RECLAMATION
Managing Water in the West

Kahler Reach Assessment

Nason Creek

Chelan County, Washington

U.S. Department of the Interior

Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

March 2009

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The assessment teams overarching hypothesis on ecosystem processes are:

The proposed potential habitat actions presented in this reach assessment will provide a cumulative benefit that will improve ecosystem resilience at the reach scale; and the processes that naturally create and sustain habitat upon which the species of concern will be maintained or improved resulting in a net increase in abundance, productivity, spatial diversity and structure of the populations.

Cover Photograph – Cobble and boulder substrate near a unit channel of riffle in reach IZ-1, looking northeast downstream. Upper White Pine Reach; Subreach UWP IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett; August 9, 2007.

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Acknowledgements

The Bureau of Reclamation (Reclamation) was fortunate to have the support and cooperation of multiple United States (U.S.) Forest Service staff who participated in the effort to produce the *Kahler Reach Assessment, Nason Creek, Chelan County, Washington*. In particular, Reclamation acknowledges the collaborative efforts and contributions of U.S. Forest Service employees Dave Hopkins, Cindy Raekes, and Cameron Thomas with the integration of the Reach-based Ecosystem Indicators (REI) that is the overarching strength of this reach assessment.

The following Reclamation employee is acknowledged for their peer review of this report: Geologist Terril Stevenson, Geology, Exploration & Instrumentation Group, Pacific Northwest Regional Office.

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Included on the CD on the back cover of this publication are this Reach Assessment report; **Appendix A** - Reach-based Ecosystem Indicator Tables; **Appendix B –** Initial Subreach Assessments; **Appendix C –** Habitat Assessment; **Appendix D –** Vegetation Report; **Appendix E –** UCRTT Biological Rank; and **Appendix F –** Hydraulic Engineering.

EXECUTIVE SUMMARY

Nason Creek is a tributary to the Wenatchee River which flows into the Columbia River in Chelan County, Washington (Figure 1). As part of the Columbia River Basin, Nason Creek contains salmon and steelhead habitat of the Columbia River fish species. Limiting factors identified in this report and in previous reports include riparian condition, streambank condition, channel function, flood plain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007). The species of concern found in Nason Creek include Upper Columbia River spring Chinook salmon (*Oncorhynchus tshawysha*), Upper Columbia River steelhead (*Oncorhynchus mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) which are included in the Threatened and Endangered list under the Endangered Species Act (UCSRB 2007).

The Bureau of Reclamation produced this reach assessment to assist in meeting tributary habitat commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (NMFS 2008). This report provides scientific information to Tribal, State, and local partners for identifying, prioritizing, and implementing sustainable field projects that improve survival and lead to the recovery of salmon and steelhead listed under the Endangered Species Act (NMFS 2008). Three reach assessments on Lower Nason Creek are being completed based on the 2008 field surveys and evaluations. These reach assessments evaluate condition of each reach, the impacts from human activities, and the sustainability of fish habitat within the reach.

Many authors have documented strategies that emphasize restoring processes that form, connect, and sustain habitats (Beechie et al. 1996; Kauffman et al. 1997; Beechie and Bolton 1999; Montgomery and Bolton 2003; UCRTT 2007). Habitat actions of this nature often occur at the site or reach scale. Roni et al. (2002) introduced a hierarchical implementation strategy that places site-specific actions within a watershed context. The Reclamation reach assessment and the previously mentioned objectives purposely feed into this strategy by further telescoping options through Roni's strategy as well as three additional filters of geomorphic potential, river conditions, and specific habitat actions in the *Upper Columbia Salmon Recovery Plan* (UCSRB 2007) at the reach scale. Geomorphic potential and synthesis of the results of the Reach-based Ecosystem Indicators (REI) serve as filters to identify potential habitat actions by subreach unit. In turn, several other layers of information are used to prioritize potential habitat actions within a geomorphic reach context based on results by beginning with protection and transitioning through several forms of active rehabilitation (Figure 2). This so-called stratified strategy is used throughout the Subreach Unit Profile section of the report to assist with the project selection process.

The Kahler reach is located between river miles 4.65 and 8.9 on Nason Creek, a 6th field Hydrologic Unit Code (HUC) watershed (Figure 1). In its natural state, Lower Nason Creek maintained dynamic equilibrium by actively migrating laterally across its floodplain within the Kahler reach. Typically, unconfined geomorphic reaches have flatter slopes and a complex network of channels that result in a high degree of interaction between the active channel and the floodplain. This lateral channel migration helps the stream maintain a flatter channel profile as sediment is stored on the floodplain before being eroded and transported downstream. The natural ecosystem processes of the riparian, hydrologic, and geomorphic regimes create a healthy stream characterized by a dynamic cycle of conversion from stream to floodplain and vice versa, producing a constant renewal of fish habitat. If the interaction between these regimes is altered, it impacts the availability of fish habitat and threatens the continuation of the species within the basin.

Ecosystem processes in the Kahler reach are in a degraded state as a result of human-constructed constraints. The multiple functions associated with the three regimes have been impacted by the dissection of the floodplain by U.S. Highway 2, Highway 207, the hardening of the banks with riprap, and general development within the reach. These features have reduced the overall width of the available floodplain and length of the stream channel. Protection and rehabilitation strategies are recommended to prevent further degradation of the stream ecosystem.

Where restoration is the ultimate aim in many instances, it is realized that a more measured approach is sometimes necessary due to multiple human constraints, including the U.S. Highway 2 and Highway 207. Rehabilitation provides an approach that is consistent with restoration objectives to return critical stream ecosystem function to the best possible condition. In addition, rehabilitation is incremental and iterative in nature to accommodate the notion that complete restoration may not be possible due to anthropogenic structures and/or disturbance regimes. Key rehabilitation strategies include a combination of floodplain reconnection and riparian rehabilitation for promoting a return of natural ecosystem processes. Restoration strategies identified by the Upper Columbia Salmon Recovery Board (UCSRB), consisting of both potential protection and rehabilitation actions, are recommended to prevent further degradation of the stream ecosystem (UCSRB 2007).

Field surveys and evaluations were conducted in the Kahler reach during the summer and fall of 2008 to determine the condition of the riparian, hydrologic, and geomorphic regimes. The three reaches were delineated at the valley segment scale from the refinement of data from the tributary assessment in which two reaches were identified (Reclamation 2008). The three reaches were characterized into two general geomorphic reach types, confined and unconfined, based on natural channel constraints. The confined and unconfined reaches were ranked based on their coarse-scale geomorphic potential.

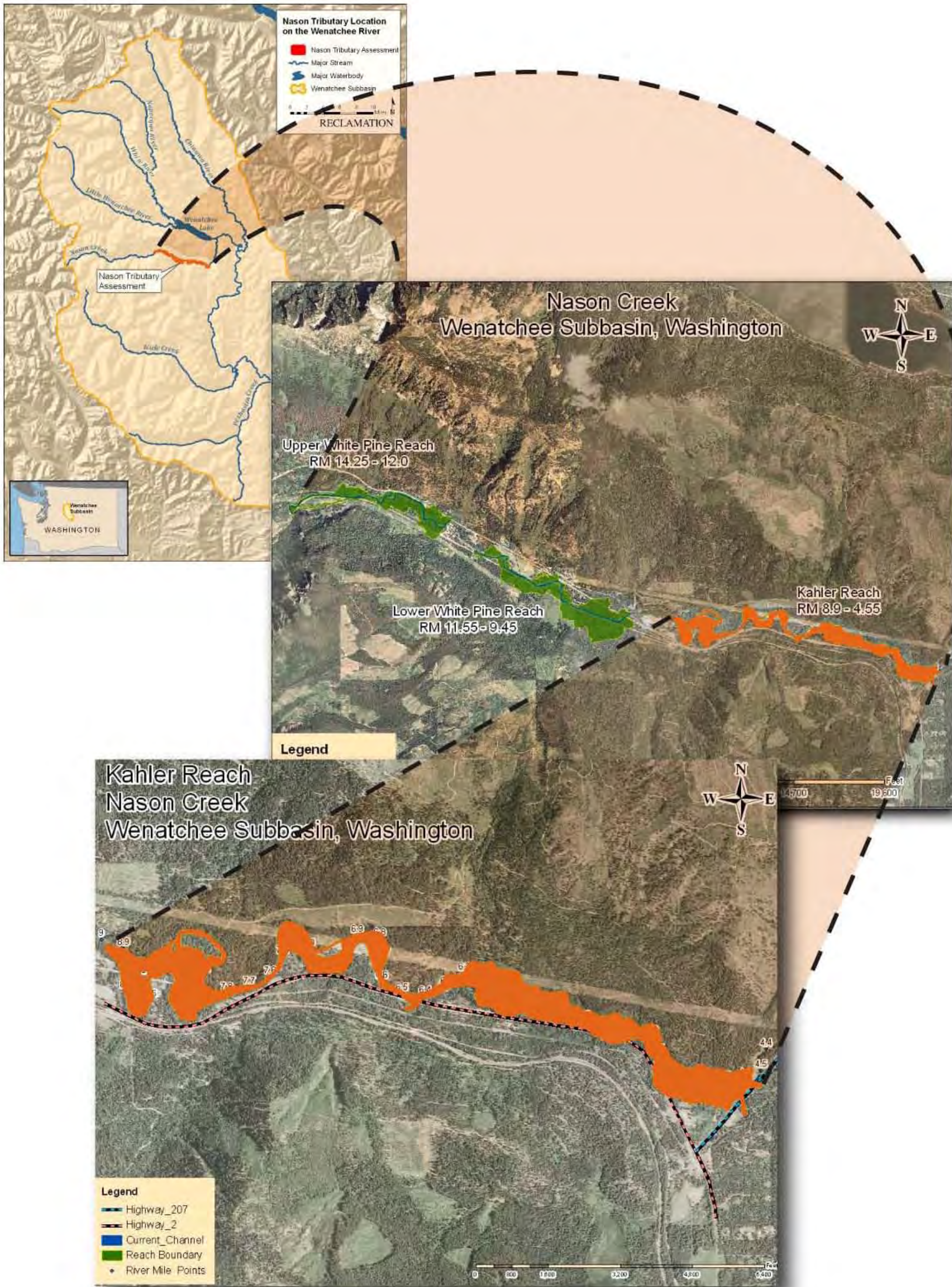


Figure 1 - Location map for the Kahler reach assessment demonstrating the nested geographic relationship of the Wenatchee watershed, Nason Creek tributary assessment area at the valley-segment scale and the Kahler reach assessment study area.

Figure 2 - Inner and Outer Zones of the Kahler Reach, Nason Creek, Wenatchee Subbasin, Washington.

Purpose of the assessment: Refine understanding of geomorphic potential within the Kahler reach and establish environmental baseline conditions to assist in the local selection, implementation, and monitoring of potential habitat actions that will address the limiting factors through the rehabilitation of habitat-forming processes.

Goal of the assessment: Provide sound integrative river science that will assist the local watershed action group in the development of an implementation strategy and aid in project selection. The reach assessment had these objectives:

1) Determine the functional arrangement of physical and biological components of the reach.
2) Establish an understanding of the predominant physical processes.
3) Interpret and document the problems.
4) Propose potential solutions.
5) Develop a recommended prioritization of the subreaches to be utilized by local watershed action groups when developing an implementation strategy and the selection of projects.

This reach assessment establishes environmental baseline conditions in Kahler reach by examining fluvial geomorphic forms and processes (i.e., those landforms and processes that are related to the movement of flowing water) and assessing their influences on forming and maintaining fish habitat at the reach scale. A reach is comprised of smaller scale components that include the active main channel, the floodplain, and off-channel areas which are called subreaches. Subreaches are delineated by lateral and vertical controls with respect to the presence or absence of inner or outer zones (Figure 2). An inner zone (IZ) is an area where ground-disturbing flows take place, such as the active main channel or related side channels (USFS 2008). An outer zone (OZ) is an area that may become inundated at higher flows, but does not experience a ground-disturbing flow. The outer zone, also known as the floodprone width, is typically a terrace that is generally coincidental with the historic channel migration zone except where the channel has been modified or incised, cutting the creek off from the historic floodplain.

The river condition describes the current state of fluvial processes and their relationship to habitat-forming processes. Human features can be analyzed to establish their impacts to the current river condition. Subsequently, the river condition provides a baseline for comparisons in future references. In the instance of the Kahler reach, the habitat-forming processes have been unfavorably impacted, with over 93 percent of the river condition indicators in a degraded condition (i.e., one of the indicators is at unacceptable risk and ten out of twelve are at risk as shown in Table 3). With the exception of habitat access, all other pathways have at least one river condition indicator functioning in an at-risk or unacceptable-risk condition.

This is indicative of impaired habitat-forming processes. Three indicators in particular, large woody debris, pool quality, and floodplain connectivity, are symptomatic of the larger issue of lost geomorphic potential. Reclamation defines geomorphic potential as the capability of adjustment or change in process/structural components of an ecosystem through the combined interaction of hydrologic, riparian, and geomorphic regimes to form, connect, and sustain fish habitat over time.

The geomorphic potential has been altered through the dissection of the floodplain by U.S. Highway 2, Highway 207, riprap associated with both highways, and general development within the reach. The result is a diminished capacity to dissipate stream power; a reduced ability to migrate in subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5; and very little off-channel habitat for fish rearing (Figure 3). At low flow, only about 1.5 percent of the habitat area consists of side channels and off-channel habitat. The inability to decrease stream power promotes incision of the channel bed; reduces heterogeneity of channel units; decreases large woody debris recruitment and retention; decreases deposition of spawning gravel; and reduces nutrient supply and storage in the connected inner zones. Impaired channel migration and the disconnection of the floodplain reduce the ability of the stream to rejuvenate ecosystem functions, such as riparian vegetation and substrate throughout the current main channel of the reach.

Over 5 percent of the Kahler reach does not contribute to habitat-forming processes through the interaction of hydrologic, riparian, and geomorphic regimes. Figure 3 shows a prioritization of each subreach unit for the Kahler reach. A dual focus approach would concentrate on both protection and rehabilitation goals necessary for reestablishment of geomorphic potential and healthy stream conditions (Table 3). The rehabilitation goals would address two types of subreaches. The first type addressed by rehabilitation actions are those subreaches that are currently disconnected by the highways or other human features. Subreaches of particular interest include DIZ-1 and DIZ-2, along with historic outer zone areas of DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. The second type of subreach addressed by rehabilitation actions are the outer zones that have impacted habitat units and include subreaches OZ-1 through OZ-19. This cooperative effort could be executed in conjunction with the protection goals that will complement reconnection of the disconnected subreaches and the connected subreaches that lack habitat. Potential habitat actions are identified and prioritized based on several key parameters established in the reach assessment.

A dual focus approach is expected to run in parallel with a measured difference in timing for implementation. Protection goals are a series of potential habitat actions that will complement the reconnection of the disconnected subreaches. Potential protection actions necessary in the short term include land acquisition or lease and stream bank and wetland protection. The rehabilitation goals covering the disconnected subreaches is a long-term enterprise requiring the full cooperation of the State of Washington Department of

Transportation as well as local landowners. Potential rehabilitation actions should be considered as components of a comprehensive strategy to reinitiate habitat-forming processes and include relocation or modification of the highway and/or culverts; unimproved road relocations or removals; small bridge placements; culvert removals, modifications, or replacements; riparian plantings and noxious weed eradication; and instream structures.

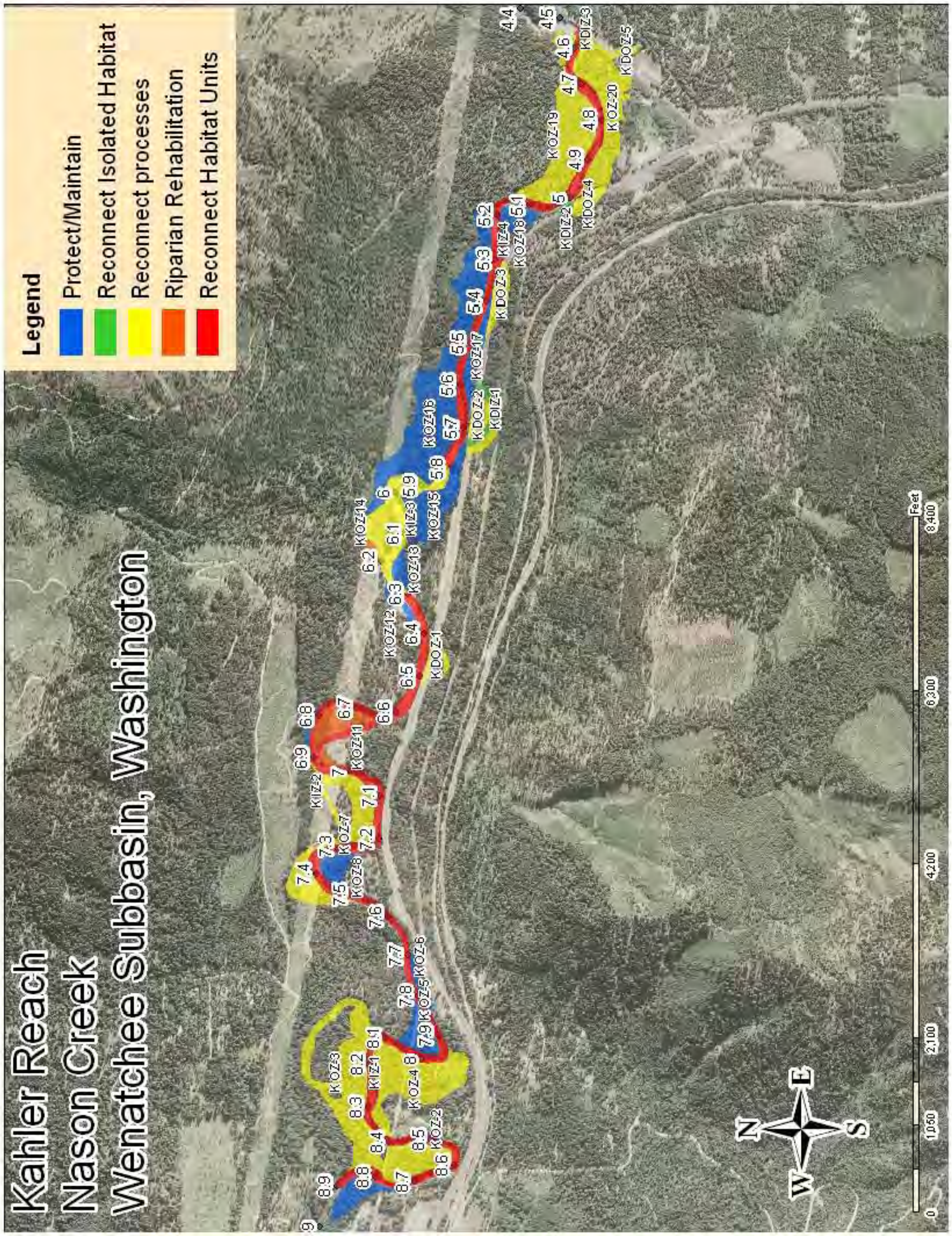


Figure 3 - A spatial representation of a prioritized rehabilitation approach for the Kahler reach by subreach unit.

OVERVIEW

Assessments are hierarchically nested to address the spatial and chronological scales of an ecosystem (Figure 4). Assessments telescope from the largest scale called a basin to a smaller scale called a reach from which habitat actions are implemented. This is called a top-down approach. After implementation of a habitat action, monitoring of the physical and biological variables telescope in reverse from the reach to the basin, called a bottom-up approach, from which intervention analysis or monitoring may be conducted on the status of the species of concern. This nesting approach enables development of an overall understanding of the ecosystem's current and historic conditions and how the species of concern and stream processes such as the creation and maintenance of aquatic habitat have been affected.

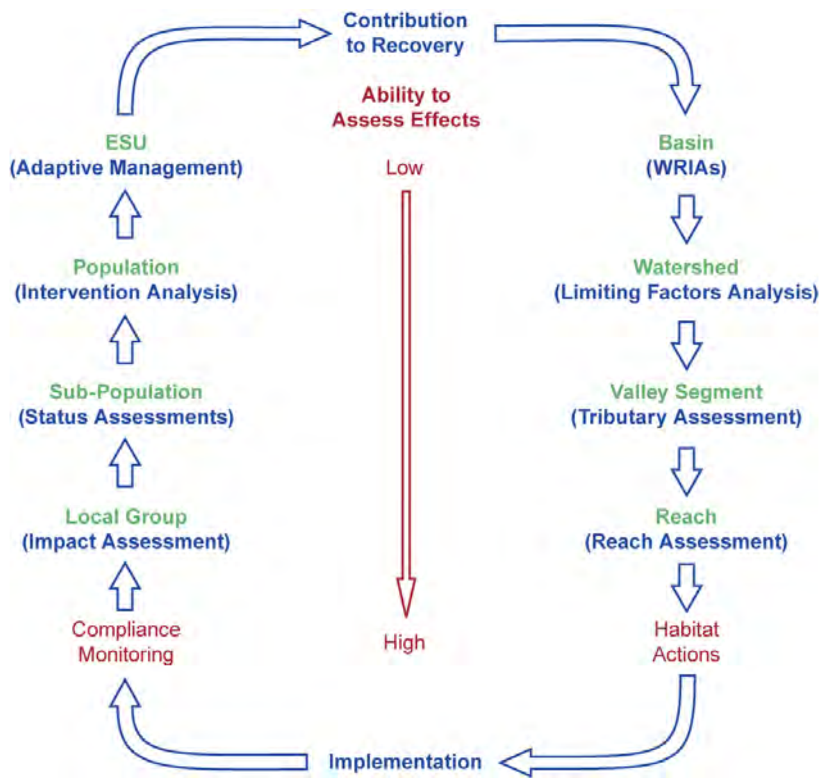


Figure 4 - Idealized model showing how assessments and monitoring are hierarchically nested and related. Clockwise from the top, Compiled from Hillman (2006), UCSRP (2007), and Stewart-Oaten and Bence (2001).

Tributary assessments can be conducted to further analyze impaired stream processes and their effects and to provide a prioritized list of geomorphic reaches based on floodplain or valley confinement (i.e., confined, moderately confined, and unconfined). Not all reaches require a reach assessment. For example, naturally confined reaches that are not severely degraded and pose little risk to property and infrastructure may not need a reach assessment. Reach assessments are generally recommended for moderately to unconfined geomorphic reaches where complex processes have been degraded and where the implementation of habitat actions may pose risks to property and infrastructure. Even in instances where a reach assessment is not conducted, some baseline data should be collected prior to implementing any habitat action so that the action can be monitored for effectiveness.

The purpose of a reach assessment is to refine understanding of the geomorphic potential within a reach and establish environmental baseline conditions at the reach-scale. The reach assessment evaluates the current condition of a group of indicators. The physical variables, which are quantifiable and have geospatial reference, are organized in a reach-based ecosystem indicator matrix (REI). Incorporating quantifiable biological variables into the REI is currently being done by the Bureau of Reclamation (Reclamation). The variables measured in the REI record the baseline environmental conditions and are hierarchical in nature in that they are used as information about the condition of higher-level indicators called pathways. The REI identifies deficiencies in the vegetation, geomorphic, and hydrologic regimes upon which habitat actions can be implemented using a cost effectiveness approach.

Following implementation of a habitat action or series of actions, the action is documented by including what was done, where it was done, and why it was done (i.e., compliance monitoring). After several habitat actions have been implemented in a reach, an impact assessment can be completed using a subset of the physical variables from the REI based on the overall intent of the actions (i.e., reconnect isolated habitats).

Status assessments that document changes to physical and biological variables can be used to evaluate how the ecosystem and the species of concern are responding to the habitat actions. This is known as an intervention analysis to determine if the overall response is positive. If the response is positive, then the actions were effective and there is no need for adjustments. If the response is flat or negative, the habitat actions may need to be adjusted within an adaptive management framework. These checks and balances are intended to improve the habitat of the species of concern and ultimately contribute to their recovery.

PURPOSE AND LOCATION

Reclamation produced this report to help meet tributary habitat commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (NMFS 2008). This report provides scientific information to help identify, prioritize, and implement sustainable field projects in collaboration with Tribal, State, and local partners that improve survival and lead to the recovery of salmon and steelhead listed under the Endangered Species Act (NMFS 2008).

The goal of a reach assessment is to set up local stakeholder processes for project selection based on sound integrative river science, through the following objectives:

- *Determining the functional arrangement of physical and biological components of the response reach.* Establish the geomorphic potential of the river reach through a spatial framework and relevant scaling relationships for the assessment area. This is done through scaling down the response reach to individual subreaches and channel/geomorphic units, which are smaller scale structural components of the reach. Subreach units are comprised of the active main channel, floodplain, and off-channel areas. A local geomorphic regime has inherent constraints and capabilities for forming, connecting, and sustaining aquatic river habitat.
- *Establishing an understanding of the predominant physical processes.* Identify linkages between physical processes and anthropogenic impacts based on the understanding of the key physical processes operating in the reach or within and among the context of subreach units; and identify how these processes have been impacted by past and present human activities.
- *Interpreting and documenting the problems.* Diagnose river conditions at the reach-scale based on integrating physical, biological, and habitat information into an REI. The REI is a diagnostic tool for measuring baseline environmental baseline conditions and identifying deficiencies in three regimes: geomorphic, vegetation, and hydrologic.
- *Proposing potential solutions.* Identify and prioritize potential habitat actions at the subreach scale that support the greatest cumulative biological benefit based on a refined understanding of the geomorphic potential and environmental baseline conditions.
- *Developing a recommended prioritization.* Develop a recommended prioritization of the subreaches based on refined understanding of geomorphic potential and ecosystem conditions to be utilized by local watershed action groups when developing an implementation strategy and the selection of projects.
- *Presenting the results to the local group for project selection.* Use the proposed implementation strategy along with other local factors provided by local stakeholders and partners to discuss a synthesis of all available information and ultimately, an implementation time line.

Nason Creek is a tributary to the Wenatchee River, Chelan County, Washington (Figure 5). A total of three reach assessments on Lower Nason Creek are being completed sequentially based on summer and fall of 2008 field surveys and evaluations. Collectively, the three reach assessments will provide a foundation for a holistic, comprehensive strategy for rehabilitation and protection at the scale of the valley segment (Figure 6).

The Kahler reach is located between river miles (RM) 4.65 and 8.9 on Nason Creek, a 6th field Hydrologic Unit Code (HUC 170100100104) watershed within the Eastern Cascade Section of the Cascade Province (Hillman 2006). The species of concern found in Nason Creek include Upper Columbia River (UCR) spring Chinook salmon (*Oncorhynchus tshawysha*), UCR steelhead (*Oncorhynchus mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) (UCSRB 2007).

Limiting factors at the watershed scale that are the result of various anthropogenic impacts include riparian condition, streambank condition, channel function, floodplain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007).

The Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan identified potential restoration strategies based on a combination of available data, aquatic ecosystem modeling, and professional judgment of a panel of scientists (UCSRB 2007). Further technical evaluation was recommended to refine the level of detail needed to implement projects and determine if the recommendations are sustainable and compatible with the geomorphic conditions of the river. Regarding physical processes, the Upper Columbia Salmon Recovery Board (UCSRB) recommends conducting additional research to identify priority locations for protection and rehabilitation and examining fluvial geomorphic processes to assess how these processes affect habitat creation and maintenance. This reach assessment is intended to address those recommendations.

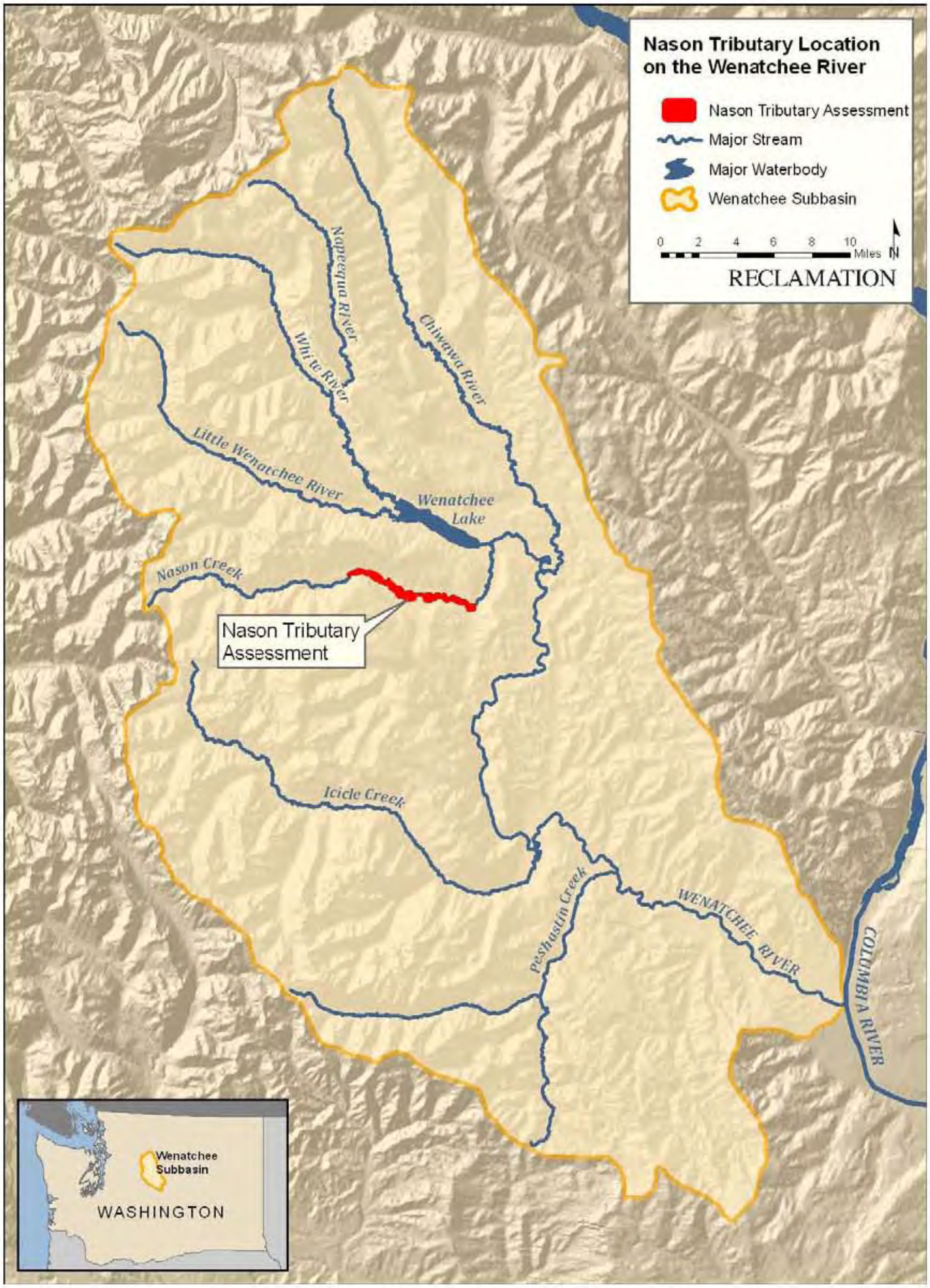


Figure 5 - Location map of Nason Creek within the Wenatchee subbasin. The section in red notes the valley segment that was examined in the tributary assessment.

Figure 6 - Location map with river miles for the three response reaches identified in the Nason Creek Tributary Assessment, Chelan County, WA.

TRIBUTARY ASSESSMENT

Previously identified watershed-scale limiting factors are typically the result of various anthropogenic impacts and include riparian condition, streambank condition, channel function, floodplain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007). The *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007) has identified potential restoration strategies based on a combination of available data, aquatic ecosystem modeling, and the professional judgment of a panel of scientists. The Plan recommends refinement of existing data and/or the collection data at the appropriate scale that will allow habitat actions to be implemented.

The Nason Creek Tributary Assessment, Chelan County, Washington (Tributary Assessment) was completed by a multidisciplinary team of hydraulic engineers, geologists, hydrologists, biologists, and botanists (Reclamation 2008). The focus of the Tributary Assessment was to complete a comprehensive geomorphic analysis of the fluvial system along about 10 miles of Nason Creek located in the Wenatchee subbasin in Chelan County, Washington (Figure 5).

The objectives of the Tributary Assessment were to (1) delineate and characterize channel reaches on the basis of their geomorphic characteristics and biological opportunities and develop potential rehabilitation strategies organized on a reach-based approach; (2) provide technical ranking of the geomorphic reaches that can be used to prioritize the potential habitat protection and improvement areas within the assessment area based on linkage to primary limiting factors for salmon recovery; (3) identify the recurrence intervals of natural and human-induced disturbances and how they affect channel processes within the assessment area; and (4) evaluate the habitat-forming physical processes and disturbance regimes working at the subbasin and reach scales from both historical and contemporary context (Reclamation 2008).

At the tributary scale, three reaches were delineated and characterized into two general geomorphic reach types based on natural channel constraints, referred to as confined and unconfined geomorphic reaches (a third geomorphic reach type, moderately confined, was not encountered; see Table 1). The unconfined and confined reaches were ranked based on their geomorphic potential. The confined reach identified as Reach 2 in the Tributary Assessment was not assessed. The White Pine reach had the higher geomorphic potential and the largest impact from anthropogenic features within the low surface (i.e., more departed from a natural condition). The Lower White Pine and Upper White Pine reach assessments were completed in February and March 2009 respectively for the White Pine reach.

The White Pine reach was initially identified as geomorphic reach 3 in the Tributary Assessment. Refined mapping and analysis performed for this reach assessment further delineated this area into two response reaches, the Upper and Lower White Pine, that are separated by a confined reach (reach 4) located at river miles 11.55 to 12.0 (Table 1).

Table 1 - Geomorphic Reach and response reach location by river mile, reach type, and floodplain area for Upper Nason Creek between RM 4.5 and RM 14.3 (Reclamation 2008).

Geomorphic Reach Designation (Reclamation 2008)	Reach Assessment Name	River Miles	Reach Type	Total Floodplain Area (Approximate Acres)
Reach 1	Kahler	4.5 - 8.9	Unconfined	about 221
Reach 2	Reach 2	8.9 - 9.42	Confined	about 14
Reach 3	Lower White Pine	9.42 - 11.55	Unconfined	about 229
	Reach 4	11.55 - 12.0	Confined	
	Upper White Pine	12.0 - 14.25	Unconfined	about 135

Within the Kahler reach, there has been no large-scale change to the balance between incoming water and sediment loads that would indicate a potential for incision or aggradation (Reclamation 2008); however, several sections of the river within the reach have been artificially straightened and confined by bank hardening. Highway 2 disconnects Nason Creek from its tributaries. The absence of sediment that would have been provided indicates a potential for increased sediment transport capacity and possible incision.

