YAKIMA RIVER BASIN
ECOSYSTEM RESTORATION
YAKIMA COUNTY, WASHINGTON

APPENDIX H

Monitoring and Adaptive Management Plan

June 2018

Integrated Feasibility Report and Environmental Assessment

US Army Corps
of Engineers®
Seattle District

Yakima River Gap to Gap Ecosystem Restoration Project

Draft Monitoring and Adaptive Management Plan

April 2018

This is a draft plan that will be revised during the design phase as necessary to reflect the final design of the project.

Contents

1. INTRODUCTION

The Corps of Engineers and Yakima County (non-Federal sponsor) are proposing to restore ecosystem structure, function and processes in the Gap to Gap reach of the Yakima River. The extent and function of the Gap to Gap reach of the Yakima River and its floodplain have been reduced significantly by land use changes and development adjacent to the cities of Yakima and Union Gap (Eitemiller et al, 2002). Biological resources, including salmonid species listed under the Endangered Species Act, depend on a connected river and floodplain. 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 native salmonids. The proposed restoration spans 4 miles of the Yakima River in the Gap to Gap reach and includes levee removals, spur dike removals, 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, 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. Indirect benefits from restoring the primary benefit area (flood velocity and depth normalization) extend to adjacent riparian areas of the main channel and right bank, totaling several hundred acres. Work will be completed in four areas, in order of size: the Diking District #1 floodplain area, Sportsman Island, Blue Slough, and Spring Creek.

1.1 Location

The general study area is located in Yakima County, Washington, east of the Cascade Mountain Range in central Washington State (Figure 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 2).

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. 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.

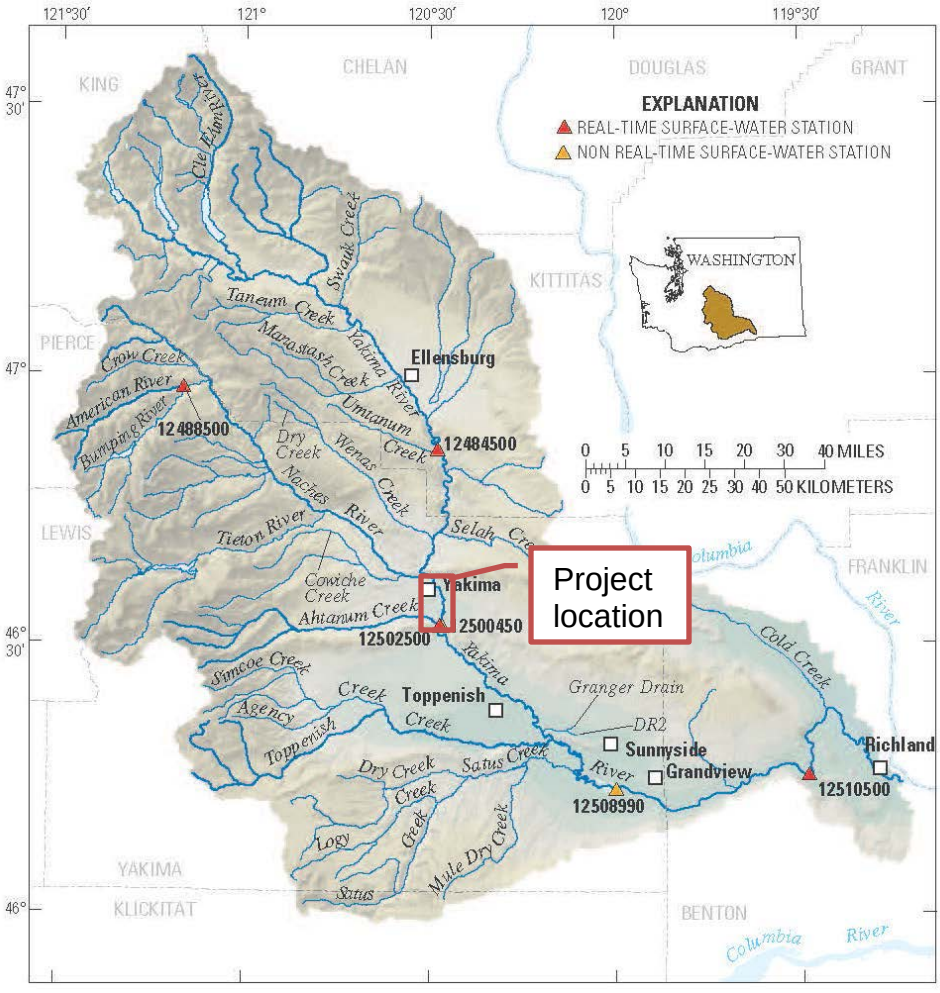

Figure 1. Yakima River basin overview.

