FINDING OF NO SIGNIFICANT IMPACT

Yakima River Gap to Gap Ecosystem Restoration Project
Yakima County, Washington

1. Background. The U.S. Army Corps of Engineers, Seattle District (Corps), in partnership with Yakima County is proposing to implement an ecosystem restoration project along the Yakima River. Located east of the Cascade Mountain Range in central Washington State, the Yakima River ecosystem between the cities of Yakima and Union Gap has been degraded and reduced over time as a result of infrastructure and urban development. Environmental impacts and degradation can be tied directly to the Congressionally Authorized Yakima Levee System built by the Corps beginning in 1947. The federal levee system includes approximately five miles of levee along the right bank and two miles of levee along the left bank of the Yakima River. In addition, local and federal entities have extended the original Corps system to include several additional miles of levee both upstream and downstream of the original authorized project.

The Yakima River Gap to Gap Ecosystem Restoration Project (Yakima Project) is located near the city of Yakima between the Selah Gap and Union Gap, commonly known as the Gap to Gap Reach. The need for the proposed federal action arises from the degradation of natural processes such as channel migration, development of side channels, spawning gravel deposition and large woody debris recruitment in the study area due to the floodplain infrastructure and historical land uses. The degradation and loss of aquatic habitat, especially side channels, are significant limiting factors for Endangered Species Act (ESA)-listed salmonids and other species of fish and wildlife. The recommended plan encompasses restoration of lost riparian, floodplain, and aquatic habitat within the Gap to Gap Reach.

2. Authority. The proposed project falls under the Authority of Section 1135 of the Water Resources and Development Act of 1986, as amended (Section 1135). Section 1135 provides the Corps the authority to evaluate potential modifications to existing Corps' projects to restore aquatic habitats for fish and wildlife. Measures at off-project locations that have been affected by the construction or operation of the project can be undertaken, if such measures do not conflict with the authorized project purpose.

3. Purpose and Need. The purpose of the project is to restore ecosystem process, structure, and function in the Gap to Gap Reach of the Yakima River. The need for the proposed federal action arises from the degradation of natural ecosystem processes stemming from the disconnection of the river with its historic floodplain.

4. Proposed Action. The proposed action includes levee removals, levee realignment, spur dike removals, floodplain topographic restoration, side channel construction, hydrologic enhancement of a disconnected floodplain channel, and wetland reconnection. Work would be completed in four areas: the Diking District #1 (DID#1) floodplain area, Sportsman Island, Blue Slough, and Spring Creek. The

proposed action would reconnect and restore natural riverine processes beneficial to native fish to over 320 acres of floodplain through the realignment of the existing DID#1 levee. Realignment of the DID#1 levee would improve fish habitat by giving the river channel the opportunity to migrate and promote bar, island, and side channel formation. The proposed action would also create and restore approximately 20 acres of side channel habitat at the Sportsman's Park Island that is currently lacking in this reach of the Yakima River. Restoration of flow to Blue Slough would restore surface water hydrology to 2 miles/12 acres of relic channel that currently is only wet seasonally when ground water elevations are high. The reconnection of Spring Creek would restore fish access to rare cold water off-channel habitat.

By removing constraints to the natural flow of the river the proposed action reestablishes the conditions that allow the dynamic processes of channel formation and sediment transport to function naturally, which creates and sustains the habitat conditions suited to the ESA-listed fish and other species native to the Yakima River. Restored anabranching channels provide important rearing and refuge habitat for salmonids, especially important during high flows, as well as increased riparian vegetation which provides forage (insect drop) and cover. Many historic side channels that were isolated from the river when the levee was constructed would be reconnected by the proposed action. The proposed action restores inundation of the historic floodplain and associated exchange of nutrients and increases habitat complexity via food subsidies and large wood. The proposed action restores conditions such that this dynamic river system can continue to form and re-form channels as sediment moves around in the system. The project would restore the ecosystem processes that form and sustain riverine habitat, which is key to successful restoration and consistent with Corps restoration policy.

5. Summary of Impacts and Compliance. The impacts of the proposed action are described fully in the project Detailed Project Report/Environmental Assessment (DPR/EA) dated June 2018, and summarized herein.

Temporary unavoidable adverse impacts associated with this project are expected to include construction impacts such as noise disturbance to wildlife and residents in the vicinity of operating heavy machinery; exhaust emissions from heavy machinery; impacts to turbidity during the connection of the Sportsman's Park channel to the river; and disruption of local traffic in the project vicinity. To lessen the potential impacts to threatened, endangered, and sensitive species, in-water work would take place during the work window of June 1 through September 15. Implementation of best management practices (BMPs) would also minimize impacts to fish and wildlife habitat.

The Corps is coordinating with federal agencies to ensure careful consideration of fish and wildlife resources. The Corps has determined that this project is "not likely to adversely affect" federally listed species under the ESA. In a letter dated 6 July 2017, the U.S. Fish and Wildlife Service concurred with the Corps' assessment of effects to bull trout, yellow-billed cuckoo, and their designated and proposed critical habitat. The National Marine Fisheries Service (NMFS) did not concur with the Corps' assessment of impacts to steelhead and its designated critical habitat and issued a Biological Opinion

(BiOp) on 13 July 2017. NMFS concluded "...the proposed action is not likely to jeopardize the continued existence of ESA-listed Middle Columbia River (MCR) steelhead...will not destroy or adversely modify designated critical habitat for MCR steelhead." The Corps will implement Reasonable and Prudent Measures and Terms and Conditions outlined in the NMFS BiOp. The Corps has prepared a draft 404(b)(1) analysis and will coordinate with the Washington Department of Ecology during the final design phase to receive a 401 water quality certification prior to project implementation. To comply with the National Historic Preservation Act, the Corps consulted with the State Historic Preservation Office (SHPO) and all recognized Native American Tribes in the project vicinity. An initial letter to document the area of potential effect (APE) was sent to SHPO on 3 April 2017. The SHPO agreed with the Corps' determination of the APE on 3 April 2017. The Corps also requested knowledge and concerns from the Yakama Nation on 3 April 2017. The Tribe did not comment. The Corps submitted its finding that there would be no historic properties affected to SHPO on 19 July 2017. SHPO agreed with the Corps' finding in a letter dated 23 August 2017.

Avoidance measures and reduction of impacts would take the form of on-site biological and cultural resources monitoring, the implementation of BMPs during construction, and scheduling to avoid potential impacts to fish and wildlife species.

6. Finding. Based on the attached environmental documentation, coordination, and analysis conducted to date by the Corps environmental staff, the Yakima Project is not expected to result in significant adverse environmental impacts. The Yakima Project is not considered a major Federal action having significant impact on the human environment. Therefore, the preparation of an environmental impact statement is not required.

20 MAY 19

Date

MARK A. GERALDI
COL, EN
Commanding

YAKIMA RIVER GAP TO GAP ECOSYSTEM RESTORATION PROJECT

CONTINUING AUTHORITIES PROGRAM
SECTION 1135

Integrated Detailed Project Report
and Environmental Assessment

June 2018

US Army Corps of Engineers
Seattle District

In Partnership With:
Yakima County, Washington

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LIST OF ABBREVIATIONS AND ACRONYMS

AAHU Average Annual Habitat Unit
ACE Annual Chance of Exceedance
BE Biological Evaluation
BMP Best Management Practice
CAA Clean Air Act
CE/ICA Cost Effective/Incremental Cost Analysis
CEQ Council on Environmental Quality
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CFHMP Comprehensive Flood Hazard Management Plan
CFS Cubic feet per second
CY Cubic yards
DAHP Department of Archaeology and Historic Preservation
DID#1 Diking Improvement District #1
DO Dissolved Oxygen
DPS Distinct Population Segment
DPR/EA Detailed Project Report and Environmental Assessment
EA Environmental Assessment
EC Engineering Circular
ECO-PCX Ecosystem Planning Center of Expertise
EFH Essential Fish Habitat
EO Ecosystem Outputs
ER Engineer Regulation
ESA Endangered Species Act
EPA U.S. Environmental Protection Agency
FMP Fishery Management Plan
FPPA Farmland Protection Policy Act
FONSI Finding of No Significant Impact
FWCA Fish and Wildlife Coordination Act
GHG Greenhouse Gas
HAPC Habitat Area of Particular Concern
IWR Institute for Water Resources
LWD Large Woody Debris
MBTA Migratory Bird Treaty Act
MCACES Micro-Computer Aided Cost Estimating System
MCR Middle Columbia River
MSFCMA Magnuson-Stevens Fishery Conservation and Management Act
NAGPRA Native American Graves Protection and Repatriation Act
NEPA National Environmental Policy Act
NHPA National Historic Preservation Act
NLD National Levee Database
NMFS National Marine Fisheries Service
NOAA National Oceanic and Atmospheric Administration
NOI Notice of Intent
NPDES National Pollutant Discharge Elimination System
NRHP National Register of Historic Places
NWI National Wetlands Inventory
O&M Operations and Maintenance
PDT Project Delivery Team
PL 84-99 Public Law 84-99
PPA Project Partnership Agreement
RCO Recreation and Conservation Office
RM River Mile
SHPO State Historic Preservation Officer
SR State Route (Highway)
TCP Traditional Cultural Properties
TSP Tentatively selected plan
Tribe Confederated Tribes and Bands of the Yakama Nation
U&A Usual and Accustomed
USACE U.S. Army Corps of Engineers
USBR United States Bureau of Reclamation
USC United States Code
USFS U.S. Forest Service
USFWS U.S. Fish and Wildlife Service
WDFW Washington State Department of Fish and Wildlife
WDNR Washington State Department of Natural Resources
WDOE Washington Department of Ecology
WRIA Water Resource Inventory Area
WRDA Water Resources Development Act
WSDOT Washington State Department of Transportation
WWTP Wastewater Treatment Plant
WQC Water Quality Certification
YBIP Yakima Basin Integrated Plan
YSFWPB Yakima Subbasin Fish and Wildlife Planning Board

Executive Summary

This Integrated Detailed Project Report and Environmental Assessment was developed by the U.S. Army Corps of Engineers, Seattle District (Corps) in partnership with Yakima County, Washington. Located east of the Cascade Mountain Range in central Washington State, the Yakima River ecosystem between Selah Gap and Union Gap (Gap to Gap Reach) has been degraded and reduced over time as a result of infrastructure and urban development. Environmental impacts and degradation can be tied to the construction of the Yakima Authorized levees, in combination with other federal & non-federal levees, smaller local flood control works, and development in the Yakima valley. The Yakima Authorized federal levee system includes approximately 5 miles of levee along the right bank and 2 miles of levee along the left bank of the Yakima River. In addition, local and federal entities over time have extended the original system to include several additional miles of levee both upstream and downstream of the original authorized project. Between 1964 and 2002 the total mainstem channel length decreased by more than 40% in the study area primarily due to levee construction. As of 2002 only 25% of the pre-settlement (late Holocene) active floodplain in the Gap to Gap Reach (RM 107 to RM 117) was connected to the river, representing a loss of 75% of the active floodplain habitat in this reach due to development and levee construction.

Currently the length of levees and revetments combined (19.9 miles) is twice the main channel length in the reach. This means that the river is confined for nearly the entire length of the Gap to Gap Reach on both banks. The levee system and channelization and snagging efforts completed by the Corps, project sponsor, and others in past decades have considerably reduced channel length and complexity, degraded and fragmented habitat and disrupted natural fluvial processes. These changes have negatively impacted in-stream habitat, and they have increased in-channel velocities and depths, which results in increased likelihood of levee damage and increasing operations and maintenance costs.

Natural processes such as channel migration, development of side channels, spawning gravel deposition and large woody debris recruitment are degraded in the study area due to the floodplain infrastructure and historical land uses. The degradation and loss of aquatic habitat, especially side channels, are significant limiting factors for Endangered Species Act (ESA) -listed steelhead and bull trout, as well as other salmonids and Pacific lamprey. Once an important food source for Native Americans, Pacific lamprey are now listed as a federal and state species of concern. In addition to aquatic habitat, the levees also negatively impact adjacent riparian habitat for birds and mammals by preventing overbank flooding and sediment deposition, and by reducing hydrologic connectivity with the river.

The Recommended Plan would restore frequent inundation to more than 320 acres of historic floodplain by realigning 1.7 miles of revetment and levee and removing 8% of the hardened streambank in the nearly 10 mile long Gap to Gap Reach. It would also reconnect approximately 2.4 miles of historic side channel habitat. The Recommended Plan would not lead to any increase in flood risk to adjacent properties. The total federal and non-federal estimated project first cost to design and implement the TSP is $12,238,000.

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1. Introduction

The U.S. Army Corps of Engineers, Seattle District (Corps) has partnered with Yakima County, Washington (County) to evaluate potential ecosystem restoration actions along the Yakima River between Selah Gap and Union Gap (Gap to Gap Reach), RM 107 to RM 117. If implemented the work proposed herein would complement efforts completed and underway by state, Tribal, local and other federal entities to restore the reach. The Yakima River floodplain ecosystem in this reach has been degraded over time as a result of the Yakima Authorized levees (constructed by the Corps and comprising the majority of levee miles in the reach), other federally-constructed and local flood control works on both banks of the river dating back to the 1940's, and development in the Yakima valley. This Detailed Project Report/Environmental Assessment (DPR/EA) documents the feasibility phase planning process for ecosystem restoration in the Gap to Gap Reach of the Yakima River to demonstrate consistency with both the applicable Congressional authorization and Corps planning policy. In addition, this DPR/EA demonstrates consistency, compliance, and consideration of potential environmental effects in accordance with the National Environmental Policy Act (NEPA). Opportunities will be presented for the public to provide comments on potentially affected resources, environmental issues to be considered, and the Corps' approach to the analysis. The public comment period for the Draft DPR/EA was 27 March 2017 through 26 April 2017. If upon completion of the feasibility phase it is determined that there is a federal interest in the project, the project would proceed into the Design and Implementation Phase to finalize the design and implement the project.

1.1 Study Purpose and Scope

Construction of the Yakima Authorized levees, in combination with other federal levees and smaller local flood control works, has resulted in ecosystem degradation through the Gap to Gap Reach. The purpose of this study is to evaluate the feasibility of ecosystem restoration actions within that reach and to identify a recommended plan to be implemented to address that environmental degradation. The recommended plan encompasses restoration of lost riparian and aquatic habitat within the Gap to Gap Reach.

1.2 Study Authority

This DPR/EA is being prepared under the Authority of Section 1135 of the Water Resources Development Act (WRDA) of 1986, as amended (Section 1135). Section 1135 provides the Corps the authority to evaluate potential modifications to existing Corps projects for the purpose of improving the environment in the public interest. Measures at off-project locations that have been affected by the construction or operation of the project can be undertaken, if such measures do not conflict with the authorized project purpose. The following is excerpted from the authorizing legislation:

"SEC. 1135. PROJECT MODIFICATIONS FOR IMPROVEMENT OF ENVIRONMENT.

(a) Determination of need

The Secretary is authorized to review the operation of water resources projects constructed by the Secretary before the date of enactment of this Act to determine the need for modifications in the structures and operations of such projects for the purpose of improving the quality of the environment in the public interest."

(b) Authority to make modifications

The Secretary is authorized to carry out a program for the purpose of making such modifications in the structures and operations of water resources projects constructed by the Secretary which the Secretary determines

(1) are feasible and consistent with the authorized project purposes, and

(2) will improve the quality of the environment in the public interest.

(c) Restoration of environmental quality

(1) In general

If the Secretary determines that construction of a water resources project by the Secretary or operation of a water resources project constructed by the Secretary has contributed to the degradation of the quality of the environment, the Secretary may undertake measures for restoration of environmental quality and measures for enhancement of environmental quality that are associated with the restoration, through modifications either at the project site or at other locations that have been affected by the construction or operation of the project, if such measures do not conflict with the authorized project purposes.

…

(d) Non-Federal Share; Limitation on Maximum Federal Expenditure

The non-federal share of the cost of any modifications or measures carried out or undertaken pursuant to subsection (b) or (c) of this section shall be 25 percent. Not more than 80 percent of the non-federal share may be in kind, including a facility, supply, or service that is necessary to carry out the modification or measure. Not more than $10,000,000 in federal funds may be expended on any single modification or measure carried out or undertaken pursuant to this section.

…"

1.3 Relationship to Corps Operating Project

Projects carried out under the Section 1135 authority of the Continuing Authorities Program must demonstrate a link between the degraded environment and a Corps project. Severe flooding in 1933 prompted the authorization and construction of the Yakima Authorized Flood Control Project levees (Yakima Authorized) along the Yakima River to limit future flood damages near the City of Yakima. Construction of the Yakima Authorized project levees was authorized by the Flood Control Act of 1938 set forth in House document 579 of the seventy-fifth Congress. Obligations between the United States Government and the County are outlined in the February 21, 1946 cost sharing agreement:

"WHEREAS, the United States Government has by act of Congress appropriated funds for flood control works in Yakima County subject to the following requirements of the law adopting the project – that hereafter no money appropriated under authority of the Act shall be expended on the construction of

any projects until States, political subdivisions thereof, or other responsible local agencies have given assurance satisfactory to the Secretary of War that they will (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, except as otherwise provided herein: (b) hold and save the United States free from damages due to the construction works: (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War …".

Beginning in 1947, the U.S. Army Corps of Engineers constructed nearly 8.6 miles of levees that have since been modified, repaired, and expanded. Repairs conducted by the Corps of Engineers in 1949, 1996, 2009 and 2012 addressed damages caused by large events in the basin. Since the original construction, non-federal entities, such as the City and Diking Improvement District #1, have expanded the flood risk reduction system and increased protection from flood damages downstream.

The presence of the levees in the reach, of which federal levees comprise approximately 75%, has reduced active floodplain acreage from 1,988 acres in 1927 prior to the construction of the federal levees to 1,425 acres in 2002 (Eitemiller, D.J., Arango, C.P., Clark, K.L., and Uebelacker, M.L., 2002). This has led to simplification of the reach, which transitioned from an anabranched system comprised of multiple dynamic channels to a single channel in much of the area. Sediment distribution in the river bed throughout the reach is more simplified and static, which leads to less spawning and rearing habitat for ESA-listed and other fish species. Thus, there is a link between the federal levee system and a reduction in both quantity and quality of habitat. The proposed project would increase active floodplain acreage by 427 acres, approximately 30%. While this figure is derived from the report referenced above, elsewhere in this report we reference 320 acres restored; the latter figure is formally what this project can be credited for restoring given real estate considerations.

1.4 Lead Federal Agency and Non-Federal Sponsor

The study documented herein has been conducted jointly by the Corps (lead federal agency) and Yakima County (non-federal sponsor).

1.5 Stakeholders and Cooperating Agencies:

Several federal, state, local, and tribal stakeholders have been identified at this time.

- Diking Improvement District #1
- U.S. Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- U.S. Bureau of Reclamation (USBR)
- Yakama Nation
- Washington Department of Fish and Wildlife (WDFW)
- Washington Department of Natural Resources (DNR)
- Washington Department of Ecology (WDOE)

- Washington Department of Archaeology and Historic Preservation (DAHP)
- Washington State Department of Transportation (WSDOT)
- Washington State Parks and Recreation Commission
- City of Yakima, Washington
- City of Union Gap, Washington
- Members of the general public

There are no cooperating agencies at this time.

1.6 Location of the Study Area

The general study area is located in Yakima County, Washington, east of the Cascade Mountain Range in central Washington State. The Yakima River basin is the largest river basin located wholly in Washington State (Figure 1-1). The study is focused near the City of Yakima in the Yakima River floodplain between Selah Gap and Union Gap, commonly known as the Gap to Gap Reach. The river reach and adjacent floodplain being considered for restoration are entirely within Yakima County, near the cities of Yakima and Union Gap. The Gap to Gap Reach comprises nearly 10 river miles of the Yakima River (river mile 107 near Wapato dam, to RM 117, just upstream of the Naches River confluence. Within the Gap to Gap Reach, there are highly developed areas on the right bank of the Yakima River through the City of Yakima, as well as less developed, rural and natural areas on the left bank and upstream and downstream of the city. The project actions span 4 miles of the river, from RM 109 near the Spring Creek confluence to RM 113 just downstream of the Terrace Heights Bridge (Figure 1-2).

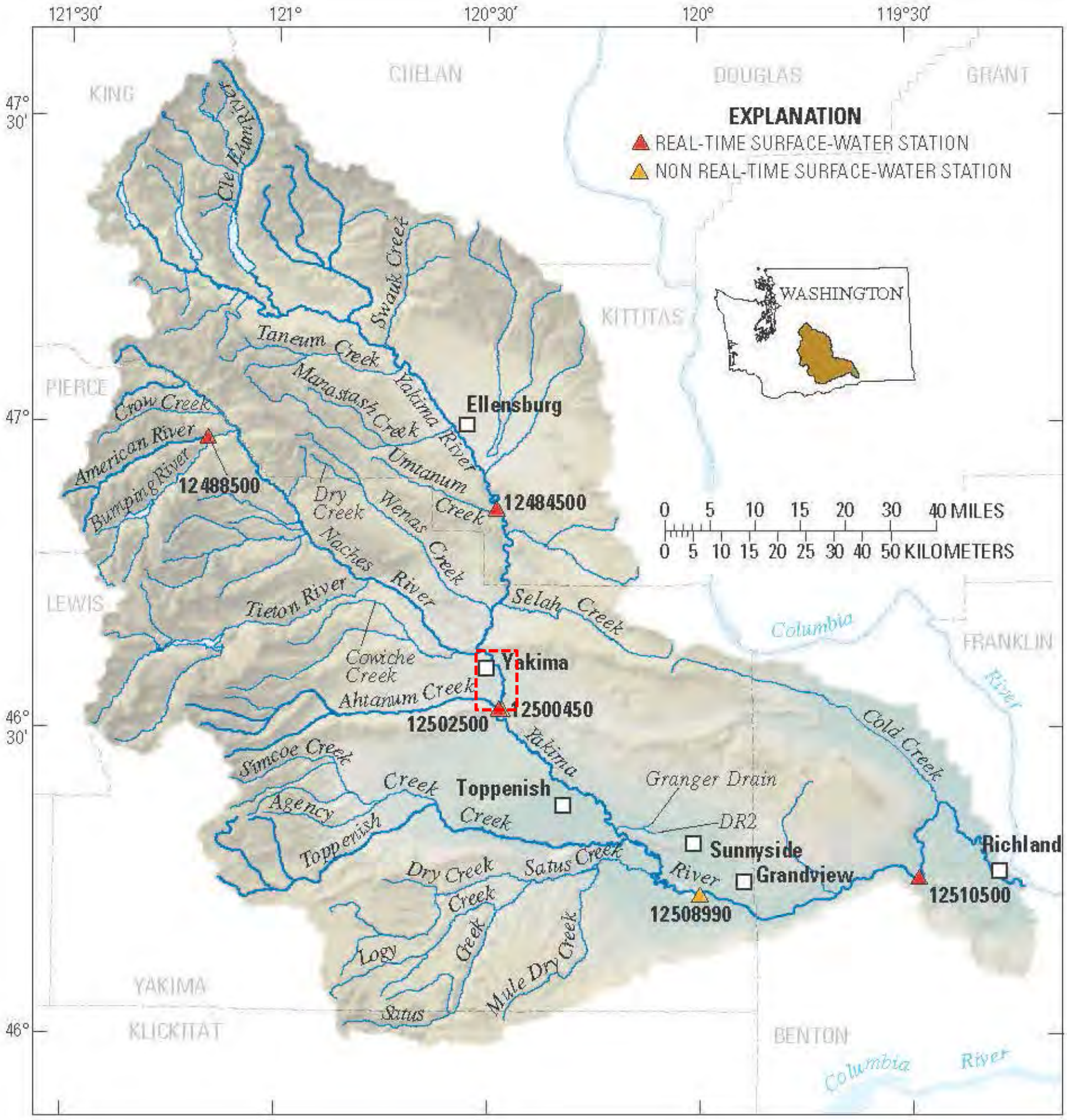

Figure 1-1. Yakima River Basin Overview

Study area (Gap to Gap Reach) shown in red dashed box.

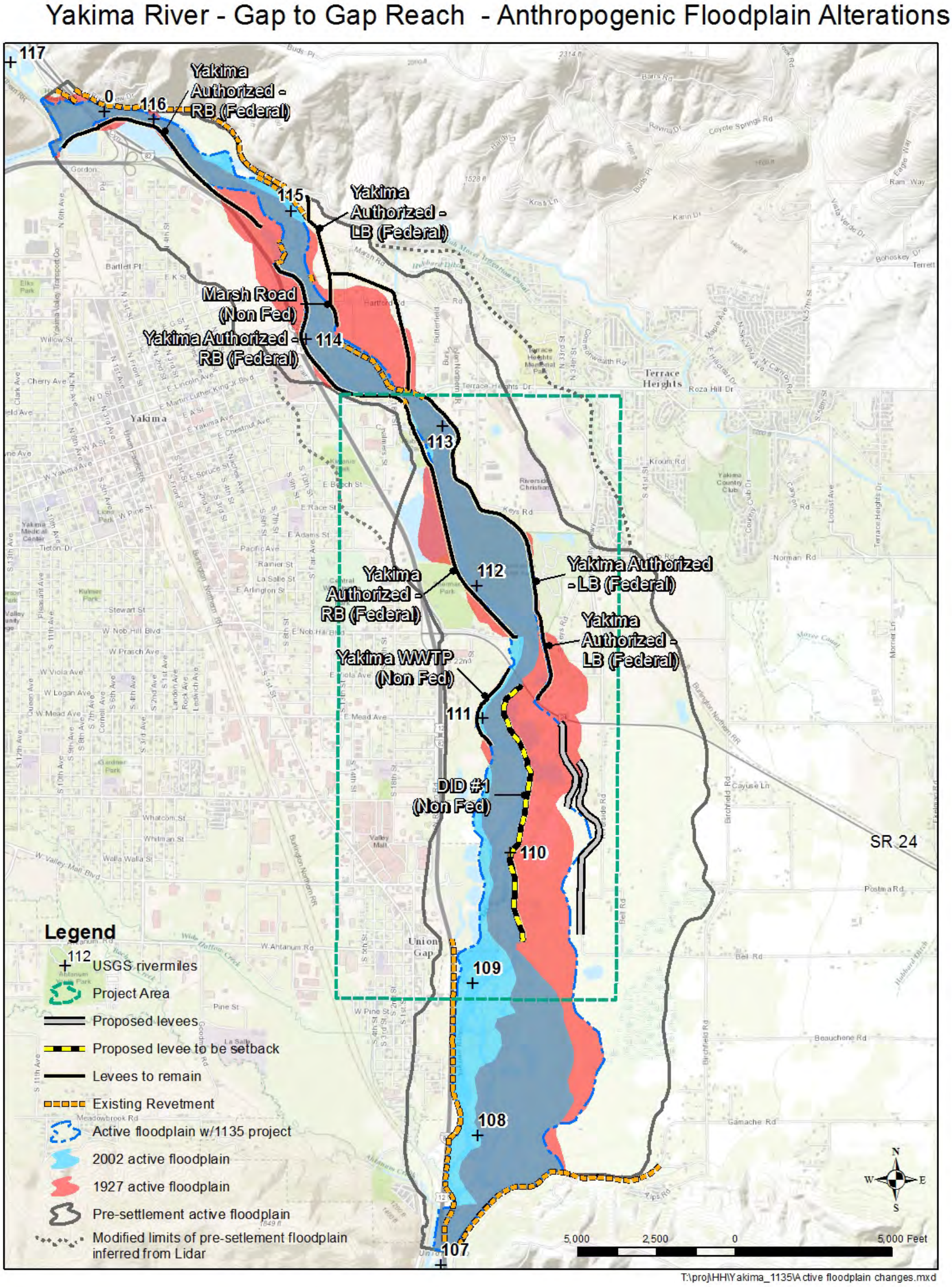

Figure 1-2. Study Area & Historic Changes in the Gap to Gap Reach

1.7 Proposal for Federal Action

The proposal to implement ecosystem restoration along the Yakima River Gap to Gap Reach triggered the National Environmental Policy Act (NEPA) process recorded in this document (40 CFR 1501.2). Based on study results, the Corps is proposing restoration of ecosystem structure, function and processes through reconnection of more than 320 acres of historic active floodplain to the main channel of the Yakima River, from the Terrace Heights Bridge at the upstream (north) end to 1.5 miles downstream (south) of the State Route 24 (SR 24) bridge. This report analyzes the feasibility of measures to improve the environment, including realignment of a levee that ties into the downstream (south) end of the left bank Yakima Authorized levee.

1.8 Overview of Integrated DPR/EA

This document is a combined Detailed Project Report (DPR) and Environmental Assessment (EA). The purpose of the DPR is to identify the plan that reasonably maximizes ecosystem restoration benefits, is technically feasible, and preserves environmental and cultural values. The purpose of the EA portion of the report is to comply with the National Environmental Policy Act (NEPA) by identifying and presenting information about the environmental effects of the alternatives and incorporating environmental concerns into the decision-making process. The six steps of the Corps planning process each align with a NEPA requirement. The planning steps are listed below with the document chapter and NEPA element to which they relate:

Table 1-1. Overview of DPR/EA

• Planning Step:	• Document Chapter and Analogous NEPA Requirement:
• **Step One – Specify Problems and Opportunities**	• Appears in Chapter 2, as described in the purpose and need for action.
• **Step Two – Inventory and Forecast Conditions**	• Appears in Chapter 4, which describes the existing conditions of the study area and discusses the effects of the no-action alternative, also known as the future without-project condition.
• **Step Three – Formulate Alternative Plans**	• Appears in Chapter 3 in the description of the screening process and formulation of alternative plans to meet the purpose and need.
• **Step Four – Evaluate Effects of Alternative Plans**	• Appears in Chapter 4 with the comparison of how each alternative affects the significant resources identified in Chapter 4.

• Planning Step:	• Document Chapter and Analogous NEPA Requirement:
• **Step Five – Compare Alternative Plans**	• Begins in Chapter 3 after the description of the alternatives and continues in Chapter 4 with the comparison of how each alternative may affect the significant resources.
• **Step Six – Select Recommended Plan**	• Appears in Chapter 5 and includes details of the Recommended Plan (agency preferred alternative).

2. Need For and Objectives of Action

2.1 Purpose and Need for Action

The purpose of the project is to restore ecosystem process, structure, and function in the Gap to Gap Reach of the Yakima River. The need for the proposed federal action arises from the degradation of natural ecosystem processes stemming from the disconnection of the river with its historic floodplain. This reach has the greatest potential for restoring fish habitat for ESA-listed fish in a basin that is impacted in various ways by human activity, including presence of federal and non-federal levees that disconnect the river from its historic floodplain; managed, non-normative hydrology; and agricultural runoff (nonpoint source pollution).

2.2 Problems

The extent and function of this reach of the Yakima River and its floodplain have been reduced by infrastructure and urban development adjacent to the cities of Yakima and Union Gap. The Yakima Authorized levee system, built by the Corps in 1947, includes approximately 5 miles of levee along the right bank and 2 miles along the left bank. The Corps levee system ties into several non-Corps levees, including a U.S. Bureau of Reclamation levee, a City of Yakima levee, a Washington State Department of Transportation levee, and a Diking Improvement District #1 (DID1) levee; the latter extends about 2 miles south from the downstream terminus of the left bank Corps levee.

Eitemiller et al., (2002) documented the anthropogenic changes that have occurred in the Yakima Basin including the Gap to Gap Reach. Figure 1-2 overlays the historical floodplain delineations of Eitemiller et al., with current road and levee alignments. The researchers estimated the contribution of levees and roads to loss of the Holocene (pre-settlement) floodplain and connected channel length within the historic period of record (1885 to 2002). The results of the study indicate that about 75% of the active (frequently wetted) floodplain area has been lost due to changes in land use and floodplain fragmentation caused by levees, roads and revetments. Levees constructed since the 1960s contributed to more than 40% loss in connectivity alone (Eitemiller et al., (2002). The total length of levees and revetment constructed is twice the channel length in the Gap to Gap Reach. Essentially the river is confined by revetments on both banks for its full length of the Gap to Gap Reach.

The levee system has effectively channelized the reach through the study area, leading to localized sediment aggradation/degradation and increased erosional forces which in turn impact in-stream habitat and levee integrity. Natural processes such as channel migration, development of side channels, and large woody debris recruitment are hampered within the study area due to the channel constraints which limit channel-floodplain interaction. The degradation and loss of aquatic habitat, especially side channels, are significant limiting factors for Endangered Species Act (ESA) -listed steelhead and bull trout, as well as other salmonids and Pacific lamprey. Once an important food source for Native Americans, Pacific lamprey are now listed as a federal and state species of concern. In addition to

aquatic habitat, the levees also negatively impact adjacent riparian habitat by preventing overbank flooding and sediment deposition, and by reducing hydrologic connectivity with the river.

