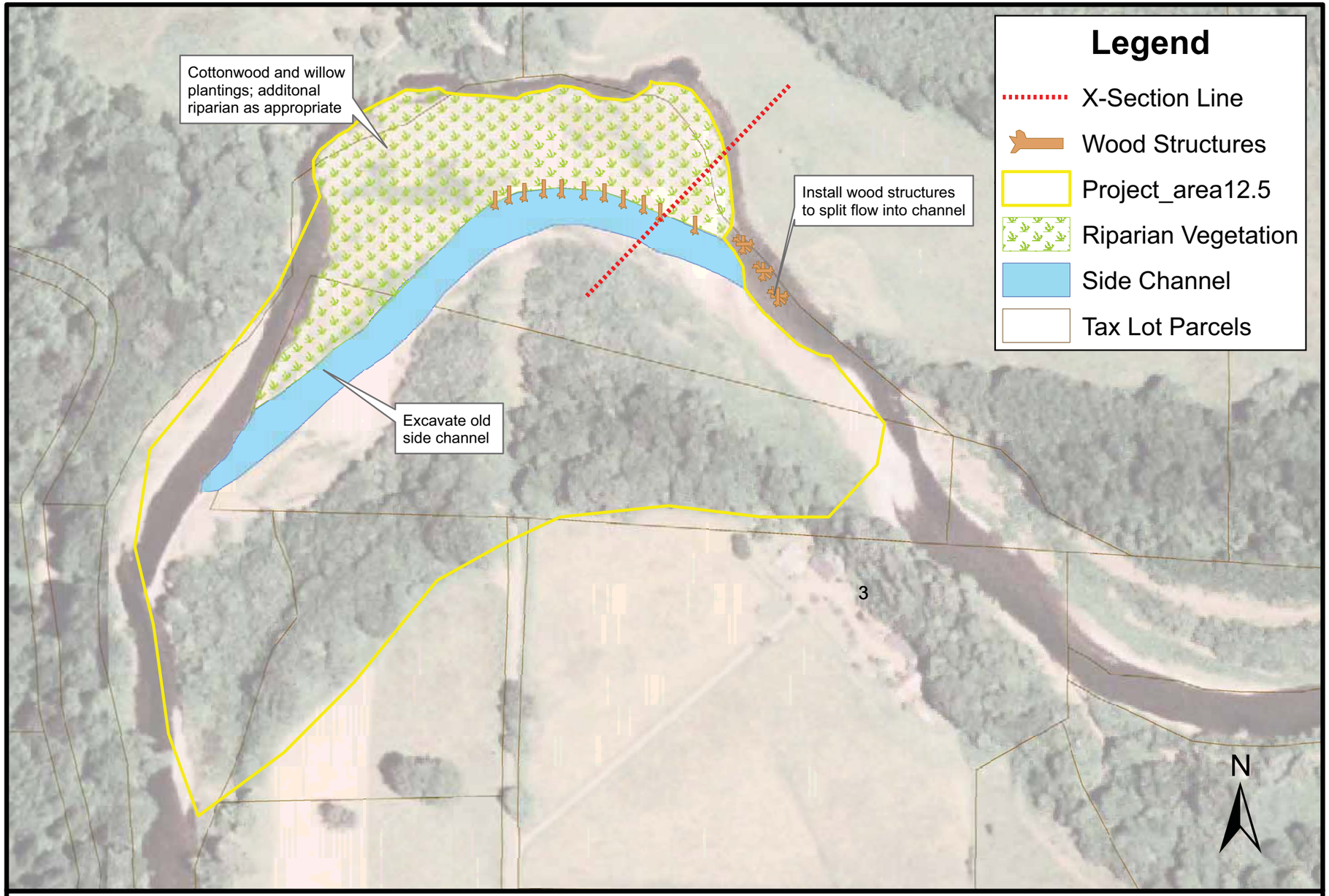
Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation, mob/demob	LS	$10,000	1	$10,000
2	Bank sloping excavation	CY	$50	1000	$50,000
4	Logs or rock toe	LF	$100	500	$50,000
5	Plantings	AC	$10,000	4	$40,000
6	Design	LS	$75,000	1	$25,000
7	Contingency	LS	$100,000	1	$50,000
	TOTAL				**$225,000**