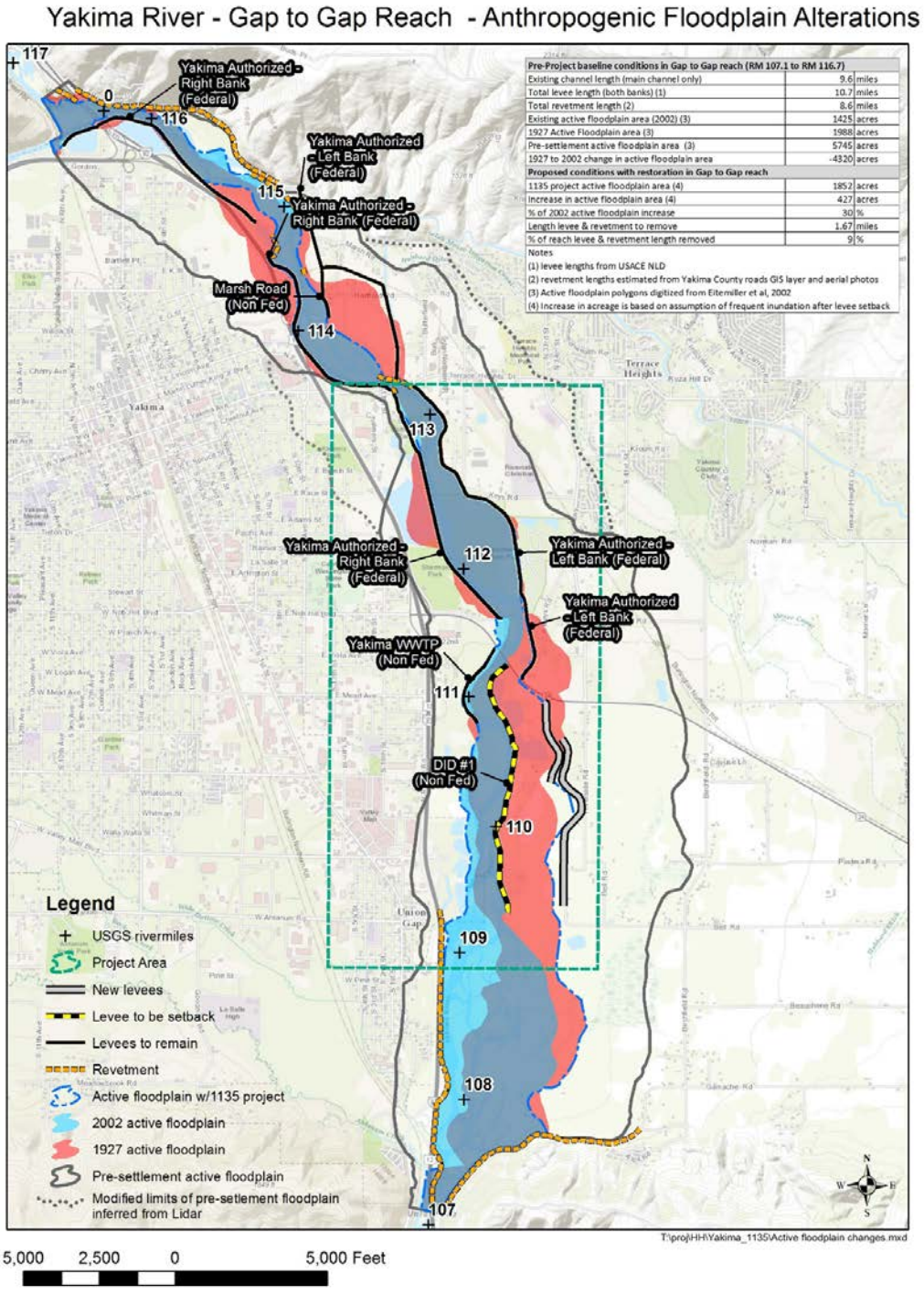

Figure 2. Study area and historic changes in the Gap to Gap Reach. Project area shown in green dashed box.

1.2 Project Objectives

The primary ***goal*** of the project is, within the Gap top 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 are the objectives of the Yakima River restoration project:

1) Restore connectivity between the Yakima River and its historic floodplain for the 50-year period of analysis.
2) Improve riparian habitat within the Gap to Gap Reach for mammals and birds for the 50-year period of analysis.
3) Reconnect historic channels to restore lost fish habitat, for the 50-year period of analysis.