River and floodplain gravel mining have also contributed to extensive disturbances and degradation of the active floodplain in the historic period. The Yakima River has experienced some of the most intensive gravel mining in Washington State (YRFMIST, 2004). While the current mining activities in the active floodplain are greatly diminished from recent decades, the legacy effects remain. These effects include direct loss of active floodplain, construction of dikes to protect mining areas, hydrologic alterations, water quality impacts, invasive species introduction and capture of gravel pits during floods, which can cause upstream headcutting and downstream gravel starvation. Documented gravel pit captures in the Gap to Gap Reach include the Terrace Heights pit in 1971 and Edler ponds in 2002. Several abandoned gravel mines are located in the project reach. These include Buchanan Lake (right bank, upstream of SR 24, near RM 112.5), the Newland Pits (left bank, downstream of SR 24, near RM 111), and Edler ponds near Union Gap on the right bank. The Yakima River Floodplain Mining Impact Study Team (YRFMIST) recommended reclamation of active gravel mines within the 100-year floodplain to help alleviate these historic and ongoing impacts.

Specific problems include:

- **Degraded channel structure, width and complexity** (pools, riffles, substrate, and depth variability) which limits quantity and quality of available rearing, foraging, migratory, and overwintering habitat utilized by ESA-listed steelhead and bull trout and non-listed species, including other salmonids and Pacific Lamprey.
- **Loss of refuge and rearing habitats** such as side channels, back channels, shallow habitat with cover from predators, slow-water refuge areas, riparian wetlands, and other off-channel habitat; and also includes direct loss of channel length due to channelization and levee construction.
- **Reduced floodplain connectivity** and lost functions such as floodwater storage, groundwater recharge, exchange of nutrients and organic material between land and water, and floodplain sediment sink.
- **Degraded riparian vegetation and wetlands** contributing to elevated water temperatures and reduced availability of terrestrial food sources for aquatic organisms, and reduced habitat for mammals and birds.
- **Fewer pools and less cover for juvenile fish**, historically provided by large woody debris recruited into the channel from the floodplain.

2.3 Opportunities

This reach has been identified in regional planning documents as providing excellent opportunities for floodplain restoration (Yakima County 2007, YSFWPB 2004). There is broad regional support for completing restoration in the reach, and a natural nexus for the Corps to participate given the impacts related to the federal levee that lines a significant portion of the reach. Additionally, the levees in this

reach often require maintenance, and in turn that maintenance often negatively impacts the ecosystem. Reconnecting parts of the river to its historic floodplain presents an opportunity to reduce future levee maintenance needs and associated harm to the environment. While maintenance costs avoided is incidental to the ecosystem restoration purpose of this project, avoiding impacts to the ecosystem as a result of that maintenance may increase the net ecosystem benefits attributable to the project over the period of analysis.

Opportunities have been identified to achieve the following:

- Restore channel structure, width and complexity
- Restore refuge and rearing habitats for ESA listed salmonids
- Restore floodplain connectivity
- Improve riparian vegetation and wetlands
- Restore pools and cover that benefit juvenile fish

2.4 Resource Significance – Technical, Institutional, Public

The Yakima basin is a productive part of the greater Columbia watershed, and the Gap to Gap Reach is particularly important for restoring conditions for sustaining and recovering fish populations in the basin. The following subsections (2.4.1 – 2.4.3) explain its importance in greater detail.

2.4.1 Technical Significance

Floodplains located on aggraded segments, such as the Gap to Gap Reach, maintain a highly diverse and productive biological community, including resident and migratory species (Stanford and Snyder 2001). Aggraded river segments are regional hot spots of biodiversity (richness or abundance of species of plants and animals). Many species are supported by the continually shifting habitat mosaic that is mediated by the process of cut (erosion) and fill (deposition) alluviation as flooding and sediment deposition forces the channel to move or meander across the floodplain, creating new disturbed patches for colonization. In essence, the shifting habitat mosaic is a dynamic template that allows many species to co-exist.

In addition, floodplains are giant retention devices for flood waters that maintain baseflow during the drier and hotter parts of the growing season. They act as the flywheel on the regional “engine” or river ecosystem, providing a cool supply of groundwater to sustain baseflow when snowpack derived runoff ceases (Stanford and Snyder 2001). Moreover, floodplains attenuate, recycle, retain, and transform pollutants carried by river systems. Hence, the basis of a normative habitat condition is enough channel and riparian or floodplain “connectivity” to create and maintain quality habitat that sustains each life history stage of the various salmonid species that occur in the river system.

The Pacific Northwest ecoregion is home to many species of the Salmonidae family. These fish serve as an indicator of the overall health of not only the aquatic environment where they dwell, but also the connected riparian, wetland, and upland habitats. A comprehensive restoration plan for all species in

the Salmonidae family, as keystone species, can provide direct and indirect benefits for a broad suite of over 130 other native plant and animal species (Cederholm et al., 2000). Keystone species play a unique and crucial role in the way an ecosystem functions; these fish are extremely sensitive to changes in water quality, trophic webs, and perturbations to the river flow, turbidity, and temperature. Pacific salmon are a food source for a variety of marine, freshwater, and land animals and provide a source of marine-derived nutrients to freshwater environments after spawning (Cederholm Kunze, Murota, Sabatini, 1999). Juvenile salmonids feed on aquatic invertebrates that are indicators of good water quality.

Generally, the more pristine, diverse, and productive the ecosystem is, the healthier the salmon stocks. A decline in the capacity of a watershed to support juvenile salmonids is one indication of declining ecosystem health. Restoration planning centered on habitat for the Salmonidae family reinstitutes dynamic processes that tend to maintain healthy ecosystem characteristics.

Riparian wetlands in the Yakima watershed provide significant ecological functions, including rearing and resting sites for aquatic and land species, natural drainage, storage areas for floodwater, groundwater discharge areas critical to summer low flow, and significant water purification functions through natural filtration. The wetlands associated with the Yakima River benefit water quality in both in the Yakima and in the Columbia River, to which it is a tributary.

The Yakima Basin Subbasin Plan (YSFWPB, 2004) identifies the loss of floodplain habitat as a principal limiting factor for the productivity of aquatic habitat in the subbasin. It further reports that floodplain loss has been estimated at 82% in the Gap to Gap Reach and directly ties reduction of wetted stream channel area to loss of primary habitats utilized by salmonid species targeted for restoration.

The Reaches Project (Stanford et al., 2002) has identified that in the Yakima Basin, restoration potential is highest on the Gap to Gap floodplain (Naches confluence to Union Gap), because the amount of land needed for full floodplain restoration is clearly delineated and has a fair amount of intact habitat, and habitat forming floods naturally occur in this reach. Moreover, the report documents considerable use of floodplain (off-channel) habitats by juvenile salmonids in this area, habitat which is scarce in the basin.

2.4.2 Institutional Significance

Two ESA-listed fish species of the Columbia Basin area occur in the Yakima River. These are Columbia River Bull Trout and Middle Columbia River (MCR) Steelhead.

Bull trout are estimated to currently occur in 45% of their estimated historical range (Quigley and Arbelbide 1997). The USFWS indicated that, aside from the Rimrock subpopulation, the Yakima drainage subpopulations were considered depressed. *Salmonid Stock Inventory* (WDFW, 2002) termed most of the Yakima basin stocks as “critical.” The Yakima River is designated as critical habitat for bull trout.

Despite substantial efforts to improve habitat conditions in the range of MCR steelhead, much of the habitat remains degraded. In their 2011 study titled *5-Year Review: Summary and Evaluation of Middle Columbia River Steelhead*, NMFS notes that in particular, the poor status of the habitat and populations in the Yakima Basin are a major obstacle to achieving viability for this population. The Yakima River is designated as critical habitat for steelhead.

Floodplain habitat issues are concentrated in mainstem reaches of the Yakima River, including the Kittitas, Gap to Gap and Wapato floodplains, in the Naches River, and in the valley floor reaches of priority tributaries including the Cle Elum River, Taneum Creek, the Teanaway River, Cowiche Creek, the Little Naches River, Ahtanum Creek and others.

The Yakama Tribal Reservation is along the right bank of the Yakima River adjacent to and downstream of the proposed project. The multiple species of fish and other resources in the Yakama River play an integral part of tribal culture, religion, and physical sustenance. The Yakama Nation has treaty-protected harvest rights within their Tribe's Usual and Accustomed (U&A) harvest area, which reflects the historical region in which fish and other natural resources were collected. The government has an obligation to protect tribal land, assets, and resources that it holds in trust for the Tribes, and a responsibility to ensure that its actions do not abrogate Tribal treaty rights.

2.4.3 Public Significance

The Yakima River Basin Water Enhancement Project (YRBWEP, 2004) identified floodplain restoration in the Gap to Gap Reach as a top priority habitat restoration project for the basin. Further evidence of public significance is provided by the number of related floodplain restoration actions that have been implemented by various public entities in the reach, including The City of Yakima wastewater treatment plant outfall relocation and floodplain restoration, relocation of the Waste Water Treatment Plant levee by the City of Yakima, replacement of the SR-24 Bridge by the Washington State Department of Transportation (WSDOT) with a wide-span bridge designed to accommodate the restored floodplain, and interior levee breaching by the County at the Boise Cascade levee and upstream of Terrace Heights Bridge. In addition, the Yakama Nation has invested funds in restoration of the Yakima River and floodplain through floodplain and in-channel habitat restoration in Ahtanum Creek (a tributary to the Gap to Gap Reach) and the Wapato Reach, the reach directly downstream of the Gap to Gap Reach (Figure 1-1).

2.5 Planning Goals and Objectives

The primary ***goal*** of the project is, within the Gap to Gap reach, to:

- Restore the hydraulic connection between the floodplain and the river and associated ecosystem processes, to address habitat degradation for ESA-listed and other fish and wildlife species.

The following ***planning objectives*** will guide formulation and evaluation of alternative plans to address the identified problems:

- Restore connectivity between the Yakima River and its historic floodplain for the 50-year period of analysis.
- Maintain high quality riparian habitat adjacent to aquatic environments within the Gap to Gap Reach for the 50-year period of analysis.
- Reconnect historic channels to restore lost fish habitat for the 50-year period of analysis.

Table 2-1 shows the connection between the identified problems and the specific planning objectives for this study. Measures were subsequently developed to address the planning objectives.

Table 2-1. Restoration Objectives and the Problems They Address

	Ecosystem Problems in the Study Area				
Objectives	Degraded channel structure	Loss of salmonid refuge and rearing habitat	Reduced floodplain connectivity	Degraded riparian vegetation	Fewer pools/cover
Floodplain/river connectivity	x	x	x		x
Maintain riparian habitat				x	
Reconnect historic channels	x	x	x		

2.6 Planning Constraints

Planning constraints are significant barriers or restrictions that limit the extent of the planning process. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. In addition to the limitations of the Section 1135 authority, the following constraints (i.e., limitations on the range of measures and alternatives that can be proposed) have been identified for the study:

- Ensure the Yakima Authorized levee continues to provide the same level of flood protection after construction of the Sec. 1135 project as currently exists.
- Avoid causing induced flooding.
- The project should avoid impacts to the extent practicable to flood risk of the surrounding structures or infrastructure, and should not increase life safety concerns associated with flood risk.
- The project should, to the extent practicable, be designed and implemented such that capture of old gravel pits along the Yakima River does not result in head-cutting to a degree that would undermine bridge abutments, levees, or other critical infrastructure.

- Impacts to the Greenway Trail and other recreation facilities should be avoided to the extent practicable.
- Ensure continued access for levee maintenance and flood fights.

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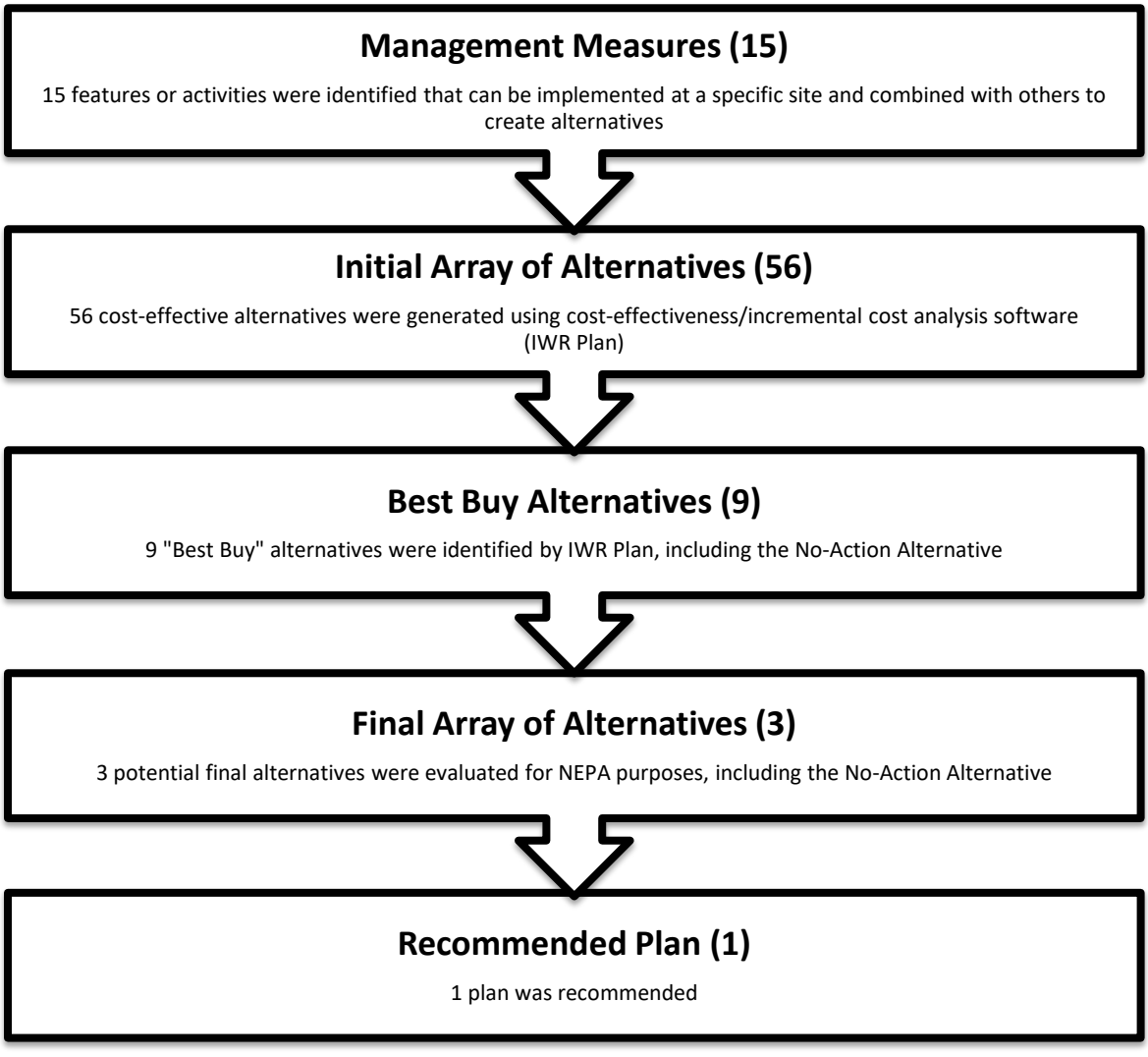
3. Plan Formulation

The guidance for conducting civil works planning studies, Engineer Regulation (ER) 1105-2-100, Planning Guidance Notebook, requires the systematic formulation of alternative plans that contribute to the federal objective. To ensure that sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic and repeatable approach. This chapter presents the results of the plan formulation process. Measures were developed in consideration of study area problems and opportunities as well as study objectives and constraints. Alternative plans were evaluated with respect to the four criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability). Figure 3-1 presents a summary of the plan formulation process that will be presented throughout this chapter.

Figure 3-1. Plan Formulation Process and Results



3.1 Management Measures

An initial list of 15 measures was identified jointly by the Corps and County using previously developed measures and by evaluating potential areas that could provide large environmental benefits. Over the past 20 years, the County, along with several other federal, state, and local agencies, has conducted multiple analyses for the entire Yakima River basin to identify potential ecosystem restoration efforts. To the extent reasonable, measures identified within these efforts have been considered in the planning process within the study area. Some measures were found to be inconsistent with the Section 1135 authority (i.e., flood risk management measures are not consistent with the authority unless included to ensure an ecosystem restoration measure does not impact the with-project-condition flood risk). These measures consisted primarily of removing impediments to river flow, excavating pilot channels, and associated actions. The initial array of 15 measures is listed below, 13 of which were carried forward after the screening process. Descriptions of the 13 measures carried forward can be found in Section 3.3, and are illustrated in Figure 3-2 and Figure 3-3. Those measures were then input into IWR Planning Suite (USACE cost-effectiveness/incremental cost analysis software) and 56 cost-effective alternatives were generated as described in Section 3.4.3.2.

Initial Array of Measures

- Diking Improvement District #1 (DID #1) Floodplain Process Restoration
  Realign levee to allow river to interact with floodplain to reestablish/improve habitat
- Floodplain Topographic Restoration
  Relocate fill in the floodplain to improve hydraulics and allow river forces to reestablish habitat
- KOA Campground Floodplain Restoration
  Relocate fill in the floodplain to improve hydraulics and allow river forces to reestablish habitat
- Sportsman Island Channel Restoration
  Excavate pilot channels to allow river to restore historic channels and associated habitat
- Sportsman Upstream Groin Removal
  Remove left bank groins to improve hydraulic conditions for Sportsman Island channel formation
- Lake Buchanan Spurs
  Construct right bank spurs to improve hydraulic conditions for Sportsman Island channel formation
- Victory Lane Setback
  Realign levee to allow river to interact with floodplain to reestablish/improve habitat
- Old Y9 Levee Channel Restoration
  Excavate pilot channels to allow river to restore historic channels and associated habitat
- Nob Hill Floodplain Restoration
  Realign levee to allow river to interact with floodplain to reestablish/improve habitat
- Blue Slough Automated Headgate
  Replace manual headgate with automated headgate to reestablish a normative hydrograph to restore salmonid habitat
- Blue Slough Culverts

Replace undersized culverts to ensure habitat availability to all life stages of salmonids throughout the year

- Lower Blue Slough Connection
  Excavate relic channels to increase connectivity between the Yakima and Blue Slough to increase fish habitat
- WSDOT Pilot Channels
  Excavate pilot channels to allow river to restore historic channels and associated habitat
- Greenway Trail Armor Removal
  Relocate fill in the floodplain to improve hydraulics and allow river forces to reestablish habitat
- Spring Creek Reconnection
  Remove fill blocking entrance to groundwater fed Yakima tributary stream to restore fish access

3.2 Screening of Measures

To screen the initial array of measures, qualitative evaluation criteria were developed based on the four evaluation categories prescribed for use in Corps plan formulation: effectiveness, efficiency, acceptability, and completeness. Under each of these four categories, several screening criteria were identified to evaluate and compare each measure. The criteria used were intended to focus the array of measures down qualitatively based on known factors and assumptions. Measures carried forward were utilized to formulate alternatives for further evaluation and comparison to identify a preferred alternative.

The four criteria were weighted evenly. A rating scale of 0 to 3 was used to rate each of the evaluation criteria, where 0 was the lowest score and 3 was the highest score. The higher the score, the more ecosystem benefit the particular measure was assumed to provide for that particular evaluation criterion, or the higher the score, the greater the ease of successful implementation. Table 3-1 provides a summary of the scores for each evaluation criteria.

Scores for each measure appeared to favor larger areas as they provide a more effective and efficient means of restoration by impacting a greater area and more diverse habitat. Other factors, such as real estate requirements and the potential for induced flooding or impacts, were also considered. Larger measures also tend to be of a scale and complexity more suited to federal participation under the current study authority.

After reviewing the screening results, the PDT carried forward all measures except Victory Lane Setback and Old Y9 Channel Restoration. Victory Lane was screened out largely due to the complexity and uncertainty of the real estate acquisition that would be required. Old Y9 Levee Channel Restoration was screened out primarily due to the fact that it would require infrastructure modification by other entities, putting it outside the scope of a project in the Continuing Authorities Program. The remaining measures are described below in Section 3.3. Subsequent sections describe how costs and benefits were estimated for each measure, and how they were combined into alternatives which were then evaluated and compared with regards to their cost effectiveness.

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Table 3-1. Measures Screening

	Ecosystem Benefit					Ease of Implementation							
Scoring: 1=Low, 3=High	Effectiveness				Comp-leteness	Acceptability			Efficiency				
Measures	Acres of Habitat Restored	Restoration of Processes[1]	Off-Measure Benefit[2]	Addresses Objectives	Does Not Rely on Elements Outside of the Project	Complements Regional Planning Efforts & Goals[3]	Considers Constraints	Impacts to Existing Flood Control Features and Induced Flooding Risks	Real Estate Complexity[4]	Overall Constructability	Impacts Utilities etc.	Scale Warrants Corps[5] participation	Total Score
DID #1 FLOODPLAIN PROCESS RESTORATION	3	3	3	3	3	3	2	3	2	2	3	3	**33**
FLOODPLAIN TOPOGRAPHIC RESTORATION	1	3	1	3	3	2	3	3	2	3	2	1	**27**
KOA FLOODPLAIN RESTORATION	2	3	2	3	3	2	3	3	3	3	3	2	**32**
SPORTSMAN ISLAND CHANNEL RESTORATION	2	3	2	3	3	2	3	3	3	2	3	3	**32**
SPORTSMAN UPSTREAM GROIN REMOVAL	1	3	2	3	3	1	3	2	3	3	2	1	**27**
LAKE BUCHANAN SPURS	1	3	2	3	3	1	3	3	3	3	2	1	**28**
VICTORY LANE SETBACK	1	3	1	3	3	2	3	2	1	2	2	2	**25**
OLD Y9 CHANNEL RESTORATION	1	3	2	3	3	1	3	3	3	2	0	2	**25**

Continued on next page.

	Ecosystem Benefit					Ease of Implementation							
Scoring: 1=Low, 3=High	Effectiveness				Comp-leteness	Acceptability			Efficiency				
Measures	Acres of Habitat Restored	Restoration of Processes[1]	Off-Measure Benefit[2]	Addresses Objectives	Does Not Rely on Elements Outside of the Project	Complements Regional Planning Efforts & Goals[3]	Considers Constraints	Impacts to Existing Flood Control Features and Induced Flooding Risks	Real Estate Complexity[4]	Overall Constructability	Impacts Utilities etc.	Scale Warrants Corps[5] participation	Total Score
NOB HILL FLOODPAIN RESTORATION	1	3	2	3	3	3	3	3	2	3	3	2	**30**
BLUE SLOUGH AUTOMATED HEADGATE	3	3	3	3	3	2	3	2	3	2	3	3	**33**
BLUE SLOUGH CULVERTS	3	2	3	3	3	3	3	3	3	3	3	1	**33**
LOWER BLUE SLOUGH CONNECTION	2	2	3	3	3	3	3	3	2	3	3	2	**31**
WSDOT PILOT CHANNELS	2	2	2	3	3	3	3	3	3	3	3	2	**31**
GREENWAY TRAIL ARMOR REMOVAL	2	3	2	3	3	3	3	3	3	3	3	1	**30**
SPRING CREEK RECONNECTION	2	3	3	3	3	3	3	3	3	3	3	1	**36**

Notes

1. Evaluates if the measure restores ecosystem processes vs. simply a feature; process restoration is considered more sustainable.
2. Evaluates whether a measure is likely to have benefits beyond those that accrue at the site, e.g. downstream benefits.
3. Evaluates whether a measure has been identified by entities working on regional floodplain management plans.
4. Evaluates risk associated with acquiring real estate, e.g. multiple landowners or zoning.
5. Evaluates whether a measure is so small or simple as to be not be worth the time/money needed to plan/implement a Corps projects.

3.3 Measures Carried Forward for Further Evaluation and Alternative Formulation

Thirteen of 15 measures remained after screening. These were then numbered (see descriptions below) to simplify discussions as the plan formulation process continued. Measures 1, 2, 3, 4, 5, 6 and 7 are primary measures. Measures 1.1, 1.2, 2.1, 2.2, 4.1 and 4.2 are secondary measures which would not be implemented without their corresponding primary measure. Additional combinability and dependency details are included in the descriptions below. For plan formulation purposes, measure costs and benefits are treated as additive; i.e. the costs and benefits of combinations of measures are equal to the sums of the costs and benefits of the individual measures. The 13 measures that were used to formulate alternatives are described below. For more detail on measures, please see the Engineering Appendix (Appendix A). A plan view depiction of the measures is presented in Figure 3-2 and Figure 3-3.

Measure 1.0: Diking Improvement District (DID) #1 Floodplain Process Restoration

Multiple measures were originally considered at this site. Large wood placement and invasive plant removal and replacement with native species were screened out as elements that were not needed to achieve the fundamental riverine process restoration to enable river/floodplain interaction and channel meander and creation over time. The first step to achieve such process restoration is to remove the levee impeding those processes. While levee breaching vs. removal was an option, breaching-only was screened out because the material from the levee could be put to beneficial use in filling decommissioned gravel pits onsite to ameliorate risks (see Measure 1.1 for more discussion) at the same time accelerating reestablishment of natural floodplain habitat.

Measure 1.0 consists of removing 1.7 miles (all) of the DID #1 levee along its present alignment to restore hydrology and natural processes to the historic floodplain. Approximately 1.7 miles of levee would be rebuilt eastward to maintain the existing level of performance currently provided to a state road (SR 24), a county road (Riverside Road) and nearby homes and businesses. The levee alignment has a west, upstream segment and an east, downstream segment. The east and west segments are connected by fills across Blue Slough, where Blue Slough flow is currently conveyed by culverts that will be replaced in kind. The west segment includes a spur that extends downstream to control backwater elevations to prevent flooding of private properties and SR 24, and to reduce need for hydraulic closure across Blue Slough, thereby maintaining fish passability. An emergency closure gate will be provided at Blue Slough to assure that backwater can be actively controlled if necessary. Running a single levee alignment along the East side of Blue Slough was ruled out in initial design by the non-federal sponsor because it necessitates a much larger closure structure at SR 24 and it exposes two site access roads to increased flood damage risk. NWS Real Estate specialists have worked with the Hydrology and Hydraulics section and the non-federal sponsor to ensure no properties will experience adverse conditions resulting from expected hydraulic changes without due compensation.

Consistent with existing policy applied to other Corps ecosystem restoration projects, the rebuilt levee would provide an equivalent level of performance to offsite lands as the existing levee, and would be designed and constructed to USACE standards (for more information see section 4.3.1, Engineering Appendix par. 3.2.1, and Annex D-1, par. 4.5). Approximately 275 acres of floodplain would be reconnected to the river from this measure alone, which represents the single most beneficial action proposed as part of this project. An additional several hundred acres downstream could be directly benefited as a result of improved surface hydrology conditions; incidental downstream benefits are not included when conducting the cost-benefit analysis for this study. See Section 4.3.2.2 for more information on how the floodplain acreage restored was determined.

It is recommended that the new setback levee be considered a federal project for P.L. 84-99 purposes since it would be constructed under Section 1135, a Congressional authorization; it would provide stand-alone flood risk reduction; it would be designed to federal standards; and it would be constructed by USACE utilizing federal funds. This feature directly addresses the study objective of reconnecting the Yakima River to its historic floodplain and indirectly addresses the objectives of improving riparian habitat and reconnecting historic channels. Mainstem flows would be diverted into the restored area as the river degraded the remnant (lowered) portion of the DID# 1 levee, modifying existing swales and forming new channels behind the old levee. The dynamics of the river will be partly affected by floodplain topographic restoration efforts (Measure 1.1) described below.

The DID #1 levee is located downstream of the State Route (SR) 24 bridge on the left bank of the Yakima River. At the upstream end near the SR 24 Bridge, the levee ties into the downstream end of the Yakima Authorized Left Bank Levee (underneath SR 24) and extends downstream approximately 8,800 linear feet. The levee is adjacent to the riverbank along most of its alignment. At the downstream end, the levee does not tie into high ground because it extends beyond the area of potential impacts from flooding to life safety, property, and infrastructure.

Plans for the realigned DID #1 levee would include a vegetation planting plan in areas disturbed by construction. The new levee prism would be hydroseeded on the landward side with native grasses. On the riverward side, native grass seed mix would be used to hydroseed where riprap for erosion control is not necessary. For ecological and erosion benefits, no closer than 15 feet from the riverside toe, areas waterward of the setback levee would be planted with native shrub and/or tree species. Cottonwood saplings would be planted at the riverward extent of the shrub/tree plantings. This measure does not include additional planting or seeding, except as needed where soil is disturbed.

In addition to its sub-measures, this measure is dependent on Measure 2.0 Sportsman Island Channel Restoration, as Measure 2.0 helps mitigate headcutting risks discussed below in the description of measure 1.1. This measure is combinable with all other measures. This measure restores the hydrologic processes which create and sustain natural habitat conditions over time. Habitat elements that increase in quantity and quality during the period of analysis include stream habitat for salmonids and other species, floodplain wetlands, and riparian forests providing habitat for migrant songbirds, mammals and other species.

Measure 1.1: Floodplain Topographic Restoration

This measure is sited in the historic floodplain being connected to the river by Measure 1.0, just south of the SR 24 Bridge on the left bank of the Yakima River. The area is characterized by three large decommissioned gravel pits (the Newland Pits) and several acres of upland disposal piles. The measure consists of the following three project actions: 1) Removal of aggraded point bar material that has resulted from the fixed meander downstream of the SR 24 Bridge. This action, when implemented with Measure 1.0, would allow re-initiation of normal channel migration processes. It would also distribute energy more evenly across the channel, and reduce the potential for immediate avulsion into the pits. 2) Place excavated material into the three pits strategically to reduce the risk and effect of floodplain pit capture and any associated headcutting upstream. 3) Remove remnant gravel pit spoils from the floodplain to allow the river more conveyance and wetted area within the floodplain area reconnected through Measure 1.0 and deposit that material in the former pits. These actions allow for a more active floodplain, lower flood elevations, and increased habitat within the reach, while ameliorating risk associated with potential pit capture by the main channel.

The entrances to the restored site are channels cut into and through the existing levee and the lowered levee. The modeling indicates that site will be activated.

The area that would be restored/enhanced consists of a large vegetated point bar riverward of the DID 1 levee, and the extensive (now abandoned) gravel mining complex known as the Newland Pits. The Floodplain Topographic Restoration measure would convert relatively unproductive warm ponds to riparian wetland habitat for a variety of birds and mammals in the near term, becoming anabranch channels and habitat for listed fish species over time. At the same time it would ameliorate the risks associated with headcutting that could result from the Newland pits being captured by the river following removal of the DID#1 levee as part of Measure 1.0.

Once the floodplain is regraded, it is expected that the river would go out of bank at a 2-year frequency and spread out across the active limits and begin sculpting side channels along the left margin of the DID #1 levee. Pilot channels would also be excavated to focus the flow energy into areas most likely to remain stable while the floodplain adjusts to levee removal.

To ensure that the project does not result in excessive rates of channel migration into the site, portions of the DID#1 levee riprap below the floodplain elevation will be preserved to keep the Yakima River mainstem channel in its current alignment. Strategically placed causeways would be built across the pits up to the elevation of the undisturbed floodplain to dissipate and redirect flow energy. In addition, all large trees and woody vegetation cleared as part of the project would be used as backfill within the ponds. The woody material would increase roughness and channel stability within the partially filled pits, would likely partially re-sprout, and enhance habitat. Riparian revegetation would consist of natural recruitment from adjacent stands and seed sources.

This measure does not include planting or seeding, except as needed where soil is disturbed.

Measure 1.0 is dependent on this measure, as this measure mitigates risks tied to the potential for river avulsion into the Newland Pits, related headcutting, and possible impacts to the federal levee. Conversely, this measure would not be implemented without Measure 1.0.

In addition to ameliorating risks associated with possible pit capture and associated headcutting, the regrading associated with this measure results in topographic conditions suitable for side channel development (fish habitat), more typical wetland hydrology, and riparian forest establishment. See H&H Annex D-1, sections 6.6 and 6.7 for more discussion of how these risks will be managed during design and post construction phases.