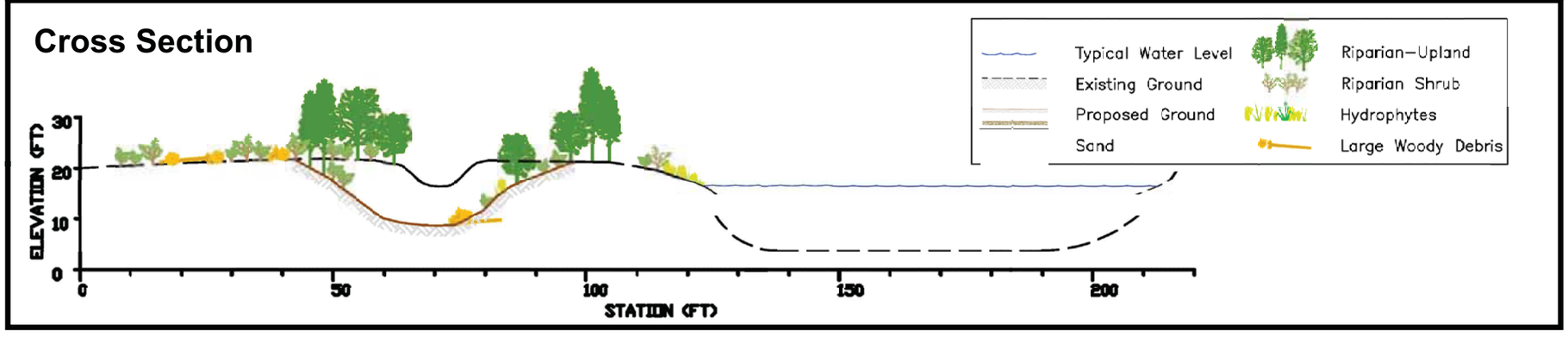


Grays River

Habitat Restoration Technical Report

Project RM 12.5 Concept Design





Cost Estimate

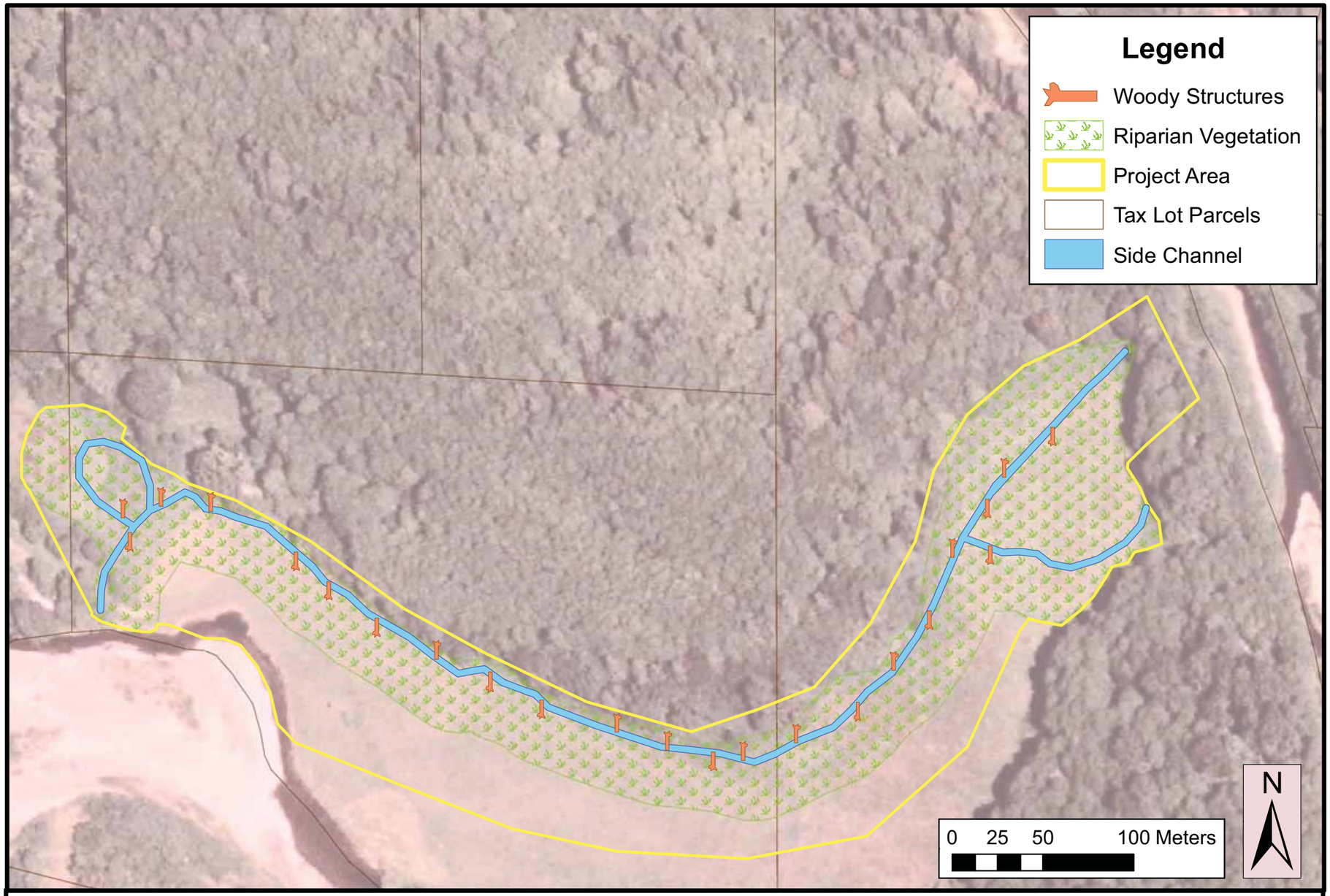
Cost Estimate Summary Project RM 12.5L

Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation	LS	$10,000	1	$10,000
2	Channel excavation and dispose of material	CY	$50	3400	$170,000
3	Wood structures	EA	$50,000	3	$150,000
4	Individual logs	EA	$1,000	20	$20,000
5	Plantings	AC	$10,000	7	$70,000
6	Design	LS	$75,000	1	$75,000
7	Contingency	LS	$100,000	1	$100,000
TOTAL					**$595,000**