1.3 Proposed Action

Measures Used for Final Step in Formulating Tentatively Selected Plan – The following measures remained after initial screening by the PDT and were used for plan formulation. See Figures 3 and 4.

Measure 1.0 DID#1 Floodplain Process Restoration (Remove DID#1 Levee, rebuild landward of historic floodplain area.)

Measure 1.1 Floodplain Topographic Restoration (Excavate material to encourage establishment of historic side channels; place material in old gravel pits. Ameliorates risk associated with potential capture of pits by main channel and associated headcutting; therefore, for plan formulation purposes, included with Measure 1.)

Measure 1.2 KOA Floodplain Restoration (Remove old levee and cross dike material no longer needed once DID#1 levee is realigned landward. Restores floodplain processes; provides material for new levee.)

Measure 2.0 Sportsman Island Channel Restoration (Reestablishes lost side channel habitat; ameliorates risk associated with potential capture of pits by main channel and associated headcutting.)

Measure 2.1 Sportsman Upstream Groin Removal (Restores natural flow pattern towards head of newly reestablished Sportsman channels.)

Measure 2.2 Lake Buchanan Spurs (Directs flow away from Buchanan Lake, old gravel pits just landward of right bank levee, and towards head of newly reestablished Sportsman channels.)

Measure 4.0 Blue Slough Automated Headgate (Allows reintroduction of normative flows to Blue Slough to support listed fish species.)

Measure 7.0 Spring Creek Reconnection (Removes fill form mouth of Spring Creek, a groundwater fed stream, allowing access to the stream from the river by listed fish species; creek would provide cold water, off-channel refuge.)