Measure 1.2: KOA Floodplain Restoration

This measure is located on the left bank between SR 24 on the downstream end and Sportsman's Park on the upstream end. In 2012, 3,000 feet of the federal levee was rebuilt along a setback alignment under PL 84-99; approximately 2,000 feet of remnant levee was left in place, impairing riparian process and isolating the river from about 15 acres of floodplain. This measure would remove the remnant portion of levee, reconnecting the river with its historic floodplain. It would also remove an approximately 800-foot spur dike isolating this area from the DID #1 floodplain area downstream. Removal of the remnant levee and the spur dike at SR 24 would allow water to flow freely into the restored DID #1 floodplain area. Removed fill would be used as borrow material for the levee rebuild included as part of Measure 1.0. The federal levee and new SR 24 Bridge and approach were designed to accommodate the increased erosion and scour risk associated with this restoration effort. A buried grade control sill would be installed to help mitigate the risks of floodplain overflows avulsing into the Newland Pits. Riparian revegetation would consist of natural recruitment from adjacent stands and seed sources.

Measure 1.0 is treated as dependent on this measure, as this measure provides suitable material for use in constructing the realigned levee that is part of Measure 1.0, and this measure improves flow conditions at the upstream end of the DID#1 Floodplain area. Conversely, this measure would not be implemented without Measure 1.0, which includes new levee construction to prevent induced flooding offsite.

This measure does not include planting or seeding, except as needed where soil is disturbed.

In addition to providing a good borrow source for use in constructing the realigned levee that is part of Measure 1.0, this measure reconnects the portion of floodplain landward of the remnant levee to the Yakima River. Channel habitat will benefit from input of organic matter from the floodplain, and off channel habitat for salmonids and other species can develop over time as a result of natural riverine processes.

Measure 2.0: Sportsman Island Channel Restoration

Multiple measures were originally considered at this site. Large wood placement and invasive plant removal and replacement with native species were screened out as elements that were not needed to achieve the fundamental riverine process restoration to enable river/floodplain interaction and channel meander and creation over time. Pilot channel construction was scaled to minimize required excavation and take advantage of the river's natural hydrology to fully develop channels. This approach has been successfully implemented by Yakima County elsewhere in the area, and is less likely to result in excavated channels later abandoned as the river naturally meanders over time during flood conditions.

In the 1940s, the Corps and Yakima County dredged a new low flow river channel, built new levees, and cleared the active channel of woody material between the Terrace Heights Bridge and the SR 24 Bridge. This action caused the channel to shift away from its old location (where the channel restoration is proposed) to the new channel and become entrained upon the right bank federal levee. Recent levee repairs upstream have reinforced this flow pattern. Previous to the Corps work in the 1940s, the river was anabranched into 2 or more large threads in this reach at low flow. In the last several decades the river has occupied a single deep narrow channel at low flow, the side channel size has reduced, and the river has developed 3 "fixed" meanders. The "fixed meanders" have caused the associated point bars to aggrade with generally finer sands and gravels, which has buried most of the former side channel habitat on Sportsman Island. The main river channel has narrowed and incised, greatly simplifying available habitat and limiting spawning opportunities. These altered riverine processes are expected to continue into the future without this project measure.

Construction of this side channel (anabranch) complex directly restores 20 acres of side channel habitat, reconnects the upstream and downstream ends of the island, allowing for additional conveyance to mitigate risk associated with potential downstream pit capture and headcutting, creates a more even distribution of stream power across this leveed reach (improving spawning conditions), and more frequently connects various side channels along the alignment. Introduction of hydrology to the interior of the island would benefit the entire 262 acres of the island over the period of analysis through increased frequency of inundation. The as-built channel would be inundated at the 2-year flow, which would relieve pressure on the adjacent right bank levee by redistributing flow away from the levee and reducing flood stages.

This measure, located at the upper end of the project footprint, would include excavation of a complex of three relatively straight side channels requiring removal of approximately 100,000 cubic yards of alluvium and woody debris. Excavated material from this channel would be contributed towards Measure 1.0 and/or Measure 1.1. The design consists of two smaller anabranch channels at the head of the island (channel A, 1384 LF long, Channel B, 820 LF long), that combine to form a 100-foot wide 2,550 LF long primary side channel/anabranch that would tie in to an existing natural side channel towards the downstream end of the island.

This measure is not dependent on other measures (except its sub-measures) and is combinable with all other measures. This measure does not include planting or seeding, except as needed where soil is disturbed.

No LWD structures, pool riffle sequences, or bioengineering of streambanks would be included as high flows, and natural processes are expected to rapidly sculpt the banks and bed of the side channel, adding complexity (sinuosity, large wood, pool-riffle sequences, bars, side channels) that would be initially absent from the as-built channel. Erosion of the banks and bed of the side channel provide a valuable source of gravel to the river in the short run. Full capture of the side channel by the river would not be viewed as a negative since the river would still have access to existing main channel at high flows, and if downstream headcutting was initiated, this would reduce pressure on the right bank levee near Buchanan Lake. This constructed side channel would convey surface water to a smaller side channel that runs along the toe of the left bank federal levee that feeds water into Blue Slough via an irrigation diversion culvert. Occasional removal of blockages or strategic placement of large wood to ensure adequate water flow to the Blue Slough water supply side channel may be required on occasion.

Measure 2.1: Sportsman Upstream Groin Removal

A series of groins or bendway weirs were placed by the Corps following the 1996 flood to prevent erosion along the federal project left bank levee. These groins have been effective at preventing erosion along the levee, but have been equally effective at shifting main flows towards the downstream right bank levee near Buchanan Lake, depositing material at the top end of the Sportsman's Park island, and preventing flow in side channels throughout the island. This measure would remove the bulk of the three most downstream groins to restore the natural flow pattern of the river and encourage access to the island and its side channel habitat. Given changed river conditions and some restoration work underway across the river and upstream from where the groins are located, this groin removal will not lead to increased erosion of the levee. The overall configuration would be consistent with the approach implemented by NWS Emergency Management during a repair this year, designed to direct flow away from areas to be protected and toward s areas to be restored. Groin removal would also allow more water to be funneled into the Sportsman's Park channel (Measure 2.0). This measure does not include planting or seeding, except as needed where soil is disturbed. Measure 2.0 is treated as dependent on this, as this measure creates conditions more conducive to wetting the channels restored by Measure 2.0. Conversely, this measure would not be implemented without Measure 2.0.

Measure 2.2: Lake Buchanan Spurs

A series of low spurs along the existing right bank federal levee adjacent to Buchanan Lake are proposed to increase local water surface elevations directing flow into the new channel excavated through Sportsman island (measure 2.0) and reduce velocities and stream power in the main channel at the base of the right bank federal project levee which separates the main stem from Buchanan Lake. The spurs would be located at two sites along the levee, spaced 120 feet apart, and would be constructed of large riprap. This measure does not include planting or seeding, except as needed where soil is disturbed.

Measure 2.0 is treated as dependent on this as this measure creates conditions more conducive to wetting the channels restored by Measure 2.0. Conversely, this measure would not be implemented without Measure 2.

Measure 3.0: Nob Hill Floodplain Restoration

Multiple measures were originally considered at this site. Large wood placement and invasive plant removal and replacement with native species were screened out as elements that were not needed to achieve the fundamental riverine process restoration to enable river/floodplain interaction and channel meander and creation over time.

This measure would realign approximately 250 feet of the right bank federal levee just upstream of SR 24. In addition, this measure would include excavating pilot channels through a hardened point bar along the fixed meander just upstream of the SR 24 Bridge. This work would reconnect approximately 36 acres of the historic floodplain to the Yakima River, and reestablish historic anabranching channels at this location. This measure does not include planting or seeding, except as needed where soil is disturbed.

This measure is not dependent on other measures and is combinable with all other measures. This measure restores the hydrologic processes which create and sustain natural habitat conditions over time. Habitat elements that increase in quantity and quality during the period of analysis include stream habitat for salmonids and other species, floodplain wetlands, and riparian forests providing habitat for migrant songbirds, mammals and other species.

Measure 4.0: Blue Slough Automated Headgate

This measure was conceived as the simplest way to restore a normative hydrograph in this relic Yakima River side channel, while also maintaining upstream and downstream fish passage for all species and life stages.

Blue Slough is a relic channel that runs parallel to the Yakima River and extends from approximately the Sportsman Park campground downstream beyond the DID #1 area before out-falling back into the Yakima River. Near the upstream end of the slough at the Sportsman Park campground there is a gate closure structure that can be manually closed during high water events to prevent flooding. Downstream of the SR 24 Bridge the slough crosses several privately-owned properties and it passes through culverts beneath two private roadways.

This measure would include replacement of the headgate and associated culvert with an automated structure that would allow floodplain managers to maintain a normative hydrograph in the slough without increasing flood risk. Given that flows in the river are managed for irrigation, and irrigation draws vary throughout the season, to manually adjust the headgate sufficiently mimic the natural hydrograph is not practical, potentially requiring daily adjustments of the gate during the summer months.

This measure is dependent on Measure 2.0 Sportsman Island Channel Restoration, as Measure 2.0 restores the flow that would be regulated by the headgate. This measure is combinable with all other measures. This measure does not include planting or seeding, except as needed where soil is disturbed. Regular flows in the slough would make it useable by the various ESA-listed salmonids and other native fish species that inhabit the reach. Benefits would accrue to approximately 12 acres of this historic channel as a result of this hydrologic restoration measure.

Measure 4.1: Blue Slough Culverts

Existing culverts across Blue Slough range in span from 2 feet to 12 feet. At a flow of 20 cfs downstream flooding would be expected to begin due to the backwater associated with undersized culverts that cross Blue Slough at Sportsman's Park, Blue Crane Lane, an un-named private road and Lester Lane. This measure would upgrade all of the undersized culverts (4 culverts) to 6 feet wide (to match the span of 2 of 3 of the largest culverts). Upgrading the undersized culverts significantly improves passage for all native salmonids and life stages. With the existing headgate, the slough is essentially disconnected from the Yakima River, and replacing the culverts would not provide any fish benefits. Consequently this measure is dependent on Measure 4; it would only be implemented if Measure 4 were implemented.

Measure 4.2: Lower Blue Slough Connection

This measure would improve flows in lower Blue Slough by reestablishing historic connections between the main channel of the Yakima River and lower Blue Slough. The measure entails excavation of approximately 2000 feet of pilot channels in a southeasterly direction across the lower DID#1 Floodplain Restoration area, from the main channel to Blue Slough. This measure does not include planting or seeding, except as needed where soil is disturbed. The Lower Blue Slough Connection would restore more historic side channel habitat, making it available for salmonids and other species. Increasing the connection between the floodplain and the mainstem of the Yakima through implementing this measure would also provide a conduit for delivery of organic matter and large wood to the river, improving fish habitat there. This Measure is dependent on Measure 1.0, which would address any flooding concerns tied to this measure, and to Measure 2.0, which would restore flow to Blue Slough.

Measure 5.0: WSDOT Pilot Channels

Multiple measures were originally considered at this site. Large wood placement and invasive plant removal and replacement with native species were screened out as elements that were not needed to achieve the fundamental riverine process restoration to enable river/floodplain interaction and channel meander and creation over time. Pilot channel construction was scaled to minimize required excavation and take advantage of the river's natural hydrology to fully develop channels. This approach has been successfully implemented by Yakima County elsewhere in the area, and is less likely to result in excavated channels later abandoned as the river naturally meanders over time during flood conditions.

This measure is not dependent on other measures and is combinable with all other measures. This measure is located on the right bank and downstream from SR 24, across the river from the DID#1 Floodplain Restoration area. The measure would entail excavation of material to encourage establishment of historic anabranching channels; excavated material would be placed in decommissioned gravel pits in the same area of the floodplain, to the southwest. This measure does not include planting or seeding, except as needed where soil is disturbed. This measure would create conditions for side channels to naturally reestablish, increasing habitat for listed fish species. The increased frequency of inundation would benefit approximately 228 acres in this area of the right bank floodplain.

Measure 6.0: Greenway Trail Armor Removal

This measure is located on the right bank and downstream from SR 24, across the river from the DID#1 Floodplain Restoration area, south and west of the area where pilot channels would be excavated as part of Measure 5. This measure involves removing armor preventing natural channel formation in the area and relocating the Greenway Trail protected by that armor towards the upland edge of the floodplain. This measure is not dependent on other measures and is combinable with all other measures. This measure does not include planting or seeding, except as needed where soil is disturbed. The measure would create conditions for anabranching channels to naturally reestablish, increasing habitat for listed fish species.

Measure 7.0: Spring Creek Reconnection

Spring Creek is a natural side channel of the Yakima River. During construction of Interstate 82 in the 1970s, a gravel pit was constructed in the floodplain; Spring Creek now flows across the compacted former haul road to this pit, creating an approximate 3 foot waterfall into the former pit. This has disconnected this valuable spawning and rearing habitat from the Yakima River, preventing fish access to the fresh, cold water of Spring Creek. Spring Creek reconnection involves the removal of this compacted road bed from the mouth of Spring Creek, a groundwater fed stream, providing access to rare cold water off-channel habitat for listed fish species. This measure is not dependent on other measures and is combinable with all other measures. This measure does not include planting or seeding, except as needed where soil is disturbed. This hydrologic restoration measure would directly benefit approximately 14 acres

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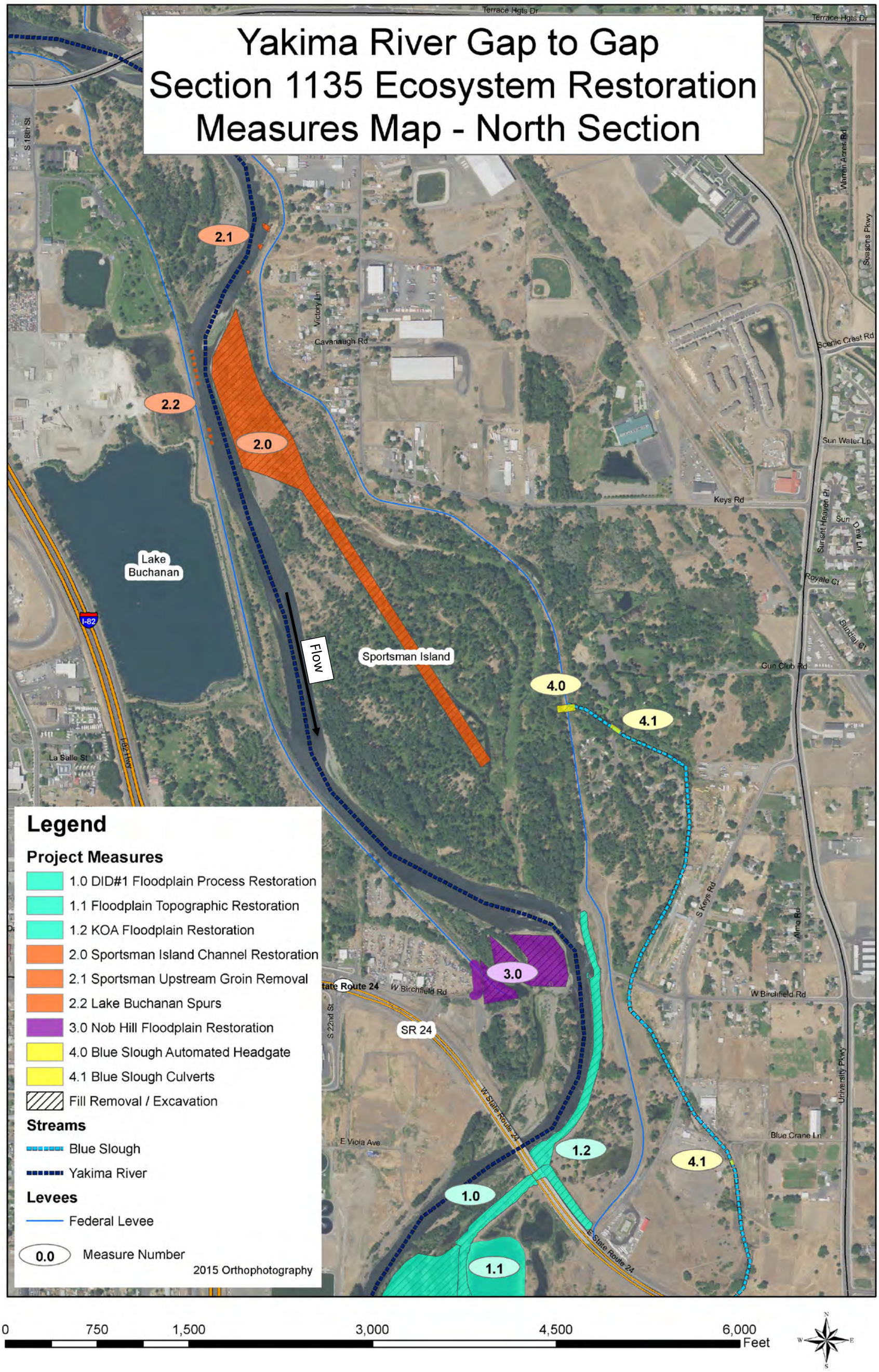


Figure 3-2. Final Array of Measures for Plan Formulation - North Section

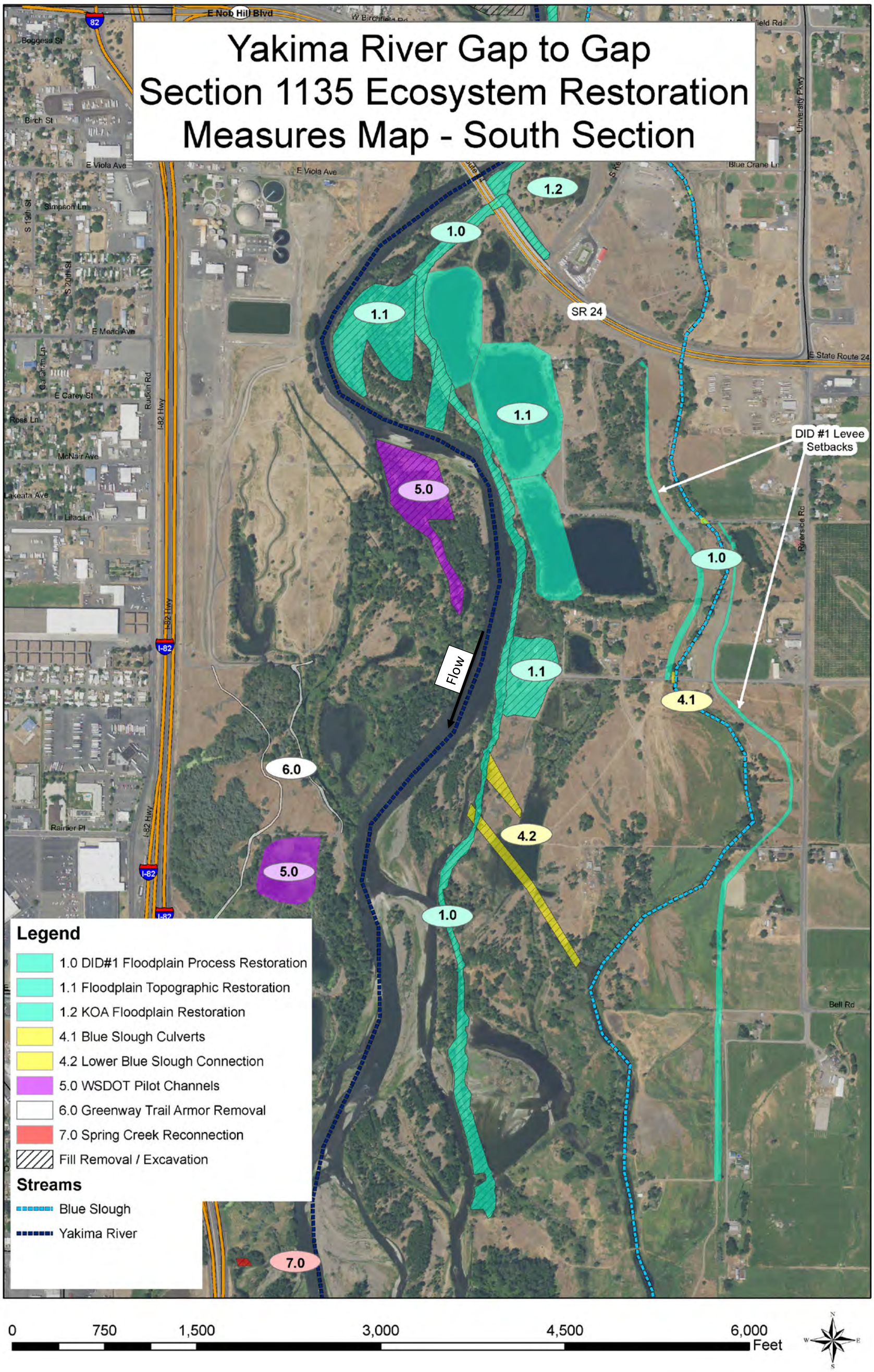


Figure 3-3. Final Array of Measures for Plan Formulation - South Section

3.4 Formulation, Evaluation and Comparison of Alternatives

The 13 measures described above were combined to formulate alternative plan. Alternative plan formulation, as well as cost effectiveness and incremental cost analyses (CE/ICA) of alternative plans, was conducted using the Institute for Water Resources (IWR) Planning Suite, version 2.0.6.1 (a Corps certified model). The Corps' IWR developed this software to assist with the formulation and comparison of alternative plans. Data inputs for IWR Plan include costs and benefits for each measure. Results included 56 cost effective alternative plans and nine Best Buy Plans alternative plans (including the No Action Alternative).

3.4.1 Measure Cost Estimates

Cost estimates were developed for each of the 13 measures using concept-level designs as a basis for the estimates, along with general assumptions and a risk-informed contingency. Separate estimates were prepared in Micro-Computer Aided Cost Estimating System (MCACES) for each of the measures resulting from the screening process. As Measures 1.1 and 1.2 would not be implemented without Measure 1.0 and vice versa, costs and benefits for those measures were estimated together. Likewise costs and benefits for Measures 2.0, 2.1 and 2.2 were estimated together. Measure costs used with IWR Plan are shown in Table 3-2.

Table 3-2. Estimated Costs of the Measures for Plan Formulation ($1,000's)

Measure	Const-ruction[1]	Engineering and Design	Real Estate[2]	Interest During Construction	Monitoring[3]	Total Investment Cost	O&M[4]	Total Average Annual Cost
1.0+1.1+1.2	6,711	553	1,024	129	13	8,430	0	335
2.0+2.1+2.2	1,247	103	545	29	2	1,926	0	77
3.0	947	78	8	16	2	1,051	0	42
4.0	130	11	0	2	0.5	144	1	7
4.1	321	26	0	5	0.5	353	0	14
4.2	703	58	0	11	1	773	0	31
5.0	1,993	164	0	33	4	2,194	0	87
6.0	309	25	88	6	1	429	0	17
7.0	11	1	0	0.2	0.5	12	0	0.5

Notes:
1. Includes contingency and construction management.
2. Burdened publicly owned lands landward of levee valued at $0 for CE/ICA purposes.
3. Amount to cover 5 years of whole site est. at $25K; measures assigned cost proportionate to construction. Draft monitoring plan for project success includes monitoring depths in side channels, photo point monitoring, and canopy cover monitoring.
4. Levee & culvert O&M costs are not expected to increase from current levels. No O&M anticipated for restoration features other than headgate.

3.4.2 Measure Ecosystem Output Estimates

For the purposes of conducting cost-effectiveness evaluations, the Habitat Evaluation Procedure (HEP) model was used to assess habitat benefits (Appendix B). This model was used as a method for comparing existing and future without-project habitat conditions to those conditions that would result from proposed restoration alternatives (with-project conditions).

A HEP is a tool for comparing existing and proposed future habitat conditions for a species or assemblage of species in a particular geographic area. A HEP is comprised of one or more Habitat Suitability Indices (HSI's), which are models for calculating the habitat suitability of an area for a single species or assemblage of species. A set of variables that represent the life requisites for the species (e.g. percent cover, water depth, tree height) is combined into a mathematical model. The variables are then measured in the field and their corresponding index values are inserted into the model to produce a score that describes existing habitat suitability. The value is an index score between 0 and 1. The mathematical models used for this HEP are derived from existing models, developed by the USFWS.

The HEP for this project is directed at the riparian, floodplain, and aquatic species and habitats. Although only a few species were selected out of the many that could be present in the project area, the selected species are representative of guilds that currently do or could utilize habitats in the project area, or are

representative of species of concern in the project area. Three species were chosen to represent the riparian and aquatic communities for the HEP analysis, including yellow warbler (*Dendroica petechia*), beaver (*Castor canadensis*), and steelhead trout (*Oncorhynchus mykiss*). These species were chosen as there are existing models developed for each of them. In addition, each of these species represents a particular niche or guild of species that utilize these habitats in the project area. The yellow warbler represents migratory neotropical birds that utilize riparian scrub-shrub habitat for nesting. Beaver is a mammal species dependent on riparian structure for food and habitat. Steelhead trout is an anadromous salmonid species that inhabits a wide range of aquatic habitats in the Yakima basin.

To assess existing conditions, HSI's were calculated for each species utilizing input data collected at the specific measure sites and by the use of aerial photographs, existing reports, modeling, and GIS analysis. Three HSI's were chosen to adequately represent the project benefits, with yellow warbler representing scrub-shrub habitat, beaver representing forested habitat, and steelhead representing instream habitat. Assumptions for scoring the no-action alternative were based on the projection of the site if no restoration actions were made. Assumptions for scoring the HEP model under with-project conditions were based on the implementation of restoration measures at each site. The individual HSI's for each species were multiplied by the area of forested, shrub, or aquatic habitat, respectively that would be affected by a measure at each site. This final score is called a Habitat Unit (HU). HU's for scrub-shrub, forested, and instream habitat were summed to determine the total HU's for each measure. The future with- and without-project HUs were compared to determine the net difference (either positive or negative) between measures. For each measure, conditions that would result from proposed restoration actions were calculated at 5, 20, and 50 years in the future. These values were averaged creating an output of average annual HUs (Table 3-3).

Table 3-3. Estimated Ecosystem Outputs of the Measures for Plan Formulation

Measure	Total Acres	Existing Conditions Habitat Units	Average Annual Habitat Units Without Project	Average Annual Habitat Units With Project	Average Annual Net Benefit (Habitat Units)
1.0+1.1+1.2	275	96.5	95.0	138.4	43.4
2.0+2.1+2.2	262	152.2	161.0	178.6	17.6
3.0	36	21.1	20.0	25.2	5.2
4.0	12	0	0	6.8	6.8
4.1	12	0	0	2.0	2.0
4.2	6	0	0	1.9	1.9
5.0	228	121	119.9	128.8	8.9
6.0	228	97	95	96	1.0
7.0	14	6.3	6.2	7.8	1.6

3.4.3 Cost Effectiveness and Incremental Cost Analysis

This section describes the cost effectiveness and incremental cost analyses (CE/ICA) conducted using IWR Planning Suite, version 2.0.6.1 (a Corps certified model). The Corps' Institute for Water Resources (IWR) developed this software to assist with the formulation and comparison of alternative plans. Software inputs include cost estimates for measures, estimates of the relative magnitude of ecosystem output generated by those measures, and information on the combinability and dependencies of those measures relative to one another. Results show which combinations of measures (or alternatives) are a cost effective means to generate outputs as measured by the environmental output model. Results include information on how efficient alternatives and increments between them are at generating those outputs.

3.4.3.1 Cost Effectiveness Analysis Results

The first step in the Corps' economic analysis of ecosystem restoration alternatives is to determine which plans are cost effective. The average annual costs to implement each alternative and the average annual benefits that would accrue (as quantified by the methodology described in Section 3.4.2) are compared. Any plan that generates less benefits at an equal or greater cost than any other plan is determined to be not cost effective, and is eliminated from further consideration.

The analysis generated 160 possible action alternatives (or combinations of the 13 measures listed above). Of those, 56 were cost effective. The costs and benefits of all possible action alternatives are displayed below in Figure 3-4. Non cost-effective alternatives are represented with circles, cost-effective alternatives with blue triangles, and the subset of cost-effective alternatives identified as "Best Buys" with red squares.

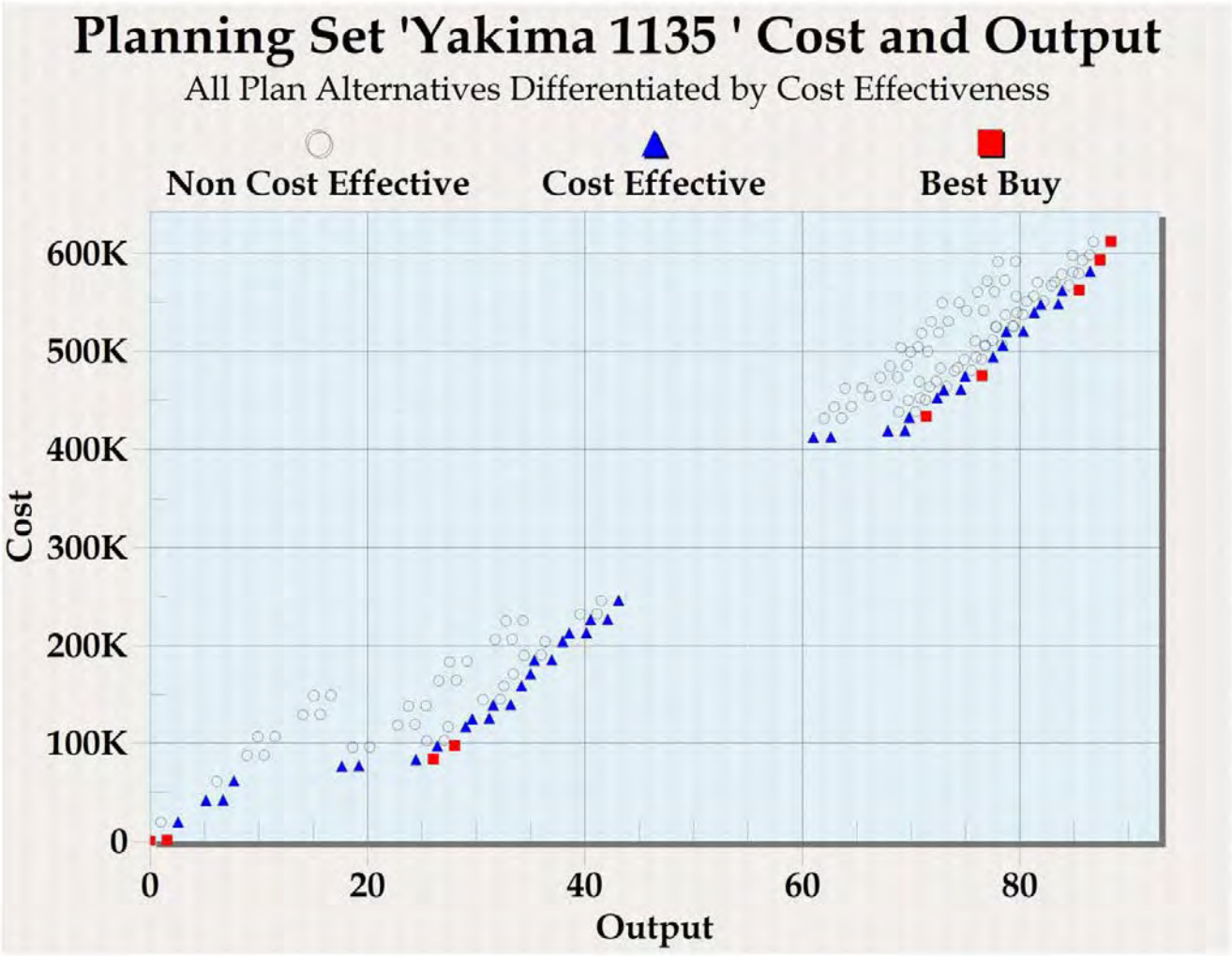


Figure 3-4. Average Annual Costs and Outputs of the Alternatives

3.4.3.2 Incremental Cost Analysis

The second step in the Corps' economic analysis of ecosystem restoration alternatives is to conduct an incremental cost analysis to evaluate and compare costs and benefits of the increments between cost effective plans. A cost effective plan which has a lower incremental cost per incremental output than all cost effective plans with greater costs and outputs is classed as a "Best Buy Plan". The 56 cost-effective plans were compared, and nine Best Buy Plans were identified (including the No Action Alternative). The incremental costs and benefits of the Best Buy alternatives are displayed in Table 3-4.