The largest impact to physical processes and habitat is the Highway 2 realignment and widening in the 1960s. The impacts of these features include channel straightening and relocation, reduced channel migration, reduced floodplain connectivity, altered sediment and large woody debris delivery and retention, and disconnected tributaries and groundwater sources from the main channel. Bridges, small levees, and the power line corridor also impact physical processes, but to a more localized degree.

The Kahler reach assessment provides the recommended technical evaluation to refine the level of detail necessary for selecting and implementing potential habitat actions. The reach assessment establishes environmental baseline conditions tied into a geospatial reference. This is done through an in-field evaluation of fluvial geomorphic form and processes. In turn, this reach-based baseline can be used to assess the influence and feedback on habitat formation and maintenance over time.

REACH CHARACTERIZATION

The Kahler reach encompasses about 221 acres of floodplain and active channel of Nason Creek within an alluvial valley from RM 4.55 to 8.9. The current channel and active floodplain are located to the north of Highway 2 (Figure 7). The valley bottom is classified as a U-shaped trough with a valley bottom gradient of less than 1 percent and a slightly confined, moderately sinuous channel (Naiman et al. 1992). The stream type is C and F type (Rosgen 1996) showing evidence of slight to moderate incision with predominantly riffle and run bedform (Montgomery and Buffington 1993) and cobble as the dominant substrate. Landforms typically include alluvial and glacial deposits comprising terraces and alluvial fans (Hillman 2006). Alluvial fan and terrace deposits with large substrate provide lateral and vertical channel controls.

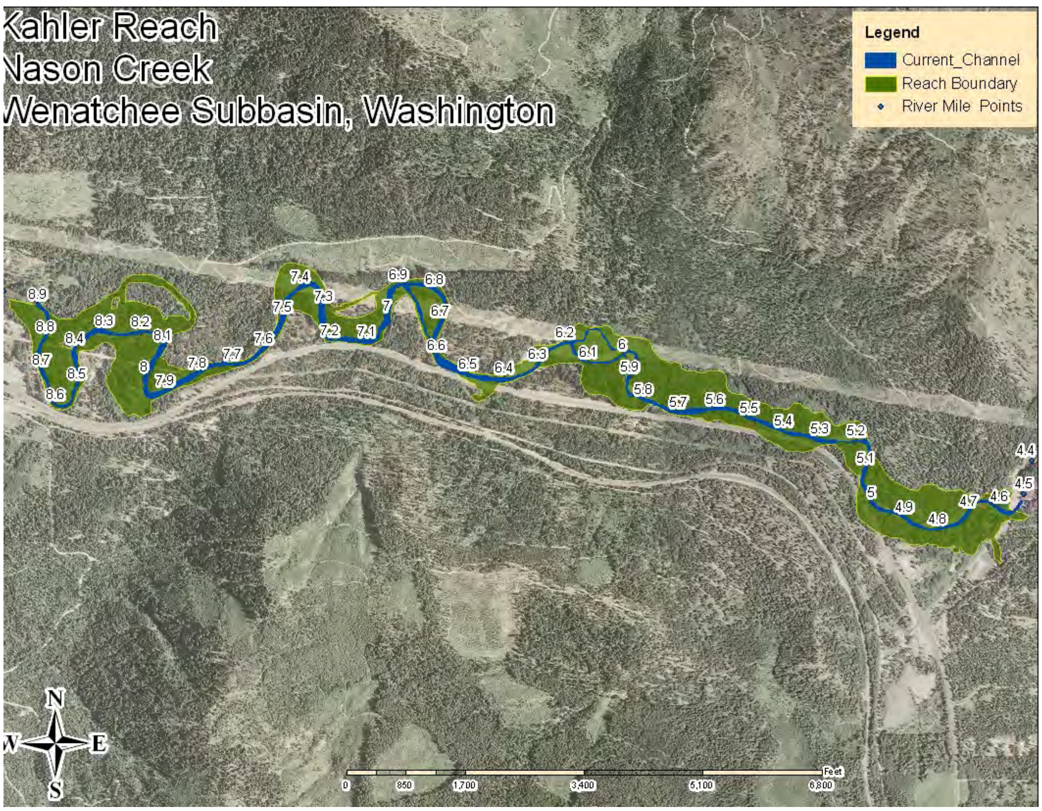


Figure 7 - Refined reach delineation and boundary conditions of the Kahler Reach.

Table 2 - Acres by zone type on the Kahler reach, Nason Creek, Wenatchee Subbasin, Washington.

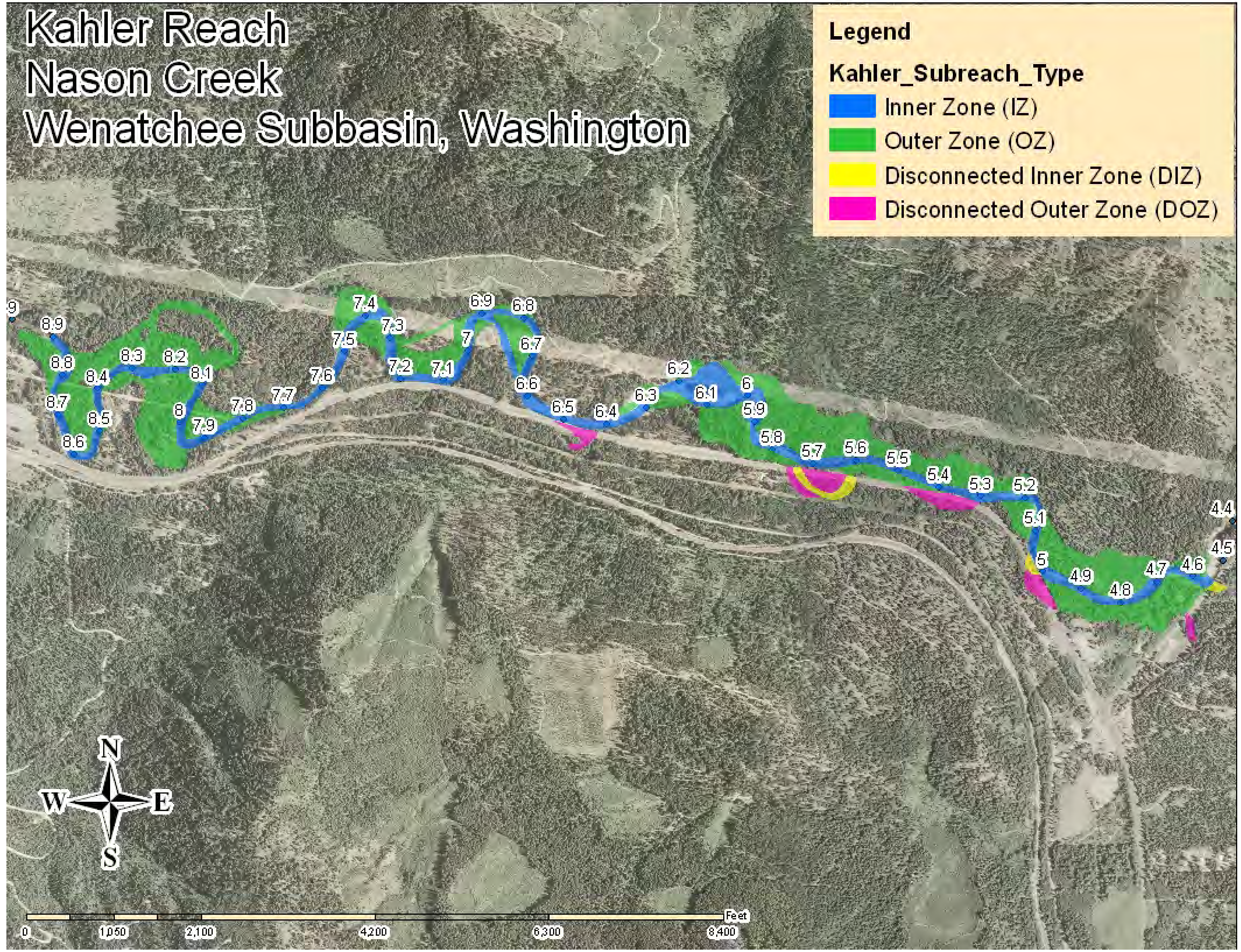
Inner Zone	Connected Outer Zone	Disconnected Outer Zone	Disconnected Inner Zone
60 Acres	147 Acres	11 Acres	3 Acres

The reach is comprised of the active main channel, floodplain, and off-channel areas. The reach was further broken down into two types of morphologically distinct areas or subreach unit types to denote greater local control and variability. Called inner and outer zones, these subreach unit types essentially represent areas of existing and potential habitat formation and maintenance within the response reach. Subreaches are delineated by lateral and vertical controls based on the presence/absence of inner or outer zones processes (Figure 8). An inner zone (IZ) is characterized by the presence of primary and secondary side channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition. It is generally associated with ground-disturbing flows with sufficient frequency that mature conifers are rare and a distinct hardwood zone is identifiable (USFS 2008). In the instance of the active main channel, it was further subdivided into six inner zones based on the mapping of channel units (Figure 9 and Figure 10).

In contrast, an outer zone (OZ) also known as the floodprone width, is typically a terrace tread and generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. This zone includes overflow channels, wetlands, and other off-channel habitat and is usually predominated by riparian vegetation and hillslope processes. An outer zone is further distinguished from an inner zone by the presence of flood deposits, a change in vegetation, and bounding geologic landforms such as an older terrace, bedrock or valley wall, alluvial fan, colluvium, or glacial deposits.

The highway disconnects sections of inner and outer zones from the active channel and floodplain that total about 3 percent of the total reach area. Table 2 summarizes the number of acres in the inner and outer zones.

Figure 8 - Image showing Inner and Outer Zones of the Kahler Reach, Nason Creek, Wenatchee Subbasin, Washington.



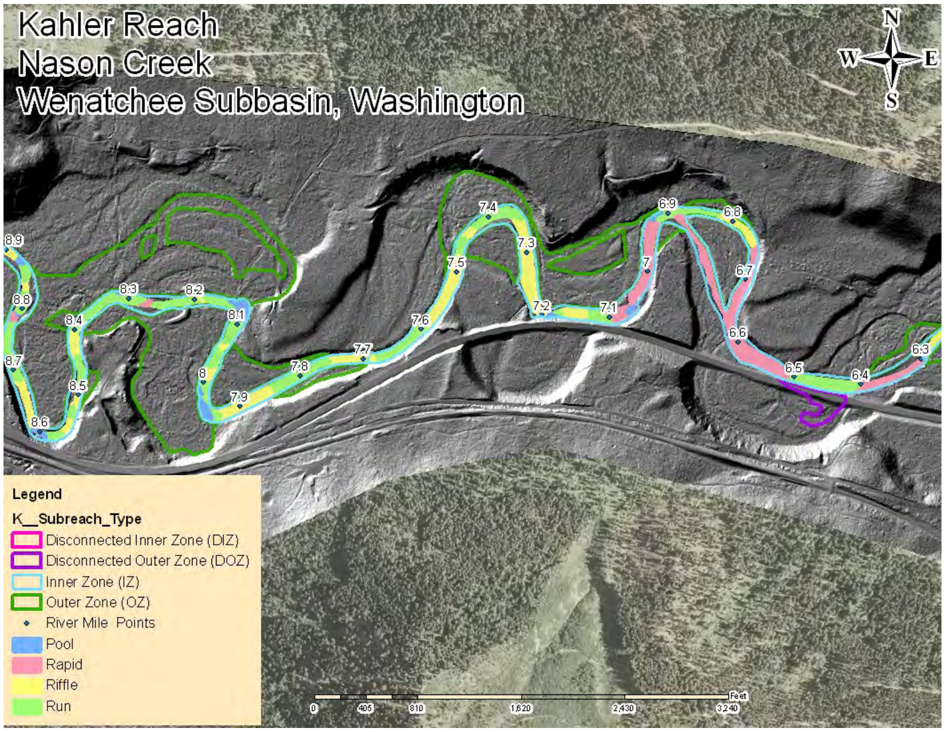


Figure 9 - Channel unit mapping of the upper portion of the Kahler Reach including subreach unit boundary conditions.

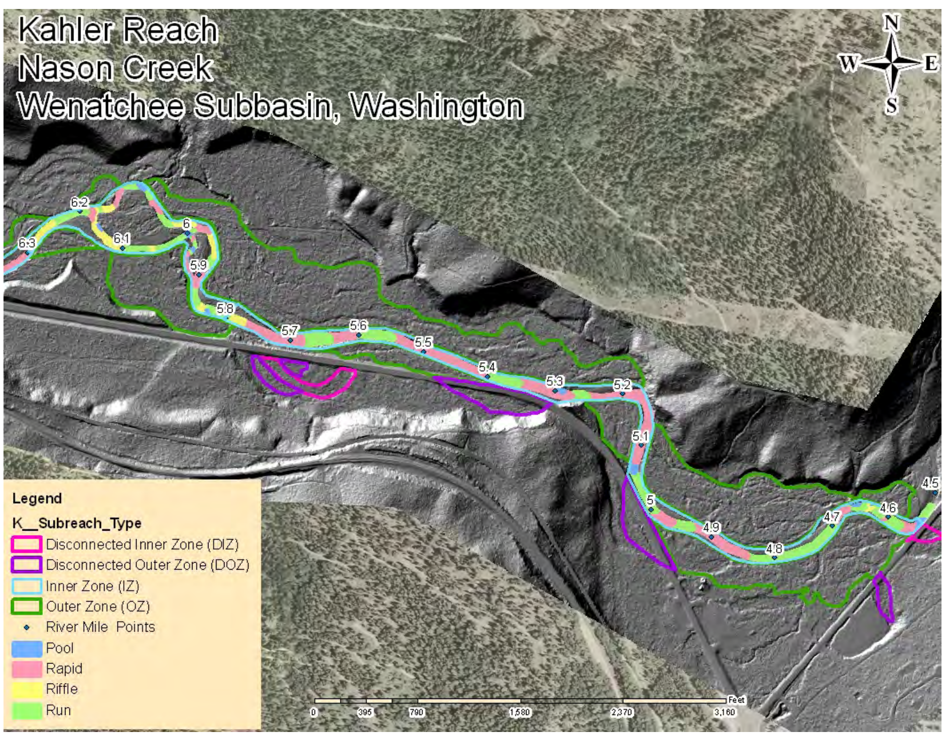


Figure 10 - Channel unit mapping of the lower portion of the Kahler Reach including subreach unit boundary conditions.

RIVER REACH CONDITION

The river reach condition is a combination of all information available at the time of the investigation. The REI matrix is a compilation of the information and data collection from multidisciplinary analyses that were conducted prior to or during this investigation (Appendix A). Specific data collected and documented within separate disciplinary analyses are the Initial Site Evaluations (Appendix B), Level 2 Habitat Assessment (Appendix C), and two-dimensional (2D) Hydraulics and Sediment Analysis (Appendix H, Reclamation 2008). The biological ranking of the subreaches was performed by the Upper Columbia Regional Technical Team (RTT) subcommittee (Appendix G).

River condition limiting factors are determined by measuring and synthesizing results from indicators within five pathways: water quality, habitat access, habitat quality, channel dynamics, and riparian vegetation. The indicators measured in the REI record baseline environmental conditions which are indicative of the condition of higher-level indicators such as pathways. The synthesis of the collected information provides a “snapshot” understanding of the combined condition of the geomorphic, riparian vegetation, and hydrologic regimes. In turn, this information is used to develop an overall interpretation of reach-based river conditions with respect to the primary limiting factors.

Based on the best available information and measurements from the field evaluation, each indicator was determined as functioning at one of three conditions: adequate, at risk, or unacceptable risk, based on criteria contained in the REI. Table 3 shows the results of the REI.

Table 3 - Summary results of the reach-based ecosystem indicators (REI) for the Kahler reach. Each indicator was interpreted to be in one of three conditions: *adequate*, *at risk*, or *unacceptable risk*.

Pathway	Reach-based Indicator (REI)	Condition
Water Quality	Temperature	Unacceptable Risk
	Turbidity	At Risk
	Chemical Contaminants/Nutrients	At Risk
Habitat Access	Physical Barriers	Adequate
Habitat Quality	Substrate	At Risk
	LWD	At Risk
	Pool Frequency and Quality	At Risk
	Connectivity w/ Main Channel	At Risk
Channel Condition and Dynamics	Floodplain connectivity	At Risk
	Bank Stability/Channel Migration	At Risk
	Vertical Channel Stability	At Risk
Riparian Vegetation	Structure	At Risk
	Disturbance	At Risk
	Canopy Cover	At Risk

The following are summary results of reach-based conditions:

- 1 of the 14 indicators is at unacceptable risk.
- 12 of the 14 indicators are at risk.
- 1 of the 14 indicators is adequate.

Limiting factor indicators should be monitored to gauge the response of the creek to the implemented actions. The assessment team suggests that monitoring these indicators may provide pro-active opportunities to maintain or improve the overall ecosystem resiliency of the Kahler response reach.

Following implementation of a habitat action or series of actions, the action is documented by including what was done, where it was done, and why it was done (i.e., compliance monitoring). After several habitat actions have been implemented in a river reach, an impact assessment can be completed using a subset of the physical variables from the REI based on the overall intent of the actions such as reconnection of isolated habitats.

At the reach scale, the ability to assess both the physical and biological effects of the actions is considered high (Hillman 2006). Improvements made to physical variables coupled with the biological variables (i.e., status and trend) can be used to evaluate the ecosystem's response and whether the species of concern are responding. If the response is positive, the actions were effective and there is no need for adjustment. If the response is flat or negative, adaptive management may be needed for implementation of additional habitat actions to achieve the desired effect. These checks and balances are intended to improve fish habitat upon which the species of concern depend for their recovery.

Water Quality

The condition of the water quality pathway throughout the reach is at risk based on indicators of temperature, turbidity, and chemical contaminants. Temperature is at unacceptable risk, due to the replacement of bank vegetation with riprap within the reach, along with upstream factors and contributions (Thomas 2007). Temperature surveys indicated the stream fluctuates from 18.4° C to 14.8° C upstream of the Kahler reach (Watershed Sciences 2003). Cooling was noted around the area of White Pine campground, but temperatures increased steadily downstream to the Wenatchee River (Watershed Sciences 2003). Turbidity issues stem from increased timber harvest roads and development (UCSRB 2007). The indicator of chemical contaminants and nutrients is interpreted to be at risk due to current water use or withdrawals upstream.

Although the water quality pathway and the associated indicators are an issue at the watershed scale, impacts to the indicators can be attributed to acute problems observed at the subreach scale within the Kahler reach. For example, by drawing a 10-meter buffer zone along the banks of the channel, the condition of canopy cover for shading can be quantified by looking at the seral stage and composition of the riparian vegetation. Subreaches OZ-7, OZ-9, OZ-11, and 0Z-14 with greater than 20 percent disturbed vegetation likely contribute to the temperature issue. Given the overall young seral stage, those subreaches likely contribute to the at-unacceptable-risk condition of temperature to varying degrees. Subreaches DIZ-1 impounds runoff and groundwater behind the highway. That impounded water will likely increase in temperature before it enters the main channel if inadequate shading exists along the perimeter of the wetlands. Upon entering the main channel, the impounded water contributes to the temperature condition of the reach.

Habitat Access

The condition of the habitat access pathway is adequate given that there are no barriers on the mainstem.

Habitat Quality

The habitat quality pathway is at risk due to the following conditions: (1) lack of large woody debris in the channel; (2) pool quality; and (3) culverts placed through the highway embankments to drain runoff water and base flow. The culverts do not provide adequate fish passage to isolated pockets of habitat.

Multiple subreaches contribute to an at-risk condition for habitat quality through the indicator of large woody debris in the channel. The connected inner zones IZ-1, IZ-2, IZ-3, and IZ-4 contribute through a low large woody debris count. Subreach inner zone IZ-3 was noted to have higher large woody debris counts, but it was concentrated in four complexes at RM 5.3, RM 7.0, and RM 6.2 where two were located (Appendix C). Disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5 cannot contribute large woody debris to the system. Low in-channel wood counts and diminished amounts of large wood available for recruitment from the subreaches listed above contribute directly to an at-risk pool frequency and quality condition within the inner zones. The indicator of connectivity with the main channel is impacted in the disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and, DOZ-5 where anthropogenic features including the highway disconnect existing habitat from the current channel and/or where culverts do not allow access to off-channel habitat at base flow.

Channel Dynamics

The channel condition and dynamics pathways are at risk. The impacts on floodplain connectivity of Highway 2 have been well documented (Andonaegui 2001; UCSRB 2007; UCRTT 2007). Bank stability and channel migration are affected by Highway 2, but are also impacted by bank hardening with riprap and clearing of riparian vegetation.

The current channel and floodplain are to the north of Highway 2. The highway disconnects fluvial processes in one inner and multiple outer zones of the active channel and floodplain that total about 3 percent of the reach. The disconnection of fluvial processes results in a reduction of lateral channel migration and floodplain connectivity. Subreaches that contribute to the at-risk condition of the floodplain connectivity indicator are the disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. Subreach inner zones IZ-1, IZ-2, IZ-3, and IZ-4 contribute to an at-risk condition for the bank stability and channel migration indicators. Where the active channel is channelized, or banks of the inner zone are hardened with riprap, no lateral migration occurs. This increases the potential of vertical migration. Observations were made of accelerated channel migration at locations where riprap is not present and riparian vegetation is removed along banks.

Riparian Vegetation

The riparian vegetation pathway is at risk. Although the riparian composition at the floodplain width may have a high percentage of native species, the available large wood is only about 30 percent for the entire reach. The riparian disturbance indicator is at risk given that about 11 percent of floodplain vegetation has been disturbed by way of clearing and/or modification to some degree. The percentage of mature or late seral stage vegetation in the 30-meter buffer is acceptable only in one outer zone, thus large wood recruitment potential is impaired (USFS 2008).

The indicator of canopy cover is also at risk. About 12 percent of the vegetation in the 10-meter buffer zone is large diameter (Hillman 2006). The common factor with all three indicators is a low percent of large diameter trees (USFS 2008). Additionally, the disconnected inner and outer zone subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5 have disturbed vegetation that is greater than 20 percent of the total area of the subreach.

DISCUSSION

The river condition describes a baseline or current condition of fluvial processes and their relationship to habitat-forming processes. Human features can be placed within a context when using current river condition to establish their impacts. In the instance of the Kahler reach, the diagnosis is not favorable with over 93 percent of the indicators in either an at-risk or unacceptable-risk condition. With exception of habitat access, all other pathways possess at least one indicator with observed degraded condition of at risk or unacceptable risk. Three indicators in particular, large woody debris, pool quality, and floodplain connectivity, are symptomatic of a larger issue of lost geomorphic potential or the potential for geomorphic regime change. Geomorphic potential is essential in forming, connecting, and sustaining fish habitat because of the combined influence of hydrologic, riparian, and geomorphic regimes over time.

The multiple functions associated with all three regimes have been impacted through the dissection of the floodplain by Highway 2, hardening of the banks with riprap, and disturbance of vegetation. These features have reduced the overall width of the available floodplain, length of the stream channel, and fluvial-riparian interactions. The result is a diminished capacity to dissipate stream power and a reduced ability to migrate in the subreaches. The outcome is very little off-channel habitat exists for rearing fish. At low flow, only about 1.5 percent of the habitat area consists of side channels and off-channel habitat. An increase in stream power promotes incision, reduces the diversity of channel units, decreases large woody debris recruitment, decreases spawning gravel and large woody debris retention, and reduces nutrient supply and storage in the connected inner zones.

Impaired channel migration and the disconnection of the floodplain reduce the ability of the stream to rejuvenate ecosystem elements, such as riparian vegetation and substrate, throughout the current main channel of the reach.

Typically, unconfined geomorphic river reaches have flatter slopes and a complex network of channels and large woody debris that result in a high degree of interaction between the active channel and the floodplain. Prior to human impacts, Lower Nason Creek maintained dynamic equilibrium by actively migrating laterally across its floodplain within the Kahler reach. This lateral channel migration helped the river maintain a flatter channel profile as sediment was stored on the floodplain before being eroded and transported down gradient. The result was a dynamic cycle of conversion from river to floodplain and vice versa and with it, continual renewal of fish habitat.

In a properly functioning system, the average channel bed elevations within the reach do not change over time so that there is no net change in the total volume of sediment stored in the reach beyond a natural range of fluctuation (Reclamation 2008). Lateral channel migration and floodplain connectivity are especially critical in the Kahler reach to maintain the following at optimal levels that will create, maintain, and rejuvenate habitat:

- Riparian structure and composition
- Groundwater recharge
- Water temperature
- Stream power
- Large woody debris recruitment and retention
- Spawning gravel recruitment and retention
- Nutrient supply and storage

On Lower Nason Creek, impacts to the overall hydrologic regime have resulted in an increase in stream power that gives rise to transport as the dominant process, over-all similarity of channel units, and lack of channel complexity at the reach scale. At the subreach scale, subreaches where transition-to-deposition is the dominant process alternate between longer subreaches of transportation. Within the transport subreaches, the bed load is hypothesized to become mobile when flows are increasing and deposited when flows are decreasing with the ultimate result being plane-bed features. Conversely, it is hypothesized that the mobilized bed load from the transport reaches deposits in the smaller subreaches where transition-to-deposition is the dominant process during the increasing flows. As runoff flows decrease, the newly deposited bed material is then incised, resulting in tall bars and only moderate change of form.

The loss of riparian function within all subreaches at the floodplain width and within the 30-meter and 10-meter buffer zones has both direct and indirect impacts to multiple pathways. At the floodplain width, an overall young seral stage indicates a risk to ecosystem health. At the 30-meter buffer zone, high percentages of disturbed or removed vegetation and limited existing large diameter trees create a decreased large woody debris recruitment potential, thus a lack of large woody debris in the system. The same conditions within the 10-meter buffer zone reduce shading potential which ultimately promote elevated water temperatures. Another contributing factor to an increase in water temperature in the main channel is due to the impounding of surface water behind the highway in subreach DIZ-1.

Overall, ecosystem processes in the Kahler reach are in a degraded state as a result of human impacts. Rehabilitation activities, consisting of both potential protection and rehabilitation actions, are recommended to prevent further degradation of the river ecosystem. Where restoration is the ultimate aim in many instances, a more measured approach is sometimes necessary due to multiple natural and human-made constraints (Figure 11). Rehabilitation provides an approach that is consistent with restoration objectives to return critical river ecosystem function to a pristine condition (UCSRB 2007). In addition, rehabilitation is incremental and iterative in nature to accommodate the notion that complete restoration may not be possible due to structural limitations and disturbance regimes. Potential protection and rehabilitation actions specific to this river reach should be prioritized with the following objectives based on Table 5.9 in the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007).

Many authors have documented strategies that emphasize restoring processes that form, connect, and sustain habitats (Beechie et al. 1996; Kauffman et al. 1997; Beechie and Bolton 1999; Montgomery and Bolton 2003; UCRTT 2007). Habitat actions of this nature often occur at the site or reach scale. Roni et al. (2002) introduced a hierarchical strategy that places site-specific actions within a watershed context. The Reclamation reach assessment and previous objectives purposely feed into this strategy by further telescoping options through several additional filters or layers of consideration at the reach scale. This so-called stratified strategy can be used to prioritize potential habitat actions within a geomorphic reach context based on the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007) objectives and reach assessment results by beginning with protection and transitioning through several forms of active rehabilitation.

The hierarchical implementation strategy, which is illustrated in Figure 12, is tied to a corresponding gradational color scheme (Table 4) and used throughout the Subreach Unit Profile section to assist with correspondences throughout the project selection process. A subreach unit is recommended for protection actions where visual field evidence shows that

80 percent or more of the indicators are functioning adequately. A subreach unit is recommended for rehabilitation, where visual field evidence shows that less than 80 percent of the indicators are functioning adequately (i.e., the indicators are either at risk or are at unacceptable risk).

However, the stratified strategy does not consider landowner willingness, construction feasibility, costs, and other local considerations. There are alternative methods that can be used to sequence project selection (i.e., degree of departure, landowner willingness, and construction costs) that can be factored in along with the results of reach assessment.

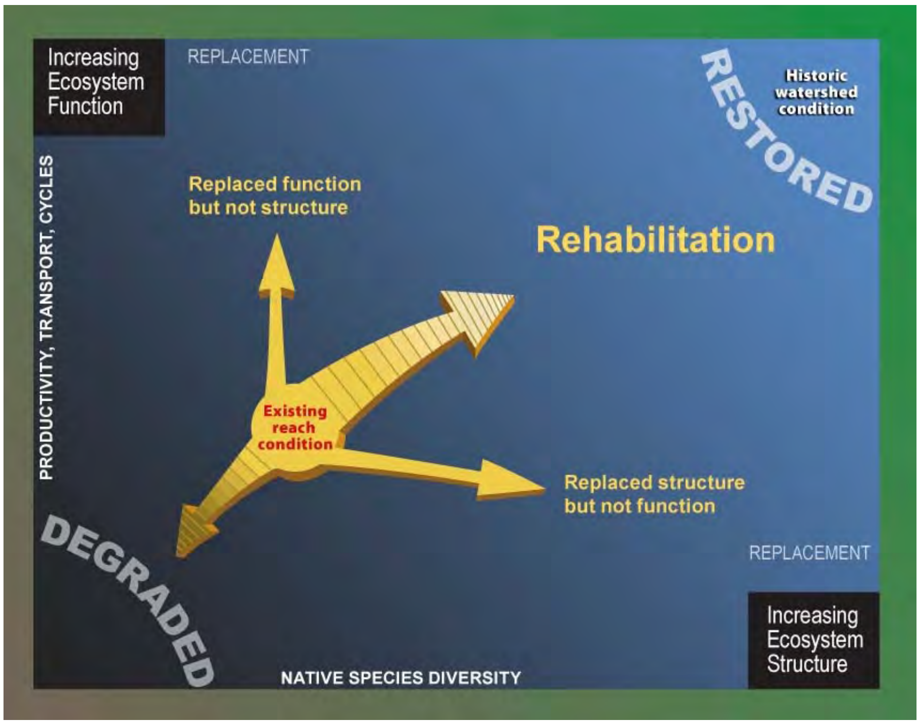


Figure 11 – Responses to Reach Assessment Actions. Through time, land development and management activities lead to altering natural flows that sustain balance and ultimately, the condition of an ecosystem. Healthy aquatic stream ecosystems by nature are resilient and able to cope with impacts through feedback and adjustment. Rehabilitation offers the opportunity to resurrect balance and redirect stream aquatic habitat on a resilient course once again.

Table 4 - Definitions for reach conditions, which are tied into the hierarchical implementation strategy in Figure 12. The stratified strategy is used to filter results of the reach assessment to illustrate the differential responses expected for potential habitat protection and rehabilitation actions. Note corresponding gradational color scheme.

Protect/Maintain Processes: off-channel and riparian areas such as wetland, channel network, side channel, and riparian buffers possessing "adequate" ecological conditions and a present high or a potential high biological benefit.
Protect/Reconnect Isolated Habtats: off-channel and riparian areas possessing "adequate" ecological condition, but are fagmented by anthropogenic disturbances.
Reconnect Processes (Long-term): through regaining of channel dynamics and riparian interactions for areas possessing "adequate" or "at risk" ecological conditions that have a present high or potential high biological benefit.
Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions for areas possessing "at risk" ecological conditions that have a moderate to low present or high potential biological benefit.
Reconnect Habitat Units (Short-Term): through in-channel replacement of wood and rock habitat features or structures.

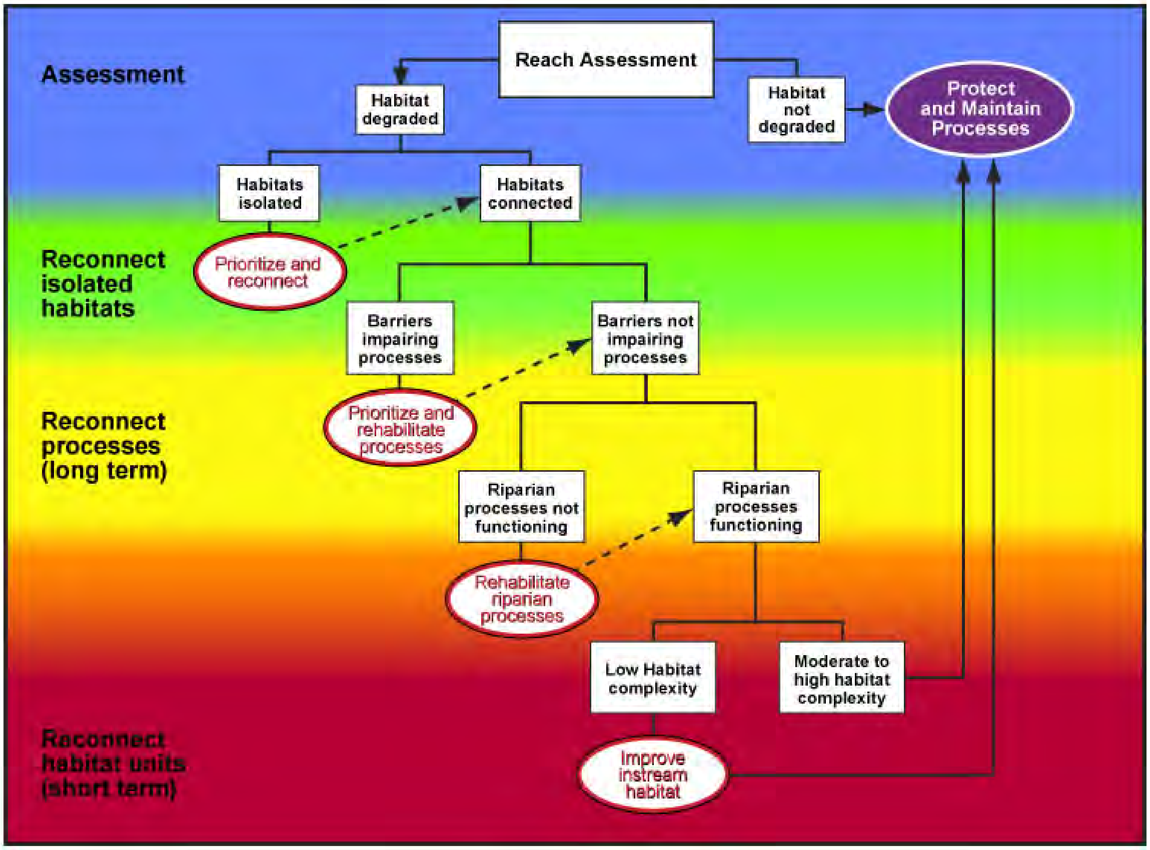


Figure 12 – Implementation strategy for prioritizing potential habitat actions from protection-to rehabilitation at the reach scale. Individual ovals indicate decisions and their interconnectivity correspond to stratified interrelationships (adapted from Roni et al. 2005).