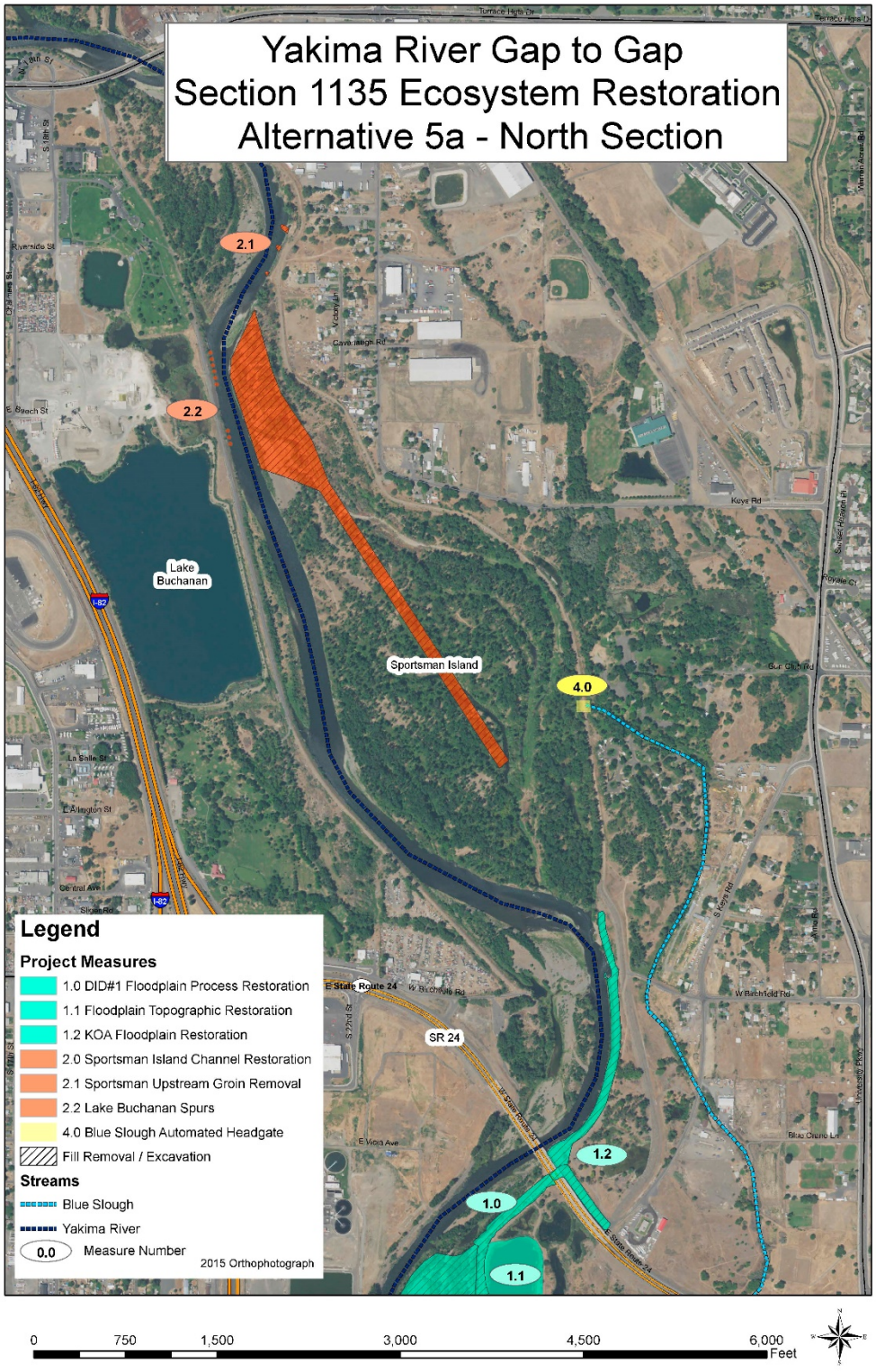

Figure 3 – Recommended Plan – 1 of 2

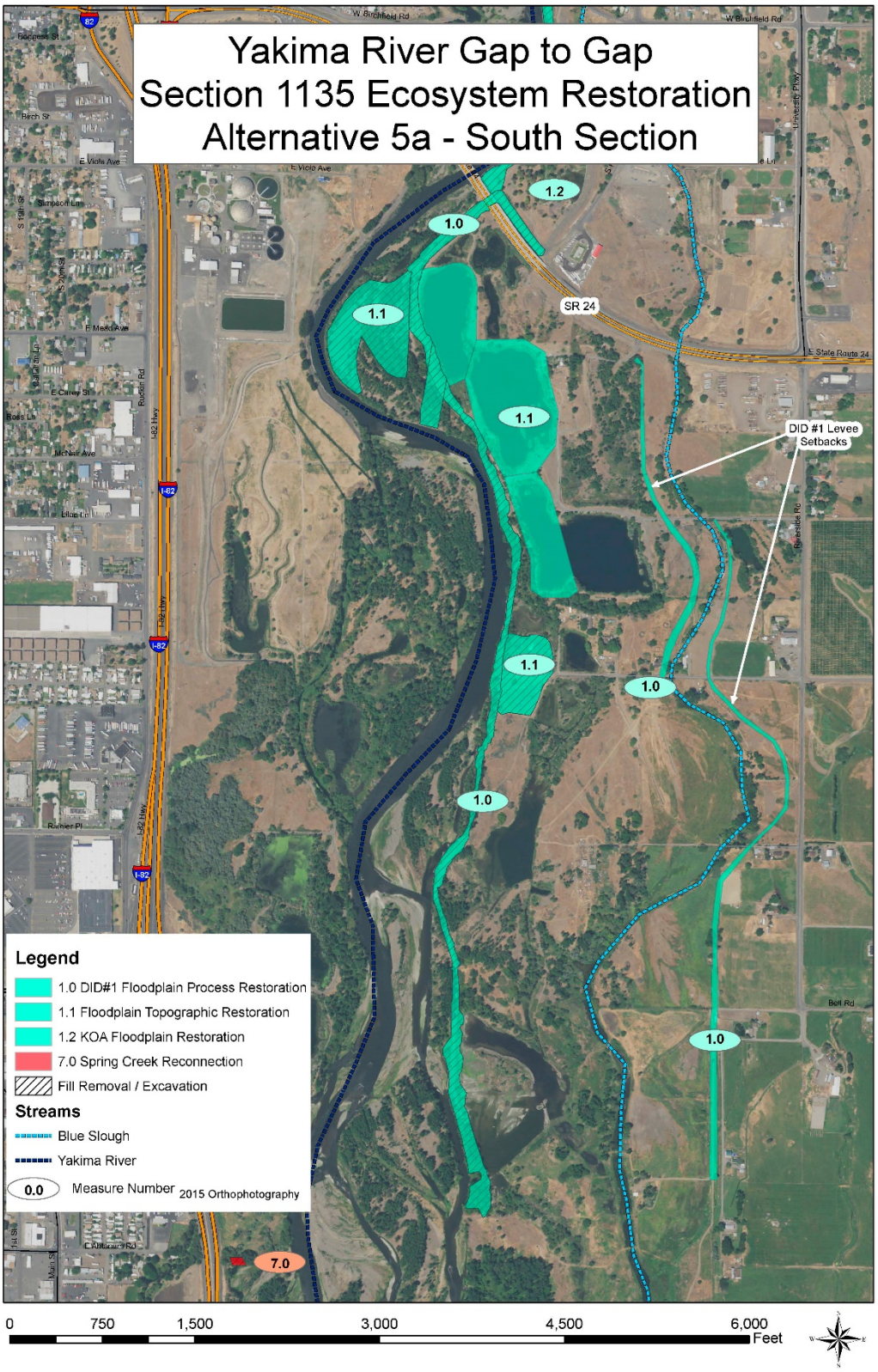

Figure 4 – Recommended Plan – 2 of 2

2. CORPS GUIDANCE ON MONITORING

Monitoring guidance for Corps projects was detailed in ER1105-2-100 in 2000 (USACE 2000). Since then, Implementation Guidance for Section 2039 of WRDA 2007- Monitoring of Ecosystem Restoration (USACE 2009) was issued and supersedes the 2000 guidance. The 2009 guidance states that a plan for monitoring ecological success must be included in the decision document, must include the rationale for monitoring and must identify key project-specific parameters and how they relate to achieving the desired outcomes for making a decision about the next phase of the project. The guidance also states that the monitoring and adaptive management costs will be included in the project cost estimate and cost-shared accordingly; allowing for a monitoring period of up to, but not exceeding, ten years. The monitoring plan should also identify the criteria for success and when adaptive management is needed.

3. PURPOSE OF THE PLAN

As described in the previous section on Corps guidance, the purpose of this plan is to demonstrate ecological success of the project. This success is determined by monitoring metrics that are specifically tied to project objectives, and in most cases, setting performance targets. The plan will also identify what adaptive management is necessary if the performance targets are not met.

This plan presents the framework for the above methodology, but it will continue to evolve as the Yakima River Gap to Gap Ecosystem Restoration Project progresses to further levels of design, including more detailed methods for monitoring, and potential changes in monitoring metrics, performance criteria, and adaptive management. It will also be refined in collaboration with the non-Federal sponsor, as well as per requirements issued in the project's environmental permits.

4. PROJECT MONITORING

Given the setting, it is expected that this site will be dynamic and evolve. Thus, for some parameters strict achievement of predetermined "performance standards" will not necessarily predict the success or reveal the failure of the restoration effort. The monitoring and evaluation will focus on determining whether the overall project objectives of the restoration are being met. Monitoring efforts will be performed by using "monitoring metrics" listed in Section 5 (Evaluation of Specific Objectives); some have specific performance targets associated with them and others measure the more unpredictable aspects of the development and use of the site. All post construction monitoring will be performed by qualified scientists and engineers.

Evaluating the evolution of restored habitats will be based on the establishment of the targeted habitat within the restoration site and on the ecologic functioning of those habitats. Post-

construction monitoring will be conducted every year for 10 years and will be cost shared between the Corps and the non-Federal sponsor.