Table 3-4. Incremental Costs and Benefits of the Best Buy Alternatives

Best Buy Alternative	Measures	Output (Habitat AA Units – AAHUs)	Average Annual Cost	Average Annual Cost/AAHU	Incremental Average Annual Cost	Incremental Output (AAHUs)	Incremental Avg. Ann. Cost/AAHU
1 (No Action)		0.00	$ 0	$ 0	$ 0	0.00	$ 0
2	Spring Creek	1.58	$ 487	$ 308	$ 487	1.58	$ 308
3	Spring Creek + Sportsman + Blue Slough Headgate	26.07	$ 83,858	$ 3,2178	$ 83,371	24.48	$ 3,405
4	#3 + Blue Slough Culverts	28.02	$ 97,912	$ 3,495	$ 14,054	1.950	$ 7,196
5	# 4 + DID 1	71.40	$ 433,361	$ 6,069	$ 335,449	43.38	$ 7,733
6	#5 + Nob Hill	76.55	$ 475,186	$ 6,208	$ 41,825	5.15	$ 8,122
7	#6 + WSDOT Pilot Channels	85.48	$ 562,519	$ 6,581	$ 87,333	8.93	$ 9,779
8	# 7 + Lower Blue Slough Connection	87.38	$ 593,308	$ 6,790	$ 30,789	1.90	$ 16,192
9	#8 + Greenway Trail Armor Removal	88.38	$ 612,457	$ 6,930	$ 19,149	1.00	$ 19,149

Note: Price level = October 2015, FY16 discount rate = 3.125%.

The bar graph below (Figure 3-5) compares only the Best Buy alternatives, graphically displaying the cost per unit of ecosystem output for the increment added with each successive Best Buy (bar heights) and the increment of ecosystem output added with each successive Best Buy (bar widths).

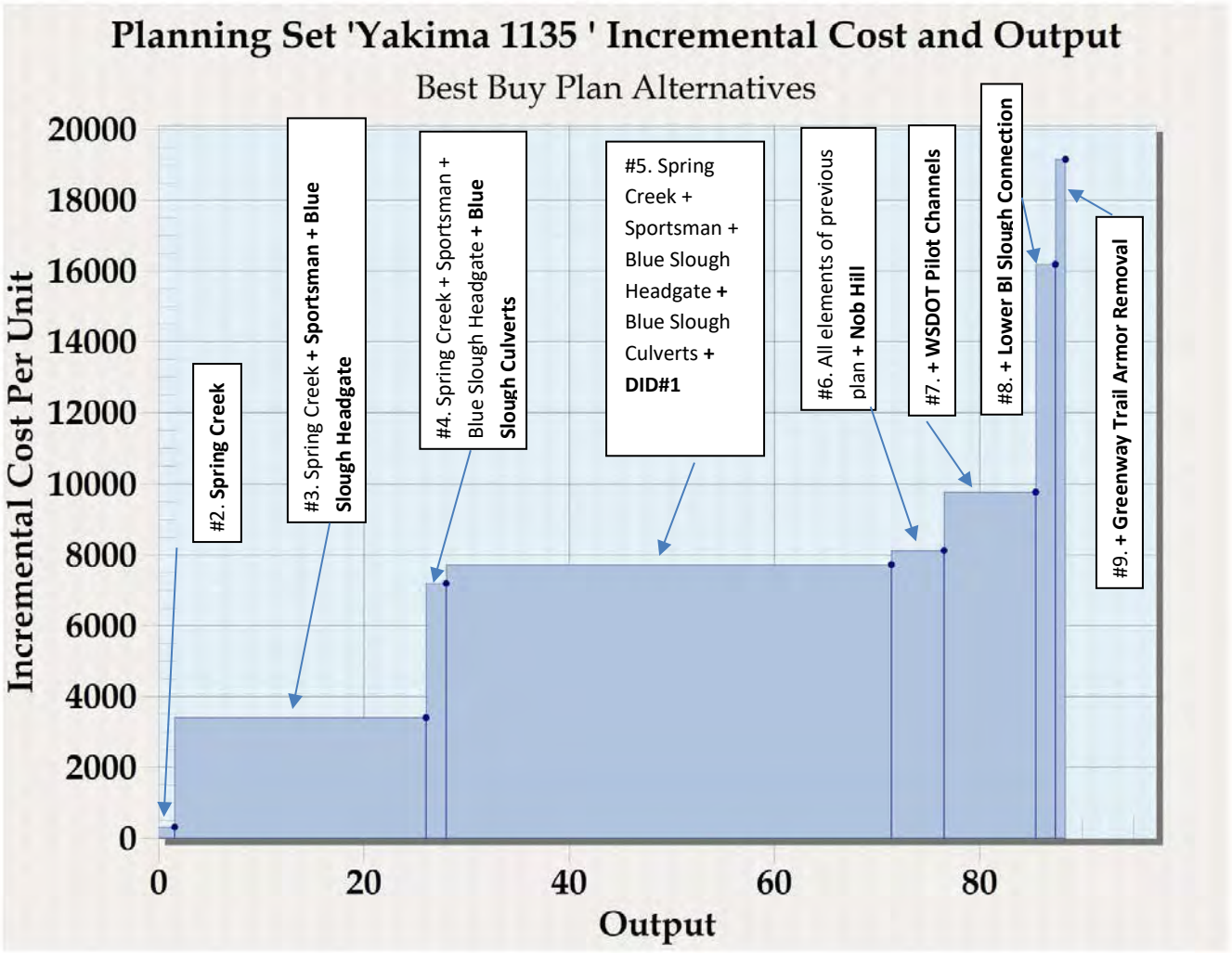


Figure 3-5. Incremental Costs and Outputs of the Best Buy Alternatives

Table 3-4 illustrates that the increment which provides the greatest amount of ecosystem benefit is Measure 1.0, DID#1 Floodplain Process Restoration (added in Alternative #5). The average cost to achieve that increment of benefits is less than the corresponding costs for most Best Buy increments. The costs per unit of output for the increments that are added to generate Alternatives #4, #6 and #7 are very close to that for Alternative #5. The average costs per output for the increments added to create Alternatives #8 and #9 are considerably higher.

3.4.4 Final Array of Alternatives

The PDT reviewed the incremental costs and benefits of the Best Buy plans with the goal of identifying a final array of alternatives to be compared for NEPA purposes that would include the full range of possible benefits and area of impact. All the Best Buy plans are inherently the most efficient in producing benefits, and all are complete in themselves: they would generate benefits independent of

external actions. The measures included in the following alternatives are illustrated in Figure 3-2 and Figure 3-3.

Alternative 1 (The No Action Alternative)

The No Action alternative, which is synonymous with the "Future Without-Project Condition," assumes that the Corps does not participate in developing solutions for ecosystem restoration within the Gap to Gap Reach. The reach would continue to degrade as a result of the existing levees systems and development in the valley. It is expected that the degradation would continue at its current pace because expansions to the current levee configurations are not expected at this time. The results of the No Action alternative reflect the future without project conditions for the study area if no action was taken by the Corps of Engineers. Inclusion of the No Action Alternative in the Final Array is required for NEPA comparison purposes.

Alternatives 2, 3, 4, 6, 7 and 8

Alternatives 2, 3 and 4 are not included in the final array of alternatives because they achieve minimal benefits and are of a scale such that they do not independently warrant Corps involvement. Alternative 5 was not screened out because it is the least cost Best Buy to include the DID#1 floodplain restoration measure, considered by a number of stakeholders to be central to the restoration of the Gap to Gap Reach. Alternative 7 was screened out because its incremental costs per unit of output are 20% greater than those for Alternative 6. Alternative 8 was screened out because the increment added to create that alternative has a cost per unit of output that is 66%, 99% and 109% more, respectively, than that for the increments added to create the three less-cost/lower-output Best Buy alternatives.

Alternative 6 has incremental costs per unit of output that are 5% greater than the next least cost alternative. Given the inherent uncertainty in models to estimate benefits, by itself this fact may not be sufficient to screen out the alternative on the basis of efficiency. However, the costs to implement Alternative 6 would likely exceed the statutory limit of Section 1135, and the benefits added by Alternative 6 do not warrant the additional time (i.e. delay in accruing benefits) and funding that would be required to pursue a specific authorization to implement this project. While it could be argued that Alternative 6 reasonably maximizes ecosystem restoration benefits compared to costs and therefore should be the NER Plan, the Sponsor would prefer not to exceed the statutory limit of Section 1135; for these reasons Alternative 6 is not included in the final array of alternatives.

Alternative 5

Alternative 5 is a Best Buy alternative and includes levee removal, related realigned levee construction conforming to USACE standards, spur dike removal, floodplain topographic restoration, side channel construction, hydrologic enhancement of a disconnected floodplain channel, replacement of barrier culverts, and wetland reconnection. Primarily through removal of fill and replacement of a headgate and of undersized culverts, hydrologic and habitat connectivity is restored between a stretch of the Yakima

River in the Gap to Gap Reach and over 320 acres of its historic floodplain. Work would be completed in five areas, in order of size: the DID#1 Floodplain area, Sportsman Island, right bank floodplain, Blue Slough, and Spring Creek.

The following measures comprise Alternative 5:

- Measure 1.0: DID #1 Floodplain Process Restoration
- Measure 1.1: Floodplain Topographic Restoration
- Measure 1.2: KOA Floodplain Restoration
- Measure 2.0: Sportsman Island Channel Restoration
- Measure 2.1: Sportsman Upstream Groin Removal
- Measure 2.2: Lake Buchanan Spurs
- Measure 4.1: Blue Slough Automated Headgate
- Measure 4.0: Blue Slough Culverts
- Measure 7.0: Spring Creek Reconnection

These measures are described in Section 3.3, and in the Engineering Appendix (Appendix A).

Alternative 5 was selected as part of the final array of alternatives because it is a Best Buy, and because it is the least cost Best Buy alternative that includes the DID#1 Floodplain Topographic Restoration measure. The DID#1 Floodplain Process Restoration measure represents the best opportunity to generate substantial benefit to the ecosystem in a relatively cost-effective manner, as illustrated in Figure 3-5.

Alternative 9

Alternative 9 is a Best Buy alternative and includes levee removals (and related realigned levee construction) to include a small section on the right bank (Nob Hill) in addition to the larger section on the left bank (DID#1), spur dike removals, floodplain topographic restoration, side channel construction, hydrologic enhancement of a disconnected floodplain channel, as well as related further anabranch channel construction, replacement of barrier culverts, excavation of pilot channels in the right bank floodplain, removal of Greenway Trail related armoring, and wetland reconnection. Primarily through removal of fill and replacement of a headgate and of undersized culverts, hydrologic and habitat connectivity is restored between a stretch of the Yakima River in the Gap to Gap Reach and over 585 acres of its historic floodplain. Work would be completed in four areas, in order of size: the DID#1 Floodplain area, Sportsman Island, Blue Slough and Spring Creek.

Alternative 9 is comprised of the measures in Alternative 5, as well as the following:

- Measure 3.0: Nob Hill
- Measure 4.2: Lower Blue Slough Connection
- Measure 5.0: WSDOT Pilot Channels

- Measure 6.0: Greenway Trail

These measures are described in Section 3.3.

Alternative 9 is included in the final array of alternatives because it is the alternative that would generate the maximum amount of benefit to the ecosystem. It also includes all the measures, serving as a bookend alternative when considering environmental impacts.

The final array of alternatives consist of Alternatives 1, 5 and 9.

3.4.5 Contributions to the Study Planning Objectives

Table 3-5. Comparison of Alternative Plans and Study Objectives

Alternative Plan	Objectives		
	Restore Connectivity of Yakima to Historic Floodplain	Improve Riparian Habitat	Reconnect Historic Channels
No Action			
Alternative 5	+	+	+
Alternative 9	++	++	++

Both action alternatives would address all the objectives to some degree, with Alternative 9 having the greatest beneficial impact. By removing the constraints to the natural flow of the river (i.e., levee material and hardened material in fixed meanders), both alternatives reestablish the conditions that allow the dynamic processes of channel formation and sediment transport to function naturally, which creates and sustains the habitat conditions suited to the ESA-listed fish and other species native to the Yakima River. With Measure 3.0, Alternative 9 would reconnect additional acreage to the floodplain. Anabranching channels restored by both alternatives provide important rearing and refuge habitat for salmonids, especially important during high flows, as well as increased riparian vegetation, which provides forage (insect drop) and cover. Alterative 9 would accelerate achievement of riparian habitat and channel reconnection objectives as compared to Alternative 5 through additional armor removal (Measure 6.0) and pilot channel construction (Measures 4.2 and 6.0). Many historic side channels that were disconnected when the levee was constructed would be reconnected by both alternatives, albeit considerably more with Alternative 9 than Alternative 5.

3.4.6 Completeness, Effectiveness, Efficiency, and Acceptability

Completeness, effectiveness, efficiency, and acceptability are the four evaluation criteria specified in the Corps' Principles and Guidelines (Paragraph1.6.2(c)) in the evaluation and screening of alternative plans. Alternatives considered in any planning study should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans.

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

Efficiency is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.

Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

Alternative 1 (No-Action Alternative)

The No-Action Alternative does not meet the completeness criterion because it does not provide any means to realize the planning objectives of this feasibility study.

The No-Action Alternative does not meet the effectiveness criterion because it does not achieve any of the planning objectives.

The No-Action Alternative is the least efficient alternative because it is not the most cost effective means of alleviating the problems and realizing the opportunities of the study area.

The No-Action Alternative is the least acceptable plan with respect to acceptance by State and local entities and the public.

Alternative #5

All actions required to achieve the planning objectives are accounted for in Alternative #5, and it is not significantly dependent on the actions of others. Alternative #5 is a complete plan that would enhance the overall goals of restoring the Gap to Gap Reach of the Yakima River by complementing other restoration efforts.

Alternative #5 is effective because it alleviates the specified ecosystem problems and achieves the specified restoration opportunities.

Alternative #5 is an efficient plan. The incremental cost per output for this alternative is considerably lower than that for Alternative #9 (approximately 40% of the comparable cost for Alternative 9).

Alternative #5 is acceptable because it does not violate public laws or regulations or policies. The main components of Alternative #5, Measure 1 (floodplain reconnection through setback of the DID#1 levee) and Measure 2 (channel restoration through Sportsman Island) were first recommended in a report commissioned by USBR, WDOE, and the Yakama Nation. These measures have also been incorporated into Yakima County's Upper Yakima River Comprehensive Flood Hazard Flood Hazard Management Plan. Yakima County has received letters of support from State Senator Curtis King, USFWS, USBR, NMFS, WDFW, WDOE, WSDOT, the Washington State Parks and Recreation Commission, and Diking Improvement District #1.

Alternative #9

All actions required to achieve the planning objectives are accounted for in Alternative #9, and it is not significantly dependent on the actions of others. Alternative #9 is a complete plan that would enhance the overall goals of restoring the Gap to Gap Reach of the Yakima River by complementing other restoration efforts.

Alternative #9 is effective because it alleviates the specified problems and achieves the specified opportunities. It is more effective than Alternative #5 because it reconnects more acres of historic floodplain to the main channel, restores more historic channels, and removes more stressors impeding natural riverine processes (e.g., armor rock impeding river meander).

Alternative #9 is less efficient compared to the other alternatives. The incremental average annual costs per habitat unit for this plan are approximately two and a half times greater than for Alternative #5.

Alternative #9 is acceptable because it does not violate public laws or regulations or policies.

3.4.7 Trade-Off Analysis

A trade-off analysis is the procedure the Corps uses to identify the potential gains and losses associated with the array of alternatives. The results of the trade-off analysis are used to inform selection of the Tentatively Selected Plan. The study team identified several trade-offs between the three alternatives.

Table 3-6. Trade-offs Between the Alternatives

Trade-Off Criteria	No Action Alternative	Alternative #5	Alternative #9
Average Annual Cost	$0	$433K	$612K
Total Habitat Units	0 AAHUs*	71.4 AAHUs*	88.4 AAHUs*
Acres Restored	0 acres	320 acres	585 acres
Incremental Average $ per HU	$0	$7.7K	$19.1K

- AAHUs = Average Annual Habitat Units

While the No-Action Alternative would have no construction costs, it would provide no benefit to the ecosystem, as the floodplain would remain disconnected from the river channel. No increase in water or sediment storage capacity would result.

Alternative 5 is less costly than Alternative 9. It reconnects to the floodplain approximately 6 times more acreage than alternatives that do not include the DID#1 Floodplain Restoration measure, and 45% less acreage than Alternative 9. The average cost per habitat unit for Alternative 5 is 12% lower than that for Alternative 9, and the respective incremental average annual cost is 60% lower.

Alternative 9 is the most costly alternative, restores the greatest amount of habitat, and reconnects the greatest number of acres to the floodplain. While it would take full advantage of opportunities to restore habitat and habitat forming processes in the reach, it requires significantly more funding and real estate, and would take longer to implement.

3.5 Tentatively Selected Plan and Recommended Plan

After the first planning iteration, the project delivery team identified Alternative 5, a Best Buy, as the Tentatively Selected Plan (TSP). Subsequently a new TSP was identified when it was determined that to better ensure alternative completeness, alternatives involving redistribution of sediment should include adaptive management measures. With costs for adaptive management included, implementation costs for Alternative 5 exceed the per project limit for Federal contributions under Section 1135. For this reason the planning team reconsidered less-costly alternatives.

A less costly, cost-effective alternative (Alternative 5a) includes all the elements of Alternative 5 except Measure 4.0 Blue Slough Culverts. As illustrated in Table 3-7, Alternative 5a, while cost-effective, is not a Best Buy because the incremental average annual cost per habitat unit is greater than for Alternative 5. However, as those costs are just 1/3 of 1 percent greater, Alternative 5a is comparable in efficiency of output production to Alternative 5.

Table 3-7. Incremental Costs and Benefits of the Best Buy Alternatives and Alternative 5a[1]

Alternative	Measures	Output (AA Habitat Units – AAHUs)	Average Annual Cost[2]	Average Annual Cost/AAHU	Incremental Average Annual Cost	Incremental Output (AAHUs)	Incremental Avg. Ann. Cost/AAHU
1 (No Action)		0.00	$ 0	$ 0	$ 0	0.0	$ 0
2	Spring Creek	1.58	$ 487	$ 308	$ 487	1.58	$ 308
3	Spring Creek + Sportsman + Blue Slough Headgate	26.07	$ 83,858	$ 3,217	$ 83,371	24.48	$ 3,405
4	#3 + Blue Slough Culverts	28.02	$ 97,912	$ 3,495	$ 14,054	1.95	$ 7,196
5a	**#3 + DID 1**	**69.45**	**$ 419,307**	**$ 6,038**	**$ 321,395**	**41.43**	**$ 7,758**
5	# 4 + DID 1	71.40	$ 433,361	$ 6,069	$ 335,449	43.38	$ 7,733
6	#5 + Nob Hill	76.55	$ 475,186	$ 6,208	$ 41,825	5.15	$ 8,122

7	#6 + WSDOT Pilot Channels	85.48	$ 562,519	$ 6,581	$ 87,333	8.93	$ 9,779
8	# 7 + Lower Blue Slough Connection	87.38	$ 593,308	$ 6,790	$ 30,789	1.90	$16,192
9	#8 + Greenway Trail Armor Removal	88.38	$ 612,457	$ 6,930	$ 19,149	1.00	$19,149

Notes: 1. All alternatives are Best Buys except 5a, which is a cost-effective alternative.
2. Price level = October 2015, FY16 discount rate = 3.125%.

Alternative 5a generates 148% more average annual habitat units than Alternative 4, at an average annual cost that is 328% higher. The incremental average annual cost per habitat unit of $7,758 is worth it due to the fact that the incremental benefit includes reconnecting 275 acres of historic floodplain to the mainstem of the river. Due to the scarcity of hydrologically connected floodplain habitat in this reach, the Yakima Basin Subbasin Plan (YSFWPB, 2004) identifies the loss of floodplain habitat as a principal limiting factor for the productivity of aquatic habitat in the subbasin. For these reasons Alternative 5a is the National Ecosystem Restoration (NER) Plan. As the NER Plan it reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective. While Alternative 5 would yield greater output than Alternative 5a at a lesser *incremental* cost per AAHU, the *total* cost for Alternative 5 is high enough that implementation would not be possible under the Section 1135 authority. Corps implementation would require conversion of this study to the General Investigation program. Because Alternative 5a is a complete project offering considerable benefit to the ecosystem in and of itself, and because it can be more efficiently implemented under the CAP Section 1135 program, it was identified as the Tentatively Selected Plan. Upon completion of technical, policy and public reviews and the consideration of environmental effects described in Chapter 4, Alternative 5a was also identified as the Recommended Plan.

4. Affected Environment and Environmental Consequences of the Alternatives

This chapter describes the existing conditions and future without-project conditions used for analysis during the study, as well as the probable environmental outcomes of implementing each proposed alternative. Existing conditions are the physical, chemical, biological, and sociological characteristics of the study area. Characterizing resource conditions is critical for understanding the probable future condition of those resources (i.e., the future without-project condition) and for defining problems and opportunities. The assessment of environmental effects is based on a comparison of conditions with and without implementation of the proposed plan and a reasonable range of alternatives; in this case, two action alternatives were formulated through the screening process and are compared to the No-Action Alternative. The analysis focuses only on significant resources that are potentially affected by the alternatives and have a material bearing on the decision-making process. The spatial scale of analysis focuses on the locations of the proposed sites to provide a comparison between the No-Action Alternative and the two action alternatives. The time scale for analysis is a 50-year period beginning in 2016 and extending to 2065.

The final array of alternatives carried forward for the assessment of environmental effects in Chapter 4 is the following:

Alternative 1 - (No Action)

Alternative 5a - Alternative 5a includes levee removal on the left bank (and related realigned levee construction), spur dike removal, floodplain topographic restoration, side channel restoration, and hydrologic enhancement of a disconnected floodplain channel. Primarily through removal of fill and replacement of a headgate, hydrologic and habitat connectivity is restored between a stretch of the Yakima River in the Gap to Gap Reach and over 320 acres of its historic floodplain.

Alternative 9 - Alternative 9 is a Best Buy alternative and includes levee removals (and related realigned levee construction) to include a small section on the right bank (Nob Hill) in addition to the larger section on the left bank (DID#1), spur dike removals, floodplain topographic restoration, side channel restoration, hydrologic enhancement of a disconnected floodplain channel, as well as related further anabranch channel construction, replacement of barrier culverts, excavation of pilot channels in the right bank floodplain, and removal of Greenway Trail related armoring. Primarily through removal of fill and replacement of a headgate and of undersized culverts, hydrologic and habitat connectivity is restored between a stretch of the Yakima River in the Gap to Gap Reach and over 585 acres of its historic floodplain.

4.1 Resources Analyzed and Resources Screened from Detailed Analysis

The following table identifies the resources analyzed or screened from detailed analysis including a rationale for inclusion or exclusion. Resources were excluded from detailed analysis if they are not

potentially affected by the alternatives or do not have a material bearing on the decision-making process.

Table 4-1. Resources Analyzed and Resources Screened from Detailed Analysis

Resource	Included in Detailed Analysis (Y/N)	Rationale for inclusion or exclusion
Hydraulics and Hydrology	Y	Problems identified center on the relationships among hydraulics, hydrology, and sedimentation. Proposed alternatives require study of these characteristics.
Geomorphology and Sediment Transport	Y	Problems identified center on the relationships among hydraulics, hydrology, and sedimentation. Proposed alternatives require study of these characteristics.
Water Quality	Y	Water quality benefits could occur from several of the proposed actions, including improved shading and nutrient input from enhanced riparian habitat, increased connectivity of area waterways (i.e., Blue Slough and the gravel ponds), and reconnection to the floodplain.
Air Quality and Greenhouse Gas Emissions	Y	The project occurs in a maintenance area for particulate matter and carbon monoxide. Burning of fossil fuels in equipment for construction and transport of materials and workers would increase local emissions during the construction.
Climate Change	Y	Climate change is expected to result in reduced water supplies in the Yakima River. The effect of climate change on the proposed action should be considered.
Noise	N	Noise impacts will be discussed below for the impact it may have on people, fish, and wildlife (Sections 4.4 and 4.6) in the area during construction. However, noise would only be generated during the construction activity, and no long term change to the noise environment of the project area would occur. Consideration under its own section is not warranted.
Hazardous, Toxic, and Radiological Waste	N	The proposed action alternatives would not create a significant hazard to the public or the environment through transport, use, or disposal of hazardous materials, nor would they affect hazardous materials otherwise.
Fish	Y	Improving fish habitat, particularly for listed salmonids, is one of the drivers for this project.
Wildlife	Y	Changes to habitat and increased diversity of habitats would benefit local wildlife, including mammals, birds, reptiles, and amphibians.
Vegetation (Wetland, Riparian)	Y	Improving habitat complexity and promoting native plant diversity through plantings and restoration of processes for +natural recruitment are goals of the proposed action.
Rare, Threatened, and Endangered Species	Y	Improving habitat, particularly for listed salmonids, is one of the drivers for this project.
Cultural Resources	Y	Potential exists for inadvertent discovery of cultural resources; discovery during construction could have an adverse effect to those resources.
Indian Trust Assets	Y	The Federal Government must consider the effects its actions may have on American Indian traditions and cultural practices. In the Yakima area, this includes impacts to tribal fisheries. Improving fish habitat is one of the drivers for this project.
Environmental Justice Communities	N	Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA 2014a). No group of people would be disproportionally affected by the proposed action, and all people would have an equal opportunity to participate in the decision making process by providing comments during the public comment period.
Land Use	Y	Individual property owners may be affected, thus effects to land use should be considered

Resource	Included in Detailed Analysis (Y/N)	Rationale for inclusion or exclusion
Recreation and Aesthetics	Y	Several public parks exist in the project vicinity, including the Yakima Greenway Trail, Sportsman State Park, and the Yakima Area Arboretum. Impacts to these public facilities or the viewsheds of these facilities should be considered.
Transportation, Utilities, and Public Services	Y	The project area contains or is adjacent to a number of important transportation corridors and public utilities. Any impact to these facilities needs to be considered.
Public Health and Safety	N	No change to the level of flood protection or other public health and safety resources is expected as a result of the proposed actions.

4.2 Cumulative Effects

Cumulative effects can result from the incremental effects of the proposed action when added to the effects of other past, present, and future actions, regardless of which government agency or private entity undertakes such actions. When effects that are individually minor combine over space or time, the cumulative effects can be significant. NEPA requires analyzing whether the incremental effect of the proposed action would cause a significant impact to the environment when added to past, present, and reasonably foreseeable future actions. This section will summarize actions that have affected the environment, and each resource in Sections 4.3 through 4.6 will be analyzed for whether it would accrue a significant cumulative effect.

4.2.1 Past Actions

The following nine projects have been completed in the project area:

1. SR 24 Bridge Replacement: This project was led by Washington State Department of Transportation (WSDOT) and involved widening the span of the SR 24 Bridge by 1,500 feet to allow for reconnection of floodplain above and below the bridge, which had previously been a significant constriction on the river. This project was completed in 2006.
2. Emergency Yakima Authorized Left Bank Federal Levee Setback (Sportsman): This project (completed in 2012) was an emergency action performed when the levee located on the east bank of the Yakima River upstream of the new SR 24 Bridge began to fail (erosion and loss of embankment). The Corps built the relocated levee on lands acquired by Yakima County and the Bureau of Reclamation. The levee ties into the east abutment of the new SR 24 Bridge with a temporary levee connecting the setback alignment to the levee downstream of the SR 24 Bridge (DID#1, known as Moxee Bridge Yakima Segment 7 in the NLD).
3. Floodplain Land Acquisition: The U.S. Bureau of Reclamation (USBR) has purchased lands south of the 1135 project and north of Union Gap. These lands can provide increased access to the floodplain when levees are relocated landward.

4. City of Yakima Waste Water Treatment Plant (WWTP) Outfall Relocation and Floodplain Restoration: This City of Yakima-led project is a continuation of the cumulative action project #4 described in Section 4.2.1 and was completed in 2015. The existing outfall was relocated to south of the WWTP with wastewater discharge released through a series of constructed channels, returning 330 acres to the active floodplain and allowing for DID #1 levee setback.
5. City of Yakima Levee Relocation: This City of Yakima-led project was completed in 2013. It occurred south of the WWTP, moving the levee and the existing Greenway Trail west around where the reconfigured outfall area will be, once relocated. In addition, a noise control berm was reconstructed along I-82 in 2015.
6. Levee Armoring Repair: This project lies adjacent to the Boise Cascade Parking lot on the Greenway Trail. The federal project levee is located adjacent to I-82 landward of the Yakima River. The riprap armor on this portion of levee did not meet flood protection standards and 1,100 feet of armor along the setback levee was replaced in 2012.
7. Interior Levee Breaching (Boise Cascade): The Boise Cascade Levee extends from the Boise Cascade Parking lot along the Yakima River for 900 feet, riverward of the federal project levee. The orientation of the Boise Cascade levee relative to the river and the valley wall created a major constriction to flow, with adjacent gravel aggradation upstream. The armored face and toe of this levee was removed, and three breaches excavated at locations of former side channels.
8. Interior Levee Removal Upstream of Terrace Heights: This large levee removal and floodplain restoration project was completed in 2012 in association with the emergency Sportsman levee setback near the SR 24 Bridge. The levee material was used to construct the new Sportsman setback levee downstream. Approximately 170 feet of the Marsh Road Yakima Seg 9 Levee, 800 feet of a large gravel berm (which acted as a levee), and 1,500 feet of former gravel pit perimeter levee were removed on USBR and WSDOT properties upstream of the Terrace Heights Bridge.
9. DID #3 Levee Crest Removal and New Trail: This is a component of the City's floodplain restoration and Greenway Trail relocation project, which occurred in 2013 (see Item 5 above).
10. O&M Projects – Seepage and Erosion Repairs: Erosion repairs to the federal Yakima Authorized Left and Right Bank Levees have occurred in 2012 (as a result of the 2009 and 2011 floods) upstream and downstream of the Moxee Branch railroad bridge and downstream of the Terrace Heights Bridge. These repairs consisted of significant slope armor and toe replacement. Seepage repairs (noted during the 2009 and 2011 floods) were performed in 2011 at the Yakima Authorized Left Bank Levee near the Selah Moxee diversion and at the Yakima Authorized Right Bank Levee near Buchanan Lake. These seepage repairs consisted largely of reinforcement on the landward side of the levee to prevent levee failure due to piping or seepage.

4.2.2 Present/Future Actions

The following projects are in progress or expected to occur and would also be considered in the cumulative effects analysis:

1. Removal of Toe Rock Upstream of Terrace Heights Bridge: During the Interior levee removal described as number 7 in Section 4.2.1 the toe rock of the County's PL 84-99 levee was not removed because in-water work was not allowed during that time period. This project is to remove those pieces of toe rock and armor that inhibit channel migration and side channel formation on USBR and WSDOT parcels.
2. East-West Corridor: This Yakima County-led project would include installation of a new road to help reduce traffic congestion on Terrace Heights Drive, help connect the City of Yakima with the Terrace Heights neighborhood, and provide improved access across the Yakima River. Anticipated start of this project is to be determined in coordination with WSDOT. Funding has not yet been secured for this project.
3. Terrace Heights Bridge/Road Improvements: This WSDOT-led project includes widening the Terrace Heights Bridge to the east to improve channel alignment, increase floodplain area, and increase flow conveyance and sediment transport (reduce backwater). Anticipated start of this project is to be determined by WSDOT. Funding has not yet been secured for this project.
4. Yakima Basin Integrated Plan (YBIP) – Projects on Naches and Wapato Reaches: These are floodplain restoration actions identified in the habitat enhancement program of the YBIP for reaches above and below the Gap to Gap Plan area. USBR has authority to implement some of the actions in the YBIP and is seeking additional authorities to implement the entire plan, including projects on these reaches.

4.3 Physical Environment

This section provides an analysis of the existing and future without-project condition of the significant physical resources in the study area, as well as how each alternative would affect these resources.

4.3.1 Hydrology and Hydraulics

A summary of the basin hydrology is presented in this report and detailed analyses appear in the Hydrology and Hydraulics Annex to the Engineering Appendix (Appendix A). The four mile 1135 project reach (Figure 1-2) is located between river mile (RM) 111 and RM 115 (based on USBR river mileage, RM 109 to RM 113 based on USGS river mileage) within what is locally referred to as the Gap to Gap Reach. This reach is a 10 mile stretch of Yakima River between the bedrock constrictions at Selah Gap (RM 117) and Union Gap (RM 107) near Wapato dam. Two federal levees constructed by the Corps in the late 1940s are located on the left and right bank (left bank and right bank levees respectively) upstream of the SR 24 Bridge. The northern half of the project footprint spans both the former KOA campground and

the Yakima Sportsman State Park. The left bank federal levee intersects both park boundaries. Portions of the federal levee through the former KOA campground (between Sportsman Park and SR 24) was set back by the Corps and Yakima County in 2011 due to flood damage to the old levee. The southern half of the 1135 project is spanned by the DID#1 non-federal levee (left bank) and the recently modified Yakima waste water treatment plant (WWTP) levee (right bank), which protects the City of Yakima WWTP. The DID#1 existing levee crest is on average approximately 2 feet above the 1% annual exceedance flood event. The February 9, 1996 flood was slightly in excess of the predicted 1% annual exceedance flood, and while the DID # 1 levee south of SR 24 did require emergency repair and reinforcement during the flood, it did not fail or overtop (Yakima County, 2007). The Yakima Greenway recreational trail spans the entire project footprint along the right bank. Spring Creek joins the Yakima River along the right bank.