Geomorphic potential is essential for habitat-forming processes. Geomorphic potential is the combined influence of water, sediment, and large woody debris in forming, connecting, and sustaining fish habitat. Where 6 percent of the Kahler reach does not contribute to habitat-forming processes due to a disconnection of floodplain and riverine processes, a dual-track rehabilitation approach is necessary to reestablish geomorphic potential and with it healthy river conditions (Table 5). Figure 13 offers a spatial representation of a prioritized rehabilitation strategy for the Kahler reach. The dual focus approach would concentrate on both protection and rehabilitation goals necessary for reestablishment of geomorphic potential and healthy stream conditions (Table 3). Subreaches that are candidates for protection include OZ-1, OZ-2, OZ-5, OZ-6, OZ-8, OZ-10, OZ-12, OZ-13 and OZ-15 through OZ-18, all of which already offer form and connectivity. Rehabilitation goals would address two types of subreaches. First are those subreaches that are currently disconnected by the highway or other human features. Subreaches of particular interest include DIZ-1 and DIZ-2, along with adjacent historic outer zone areas of DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. The second type of subreach addressed with rehabilitation goals is the reconnection proesses and of isolated habitat units within impacted inner zones. Specific subreaches of particular interest include OZ-3, OZ-4, OZ-7, OZ-20, IZ-1, IZ-2, IZ-3, and IZ-4. This cooperative effort could be executed in conjunction with the protection goals that will complement reconnection of the disconnected subreaches and the connected subreaches that lack habitat. Potential habitat actions are identified and prioritized based on several key parameters established in the reach assessment.

A dual focus approach is expected to run in parallel with a measured difference in timing for implementation. Protection goals are a series of potential short-term habitat actions that will complement the reconnection of the disconnected subreaches. Potential protection actions necessary in the short term include land acquisitions or lease and stream bank and wetland protection (UCRTT 2009). The rehabilitation goals covering the disconnected subreaches is a long-term enterprise requiring full cooperation of the State of Washington Department of Transportation as well as local land owners. Potential rehabilitation actions should be considered as a component to a comprehensive strategy to reinitiate habitat-forming processes and include culvert removals, modifications, or replacements; small bridge placements; riparian plantings and noxious weed eradication; and road relocations or removals.

Subreach	Acres	Restoration Strategy	Time Frame IT	Time Frame ET	Justification
K OZ-16	30	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-15	8	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-5	4	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-1	4	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-17	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-18	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-8	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-12	2	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-13	2	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-6	1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-10	1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-2	<1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K DIZ-1	2	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect existing wetland to riverine system.
K DIZ-2	<1	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect section of historic channel.
K DIZ-3	3+	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect section of historic channel.
K OZ-3	22	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-19	16	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-4	14	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-20	14	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-7	12	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K IZ-3	11	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Increase current bed elevations to restore fluvial/riparian interactions, combine with Riparian Rehabilitation with adjacent outer zone.
K DOZ-3	3	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Increase current bed elevations to restore fluvial/riparian interactions, combine with Riparian Rehabilitation with adjacent outer zone.
K DOZ-2	3	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOZ-4	2	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOC-1	1	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOZ-5	1	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-11	4	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K OZ-14	1	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K OZ-9	1	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K IZ-2	19	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.
K IZ-4	16	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.
K IZ-1	14	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.

Table 5 - Summary of subreaches prioritized by rehabilitation strategies. The time frame column represents both time to implement and time to see benefit. LT (long-term) can be greater than 20 years; ST (short-term) can be less than 1 year or up to 5 years

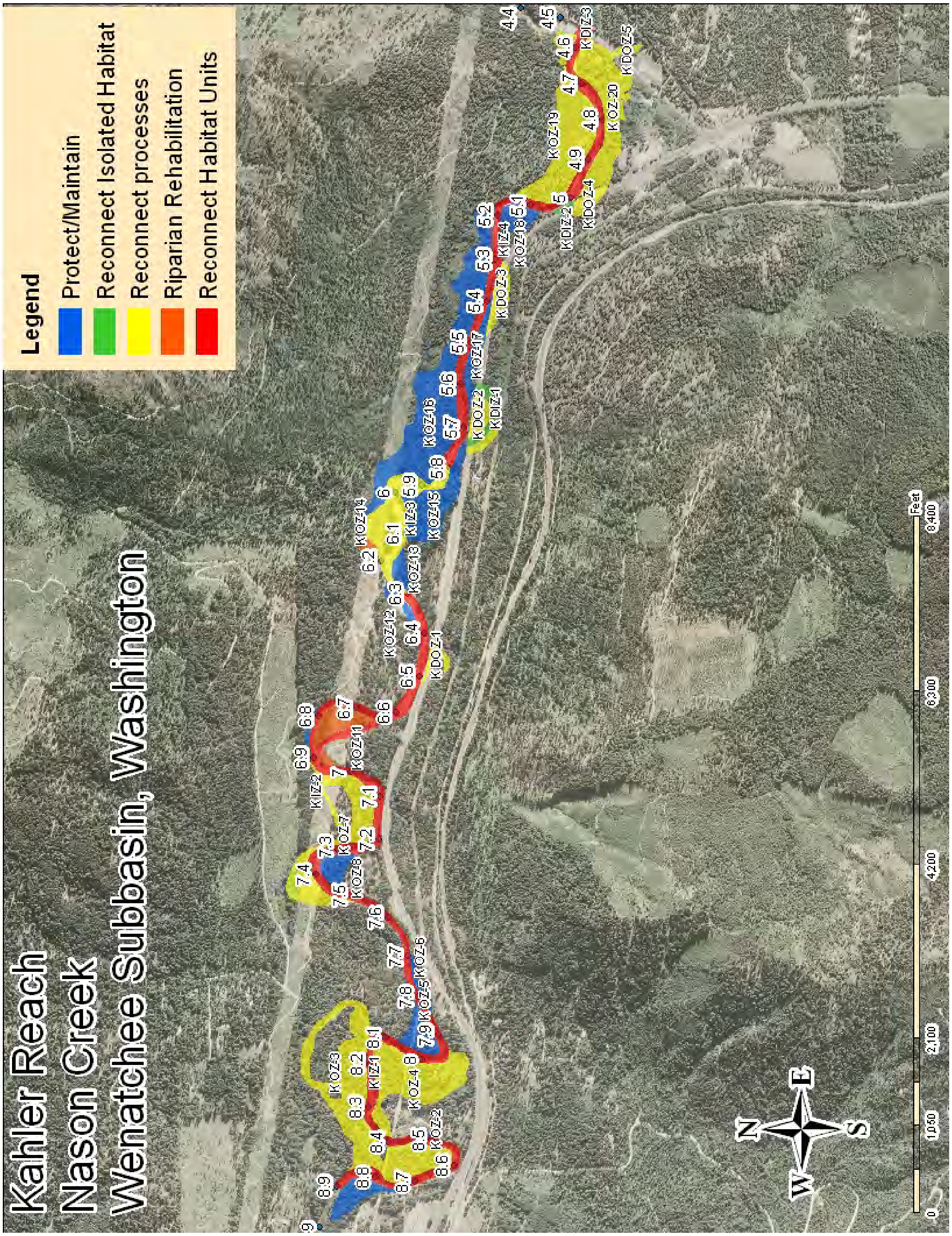


Figure 13 - Prioritized Rehabilitation strategy by subreach unit based on Table 6 for the Kahler reach.

Table 19 - Rehabilitation options for K DIZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation: Riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation: riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity and Abundance	Low
9	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DIZ-3

Subreach K DIZ-3 is located is located at the downstream end of the Kahler reach to the west of Highway 207 at RM 4.55 (Figure 28). This subreach is rehabilitation-oriented due the impacts on the riparian vegetation.

The subreach, as mapped, is about a half of an acre in size; however this represents the agreed on end point of the reach assessment. The subreach is actually the upstream end of a disconnected inner and outer zone that is nearly 3 acres in size. The subreach is disconnected from the floodplain and active riverine system by a total of 1,232 feet of Highway 207.

The inundation potential is about 3 acres. Rehabilitation options are listed in Table 20. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

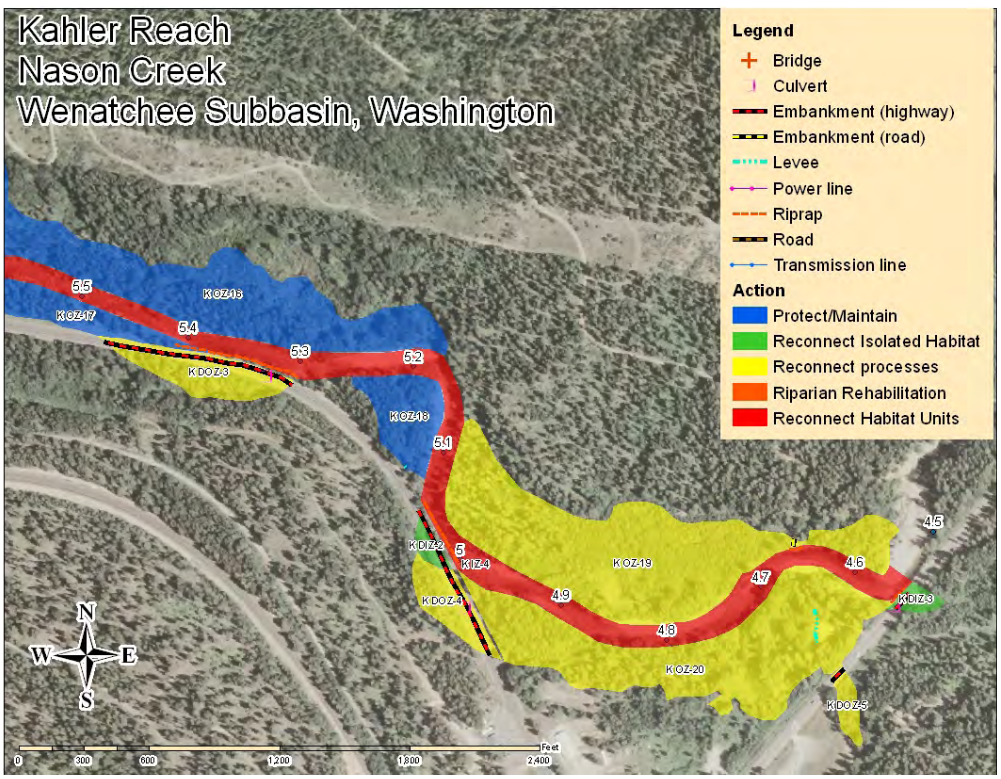


Figure 28 - K DIZ-3 and adjacent subreaches in the Kahler reach.

Table 20 - Rehabilitation options for K DIZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity and Abundance	Low
9	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-3

Subreach K OZ-3 is located in the upstream section of the Kahler reach in the left floodplain from RM 8.87 – 8.11 (Figure 29). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size. Human features include 670 feet of road embankment and 770 feet of unimproved road. A bridge abutment is also present in the center of the reach at RM 8.2. Natural lateral controls are terraces and alluvial fans. Impacts to the vegetation associated with the unimproved road and bridge abutment are just over 1 acre, or about 9% of the total subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 21. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

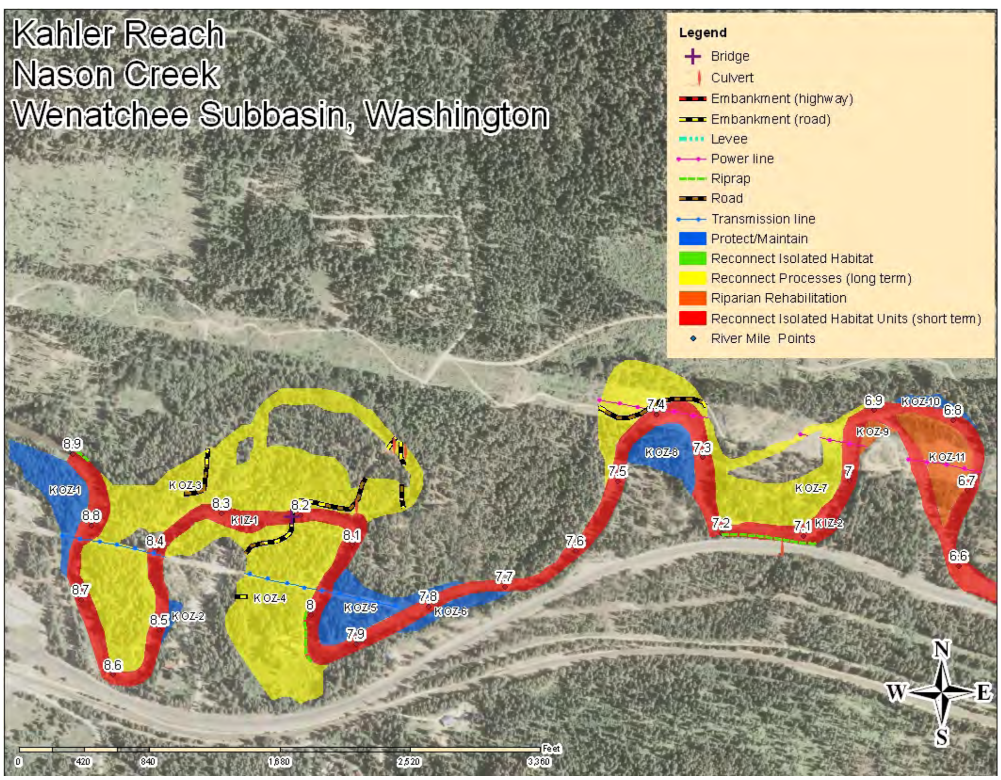


Figure 29 - K OZ-3 and adjacent subreaches in the Kahler reach.

Table 21 - Rehabilitation options for K OZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify road embankments and bridge abutment to reconnect floodplain to riverine system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system. Protect and maintain current levels of hydrologic, riparian, and geomorphic function. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity, Abundance,	Medium
5		Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system.	2; Productivity, Abundance,	Medium
6		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity, Abundance,	Medium
7		Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity, Abundance,	Maintain

K OZ-19

Subreach K OZ-19 is located in the downstream section of the Kahler reach in the left floodplain from RM 4.55 to 5.13 (Figure 30). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 16 acres in size and contains 3 acres of wetlands. Human features include 35 feet of unimproved road embankment and a bridge abutment that disconnect the downstream end of the subreach from the adjacent floodplain and active channel. Natural lateral controls are terraces and alluvial fans. Impacts to the vegetation associated with the unimproved road and bridge abutment are less than 1 acre.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 22 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

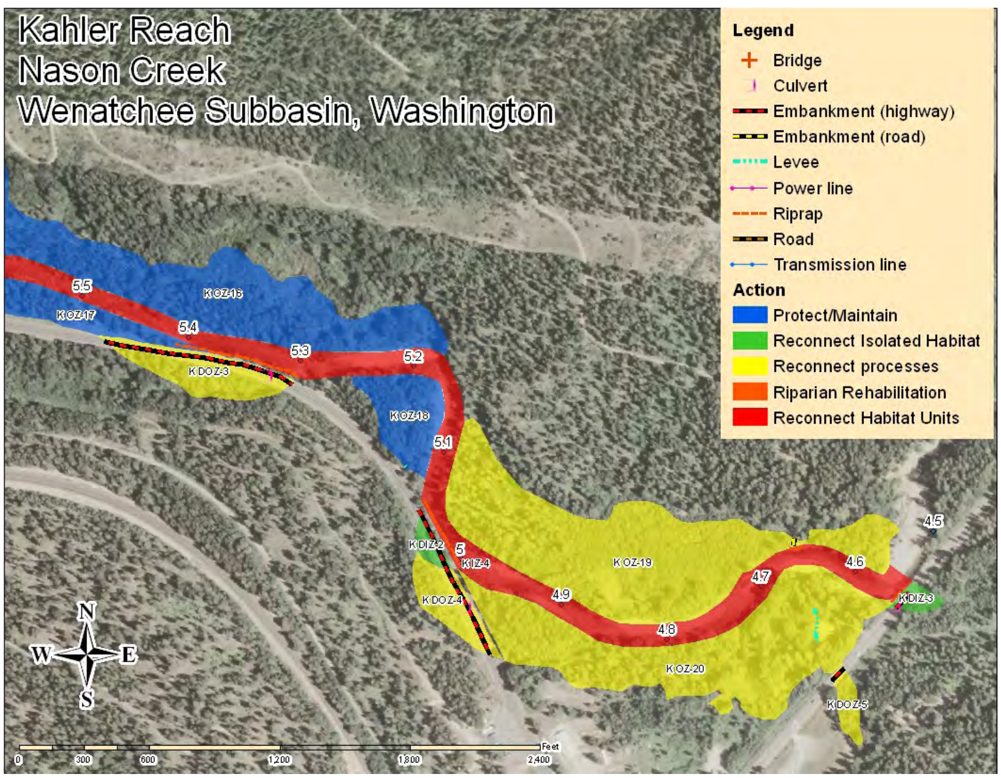


Figure 30 - K OZ-19 and adjacent subreaches in Kahler reach.

Table 22 - Rehabilitation options for K OZ-19.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments to reconnect floodplain area to riverine system. Protect existing wetlands and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments to reconnect floodplain area to riverine system.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Protect existing wetlands and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-4

K OZ-4 is located in the up-stream section of the Kahler reach in the right floodplain from RM 7.94 to 8.4 (Figure 31). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size. Anthropogenic features include 337 feet of road embankment, 146 feet of unimproved road, and 384 feet of power lines. The subreach also includes developed areas. Natural lateral controls are terraces. Impacts of anthropogenic features to the vegetation total about 1 acre or about 7 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 23 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

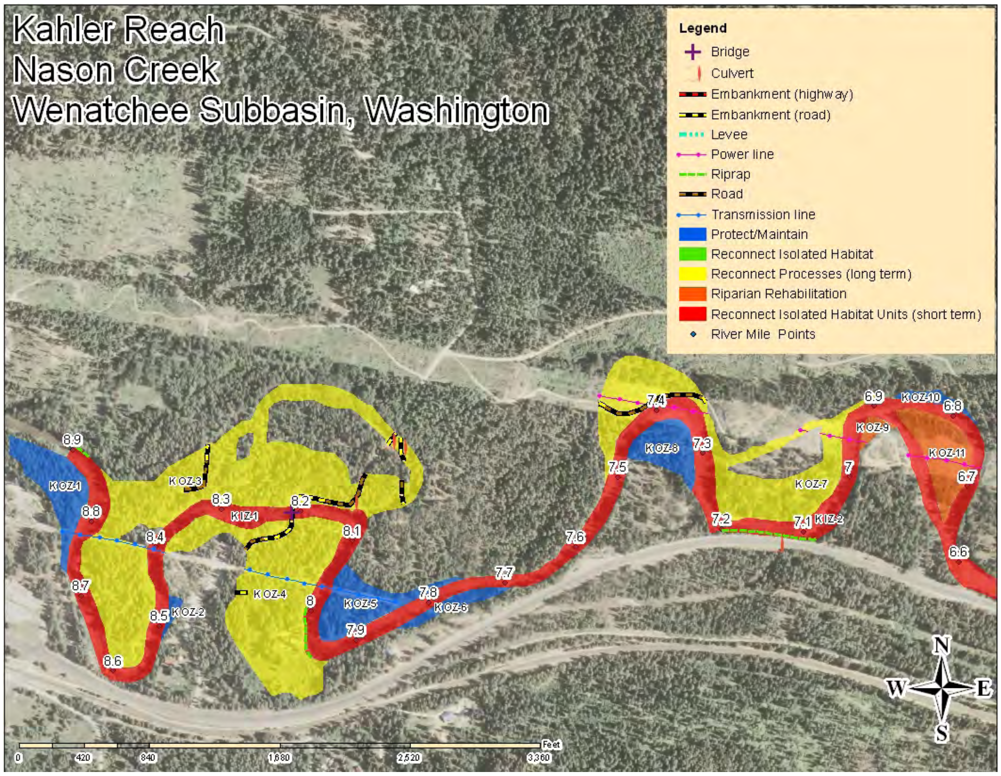


Figure 31 - K OZ-4 and adjacent subreaches in Kahler reach.

Table 23 - Rehabilitation options for K OZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with culverts where appropriate to reconnect existing wetland area to riverine system. Modify unimproved roads to control fine sediment input to the system. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
5	Rehabilitation	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system	2; Productivity and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-20

Subreach K OZ-20 is located in the downstream section of the Kahler reach in the right floodplain from RM 4.55 to 4.99 (Figure 32). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size and contains 6 acres of wetlands. Human features include 160 feet of levee that protects an elevated parking area and 20 feet of riprap. The riprap serves as bank protection and is addressed in the K IZ-4 profile. Impacts to the vegetation from the parking area and other disturbances total about a quarter of an acre or about 2 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 24. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

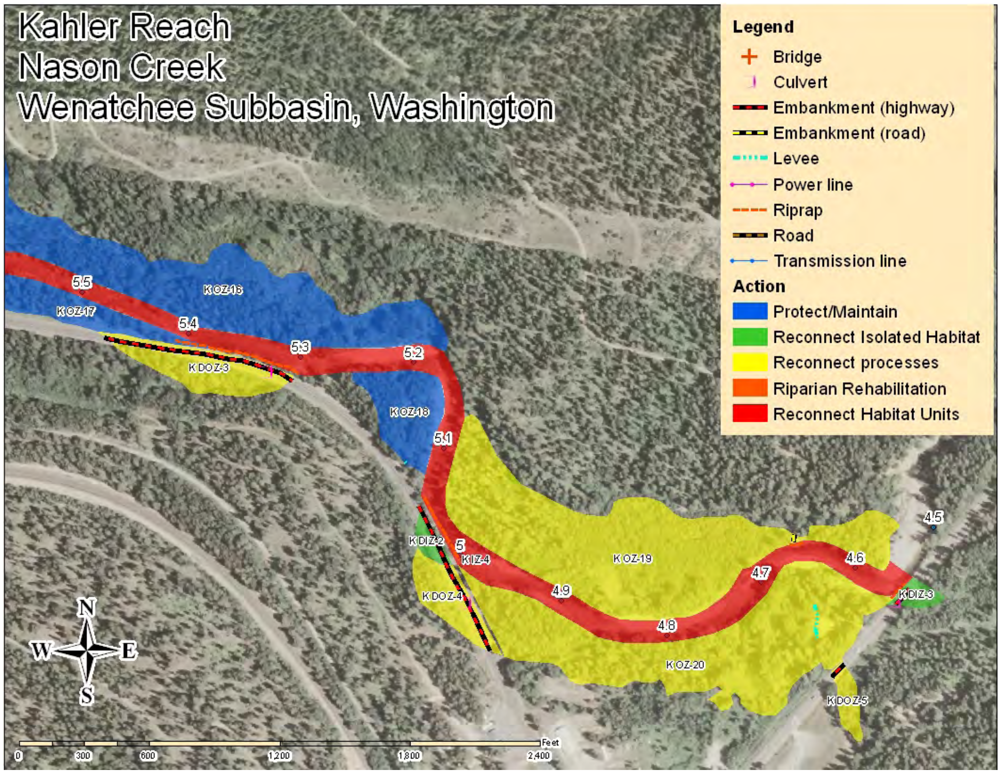


Figure 32 - K OZ-20 and adjacent subreaches in Kahler reach.

Table 24 - Rehabilitation options for K OZ-20.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments and levee to reconnect floodplain area to riverine system. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments and levee to reconnect floodplain area to riverine system.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-7

Subreach K OZ-7 is located in the upstream section of the Kahler reach in the left floodplain at RM 6.9 to 7.5 (Figure 33). This subreach is rehabilitation-oriented due to the disconnection from the floodplain and riverine system.

The subreach is about 13 acres in size and contains 1 acre of wetlands. Anthropogenic features include 75 feet of road embankment, 680 feet of unimproved road, and 580 feet of powerline. Natural lateral controls are alluvial fans and terraces. Impacts to the vegetation total just over 3 acres or about 27 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 25. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

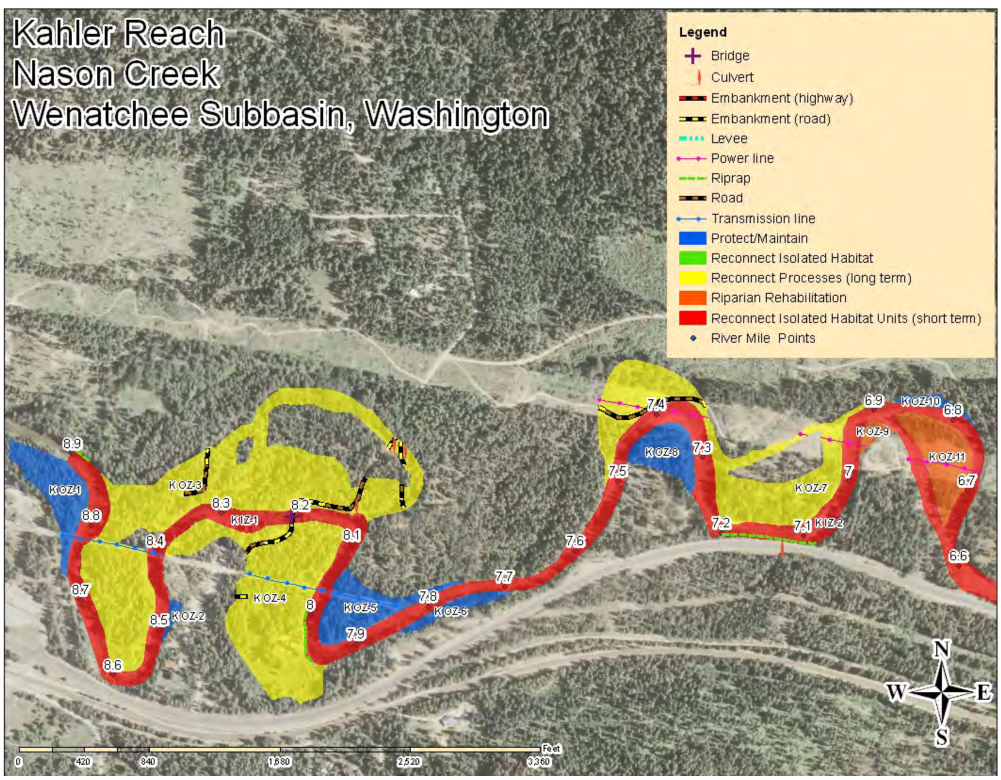


Figure 33 - K OZ-7 and adjacent subreaches in Kahler reach.

Table 25 - Rehabilitation options for K OZ-7.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2		Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Abundance and Productivity	Medium
3		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the transmission line and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Abundance and Productivity	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Combine with riparian rehabilitation of sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the highway and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Abundance and Productivity	Medium
5	Rehabilitation	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes.	2; Productivity and Abundance	Medium
6	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the transmission line and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
7	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-3

Subreach K IZ-3 is just over 11 acres and comprises a section of the current active channel from RM 5.8 to 6.3 in the Kahler reach (Figure 34). The dominant process is transition to deposition, as noted by the increase in sinuosity, gravel substrate and increase in the diversity of channel units. The subreach composition is 57 percent runs, 25 percent riffles, and 18 percent pools.

Anthropogenic features included one cabled log, one boulder cluster, and riprap. The biggest impact comes from two sections of riprap for a total of 390 linear feet along the left bank at the upstream and downstream boundaries of the subreach. Other anthropogenic impacts include two powerline crossings in the downstream end of the subreach.

Rehabilitation options are listed in Table 26. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

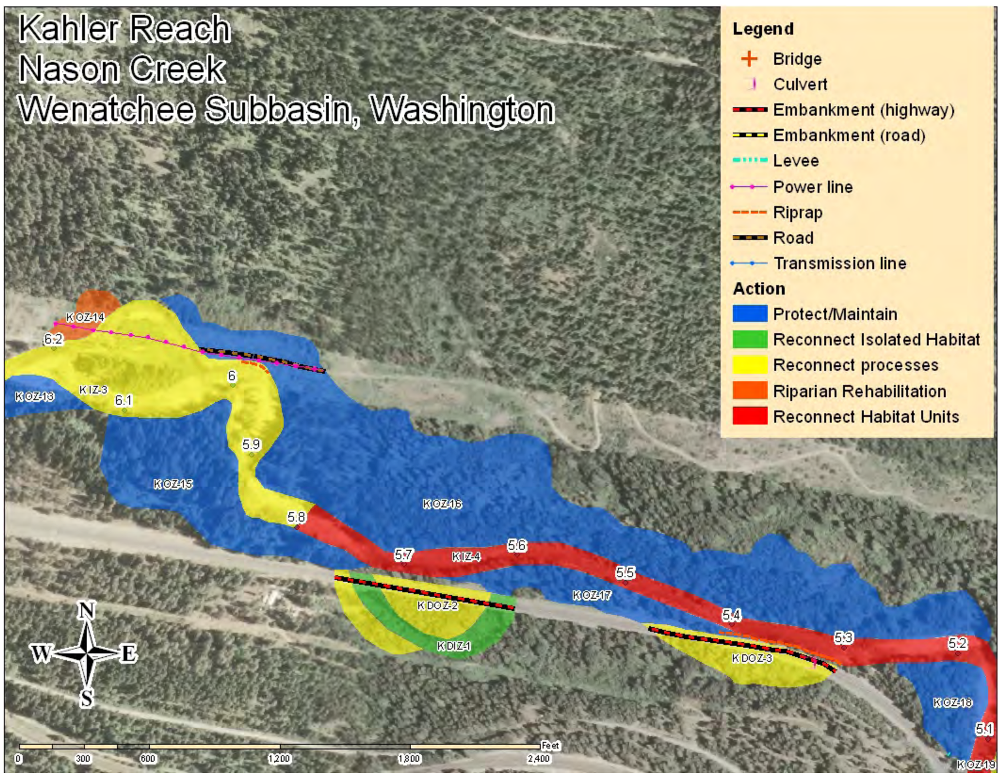


Figure 34 - K IZ-3 and adjacent subreaches in Kahler reach.

Table 26 - Rehabilitation options for K IZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. This will in turn allow fluvial processes to work within adjacent outer zones more frequently. Combine with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. Combine with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation + Protection	Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation.	Ranges from 2 up to 4 depending on action and action class	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ 3

K DOZ-3 is located in the downstream section of the Kahler reach in the right floodplain to the west of Highway 2 from RM 5.4 to 5.3 (Figure 35). This subreach is rehabilitation-oriented due to disconnections from the adjacent active floodplain and riverine system.

The subreach is just less than 3 acres in size. Human features include 884 feet of Highway 2. The highway disconnects the subreach from the adjacent floodplain and riverine system. There is a culvert at the downstream end, but it is believed to allow run-off water to enter the system rather than fish passage. Disturbance to the riparian vegetation associated with the highway totals just over 1 acre or about 44 percent of the subreach.

The inundation potential is about 1.4 acres or 1.4 percent of the inundation potential of the Kahler reach. Rehabilitation options are listed in Table 27 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

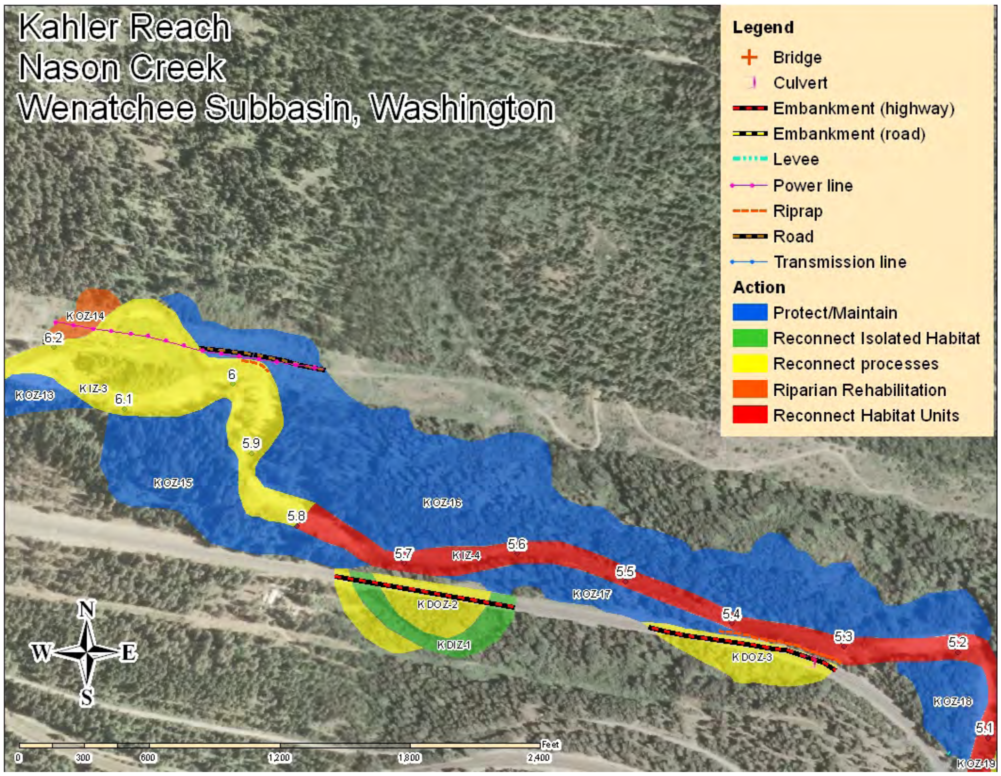


Figure 35 - K DOZ-3 and adjacent subreaches in Kahler reach.

Table 27 - Rehabilitation options for K DOZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
2	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium
3	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
5	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
6	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-2

The subreach K DOZ-2 is located in the mid-section of the Kahler reach to the south of Highway 2 at RM 5.7 (Figure 36). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about 3 acres in size and is the complimentary outer zone to DIZ-1. Human features include about 588 feet of Highway 2. Impacts to the vegetation associated with the highway total nearly 1 acre or about 30 percent of the subreach.