Baseline monitoring will be completed as part of the design effort, prior to ground disturbing actions, using the same protocols as the monitoring and adaptive management plan. The baseline monitoring data will be used to evaluate changes that occur post-implementation. By monitoring prior to implementation, any issues with monitoring protocols can be resolved such that out-year monitoring methods are applied consistently, resulting in quality monitoring data and strengthened conclusions of pre-post project comparisons.

The non-Federal sponsor may choose to monitor beyond this ten year period, although the cost effort would be 100% their responsibility. Data collection will be used to determine success of the project, as well as further the understanding of riverine and floodplain restoration, with the focus on the development of in-stream and riparian habitats and their use by fish and wildlife. The Corps and the non-Federal sponsor will use the knowledge gained through this monitoring effort to adaptively manage the project site.

5. EVALUATION OF SPECIFIC OBJECTIVES

The monitoring metrics listed below are grouped by the project objectives listed in Section 1.2.

5.1 Evaluation of Objective 1

Restore connectivity between the Yakima River and its historic floodplain for the 50-year period of analysis

5.1.1 Monitoring Metric 1: Connectivity of the Yakima River to the Floodplain at the DID#1 Site.

Methods and timing: Monitor and document the progression of the restored DID#1 site through a series of established photo points, satellite or ortho imagery classification of wetted, dry and vegetated areas at known flows during critical hydrologic conditions, and continuous stage data collection. For this metric the critical period is the fall (October, November, December) corresponding to a Yakima River discharge of 1,310 cfs at the Umtanum gage. Care should be taken to collect site data corresponding to this discharge (+/- 10%) during leaf-off conditions. Baseline inundation limits will be computed from the project HEC-RAS model using as-built topography, or delineations from aerial imagery during the critical hydrologic period shortly after completion of construction. Inundation limits during a monitoring year will be determined either from the as-built HEC-RAS model (calibrated to measured stage data), or from aerial photos for the same hydrologic conditions as the baseline data. Verification of fish

passable hydraulic connections will be through photo points obtained during the critical hydrologic period or from model data if updated survey information is available at side channel connection points. Depths in critical wetted channels will be logged continuously to confirm that adequate inundation is being maintained. Increases in connectivity and inundation with time are expected and desirable. Features of interest to document (anecdotally) are formation of side channels, river channel changes, bar development wetland development, and vegetation growth and colonization.