The Gap to Gap Reach and Yakima River are notable regionally due the extensive gravel mining that has occurred in the river and floodplain. Close to twenty active or abandoned gravel pits are present along the river and floodplain within the project reach. The largest single pit, Buchanan Lake (also referred to as Beech Street pit) covers nearly 40 acres of formerly active channel and is disconnected from the river by the right bank federal levee. Opposite of the City of Yakima WWTP on the left bank, separated by the DID#1 levee, are the Newland Ponds. These ponds are a significant feature in the project footprint and span nearly 0.8 miles of the riverbank (roughly 90 acres of floodplain). The ponds are separated by narrow remnant portions of floodplain which form berms or weirs between ponds (also referred to as causeways). The Edler and Segment 5a ponds are remnant gravel pits located on the right bank, near the downstream project boundary where the Greenway Trail meets the East Valley Mall Boulevard interchange with I-82.

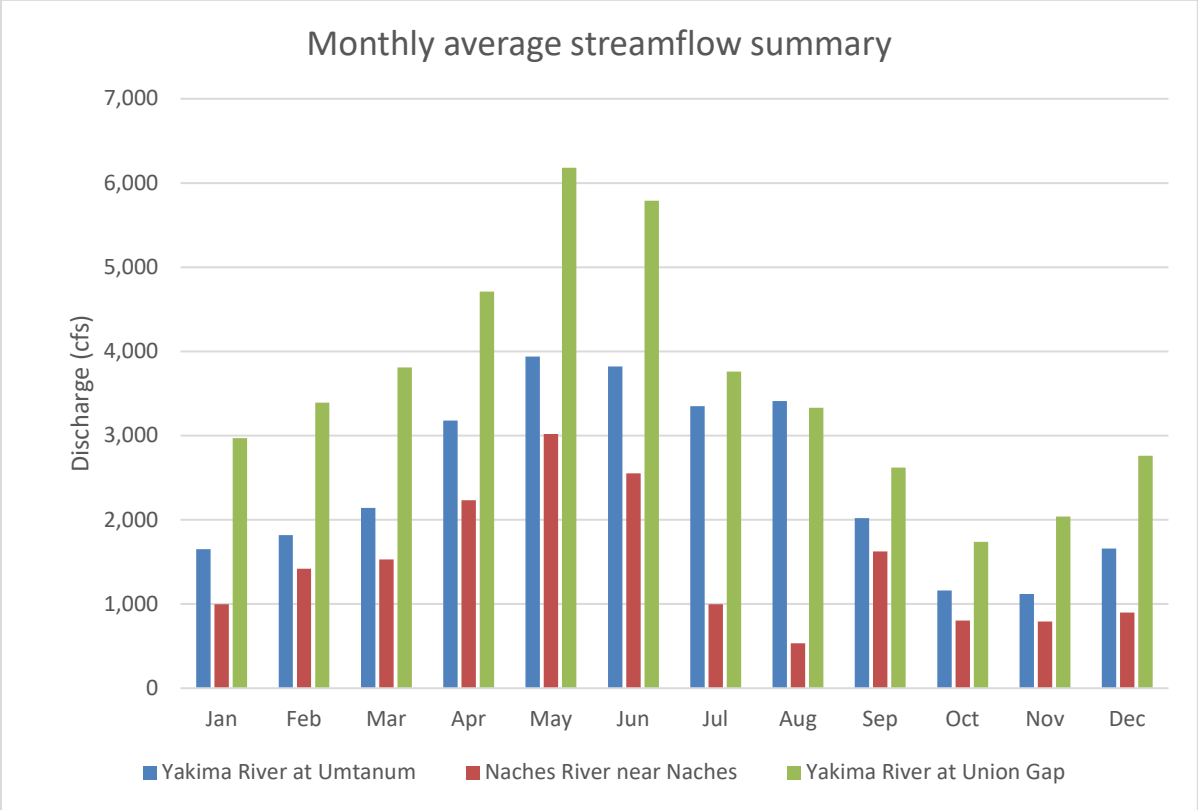
With the exception of the lower two miles along the left bank, armored levees and highway embankments act as controls on channel migration and confine the river to a much narrower active width. The Wapato Dam, which is located 2.7 miles downstream of the project boundary at the Ahtanum Gap (a constriction formed by a basalt ridge) near RM 108.5, acts as a control on channel elevation and has been attributed to upstream aggradation.

Nine bridges cross the river in the Gap to Gap Reach; however, only two are located in the project vicinity (Terrace Heights and SR 24). The SR 24 Bridge had been a major constriction point, but was recently replaced with a much wider span.

Spring Creek flows into the Yakima River at Union Gap (right bank), and is a source of backwater flooding for the City. The City of Yakima WWTP effluent treatment ponds and outfall to the river are located between RM 112-112.5 on the right bank.

An existing irrigation diversion is located at Sportsman's Park near RM 114. This structure diverts a small portion of the Yakima River into Blue Slough (relic channel) which flows (ephemerally) for 2 miles behind the Left Bank federal Levee and DID#1 levee, rejoining the river near the downstream end of the Newland Ponds. At present the 36-inch diameter head gate is operated by the USBR and is closed and the slough only flows when river levels are high enough to supply groundwater to the slough.

The five Yakima Project reservoirs in the upper basin (Figure 1-1) have been operated by the USBR for agricultural flow augmentation and for flood control beginning in the early 1900s. The reservoirs store water at times of high flow and release it for irrigation during spring and summer. This reduces flood flows in the winter and increases otherwise low flows in the summer in some of the upstream tributaries (locally referred to as "flip-flop").



Data Sources:

- Union Gap: Data from USGS. Calculation Period: 1966-10-01 -> 2016-01-31. Meas. Rating "excellent to good"
- Umtanum: Data from USGS. Calculation Period: 1933-10-01 -> 2016-01-31. Meas. Rating "excellent to fair"
- Naches River near Naches: Data source - USBR Pacific Northwest Region, Hydromet System Data Access, 2003. As presented in the Yakima County Naches River Comprehensive Flood Hazard Management Plan, Fig. 3-7, Appendix A. No accuracy of streamflow measurements reported.

Figure 4-1. Monthly Average Streamflow Summary, Gap to Gap

Flows through the project area tend to be on the order of 1,500 cfs during the lowest summer to fall periods and roughly 15,000 cfs during a "bankfull" (2-year) recurrence event. Average annual flows are roughly 3,500 cfs at Union Gap, which is less than the combined average annual flow at the upstream gages due to agricultural diversions (Roza canal, etc.). Yakima River flows primarily originate from snowmelt and rainfall on the eastern slope of the Cascade Mountains in the fall and winter, and are augmented by reservoir releases in dry months. Average flows are highest during the months of April, May, and June as a result of spring snowmelt runoff (Figure 4-1), however peak flood flows typically occur during the winter. Winter flood flows are associated with warm temperatures and rainfall on

melting snow pack and typically follow precipitation periods that have saturated soils, producing greater rates of runoff (Yakima County, 2007).

4.3.1.1 No-Action Alternative/Future Without-Project Conditions

The No-Action Alternative would maintain existing levels of flood risk in the short term, but due to expected peak flow increases from climate change, flood risks will increase with time. The existing levee is expected to contain the 1% AEP (100-year) event with an average of 2 feet of freeboard. The No-Action Alternative would result in the continuation of current reach scale trends and persistence of degraded habitat in the area slated for restoration. Climate change forecasts for the Yakima Basin predict that the basin will become rain dominated by 2080, increasing peak flows and changing the timing of peak flows from the spring to winter. This would likely be coupled with increased sediment delivery (due to more rain on bare ground) in the winter, and higher rates of flood disturbance (reduced snowpack, higher peak streamflows). In the summer, higher temperatures and reduced flow availability would have significant effects on habitat and species composition. The main river channel flow is augmented during the hottest months by reservoir releases; however, some forecasts indicate water shortages are possible, which could significantly impact species adapted to the current seasonality. Due to planned reservoir storage increases, the impacts on the basin may be buffered somewhat. While vegetation growth would increase complexity in the river and floodplain, disconnected wetlands in the project area would be degraded by expected temperature increases. The river is likely to continue its slow down cutting trend upstream of SR 24 and slow aggradational trend upstream of Wapato dam for the foreseeable future (See Annex D-2 and D-3 for more information). The federal levee on the right bank has experienced severe flood damage in the past, and the O&M to prevent levee failure would increase. It is possible that continued down cutting combined with worsening flood peaks caused by climate change could result in a levee failure in a 50 year period of analysis. Likewise the DID #1 levee could breach in a 50 year period of analysis. Flood risks would increase with time due to increased peak flood magnitudes and frequencies and higher expected sediment loads. Development behind the levees is likely to remain at status quo levels due to proactive floodplain management by Yakima County.

Given the low intermittent flows on Blue Slough and numerous undersized culverts, existing conditions are highly degraded, and future without-project future conditions would only worsen. Industrial and commercial land uses abut the slough, impacting it with non-point source pollution from stormwater runoff. This would likely worsen with ongoing development. With climate change, increased air temperatures and reduced summer streamflows would have major impacts on the ecology of the Slough. It would likely dry up for more of the year, and when flow is present it may be too warm to provide habitat for salmonids. Wintertime floods would cause groundwater elevations to increase modestly, which could increase overall flows in the slough in wet months. Hydraulic conditions in the channel may change with the hydrology, but additional modeling would be needed to identify these changes.

4.3.1.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Setting back the DID#1 levee (and associated pit filling and upstream improvements) would extensively alter the hydrology, hydraulics, and resulting habitat within the existing river channel, floodplain, and restored area within the project reach and for a significant distance upstream and downstream. The diversion of flow into the restored area would reduce the discharge, velocity, depth, and shear stress in the main channel, but increase them in the restored area and in connected floodplain areas downstream of the project. The diversion of flow would restore natural erosional, depositional, and successional processes important for creating and sustaining riparian habitat, such as pool riffle complexes, bars, logjams, islands, shallow water, and deep water and off channel wetlands. Flow into and through the Newland ponds would restore cold water habitat and native fish populations. Provision of a new setback levee will allow for beneficial inundation of lands to be restored (see Figure 4-2 and Figure 4-3). The design top elevation will match existing levels of performance with respect to overtopping risk. Because the levee will be new and built to modern standards it is possible that the overall levels of flood risk would be reduced despite the existing hydraulic performance with respect to overtopping being maintained. Because of expected peak flow increase over time as a result of climate change (shift to rain dominated flooding from mixed rain/snowmelt dominated), flood risks will similarly increase over time.

Construction of this Sportsman's Park side channel upstream of the DID#1 restoration area improvements directly restores 20 acres of side channel habitat, reconnects the upstream and downstream ends of the island allowing for additional conveyance to mitigate risk associated with potential downstream pit capture and headcutting, creates a more even distribution of stream power across this leveed reach (improving spawning conditions), and reconnects various side channels along the alignment. The as-built channel will be inundated at less than the annual flow, which will relieve pressure on the adjacent right bank levee by redistributing flow away from the levee and reducing flood stages.

The Sportsman's Park measure, located at the upper end of the project footprint, would include excavation of two relatively straight side channels requiring removal of approximately 107,000 cubic yards of deposited material and woody debris. One channel is 3884 LF long, and the other is 1382 LF long. Excavated material from this channel would be contributed towards Measure 1.2. A large channel mouth would be constructed at the head of the island that would then funnel into a 100-foot wide channel that would tie in to an existing channel towards the downstream end of the island. A 3-foot deep 30-foot wide low flow (pilot) channel would be constructed along the bottom of both side channels. These channels are expected to enlarge and widen rapidly due to the erodibility of the bed materials and channel alignment.

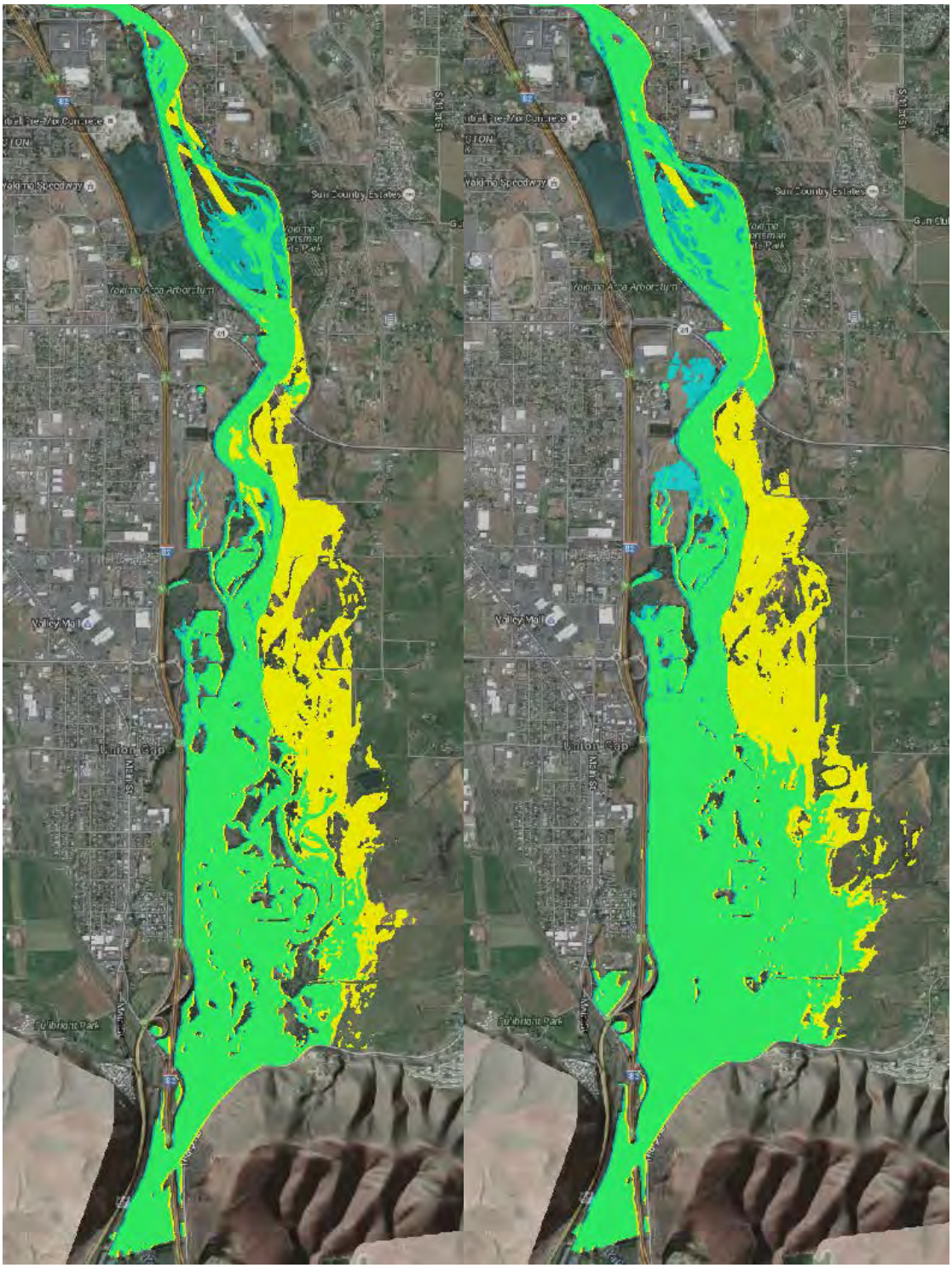


Figure 4-2. Change in 2 year (left) and 10 year (right) Inundation Areas in Project Reach.
Yellow area is increased inundation resulting from levee setback, while blue area is an area that is not flooded under with project conditions but is under existing conditions. Green areas are coincident inundation for existing and with project conditions. Note the change in active floodplain extent.

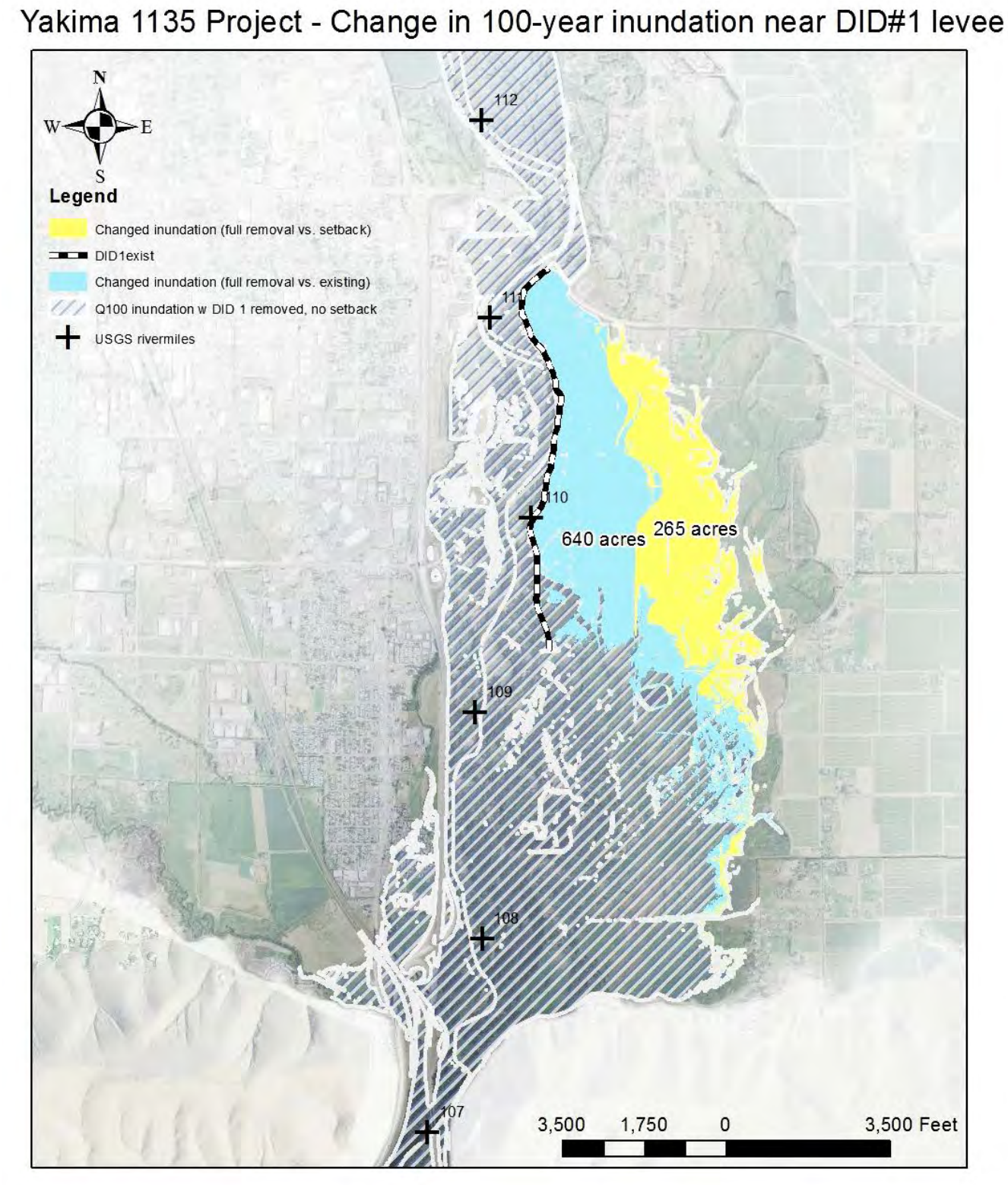


Figure 4-3. Yakima River 1% AEP (100-year) With-Project Floodplain Conditions
Changes from existing conditions due to full levee removal (640 acres) and setback levee construction (375 acres).

Restoration of flow to Blue Slough would restore surface water hydrology to 9,200 lineal feet of relic channel that is only wet seasonally when ground water elevations are high. Generally, conditions would appear to become very favorable for spawning given the gradient, substrate, and lower flood frequency and magnitude of disturbance. By replacing the existing culvert and headgate on Blue Slough, flow frequency, duration, and depths would be increased significantly in the slough. Because flows would be controlled, the frequency of flood disturbance would not be high; however, seasonal inundation of near bank vegetation would occur more frequently. A more reliable supply of water would promote riparian vegetation establishment and eventually, large wood recruitment. Vegetation would buffer the slough from local land uses, and improved hydrology would enhance adjacent wetlands. Without diverting flow into Blue Slough, there is a higher risk of it running dry or becoming too warm for salmonid use. With the headgate in operation, flow can be optimized to offset these impacts. Hydraulic conditions in the channel would change with the increased flow, but since flood peaks are expected to be small, channel disturbance and geomorphic change would be minimal.

Alternative 9

In addition to the effects described from implementation of Alternative 5a, Alternative 9 would include excavation of material to create pilot channels at two other locations (WSDOT and Nob Hill) and realignment of the levee at Nob Hill. This would create conditions for side channels to naturally establish, which would restore natural erosional, depositional, and successional processes important for creating and sustaining riparian habitat, such as pool riffle complexes, bars, logjams, islands, shallow water, and deep water and off channel wetlands.

Cumulative Effects

No significant negative cumulative effects to hydrology or hydraulics are anticipated to accrue from any of the alternatives. Both of the action alternatives would work in conjunction with the completed and planned restoration projects and levee setbacks by the City, County, Tribe, and other entities to reconnect the floodplain to the river and improve the quality, quantity, and complexity of habitat in the Gap to Gap Reach. The 1135 project is vital to maximizing the restoration potential of the Gap to Gap Reach.

4.3.2 Geomorphology and Sediment Transport

Geomorphic Summary

In the Gap to Gap Reach (RM 107 to 117), which includes the four mile project reach (RM 109 to RM 113), the Yakima River has a gravel and cobble bed, a moderate to steep slope, and variable active width and planform. The planform morphology is dynamic, and varies from single thread to meandering single thread to anabranching to braided depending on location, recovery time from historical alternations, and flood history. Prior to anthropogenic alterations, which began in the 1850s, the river was predominately anabranched (multiple channel threads divided by forested islands, but not highly

braided) and well connected to its floodplain (See Annex D-2 and D-4 for a discussion of historical channel conditions).

The bankfull width of the Yakima and the Naches River at I-82 upstream of their confluence is 180 feet. Downstream of the confluence to Wapato dam the channel bankfull width varies between 150 and 650 feet, and the flood-prone (active) width varies from 550 to 2500 feet. Bankfull widths are widest between the Naches River confluence and Terrace Heights Bridge where the river is locally braided. Bankfull widths are narrowest at the apex of armored meander bends near the WWTP and Buchanan Lake where the river has become entrained to the revetment and scoured the bed deeply, creating a narrow channel with a high "fixed" point bar on the opposite bank. It is notable that at these constrictions the river channel is conveying the combined flow of the Yakima and Naches at a bankfull width narrower than either river channel just upstream of the confluence.

The projects are expected to need 5 to 10 years to fully establish desired restoration conditions, with occasional adaptive management guided by monitoring to nudge the project to full sustainability. The hydrologic, hydraulic and morphological response to restoration is discussed in detail in H&H Annex D-1 par. 5.3.2. The restoration approach is based on successful projects completed by Yakima County (the non-federal sponsor) that use the energy of the river and extended duration spring freshet and high winter flows to enlarge constructed pilot channels over time to enhance and restore riparian habitat. In addition, where the channel has become entrained to hardened embankments, floodplain grading is used to divert flow energy and reverse the main channel velocities and vertical degradation.

Uncertainties with channel response rates and magnitudes relative to restoration actions and measures will be addressed through updated river and topographic surveys and modeling during PED to guide design refinements followed by monitoring and adaptive management post-construction. See H&H Annex D-1 for a discussion of how restoration uncertainties will be addressed, and Appendix H for the monitoring and adaptive management plan.

Channel migration rates

From inspection of recent air photos it is seen that channel migration is most pronounced at the downstream end of the WWTP near the Edler Ponds where the Yakima River has migrated westward 550 feet in 19 years toward the Greenway trail and I-82 and moved an equivalent amount away from the highway just downstream (abandoning a captured gravel pit) (Figure 4-4). The average rate of migration (30 feet per year) matches that noted in the CFHMP (Yakima County, 2007). The USBR also noted that channel migration in this reach was often associated with avulsion into old channels.

Figure 4-4. Representative Channel Migration
In vicinity of Union Gap near Greenway Trail and Edler ponds between 1996 and 2015. Left bank has remained fixed while right bank has migrated toward and away from I-82 by more than 500 feet. (Data from Google Earth.)

Within the project reach there are several large floodplain ponds (remnant of gravel mining operations) that remain in the channel migration zone, which indicates dynamic conditions should be expected whether or not restoration actions occur (assuming eventual pit capture and dynamic response). The landward migration rate can increase sharply from average conditions when a pit is captured as the pit wall effectively becomes the river bank.

Effects of historical anthropogenic alterations on river hydraulics, channel morphology and complexity

More than a century of levee, road, and revetment construction have confined the active floodplain of the Yakima River to a much narrower corridor, forcing the river channel into a shorter, steeper single threaded condition in places. This has led to elevated velocities and stream power at constriction points and has been associated with habitat simplification (Stanford et al., 2002) and repeated flood damages, especially near SR 24 and the Yakima WWTP (Yakima County, 2007). Floodplain gravel mine (pit) captures and avulsions have occurred several times in the Gap to Gap Reach (see Engineering Appendix Annex D-1 and Annex D-2, Clark 2003). Pit captures can create unstable conditions that result in

localized (and usually short-lived) braiding and channel incision that have damaged habitat as well as infrastructure (YRFMIS 2004, Yakima County 2007, NHC 2015).

From inspection of modern aerial photos, the active floodplain width varies from 550 to 2500 feet (approximately). Within the project reach the narrowest portions of the floodplain are located where existing levees pinch the river down to about 25% of its natural active width (at SR 24 for example). Within the project reach there is a notably large change in both active width and channel complexity between the downstream end of the DID 1 levee and Union Gap. The abrupt increase in active width is associated with the downstream termination point of the DID #1 levee, which allows the floodplain to expand to nearly its full pre-settlement width. The river experiences the greatest rate of planform change and channel migration in this sub-reach and remains free to move laterally. The USBR (2010) and others (Stanford et al., 2002) noted that the river has experienced aggradation (related to Wapato dam), avulsions, and pit captures in the recent decades. This reach has four to ten times the complexity (in terms of total channel length) in the study reach (USBR 2010), can serve as a reference condition for restoration of upstream reaches, and represents a likely end state for the project area post-restoration.

Others (Eitemiller et al., 2002, Table 4-2, Table 4-3) have compared the surficially connected active floodplain extent from the time of European settlement (1850s) to 2002, and documented a total reduction of 60% (loss of nearly 3,500 acres) of surficially connected floodplain area and a loss of 75% (4,320 acres) of active floodplain area. These reductions coincide with a decrease in the mainstem river channel length of 43% from its pre-settlement condition due to compounding effects of anthropogenic alterations, primarily levee and road construction and land use changes.

Table 4-2. Loss of Connected Floodplain Area in Gap to Gap Reach

Date	Surficially connected floodplain area (acres)	Change from pre-settlement (acres)	% Change from baseline
pre-settlement	5745	NA	NA
1915	4546	-1199	-21%
1964	3933	-1812	-32%
2002	2276	-3469	-60%

Adapted from Eitemiller et Al., (2002).

Table 4-3. Future w/o Project Hydrologic Summary & Historical Active Floodplain Alterations

Pre-Project baseline conditions in Gap to Gap Reach (RM 107.1 to RM 116.7)		
Existing channel length (main channel only)	9.6	miles
Total levee length (both banks) (1)	10.7	miles
Total revetment length (2)	9.2	miles
Existing active floodplain area (2002) (3)	1425	acres
1927 Active Floodplain area (3)	1988	acres
Pre-settlement active floodplain area (3)	5745	acres
1927 to 2002 change in active floodplain area	-4320	acres

Notes: (1) levee lengths from USACE National Levee Database. (2) Revetment lengths estimated from Yakima County roads GIS layer and aerial photos. (3) Active floodplain areas digitized from Eitemiller et al., (2002).

Using ortho rectified air photos (1927 through 2008), the USBR (2010) and Clark (2003) documented rapid and significant decreases in channel complexity by comparing the number of flow divisions, sinuosity, and unvegetated gravel bar areas in the reach. In about 30 years the Gap to Gap Reach lost about half of its complexity (using nodal analysis) due to anthropogenic channel alterations (Figure 1-2). The point in time of lowest complexity (1966) correlates to extensive in-channel gravel mining for construction of I-82, and legacy effects of levee construction and channelization projects by the Corps in the 1940s-1960s and others. Wide scale gravel mining in the active channel had largely ceased by the 1970s after completion of I-82.

Since 1966 there has been a slow increase in complexity as channel gravel pits were captured and sediment and wood were recruited during high flow events (Clark 2003). From inspection of air photos between 1996 and 2015, bars created during large floods (from general deposition or from floodplain erosion) increased the surface area available for vegetation recruitment and increased the number of quasi-stable vegetated islands. These islands act as hard points and deflect flow into adjacent banks, which can cause additional erosion, sedimentation, and increases in complexity.

4.3.2.1 No-Action Alternative/Future Without-Project Conditions

Channel migration is an important consideration in the future condition of the Newland Ponds area. Without bank erosion protection the river is likely to migrate into the ponds within 5 years based on their proximity to the river channel and the reach average channel migration rate. It is also possible that the river could erode the levee and avulse into the ponds on its own during a major flood event.

In their 2010 study the USBR compared survey data collected in 2005 to surveys by the Corps from 1969 to assess longitudinal trends in channel aggradation and degradation by segment. As described in more detail in Section 3.8 of Annex D-1 to the Engineering Appendix (Appendix A), thalweg elevations have changed by as much as +15 feet (aggradation) downstream of the Naches River confluence) to -10 feet (degradation) at the upstream end of Buchanan Lake where the Right Bank federal levee has experienced toe erosion and scour in the past. In segment 4 (DID #1 levee) the river has both degraded (-3 feet) and aggraded (3 feet). The river thalweg has aggraded by as much as 7.5 feet in the SR 24

backwater zone. Note that there are clear aggradation/degradation trends by segment but not at the reach scale. Sediment transport modeling of the existing condition by the USBR also indicates no significant trend in aggradation or degradation throughout the reach, which is consistent with the measured data from 1969 to 2005 and no significant change to reservoir operations.

Further work by Yakima County and their consultants NHC investigated vertical stability trends between 2005 and 2014. The largest change in the area of overlapping survey (between the USBR and NHC study) occurs at the SR 24 bridge. The 7.5 feet of aggradation in the 1969 to 2005 comparison is not observed in the 2005 to 2014 comparison, in fact the trend is reversed (scour of 5 feet). The reason for this change is not clear but may be related to the recent large floods and the replacement of the bridge in 2006 with a larger span that allowed the river to migrate, forming a scour pool at the bend next to the KOA levee. Additionally there has been degradation upstream of the bridge comparable in magnitude over a shorter time interval. This suggests that the river may have a degrading trend or is reworking flood deposits created by the old bridge restriction. It is also notable that the changes downstream of the bridge in the 2005 to 2014 comparison are similar in direction but smaller in magnitude than the 1969 to 2005 comparison, indicating that the trends there have been maintained.

Without project trends were assessed with a sediment transport analysis by NHC (2015) over a 50 year period. The riverbed average elevation is expected to remain static from the downstream project limit to the mid-point of the DID#1 levee, then aggrade by as much as 2 feet near the SR 24 bridge, degrade about 1 foot near Buchanan Lake, aggrade about 3 feet between the Terrace Heights bridge, and downcut by about 3 feet near the Naches River confluence.

4.3.2.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

If Alternative 5a is implemented, large increases in active and surficially connected floodplain area are expected. These changes are a direct result of inundation of low lying lands reconnected to the river by removal of the DID 1 levee. More than 425 total acres of active floodplain habitat are likely to be reconnected to the river (Figure 4-3, Table 4-4). Note that approximately 320 of these acres are within the project footprint, while the remaining acres are downstream in lands dedicated for conservation. Areas that are active floodplain are expected to be dynamic for the life of the project.