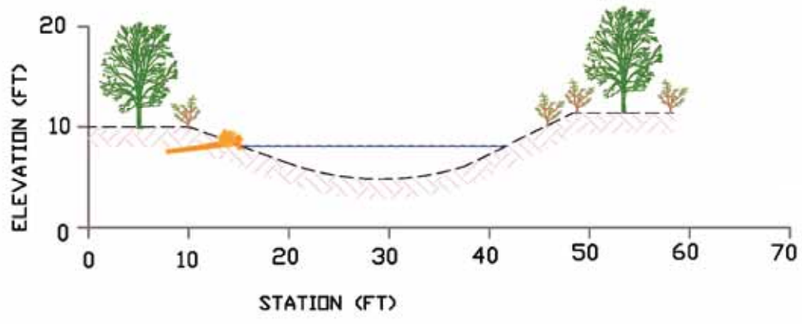
Grays River

Habitat Restoration Technical Report

Project RM 13.5 R Concept Design



Cross Section



Cost Estimate

Cost Estimate Summary Project RM 13.5R

Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation, mob/demob	LS	$10,000	1	$10,000
2	Channel excavation and dispose of material	CY	$50	5500	$275,000
3	Wood structures	EA	$50,000	1	$50,000
4	Individual logs for cover	EA	$1,000	25	$25,000
5	Plantings	AC	$10,000	11	$110,000
6	Design	LS	$75,000	1	$75,000
7	Contingency	LS	$100,000	1	$100,000
TOTAL					**$645,000**