Performance Target: ~~There are no specific performance standards for this metric.~~ Successful restoration will result in measured inundation limits for the critical hydrologic period (avg. flow for Oct., Nov., Dec.) during a monitoring year being equal to or greater than 75% of the as-built inundation limits with at least one surface flow connection between the river and DID#1 site.

Adaptive Management: If inundation is equal to or less than 75% of as-built conditions during the critical flow period, determine potential range of adaptive management measures to ensure target conditions can be maintained and closely monitor conditions. If inundation (acreage) decreases to less than 50% of the as-built inundation or no active flow connections are present during the critical flow period, adaptive management will be implemented. If no active flow connections are observed during critical periods then grading or manipulation of on-site large wood accumulations shall be required to restore flow. Additional survey data may also be collected prior to adaptive management actions to determine appropriate grading elevations and extents.

5.2 Evaluation of Objective 2:

Improve riparian habitat within the Gap to Gap Reach for mammals and birds for the 50-year period of analysis.

5.2.1 Monitoring Metric 2: Riparian Canopy Cover Along New Sportsman Island Channel and along Yakima River where levees are removed at Sportsman's Park and the DID#1 site.

Methods and timing: Measure percent cover of riparian vegetation along the newly constructed Sportsman Island channel, at the Sportsman's Park site, and within 200 feet of the Yakima River at the DID#1 site during late summer/early fall. GIS image classification techniques will be utilized to distinguish trees, shrubs, grasses, open areas (developed, bare, wet). The primary data sources will be public Landsat satellite imagery, NAIP imagery, first-return Lidar data coupled with spot measurements of canopy height at monitoring photo point locations.

Performance Target: It is expected that cover will increase as volunteer species grow. Desirable native volunteer trees and shrubs should have a high percentage of ground cover compared to bare dirt or invasive species. Performance targets include the following:

- Year 3: 15% aerial cover of native species
- Year 5: 30% aerial cover of native species
- Year 7: 50% aerial cover of native species
- Year 10: 70% aerial cover of native species

Adaptive Management: If the above cover targets are not met, then native plantings could be installed. Invasive species removal may be needed if invasives appear to be outcompeting native species.

5.3 Evaluation of Objective 3

Reconnect historic channels to restore lost fish habitat, for the 50-year period of analysis.

5.3.1 Monitoring Metric 3: Maintenance of side channel connections at Sportsman's Island, Blue Slough, and Spring Creek.

Methods and timing: Observe connection of Sportsman's Island inlets and Spring Creek outlet during spring, summer, and fall. Measure depths in the side channel connections during these same time periods. This would be accomplished by installing water level loggers/staff gages and running the as-built project hydraulic model to establish wetted areas, depth, velocities, duration of inundation, etc. The model would be run during the hydrologic period of interest and validated with gage data to establish connectivity with the Yakima River. A monitoring report would be prepared with level logger data and photo-points showing inundation at periods of interest along with model results. If the modeled inundation is not lining up with observed conditions this could be an indicator that maintenance might be needed. If available, infrared satellite imagery during known flow conditions may be utilized and classified in lieu of or in addition to modeling to document inundation. For this metric the critical period is the fall (October, November, December) corresponding to a Yakima River discharge of 1,310 cfs at the Umtanum gage. Care should be taken to collect site data corresponding to this discharge (+/- 10%) during leaf-off conditions.

Performance Target: Connection at the inlets/outlet during typical flows that occur regularly spring through fall. An actively flowing fish-passable connection at the upstream end of the side channel will be present in all years during the critical flow condition.

Adaptive Management: If actual inundation is less than 75% of as-built inundation, monitor closely and determine potential adaptive management measures to maintain target inundation. If actual inundation drops to less than 50% of as-built inundation or no active flow connections are observed during critical time periods then additional excavation at the inlet, manipulation of on-site large wood accumulations shall be required. Additional survey data may also be collected prior to adaptive management actions to determine appropriate grading elevations and extents.

Manipulation of hydraulic conditions on the right bank where spur dikes are being constructed should also be considered.