The 2-D hydraulic model did not predict any inundation with the human features removed at 5,000 cfs, although the wetlands may be inundated by ground water and/or a small seasonal tributary. By improving the connection as a minimum, a cold water source may be utilized. Rehabilitation options are listed in Table 28. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale

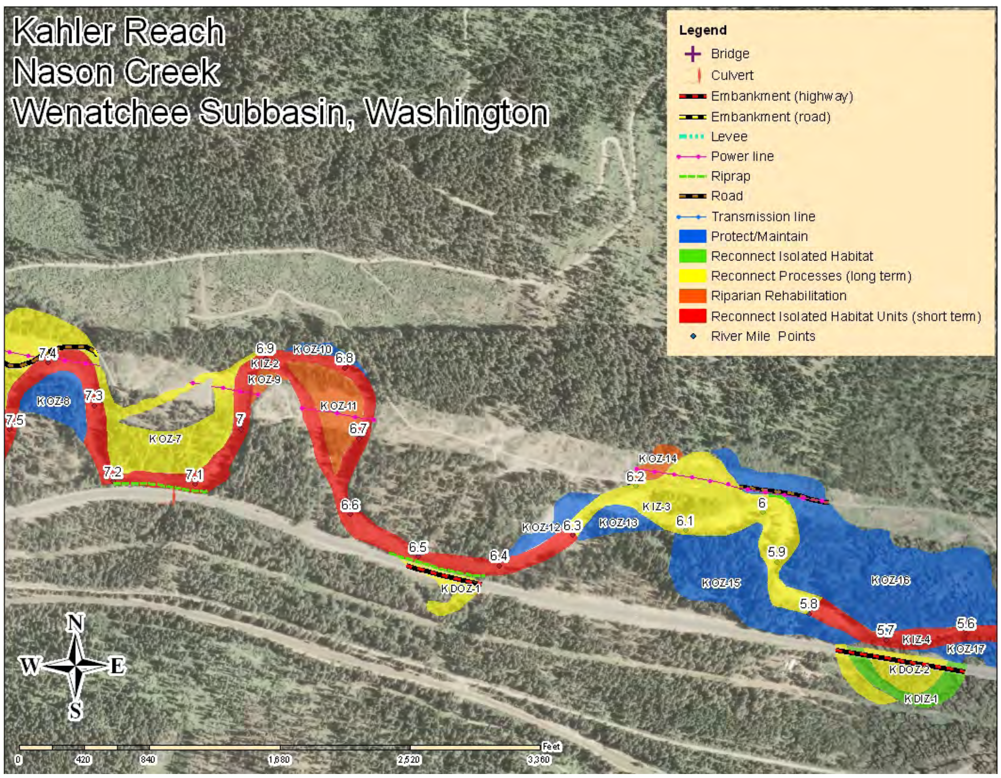


Figure 36 - K DOZ-2 and adjacent subreaches in Kahler reach.

Table 28 - Rehabilitation options for K DOZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect processes of fluvial and riparian interaction throught Riparian Rehabilitation: Restore sections of riparian vegetation impacted by highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-4

K DOZ-4 is located in the downstream section of the Kahler reach in the right floodplain to the west of Highway 2 at RM 5.0 (Figure 37). This subreach is rehabilitation-oriented due to disconnections from the adjacent active floodplain and riverine system.

The subreach is just less than 2 acres in size. Human features include 447 feet of Highway 2 that disconnects the subreach from the active channel and floodplain. The highway disconnects the subreach from the adjacent floodplain and riverine system. A culvert at the downstream end is believed to allow run-off water to enter the system but does not allow fish passage. Disturbance to the riparian vegetation associated with the highway totals about 1 acre or about 44 percent of the subreach.

The inundation potential is about 2.3 acres or 2.3 percent of the inundation potential of the Kahler reach. Rehabilitation options are listed in Table 29. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

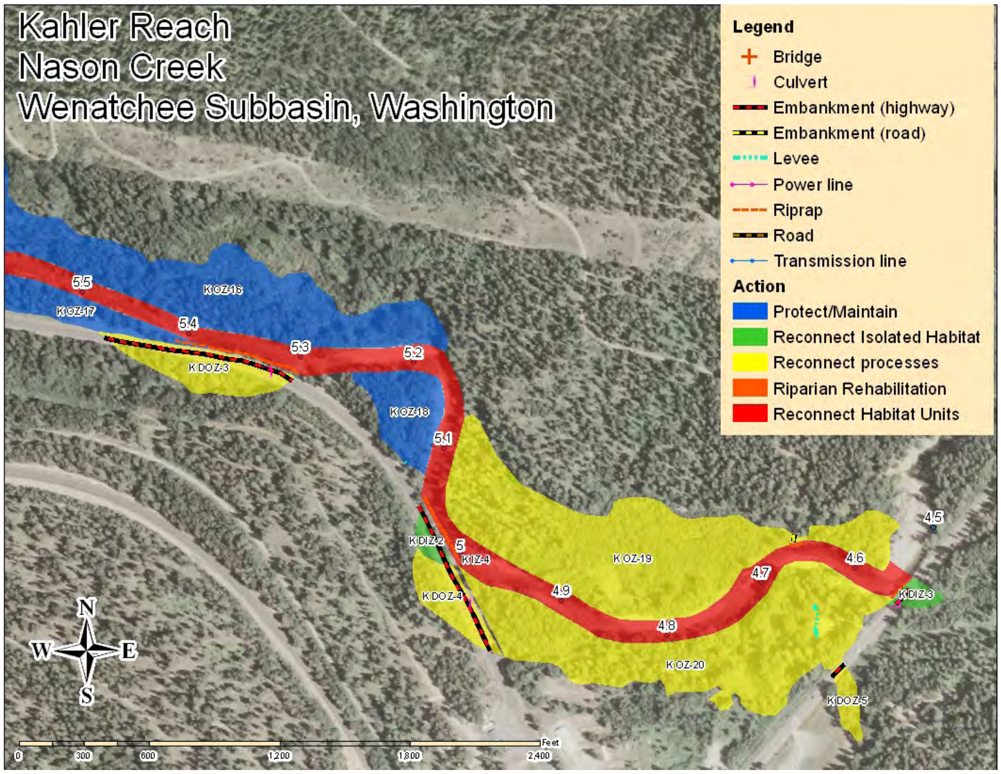


Figure 37 - KDOZ-4 and adjacent subreaches in Kahler reach.

Table 29 - Rehabilitation options for K DOZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power lines) by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
9	Protection	Protect existing wetlands and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-1

Subreach K DOZ-1 is located in the mid-section of Kahler reach to the south of the right floodplain and Highway 2 from RM 6.42 to 6.53 (Figure 38). This subreach is rehabilitation-oriented due to disconnections within the floodplain and active channel.

The subreach is about 2 acres in size. Anthropogenic features include 500 feet of highway embankment that disconnects the subreach from the adjacent floodplain and active channel. Natural lateral controls are terraces. Impacts to the vegetation associated with the highway total just less than 1 acre or about 30 percent of the subreach.

The inundation potential is about 1 acre, which is about 1 percent of the inundation potential for the entire Kahler reach. Rehabilitation options are listed in Table 30. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale.

Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

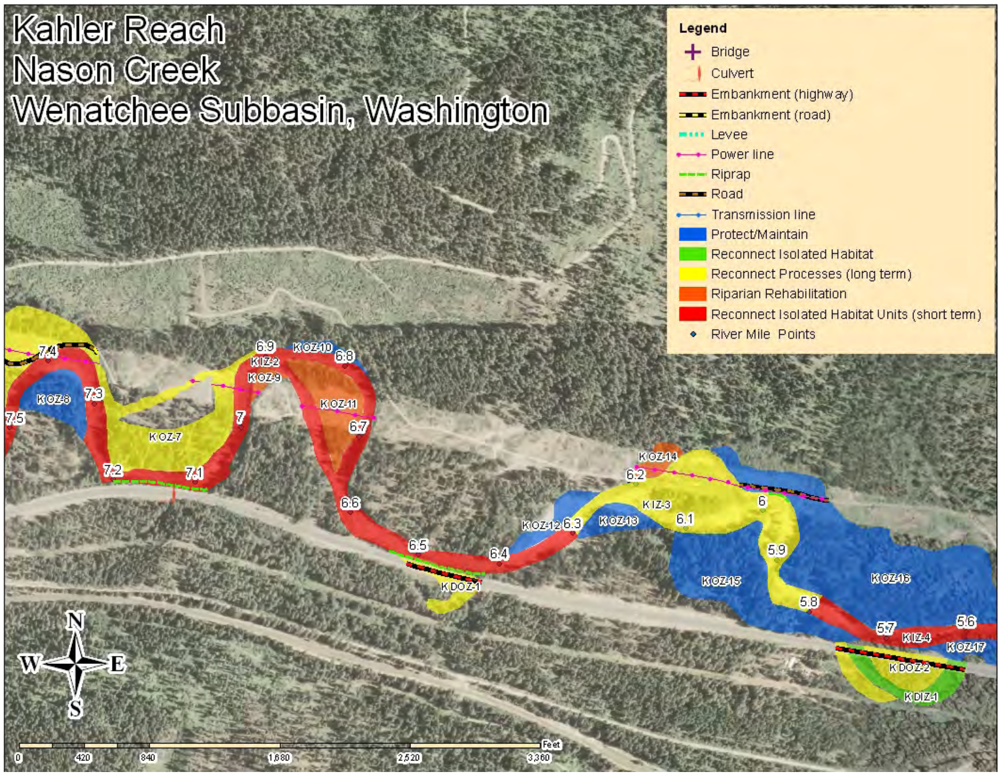


Figure 38 - K DOZ-1 and adjacent subreaches in Kahler reach.

Table 30 - Rehabilitation options for K DOZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation + Protection	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
6	Rehabilitation	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-5

Subreach K DOZ-5 is located in the downstream section of Kahler reach to the west of Washington State Highway 207 near RM 4.7 (Figure 39). This subreach is rehabilitation-oriented due to disconnections within the floodplain and active channel.

The subreach is less than 1 acre in size. Anthropogenic features include 78 feet of highway embankment that disconnects the subreach from the adjacent floodplain. Additional human impacts include the adding of fill material to the south. Natural lateral controls are terraces. Impacts to the vegetation associated with the highway total just less than 1 acre or about 30 percent of the subreach.

The inundation potential is about 1 acre, which is about 1 percent of the inundation potential for the entire Kahler reach. Rehabilitation options are listed in Table 31. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

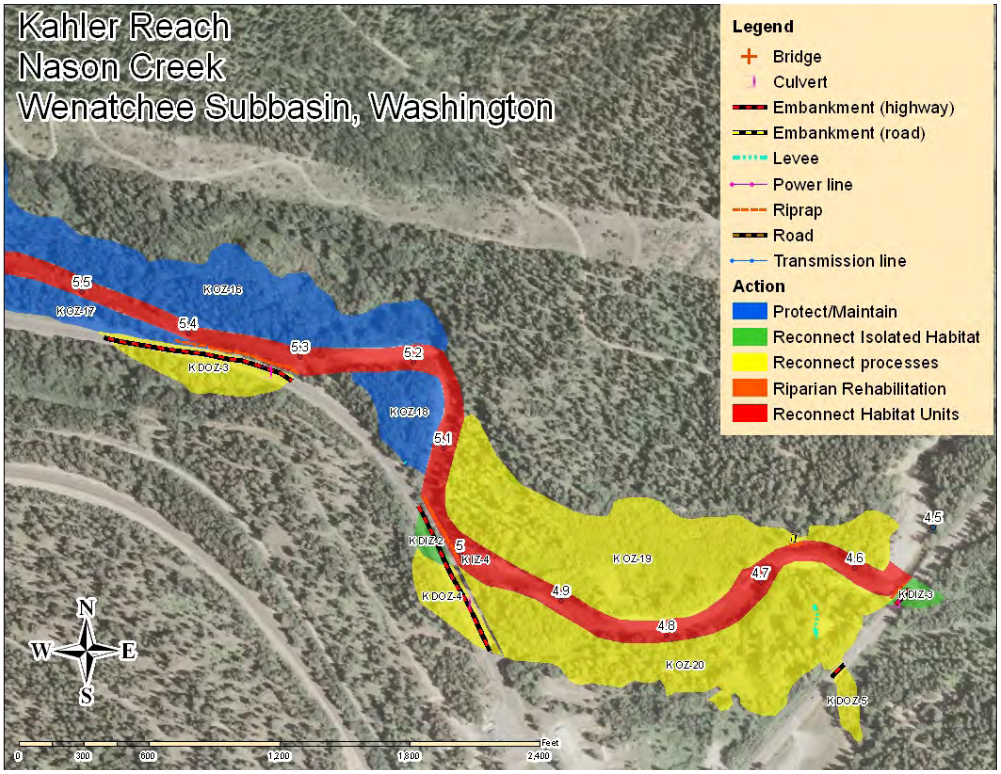


Figure 39 - K DOZ-5 and adjacent subreaches in Kahler reach.

Table 31 - Rehabilitation options for K DOZ-5.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation + Protection	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
5	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
6	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-11

Subreach K OZ-11 is located in the mid-section of the Kahler reach as a vegetated island at RM 6.85 to 6.95 (Figure 40). This subreach is rehabilitation-oriented due to impacts to the riparian vegetation.

The subreach is about 4 acres in size. Human features include about 300 feet of power lines. Impacts to the vegetation associated with the power line total about 2 acres or about 50 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 32. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

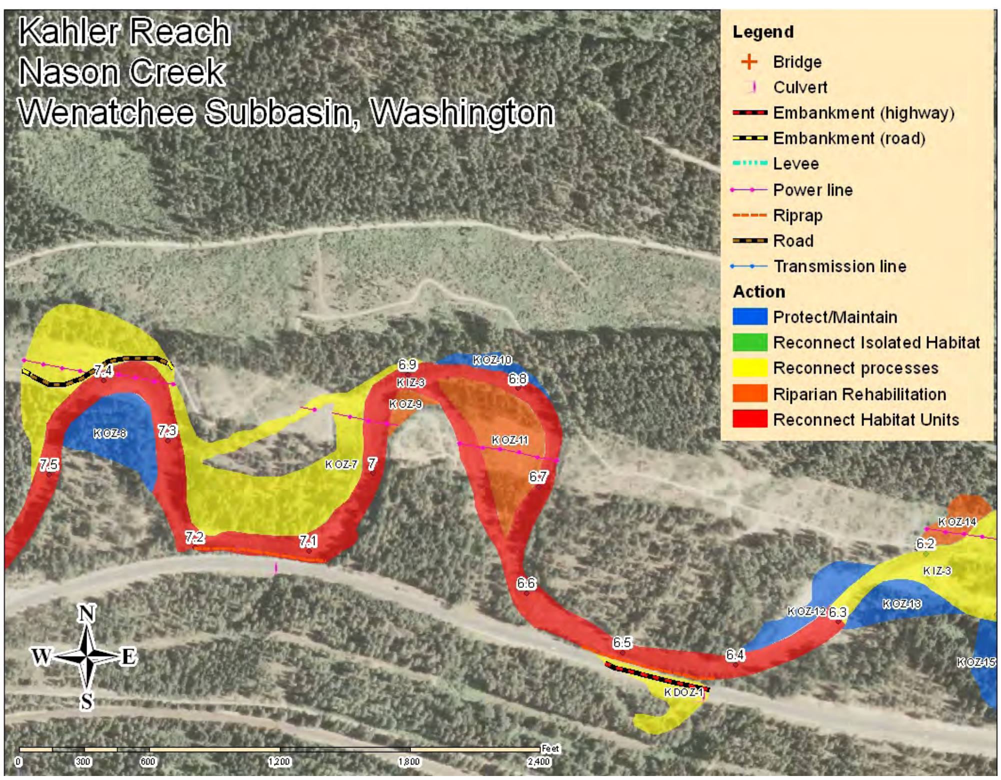


Figure 40 - K OZ-11 and adjacent subreaches in Kahler reach.

Table 32 - Rehabilitation options for K OZ-11.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-14

The subreach K OZ-14 is located in the mid-section of the Kahler reach in the left floodplain at RM 6.2 (Figure 41). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about 1 acre in size. Human features include about 185 feet of power lines and about 20 feet of access road that is utilized for recreation. Impacts to the vegetation associated with the power line total just under 1 acre or about 72 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed Table 33. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

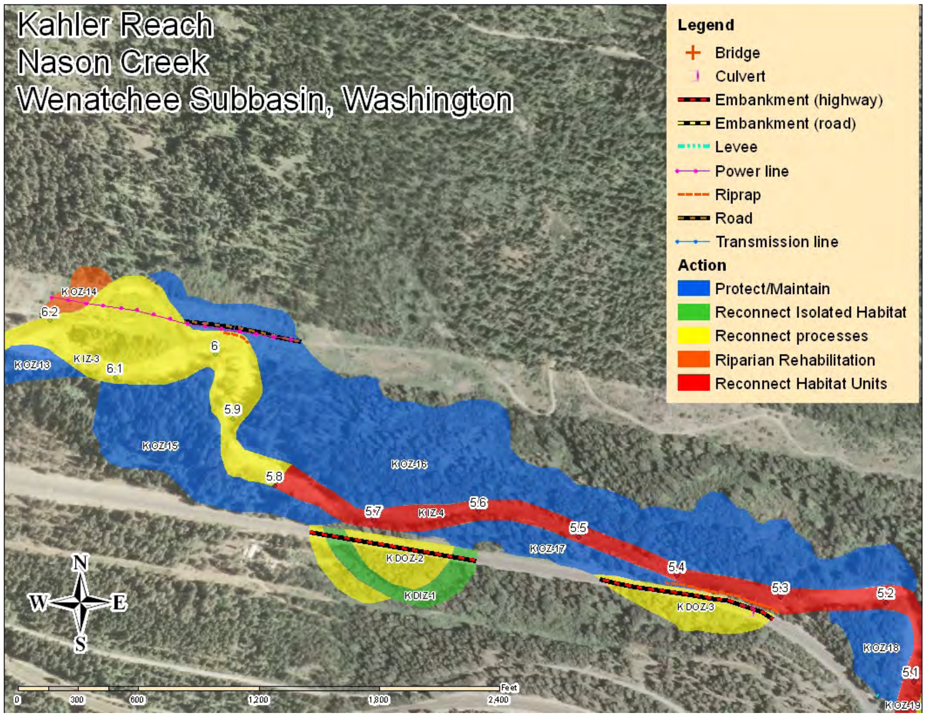


Figure 41 - K OZ-14 and adjacent subreaches in Kahler reach.

Table 33 - Rehabilitation options for K OZ-14.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-9

Subreach K OZ-9 is located in the mid-section of the Kahler reach in the right floodplain at RM 6.85 to 6.95 (Figure 42). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about one half of an acre in size. Human features include about 44 feet of power lines. Impacts to the vegetation associated with the power lines total about two-tenths of an acre or about 40 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 34. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

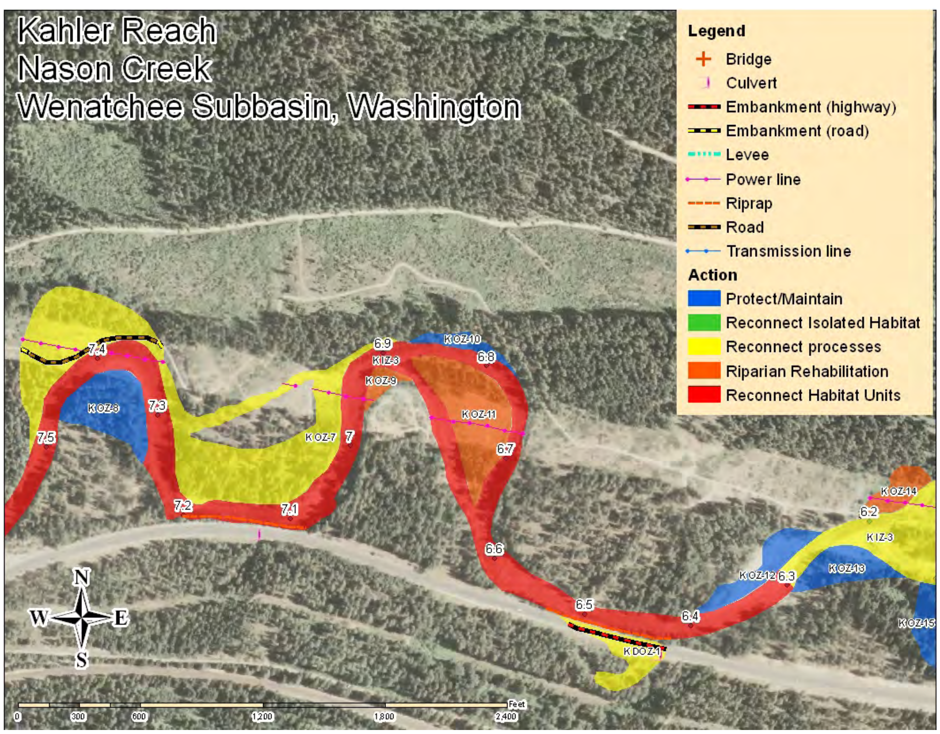


Figure 42 - K OZ-9 and adjacent subreaches in Kahler reach.

Table 34 - Rehabilitation options for K OZ-9.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-2

Subreach K IZ-2 is about 19 acres in size and comprises a section of the current active channel and bars from RM 6.3 to 7.7 (Figure 43). The dominant process is transition-to-deposition. The dominant substrate is gravel and cobble. The subreach channel unit composition is 41 percent runs, 7 percent pools, 33 percent riffles, and 19 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include about 1,250 feet of riprap that protects Highway 2 along the right bank at RM 7.15 and 6.5. There are also four power line crossings throughout the reach. Natural lateral control for the subreach is alluvial fan and terraces with coarse substrate. Large woody debris is concentrated in three large wood complexes at RM 7.0 and two complexes at RM 6.2.

Rehabilitation options are listed in Table 35. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

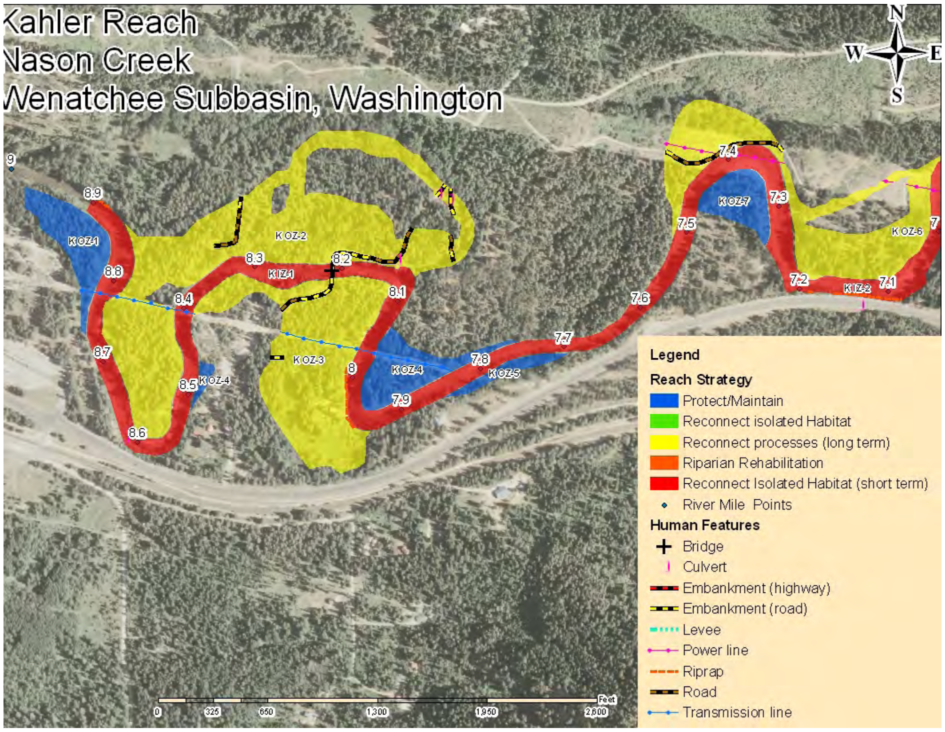


Figure 43 - K IZ-2 and adjacent subreaches in Kahler reach.

Table 35 - Rehabilitation options for K IZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-4

Subreach K IZ-4 is about 16 acres in size and comprises a section of the current active channel and bars from RM 4.65 to 5.8 (Figure 44). The dominant process is transition-to-transport. The dominant substrate is gravel and cobble. The subreach channel unit composition is 38 percent runs, 4 percent pools, 3 percent riffles, and 55 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include about 950 feet of riprap. The riprap protects Highway 2 and State Highway 207 along the right bank of the active channel. Natural lateral control for the subreach is alluvial fan, terraces with course substrate, and bedrock. Large woody debris is concentrated in a large wood complex at RM 5.3.

Rehabilitation options are listed in Table 36. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

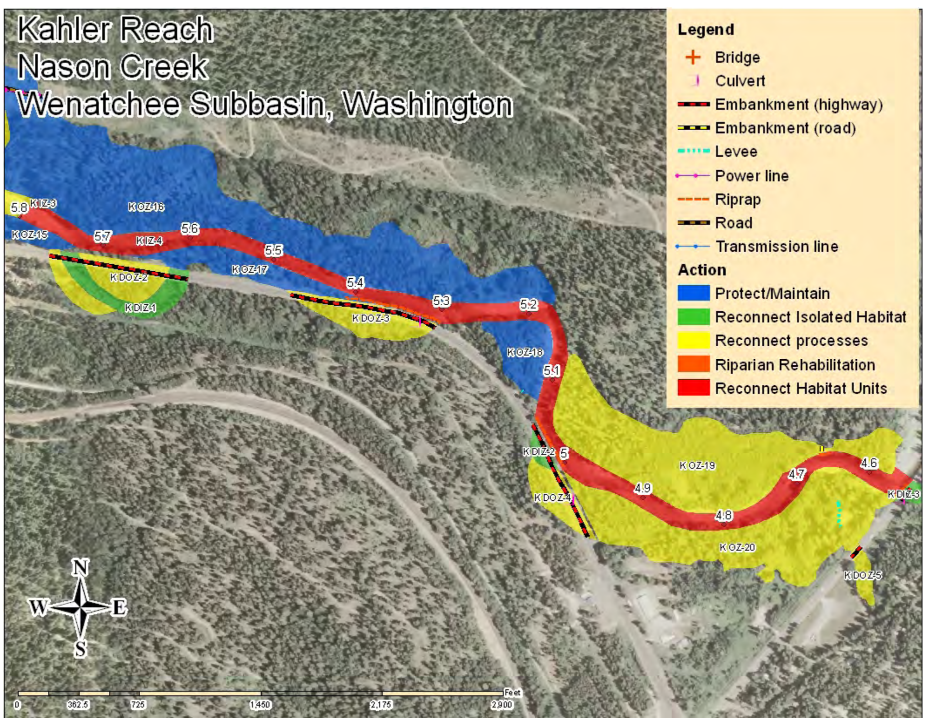


Figure 44 - K IZ-4 and adjacent subreaches in Kahler reach.

Table 36 - Rehabilitation options for K IZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-1

Subreach K IZ-1 is slightly less than 14 acres and comprises a section of the current active channel and bars in the Kahler reach from RM 7.7 to 8.9 (Figure 45). The dominant process is transition-to-deposition. The dominant substrate is gravel and cobble. The subreach channel unit composition is 58 percent runs, 10 percent pools, 30 percent riffles, and 2 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include 490 feet of riprap along the left bank at the top of the subreach and near RM 8 along the right bank. A bridge is located just upstream of RM 8.2. Other impacts include four power line crossings throughout the reach and one culvert that allows run off water to enter from the right bank near RM 8.6.

Natural lateral controls for the subreach are higher terraces that confine this subreach to a moderate extent. The existence of riprap and the higher terraces reduce the amount of lateral migration. The result is a decrease in diversity of channel units and reduced instream habitat complexity. Large woody debris counts are low which hinders the creation of complexity at higher flows. It is hypothesized that material begins to deposit during low flow.

Rehabilitation options are listed in Table 37. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

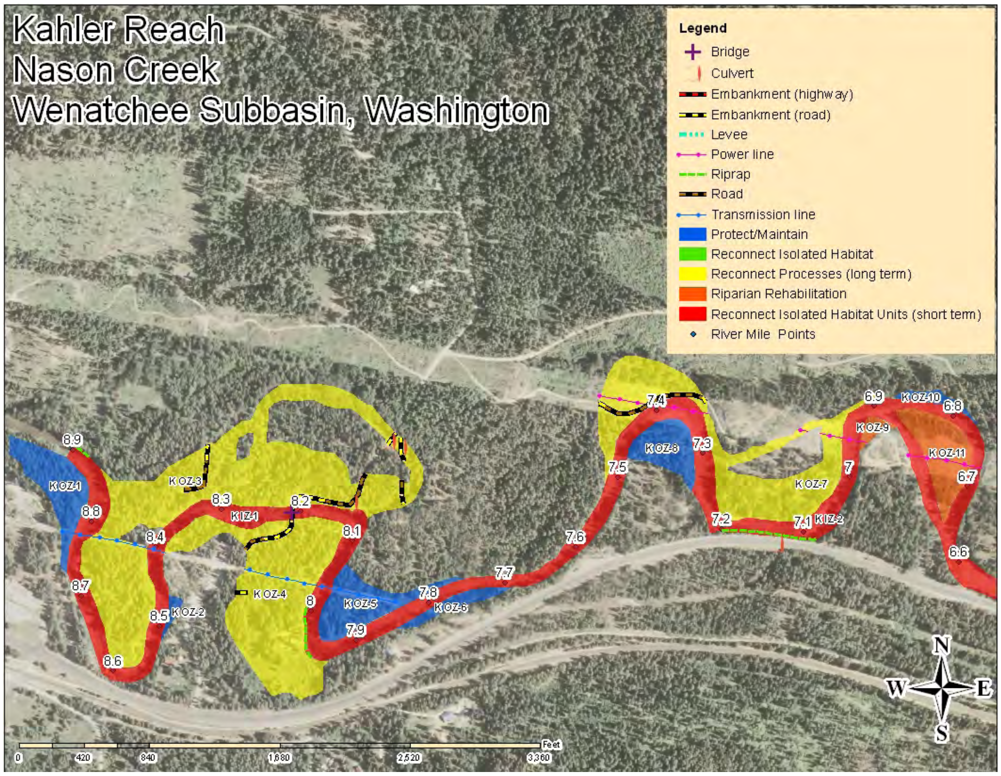


Figure 45 - K IZ-1 and adjacent subreaches in Kahler reach.

Table 37 - Rehabilitation options for K IZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

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GLOSSARY

Some terms in this glossary appear in this *Reach Assessment.*

	DEFINITION
2D-hydraulic analysis	Information derived from a two-dimensional computer model that calculates the water surface profiles and features or processes (i.e., sediment, water velocity) that may affect stream flows.
adaptive management	A management process that applies the concept of experimentation to design and implementation of natural resource plans and policies.
alluvial fan	A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream at the place where it issues from a narrow mountain valley upon a plain or broad valley, or where a tributary stream is near or at its junction with the main stream, or wherever a constriction in a valley abruptly ceases or the gradient of the stream suddenly decreases; it is steepest near the mouth of the valley where its apex points upstream, and it slopes gently and convexly outward with a gradually decreasing gradient (Neuendorf et al. 2005).
alluvium	A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream, as a sorted or semi-sorted sediment on the river bed and floodplain (Neuendorf et al. 2005).
anadromous (fish)	A fish, such as the Pacific salmon, that spawns and spends its early life in freshwater but moves into the ocean where it attains sexual maturity and spends most of its life span (Owen & Chiras 1995).
anthropogenic	Caused by human activities.
bedload	The sediment that is transported intermittently along the bed of the river channel by creeping, rolling, sliding, or bouncing along the bed. Typically includes sizes of sediment ranging between coarse sand to boulders (the larger or heavier sediment).
bed-material	Sediment that is preserved along the channel bottom and in adjacent bars; it may originally have been material in the suspended load or in the bed load.
bedrock	A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material (Neuendorf et al. 2005). The bedrock is generally resistant to fluvial erosion over a span of several decades, but may erode over longer time periods.

	DEFINITION
canopy cover (of a stream)	Vegetation projecting over a stream, including crown cover (generally more than 1 meter (3.3 feet) above the water surface) and overhang cover (less than 1 meter (3.3 feet) above the water).
cfs	Cubic feet per second; a measure of water flows
channel morphology	The physical dimension, shape, form, pattern, profile, and structure of a stream channel.
channel planform	Characteristics of the river channel that determine its two-dimensional pattern as viewed on the ground surface, aerial photograph, or map.
channel sinuosity	The ratio of length of the channel or thalweg to down-valley distance. Channels with a sinuosity value of 1.5 or more are typically referenced as meandering channels (Neuendorf et al. 2005).
channel stability	The ability of a stream, over time and under the present climatic conditions, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either raising or lowering the level of the streambed.
channelization	Alteration of a natural channel typically by straightening and deepening the stream channel to permit the water to move faster, to reduce flooding, or to drain wetlands.
constructed features	Human-made features that are constructed in the river and/or floodplain areas (e.g., levees, bridges, riprap). These features are referred to as human features in the *Map Atlas*.
controls	A feature that is highly resistant to erosion by flowing water and limits the ability of a river or stream to migrate across a valley in either the lateral (horizontal) or vertical direction or both. Geologic controls are naturally occuring features such as bedrock outcrops, landslides, or alluvial fans that erode slowly over long periods of time. Human-constructed features such as highways, railroads, bridge abutments, or riprap may also act as controls and limit the ability of a river to migrate.
degradation	Wearing down of the land surface through the processes of erosion and/or weathering
depositional areas (stream)	Local zones within a stream where the energy of flowing water is reduced and sediment settles out, accumulating on the streambed.
diversity	Genetic and phenotypic (life history traits, behavior, and morphology) variation within a population.
ecosystem	A unit in ecology consisting of the environment with its living elements, plus the non-living factors, that exist in and affect it (Neuendorf et al. 2005).