Short portions of the existing riprap along the DID#1 levee would be left in place to reduce the tendency of the river to migrate and capture the ponds. Given that riprap alone is unlikely to prevent pit capture, other measures are included to manage this process. Sediment deposition over the course of several decades at DID#1 would help fill in the ponds and rebuild floodplain surfaces. The island-braided (anabranching) morphology present downstream of the project boundary was present prior to the levee construction within the project site. Reestablishment of connectivity with the river would result in a rapid transition from a single thread to anabranching planform in the setback reach. Existing isolated ponds and wetlands, a refuge for non-native warm-water fish species would become connected to the

mainstem, displacing non-native invasive species. Moving the levee away from the river channel to the floodplain would reduce risks of levee failure due to toe erosion. Setting back the levee reduces flood elevations and loading at the toe. Reconstructing the levee to modern standards combined with above reduces risk of levee failure and flood risk. It also lowers flood risks for properties on the left bank and levees upstream. Development behind the levee could increase residual risks over time. Concerns over upstream head-cutting caused by river avulsion into the Newland pits are assumed to be addressed by mitigation measures (Measures 1.1, 1.2) and the Sportsman's Park measures (Measures 2.0, 2.1, 2.2).

Table 4-4. Future with project hydrologic summary in Gap to Gap Reach (RM 107.1 to RM 116.7)

Proposed conditions with restoration in Gap to Gap Reach	Amount	Unit
1135 project active floodplain area[1]	1852	acres
Increase in active floodplain area[2]	427	acres
% of 2002 active floodplain increase	30	%
Length levee & revetment to remove	1.67	miles
% of reach levee & revetment length removed	8	%

1. Increase in acreage is based on assumption of frequent inundation after levee setback.
2. This project can be credited for restoring 320 given real estate considerations.

Diversion of flow caused by the side channel grading and spur dike removal and construction is expected to enlarge the constructed side channel – this would rapidly recruit wood and sediment from the banks and bed, resulting in a highly complex pool riffle sequences and export of large quantities of fine and coarse sediment until the channel stabilizes. Reestablishment of connectivity with the river would result in a rapid transition from a single thread to anabranching planform in the project reach. Existing isolated side channels and wetlands would become connected to the mainstem, providing forage opportunities for juvenile salmonids. Redistribution of a larger percentage of the flow from the main channel into the new side channel would reduce risks of levee failure due to toe erosion on the right bank levee. This also reduces flood elevations and loading at the toe increasing the resilience of existing levees despite increasing peak flows caused by climate change. While the lowered flood elevations reduce risk and O&M concerns initially, expected channel degradation (down cutting) would slowly increase risks of toe erosion. The side channel, island and main river channel could also become more dynamic with increased flood peaks and sediment delivery and this could cause the channels to migrate and alter the rivers' angle of attack on the left or right bank levees such that the O&M burden returns to current levels. Because down cutting reduces the risk of levee overtopping, overall flood risks are decreased. No changes to land uses behind the levees are expected to result from this project.

For Blue Slough, hydraulic conditions in the channel would change with increased flows, but since flood peaks are expected to be small, channel disturbance and geomorphic change would be minimal.

Floodplain topographic modification downstream of the SR 24 Bridge on left bank of the Yakima River is intended to ameliorate risk associated with potential capture of the Newland gravel pits/ponds by the main channel and consists of three project actions:

1) Remove aggraded point bar material that has resulted from the fixed meander (formerly the location of the WWTP outfall) downstream of the SR24 bridge. This action would allow re-initiation of normal channel migration processes, distribute energy more evenly across the channel, and reduce the potential for immediate avulsion into the pits due to the large material contained in the bar (just downstream of the narrow SR24 bridge opening);

2) Because setting back the levee and restoring of native floodplain contours through regrading of the floodplain reduces the backwater effect at SR24 there is a steepening of the hydraulic profile at the

bridge. The sediment transport modeling work done by USBR (2010) and NHC (2015) predict both degradation and aggradation upstream of SR 24 and degradation and aggradation downstream of SR 24 depending on whether or not a pit capture is allowed to occur. By excavating the Sportsman's channel and strategically placing all of the excavated and unsuitable material into the three existing gravel pits the risk and effect of floodplain pit capture is expected to reduce the potential degradation from an unmitigated pit capture scenario by about half (from as much as 5.5 feet of degradation to about 2-3 feet). Under all scenarios the effects of the down-cutting could extend upstream as far as 14,000 feet over 25 years based on morphodynamic modeling (Annex D-2); and

3) Remove relict gravel berms from the floodplain that are artifacts of floodplain mining operations to allow the river more conveyance and wetted area within the new setback limits and deposit that material in the former pits. These actions increase active floodplain area, lower flood elevations, and increase habitat within the reach, while ameliorating risk associated with potential pit capture by the main channel.

Alternative 9

If Alternative 9 is implemented, we would expect similar conditions as described for Alternative 5a, except that the right bank floodplain would be more prone to undergo channel migration. Conditions upstream and downstream of the project would likely remain unchanged as compared to Alternative 5a.

Cumulative Effects

No significant negative cumulative effects to geomorphology or sediment transport are anticipated from implementation of the TSP, Alternative 5a, as project features are included to mitigate risks associated with expected changes in depositional and scour patterns. In the first decade post-construction, monitoring will be conducted to determine if adaptive management actions are necessary to maintain geomorphic risk levels due to unexpected changes. If unexpected changes occur, cost shared adaptive management will be conducted to address these risks.

Project constraints evaluation

The project planning constraints (par. 2.6) were evaluated to verify that the proposed TSP addresses the planning constraints. In this evaluation the FWP condition assumes Alternative 5a is the TSP, which is compared to the no action (FWoP) condition. As shown in Table 4-5 below, all of the planning constraints are addressed. Because the TSP includes construction of a new levee, it is expected that the new levee would be eligible for federal rehabilitation assistance through the PL84-99 program. While the performance of the new levee is not expected to be different from the existing levee in terms of overtopping risk, flood risks would qualitatively be reduced by the inspection requirements and federal flood fighting and rehabilitation assistance. The setting back of the levee converts at-risk developable properties behind the levee to restoration area, which also reduces flood risks.

Table 4-5. Planning constraints checklist

Planning Constraint	Do FWoP conditions address constraint?	Do FWP (Alt. 5) conditions address constraint?
Ensure the Yakima Authorized levee continues to provide the same level of flood protection after construction of the Sec. 1135 project as currently exists.	No change. (avg. of 2 feet of freeboard wrt 1% AEP event with flood fighting by Yakima county)	No change in overtopping performance. Avg. of 2-feet of freeboard wrt 1% AEP event with USACE flood fighting. Number of at risk structures is reduced because developable floodplain converted to restoration area.
Avoid causing induced flooding.	No change	Includes closure gates and spur levees to prevent flooding outside leveed area.
The project should avoid impacts to the extent practicable to flood risk of the surrounding structures or infrastructure, and should not increase life safety concerns associated with flood risk.	Existing levee conditions and integrity not fully known since levee is not in the PL84-99 program. Levee breach or overtopping risks may be greater than if levee in program.	New levees to be built to modern standards. Risks should be lower wrt to existing conditions since new levee and will be in PL84-99 program. Project includes head cut mitigation and adaptive management measures to keep geomorphic risks tolerable.
The project should, to the extent practicable, be designed and implemented such that capture of old gravel pits along the Yakima River does not result in head-cutting to a degree that would undermine bridge abutments, levees, or other critical infrastructure.	If existing levees breach or are overtopped there will be no mitigation in place to address risk posed by uncontrolled headcutting other than post-emergency actions. Under a no action pit capture scenario conditions are potentially unacceptable.	By including a new side channel at Sportsman's park, spur dikes along Buchanan Lake, armored overflow sill between Yakima River and gravel pits, and strategic grading of the gravel pits expected river down cutting is reduced to an acceptable level (half what it would be otherwise be without mitigation measures, but greater than under a no action/no pit capture scenario).
Location of available real estate for project purposes should be considered.	No change	H&H modeling using state-of-the-art techniques to capture inundation in physically realistic manner to guide County RE acquisition and civil design of levees
Impacts to the Greenway Trail and other recreation facilities should be avoided to the extent practicable.	No change. DID 1 levee will concentrate flood flows on right side of floodplain continuing to impact Greenway trail.	Project will draw high flows to left side of floodplain away from Greenway trail, reducing O&M needs for trail

Ensure continued access for levee maintenance and flood fights.	No change. Levee not in PL84-99 no federal flood fighting or rehab assistance.	Levee will be in PL84-99 & eligible for federal flood fighting & rehab assistance. Levee being designed in cooperation with Yakima County and USACE Emergency Managers.

4.3.3 Water Quality

Section 303(d) of the Clean Water Act requires states to identify waters where water quality standards are not being met. The Yakima Valley watershed is on the state's 303(d) list of impaired waters for fecal coliform, temperature, suspended sediments, toxic chemicals, reduced dissolved oxygen, and sulfur and nitrogen compounds (Ecology 2014a). Many of these parameters are interconnected, such as the fact that warmer waters cannot hold as much oxygen. High nitrogen can lead to increased algae growth which influences dissolved oxygen as well.

Potential sources of fecal coliform include wildlife feeding areas; livestock farms; stormwater runoff; septic systems; and wastewater treatment facilities. Lack of riparian shade, excessive sediment load, and low stream flow can increase stream temperature. The toxic chemicals found are typically banned pesticides or PCBs (polychlorinated biphenyls) which get into the water when contaminated soil erodes and enters the water.

Water quality is improving in the area. In 1993, the level of toxics in the water led the Department of Health to set a fish consumption advisory for the Yakima River. Ecology established limits on pollutant inputs in 1997 and worked with farmers and other land users in the watershed to implement these changes (Ecology 2014). By 2009, conditions had improved enough that the fish consumption advisory was lifted (DOH 2009).

In portions of the study area, water quality is diminished by the existing conditions. Irregular flow through Blue Slough and the sections barren of riparian growth along this channel cause warm summer water temperatures and high volumes of milfoil, algae, and duckweed. The gravel ponds are disconnected from the river, fed largely by runoff and groundwater.

Approximately 450,000 acres of land are currently irrigated from the Yakima River and its tributaries (USBR and Ecology 2012). Irrigation has created a strong agricultural economy in the basin. This irrigation is heavily dependent on the timing of spring and summer runoff from snowmelt and rain events. However, demand for irrigation water by existing users significantly exceeds supply in dry and drought years, leading to severe rationing for junior water rights holders (USBR and Ecology 2012). Water rights in the basin are fully appropriated, making it difficult to acquire water rights to meet future municipal and domestic water demand.

Climate change projections indicate that there would be changes in runoff and streamflow patterns, which would increase the need for rationing and reduce flows for fish (EPA 2014b, USBR and Ecology 2012).

4.3.3.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition the regulations implemented by Ecology are expected to continue. Improvements to water quality throughout the basin would also be expected to continue. However, existing conditions at the project sites would be expected to be maintained. The continued disconnection from the river of Blue Slough and the gravel ponds is expected to maintain the existing poor water quality at these sites.

4.3.3.2 Action Alternatives/Future With-Project Conditions

Alternatives 5a and 9

Alternatives 5a and 9 would provide long-term incremental water quality improvements as a result of the restoration plan. The reconnected floodplain and associated wetlands would remove nutrients, suspended sediment, metals, and bacteria, and help moderate the temperature of the water. Plants would filter receding floodwaters, trapping fine-grained sediments and capturing pollutants. Fecal coliform bacteria adsorbed to particulates would be retained in the onsite wetlands and floodplains, promoting bacteria die-off, since many of the microorganisms associated with fecal matter cannot survive for long periods of time without a host organism (Hemond and Benoit 1988, Johnston et al., 1990). The increased floodplain connections and inundation would also result in increased groundwater recharge and subsequent discharge that could provide cooler water to the river during low flows.

Temporary impacts to water quality, mainly turbidity, may occur during construction of the project. Impacts would be minimized by isolating construction activities prior to making a connection to the river. The largest impact would occur during the connection of the Sportsman Island channel with the river, resulting in short term turbidity increases as the channel adjusts to the new flow. Localized shifting of sediments would continue sporadically as the side channels adjust.

In order to reduce temporary increases in turbidity and potential related effects on juvenile salmonids, all 'in-water' construction work in salmonid accessible waters would take place during the established fish window (June 1 – September 15), during which spawning or incubating salmonids are least likely to be present. Construction techniques, sequencing, and timing would minimize soil disturbance to the extent practical to reduce the generation of turbidity during connection of the new channels. Similarly, the design and implementation of the erosion-control and the Storm Water Pollution Prevention (SWPPP) plans would incorporate Best Management Practices (BMPs), such as installation of silt fences, placement of staging areas in uplands, minimizing the number of trips heavy equipment makes through the site, and revegetation of disturbed areas to further reduce the duration and magnitude of the

temporary increases in turbidity. Turbidity monitoring during construction would ensure that these temporary increases are in compliance with State Water Quality Standards.

Cumulative Effects

The short-term cumulative effects to water quality during and immediately following construction of either of the action alternatives would not be significant, and would end soon after construction is complete. Long-term cumulative effects are anticipated to be an overall benefit to water quality in the Yakima River, Blue Slough and Spring Creek.

4.3.4 Air Quality and Greenhouse Gas Emissions

Air quality in the lower Yakima Basin in Yakima County is within the Environmental Protection Agency's (EPA) standards for all air quality parameters (EPA 2008). Areas of the country where air pollution levels persistently exceed the national ambient air quality standards are designated as "non-attainment" areas. Additional pollution controls are placed on non-attainment areas by the EPA, as required by the Clean Air Act. After monitoring shows that a non-attainment area is meeting standards, the area can be redesignated as a "maintenance area." The project area includes maintenance areas for particulate matter and carbon monoxide.

Greenhouse gases (GHG) are gases that act to trap heat in the atmosphere. These include carbon dioxide, nitrous oxide, methane, and several others. Human activities, such as the burning of fossil fuels, can increase the amounts of certain GHGs in the atmosphere.

Emissions of carbon dioxide from hauling activities is the largest GHG producer expected with the implementation of the project. Estimating the total quantity of emissions and GHGs that each alternative may produce would require extensive analysis and numerous assumptions about each site's final design and construction details, such as types of equipment, location of quarries, etc. These details are unknown at this time and would likely be similar across each alternative; therefore the largest difference between the alternatives is the quantity of material to be hauled. Qualitative comparisons of the alternatives can therefore be drawn by comparing the relative quantities of material needed.

4.3.4.1 No-Action Alternative/Future Without-Project Conditions

GHG emissions would not be expected to increase or decrease as a result of the No-Action Alternative. With no construction effort associated with the No Action, no impact to air quality would occur.

4.3.4.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Construction activities required for implementation of Alternative 5a would have short term effects to air quality. Machinery and equipment employed for the construction of Alternative 5a would release

emissions, including greenhouse gases. Equipment such as dump trucks and front-end loaders would have mufflers and exhaust systems in accordance with state and federal standards. Overall, adverse impacts from construction would be localized, minor, and temporary. The potential impacts on air quality from construction activities would be from PM (fugitive dust) and emissions from vehicle exhaust generated from earth-moving operations during construction. During the phased approximately 6 month construction duration, total emissions have been estimated using the Road Construction Emissions Model, Version 7.1.5.1 (Sacramento 2016). Based on the results from the emissions model, this alternative would remain well below the *de minimis* thresholds and would be exempted pursuant to 40 CFR § 93.153(c)(2)(ix) from the requirement of a conformity determination (Table 4-6). In addition, CO_2 is estimated to be 1,464 tons for the entire construction period that is well below the CO_2-equivalent of 25,000 metric tons to require a GHG assessment.

Table 4-6. Estimated Emissions Generated by Construction of Alternative 5a.

	CO	NO_x	PM_{10}	$PM_{2.5}$	SOx	CO_2	CH_4	N_2O	GHG[1]
Total (tons)	5.32	8.35	5.80	1.45	0.01	1463.96	0.43	0.01	1464.40
Threshold	*100*[a]	*100*[a]	*100*[a]	*100*[a]	*250*[b]	-	-	-	*25,000*[c]

1 – GHG = Greenhouse Gas and here represents the sum of CO2, CH4, and N2O emissions as CO2-equivalent GHG emissions.

a – Maintenance area *de minimis* threshold (40 CFR 93.153).

b – Attainment area. PSD new major source definition (40 CFR 52.21) shown for comparison purposes.

c – CEQ benchmark of 25,000 metric tons total. (Sutley, 2010).

Alternative 9

If Alternative 9 is implemented, we would expect slightly higher levels of emissions during construction activities. Based on the emissions estimates for Alternative 5a, we would expect levels for Alternative 9 to also be well below *de minimis* thresholds for air quality and well below CO_2 levels that would require a GHG assessment.

Cumulative Effects

Since emissions would cease following construction completion, no adverse cumulative effects to air quality or GHG emissions would occur from the implementation of the proposed project

4.3.5 Climate Change

Temperatures increased across the region from 1895 to 2011, with a regionally averaged warming of about 1.3°F. An increase in average annual temperature of 3.3°F to 9.7°F is projected by 2070 to 2099 (Meillo et al. 2014). Precipitation may vary slightly, but the magnitude and direction are uncertain (Raymond et al. 2013).

4.3.5.1 No-Action Alternative/Future Without-Project Conditions

Climate change is expected to cause continued decline in snowpack and earlier snowmelt resulting in reduced water supplies in the Yakima River. Observations suggests that this process is already underway (Mote et al., 2005; *in* Vano et al.; 2009). The Cascade Mountains, from which the Yakima River drains, are likely to lose about 20% of their April 1st snowpack with 1°C (1.8°F) of warming (Casola et al., 2008 *in* Vano et al., 2009). The snowpack acts as a natural water storage for the area, with spring and summer runoff occurring when there is little rain. Loss of snowpack could have important consequences to the timing of runoff and the amount of water available in rivers and streams throughout the year (EPA 2014b).

Climate change forecasts for the Yakima Basin predict that the basin would become rain dominated by 2080, increasing peak flows and changing the timing of peak flows from the spring to winter. This would likely be coupled with increased sediment delivery (due to more rain on bare ground) in the winter and higher rates of flood disturbance (reduced snowpack). In the summer, higher temperatures and reduced flow availability would have significant effects on habitat and species composition. The main river channel flow is augmented during the hottest months by reservoir releases; however, some forecasts indicate water shortages are possible, which could significantly impact species adapted to the current seasonality. Due to planned reservoir storage increases, the impacts on the basin may be buffered somewhat. While vegetation growth would increase complexity in the river and floodplain, disconnected wetlands in the project area would be degraded by expected temperature increases. The DID #1 levee is in poor condition, and breaching is likely in a 50 year period of analysis. Development behind the levee is likely to remain at status quo levels. Flood risks would increase with time due to increased peak flood magnitudes and frequencies.

With climate change, increased air temperatures and reduced summer streamflows would have major impacts on the ecology of Blue Slough. It would likely dry up for more of the year, and when flow is present it may be too warm to provide habitat for salmonids. Wintertime floods would cause groundwater elevations to increase modestly, which could increase overall flows in the slough in wet months. Hydraulic conditions in the channel may change with the hydrology, but any guesses as to the direction are speculative without additional modeling. For the sake of convenience, it is assumed that the hydraulic and geomorphic conditions remain unchanged in the 50-year period.

4.3.5.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Due to the large predicted change in with-project flood elevations and increase in inundation in the restored area during low flows, it is assumed that the effects of Alternative 5a would initially outweigh those of climate change in the period of analysis. For example, while river temperatures would increase with time, they would still remain much colder and better oxygenated than that of isolated floodplain ponds and wetlands. Thus, diversion of the river into the floodplain is expected to improve conditions in

the Newland ponds area and adjacent wetlands, even with expected temperature increases. Similarly the increases in flood frequency and magnitude expected from climate change are initially expected to be offset by the reduction in flood elevations caused by the large change in conveyance area resulting from setting back the levee.

By replacing the existing headgate and associated culvert on Blue Slough with an automated headgate and corresponding culvert (see description of Measures 4.0 in Section 3.3), flow frequency, duration, and depths would be increased in the slough. Because flows would be controlled, the frequency of flood disturbance would not be high; however, seasonal inundation of near bank vegetation would occur more frequently. A more reliable supply of water would promote riparian vegetation establishment and eventually large wood recruitment. Vegetation would buffer the slough from local land uses, and improved hydrology would enhance adjacent wetlands. Without diverting flow into Blue Slough, there is a higher risk of it running dry or becoming too warm for salmonid use. With the headgate in operation, flow can be optimized to offset these impacts.

Alternative 9

Effects of climate change for Alternative 9 would be similar to those described in Alternative 5a, but on a slightly larger scale.

4.4 Biological Environment

This section provides an analysis of the existing and future without-project condition of the significant biological resources in the study area, as well as how each alternative would affect these resources.

4.4.1 Fish

At least 48 fish species have been reported in the subbasin (Freudenthal et al. 2005). Three salmonid species (brook trout, *Salvelinus fontinalis*; lake trout, *S. namaycush*; brown trout, *Salmo trutta*) have been introduced, along with a variety of sunfish, perch, catfish, and minnow species. Before the introduction of exotics, northern pikeminnow (*Ptychocheilus oregonensis*), sculpin (*Cottus* spp.), bull trout (*Salvelinus confluentus*), rainbow trout (*Oncorhyncus mykiss*), cutthroat trout (*O. clarkii lewisi*), and burbot (*Lota lota*) were the primary piscivores in the subbasin. Other species of importance within the Yakima subbasin include spring and fall Chinook salmon (*O. tshawytscha*), reintroduced coho salmon (*O. kisutch*), and Pacific lamprey (*Lampetra tridentata*). The Gap to Gap reach is the lowermost portion of the mainstem Yakima thermally suitable for year-round rearing of salmonids (YSFWPB 2004).

Historically, the Yakima Basin produced robust annual runs of chinook, sockeye (*O. nerka*), chum (*O. keta*), and coho salmon and steelhead (*O. mykiss*). Many different stocks or life history types existed because of the diverse physiography of the basin (Stanford et Al., 2002). The decline of salmonids in the Yakima Basin occurred in two phases. From 1850 through roughly 1900, Yakima runs declined about 90% (Freudenthal et al. 2005). From 1900 to the present, native sockeye, coho, and summer Chinook were extirpated, and the abundance of the other stocks fell significantly. The major cause of decline in

the catastrophic first phase was the diversion of water from the river for irrigation, although over-harvest also played a role (Freudenthal et al., 2005). More than 100 years of development for irrigated agriculture, municipalities, gravel mines, and transportation infrastructure has altered flow regimes, floodplains, and riparian areas, and has severely affected native fish habitat (Freudenthal et al., 2005).

The floodplains of the Yakima River were important for spawning and rearing of salmonids (Snyder and Stanford 2001 *in* Stanford et al., 2002). These flood plains have been substantially degraded due to: revetments that disconnect main and side channel habitats; dewatering associated with irrigation; chemical and thermal pollution; and extensive gravel mining that has severed groundwater-channel connectivity, increased thermal loading, and increased opportunities for nonnative species (Stanford 2002).

4.4.1.1 No-Action Alternative/Future Without-Project Conditions

As noted in Section 4.2, many stakeholders have been actively designing and implementing restoration projects in the Yakima Basin. However, the project area and other portions of the lower river would continue to be isolated from its historic floodplain and distributary channels by levees. Off-channel habitat (i.e., wetted habitat that still maintains a surface hydrological connection, but is out of the high flow channel) used for rearing and refuge functions would be scarce. The mosaic of habitats (forested islands, riparian areas, wetlands, off-channel, and mainstem) would continue to be altered, not meeting the habitat needs of native fish and a variety of other aquatic related species such as mink, amphibians ,and waterfowl.

4.4.1.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Alternative 5a would reconnect over 320 acres of floodplain and restore natural riverine processes beneficial to native fish through the realignment of the DID#1 levee. Pools, riffles, boulders, logjams, side channels, wetlands, and other features would be reconnected with the floodplain and the river. Realignment of the levee would improve fish habitat by giving the river channel the opportunity to migrate and promote bar, island, and side channel formation.

This alternative would also create and restore approximately 20 acres of side channel habitat at the Sportsman's Park Island that is currently lacking in this reach of the Yakima River. Side and back channels would have lower water velocities during floods, providing valuable fish habitat, and act as storage areas for sediment in the watershed. As these channels experience flooding, erosion, sedimentation, and debris recruitment, the size and position of the channels, including potentially the mainstem river, would change. Maturation of native tree and shrub species in the restored riparian and floodplain habitat would contribute to the long-term recruitment of large wood into the river to further promote and maintain channel processes.

Trees and woody vegetation cleared from channel or floodplain grading would be placed in the gravel pits (Newland ponds) with root wads and attached limbs. This material would be partially ballasted with excavated floodplain sediment to create large scale hydraulic roughness, dissipate energy, increase channel stability, and improve habitat in the ponds. Some of the wood would float freely and be held in place by partially or fully buried trees and logs. Enough material would be used that it would be redundant even if portions were lost to floods. Incorporation of large wood into the pit capture mitigation design would constitute a beneficial reuse of the clearing debris because it improves the habitat value of the ponds by increasing shading (temperature control), cover (juvenile rearing) and substrate and hydraulic diversity (complexity, primary productivity), and reduces reliance upon river bedload to fill the ponds.

Restoration of flow to Blue Slough would restore surface water hydrology to 2 miles/12 acres of relic channel that currently is only wet seasonally when ground water elevations are high. Replacing the existing culvert in-kind and upgrading the slide gate to an automatic flow controlled gate (Rubicon Slip-Meter or equivalent) would ensure the flows do not exceed thresholds that would result in downstream flooding. Upgrades to the culvert entrance include removal of accumulated sediment and debris, installation of a trash rack, and installation of flow control weirs to ensure adequate head at low flows is available. At the outlet the existing energy dissipater would be replaced with a large pre-formed scour pool lined with riprap or large river cobbles to dissipate energy at the culvert outlet, and provide resting areas to allow adult salmonids access to the culvert. A flow control weir would be added at the outlet of the scour pool to partially backwater the culvert outlet to facilitate upstream passage at low flows by juvenile salmonids.

Currently, the outlet of Spring Creek consists of an approximate 3 foot waterfall into a former gravel pit. Thus, valuable spawning and rearing habitat is disconnected from the Yakima River, preventing fish access to the fresh, cold water of Spring Creek. The reconnection of the Spring Creek would restore fish access to rare cold water off-channel fish habitat.

Alternative 9

Alternative 9 would have the same fish benefits as described in Alternative 5a, but could also provide more area for the mainstem river channel to migrate. Flooding of the larger area would provide additional exchange of nutrients and organic material between land and water, thus increasing habitat complexity via food subsidies and large wood.

Cumulative Effects

This project combined with other future federal, state, and local restoration projects would result in long-term, cumulative benefits to the amount and functional value of restored fish habitat,

improvements in the overall watershed condition, and would ultimately increase the ability of the river to support critical life history stages of native fish populations.

4.4.2 Wildlife

Due to its diverse vegetative and geologic features, 390 wildlife species have been identified in the Yakima Subbasin (YSFWPB 2004). The area supports 22 reptiles and 23 amphibians (YSFWPB 2004). Amphibians surveys on the Yakama reservation have found the tailed frog (*Ascaphus truei*), western toad (*Bufo boreas*), Oregon spotted frog (*Rana pretiosa*), Columbia spotted frog (*Rana luteiventris*), Larch Mountain salamander (*Plethodon larselli*), Northwestern salamander (*Ambystoma gracile*), Cascade frog (*Rana cascadae*), rough-skinned newt (*Taricha granulosa*), long-toed salamander (*Ambystoma macrodactylum*), and Pacific tree (chorus) frog (*Hyla regilla*) (Yakama Nation, 2014).

Passerine birds, raptors, waterfowl, and uplands birds account for 247 of the subbasin wildlife species, including migrant and resident species (YSFWPB 2004). The subbasin is an important nesting area for many neo-tropical species and is a component of the Pacific Flyway. The area produces a significant portion of all wood ducks (*Aix sponsa*) hatched in the state, as well as mallards (*Anas platyrhynchos*), Canada geese (*Branta canadensis*), and other duck species. Wintering populations of waterfowl have decreased over the past 30 years; however, the area continues to host many thousands of duck and geese each winter (YSFWPB 2004). Wintering waterfowl are concentrated in the Lower Yakima Basin where they feed in many agricultural areas.

Washington State hosts resident and migrant bald eagles, which occupy wintering ranges from late October until late March. They are common breeders along lakes, rivers, marshes, or other wetland areas west of the Cascades, but are uncommon breeders along major rivers and lakes in eastern Washington. A query of the Washington Department of Fish and Wildlife (2014) Priority Habitats and Species Database indicates that no bald eagle nests are currently located at the project sites, though a communal roost is located just upstream of the sewage treatment plant.

Ninety-eight large and small mammals are found in the subbasin (YSFWPB 2004). Loss of habitat has drastically reduced numbers of western gray squirrel (*Sciurus griseus*) such that the species is now on the state threatened list. Several species of big game inhabit the Yakima Basin, including black bear (*Ursus americanus*), black-tailed deer (*Odocoileus hemionus columbianus*), mule deer (*O. hemionus hemionus*), Rocky Mountain elk (*Cervus elaphus nelsoni*), bighorn sheep (*Ovis canadensis*), mountain goats (*Oreamnos americanus*), and cougar (*Puma concolor*). Bighorn sheep were reintroduced over 40 years ago, and inhabit the canyons and ridges between Selah/Naches and Ellensburg. Extensive trapping lead to the decline of beavers (*Castor canadensis*) in Washington; however, with decreased hunting and habitat improvements, populations have recovered.

4.4.2.1 No-Action Alternative/Future Without-Project Conditions

As noted in Section 4.2, many stakeholders have been actively designing and implementing restoration projects in the Yakima Basin. These are largely focused on fish habitat improvements; however, they also improve riparian habitat for terrestrial wildlife. Incremental improvements for wildlife are expected within the Yakima Basin. However, at the proposed sites, the No Action Alternative would maintain the degraded habitat for the foreseeable future.

4.4.2.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

If Alternative 5a is implemented, over 320 acres of floodplain would be reconnected to the river and 20 acres of side channel would be created or restored, and Spring Creek would be reconnected to the river. The reconnected floodplain, including riparian and wetland habitat, would be restored through levee realignment and natural riverine processes, benefitting many species of wildlife. Over time, the restored riparian zone would further benefit the Yakima River and new side channels by providing shading and input of large and small woody debris and other detritus and insects, further contributing to cover, habitat diversity, and the riverine food web. The restored riparian zone would also improve wildlife migratory corridors and provide cover and nesting/foraging habitats.

At the time of construction, wildlife may be temporarily displaced due to the noise and movement of the machinery. Vegetation clearing, earthwork, and debris removal may impact foraging or nesting grounds for amphibians, reptiles, birds, and small mammals. However, these effects would be temporary, and displaced wildlife would be expected to return to the area after construction is completed.

Alternative 9

Alternative 9 would provide similar benefits and temporary impacts to wildlife as described in Alternative 5a, but on a slightly larger scale.

Cumulative Effects

This project combined with other future federal, state, and local restoration projects would result in long-term, cumulative benefits to the amount and functional value of restored wildlife habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the river basin to support critical life history stages of native wildlife populations.

4.4.3 Vegetation (Wetland, Riparian)

Vegetation across the Yakima Subbasin is a mixture of forest, grassland (shrub/steppe), and croplands. Historically the Yakima Valley was shrub-steppe habitat. Today 95% of that habitat has been converted

to cropland and grazing (YSFWPB 2004). Riparian and wetland conditions in the Yakima Subbasin range from severely degraded to high quality depending on the level of impact by human activities. Impacts include hydrologic alteration, land use conversion, agricultural practices, levees, and urban development projects, resulting in constriction of floodplains and reduced riparian wetland habitats. Irrigation needs have led to stream side-channels and distributaries being converted to canals and drains where timing of flows been highly altered, causing loss of natural function (YSFWPB 2004). Loss of native vegetation and replacement by non-native species is the result of these widespread hydrologic alterations.

Riparian habitat, including wetlands, covers a relatively small area of the basin, yet it supports a higher diversity and abundance of fish and wildlife than any other habitat (YSFWPB 2004). Riparian habitat provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors. It has important social values, including water purification, flood control, recreation, and aesthetics; however, it is highly vulnerable to alteration. Riparian habitat has been lost on a large scale because floodplains have been converted to human uses, such as development, irrigated agriculture, pasture, or gravel mining.