6. CONTINGENCY PLANNING AND IMPLEMENTATION

Contingency measures (adaptive management) will be implemented if the monitoring program (or any other documented observations by qualified personnel) indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-Federal sponsor, in coordination with regulatory and funding agencies, would then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. The adaptive management measures discussed below are based on a presumption that some flood damage should be anticipated as the river adjusts to the large scale project and that some additional work may be needed to nudge the site toward full sustainability. The measures proposed below are scaled to address moderate flood damage from occasional large floods, not catastrophic damage from extreme floods. Presumably catastrophic damage to the site (including the levees) would be addressed under PL 84-99 if it in involves a life safety component.

The work to complete these adaptive management measures would be directly informed by monitoring data and include development of a simplified design by the Corps and Yakima County based on field conditions. Adaptive management projects would likely consist of rough grading activities involving manipulation of on-site materials with heavy equipment (300 series excavators, off road dump trucks, D-8 dozers, etc.). It is reasonable that all of the following management measures would be utilized in a single maintenance cycle. It is assumed that routine maintenance of the channels would occur by Yakima County during the first 10-years and address smaller scale concerns that don't impact the restoration success.

6.1 Maintenance of Connectivity of the Yakima River to the Floodplain at the DID#1 Site.

Because of the extended duration of spring and summertime runoff for irrigation flows will likely be at a stage to activate constructed entrances to the DID 1 site it is likely that moderate deposition from frequent (less than 5-year recurrence) flood events will be not be problematic since it will be continually reworked by the river. It is possible that constructed connections between the mainstem Yakima River and the restored floodplain area may be experience deposition sufficient to impact connectivity in the first 10 years from the project life as the river reestablishes an anabranching planform in the reach. It is assumed that problematic high-flow related deposition may require 1 or 2 adaptive management cycles over a 10 year period to ensure that the river establishes permanent connections with the restored site. Anticipated adaptive management measures include:

1. Survey river elevations in vicinity of problem area. Update and use monitoring hydraulic model to determine grading plan.
2. Re-establish as-built topography by excavating streambed deposits at the head of constructed side channels and placing excavated materials in the unfilled portions of the DID #1 gravel pits
3. enlarging or deepening constructed channels connecting the mainstem to the restored site and placing excavated materials in the unfilled portions of the DID #1 gravel pits

4. manipulating on site large woody material to redirect flow into the restored site

6.2 Pit capture management at the DID#1 Site.

The project design includes specific features to prevent all of the flow the Yakima River from diverting into the DID#1 gravel pits after the levee is set back. Mitigation measures included in the project design include placement of earthen causeways across the pits to break up and redirect the energy of the flow and preservation of armoring along a meander bend where the river is in close proximity to the gravel pits. In addition a rock overflow sill is provided where the erosive potential is highest. It is assumed that problematic high-flow related erosion may require 1 or 2 adaptive management cycles over a 10 year period to ensure that the river establishes permanent connections within the restored site without resulting in pit capture. Anticipated adaptive management measures include:

1. Survey river elevations in vicinity of problem area. Update and use monitoring hydraulic model to determine grading plan.
2. Re-establishing as-built topography by placing excavated streambed deposits from elsewhere on site to restore topography after high flow scour events in the vicinity of the DID #1 gravel pits
3. Modifying or adding new causeways or fill to gravel pits using borrow from areas requiring excavation
4. Constructing channels or manipulating on site large woody material to redirect flow to reduce erosion risks

6.3 Maintenance of side channel connections at Sportsman's Island and Spring Creek.

Because of the extended duration of spring and summertime runoff for irrigation flows will likely be at a stage to activate constructed entrances at the Sportsman's Island and Spring Creek sites. Thus it is likely that moderate deposition from frequent (less than 5-year recurrence) flood events will be not be problematic since these deposits will be frequently reworked by the river. It is possible that constructed connections between the mainstem Yakima River and the restored floodplain area may be experience deposition sufficient to impact connectivity in the first 10 years from the project life as the river reestablishes an anabranching planform in the reach. It is assumed that problematic high-flow related deposition may require 1 or 2 adaptive management cycles over a 10 year period to ensure that the river establishes permanent connections with the restored site. Anticipated adaptive management measures include:

1. Survey river elevations in vicinity of problem area. Update and use monitoring hydraulic model to determine grading plan.
2. Re-establishing as-built topography by excavating streambed deposits at the head of constructed side channels and placing excavated materials in the unfilled portions of the DID #1 gravel pits
3. Enlarging or deepening constructed channels connecting the mainstem to the restored site
4. Manipulating on site large woody material to redirect flow into the restored site