Grays River

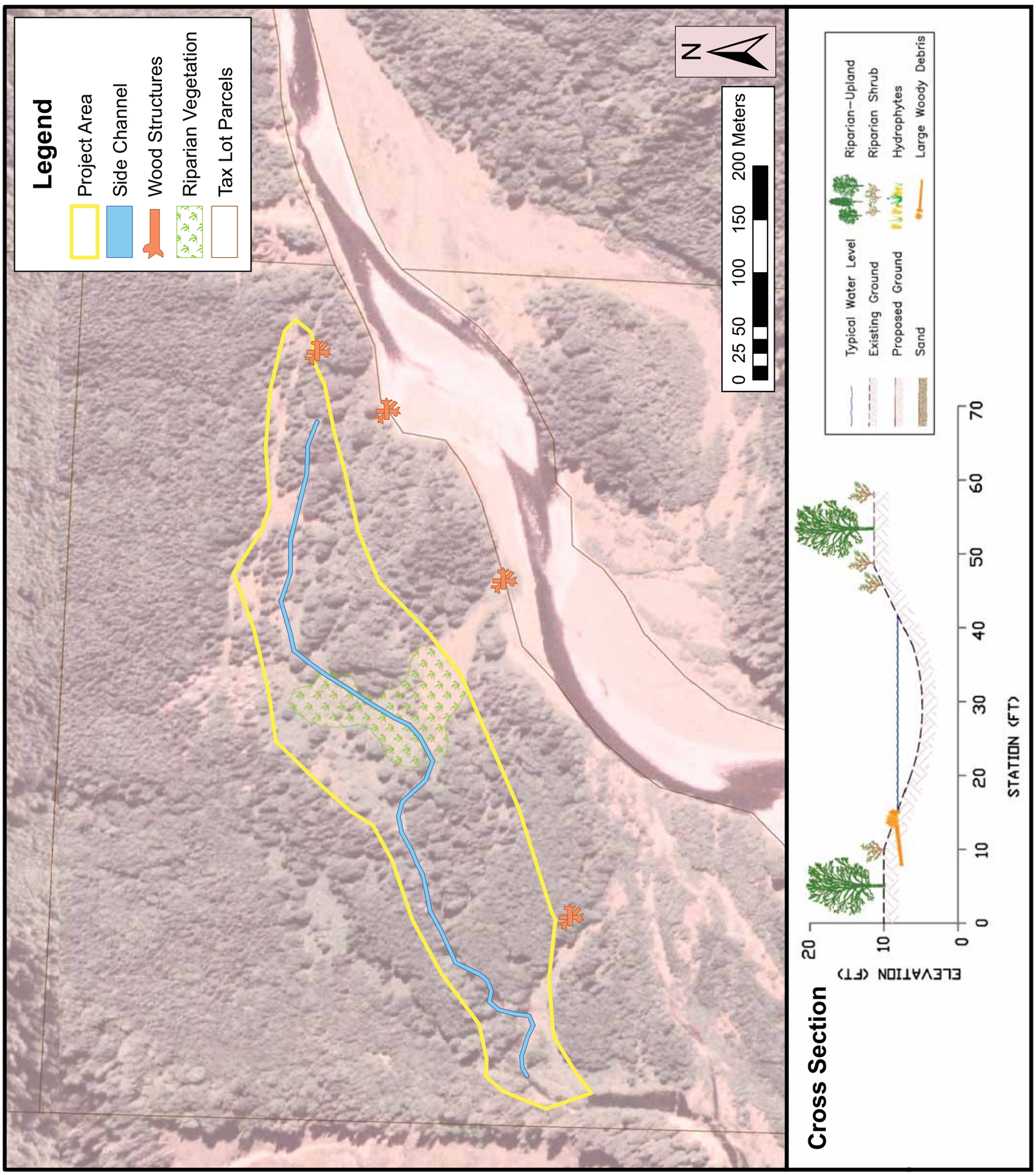
Habitat Restoration Technical Report

Project RM CJ2 Concept Design

Cost Estimate

Cost Estimate Summary Project CJ2

Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation, mob/demob	LS	$10,000	1	$10,000
2	Channel excavation and dispose of material	CY	$50	4500	$225,000
3	Wood structures	EA	$50,000	4	$200,000
4	Individual logs for cover	EA	$1,000	25	$25,000
5	Plantings	AC	$10,000	3	$30,000
6	Design	LS	$75,000	1	$75,000
7	Contingency	LS	$100,000	1	$100,000
	TOTAL				**$665,000**