	Definition
floodplain	The surface or strip of relatively smooth land adjacent to a river channel constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is built on alluvium, carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A river has one floodplain and may have one or more terraces representing abandoned floodplains (Neuendorf et al. 2005).
flow regime	The quantity, frequency, and seasonal nature of water flow.
fluvial process	Those processes related to the movement of flowing water that shape the surface of the earth through the erosion, transport, and deposition of sediment, soil particles, and organic debris.
geomorphic potential	The capability of adjustment or change in structural/process components of an ecosystem through the combined action of hydrologic, riparian, and geomorphic regimes to form, connect, and sustain fish habitat over time.
geomorphic province	A large area comprised of similar land forms that exhibit comparable hydrologic, erosional, and tectonic processes (Montgomery and Bolton 2003); any large area or region considered as a whole, all parts of which are characterized by similar features or by a history differing significantly from that of adjacent areas (Neuendorf et al 2005); also referred to as a basin.
geomorphic reach	An area containing the active channel and its floodplain bounded by vertical and/or lateral geologic controls, such as alluvial fans or bedrock outcrops, and frequently separated from other reaches by abrupt changes in channel slope and valley confinement. Within a geomorphic reach, similar fluvial processes govern channel planform and geometry through driving variables of flow and sediment. A geomorphic reach is comprised of a relatively consistent floodplain type and degree of valley confinement. Geomorphic reaches may vary in length from 100 meters in small, headwater streams to several miles in larger systems (Frissell et al. 1986).
geomorphology	The study of the classification, description, nature, origin, and development of present landforms and their relationships to underlying structures, and of the history of geologic changes caused by the actions of flowing water.
GIS	Geographical information system. An organized collection of computer hardware, software, and geographic data designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

habitat action	Proposed restoration or protection strategy to improve the potential for sustainable habitat upon which endangered species act (ESA) listed salmonids depend on. Examples of habitat actions include the removal or alteration of project features to restore floodplain connectivity to the channel, reconnection of historic side channels, placement of large woody debris, reforestation of the low surface, or implementation of management techniques.
habitat connectivity (stream)	Suitable stream conditions that allow fish and other aquatic organisms to access habitat areas needed to fulfill all life stages.
habitat unit	A morphologically distinct area within a geomorphic reach comprised of floodplain and channel areas; typically less than several channel widths in length (Montgomery and Bolton 2003). They generally correspond to different habitat types for aquatic species. Basic channel units may include pools, riffles, bars, steps, cascades, rapids, floodplain features, and transitional zones characterized by relatively homogeneous substrate, water depth, and cross-sectional averaged velocities. *Also known as channel or geomorphic units*.
indicator	A variable used to forecast the value or change in the value of another variable; for example, using temperature, turbidity, and chemical contaminents or nutrients to measure water quality.
inner zone (IZ)	Area where ground-disturbing flows take place; characterized by the presence of primary (perennial) and secondary (ephemeral) side channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition.
intevention analysis	Consists of computer models and methods based on samples collected at an impact site before and after an intervention, such as a habitat action, so that effects of the intervention may be determined.
large woody debris (LWD)	Large downed trees that are transported by the river during high flows and are often deposited on gravel bars or at the heads of side channels as flow velocity decreases. The trees can be downed through river erosion, wind, fire, or human-induced activities. Generally refers to the woody material in the river channel and floodplain whose smallest diameter is at least 12 inches and has a length greater than 35 feet in eastern Cascade streams.
limiting factor	Any factor in the environment that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.
low-flow channel	A channel that carries streamflow during base flow conditions.
mass wasting	General term for the dislodgement and downslope transport of soil and rock under the influence of gravitational stress (mass movement). Often referred to as shallow-rapid landslide, deep-seated failure, or debris flow.

	DEFINITION
overflow channel	A channel that is expressed by no or little vegetation through a vegetated area. There is no evidence for water at low stream discharges. The channel appears to have carried water recently during a flood event. The upstream and/or downstream ends of the overflow channel usually connect to the main channel.
outer zone (OZ)	Area that may become inundated at higher flows but does not experience a ground-disturbing flow; generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. (also knows as the floodprone zone)
pathways	Interpretation of one or more indicators (i.e., water quality) that is used to define or refine potential environmental deficiencies caused by natural or anthropogenic impacts that negatively affect a life stage(s) of the species of concern (i.e., limiting factor). Pathways are typically analyzed at the reach, valley segment, watershed, and basin scales.
peak flow	Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.
planform	The shape of a feature, such as a channel alignment, as seen in two dimensions, horizontally, as on an aerial photograph or map.
reach-based ecosystem indicators (REI)	Measure of physical variables that are quantifiable and have geospatial reference.
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
response reach	A reach that is more responsive to change and often characterized by unconfined and moderately confined alluvial plains/channels that lack geologic controls which often define confined channels. A response reach can be further broken down to individual subreach units that comprise finer morphologically distinct areas providing geomorphic control and transitional habitat and biological potential.
riparian area	An area with distinctive soils and vegetation community/composition adjacent to a stream, wetland, or other body of water.
riprap	Large angular rocks that are placed along a river bank to prevent or slow erosion.
river mile (RM)	Miles from the mouth of a river or for upstream tributaries; miles from the point where the tributary joins the main river.
side channel	A channel that is not part of the main channel, but appears to have water during low-flow conditions and has evidence for recent higher flow (e.g., may include unvegetated areas (bars) adjacent to the channel). At least the upstream end of the channel connects to, or nearly connects to, the main channel. The downstream end may connect to the main channel or to an overflow channel. May also be referred to as a secondary channel.

	DEFINITION
spawning and rearing habitat	Stream reaches and the associated watershed areas that provide all habitat components necessary for adult spawning and juvenile rearing for a local salmonid population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident and migratory fish, and may also support subadults and adults from local populations.
subbasin	A subbasin represents the drainage area upslope of any point along a channel network (Montgomery & Bolton 2003). Downstream boundaries of subbasins are typically defined in this assessment at the location of a confluence between a tributary and mainstem channel. An example would be the Twisp River Subbasin.
subreach units	Distinct areas are comprised of the floodplain and off-channel and active-channel areas. They are delineated by lateral and vertical controls with respect to position and elevation based on the presence/absence of inner or outer riparian zones.
terrace	A relatively stable, planar surface formed when the river abandons the floodplain that it had previously deposited. It often parallels the river channel, but is high enough above the channel that it rarely, if ever, is covered by water and sediment. The deposits underlying the terrace surface are alluvial, either channel or overbank deposits, or both. Because a terrace represents a former floodplain, it can be used to interpret the history of the river.
tributary	A stream feeding, joining, or flowing into a larger stream or lake (Neuendorf et al. 2005).
UCSRB	Upper Columbia Salmon Recovery Board
UCRTT	Upper Columbia Regional Technical Team
valley segment	An area of river within a watershed sometimes referred to as a subwatershed that is comprised of smaller geomorphic reaches. Within a valley segment, multiple floodplain types exist and may range between wide, highly complex floodplains with frequently accessed side channels to narrow and minimally complex floodplains with no side channels. Typical scales of a valley segment are on the order of a few to tens of miles in longitudinal length.
vertical migration	Movement of a stream channel in a vertical direction; the filling and raising or the removal or erosion of streambed material that changes the level of the stream channel.
viable salmonid population	An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity.

	DEFINITION
watershed	The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins. Ridges of higher ground form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.

APPENDIX A

Reach-based Ecosystem Indicators

Kahler Reach-Based Ecosystem Indicator Tables

KAHLER REACH ASSESSMENT, NASON CREEK (RM 4.55-8.9), WASHINGTON
Reach-based Ecosystem Indicators (REI) Version 1.1

The Kahler reach assessment team was comprised of Edward W. Lyon, Jr., L.G. (Reclamation geologist), Rob McAffee (Reclamation geologist), Jennifer Bountry, P.E. (Reclamation hydraulic engineer), Lucy Piety, (Reclamation Geomorphologist), Todd Maguire (Reclamation Activity Coordinator), Cindy Raekes (U.S. Forest Service Fisheries Technician) and Dave Hopkins, (U.S. Forest Service Fisheries Biologist Technician). Rating of each indicator was done as an iterative process by integrating new data collected for this reach assessment, data contained in the *Tributary Assessment* (Reclamation, 2008), and literature review. The ranges of criteria presented here are not absolute and should be adjusted to each unique subbasin as data becomes available.

PATHWAY: WATERSHED CONDITION

INDICATOR: WATERSHED ROAD DENSITY AND EFFECTIVE DRAINAGE NETWORK (ROAD DENSITY)

Criteria: The following criteria were developed by USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Condition	Effective Drainage Network and Watershed Road Density	Increase in Drainage Network/ Road Density	Zero or minimum increases in active channel length correlated with human caused disturbance. Road density <1 miles/miles^2.	Low to moderate increase in active channel length correlated with human caused disturbances. Road density 1-2.4 miles/miles^2.	Greater than moderate increase in active channel length correlated with human caused disturbances. Road density >2.4 miles/miles^2.

Data: Data was obtained through literature review.

Road Density	River Miles Effected	Density
Lower Nason Creek	RM 0-12.2	3.88 mi/mi^2

Upper Nason Creek	RM 12.2-headwaters	1.1 mi/mi^2

Interpretation:

Watershed Condition	**Condition**
Road Density Indicator	At Risk Condition
Location	Unacceptable Risk Condition
Effective Drainage network	Unacceptable Risk Condition

Narrative:
Nason Creek watershed is a 5^{th} field hydrologic unit code (HUC 5) and Lower Nason is a 6^{th} HUC (USGS HUC code 170200110602) watershed. Road Densities in Lower Nason Creek are 3.88 mi/mi^2 (RM 0-12.2) and 1.1 mi/mi^2 for the Upper Nason Creek (RM 12.2-headwaters) (USFS 2008). Road mapping in a geographical information system (GIS) by USFS include hill-slope and valley bottom roads, however, the data represents a minimum value since it does not include all logging roads, power line roads, private roads, or railroad grades. Road densities have increased, mostly between 1975 and 1985 as a result of increased logging/access roads and an increase in private and public roads that reflect the increase in devolvement (USFS, 1996). Some road related impacts include restriction and constriction of the floodplain, decrease in infiltration rate and increase in surface runoff and erosion (USFS, 1996). Based on USFS data the specific indicator of road density would be at ‘Unacceptable Risk’ downstream of RM 12.2 and ‘At Risk’ for upstream of RM 12.2.

USFS Watershed Analysis Report (USFS, 1996) indicates areas with high road density can alter drainage networks and increase fine sediment delivered to the river. Given the geologic material that includes glacial outwash and alluvial fan material that parallel the streams and the proximity of roads to streams, sediment delivery from non-paved roads can be high. However, in RM 0 to RM 14 many of the drainages are presently cutoff by railroad grade or highway embankment. Increase in road density and location of roads, especially in valley bottom location in the Lower Nason has adversely affected the effective drainage network, which is noted to be at an ‘Unacceptable Risk Condition’ (Thomas, 2007,).

INDICATOR: DISTURBANCE REGIME (NATURAL/HUMAN CAUSED)

Criteria: The following criteria were modified from USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Condition	Disturbance Regime	Natural/ Human Caused	Environmental disturbance is short lived; predictable hydrograph, high quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Scour events, debris torrents, or catastrophic fires are localized events that occur in several minor parts of the watershed. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major part of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.

Interpretation:

Disturbance Regime	Condition
Lower Nason Creek	At Risk Condition

Narrative:
At the 5th HUC (Watershed) scale disturbance history in the Lower Nason is noted to be functioning at an 'At Risk Condition' (Thomas, 2007) due to multiple clearcuts and logging roads that have been constructed over at least the last 50 years. Between 1985 and 1992, as timber harvest activity increased, mass erosion became more evident (USFS 1996, WRIA, Golder 2003). Fifty four site damage reports associated with debris flows from the 1990 flood were recorded in the Nason Creek watershed (USFS 1996). However, many of the earlier concentrated disturbances are in an early successional recovery stage.

PATHWAY: FLOW/HYDROLOGY

INDICATOR: STREAMFLOW (CHANGE IN PEAK/BASE FLOW)

Criteria: The following criteria were developed by USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Flow/ Hydrology	Streamflow	Change in Peak/Base Flows	Magnitude, timing, duration and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology and geography.	Some evidence of altered magnitude, timing duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology and geography.

Interpretation:

Streamflow	Condition
Nason Creek Watershed	At Risk Condition

Narrative:

Discharges were calculated at each RM 1 through 14 for a 2, 5, 10, 25, 50 and 100 year recurrence intervals (Reclamation 2007). There are no dams within the Nason Creek drainage basin that alter the magnitude, timing, duration, and frequency of flows. However, several tributaries are disconnected from the mainstem because of the railroad grade or highway resulting in an impact to the timing of run-off flows. Based on noted large clearcut areas on hillslopes and reduced connectivity of mainstem with tributary drainages due to railroad and highway embankments and channelization of mainstem Nason Creek, the hydrology is assumed to be altered and considered ‘At Risk’ at the 5th HUC (watershed) scale (Thomas, 2007).

PATHWAY: WATER QUALITY

INDICATOR: TEMPERATURE (MWMT/MDMT/7-DADMax)

Criteria: The following criteria were developed by Hillman and Giorgi (2002), USFWS (1998), and WDOE (2008).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Water Quality	Temp.	MWMT/ MDMT/ 7-DADMax	Bull Trout: Incubation: 2-5°C Rearing: 4-10°C Spawning: 1-9°C Salmon and Steelhead: Spawning: June-Sept 15°C Sept-May 12°C Rearing: 15°C Migration: 15°C Adult holding: 15°C Or 7-DADMax performance standards: Salmon spawning 13°C Core summer salmonid habitat 16°C Salmonid spawning, rearing and migration 17.5°C Salmonid rearing and migration only 17.5°C	MWMT in reach during the following life history stages: Incubation: <2°C or 6°C Rearing: <4°C or 13-15°C Spawning: <4°C or 10°C Temperatures in areas used by adults during the local spawning migration sometimes exceed 15°C. Or 7-DADMax performance standards exceeded by ≤15%	MWMT in reach during the following life history stages: Incubation: <1°C or >6°C Rearing: >15°C Spawning: <4°C or >10°C Temperatures in areas used by adults during the local spawning migration regularly exceed 15°C. Or 7-DADMax performance standards exceeded by >15%

Date: The following information was obtained through a literature review of USFS unpublished data (USFS, 2008b) and Wenatchee River Temperature Total Maximum Daily Load Study (WDOE, 2005) WDOE website data: http://www.ecy.wa.gov/ecyhome.html

Temperature Parameter	Location	Agency	Year	7-day mean of max. daily temp.	Maximum daily temperature
	Above Whitepine	WDOE	2003	17.9°C	18.4°C
	Bern Facility	WDOE	2003	18.4°C	18.9°C
	Above Mahar	WDOE	2003	18.0°C	18.8°C
	Coles Corner	WDOE	2003	21.4°C	22.0°C
	Above Gill Creek	WDOE	2003	18.4°C	19.0°C
	Cedar Brae	WDOE	2003	18.9°C	19.7°C
	Above Kahler	WDOE	2003	22.0°C	22.8°C
	Nason RM 0.8	WDOE	2002	18.9°C	19.7°C
	Nason RM 3.8	USFS	2002	18.9°C	19.6°C
	Nason RM 0.4	USFS	2002	19.4°C	20.0°C
	Nason near mouth	USFS	2001	No data	22.3°C
	Nason near mouth	USFS	2000	20.6°C	21.4°C
	Nason near mouth	USFS	1999	17.5°C	18.2°C
	Near Coles Corner	USFS	2001	19.1°C	19.7°C
	Near Coles Corner	USFS	2000	19.3°C	20.8°C
	Near Coles Corner	USFS	1999	17.1°C	17.6°C

Interpretation: Washington Department of Ecology water quality indicators were used to determine the water temperature condition for the reach assessment.

Temperature	Condition
Salmon spawning	Unacceptable Risk Condition
Core summer salmonid habitat	Unacceptable Risk Condition
Salmonid spawning, rearing and migration	Unacceptable Risk Condition
Salmonid rearing and migration only	Unacceptable Risk Condition

Narrative:
The Wenatchee River from the Wenatchee National Forest boundary (RM 27.1) to its headwaters is considered Class AA (extraordinary). Because Nason Creek discharges to the AA portion of the Wenatchee River, it is considered Class AA as well. Nason Creek is a Category 5 stream meaning that Washington Department of Ecology (WDOE) has data showing that the water quality standards have been violated for one or more pollutants, and there is no TMDL or pollution control plan in-place (WDOE website).

Although high water temperatures noted in 2001 can be attributed in great part to low-flow, a maximum water temperature of 70.7^{o} F was recorded in 1995 (Thomas, 2007). At the 5^{th} HUC scale, the reach with the most sustained longitudinal heating occurred between RM 10.6 and 3.5 (Watershed Sciences, 2003). Given that recorded temperatures in the tributaries were below the temperature measured in Nason Creek, the temperature problem is related to Nason Creek where stream shading has been reduced by the clearing of vegetation and riprapping of banks along the highway. Temperature above RM 12 is functioning at an ‘At Risk Condition’ due to anthropogenic impacts including wastewater return and surface diversions/withdraws, and also regulatory guidelines and because any slight temperature increase in this valley segment could have serious consequences downstream (Thomas, 2007). Lower Nason (RM 0.0 to 12.0) is functioning at an ‘Unacceptable Risk Condition’ based on temperature measurements at Coles Corner and the mouth where temperature is approaching threshold (20.6 degrees C) (303d list; WDOE Website).

INDICATOR: TURBIDITY

Criteria: The performance standard for this indicator is from Hillman and Giorgi (2002).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Water Quality	Turbidity	Turbidity	Performance Standard: Acute <70 NTU Chronic <50 NTU For streams that naturally exceed these standards: Turbidity should not exceed natural baseline levels at the 95% CL. <15% exceedance.	15-50% exceedance.	>50% exceedance.

Data:
Between 10/6/91 to 9/28/93, twenty turbidity measurements were taken at ‘station 19’ located near Nason Creek Camp Ground (CCCD, 1993).

Turbidity	NTU
Maximum observed	3.5
Minimum observed	0.1

Interpretation:

Turbidity	**Condition**
Nason Creek	At Risk Condition

Narrative:

Turbidity and sediment are noted to be functioning at an ‘At Risk Condition’ at the 5^{th} HUC scale (Thomas, 2007) based on the volatility of the system which translates into an altered sediment budget and the rivers ability to sort and route suspended load material. Based on that data turbidity at the 6^{th} HUC scale is interpreted to be functioning at an ‘At Risk Condition’. Future monitoring maybe needed as tributaries and hillsopes are reconnected through project implementation.

INDICATOR: CHEMICAL CONTAMINATION/NUTRIENTS (METALS/POLLUTANTS, pH, DO, NITROGEN, PHOSPHOROUS)

Criteria: The following criteria were developed by USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Condition
Water Quality	Chemical Contamination/ Nutrients	Metals/ Pollutants, pH, DO, Nitrogen, Phosphorous	Low levels of chemical contamination from landuse sources, no excessive nutrients, no CWA 303d designated reaches. Or Washington State Department of Ecology standards – 173-201A-200.	Moderate levels of chemical contamination from landuse sources, some excess nutrients, one CWA 303d designated reach.	High levels of chemical contamination from landuse sources, high levels of excess nutrients, more than one CWA 303d designated reach.

Data:

Between 10/6/19 to 9/28/93, twenty measurements were taken at ‘station 19’ located near Nason Creek Campground (CCCD, 1993).

Parameter	Maximum Observed	Minimum Observed
Dissolved Oxygen	15.7 mg/L	8.1 mg/L
pH	7.13	6.37
Conductivity	48.0 uSiemens	19.1 uSiemens
Total Dissolved Solids	24.0 mg/L	9.6 mg/L
NO3/No2-N	0.19 mg/L	0.01 mg/L
Suspended Solids	44 mg/L	2 mg/L
Phosphorus	44 mg/L	3 mg/L
Fecal Caliform	24 (#/100)	1 (#/100)

Interpretation:

Chemical Contamination/Nutrients	Condition
Nason Creek	At Risk Condition

Narrative:

Chemical contaminants and nutrients at the 5th HUC scale are functioning at an ‘At Risk Condition’ (Thomas, 2007). In the upper sections of the watershed there are factors such as wastewater return from a small Class IV Advanced Wastewater Treatment Plant (tertiary treatment with alum addition) that services the ski resort area and discharges to Nason Creek (WDOE, 2006), and surface diversions/withdraws. Given that these practices can have an affect on the downstream section of the watershed, the chemical contaminants and nutrients were interpreted to be functioning at an ‘At Risk Condition’ at the 6th HUC scale.

PATHWAY: HABITAT ACCESS

INDICATOR: PHYSICAL BARRIERS (MAIN CHANNEL BARRIERS)

Criteria: The following criteria have been modified from USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Access	Physical Barriers	Main Channel Barriers	No man-made barriers present in the mainstem that limit upstream or downstream migration at any flow.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.

Interpretation:

Habitat Access	Condition
Nason Creek	Adequate Condition

Narrative:

There are no manmade barriers on Nason Creek between RM 0 and RM 16.8 (at the falls). On the mainstem Wenatchee River, Dryden Dam is a non-channel spanning structure and does not present passage issues. However, Tumwater Dam has fish passage capability (LFA), but could be a partial barrier. Physical barriers at both 5th (Thomas 2007) and 6th HUC scales are interpreted to be functioning at an 'Adequate Condition'

PATHWAY: HABITAT QUALITY

INDICATOR: SUBSTRATE (DOMINANT SUBSTRATE)

Criteria: Performance standards for these criteria are from Hillman and Giorgi (2002).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Substrate	Dominant Substrate/ Fine Sediment	Gravels or small cobbles make-up >50% of the bed materials in spawning areas. Reach embeddedness in rearing areas <20%. <12% fines (<0.85mm) in spawning gravel or ≤12% surface fines of ≤6mm.	Gravels or small cobbles make-up 30-50% of the bed materials in spawning areas. Reach embeddedness in rearing areas 20-30% 12-17% fines (<0.85mm) in spawning gravel or 12-20% surface fines of ≤6mm.	Gravels or small cobbles make-up <30% of the bed materials in spawning areas. Reach embeddedness in rearing areas >30% >17% fines (<0.85mm) in spawning gravel or >20% surface fines of ≤6mm.

Data: The following information was gathered during the habitat assessment conducted by the Methow Valley Ranger District for this reach assessment.

Substrate: Pebble Count Data.	**RM 4.56-8.90**
# of Pebble counts in Reach	2
Surface fines (<6mm)	13%
D35	71 mm
D50	123 mm
D84	311 mm

Data: The following information was gathered during the habitat assessment conducted by the Methow Valley Ranger District for this reach assessment.

Substrate: Ocular estimate %	**RM 4.56-8.90**
% Sand	10%
% Gravel	25%
% Cobble	40%
% Boulder	25%

Data: McNeil core samples were collected by USFS at riffles sites downstream of Coles Corner in 1993 and 2007 and upstream of Coles Corner in 2005 and 2006. 2007 data was not available.

McNeil Core Samples Data	**Average % fines <1mm**
1993	22.7
2005	12.7
2006	9.71

Interpretation:

Substrate	**Condition RM 4.56-8.90**
Dominant Substrate	Adequate Condition
Embeddedness	At Risk Condition
Fine Sediment	Adequate Condition

Narrative:

Pebble counts and ocular estimations conducted during the habitat assessment indicated that the dominant substrate is cobble from RM 4.5 to 8. Each reach also had an ocular estimation recorded for sand, gravel, cobble and boulder percentages. The data does not account for natural variability and the sample sites may not be representative of the entire reach. Time series McNeil core sample data taken at pool tail out sites within lower Nason Creek also show a wide range of percent fines <1mm. It is unknown how this data related to sediment sources such as landslides and debris flows, especially those that are fire related.

Based on the available data, Lower Nason Creek is functioning at an 'At Risk Condition' for embeddedness. Overall, substrate embeddedness for Nason Creek at the 5th HUC scale is noted to be functioning at an 'At Risk Condition' (Thomas, 2007) for juvenile rearing habitat due to the volatility of the system. However, embeddedness was noted to not be a problem based on visual observations during the habitat assessment at the 6^{th} HUC scale. The interpretation for the indicator of dominant substrate and fine sediment is functioning at an 'Adequate Condition'.

INDICATOR: LARGE WOODY DEBRIS (PIECES PER MILE AT BANKFULL)

Criteria: The following criteria were developed by USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Large Woody Debris (LWD)	Pieces Per Mile at Bankfull	>20 pieces/mile >12" diameter >35 ft length; and adequate sources of woody debris available for both long- and short-term recruitment.	Currently levels are being maintained at minimum levels desired for "adequate", but potential sources for long-term woody debris recruitment is lacking to maintain these minimum values.	Current levels are not at those desired values for "adequate", and potential sources of woody debris for short- and/or long-term recruitment are lacking.

Data: The following information was gathered during the habitat assessment conducted by the Methow Valley Ranger District for this reach.

LWD	**RM 4.56-8.90**
Large wood per mile:	
Large (>35' long, >20" diameter)	1.8
Medium (>35' long, 12-20" diameter)	8.7
Total large and medium	10.5
Small (>20' long, >6" diameter)	18.1

Interpretation:

LWD	**Condition RM 4.56-8.9**
Total large and medium	At Risk Condition
LWD recruitment potential	At Risk Condition

Narrative:

Large woody debris (LWD) potential was calculated using the large and medium wood acres against the total acres of the reach. Pieces of large and medium wood per mile on comparable reference reaches on Methow, Chewuch, Twisp and Pasayten Rivers are 30, 22, 34 and 57, respectively. At the 5th HUC scale, LWD is noted to be functioning at an 'At Risk Condition' (Thomas, 2007). At the 6th HUC scale, Nason Creek is interpreted to be functioning at an 'At Risk Condition' due to current levels of medium and large wood being below 'Adequate Condition', but recruitment potential is at reasonable levels.

INDICATOR: POOLS (POOL FREQUENCY AND QUALITY)

Criteria: The following criteria were developed by USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Pools	Pool Frequency and Quality Large Pools (in adult holding, juvenile rearing, and over-wintering reaches where streams are >3 m in wetted width at base flow)	Pool frequency: Channel width No. pools/mile 0-5 ft 39 5-10 ft 60 10-15 ft 48 15-20 ft 39 20-30 ft 23 30-35 ft 18 35-40 ft 10 40-65 ft 9 65-100 ft 4 Pools have good cover and cool water and only minor reduction of pool volume by fine sediment. Each reach has many large pools >1 m deep with good fish cover.	Pool frequency is similar to values in "functioning adequately", but pools have inadequate cover/temperature, and/or there has been a moderate reduction of pool volume by fine sediment. Reaches have few large pools (>1 m) present with good fish cover.	Pool frequency is considerably lower than values for "functioning adequately", also cover/temperature is inadequate, and there has been a major reduction of pool volume by fine sediment. Reaches have no deep pools (>1 m) with good fish cover.

Data: The following information was gathered for this reach assessment by the Methow Valley Ranger District.

Pool Frequency and Quality	**RM 4.56-8.90**
Average wetted channel width	61 ft
Average thalweg depth (riffles)	1.3 ft
Average thalweg depth (runs)	1.6 ft
Number of pools >1 meter deep/mile	5.2
Average pool max. depth	4.1 ft
Riffle to pool ratio (main channel)	2.44 : 1
Percent runs (non-turbulent riffles)	12.4%
Percent side channels	1.5%

Data: The following information was gathered during the assessment conducted by the Methow Valley Ranger District for this reach.

Pools	**RM 4.6-5.3**	**RM 5.3-5.75**	**RM 5.75-7.75**	**RM 7.75-8.9**
Pools per Mile	12.8	4.4	6.0	10.4
Pools > 5' Deep per Mile	2.9	0	1.5	2.6
Residual Depth	2.4 ft	1.7 ft	3.3 ft	3.0 ft
LWD per mile (pools)[1]	19, 5, 9	45, 0, 0	36, 25, 0	8, 3, 0

[1]Small, medium, and large size class, respectively, in table. Calculation is large wood per mile of pool habitat.

Interpretation of pool quality by the Methow Valley Ranger District stream inventory surveyors.

RM 4.6-8.9	**RM 5.3-5.75**	**RM 5.75-7.75**	**RM 7.75-8.9**
'At Risk Condition' due to lack of wood.	'Unacceptable Risk Condition'	'At Risk Condition'	'At Risk Condition' due to lack of wood.

Interpretation:

Pool Frequency and Quality	**Condition**
Frequency	Adequate Condition
Quality	At Risk
Pool Cover	Unacceptable Risk Condition
Large Pools (greater than 5’)	Unacceptable Risk Condition

Narrative:
On Nason Creek, pool frequency and pool quality at the 5th HUC scale are noted to be functioning at an ‘At Risk Condition’ (Thomas, 2007). At the 6th HUC scale, Nason Creek is functioning at an ‘Adequate Condition’ in terms of pool frequency based on the number of pools noted in the habitat survey (Appendix C), thalweg profile (Reclamation, 2008) and comparison to reference reaches on similar stream types such as the Chiwawa River (Woodsmith and Bookter, 2008). Complex pools formed by LWD or bedrock, typically deeper than 5 ft, have biological significance on Nason Creek. The number of 5 ft. deep (or greater) pools was observed to be fewer than natural, and many of the pools were scour pools formed in artificially constrained channel sections and not at meander bends. The quality of the pools at the 6th HUC scale is noted to be functioning either at an ‘Unacceptable Risk Condition’ or ‘At Risk Condition’ due to lack of large wood associated with the pools.

INDICATOR: OFF-CHANNEL HABITAT (CONNECTIVITY WITH MAIN CHANNEL)

Criteria: The following criteria have been modified from USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Habitat Quality	Off-channel Habitat	Connectivity with Main Channel	Reach has many ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are low energy areas. No manmade barriers present along the mainstem that prevent access to off-channel areas. OR Ratio if data is available	Reach has some ponds, oxbows, backwaters, and other off-channel areas with cover, and side channels are generally high energy areas. Manmade barriers present that prevent access to off-channel habitat at some flows that are biologically significant. OR Ratio if data is available	Reach has few or no ponds, oxbows, backwaters, and other off-channel areas. Manmade barriers present that prevent access to off-channel habitat at multiple or all flows. OR Ratio if data is available

USFS habitat survey

Potential Off-channel Habitat	**RM 4.56-8.9**
Percent of low-flow wetted channel consisting of accessible side channel habitat	1.5%

Data: The following information was generated by Reclamation using a 2D hydraulic model at 5000 cfs, (Appendix D), LiDAR data and field observations during the initial and follow-up site assessment (Appendix B).

Total length of disconnected channel (feet)	395 ft
Total area of disconnected zone (acres)	7.75 acres

Data: The following information was gathered during the initial site assessments conducted by Reclamation for this reach.

Anthropogenic Features:	**RM 4.56-8.9**
Culverts	9
Levees/Berms/ Embankments	2314' of highway grade, 1212' of unimproved road embankment and 164' of levee
Riprap	2831 ft
Bridges	1
Floodplain Development	Yes

Interpretation:

Connectivity With Main Channel	**Condition RM 4.56-8.9**
Kahler Reach	At Risk Condition

Narrative:

Within the Kahler reach, Highway 2 disconnects about 4 percent of the floodplain from the main channel. Culverts were observed in the highway and unimproved roads. However, fish passage through culverts has not been evaluated and many culverts appear to be undersized and elevated above the main channel. At the 5th HUC scale off-channel habitat in the Lower Nason is noted to be functioning at an 'Unacceptable Risk Condition' due to the impact of the railroad and highway (Thomas, 2007). At the 6th HUC scale connectivity with the main channel is functioning at an 'Unacceptable Risk Condition', with the exception being between RM 5.2 and 6.6 which is functioning at an 'At Risk Condition'.

PATHWAY: CHANNEL

INDICATOR: CONDITION (AVERAGE BANKFULL WIDTH/MAXIMUM DEPTH RATIO)

Criteria: The following criteria are listed in Hillman (2006).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel	Condition	Valley Segment & Channel Segment Characterization	Informative; no criteria presented.	Informative; no criteria presented.	Informative; no criteria presented.

Data: The following data was collected by Reclamation and the Methow Valley Ranger District stream survey crew. Categories are listed in Hillman (2006).

Kahler Reach	**RM 4.56-8.9**
Valley bottom type	U2
Channel patterns	Moderate sinuosity, few braids, few side channels
Valley type	Alluvial
Bed-form types	Pool-riffle
Predominant bed material	Cobble/gravel
Typical confinement	Unconfined
Bankfull width/depth ratio	44.0
Channel type	C3, F3
Width/depth ratio value (+/- 2.0)	No data

INDICATOR: DYNAMICS (FLOODPLAIN CONNECTIVITY)

Criteria: The following criteria have been modified from USFWS (1998).

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel	Dynamics	Floodplain Connectivity	Floodplain areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly.

Data: The following information was collected during the initial site assessment by Reclamation (Appendix B).

Floodplain Connectivity: Area of anthropogenic impact	**RM 4.56-8.9**
Engineered/altered channel	10.6acres
Buildings (acres)	1.76 acres
Cleared Area (Includes buildings and roads)(acres)	0.2 acres
Embankment/highway (acres)	4.27 acres
Embankment/road (acres)	0.65 acres
Powerline right of way (acres)	14.75 acres
Transmission line (acres)	1.77 acres
Total (acres)	34 acres
Percent floodplain area occupied by anthropogenic features	16%

Data: The following information was collected by Reclamation (Appendix B).

Floodplain Connectivity (anthropogenic features in feet)	**RM 4.56-8.9**
Embankment (highway)	2,314 ft
Embankment (road)	1,212 ft
Levee	164 ft
Total	3,690 ft

Data: The following information was collected during the follow-up site assessment by Reclamation (Appendix B).

Floodplain Connectivity: Area (in m^2) of Channel units at low flow	**RM 4.56-8.9**
Pool	6,467 m^2
Riffle	30,002 m^2
Rapid	42,576 m^2
Run	52,691 m^2
Total (sq meters)	131,736 m^2

Data: The following information was collected during the follow-up site assessment by Reclamation (Appendix B).

Floodplain Connectivity: Area of Inner and Outer Zones at 5,000cfs.	**RM 4.56-8.9**
Inner Zone (Acres)	60 acres
Outer Zone (Acres)	143 acres
Disconnected Outer Zone (Acres)	8 Acres
TOTAL (Reach)	211 acres

Data: The following information was generated by Reclamation using a 2D hydraulic model (Appendix D).