7. RESPONSIBLE PARTIES

The contingency plan may require extension of the monitoring phase of the project, especially if major changes in the plan are required. As applicable, Corps project biologists and engineers, in consultation with agency personnel, will make adaptive management recommendations. The

parties responsible for implementation of the restoration plan and any associated contingencies are as follows:

Project Manager Yakima County:	Joel Freudenthal Yakima County Project Biologist 509-574-2322
Project Manager Corps:	Brian Nelson U.S. Army, Corps of Engineers, Seattle District 206-316-3929
Project Biologist Corps:	Melissa Leslie U.S. Army, Corps of Engineers, Seattle District 206-764-6587
Project Hydraulic Engineer Corps:	Zac Corum, PE U.S. Army, Corps of Engineers, Seattle District 206-764-6581

8. MONITORING AND ADAPTIVE MANAGEMENT SCHEDULE & BUDGET

Given the uncertainty in how the site will evolve over time we conservatively assume that ongoing monitoring will be necessary. The first round of monitoring will occur beginning 1 year from project completion. Follow on monitoring will be conducted every year for 10 years (a total of 10 monitoring efforts, encompassing one year of data per effort). The monitoring data will be evaluated to determine if adaptive management is required. If so, it would be implemented the following year to allow time for permitting and design. It is assumed that floods larger than a 5-year recurrence interval would necessitate some amount of adaptive management to nudge the site to a fully sustainable condition 10 years from project completion. After 10 years routine O&M will be conducted by the non-Federal sponsor to address any additional monitoring and adaptive management. With expected stabilization resulting from revegetation of disturbed areas the need for adaptive management should decrease with time.

The project cost share for Monitoring and Adaptive management phase activities is 75% federal, 25% local. The monitoring work is estimated to be 25% of the total $400k reserved for this phase of the project, with the remaining reserved for design, permitting and construction for two rounds of adaptive management. At this time it is assumed that the non-Federal sponsor will oversee and conduct annual monitoring and it is assumed that the Corps will oversee and conduct the adaptive management construction using rental equipment contracts given the limited scope and complexity and emergency nature of the work (restoring critical project elements after flood damage in an ecologically sensitive location). The costs below are preliminary and not escalated over time for inflation or depreciated due to gradually decreasing scope.

Post Construction Year	Monitoring Budget (see note 1)	Adaptive Management Budget (see Note 2)
1	$10k	
2	$10k	$150k
3	$10k	
4	$10k	
5	$10k	
6	$10k	
7	$10k	
8	$10k	$150k
9	$10k	
10	$10k	
total	$100k	$300k

Note 1: It is assumed that for logistical reasons Yakima County public works will conduct all field data collection in support of this monitoring plan as part of a cost shared effort. This data collection to include repeat photographs at permanent photo monitoring points during the critical inundation periods, stage data logger downloads, and running the as-built HEC-RAS hydraulic model with observed stages to compute inundation limits, depths, etc. for comparison with target inundation, and preparing a brief report documenting the data, findings and recommendations. The Corps' role would be reviewing the monitoring data and report and assisting with a determination of need for any necessary adaptive management. Monitoring reports would be produced bi-annually (years 2, 4, 6, 8, 10) but data will be collected every year. The annual monitoring budget consists of the following activities:

Annual Monitoring Activity	Annual Monitoring Budget
Photo point reoccupation (2 times per year)	$1500
Photo archiving for report appendix	$500
Staff gage logger download (4 times per year)	$2000
Staff gage data processing	$1000
Ortho imagery classification for overhead cover and inundation analysis	$1000
HEC-RAS modeling of depths for critical hydro-periods based on level logger data	$1000
Documentation	$2000

Corps Review	$1000
Total	$10k

Note 2: It is assumed that adaptive management will be cost shared with Yakima County. This work assumed to include a limited design phase and primarily be focused on rough grading activities occurring over a two week duration in the fall. Two projects are anticipated over a 10 year period due to the large size of the site and dynamic river conditions. USACE emergency management equipment rental contracts will most likely be utilized due to the small scope and need for engineer or biologist field direction to successfully implement the work in an ecologically sensitive location:

Adaptive Management Activity	Project Budget
Project Management	$5000
Surveying, permitting, design	$35,000
Emergency Mgt equipment rental contract	$5000
KTR supervision and administration (project engineer + biologist/engineer)	$25,000
Excavation, rough grading	$40000
Hauling, placing, shaping	$40000
Total	$150k

9. LITERATURE CITED

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