Grays River

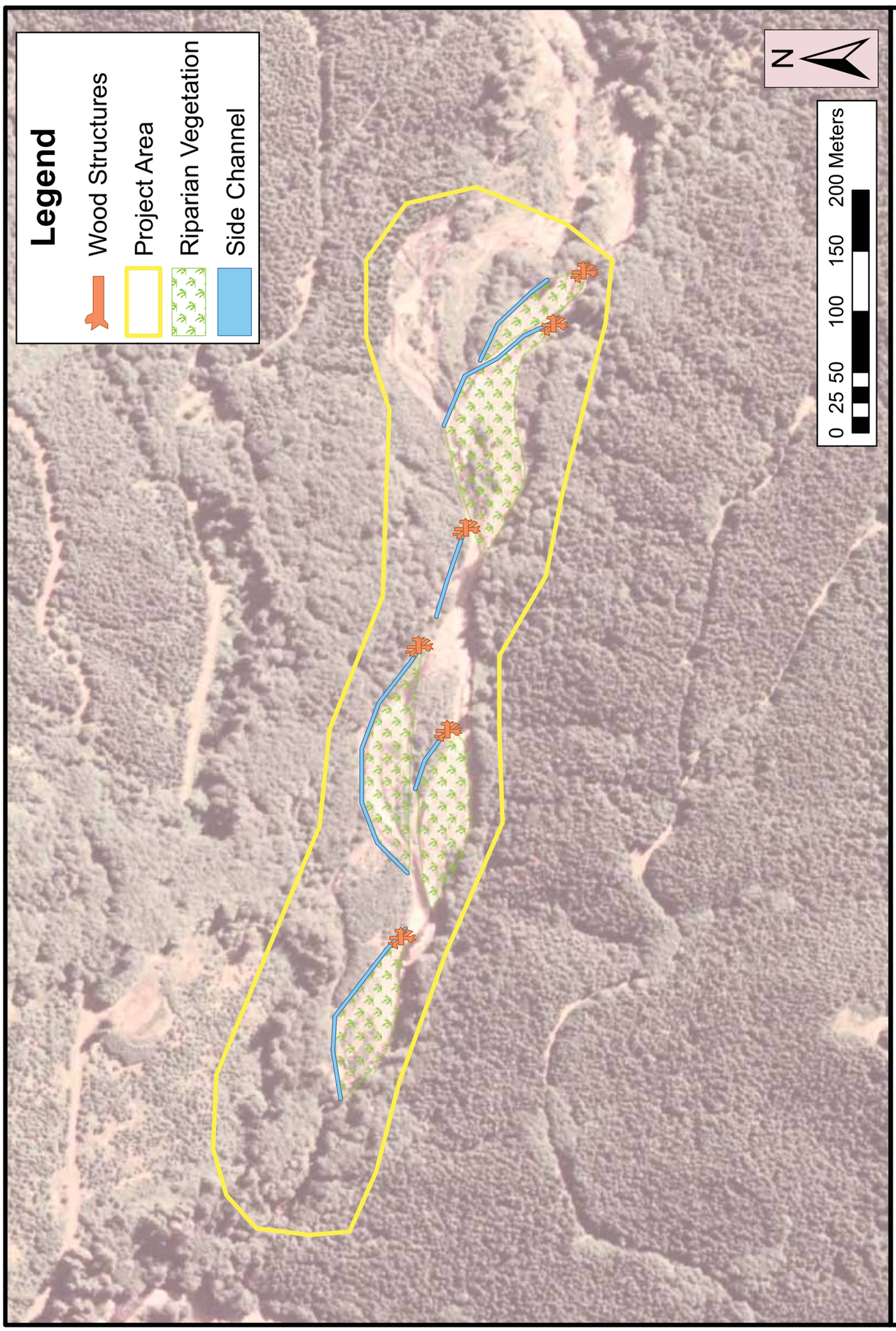
Habitat Restoration Technical Report

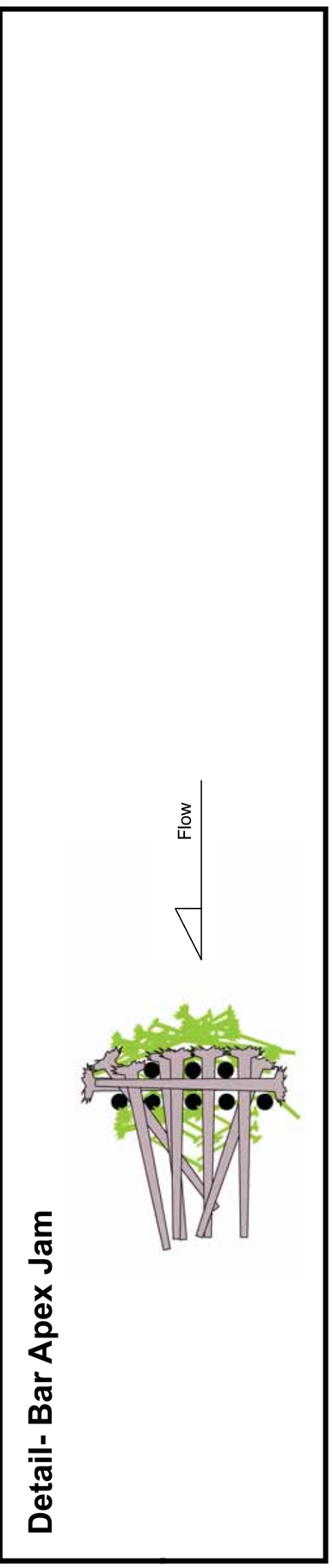
Project RM SF 1 Concept Design

Cost Estimate

Cost Estimate Summary Project SF1

Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation, mob/demob	LS	$25,000	1	$25,000
2	Channel excavation and dispose of material	CY	$70	4800	$336,000
3	Wood structures	EA	$75,000	6	$450,000
6	Design	LS	$75,000	1	$125,000
7	Contingency	LS	$100,000	1	$100,000
	TOTAL				**$1,036,000**





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Habitat Restoration Technical Report

Project RM WF4 Concept Design

Cost Estimate

Cost Estimate Summary Project WF4

Item	Description	Unit	Unit Cost	Quantity	Cost
1	Site preparation, mob/demob	LS	$25,000	1	$25,000
3	Wood structures	EA	$75,000	6	$450,000
6	Design	LS	$75,000	1	$125,000
7	Contingency	LS	$100,000	1	$100,000
	TOTAL				**$700,000**