Floodplain Connectivity:	**RM 4.56-8.9**
Existing area of inundation (acres):	
5,000 cfs	173 acres
Potential area of inundation (acres):	
5,000 cfs	185 acres
Percent of potential inundation achieved under current conditions:	
5,000 cfs	94%

Interpretation:

Floodplain Connectivity	**Condition RM 4.56-8.9**
Kahler Reach	At Risk

Narrative:
Floodplain connectivity in the Kahler reach is considered to be in an at risk condition. Highway 2 is the largest disconnecting feature with impacts throughout the reach that disconnect the right floodplain. Other disconnecting features include about 2830 feet of riparap throughout the reach and a bridge located at RM 8.2.

INDICATOR: DYNAMICS (BANK STABILITY/CHANNEL MIGRATION)

Criteria: The criteria for bank stability/channel migration were agreed upon by the assessment team as a "relative" indication to the functionality of the specific indicator.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel	Dynamics	Bank Stability/ Channel Migration	Channel is migrating at or near natural rates.	Limited amount of channel migration is occurring at a faster/slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has a least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.

Data: The following information was collected by the Methow Valley Ranger District (Appendix C).

Bank Erosion:	**RM 4.56-8.9**
Total bank erosion (both banks)	3,100 ft
Linear length per mile	710 ft/mi
Percent eroding banks	6.7%
Channel Characteristics	**RM 4.56-8.9**
Length (measured miles)	4.37 mi
Gradient	1%
Sinuosity (present)	>1.3

Data: The following information was collected by Reclamation (Appendix B).

Bank Stability/ Channel Migration	**RM RM 4.56-8.9**
Riprap (linear feet)	2,831'
Percent channel length with riprap	13%
Rock spurs	1

Data: Parameters developed by Reclamation (Appendix D).

Bank Stability/ Channel Migration:	**RM RM 4.56-8.9**
Total area of inner zone (acres)	28 acres
Percent of floodplain that is disconnected or impacted (acres)	4%

Interpretation:

Bank Stability/Channel Migration:	**Condition**
Lower Nason Creek	At Risk

Narrative:
At the 5th HUC scale streambank condition for Nason Creek is noted to be functioning at an 'At Risk Condition' (Thomas, 2007). At the 6th HUC scale all areas were interpreted to be either functioning at an 'At Risk Condition' or at an 'Unacceptable Risk Condition' due to the anthropogenic impacts on the streambank. Within the Kahler reach channel migration is limited is several locations by in large by Highway 2. Highway 2 reduces channel migration potential at RM 6.45, 5.7, 5.35 and 5.0. Migration rates may also be impacted by the removal of vegetation within the powerlin right-of-way.

INDICATOR: DYNAMICS (VERTICAL CHANNEL DYNAMICS)

Criteria: The criteria for vertical channel stability were agreed upon by the assessment team as a "relative" indication to the functionality of the specific indicator.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Channel	Dynamics	Vertical Channel Stability	No measurable trend of aggradation or incision and no visible change in channel planform.	Measurable trend of aggradation or incision that has the potential to but not yet caused disconnection of the floodplain or a visible change in channel planform (e.g. single thread to braided).	Enough incision that the floodplain and off-channel habitat areas have been disconnected; or, enough aggradation that a visible change in channel planform has occurred (e.g. single thread to braided).

Data: The following information was collected by the Methow Valley Ranger District (Appendix C).

Bankfull data (main channel):	**RM 4.56-8.9**
Average bankfull width	95 ft
Average bankfull depth (avg. of 7 measurements per bankfull width)	2.2 ft
Average width/depth ratio	44.0
Entrenchment ratio	2.4

Data: The following information was collected by Reclamation (Appendix B).

Bank Protection and Channel Constrictions	**RM 4.56-8.9**
Riprap (linear feet)	2,831 ft
Highway bridge	1

Data: Thalweg profile by Reclamation (Appendix D).

Parameter	**RM 4.56-8.9**
Channel Slope	0.7%

Interpretation:

Vertical Channel Dynamics	**Condition**
Kahler Reach	At Risk

Narrative:
Vertical stability is interpreted to be in an ‘At Risk Condition’. A sediment budget or numerical modeling to look at historical and potential future channel bed incision or aggradation was not done for this effort. There has been no large-scale change to the balance between incoming water and sediment loads (at the upstream end at RM 14.3) that would indicate a potential for incision or aggradation. Several sections of the lower 14 miles of river have been artificially straightened and confined (reduced floodplain access) indicating there is a potential for increased sediment transport capacity and reduced sediment recruitment from bank erosion in meandering channel sections. Although this has not been quantitatively evaluated, the impact would be expected to be small relative to total runoff volumes and discharge magnitudes during high flows. The most extensive impact has been that several meandering sections have been relocated and/or straightened by anthropogenic features. Channel bed elevation analyses from a 1980s FEMA analysis and 2006 LiDAR and 2007 thalweg profile show that in confined channel segments the present channel bed is 1 to 5 feet lower than the historic main channel.

PATHWAY: RIPARIAN VEGETATION

INDICATOR: CONDITION (STRUCTURE)

Criteria: The criteria for riparian vegetation structure were agreed upon by the assessment team as a "relative" indication to the functionality of the specific indicator.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Riparian Vegetation	Condition	Structure	>80% species composition, seral stage, and structural complexity are consistent with potential native community.	50-80% species composition, seral stage, and structural complexity are consistent with potential native community.	<50% species composition, seral stage, and structural complexity are consistent with potential native community.

Data: The following riparian vegetation information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; APPENDIX I).

Riparian Vegetation Structure (Acres):	**RM 4.56-8.9**
Large Conifer forest (A)	32 acres
Small Conifer Forest (B)	42 acres
Small Mixed Forest (F)	14 acres
Large Mixed Forest (E)	13 acres
Large Hardwood Forest (G)	9 acres
Small Hardwood Forest (H)	11 acres
Valley Shrub Land (K)	23 acres
Gravel Bar (GR)	5 acres
Gravel Bar/Shrub (Gr-Sh)	2 acres
Herbaceous (Herb)	8acres
Cobble Bar (Co)	4 acres
Noxious Weeds (NN)	2 acres
Percent disturbed	4%

Data: The following riparian buffer zone information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; APPENDIX D).

Riparian Vegetation Structure (Acres):	**RM 4.56-8.9**
Large Conifer forest (A)	18%
Small Conifer Forest (B)	27%
Small Mixed Forest (F)	8%
Large Mixed Forest (E)	7%
Large Hardwood Forest (G)	5%
Small Hardwood Forest (H)	6%
Valley Shrub Land (K)	13%
Gravel Bar (GR)	3%
Gravel Bar/Shrub (Gr-Sh)	1%
Herbaceous (Herb)	5%
Cobble Bar (Co)	2%
Noxious Weeds (NN)	1%
Percent disturbed	4%

Interpretation:

Structure	**Condition RM 4.56-8.9**
Kahler Reach	At Risk Condition

Narrative:
Riparian vegetation structure is interpreted to be in an ‘At Risk Condition’. Although the vegetation is interpreted to recovering back to the historic conditions, localized areas of the floodplain vegetation have been completely cleared due to construction of the highway, power lines, and development. The result is a younger seral stage of the vegetation community that lacks mature seral stage of coniferous and deciduous species.

INDICATOR: CONDITION (DISTURBANCE - HUMAN)

Criteria: The criteria for riparian vegetation disturbance were agreed upon by the assessment team as a "relative" indication to the functionality of the specific indicator.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Riparian Vegetation	Condition	Disturbance (Human)	>80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; <20% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); <2 mi/mi^2 road density in the floodplain.	50-80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; 20-50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); 2-3 mi/mi^2 road density in the floodplain.	<50% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; >50% disturbance in the floodplain (e.g., agriculture, residential, roads, etc.); >3 mi/mi^2 road density in the floodplain.

Data: The following riparian disturbance information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; Appendix D).

Riparian Vegetation Structure (Acres) in 30m Buffer:	**RM 4.56-8.9**
Large Conifer forest (A)	32 acres
Small Conifer Forest (B)	49 acres
Small Mixed Forest (F)	14 acres
Large Mixed Forest (E)	7 acres
Large Hardwood Forest (G)	4 acres
Small Hardwood Forest (H)	6 acres
Valley Shrub Land (K)	9 acres
Gravel Bar (GR)	5 acres
Gravel Bar/Shrub (Gr-Sh)	2 acres
Herbaceous (Herb)	7 acres
Cobble Bar (Co)	4 acres
Noxious Weeds (NN)	1 acres
Percent disturbed	9%

Data: The following riparian disturbance information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; APPENDIX I).

Disturbance - Floodplain:	**RM 4.56-8.9**
Cleared area (acres)	0.2 acres
Area of vegetation impacted by residence	2 acres
Area of roads	5 acres
Area impacted by power/transmission line	17 acres
Raod Density (mi./mi^2)	1.08/0.32
Percent disturbed	11%

Data: The following riparian disturbance information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; APPENDIX D).

Disturbance - Floodplain:	**RM 4.56-8.9**
Cleared area (acres)	3 acres
Area of vegetation impacted by residence	1 acres
Area of roads	4 acres
Percent disturbed	4%

Interpretation:

Disturbance	**RM 4.56-8.9**
Kahler Reach:	
Floodplain Disturbance	At Risk Condition
Road Density in Floodplain	Unacceptable Risk Condition

Narrative:
At the 6th HUC scale, riparian disturbance is interpreted to functioning at an ‘At Risk Condition’. Anthropogenic impacts in the riparian area include: construction and maintenance for U.S. Highway 2, primitive or access roads, private homes, campgrounds, powerline construction and railroad activities. All of these factors, as described in the Nason Creek Watershed Analysis (USFS, 1996) have changed the character of the riparian corridor and severely limited the lands ability to produce riparian tree vegetation (WDOE, 2003). The effects of the disturbances are wide ranging and can affect multiple ecosystem indicators. For example, oxbows and wetlands have been disconnected from the main channel of Nason Creek. The results include the loss of natural sources of large woody debris (LWD) (USFS, 1996 in WDOE, 2003) and an increase in the overall size of wetlands. The vegetation in the wetland areas are considered natural for the current condition (inundated); however, it is believed that prior to the railroad and highway embankments impounding the wetlands the vegetation would have been mixed riparian and upland vegetation.

INDICATOR: CONDITION (CANOPY COVER)

Criteria: The criteria for riparian vegetation canopy cover were agreed upon by the assessment team as a "relative" indication to the functionality of the specific indicator.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Riparian Vegetation	Condition	Canopy Cover	Trees and shrubs within one site potential tree height distance or 10 m buffer zone have >80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance or 10 m buffer zone have 50-80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance or 10 m buffer zone have <50% canopy cover that provides thermal shading to the river.

Data: The following riparian buffer zone information was computed utilizing the geographic information system (GIS) vegetation mapping from the *Tributary Assessment* (Reclamation, 2008; Appendix D). The percent medium-large wood along the 10 m riparian buffer is used as a surrogate to interpret the percent canopy cover by mature trees.

Canopy Cover	**RM 4.65-8.9**
Percent Medium-Large Wood Available in Riparian Buffer	12%

Interpretation:

Canopy Cover	**RM 4.56-8.9**
Kahler Reach	At Risk Condition

Narrative:
Canopy cover is interpreted to be at an “At risk Condition”. Canopy cover provides shading to the stream and is a factor for LWD recruitment potential. In the lower White Pine reach, anthropogenic impacts in the form of the railroad and highway have replaced the natural vegetation in the 10 meter buffer zone and create artificially confined sections of channel. These confined section show limited bar development or floodplain surfaces for vegetation to establish. The removal of the vegetation and placement of riprap reduces bank shade potential (Thomas, 2007).

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Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DIZ-1

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- 250 feet of U.S. Highway 2 disconnects the subreach from the active floodplain and riverine processes.
- Culverts do exist, but they are elevated and do not provide passage at base flow (Photograph 1, 2 and 3).
- Impacts to the vegetation associated with the highway total just over 1 acre, or about 72 percent of the tatal area of this subreach and complimentary disconnected outer zone subreach (K DOZ-2).

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	2 Acres
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	2 Acres (after reconnection)
	Total Area	2 Acres

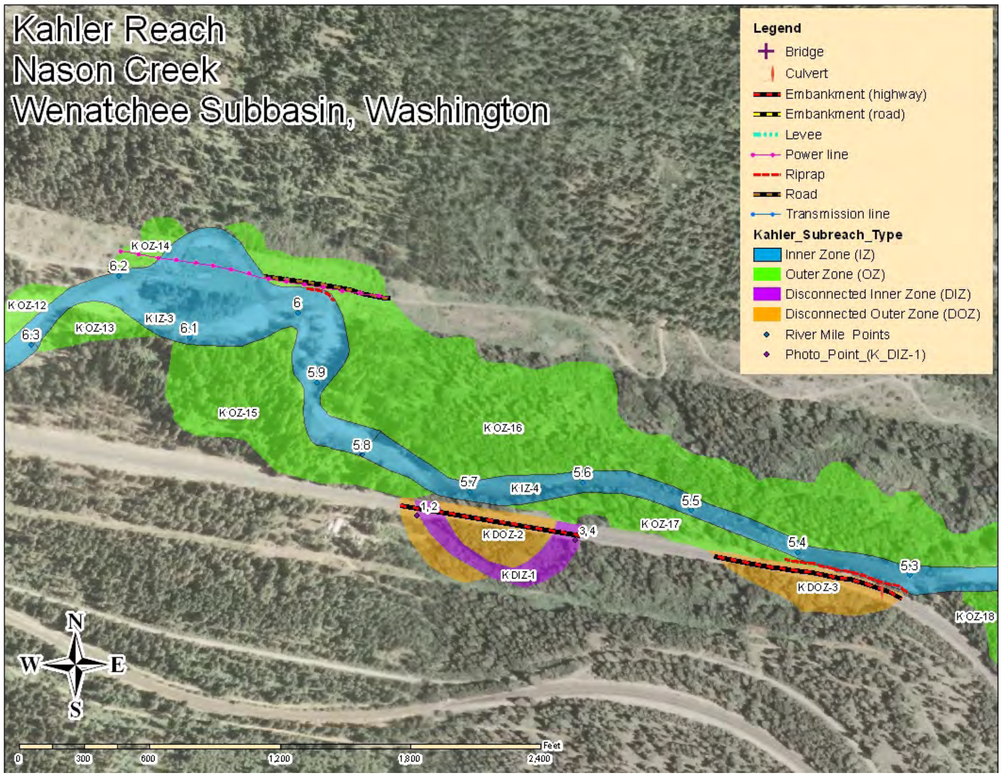


Figure 1. Image showing the location of subreach K DIZ-1 and associated human features, in addition to adjacent subreaches.


Photograph No. 1. Concrete culvert at the upstream end of a historic oxbow located to the south of U.S. Highway 2.. Kahler Reach; Subreach DIZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Photograph No. 2. Wetlands in the lower section of a historic oxbow located to the south of U.S. Highway 2.. Kahler Reach; Subreach DIZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Photograph No. 3. Intake of culvert that drains wetlands in the lower section of historic oxbow located to the south of U.S. Highway 2. Kahler Reach; Subreach DIZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Photograph No. 4. Wetlands in the lower section of historic oxbow located to the south of U.S. Highway 2. Kahler Reach; Subreach DIZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DIZ-2

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- 290 feet of U.S. Highway 2 disconnects the subreach from the active floodplain and riverine processes.
- A culvert does exist, but it is elevated and does not provide passage at base flow.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	Unknown
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	None
	Total Area	0.5 Acres

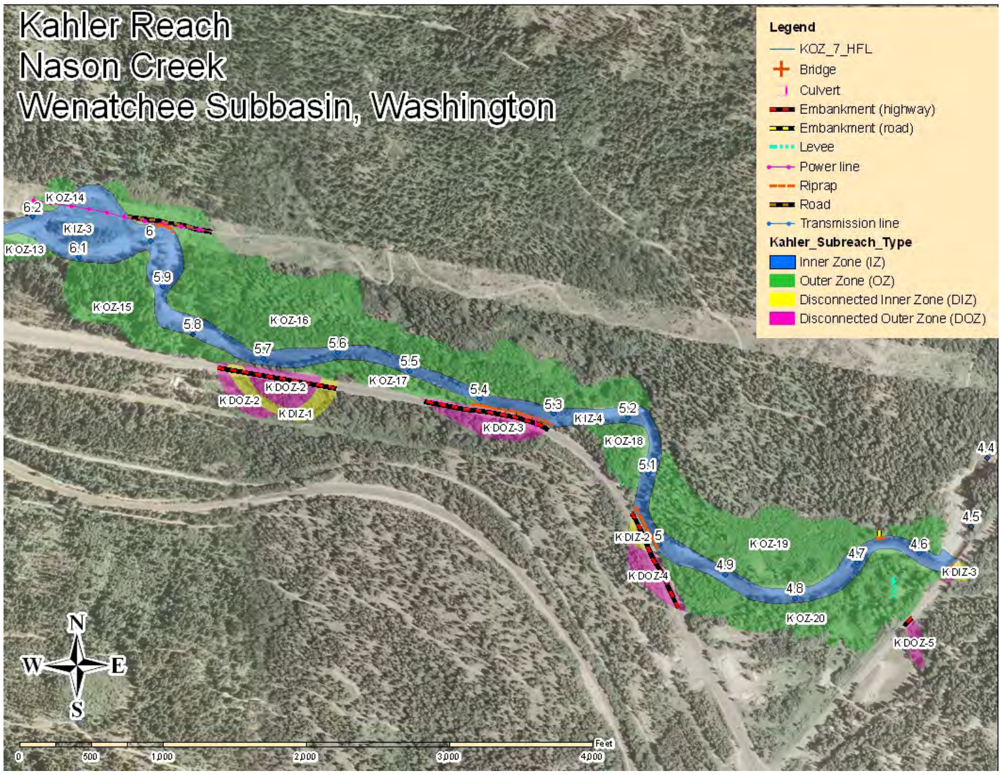


Figure 1. Image showing the location of subreach K DIZ-2 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DIZ-3

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- 1,232 feet of Washington State Highway 207 disconnects the subreach from the active floodplain and riverine processes.
- A culvert does exist, but it is elevated and does not provide passage at base flow (Photograph 1).

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	Unknown
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	Unknown
	Total Area	1 (3 total) Acres

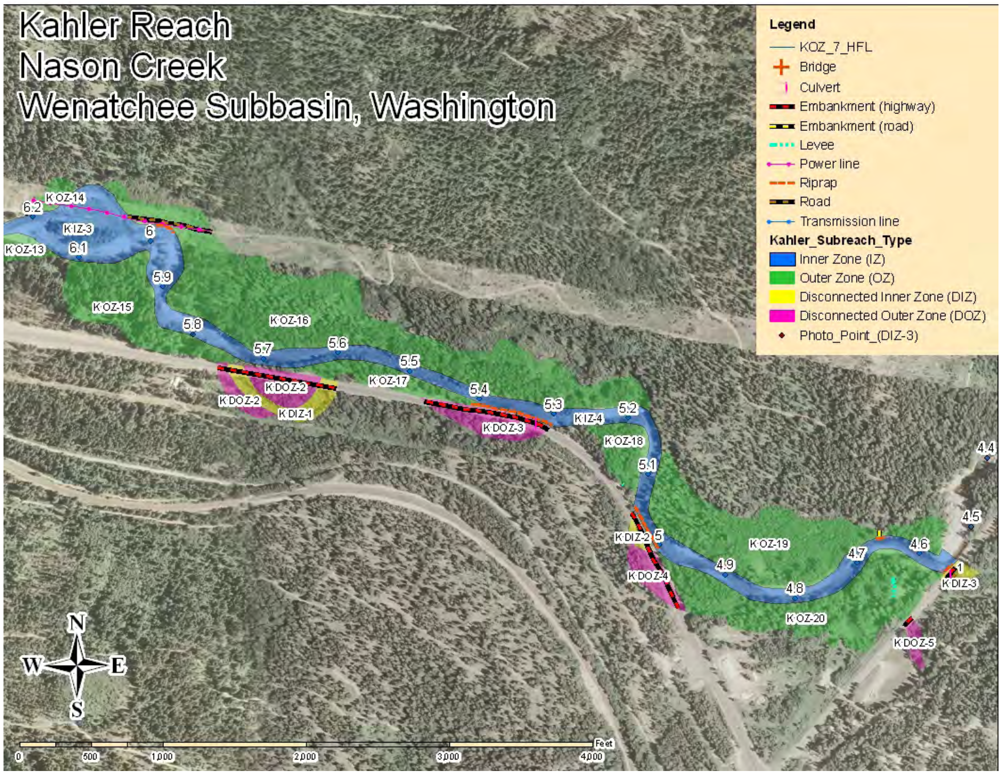


Figure 1. Image showing the location of subreach K DIZ-3 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. View of the east (wetland) side of a culvert. Kahler Reach; Subreach DIZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DOZ-1

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- The subreach is disconnected from the adjacent active floodplain and riverine processes by 500' feet of U.S. Highway 2.
- About 30 % of the vegetation for the subreach has been altered by the highway.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	None
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	2 Acres

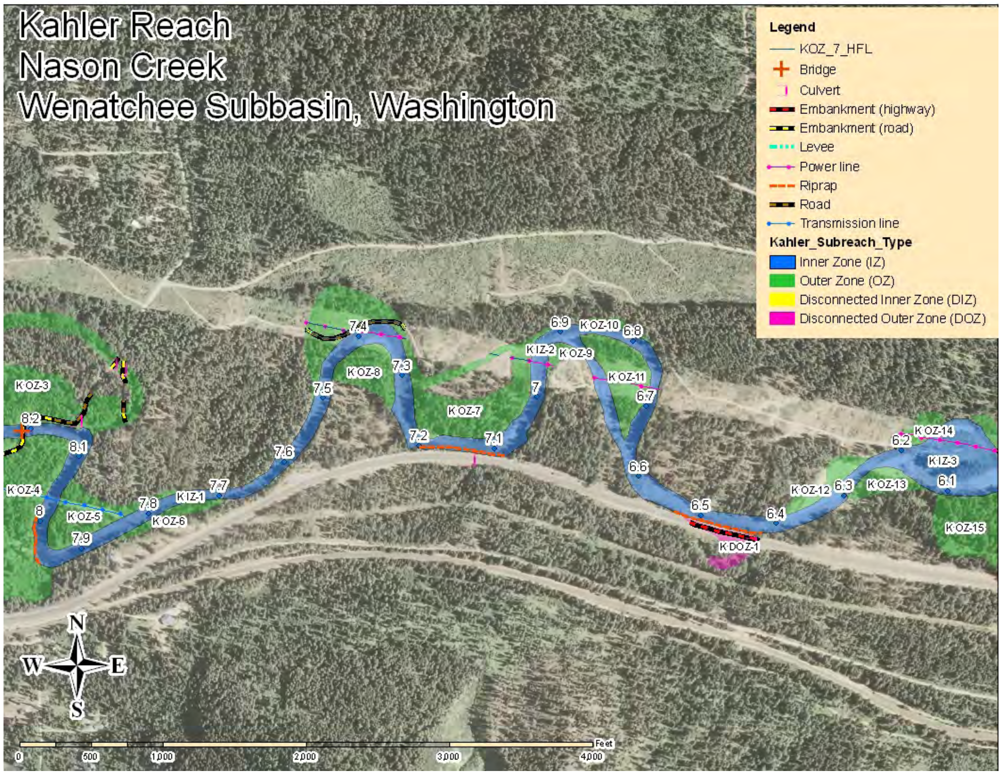


Figure 1. Image showing the location of subreach K DOZ-1 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DOZ-2

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- The subreach is disconnected from the adjacent active floodplain by 587' feet of U.S. Highway 2.
- About 70 % of the vegetation for the subreach has been altered by the highway.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	None
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	1 Acres

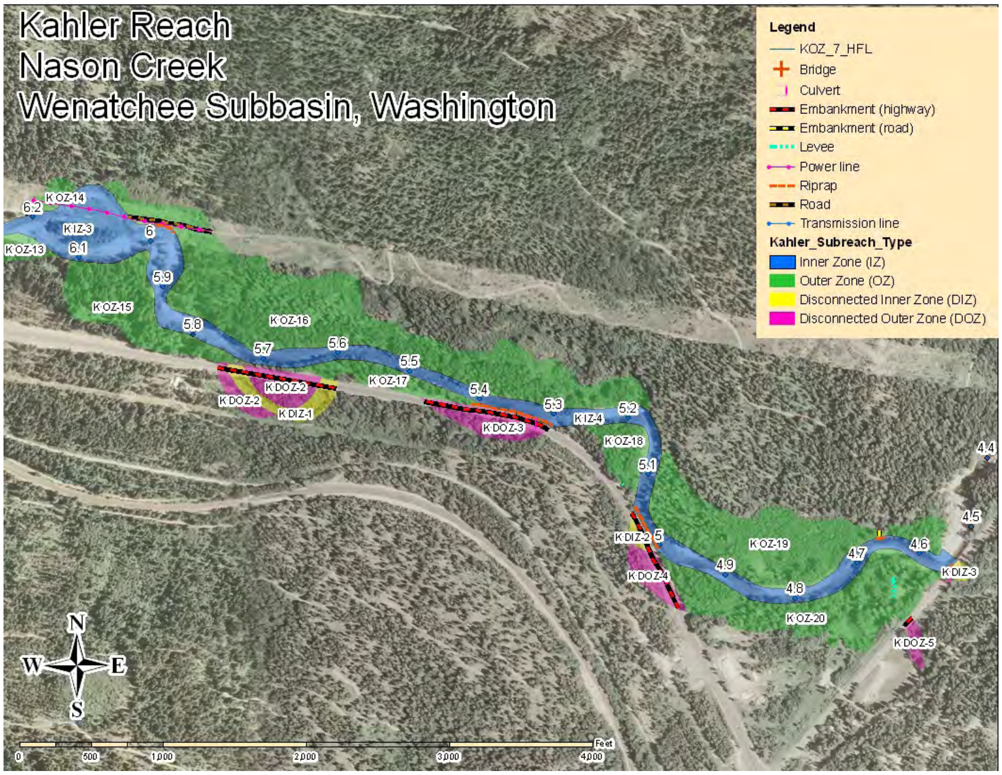


Figure 1. Image showing the location of subreach K DOZ-2 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DOZ-3

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- The subreach is disconnected from the adjacent active floodplain and riverine processes by 883' feet of U.S. Highway 2.
- About 40 % of the vegetation for the subreach has been altered by the highway.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	None
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	3 Acres

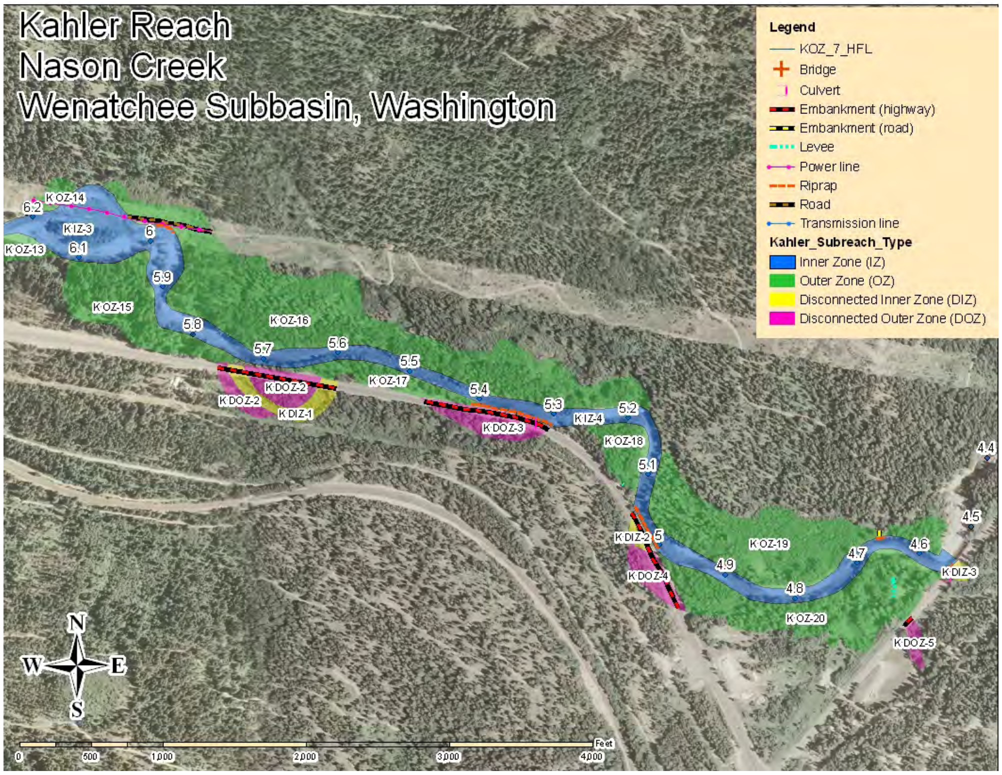


Figure 1. Image showing the location of subreach K DOZ-3 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K DOZ-4

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- The subreach is disconnected from the adjacent active floodplain by 447' feet of U.S. Highway 2.
- About 50 % of the vegetation for the subreach has been altered by the highway.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	Highway (Lateral)
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	None
Channel condition and floodplain dynamics	Floodplain connectivity	Disconnected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	2 Acres

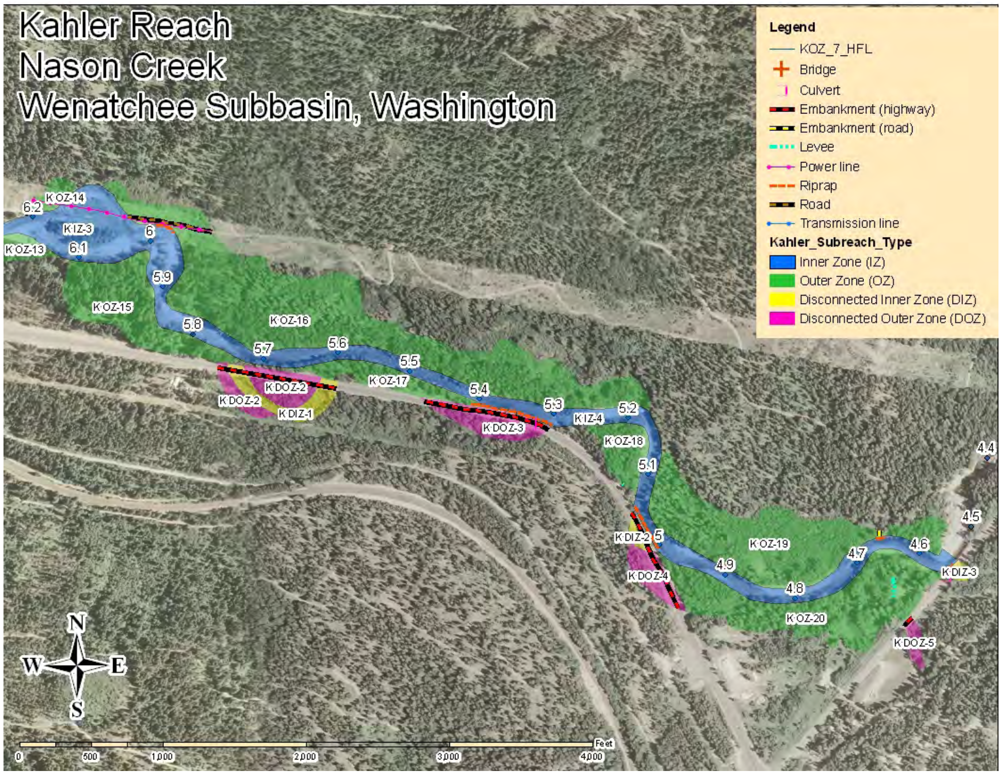


Figure 1. Image showing the location of subreach K DOZ-4 and associated human features, in addition to adjacent subreaches.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-5

Subreach K DOZ-5 is located in the downstream section of Kahler reach to the west of Washington State Highway 207 near RM 4.7 (Figure 39). This subreach is rehabilitation-oriented due to disconnections within the floodplain and active channel.

The subreach is less than 1 acre in size. Anthropogenic features include 78 feet of highway embankment that disconnects the subreach from the adjacent floodplain. Additional human impacts include the adding of fill material to the south. Natural lateral controls are terraces. Impacts to the vegetation associated with the highway total just less than 1 acre or about 30 percent of the subreach.

The inundation potential is about 1 acre, which is about 1 percent of the inundation potential for the entire Kahler reach. Rehabilitation options are listed in Table 31. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

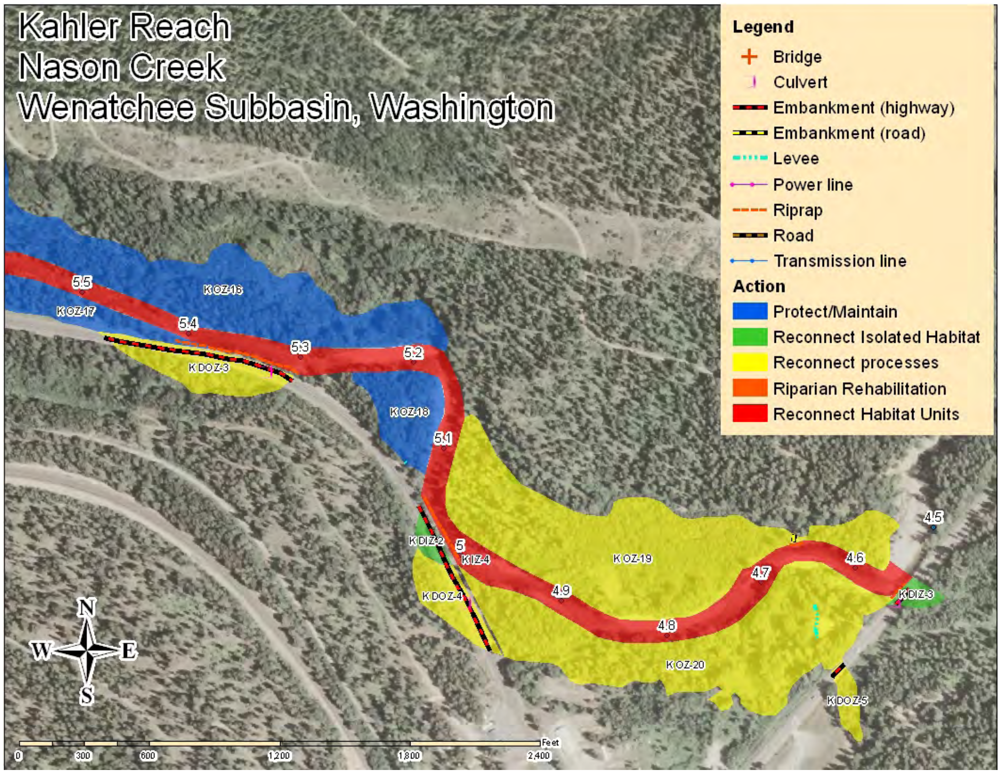


Figure 39 - K DOZ-5 and adjacent subreaches in Kahler reach.