Historical changes in riparian forest communities and the relationship between river baseflow stage and riparian species composition and age class have been documented on the Yakima River (BPA 2001). The researchers studied the Union Gap reach, which encompasses the study area, documenting significant declines in riparian forest health and extent from pre-settlement conditions (421 ha in 2001 vs. 2325 pre-settlement) and attributed the loss to revetment construction, land clearing, and flow regime alterations. The current flow regime (high stages that inundate nursery areas) has a negative effect on cottonwood seedling recruitment. Vigorous mature cottonwood stands were observed growing closer to the water edge than typical, with a higher percentage of non-native invasives due to the urban/agricultural proximity. Emergent willows and cottonwoods were infrequent.

4.4.3.1 No-Action Alternative/Future Without-Project Conditions

As noted in Section 4.2, many stakeholders have been actively designing and implementing restoration projects in the Yakima Basin. These include improvements to riparian and wetland habitat. Incremental improvements to riparian vegetation and wetlands are expected within the Yakima Basin. However, at the proposed sites the No Action Alternative would maintain the degraded and disconnected habitat for the foreseeable future.

4.4.3.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Based on the USFWS National Wetland Inventory (NWI) maps, there is an assemblage of different wetland types on the DID#1 portion of the site (USFWS 2016). All work to remove the DID#1 levee would occur in the footprint of the levee prism, thus no impacts to wetlands would occur. The current design path of the realigned levee appears to avoid impacts to the various segmented wetlands and Blue

Slough. As design progresses, the alignment would be field verified to ensure wetland and vegetation impacts are avoided or minimized to the greatest extent practicable.

For the DID#1 levee removal, revegetation would consist of the hydroseeding of erosion-control grasses to minimize the invasion of invasive species. Native tree and shrub species are expected to naturally recruit due to adequate seed sources nearby. Plans for the realigned DID#1 levee would include a more robust vegetation planting plan. The new levee prism would be hydroseeded on the landward side with native grasses. On the riverward side, native grass seed mix would be used to hydroseed where riprap for erosion control is not necessary. For ecological and erosion benefits, the area riverside of the setback levee would be planted with native shrub and/or tree species up to 15 feet beyond the toe. Cottonwood saplings would be planted at the riverward extent of the shrubby tree planting.

As for the Sportsman's Park Island, construction impacts to vegetation would include clearing of the channel footprint (20 acres). The proposed channel is surrounded by riparian vegetation including cottonwood and native shrub species (e.g., golden current, coyote willow, rose sp., etc.). It is likely that following construction of the channel, regrade and natural processes would engage the channel and native cottonwood and shrub species would begin to populate the area naturally. Therefore, no planting plan would be necessary at this site.

Implementation of Alternative 5a would greatly benefit riparian zones and wetlands in this reach of the Yakima. At the DID#1 site, reconnection of over 320 acres of floodplain would restore hydrology and recruit native vegetation species to create an assemblage of mixed riparian and wetland habitats. The proposed restoration would result in improvement of existing wetland and riparian zones through channel creation and restoration at Sportsman's Park Island. Once hydrology is restored at Blue Slough, riparian and/or wetland vegetation is expected to recruit.

Alternative 9

In addition to the effects from Alternative 5a, there would be more clearing of riparian vegetation required for the WSDOT pilot channels. The cleared area would be surrounded by riparian vegetation, including cottonwood and shrub species, thus it is likely that following construction of the channels, regrade, and natural processes would engage the channels and native cottonwood and shrub species would begin to populate the area naturally. Therefore, no planting plan would be necessary at this site.

Cumulative Effects

The Corps anticipates no significant adverse cumulative effects to vegetation to accrue from any of the alternatives. Restoration of riparian and wetland vegetation in the Gap to Gap Reach would add to the work of Yakima County, City of Yakima, Yakama Nation, USBR, and WSDOT. Reconnection of floodplain, side channel creation and restoration, and restored hydrology would recruit native vegetation species to create an assemblage of mixed riparian and wetland habitats at the project sites. These beneficial

impacts to vegetation would provide cumulative benefits to the overall biodiversity of the vegetation communities in the Gap to Gap Reach.

4.4.4 Rare, Threatened, and Endangered Species

In accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed and proposed threatened or endangered species. Three species listed as threatened are potentially found in the area of the project (Table 4-7).

Table 4-7. ESA-listed Species in Project Vicinity

Species	Listed Status	Critical Habitat
Columbia River Bull Trout *Salvelinus confluentus*	Threatened	Designated
Middle Columbia River Steelhead *Oncorhynchus mykiss gairdneri*	Threatened	Designated
Yellow-billed Cuckoo *Coccyzus americanus*	Threatened	Proposed

Other listed species and critical habitat may occur in Yakima County, but would not be affected by the proposed actions, because of intolerance of human activity, specialized habitat requirements, or both. These species include the Canada lynx (*Lynx canadensis*), grizzly bear (*Ursus arctos horribilis*), marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and Ute ladies-tresses (*Spiranthes diluvialis*). The Canada lynx is a reclusive species that is very unlikely in the urbanized project vicinity. Presence of grizzly bear in Washington is not well documented and it is likely scarce. As with Canada lynx, this species is also reclusive and is very unlikely to be found in the urban project environment. Marbled murrelet nests in old-growth forest and feeds in marine environment. No designated critical habitat for this species is located within Yakima County. As no suitable habitat exists at the project site, they are not expected to be in the project vicinity. Northern spotted owl require old-growth forest for nesting and feeding. There is no designated critical habitat for northern spotted owl in Yakima County and they are not expected to be in the urbanized project area. Ute ladies-tresses is found in wetlands, mesic to wet meadows, floodplains, and possibly continuously wet gravel bars. In Washington, Ute ladies-tresses is known only in Chelan and Okanogan counties (NatureServe Explorer 2012) and is not expected to be found in the project vicinity.

Columbia River Bull Trout

The USFWS listed the Columbia River population of bull trout as threatened effective 10 July 1998 and the threatened status was reaffirmed in 2008 (USFWS 2008). Bull trout are estimated to presently occur in 45% of their estimated historical range (Quigley and Arbelbide 1997). The USFWS indicated that, aside from the Rimrock subpopulation, the Yakima drainage subpopulations were considered depressed. WDFW (2002) termed most of the Yakima basin stocks as "critical." The Yakima River is designated as critical habitat for bull trout (USFWS 2010).

The Yakima River supports fluvial bull trout which spawn and rear in smaller tributaries and then move downstream into the mainstem where major growth and maturation occur. Spawning occurs from August to December during periods of decreasing water temperature. Incubation is normally 100 to 145 days and fry normally emerge from April to May, depending on stream flows and water temperature (YSFWPB 2004).

USFWS (2008) estimates the population in the Yakima River to be between 250-1000, noting a very rapid decline of the population and ranking the population as in substantial imminent threat. WDFW (2002) identifies the presence of bull trout in the project area; however, spawning and rearing activity are not currently documented in the project vicinity. The Columbia River/Klamath draft bull trout recovery plan (USFWS 2002) indicated that only four bull trout had been found in the mainstem Yakima River, in surveys conducted since 1990. However, based at least on WDFW (2011a), it is assumed for purposes of these actions that bull trout could be present in the project vicinity when water temperatures are suitable.

Middle Columbia River Steelhead

The Middle Columbia River population of steelhead was listed as a threatened species on 25 March 1999, and the threatened status was reaffirmed on January 5, 2006 (NMFS 2006). NMFS (2006) cites continued low returns of Yakima steelhead, at about 10% of interim recovery target, as a source of concern. The Yakima River is designated as critical habitat for steelhead (NMFS 2005).

Summer run steelhead enter the river between May and October. During this time, they rarely eat and grow very little. Adults cease movement in the cold winter months and then resume migration in February and March. Generally, spawning of Yakima summer steelhead occurs early March-early June. Most spawning occurs in tributaries to the Yakima (YSFWPB 2004). Fry emergence occurs in early June through early July. Rearing occurs in the natal stream until the following October, when juveniles migrate to lower positions in the basin.

Steelhead escapements into the Upper Yakima River, despite having increased from 2005-2011, remain very low relative to the total amount of habitat available (NMFS 2011). The overall viability ratings improved for steelhead in Satus Creek and Toppenish Creek, but remained at maintained status for the Naches River and at high risk for the Upper Yakima River (NMFS 2011). Despite significant efforts to

improve habitat conditions in the range of MCR steelhead, much of the habitat remains degraded. NMFS (2011) notes that in particular, the poor status of the habitat and populations in the Yakima Basin are a major obstacle to achieving viability for this population.

Yellow-billed Cuckoo

The western DPS of the yellow-billed cuckoo was listed as federally threatened on October 3, 2014 (USFWS 2014). The western yellow-billed cuckoo is a neotropical migrant bird that winters in South America and breeds in western North America. Historically, yellow-billed cuckoos nested in riparian woodlands along rivers in eastern Washington, as well as in various locations in western Washington. The last confirmed breeding records for the species in the state are from the 1930s, and it is likely the species is extirpated as a breeder (USFWS, 2013). Western yellow-billed cuckoos breed in large blocks of riparian habitat, particularly woodlands with cottonwoods and willows (USFWS 2013). The subspecies' preferred habitat contains a combination of a dense willow understory for nesting and a cottonwood overstory for foraging (Gaines and Laymon 1984). Most nesting in the western region occurs between June and early August, but can extend from late May until late September (Hughes 1999). Critical habitat is proposed, but not designated, for the yellow-billed cuckoo (USFWS 2014).

Although several recent surveys have been conducted in Okanogan and Yakima Counties to check locations of previous sightings (Okanogan County) and potential habitat (Yakima County), no cuckoos were detected, despite a small number of statewide accounts in recent years (USFWS 2013). No nesting has been recorded in Washington; however, in eastern Washington, individual cuckoos have been occasionally sighted during summer (WDFW 2013). Recent sightings of individuals have been recorded in 2012 and 2015 in northern Washington (Martha Jensen, USFWS, personal communication, March 2016). None of the sightings are located in Yakima County. Based on this information, western yellow-billed cuckoos are extremely unlikely to be present in the action area.

4.4.4.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition, ESA-listed salmonid species would continue to face obstacles to recovery. Limiting factors such as low stream flows, disconnected side channels, lack of accessible floodplain habitat, and lack of large wood must be addressed in order to recover and sustain listed species. As noted in Section 4.2, many stakeholders have been actively designing and implementing restoration projects in the Yakima Basin. These actions would continue to make incremental improvements to the habitat for listed fish in the Yakima River. However, as noted by NMFS (2011), further improvements are needed to help recover steelhead populations. Additionally, the rapid decline of bull trout also indicates the need for continued habitat improvements. The No Action Alternative would maintain the degraded habitat for the foreseeable future at the project sites.

The No-Action alternative would have no effect on yellow-billed cuckoo.

4.4.4.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Alternative 5a would reconnect 320 acres of floodplain and restore natural riverine processes beneficial to listed fish through the realignment of the DID#1 levee. Pools, riffles, boulders, logjams, side channels, wetlands, and other features would be reconnected with the floodplain and the river. Realignment of the levee would improve fish habitat by giving the river channel the opportunity to migrate and promote bar, island, and side channel formation.

This alternative would also create and restore approximately 20 acres of side channel habitat at the Sportsman's Park Island that is currently lacking in this reach of the Yakima River. Side and back channels would have lower water velocities during floods, providing valuable fish habitat, and act as storage areas for sediment in the watershed. As these channels experience flooding, erosion, sedimentation, and debris recruitment, the size and position of the channels, including the mainstem river, would change. Maturation of native tree and shrub species in the restored riparian and floodplain habitat would contribute to the long-term recruitment of large wood into the river to further promote and maintain channel processes.

Restoration of flow to Blue Slough would restore surface water hydrology to 2 miles/12 acres of relic channel that currently is only wet seasonally when ground water elevations are high. Replacing the existing culvert in-kind and upgrading the slide gate to an automatic flow controlled gate would ensure the flows do not exceed thresholds that would result in downstream flooding. At the outlet, the existing energy dissipater would be replaced with a large pre-formed scour pool lined with riprap or large river cobbles to dissipate energy at the culvert outlet, and provide resting areas to allow listed adult salmonids access to the culvert. A flow control weir would be added at the outlet of the scour pool to partially backwater the culvert outlet to facilitate upstream passage at low flows by listed juvenile salmonids.

Currently, the outlet of Spring Creek consists of an approximate three foot waterfall into a former gravel pit. Thus, valuable spawning and rearing habitat is disconnected from the Yakima River, preventing fish access to the fresh, cold water of Spring Creek. The reconnection of the Spring Creek would restore access to rare cold water off-channel habitat for listed salmonids.

Construction of Alternative 5a would have minimal in-water work and minimal disturbance to salmonids as machinery works to remove the existing levee, construct the new side channel at Sportsman's Park Island, and replace the Blue Slough headgate and culvert. In-water construction would be conducted during the established fish work window to avoid and minimize short-term disturbance to salmonids that may be present during the June 1 – September 15 window. Turbidity is the primary concern for stress to salmonid species during construction. Construction techniques, sequencing, and timing would minimize soil disturbance to the extent practical to reduce the generation of turbidity during connection

of the new Sportsman Park channel. Therefore, Alternative 5a may affect, but is not likely to adversely affect, Middle Columbia River steelhead and Columbia River bull trout or their critical habitat.

Yellow-billed cuckoo are likely extirpated as a breeder in Washington, and vagrant birds are very rarely seen in the state. Use of the site by this species is unlikely; however, yellow-billed cuckoo habitat does occur in the project reach. Most likely use would be as foraging and resting habitat by migrating adults. Construction impacts, such as causing birds to avoid or flee the work area, could occur from tree removal and increased noise and human presence. Construction timing is not yet fully defined, but tree removal would be conducted outside of the most likely period of yellow-billed cuckoo migration in order to reduce impacts. Overall, the project will benefit this species by restoring large tracts of riparian forest which will increase suitable habitat for cuckoos in the reach. Thus, Alternative 5a may affect, but is not likely to adversely affect yellow billed cuckoo.

Alternative 9

Alternative 9 would provide similar benefits and temporary impacts to listed salmonids as described in Alternative 5a, but on a slightly larger scale. No additional effects to yellow-billed cuckoo would be expected from implementation of Alternative 9, as compared to Alternative 5a.

Cumulative Effects

This project, combined with other future federal, state, and local restoration projects, would result in long-term, cumulative benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of listed salmonid populations.

4.5 Cultural Resources

The Corps has determined the area of potential effect (APE) for the Yakima River Gap to Gap Ecosystem Restoration Project to be area of all excavation, feature removal, restoration benefits, as well as all staging and access zones. The APE for both direct and indirect effects encompasses approximately 112 acres. The project APE is located within a region utilized ethnographically by the Yakama Nation. The settlement and land use characteristics of Native American people within this region are largely based on a mixture of early ethnographic accounts and current cultural practices which reflect traditional activities. Permanent winter villages situated along the banks of major regional water courses provided a time and place to gather with families, trade, and fish. As spring arrived, groups traveled to the uplands, gathering medicinal, edible, and other economic plants. During this period, temporary camps would be situated along smaller regional waterways. As root gathering areas matured and became ready for harvesting, groups migrated from low to high elevation ridges (Hunn, 1990). Following this harvest, groups then traveled to traditional fishing places for Chinook salmon runs. In the late spring, as the salmon runs dwindled, people migrated to meadows for the gathering of camas, bitterroot, and other plants. During the mid-to-late summer months, hunting of bighorn sheep, mountain goats, and elk

commenced in the uplands. As the summer runs of salmon and steelhead began, groups migrated towards the river once more. Women gathered and dried berries from gooseberry, golden currant, chokecherry, serviceberry, and dogwood between the salmon runs (Hunn, 1990). As fall approached, some groups returned to camping spots along the Columbia River to harvest fall Chinook salmon and silver salmon runs, while deer and elk hunting began in river-adjacent uplands. As the end of fall neared, people migrated back towards permanent winter villages along the Columbia River to harvest the final salmon runs (Woody 2016).

Initial contact between resident Native American people and Euro-American explorers began in the early 1800s, with interactions becoming more frequent throughout the ensuing decades as a host of fur traders, missionaries, ranchers, and other settlers moved into the region (Ruby and Brown, 1992). Over the first half of the 19th Century, brewing conflicts between the region's Native people and encroaching Euro-American settlers led Governor Isaac Stevens to call for treaty negations to be conducted at the present site of Walla Walla in southeastern Washington State. For several weeks, negotiations between tribal leaders and government representatives carried on, although hampered by a great deal of confusion and misunderstanding brought about by language barriers and differing cultural viewpoints. However, eventually a treaty was drafted and signed, part of which created the Yakama Nation, a sovereign entity comprising 14 formerly-independent tribal bands. The treaty called for the Yakama to cede roughly 29,000 square miles of land, from which 1,875 square miles would be reserved for the sole use of the Yakama (Schuster, 1990). Today these lands remain as the Ceded Lands and the Yakama Nation Reservation, respectively. The Ceded Lands encompass the whole of the Yakima Valley as well as Yakima County.

Settlement of the Yakima Valley by Euro-American populations from the east began slowly. Many of the first white settlers were livestock ranchers, who were lured to the region by the quality and abundance of range and the sage steppe bunchgrasses. However, spurred by the construction of a Northern Pacific Railroad (NPR) line to Yakima City (present day Union Gap) in 1884, white settlement of the region began in earnest. Within a period of months of arriving in the Yakima Valley, the NPR started establishing a new town four miles north of Yakima City. The NPR did not utilize Yakima City as a stop on their rail line and began offering free lots to businesses that moved from old Yakima City to what they called North Yakima (present day Yakima). Almost 100 businesses took up on the NPRs offer and relocated to North Yakima (Meinig, 1968). The relatively fast growth of North Yakima shows that NPR's development strategy was very successful, with the population growing from 1,535 in 1890 to 14,082 in 1910 (Woody 2016).

Although the initial economic driver in the Yakima Valley was centered on livestock ranching, various forms of agriculture would eventually become its mainstay, particularly following the establishment of a significant number of small and large irrigation projects. Walter Granger (1855-1930), an irrigation engineer, was hired by the Northern Pacific Railroad president Thomas Oakes (1843-1919) in 1889 to construct irrigation canals. Although Granger was the first professional irrigation engineer to build canals in the area, endeavors to control and manage floodwaters along the river began as early as 1881.

In 1938 designs for a federal levee system on the Yakima River were completed, but not constructed until after World War II and completed in 1948. The levee system was repaired and extended the following year, after the 1948 flood. The 1948 flood is listed as the fourth largest flood on record and considered to be a 30 year flood event. These works were constructed to protect the urban areas of Yakima and Terrace Heights. A series of large floods during the 1970s prompted further studies by the Corps. Previously constructed levees were raised twice in the 1970s and the 1980s.

During the months of November and December 2015, Field Journal Archaeological Investigations, LLC (FJAI) completed an archaeological field investigation of the proposed Gap to Gap project Area of Potential Effect (APE). Pre-field examination of historic aerial photography dating from 1927, 1947, and 1971 demonstrated significant movement of the Yakima River during this 44-year time span, with the river channel often directly encompassing portions of the project APE components. Given this, a field investigation strategy was developed wherein portions of the project APE which could be readily defined as being directly within the ca. 1971 Yakima River channel would be removed from field investigation consideration. The pedestrian field reconnaissance encompassed an overall area of approximately 225 acres and was subject to 10 meter survey transects, while areas with a proposed subsurface impact were subject to auger probes. Overall, the survey identified three historic structures and one archaeological site within the defined Gap to Gap project APE. These structures consist of the USACE Nob Hill Levee (historic), the USACE KOA/Sportsman Park Levee (historic), the DID#1 Levee (historic), and the remaining support structures of the Moxee Blvd. Bridge (archaeological site 45YA1606).

The Corps has made a reasonable and good faith effort to identify historic properties that may be affected by this undertaking. The Nob Hill Levee, KOA/Sportsman Park Levee, and DID#1 Levee are part of the federally built Yakima levee system. While the levee system was completed in 1948, individual levee segments have been routinely subject to a number of flood events and repairs, which are considered normal and routine in nature. FJAI recommends that these segments are potentially eligible for the NRHP under National Register Criterion A due to their association with early flood control measures in the Yakima area, however the Corps has determined that the individual levee segments do not meet the standards for listing under NRHP, as the routine flood events and repairs in the area have led to a clear loss of integrity through severe erosion as well as changes of prism design and structural material. While the proposed actions slightly alter the alignment of the Yakima levee system, which is potentially eligible for the NRHP, its character defining qualities will remain intact as a flood control structure in the protection of life and property. Based on this information, the Corps has determined the Nob Hill Levee, KOA/Sportsman Park Levee, and DID#1 segments not eligible for listing on the NRHP. The Moxee Blvd. Bridge (45YA1606) consists of concrete abutments found on the east and west margins of the Yakima River, and four round concrete piers found on a gravel bar near the center of the Yakima River Channel. FJAI recommends 45YA1606 as not eligible for the NRHP as there is not enough of the original structure remaining to convey a sense of integrity through appearance or function of the original structure. The Corps has determined that the Moxee Blvd. Bridge is not eligible for the NRHP. The State Historic Preservation Officer agreed with our findings and determinations on August 23rd, 2017.

4.5.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition, known cultural resources within the project APE, such as levees and archaeological sites, would continue to erode naturally due to routine flood activity. The Yakima levee system would continue to require routine maintenance and repair.

4.5.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

If Alternative 5a is implemented, the removal of the levee segments would not change the function of the Yakima levee system, and therefore would cause no adverse effect to historic properties.

Alternative 9

Alternative 9 would provide similar impacts to cultural resources as Alternative 5a.

Cumulative Effects

No significant negative cumulative effects to cultural resources are anticipated to accrue from any of the alternatives.

4.6 Social and Economic Resources

This section presents an overview of major socioeconomic characteristics and trends within the study area, including demographics and economics.

4.6.1 Land Use

The study area includes portions of unincorporated Yakima County, as well as the cities of Yakima, Selah, and Union Gap, which are in the central, northern, and southern portions of the study area, respectively. The unincorporated areas, primarily east of the Yakima River, include the Terrace Heights, Birchfield, and Yakima Sportsman Park areas. Approximately 73% of the parcel acreage within the 100-year floodplain is unincorporated Yakima County, 7% is within the City of Yakima, 7% is within the City of Union Gap, and 13% is within the City of Selah. Population densities in the study area are greatest west of the Yakima River and I-82, where the cities of Selah, Yakima, and Union Gap are located. The largest population density east of the Yakima River is in the Terrace Heights area. Land uses in the floodplain are diverse, and include residential development, light industrial, agriculture, transportation, trade, and recreation.

4.6.1.1 No-Action Alternative/Future Without-Project Conditions

As noted in Section 4.2, many stakeholders have been actively designing and implementing restoration projects in the Yakima Basin. These actions may make incremental changes to land use in the Yakima

River basin as lands adjacent to the river are restored. However, as noted by NMFS (2011), further improvements are needed to help recover steelhead populations. Additionally the rapid decline of bull trout also indicates the need for continued habitat improvements. The No Action Alternative would maintain the degraded habitat for the foreseeable future at the project sites.

4.6.1.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

Upon realignment of the DID#1 levee, land use on the riverward side of the levee would change as the land would be open to the active Yakima River floodplain. Land use in this area would change from residential and mining to recreation. Land use behind the realigned DID#1 levee would continue to be primarily light industrial and rural residential. As described in Section 3.3, the realigned levee would provide the same level of flood protection for adjacent properties and uses as currently exists. As the level of flood protection would not change and the project would not otherwise encumber services or opportunities, there would likely be no change in the use of adjacent industrial or residential uses as a result of the project.

No changes to land use are expected with implementation of the remaining Alternative 5a measures at Sportsman's Island, Blue Slough, and Spring Creek.

Alternative 9

Implementation of Alternative 9 would have no additional effects to land use as compared to Alternative 5a.

Cumulative Effects

No significant negative cumulative effects to land use are anticipated to accrue from any of the alternatives.

4.6.2 Indian Trust Assets

The federal trust responsibility to Native American Tribes arises from the treaties signed between them. Under Article VI, Clause 2 of the U.S. Constitution, treaties with the Tribes are the supreme law of the land, superior to state laws, and equal to federal laws. In these treaties, the United States made a set of commitments in exchange for tribal lands, including the promise that the United States would protect the tribe's people. The Supreme Court has held that these commitments create a trust relationship between the United States and each treaty tribe, and impose upon the government "moral obligations of the highest responsibility and trust." The scope of the federal trust responsibility is broad and incumbent upon all federal agencies. The government has an obligation to protect tribal land, assets, and resources that it holds in trust for the Tribes, and a responsibility to ensure that its actions do not abrogate Tribal treaty rights.

The Yakama Nation has designated U&A harvest areas that reflect the historical region in which finfish, shellfish, and other natural resources were collected. Tribal members are allowed to exercise their treaty-protected harvest rights only within their Tribe's U&A. The Yakama Nation has U&A in the study area.

4.6.2.1 No-Action Alternative/Future Without-Project Conditions

Under the No Action Alternative, as salmon populations continue to decline, the cultural and spiritual identity of the Tribe would be impacted. However, incremental improvements to the habitat for fisheries in the Yakima River have been ongoing and would be expected to continue. As noted by NMFS (2011) and evidenced by the rapid decline of bull trout, further improvements are needed to restore the historic health of the salmonid populations. The No Action Alternative would maintain the status quo at the project sites for the foreseeable future.

4.6.2.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

If Alternative 5a is implemented, over 320 acres of floodplain would be reconnected to the river, 20 acres of side channel would be created or restored, and Spring Creek would be reconnected to the river. The project would restore natural riverine processes throughout the project site beneficial to fish and wildlife. Realignment of the DID1 levee would improve fish habitat by giving the river channel the opportunity to migrate and promote bar, island, and side channel formation. Over time, the restored riparian zone would further benefit the Yakima River and newly constructed or restored side channels by providing shading and input of large and small woody debris and other detritus and insects, further contributing to cover, habitat diversity, and the riverine food web. Blue Slough restoration and Spring Creek reconnection would provide year-round side channel habitat that is lacking in this reach of the river. This alternative would have beneficial impacts to fish and wildlife species important to the Tribe.

Alternative 9

Alternative 9 would provide similar benefits to tribal resources as Alternative 5a.

Cumulative Effects

The proposed project combined with other future federal, state, and local restoration projects would result in long-term, cumulative benefits to the amount and functional value of restored fish and wildlife habitat, improvements in the overall watershed condition, and would ultimately increase the ability of the watershed to support critical life history stages of species important to the Tribe.

4.6.3 Transportation, Utilities, and Public Services

Several highways exist within the project area, to include Interstate 82 (I-82), U.S. Route 12, and State Route 24 (SR-24). In 2012, annual average daily traffic volumes for I-82 in Yakima (both directions) was

44,953 vehicles (WSDOT 2013). As noted in Section 4.2, in 2006 WSDOT widened the span of the SR-24 Bridge by 1,500 feet. This removed a significant constriction on the river to allow for reconnection of floodplain above and below the bridge.

Other utilities and public services in the vicinity of the project site include local and city roads, the City of Yakima Regional Wastewater Treatment Plant (WWTP), as well as power lines, public parks and public greenways. Further information about parks and recreation facilities is provided in Section 4.6.3. The WWTP is located on the right (west) bank of the river just south of the SR-24 bridge. The facility receives wastewater from Yakima, Union Gap, Terrace Heights, and Moxee.

4.6.3.1 No-Action Alternative/Future Without-Project Conditions

As there would be no construction with the No Action Alternative, no impact to transportation, utilities or public services would be expected.

4.6.3.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

During construction activities, vehicles and equipment associated with the project may disrupt local traffic. This increase in traffic would be localized and of short duration, with no long term impacts. A traffic control plan would be developed and implemented to minimize traffic impacts during construction. Realignment of the DID1 levee would retain the existing level of flood protection to residences, businesses, and associated public infrastructure. There would be no impacts to the WWTP during or after construction completion. No significant short or long-term effects to transportation, utilities, and public services would occur from the implementation of Alternative 5a.

Alternative 9

If Alternative 9 is implemented, we would expect similar short-term impacts to transportation. No significant long-term effects would occur to transportation, utilities, and public services.

Cumulative Effects

No significant negative cumulative effects to transportation, utilities, or public services are anticipated.

4.6.4 Recreation and Aesthetics

Several public parks exist in the project vicinity, including the Yakima Greenway Trail, Sportsman State Park, and the Yakima Area Arboretum.

The Yakima Greenway Trail is a 10-mile long walking and biking path that connects the Cities of Yakima and Union Gap. The trail follows the right (west) bank of the river and provides access to the Naches

and Yakima Rivers, lakes, parks, nature trails, protected conservation areas and the Yakima Area Arboretum.

The Sportsman State Park is 247 acres of greenspace along the Yakima River. The Park was created in 1940 by the Yakima Sportsman's Association. The park offers camping, hiking trails, and fishing access to the river and several ponds and lakes on the park property.

The Yakima Area Arboretum is 46 acres of over 1000 specimens of native and adapted non-native trees, forbs, grasses, and shrubs. The Yakima Greenway passes through the Arboretum along the Yakima River.

4.6.4.1 No-Action Alternative/Future Without-Project Conditions

The No Action Alternative would maintain the status quo at the project sites. The degraded habitat at these sites would continue to limit the function of the areas for fish and wildlife, and thereby continue to limit the experience available to visitors.

4.6.4.2 Action Alternatives/Future With-Project Conditions

Alternative 5a

If Alternative 5a is implemented, recreational opportunities would be improved in the project area. The restored floodplain at the DID1 site would improve fish and wildlife habitat, enhancing the recreation and aesthetic experiences available to visitors. Also, the realigned DID1 levee would be available for local residents to walk, run, and bird watch.

Short-term disruptions to recreation would occur during construction. Access to Sportsman's Park and the DID1 levee would be limited to visitors until construction completion.

Alternative 9

Implementation of Alternative 9 would have similar benefits and short-term disruptions to recreation. Short-term disruptions to the Greenway Trail system may also result due to access limitations during construction. These impacts would be temporary and disruption would cease following completion of construction.

Cumulative Effects

No significant negative cumulative effects to recreation or aesthetics are anticipated to accrue from any of the alternatives.

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5. Recommended Plan – Agency Preferred Alternative

The Corps objective in ecosystem restoration planning is to contribute to National Ecosystem Restoration (NER). Contributions to NER (outputs) are increases in the net quantity and/or quality of desired ecosystem resources. The NER Plan must reasonably maximize ecosystem restoration benefits compared to costs, consistent with the federal objective. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. After analysis of all relevant environmental benefits and impacts, the Corps has identified the TSP (NER Plan) as the recommended plan and the preferred alternative per NEPA regulations.

5.1 Description of the Recommended Plan (NER Plan)

The Recommended Plan (Alternative 5a) includes levee removals, spur dike removals, floodplain topographic restoration, side channel construction, hydrologic enhancement of a disconnected floodplain channel, and wetland reconnection. Primarily through removal of fill and replacement of a headgate, hydrologic and habitat connectivity is restored between a stretch of the Yakima River in the Gap to Gap Reach and over 320 acres of its historic floodplain. Work would be completed in four areas, in order of size: the DID#1 Floodplain area, Sportsman Island, Blue Slough, and Spring Creek.

By removing the constraints to the natural flow of the river (i.e., levee material and hardened material in fixed meanders), the Recommended Plan reestablishes the conditions that allow the dynamic processes of channel formation and sediment transport to function naturally, which creates and sustains the habitat conditions suited to the ESA-listed fish and other species native to the Yakima River. Restored anabranching channels provide important rearing and refuge habitat for salmonids, especially important during high flows, as well as increased riparian vegetation which provides forage (insect drop) and cover. Many historic side channels that were disconnected when the levee was constructed are reconnected by the Recommended Plan. The Recommended Plan restores inundation of the historic floodplain, and associated exchange of nutrients and organic and increasing habitat complexity via food subsidies and large wood. The Recommended Plan restores conditions such that this dynamic river system can continue to form and re-form channels as sediment moves around in the system. Alternatives 5 and 9 restore the ecosystem processes that form and sustain riverine habitat, which is key to successful restoration and consistent with Corps restoration policy.

The following measures are included in the Recommended Plan:

Measure 1.0: Diking Improvement District (DID) #1 Floodplain Process Restoration
Measure 1.1: Floodplain Topographic Restoration
Measure 1.2: KOA Floodplain Restoration
Measure 2.0: Sportsman Island Channel Restoration
Measure 2.1: Sportsman Upstream Groin Removal
Measure 2.2: Lake Buchanan Spurs
Measure 4.0: Blue Slough Automated Headgate

Measure 7.0: Spring Creek Reconnection

These measures are described in Section 3.3 and in more detail in Appendix A. The measure construction footprints are depicted below in the plan view images in Figure 5-1 and Figure 5-2.