Table 31 - Rehabilitation options for K DOZ-5.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation + Protection	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
5	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
6	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K IZ-1

Personnel: PNRO Geologist E. Lyon, R. McAffee and D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. Location of the subreach and the photo points are shown in figure 1.

Observations:

- Substrate is mixture of gravel (Photographs 2, 9, 15 and 24), with pockets of boulders (Photographs 11, 12, 19, 21 and 22) and cobbles (Photographs 4, 6, 14, 16 and 20) that progressively coarsens in the downstream direction.
- 1 bridge crosses the active channel at the top of the reach (Photograph 14).
- Local vertical and lateral scour is occurring (Photographs 17 and 18)
- 490’ Riprap exists along throughout much of the reach (Photograph 21).
- 1 bridge crosses the active channel at the top of the reach (Photograph 14)
- The transmission lines cross the active channel four times throughout the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Substrate	Predominantly Gravel
	Large wood	Very little
	Channel units	Predominantly Run
Channel condition and floodplain dynamics	Bank Stability/Channel Migration	Local bank erosion, limited migration
	Vertical Stability	Local scour
	Structures/bank hardening	400’ of riprap 1 bridge
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acres
	Total Area	14 Acres

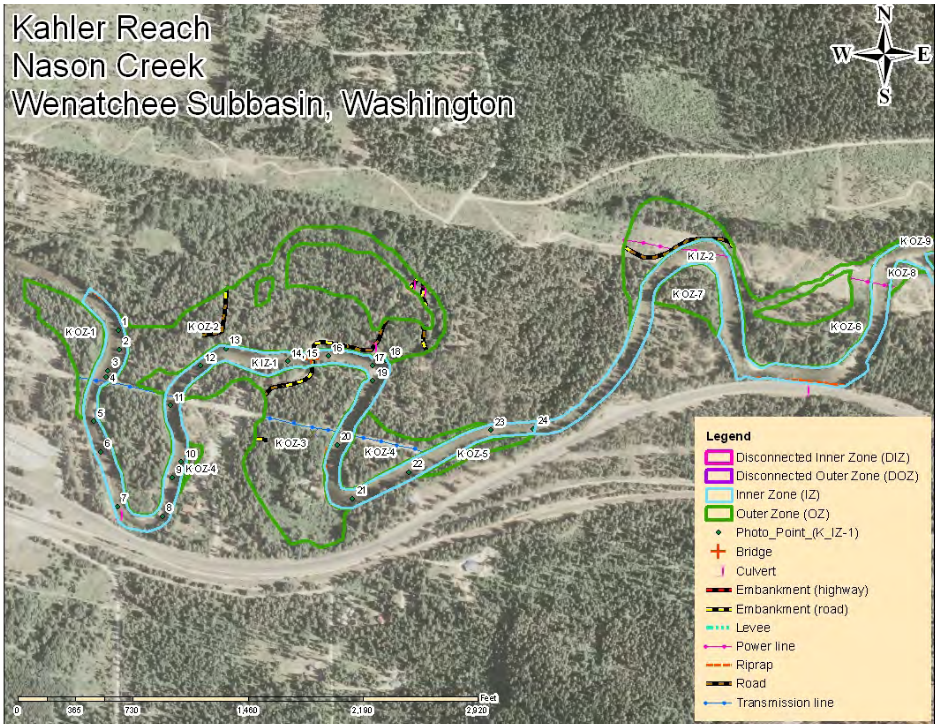


Figure 1. Image showing the location of subreach K IZ-1 and associated human features, in addition to adjacent subreaches.

Photograph No.1. View is to the south looking downstream showing a channel unit sequence of glide-riffle-glide and brushy vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.2. View of material located on bar with gravelometer for scale. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.3. View to the west looking at sand deposits along the right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.4. View is to the south looking downstream showing a channel unit sequence of riffle-pool and a cobble point bar along the left bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.5. View is to the south looking downstream showing a long run and riffle sequence and a tall terrace along the right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 6. View to the west looking at a gravel and cobble point bar and tall terrace along the right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 7. View is to the southeast looking downstream showing a channel unit sequence of riffle-pool and varying vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 8. View is to the north looking downstream showing a channel unit sequence of run-riffle-run and a gravel point bar along the left bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 9. View of gravel-sized material on a bar with gravelometer for scale. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.10. View is to the north looking downstream showing a channel unit of a long run, with varying vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 11. View is to the north looking downstream showing boulder substrate and mixed vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 12. View to the northwest showing cobble and boulder substrate and a 2 meter tall left bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 13. View is to the east looking downstream showing a channel unit sequence of run to riffle and a gravel point bar along the right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

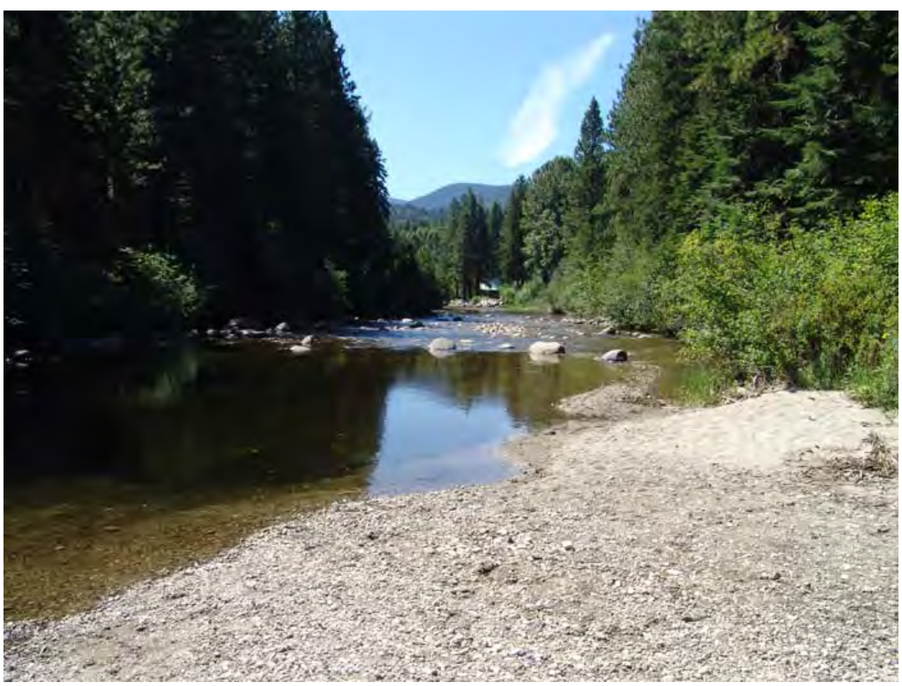
Photograph No.14. View is to the east looking downstream showing a gravel and cobble island a bridge and mixed vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 15. View of gravel sized material on the bar with gravelometer for scale. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 16. View is to the east looking downstream showing a channel unit sequence of raping to run and mixed vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 17. View is to the east looking at a scour pool and local erosion along the left bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.18. View looking to the southeast showing the eroding left bank comprised of cobbles and gravels overlain by silt and sands. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.



Photograph No. 19. View is to the south looking downstream showing a gravel point bar along the right bank, a channel unit sequence of run to riffle and mixed vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 20. View is to the south looking downstream showing a channel unit sequence of rifle to run and riprap protection along right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 21. View is to the northeast looking downstream showing cobble and boulder substrate and a tall terrace along the right bank. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 22. View is to the northeast looking downstream showing cobble and boulder substrate with a channel unit of riffle. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 23. View is to the northeast looking downstream showing a channel unit of riffle, a small cobble island and mixed vegetation along both banks. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.24. View of gravel and cobble sized material on a bar with gravelometer for scale. Kahler Reach; Subreach IZ-1, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K IZ-2

Personnel: PNRO Geologist E. Lyon, R. McAffee and D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. Location of the subreach and the photo points are shown in figure 1.

Observations:

- Substrate is a mixture of gravel and cobbles with boulders (Photographs 1-25).
- Sediment input from local bank erosion was noted (Photographs 2, 6, 8, 13, 19, 22, 23 and 25).
- The power line crosses the active channel a total of four times throughout the reach (Photographs 10, 11 and 24)
- 1,250' Riprap exists within the reach (Photograph 16).

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Substrate	Predominantly gravel and cobble
	Large wood	Concentrated in few complexes
	Channel units	Predominantly run
Channel condition and floodplain dynamics	Bank Stability/Channel Migration	Local bank erosion, limited migration
	Vertical Stability	Local scour
	Structures/bank hardening	1090' of riprap
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acres
	Total Area	19 Acres

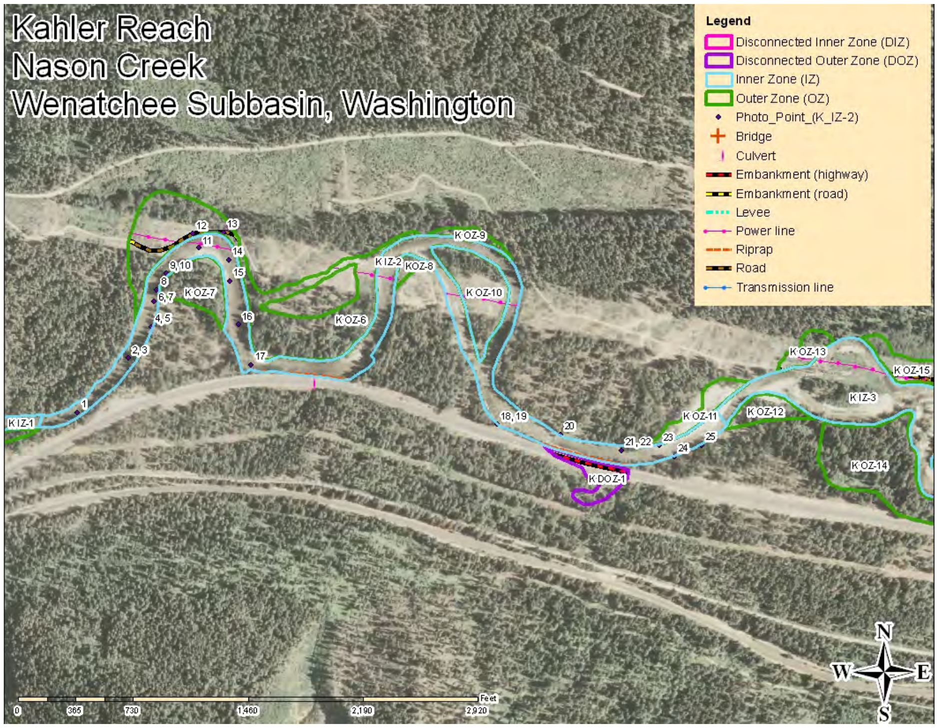


Figure 1. Image showing the location of subreach K IZ-2 and associated human features, in addition to adjacent subreaches.


Photograph No. 1. View is to the northeast looking downstream showing gravel, cobble and boulder substrate and mixed vegetation along both banks. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 2. View is to the east showing erosion along a tall terrace that forms the right bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 3. View is to the northeast looking downstream showing cobble and boulder substrate and mixed vegetation along both banks. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 4. View is to the east showing boulder substrate and a tall terrace along the right bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 5. View is to the northeast looking downstream showing cobble and boulder substrate and mixed vegetation along both banks. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 6. View is to the northeast looking downstream showing erosion of the tall terrace along the right bank. Composition is a mixture of sand and gravel with cobbles. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 7. View is to the north looking downstream showing gravel to boulder sized substrate with mixed vegetation along both banks. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 8. View is to the east showing local erosion of the terrace along the right bank. Composition is a mixture of sand with gravels cobbles and boulders. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 9. View is to the east showing predominantly gravel substrate wuth mixed vegetation along the right bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 10. View is to the northeast looking downstream showing a channel unit of a long run, with a small gravel point bar along the right bank. Note the powerline crossing the active channel. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 11. View is to the east looking downstream showing cobble sized substrate and a gravel and cobble point bar along the right bank. Note the powerlines above the active channel. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No.12. View is to the east looking downstream showing cobble sized substrate and a gravel and cobble point bar along the right bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 13. View to the southeast showing local erosion along the left bank. Composition is a mixture of sand with gravel and cobble. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 14. View is to the south looking downstream showing a channel unit of riffle, a small gravel and cobble point bar along the right bank, and muxed vegetation along both banks. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 15. View of gravel to boulder sized material located on a bar with gravelometer for scale. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 16. View is to the south looking downstream showing a cchannel unit of rapid. Note the highway that is protected by riprap in the back ground. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 17. View is to the east looking downstream showing boulder substrate and and cobble point bar along the left bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett 8/9/07.

Photograph No. 18. View is to the northwest (upstream) showing a channel unit of rapid with cobble and boulder substrate. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Photograph No. 19. View to northeast showing a glacially deposited bluff as the left bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Photograph No. 20. View to the north showing the middle surface in a succession of terraces along the left bank of the river. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 10, 2007.

Photograph No. 21. View to the north showing minor undercutting of the lowest surface in a succession of terraces along the left bank of the river. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 10, 2007.

Photograph No. 22. A view to the east showing cobble and boulder substrate and local erosion along the right bank which is comprised of finer material over cobbles and boulders. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 10, 2007.

Photograph No. 23. View to the southwest from the top of the gravel bar on the left bank showing a channel unit of rapid with boulder substrate. Note the erosion of the right bank. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 24. View from the right bank looking downstream to the northeast showing a cobble point bar on the left bank of the river. Note the powerline crossing the active channel. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 25. A view showing the right bank which is comprised of sand gravel and cobbles, with finer material deposited on top. Kahler Reach; Subreach IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K IZ-3

Personnel: PNRO Geologist E. Lyon, R. McAffee and D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. Location of the subreach and the photo points are shown in figure 1.

Observations:

- Substrate is a mixture of gravel and cobbles (Photographs 1, 3-5).
- 160’ of riprap is located along the left bank near RM 6.0 .
- The power line crosses the active channel a total of two times throughout the reach (Photographs 2 and 4).
- Large wood is concentrated within the reach (Photograph 3, 5 and 6).

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Substrate	Predominantly gravel and cobble
	Large wood	Concentrated in few complexes
	Channel units	Predominantly run
Channel condition and floodplain dynamics	Bank Stability/Channel Migration	Local bank erosion, limited migration
	Vertical Stability	Local scour
	Structures/bank hardening	1090’ of riprap
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acres
	Total Area	11 Acres

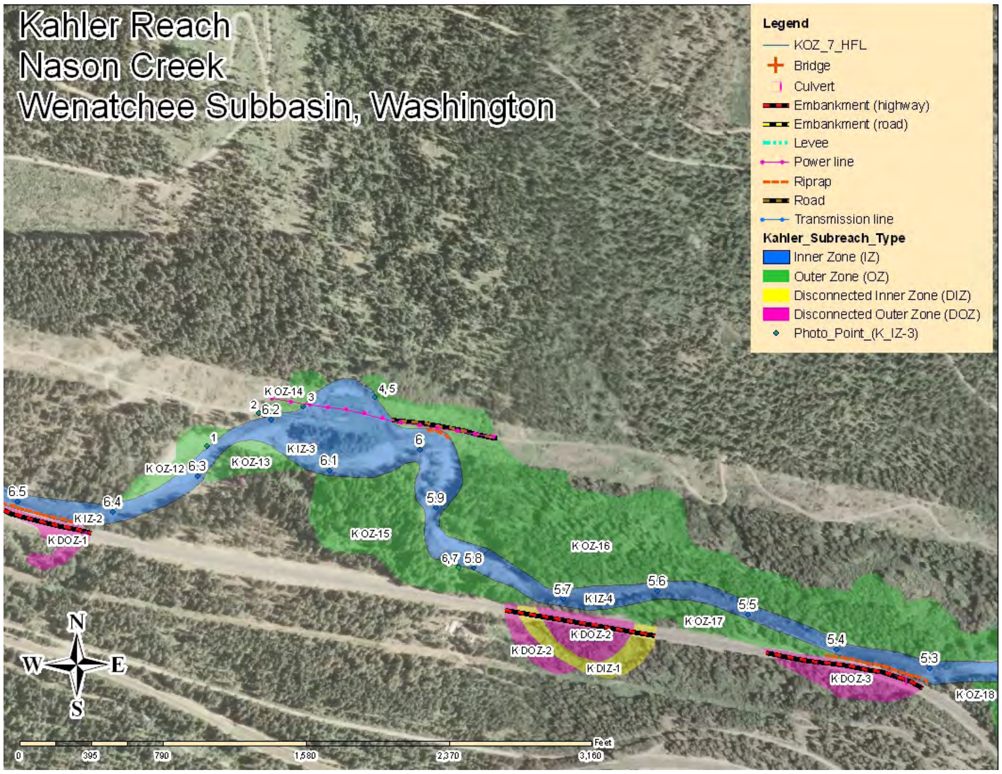


Figure 1. Image showing the location of subreach K IZ-3 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. View showing gravel and cobble sized material on the point bar with the gravelometer for scale. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 2. View to the east showing the removal of riparian vegetation from along the left bank, multiple large wood complexes with split flow. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 3. View from the left bank to the east showing cobble substrate, and large wood complexes on both sides of the river. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 11, 2007.

Photograph No. 4. View from the left bank looking upstream to the northwest, showing a vegetated cobble point bar along the right bank. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 11, 2007.

Photograph No. 5. View from the left bank looking to the southeast showing a channel unit of a run, cobble substrate, and brushy vegetation along both banks. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 11, 2007.

Photograph No. 6. View from the right bank looking to the south at the head of a functioning side channel off the right bank of the river. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 7. View from the right bank looking upstream, to the northwest showing large wood accumulation along the left bank. Kahler Reach; Subreach IZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K IZ-4

Personnel: PNRO Geologist E. Lyon, R. McAffee and D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. Location of the subreach and the photo points are shown in figure 1.

Observations:

- Substrate is a mixture of cobbles and boulders (Photographs 1-8, 11-16 and 18, 19)
- Bedrock acts as local vertical and lateral control (Photograph 5)
- 950' Riprap exists within the reach (Photographs 10 and 17).

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Substrate	Predominantly cobble and boulder
	Large wood	Concentrated in few complexes
	Channel units	Predominantly rapid
Channel condition and floodplain dynamics	Bank Stability/Channel Migration	Local bank erosion, limited migration
	Vertical Stability	Local scour
	Structures/bank hardening	950' of riprap
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acres
	Total Area	16 Acres

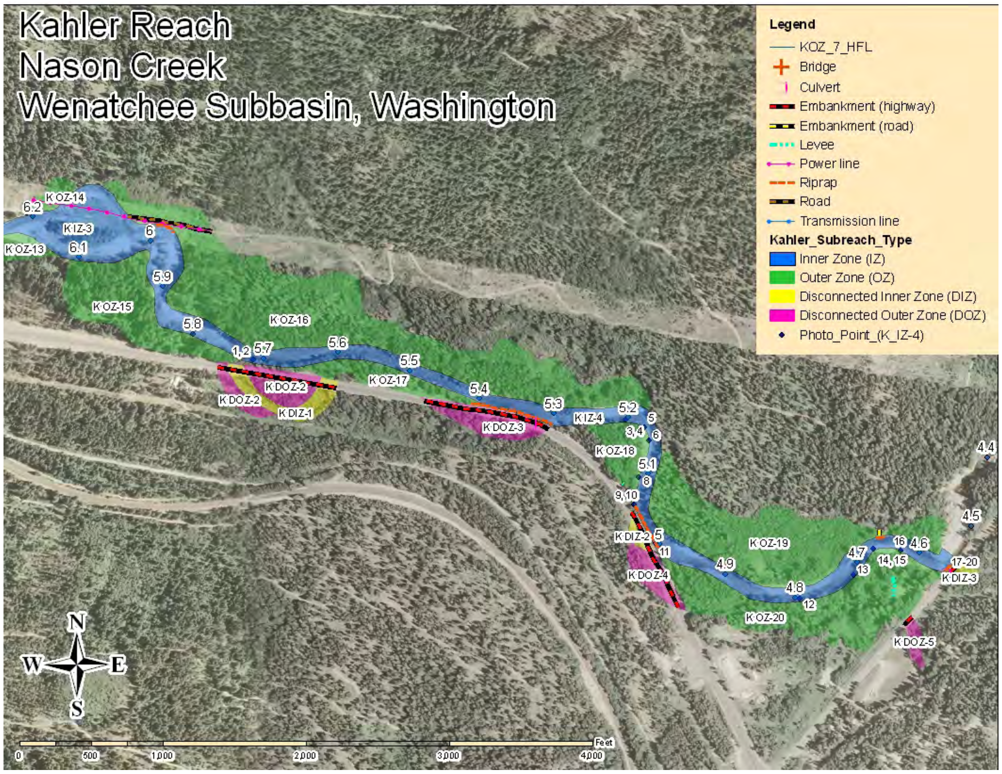


Figure 1. Image showing the location of subreach K IZ-4 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. A view from the right bank looking to the northwest upstream showing in stream boulders, a side channel entrance and cobble bar on the right bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 2. View from the right bank looking to the southeast downstream showing a channel unit of run, boulders and cobbles substrate and mixed vegetation along both banks. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 3. View from the right bank looking upstream to the west showing some large wood along the right bank, channel unit of riffle and a cobble boulder bar on the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 4. View from the right bank looking downstream to the east showing a channel unit of run and a boulder and cobble bar along the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 5. View from the right bank looking to the southeast showing a bedrock outcrop, boulders and landslide along the left bank of the river. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 6. View from the right bank looking to the south downstream showing a boulders and cobbles along the right bank and in the channel of the river. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 7. View from the right bank looking to the south, downstream showing a boulders and cobbles that comprise the right bank of the river. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 8. View from the right bank looking downstream to the south showing an armored right bank and a cobble boulder bar along the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 9. View looking upstream to the northwest of a mass wasting site on the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Photograph No. 10. View to the east of riprap along the toe of the road base on the right bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 7, 2007.

Photograph No. 11. View from the right bank looking downstream to the south east at in-channel boulders and riprap along the right bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 12. View from the right bank looking downstream to the east at boulders along the right bank of the river. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 13. A view from the right bank looking to the northeast showing a channel unit sequence of riffle-rapid-run with in-channel boulders and cobbles along the right bank and a cobble bar on the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 14. A view from the right bank looking upstream to the west at a channel unit of riffle to rapid with cobbles and boulder substrate. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 151. View from the right bank looking to the north showing a channel unit sequence of rapid to scour pool with an old bridge abutment and stream/wetland inlet along the left bank of the river. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 16. View from the right bank to the east showing a cobble point bar along the right bank and riprap along the highway in the distance. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, August 12, 2007.

Photograph No. 17. View to the north of a scour pool associated with riprap along the base of the highway. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Photograph No. 18. View looking west (upstream) showing a channel unit sequence of riffle-run-riffle and a gravel point bar along the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Photograph No. 19. View looking to the northwest across the channel at a point bar containing cobble gravels and sand on the left bank. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Photograph No. 20. View of the west (river) side of a culvert. Kahler Reach; Subreach IZ-4, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-1

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	4 Acre
	Total Area	4 Acre

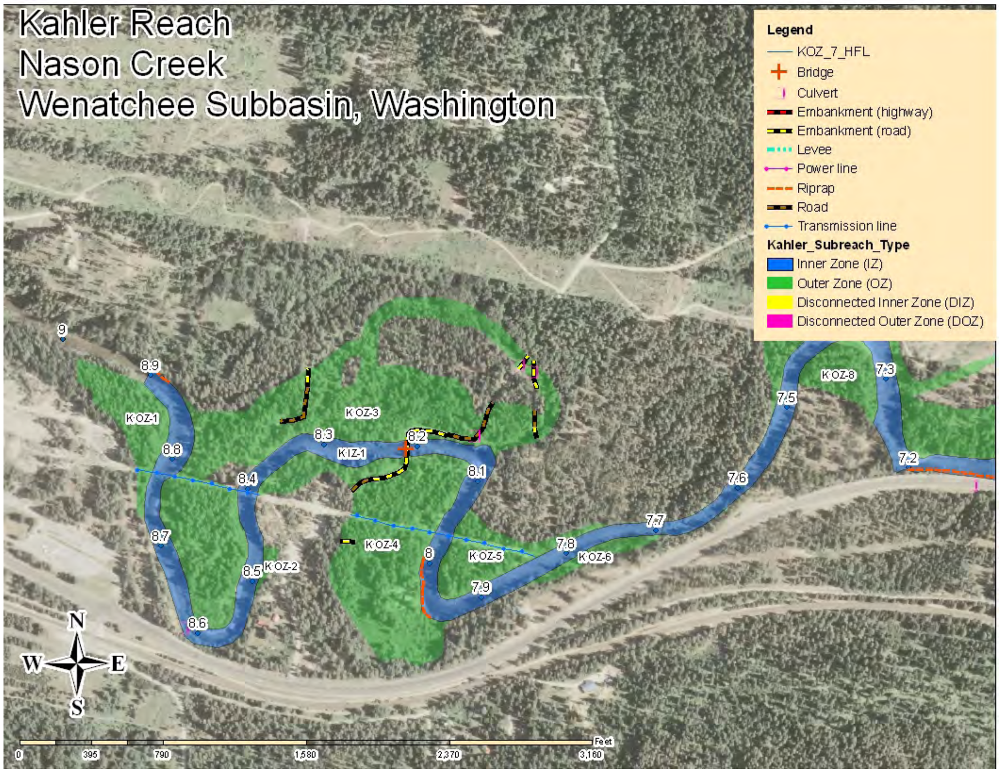


Figure 1. Image showing the location of subreach K OZ-1 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-10

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	1 Acre
	Total Area	1 Acre

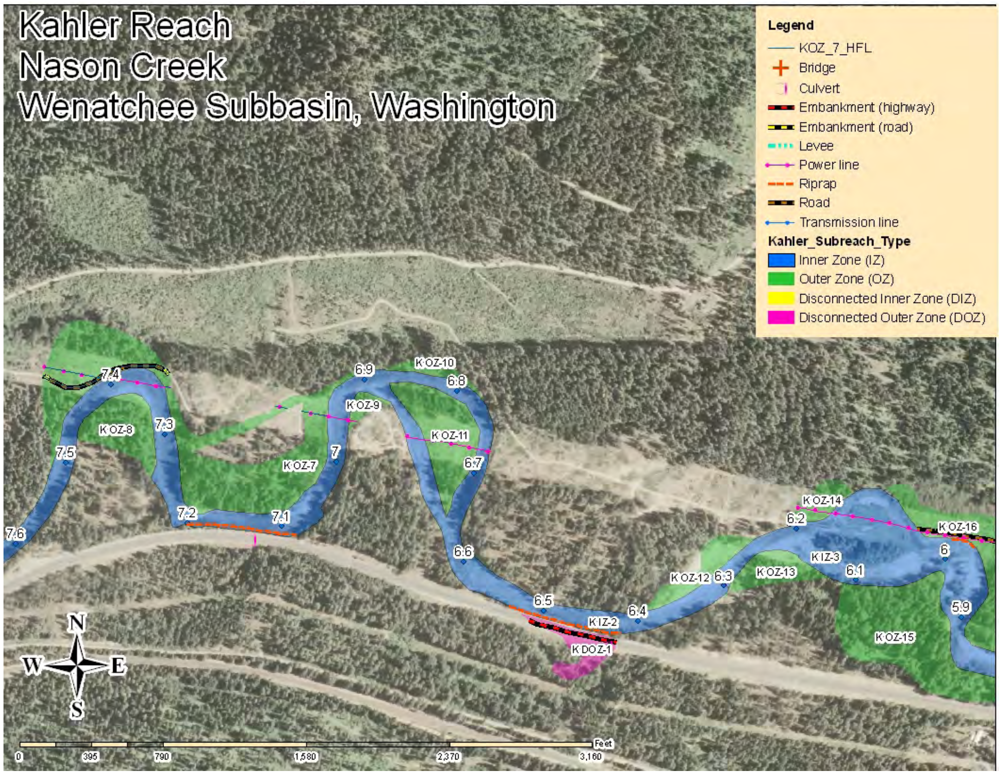


Figure 1. Image showing the location of subreach K OZ-10 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-11

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- About 50 % of the vegetation for the subreach has been altered for the powerline.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	4 Acres

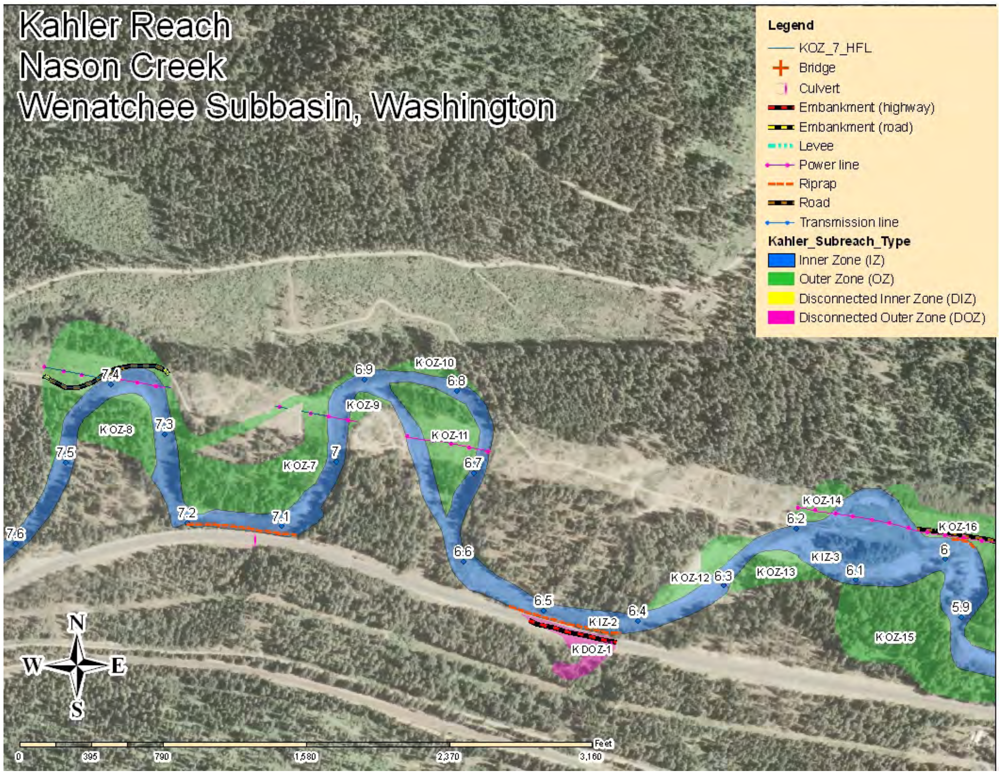


Figure 1. Image showing the location of subreach K OZ-11 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-12

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	2 Acre
	Total Area	2 Acre

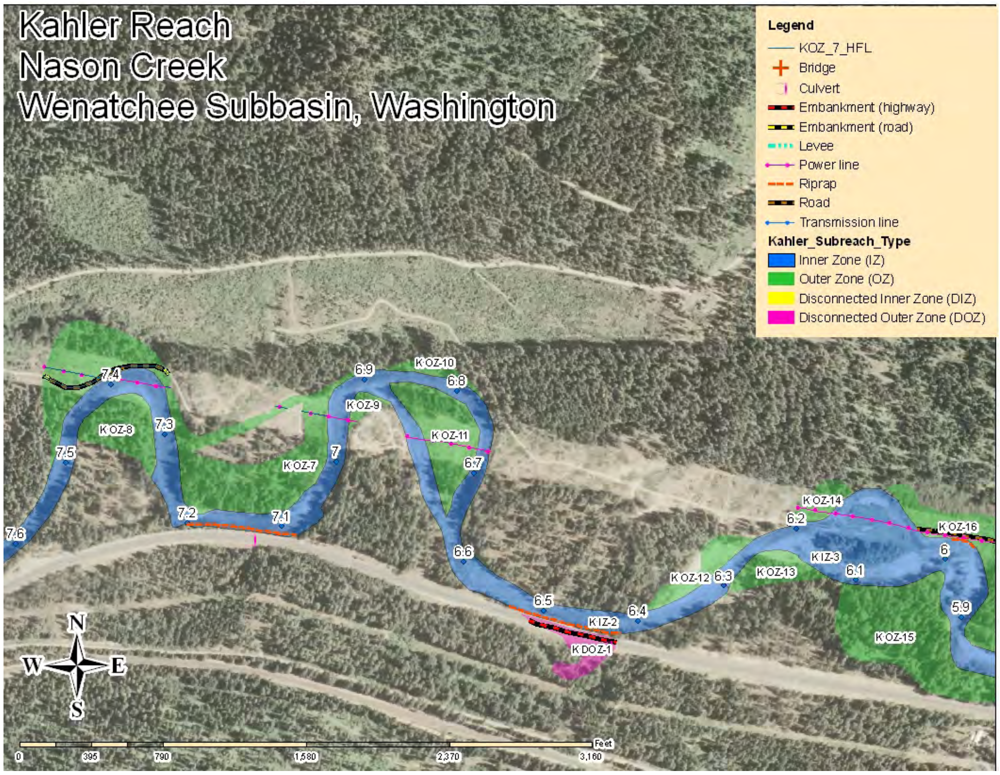


Figure 1. Image showing the location of subreach K OZ-12 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-13