5.2 Design and Construction Considerations

The Engineering Appendix (Appendix A) provides detailed information on the technical context for project feature design, including investigations completed to date and to be completed in the project Design and Implementation phase. During the design phase, the existing design data, requirements, and constraints will be verified and finalized. This may result in revisions to project feature footprints and elevations. In recognition of the constraints of the project authorization, any changes will be minimized and conducted in accordance with the change management procedures as outlined in the PMP.

On March 3, 2017, a meeting was held to ensure that the concerns of the Project Delivery Team members who represent the Levee Safety program, the Inspection of Completed Works program, and the P.L. 84-99 Assistance program were addressed in the feasibility design with respect to flood risk management features. The results of that meeting included addition of a slide gate to control flow through Blue Slough where it crosses between the two DID #1 setback levee segments, raising the elevation of the two roads that connect the two levee segments (Lester Lane and Unnamed Road), and a commitment to further investigation of the needs for armoring along the waterward side of the west setback levee segment during the revised 35% design phase. Costs were incorporated into the cost estimate for the recommended plan. The Memorandum for Record documenting the 3 March 2017 meeting can be found at Appendix A, Annex E.

Most construction work would need to be completed between mid-June and October when conditions are drier and the ground is not frozen. In-water work will need to occur during the in-water work window of June 1st – September 15th. Construction is expected to last two construction seasons.

5.2.1 Non-Project Features

Part of the proposed design includes a setback levee that ties into a Washington State Department of Transportation (WSDOT) highway, State Route 24 (SR24). The levee segment upstream, Yakima Authorized Left Bank, also ties into this highway. Construction of this project would necessitate use of approximately 1,000 feet of this highway embankment to tie the levee system together. At this time, the highway is anticipated to be suitable to function as a levee. More details can be found in the Engineering Appendix (Appendix A). WSDOT has communicated with Yakima County regarding plans to set back the levee, and the bridge span (replaced in 2007) was designed to accommodate the expanded floodplain. WSDOT has not yet been approached regarding the implications of their highway becoming part of the levee system with respect to ongoing maintenance and the PL 84-99 program. It is recommended that this coordination begin as soon as possible.

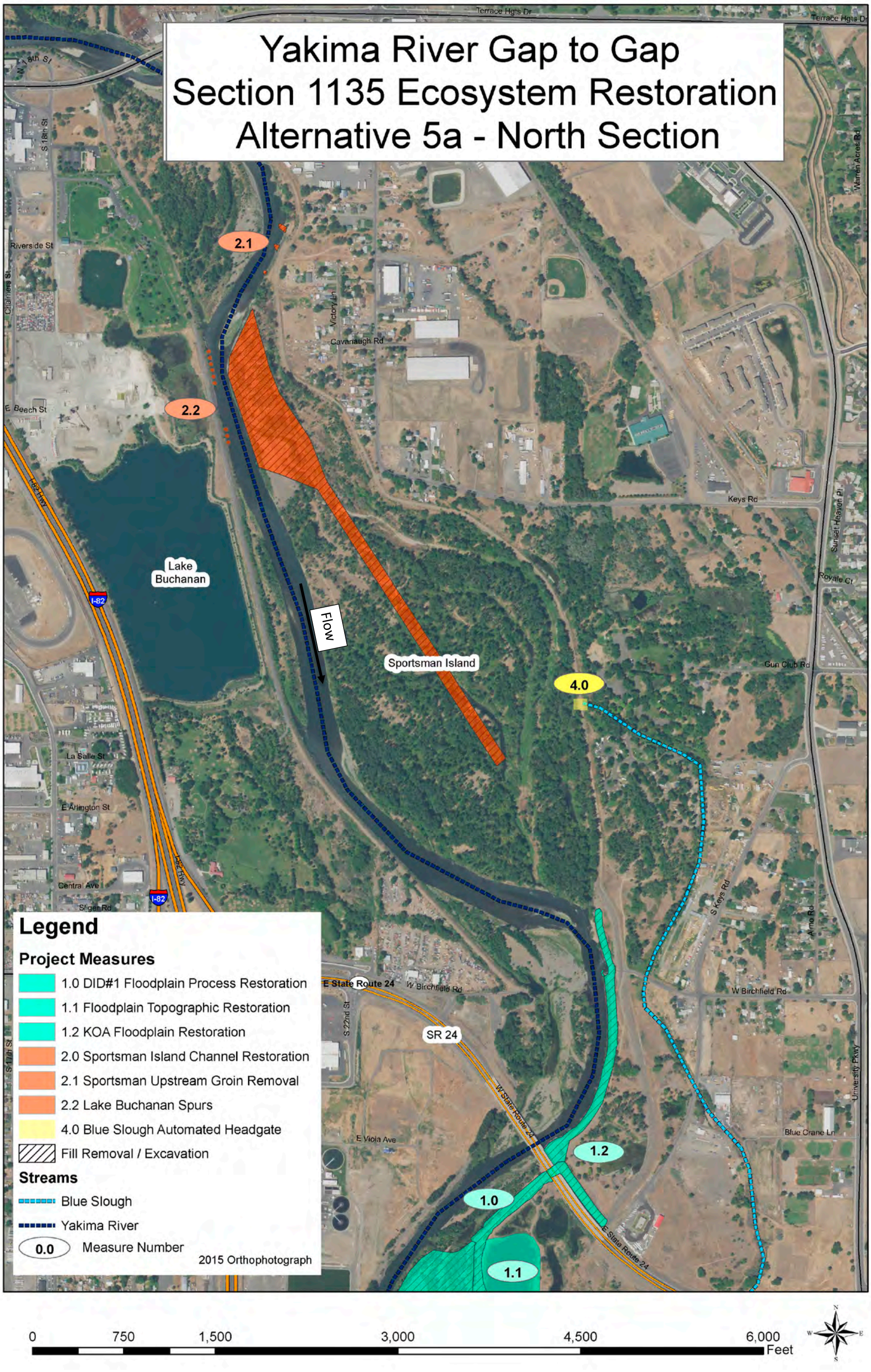

Figure 5-1. Recommended Plan - North Portion

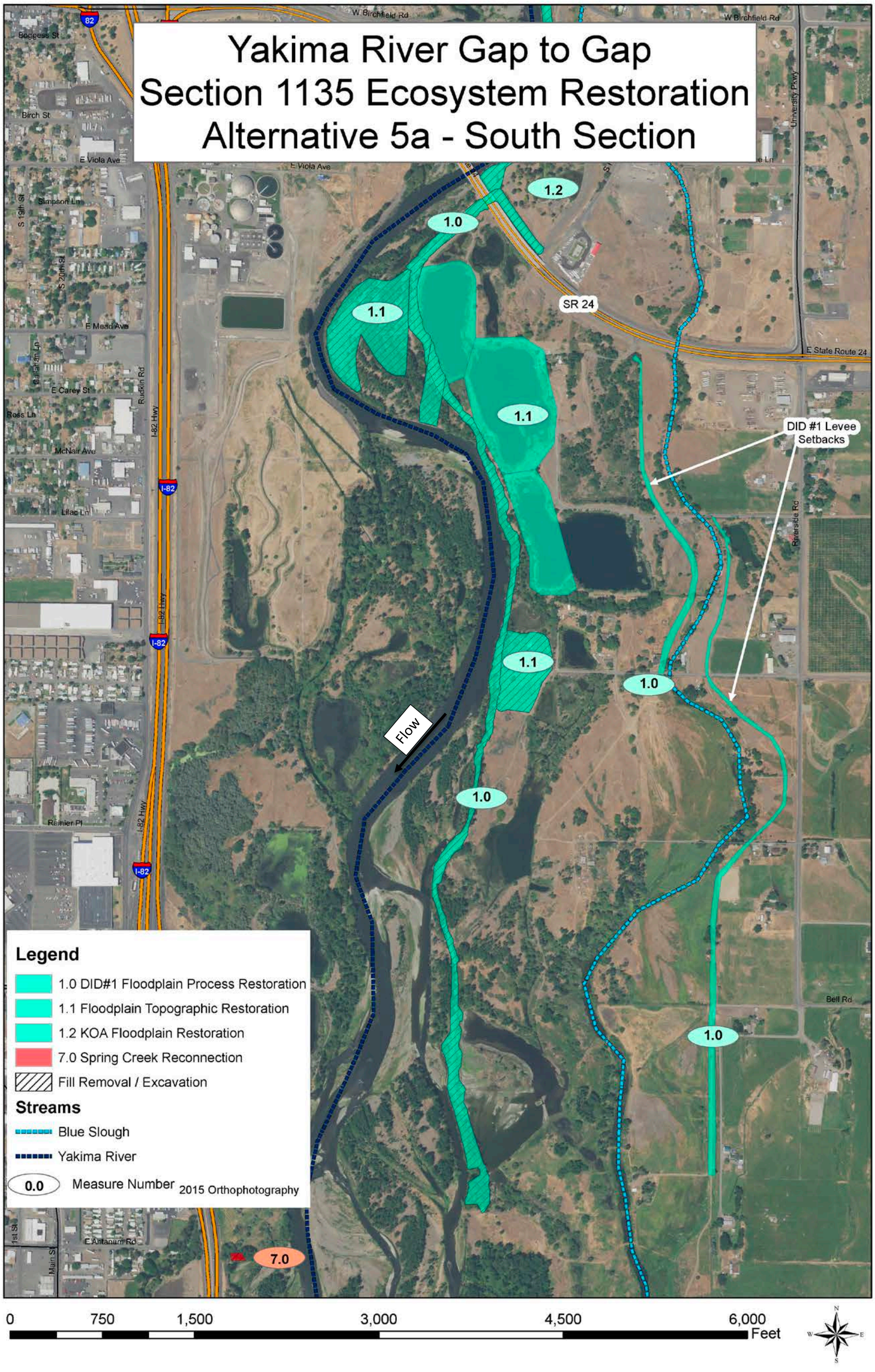

Figure 5-2. Recommended Plan - South Portion

5.2.2 Best Management Practices (BMPs)

Construction BMPs used by the Corps during past projects would be included during construction. Such BMPs include the following:

- Equipment used near the water would be cleaned prior to construction.
- In-water construction work in salmonid accessible waters would take place during the established fish window (June 1 – September 15).
- Existing roadways or travel paths would be used for access ways whenever possible and stream crossings would be minimized.
- The number of temporary access roads would be minimized and roads would be designed to avoid adverse effects like creating excessive erosion and to avoid crossing slopes greater than 30%.
- All temporary access-ways not needed for future access would be removed (including gravel surfaces) and re-planted before project completion.
- As much as practicable, any large wood, native vegetation, weed-free topsoil, and native channel material displaced by construction would be stockpiled for site restoration.
- When construction is finished, the construction area would be cleaned up and rehabilitated (replanted and reseeded) as necessary.
- Within seven calendar days of completion of site improvements, any disturbed bank and riparian areas shall be protected using native vegetation or other erosion control measures as appropriate.
- Obtaining construction materials and equipment from local producers or vendors to minimize energy use for shipping.
- Encouraging construction personnel to carpool or use a crew shuttle van.
- Turning off equipment when not in use to reduce idling.
- Maintaining equipment in good working order to maximize fuel efficiency.
- Construction equipment shall be regularly checked for drips or leaks.
- Routing truck traffic through areas where the number of stops and delays would be minimized, and using off-peak travel times to maximize fuel efficiency.
- Implementing emission-control technologies for construction equipment.
- Using ultra low sulfur (for air quality) and biodiesel fuels in construction equipment.
- Using renewable energy produced onsite or offsite. For example, using solar-powered generators to supply electricity for field offices and construction lighting.
- At least one fuel spill kit with absorbent pads would be onsite at all times.

5.3 Hazardous, Toxic and Radioactive Waste (HTRW)

A preliminary site assessment was conducted for the project (Appendix K). While some potential HTRW concerns were identified, none impacted measures that remained as part of the recommended plan after plan formulation was complete. If HTRW that would impact the project are identified during design, the local sponsor shall be responsible for ensuring that the development and execution of Federal, state, and/or locally required HTRW response actions are accomplished at 100% non-project cost. No cost sharing credit will be given for the cost of response actions.

5.4 Real Estate Considerations

Please see Appendix F Real Estate Plan.

5.5 Cost Estimate

The fully funded cost estimate to plan, design, and construct the recommend plan is $13,313,000, of which $9,842,000 is federal funds. It should be noted the Federal government may not expend more than $10,000,000 on a single Section 1135 project (see 1.2 - Study Authority); therefore if project costs exceed what is estimated such that the Corps expenditures reach $10,000,000, all further costs would be 100% the responsibility of the non-federal sponsor. The project first cost includes contingency to capture project risks and unknowns: the team applied 17.4% contingency to Lands & Damages (5% on land costs, 20% on admin costs, plus $155,000 for potential flowage easements); and 23.3% contingency to planning, engineering and design, construction and construction management. The total project cost includes escalation to the midpoints of real estate acquisition, design, and construction. The tables below summarize the project costs and the cost share plan.

Table 5-1. Abbreviated Total Project Cost Summary for the Recommended Plan

WBS Code & Feature	Project First Cost ($k)*	Total Project Cost ($k)**
01 Lands & Damages	1,575	1,591
06 Fish & Wildlife Facilities	8,304	8,470
06 Adaptive Management	370	417
06 Monitoring	123	139
30 Planning, Engineering, & Design	946	968
31 Construction Management	920	958
Total	**12,238**	**12,543**

* Price level = October 2018
** Fully funded; price level varies

Table 5-2. Project Cost Share of the Recommended Plan (Fully Funded)

Project Phase	Federal Share ($k)	Non-Federal Share ($k)	Total Project Costs ($k)
Feasibility Study (CAP)	435	335	770
Design & Construction*	9,407	3,136	12,543
Total	**9,842**	**3,471**	**13,313**

* Construction & design cost is to be cost-shared 75% federal, 25% non-federal
** Sums are +/- $1k due to rounding

5.6 Monitoring and Adaptive Management

The Corps' Implementation Guidance for Section 2039 of the Water Resources Development Act (WRDA) of 2007 specifies monitoring and adaptive management requirements for Corps ecosystem restoration projects. A draft monitoring and adaptive management plan has been developed in accordance with that guidance. Conservatively, the project has budgeted $400,000 for monitoring and adaptive management to nudge the site towards a fully sustainable condition over the first 10-years of the project life. Out of bank flooding related sedimentation is the primary concerns as it may temporarily impeded access to the restoration site. The primary work anticipated would be to remove these blockages to give the river more time to enlarge constructed channels connected to the restoration site.

5.7 Operation, Maintenance, Repair, Rehabilitation, and Replacement Requirements

After completion of construction, the non-federal sponsor will assume operations and maintenance (O&M) responsibility for the entire project. The only element that will require operation is the Blue Slough headgate. As minimal water flows though it at present, it is not currently being operated; USBR is the current agency in charge of operations. It is anticipated that Yakima County will take over operations after the headgate is replaced; this will be clarified in the Operations and Maintenance manual. The non-federal sponsor is responsible for all long-term project operations, routine maintenance, repairs, replacements, and rehabilitation following completion of construction. Federal levee repairs under PL 84-99 are typically covered at 100% federal cost share. At this time it is assumed that the recommended plan will require minimal maintenance for the levee portions of the project. The County estimates costs at approximately $1,500 per year for inspection, vegetation control, and snow removal, and $2000 per year to operate and maintain the headgate. A detailed project O&M manual will be developed during the Design and Implementation phase.

5.8 Schedule

The Corps will officially request the non-federal partner(s) to acquire the necessary real estate after the signing of the project partnership agreement when design is at a level sufficient to inform real estate requirements. The advertisement of the construction contract will follow the certification of the real estate. The final acceptance and transfer of the project to the non-federal partner(s) will occur after delivery of an operations and maintenance manual and as-built drawings.

5.9 Risk and Uncertainty

Risks and uncertainties associated with the design elements that make up the recommended plan are discussed in Sections 3 to 9 of the Engineering Appendix (Appendix A), which provide detailed information on each element. Many of the uncertainties identified as requiring further investigation during the design phase are typical for similar types of floodplain modification projects; less common project-specific risks and uncertainties are summarized in the table below.

The overall restoration approach has been developed, tested and refined over several decades by the non-federal sponsor. The approach takes advantage of the river's ability to do some of the work necessary for to create persistent hydraulic connections with restored floodplain areas. That approach is being used for the 1135 project because of its demonstrated success on other non-federal sponsor projects in the basin, which helps reduce risks and uncertainties. Because of the Yakima River's long duration spring freshet (for irrigation), there are extended periods of time for the constructed channels to be further enlarged after winter time high flows have scoured them. There is sufficient gradient for these side channel entrances to be lowered by the river to become permanent channels at low flow. Groundwater elevations are naturally high on site, with numerous off channel ponds and swales so these off channel habitat will still be wetted even if constructed entrances are dry at lowest flows. Substantial effort will be made in PED to ensure that maximal inundation is achieved from construction related activities, and post project monitoring and adaptive management budgets allow for sculpting and reshaping of these connections to ensure benefits are achieved.

Table 5-3. Risk and Uncertainty

Measure	Risk or Uncertainty	Steps to Reduce Risk
DID#1 Floodplain Restoration	Once the DID#1 Levee is removed, possible ensuing capture by the mainstem Yakima River of decommissioned gravel mines (Newland Pits) could result in the pits acting as sediment sinks, resulting in headcutting that could undermine portions of the remaining levee system.	Floodplain Topographic Restoration Measure: Further modeling during design will ensure adequate size/quantity/configuration of causeways to be constructed through the pits to reduce headcutting. KOA Floodplain Restoration Measure: Buried rock grade control at the upstream end of the pit is included in this measure. Sportsman Island Channels Measure: New anabranch channels in Sportsman Island would split headcutting energy so all would not be focused on the main channel. Adaptive Management Floodplain managers will monitor and take measures as needed to control any headcutting that occurs despite above design considerations.
Sportsman Island Channels, Upstream Groin Removal and Lake Buchanan Spurs	The model used in this study has not been calibrated to ensure that the overtopping frequency into the constructed channel will be as desired.	Once updated channel data are obtained, the model should be carefully calibrated. All identified plan elements should then be added to the model terrain to assess the hydrologic response and gravel pit avulsion potential and of the current design concept.

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6. Compliance with Environmental Statutes

This chapter provides documentation of how the recommended plan (agency preferred alternative) complies with all applicable federal environmental laws, statutes, and executive orders.

6.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 U.S.C. §4321 et seq.) commits federal agencies to considering, documenting, and publicly disclosing the environmental effects of their actions. NEPA-required documents must provide detailed information regarding the proposed action and alternatives, the environmental impacts of the alternatives, appropriate mitigation measures, and any adverse environmental impacts that cannot be avoided if the proposal is implemented. Agencies are required to demonstrate that decision makers have considered these factors prior to undertaking actions, which is exhibited in signing a Finding of No Significant Impact (FONSI). This DPR/EA is the primary vehicle to achieve NEPA compliance for the proposed project and was utilized when soliciting public comment.

6.2 Endangered Species Act of 1973

In accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species and their critical habitats. Three listed species may be found in the project area: Columbia River bull trout, Middle Columbia River steelhead, and yellow-billed cuckoo. There is a potential for turbidity increases during the construction, as well as a potential for noise disturbance during work along the riverbank. Impacts are expected to be minimal, and nearby similar unaffected areas would be available for fish to retreat to, if necessary. Overall, the impact of vegetation improvements, floodplain reconnection, and enhanced connection to off-channel habitat would increase the function of this habitat for salmonids. Riparian habitat improvements could have a beneficial effect to yellow-billed cuckoo.

The potential effects of the project were addressed in more detail in a Biological Assessment (BA). The BA was submitted to USFWS and NMFS in April, 2017 for review and consultation. In a letter dated 6 July 2017, the USFWS concurred with the Corps' assessment of effects to bull trout, yellow-billed cuckoo, and their designated and proposed critical habitat. The NMFS did not concur with our assessment of impacts to steelhead and its designated critical habitat and issued a Biological Opinion (BiOp) on 13 July 2017. NMFS concluded "…the proposed action is not likely to jeopardize the continued existence of ESA-listed Middle Columbia River (MCR) steelhead…will not destroy or adversely modify designated critical habitat for MCR steelhead." The Corps will implement Reasonable and Prudent Measures and Terms and Conditions outlined in the NMFS BiOp.

6.3 Clean Water Act of 1972

Section 401 – Any project that involves placing dredged or fill material in waters of the United States or wetlands, or mechanized clearing of wetlands, requires a water quality certification (WQC) from the

State agency as delegated by the U.S. Environmental Protection Agency (EPA). For the Yakima River, the delegated authority is WDOE. When the site-specific construction drawings and contract are prepared in the Design and Implementation Phase, the Corps will provide these and all other necessary documentation for WDOE as part of our request for WQC and the Corps will receive the WQC prior to construction contract award.

Section 402 – The National Pollutant Discharge Elimination System (NPDES), controls discharges into waters of the United States. NPDES permits contain industry-specific, technology-based, and/or water-quality-based limits, and establish pollutant monitoring and reporting requirements. EPA has established a program to address stormwater discharges. These regulations require that facilities or construction sites with stormwater discharges from a site that is one acre or larger apply for an NPDES permit. Stormwater discharge permits will provide the relevant authority for discharges from restoration sites during construction.

Section 404 – The Corps administers regulations under Section 404(b)(1) of the Clean Water Act, which establishes a program to regulate the discharge of dredged and fill material into waters of the U.S., including wetlands. The Corps has evaluated potential project-induced effects subject to these regulations during feasibility-level design and the draft 404(b)(1) evaluation is provided in Appendix D.

6.4 Clean Air Act of 1972

The Clean Air Act (CAA) as Amended (42 U.S.C. §7401, et seq.) prohibits federal agencies from approving any action that does not conform to an approved state or federal implementation plan. Three agencies have jurisdiction over air quality in the project area: EPA, WDOE, and the Olympic Region Clean Air Agency. The EPA sets standards for concentrations of pollutants in outdoor air and the State establishes regulations that govern contaminant emissions from air pollution sources. Construction activities associated with the proposal will create air emissions, but the emissions are not expected to affect implementation of Washington's CAA implementation plan.

6.5 National Historic Preservation Act of 1966

The National Historic Preservation Act (NHPA) and its implementing regulations 36 CFR §800 provides a regulatory framework for the identification, documentation, and evaluation of cultural resources that may be affected by federal undertakings. Under the Act, federal agencies must take into account the effects of their undertakings on historic properties (cultural resources that have been found to be eligible for listing in the National Register of Historic Places) and afford the Advisory Council a reasonable opportunity to comment on such undertaking. Additionally, a federal agency shall consult with any tribe that attaches religious and cultural significance to such properties.

To meet the Agency's responsibilities under NHPA, the Corps has taken actions to identify historic properties that may be affected by the proposed action as required by Section 106 of the National Historic Preservation Act. An initial letter to document the APE was sent to SHPO on April 3, 2017. The

SHPO agreed with the Corps' determination of the APE on April 3, 2017. The Corps also requested knowledge and concerns from the Yakama Nation on April 3, 2017. The Tribe did not comment. The Corps submitted its finding that there would be no adverse effect to historic properties to SHPO on July 19, 2017. SHPO agreed with the Corps' finding in a letter dated August 23, 2017.

6.6 Federal Trust Responsibility

The federal trust responsibility to Native American Tribes is a protection and preservation of land and certain rights for them. Treaties with the Tribes are the supreme law of the land, superior to State laws, and equal to federal laws. The trust responsibility is derived from the special relationship between the U.S. and Native American Indian Tribes, first defined by U.S. Supreme Court Chief Justice John Marshall in Cherokee Nation v. Georgia, 30 U.S. 1 (5 Pet.) (1831). Later, in Seminole Nation v. United States, 316 U.S. §286 (1942), the Supreme Court noted that the U.S. "has charged itself with moral obligations of the highest responsibility and trust" toward Native American Indian Tribes. The scope of the federal trust responsibility is broad and incumbent upon all federal agencies. The U.S. government has an obligation to protect tribal land, assets, resources, and rights, as well as a duty to carry out the mandates of federal law with respect to Indian Tribes.

Federal agencies have a trust responsibility to preserve and rebuild fisheries in Washington State within Tribes' usual and accustomed fishing areas and to do so in consultation and coordination with the federally recognized tribes.

6.7 Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 reaffirmed the Federal Government's commitment to a government-to-government relationship with Indian Tribes, and directed federal agencies to establish procedures to consult and collaborate with tribal governments when new agency regulations would have tribal implications. The Corps has a government-to-government consultation policy to facilitate the interchange between decision makers to obtain mutually acceptable decisions. In accordance with this Executive Order, the non-federal Sponsor has engaged in ongoing informal coordination with the Yakama Nation. The DPR/EA was shared with the Yakama Nation by both the local Sponsor and the Corps when released for public review in March 2017. The Corps received an email from a Yakama Nation habitat biologist on 17 July 2017 that stated the Gap to Gap project is viewed as complementary to the tribe's summer Chinook restoration strategies and climate change adaptation for other treaty fish resources.

6.8 Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act (16 U.S.C. §668-668c) applies to Corps civil works projects through the protection of bald and golden eagles from disturbance. There are no known eagle nests in the project area. There are several communal roosting areas in Yakima, including one upstream of the sewage treatment plant. Communal roosts are important winter habitat, largely in use from October through March. Surveys of bald eagles completed during levee repairs in Yakima in 1997 showed that

eagles in this urban environment are acclimatized to humans, flying, and even hunting near operating equipment. No construction is expected to occur in the winter, and no trees within the known roosting areas would be disturbed. No impacts to bald eagles are expected.

6.9 Fish and Wildlife Coordination Act of 1934

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 U.S.C. §661-667e) provides authority for the USFWS involvement in evaluating effects to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. On April 20, 2016, the Corps received an email from the USFWS Central Washington Field Office stating that since the purpose and need of the proposed action is restoration for the benefit of fish and wildlife, a FWCA report is not required.

6.10 Magnuson-Stevens Fishery Conservation and Management Act of 1976

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et. seq.) requires federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The objective of an EFH assessment is to determine whether the proposed action(s) "may adversely affect" designated EFH for relevant commercial, federally managed fisheries species within the proposed action area. EFH includes those waters and substrate necessary for fish spawning, breeding, feeding, or growth to maturity. The assessment describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action. During feasibility-level design phase, the Corps has prepared an effects analysis addressing EFH, which was provided to USFWS and NMFS within the Biological Assessment required under ESA Section 7. Although habitat disturbance may have temporary adverse effects to designated EFH, the conservation measures that the Corps of Engineers will include as part of the proposed site design to address ESA concerns should be adequate to avoid, minimize, or otherwise offset potential adverse effects to the EFH. The proposed restoration sites would result in long-term benefits to salmonids by increasing the amount and quality of EFH through floodplain reconnection, side channel creation and restoration, and restored hydrology. As part of the 13 July 2017 BiOp, NMFS determined that the proposed action would adversely affect EFH as construction activity will cause reduction in forage production lasting one year. NMFS outlined two conservation measures to avoid, mitigate, or offset the impact of the proposed action. The Corps provided a response in a letter dated 16 August 2017 stating that the Corps accepts the conservation measures to offset potential impacts to EFH.

6.11 Migratory Bird Treaty Act of 1918 Migratory Bird Habitat Protection

The Migratory Bird Treaty Act (16 U.S.C. §703-712), as amended protects over 800 bird species and their habitat, and commits that the U.S. will take measures to protect identified ecosystems of special importance to migratory birds against pollution, detrimental alterations, and other environmental degradations. Executive Order 13186 directs federal agencies to evaluate the effects of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative effects to migratory birds. The proposed restoration sites would result in long-term benefits to

migratory birds by increasing the amount and quality of riparian and wetland habitat through floodplain reconnection, channel creation and restoration, and restored hydrology. Migratory bird habitat would be investigated during the design phase to determine whether any negative effects would occur. The Corps would coordinate appropriate actions with USFWS.

6.12 Wild and Scenic Rivers Act of 1968

The Wild and Scenic Rivers Act (Public Law 90-542; 16 U.S.C. 1271 et seq.) establishes a National Wild and Scenic Rivers System to preserve, protect, and enhance the wilderness qualities, scenic beauties, and ecological regimes of rivers and streams. Any construction within 100 feet of a scenic stream requires a scenic streams permit. Washington has approximately 197 miles of river designated as wild and scenic. These include portions of the Klickitat River, the Skagit River, and the White Salmon River. No portions of the Yakima River are designated; thus, there would be no impact.

6.13 Executive Order 12898 Environmental Justice

Executive Order 12898 directs federal agencies to take the appropriate steps to identify and address any disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority and low-income populations. The Corps has analyzed the potential effects of the alternatives on communities in the study area and found that there would be no disproportionately high and adverse human health impacts to any environmental justice communities.

6.14 Executive Order 11988 Protection of Floodplains

Executive Order (EO) 11988 requires federal agencies to provide leadership and take action to (1) avoid development in the base 1% ACE event floodplain, unless such development is the only practicable alternative; (2) reduce the hazards and risk associated with floods; (3) minimize the effect of floods on human safety, health, and welfare; and (4) restore and preserve the natural and beneficial values of the base floodplain. To comply with EO 11988, Corps policy is to formulate projects which, to the extent possible, avoid or minimize significant effects associated with use of the without-project floodplain, and avoid inducing development in the existing floodplain unless there is no practicable alternative. As the realigned DID#1 levee would provide the same level of flood protection for adjacent properties and uses as currently exists, there would likely be no change in the use of adjacent industrial or residential uses as a result of the project.

6.15 Executive Order 11990 Protection of Wetlands

The purpose of Executive Order 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The preferred alternative would have the overall effect of enhancing wetlands and increasing their total area in the study area.

6.16 Farmland Protection Policy Act

Congress passed the Farmland Protection Policy Act (FPPA) because of substantial decreases in farmland acreage. The purpose of the Act is to minimize the extent to which federal actions contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a federal agency or with assistance from a federal agency. The study area has no designated prime and unique farmland that would be converted to other uses.

7. Public Involvement

Stakeholders, agencies, and the public are integral in providing input for defining restoration opportunities, objectives, constraints, and for developing restoration strategies that support development of the range of alternatives to be analyzed for feasibility and environmental compliance. Public involvement activities and agency coordination are summarized in this chapter.

7.1 Draft Detailed Project Report/EA Public Review

For this study, the draft DPR/EA public comment period formally ran for 30 days beginning 27 March 2016 and ending in 26 April 2016. The Corps considered all comments received during the comment period. The complete list of comments regarding the draft DPR/EA and the Corps' responses are included in Appendix J of this version of the DPR/EA.

7.2 Agency and Tribal Government Consultation and Coordination Process

Preparation of this DPR/EA is being coordinated with appropriate federal, state, and local interests as well as environmental groups and other interested parties.

The non-federal Sponsor has engaged in ongoing informal coordination with the Yakama Nation. The draft DPR/EA was shared with the Yakama Nation by both the local Sponsor and the Corps when released for public review in March 2017. Tribal coordination will continue throughout the design and construction phase in accordance with Executive Order 13175 Consultation and Coordination with Indian Tribal Governments.

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8. Recommendations

The following language outlines the Corps' recommendations for project approval and authorization for implementation.

I recommend that the recommended plan for the Yakima River Gap to Gap Ecosystem Restoration Project as generally described in this report be approved for implementation as a federal project.

The estimated project first cost to design and implement the recommended plan is $12,238,000. The federal portion of the project first cost is 75%, or $9,179,000. The non-federal sponsors' required portion of project first cost is 25%, or $3,059,000. The non-federal partners shall, prior to implementation, agree to perform the following items of local cooperation:

1. Provide 25% of total project costs for design and implementation as further specified below:
    1. a. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;
    1. b. Provide, during design and implementation, any additional funds necessary to make its total contribution equal to 25% of total project costs;
2. Shall be responsible for all costs related to project operations, maintenance, repair, rehabilitation, and replacement.
3. Shall not use funds from other federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal obligations for the project unless the federal agency providing the federal portion of such funds verifies in writing that expenditure of such funds are authorized to be used to carry out the project;
4. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments), such as any new developments on project lands, easements, and rights-of-way, or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
5. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;
6. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated

material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

7. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the Federal Government;
8. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
9. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
10. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;
11. Comply with all applicable federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);
12. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-federal sponsor with prior specific written direction, in which case the non-federal sponsor shall perform such investigations in accordance with such written direction;

13. Assume, as between the Federal Government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
14. Agree, as between the Federal Government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
15. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

Mark A. Geraldi
Colonel, Corps of Engineers
District Commander

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