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	1 Acre
	Total Area	1 Acre

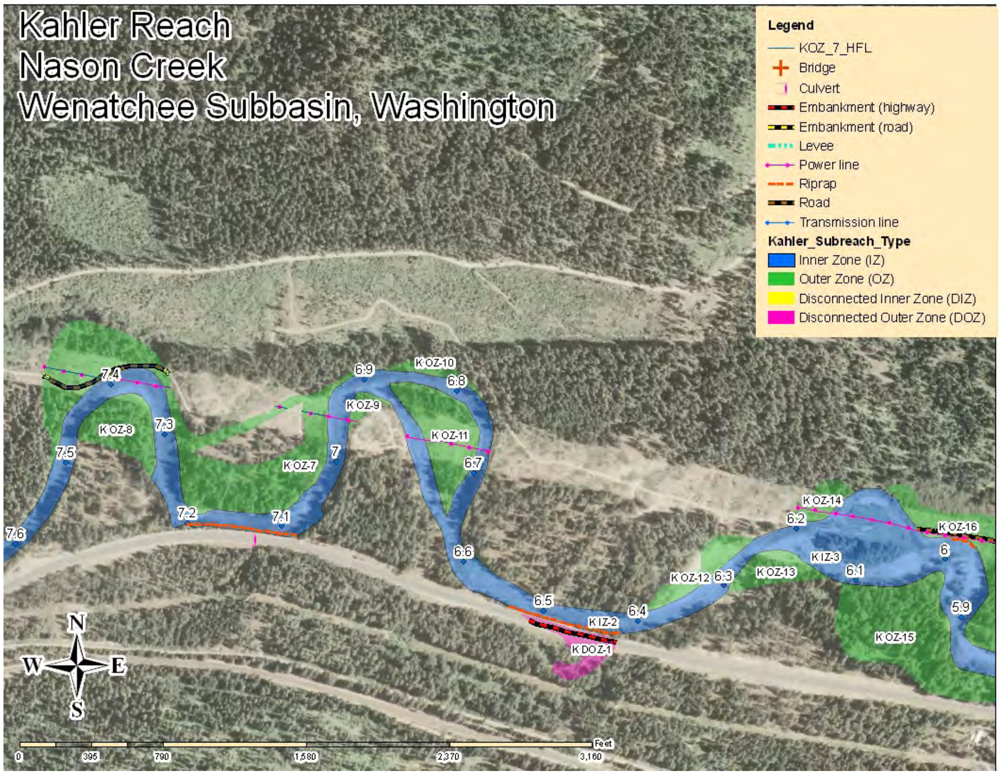


Figure 1. Image showing the location of subreach K OZ-13 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-14

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- About 72 % of the vegetation for the subreach has been altered for the powerline.
- A small section of unimproved road that is utilized for recreation lies within the subreach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	1 Acre

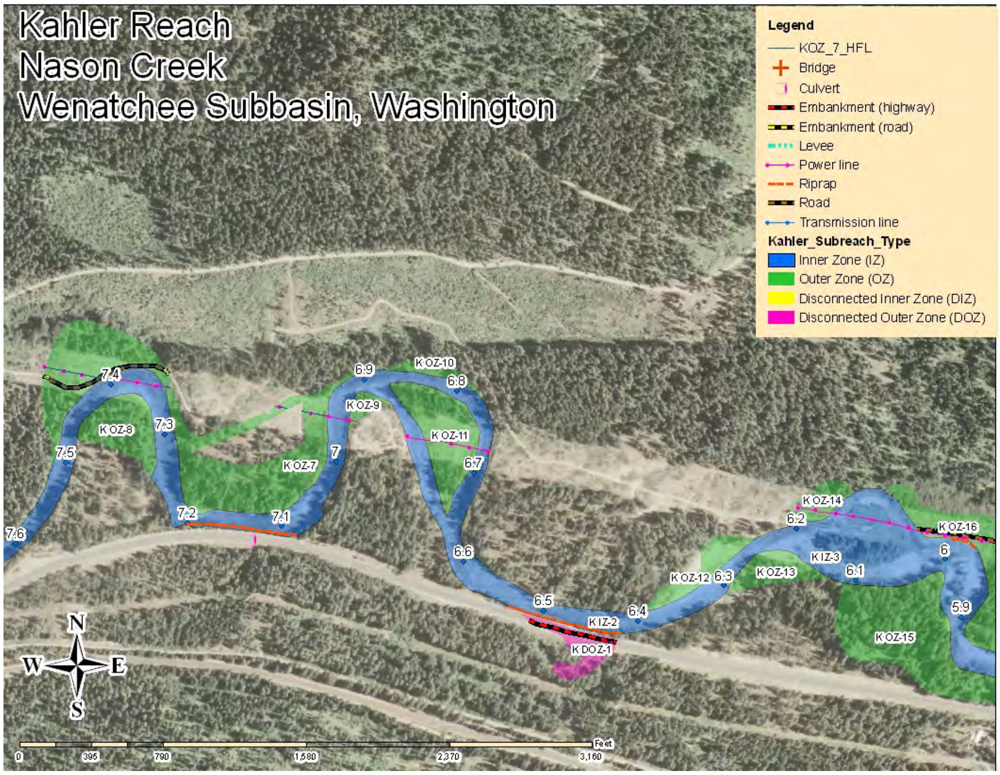


Figure 1. Image showing the location of subreach K OZ-14 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-15

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	7 Acre
	Total Area	7 Acre

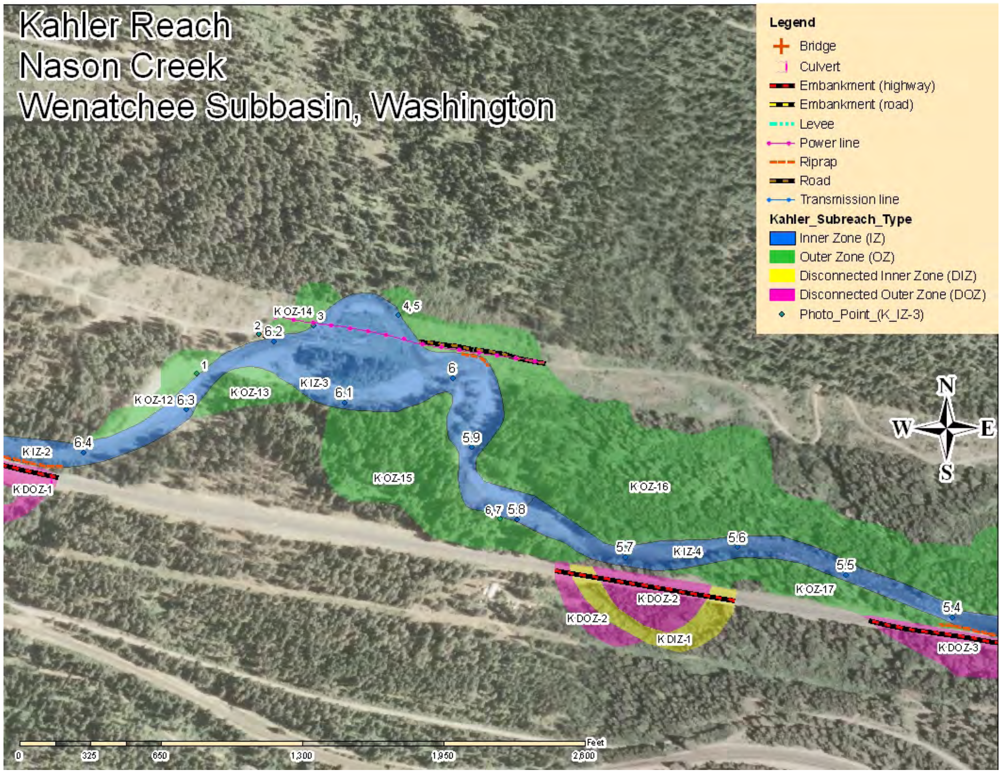


Figure 1. Image showing the location of subreach K OZ-15 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-16

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	4 Acres
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	29 Acre
	Total Area	29 Acre

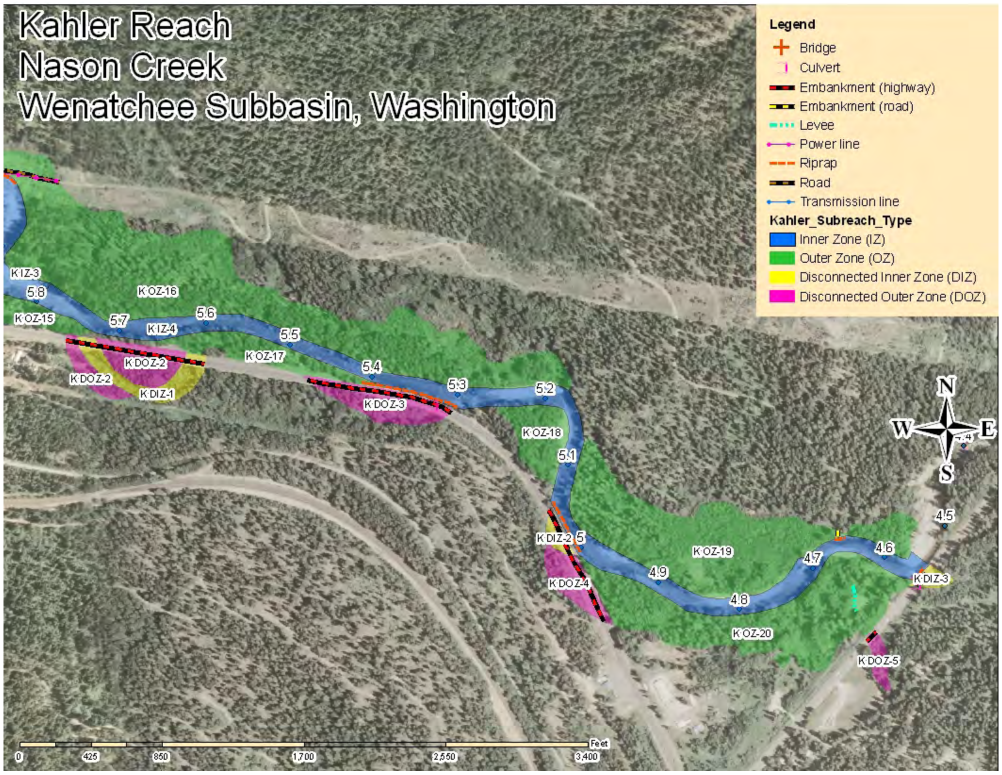


Figure 1. Image showing the location of subreach K OZ-16 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-17

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	3 Acre
	Total Area	3 Acre

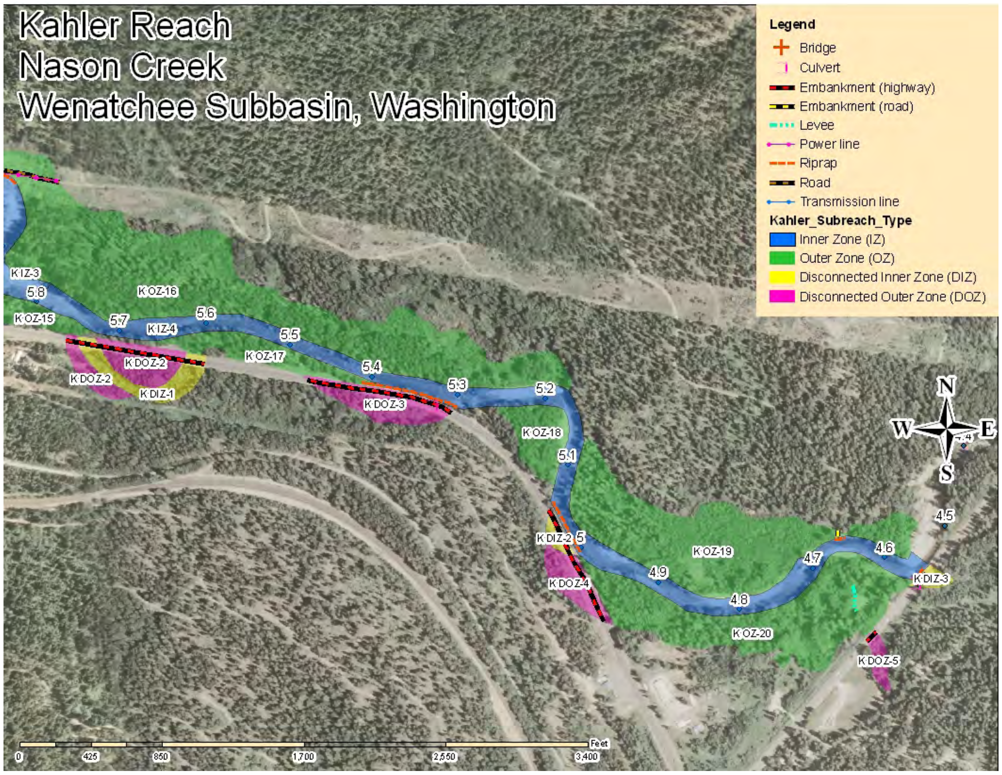


Figure 1. Image showing the location of subreach K OZ-17 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-18

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	3 Acre
	Total Area	3 Acre

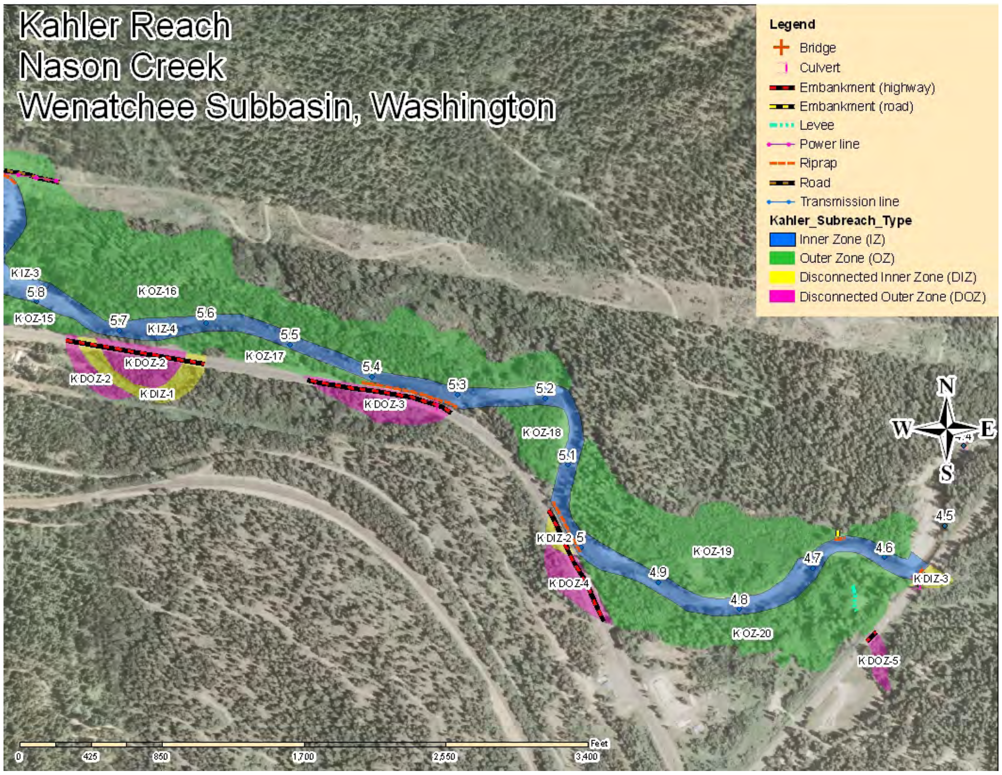


Figure 1. Image showing the location of subreach K OZ-18 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-19

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floo dplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- A small section of unimproved road and a historic bridge abutment exist with in the subreach near RM 4.65.
- About less than 1% of the vegetation for the subreach has been altered for the powerline.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	3 Acres
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	3 Acres
	Total Area	16 Acres

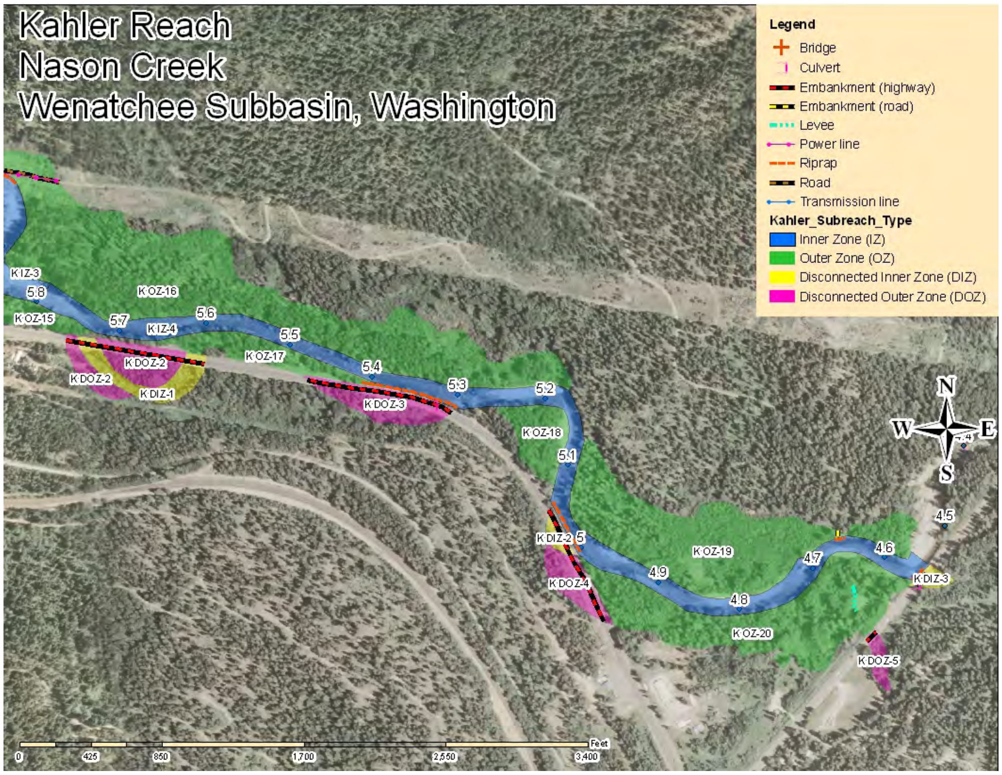


Figure 1. Image showing the location of subreach K OZ-19 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-2

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	<1 Acre
	Total Area	<1 Acre

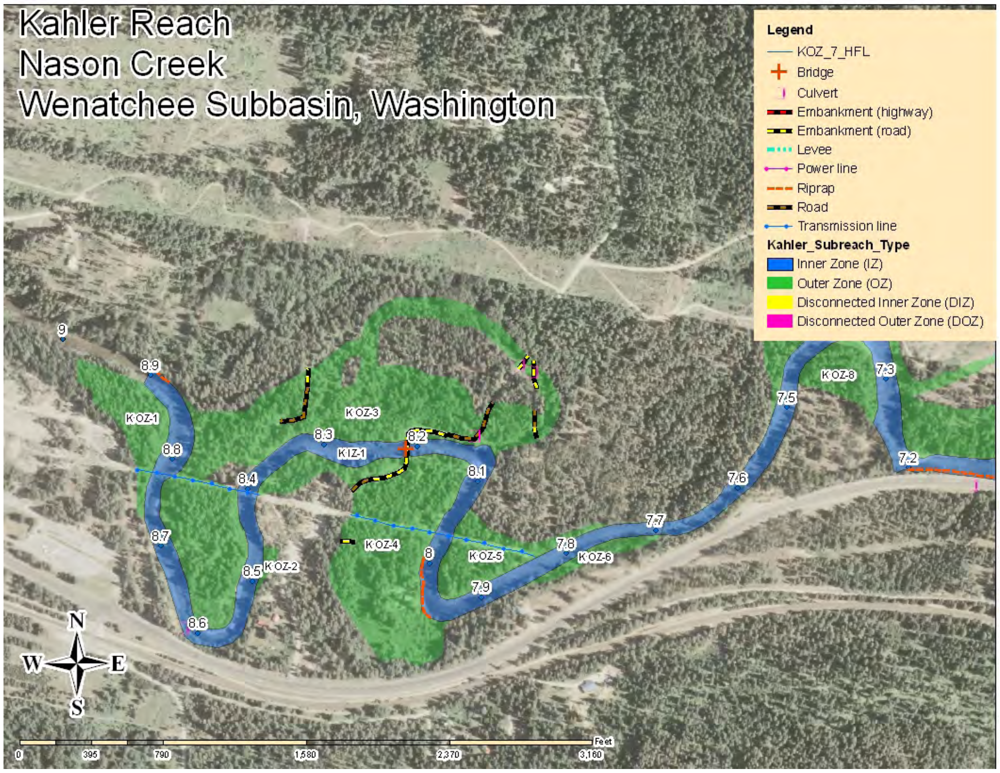


Figure 1. Image showing the location of subreach K OZ-2 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-20

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. entation of baseline conditions and geologic mapping of anthropogenic features associated with floThe location of the subreach is shown in figure 1.

Observations:

- 160 feet of pushup levee with loose riprap protects a parking area (Photograph 1).
- About 2 % of the vegetation for the subreach has been altered for the powerline.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	6 Acres
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	6 Acres
	Total Area	13 Acres

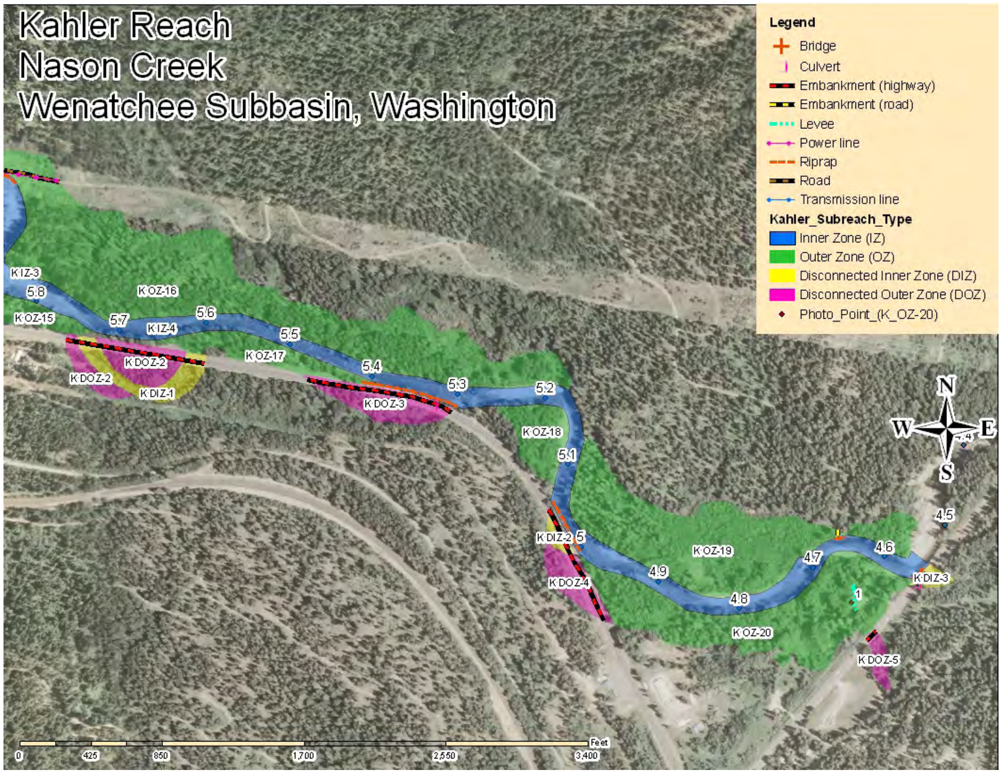


Figure 1. Image showing the location of subreach K OZ-20 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. View to the northwest of overland flow behind a levee with scattered riprap. Kahler Reach; Subreach OZ-19, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 5, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-3

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- 670 feet of road embankment exist within the subreach.
- 770 feet of unimproved road exist within the subreach.
- 384 feet of power line exist within the subreach
- 3 culvert exist; 1 along the main channel, 3 in the floodplain
- A bridge abutment exist near RM 8.2
- Residential development has occurred in the subreach.
- About 9 % of the vegetation for the subreach has been altered.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	14 Acres

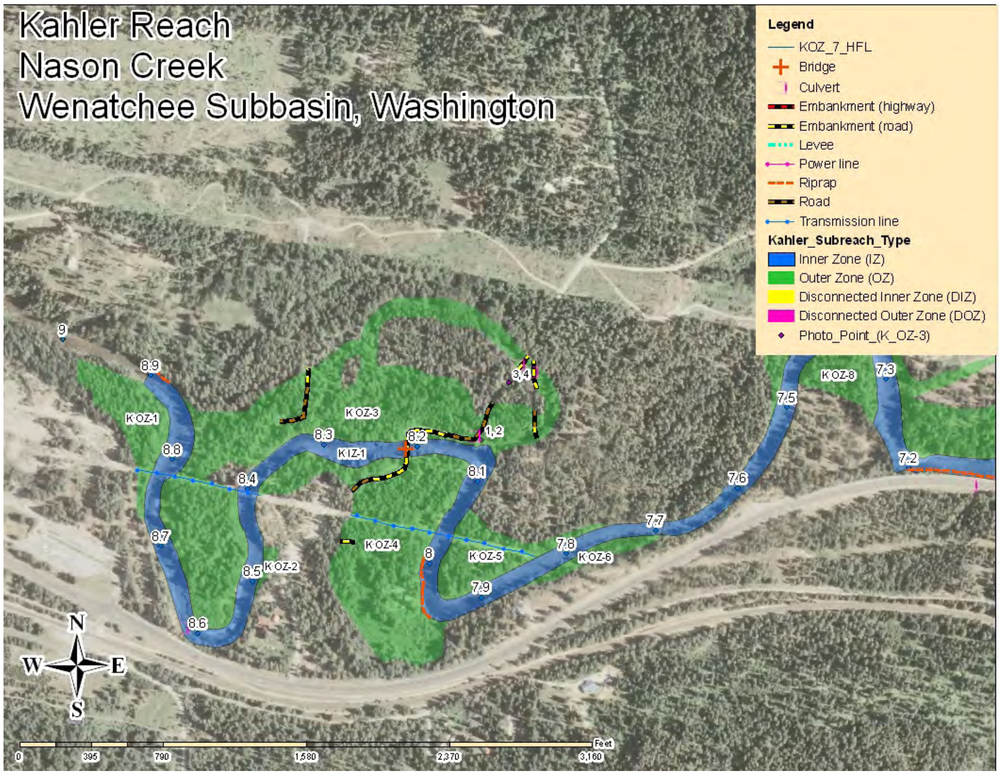


Figure 1. Image showing the location of subreach K OZ-3 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. View to the north showing a step-up to a higher surface. Kahler Reach; Subreach OZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 2. View showing the top end of a culvert that drains a wetland area. Kahler Reach; Subreach OZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 3. View of the intake of a culvert that drains a wetland area. Kahler Reach; Subreach OZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 4**.** View showing the outfall of the culvert and wetlands, with another culvert in the road embankment in the back ground. Kahler Reach; Subreach OZ-3, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-4

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- 337 feet of road embankment exist within the subreach.
- 146 feet of unimproved road exist within the subreach.
- 384 feet of power line exist within the subreach
- Residential development has occurred in the subreach.
- About 7 % of the vegetation for the subreach has been altered.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	14 Acres

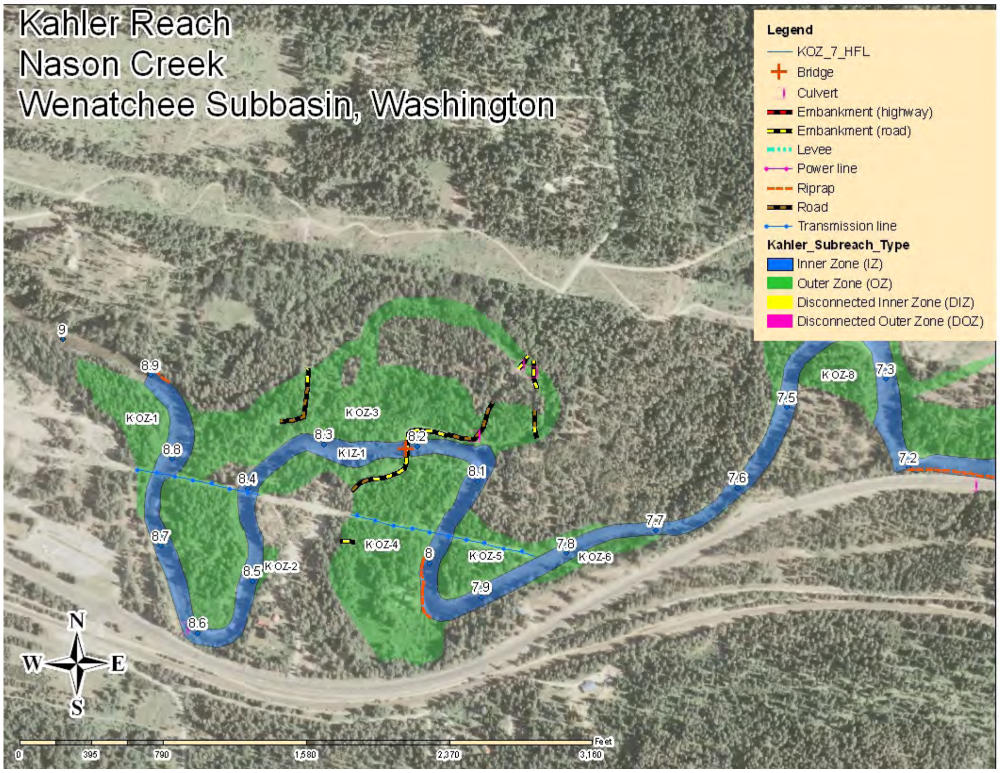


Figure 1. Image showing the location of subreach K OZ-4 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-5

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	4 Acre
	Total Area	4 Acre

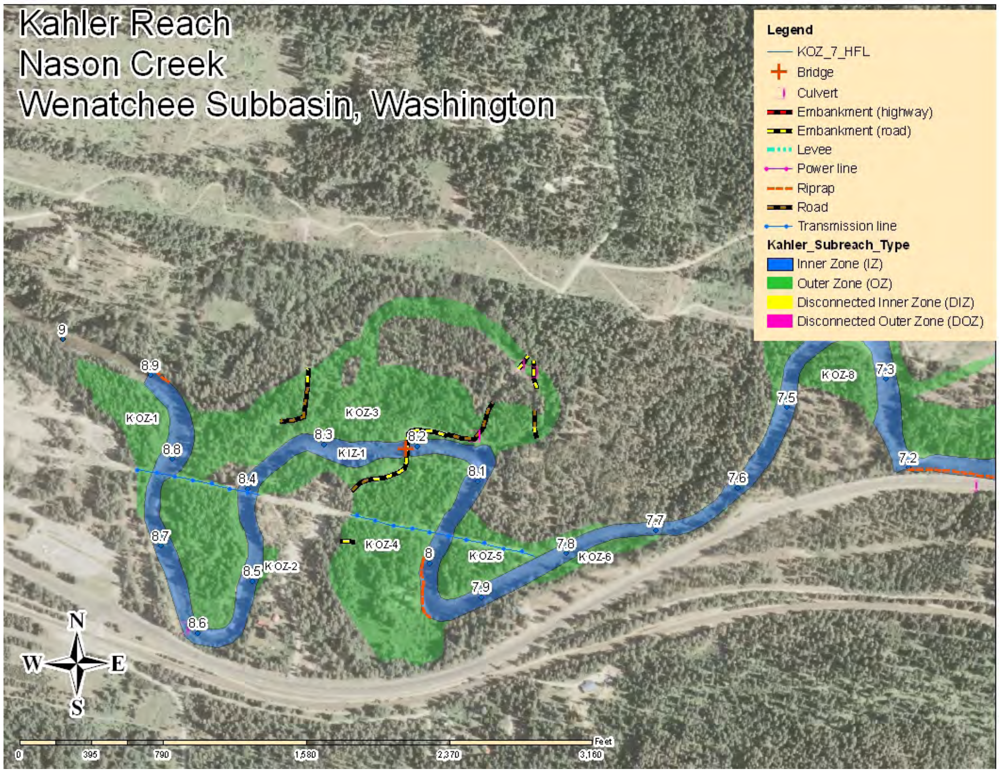


Figure 1. Image showing the location of subreach K OZ-5 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-6

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	1 Acre
	Total Area	1 Acre

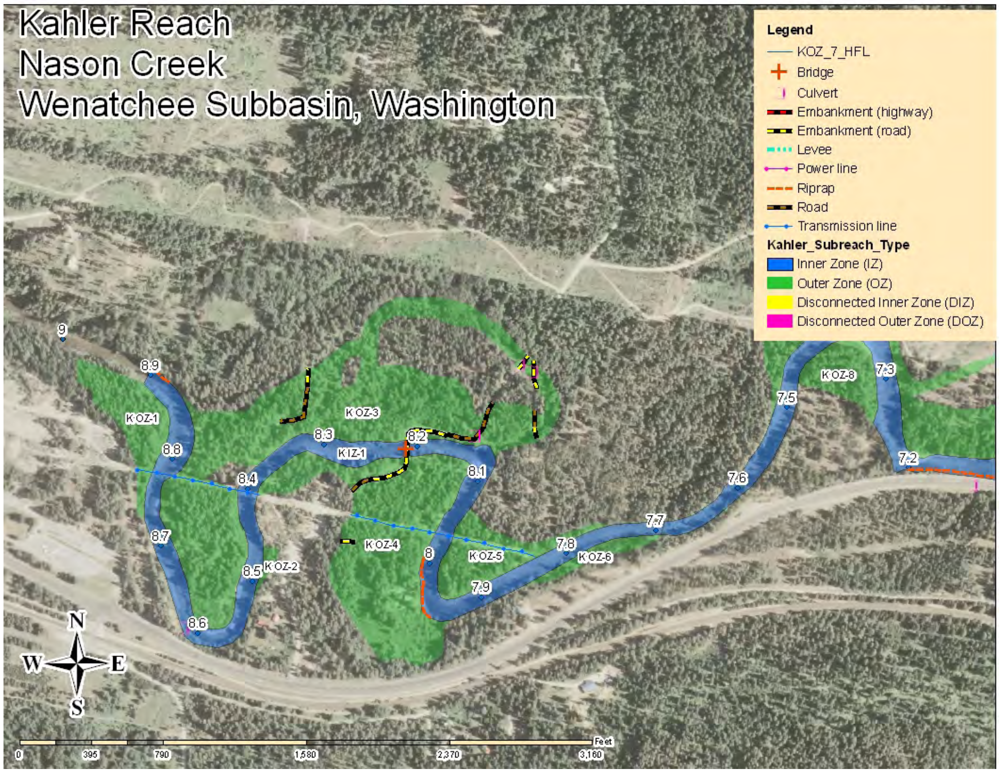


Figure 1. Image showing the location of subreach K OZ-6 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-7

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- About 1 acres of wetland is present in the subreach (Photographs 1 and 2).
- 75 feet of road embankment exist near the outer boundary in the upstream section of the subreach.
- 680 feet of unimproved road exist within the upstream section of the subreach.
- 580 feet of power line exist within the upstream section of the subreach
- About 27 % of the vegetation for the subreach has been altered.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	1 Acre
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	1 Acre
	Total Area	12 Acres

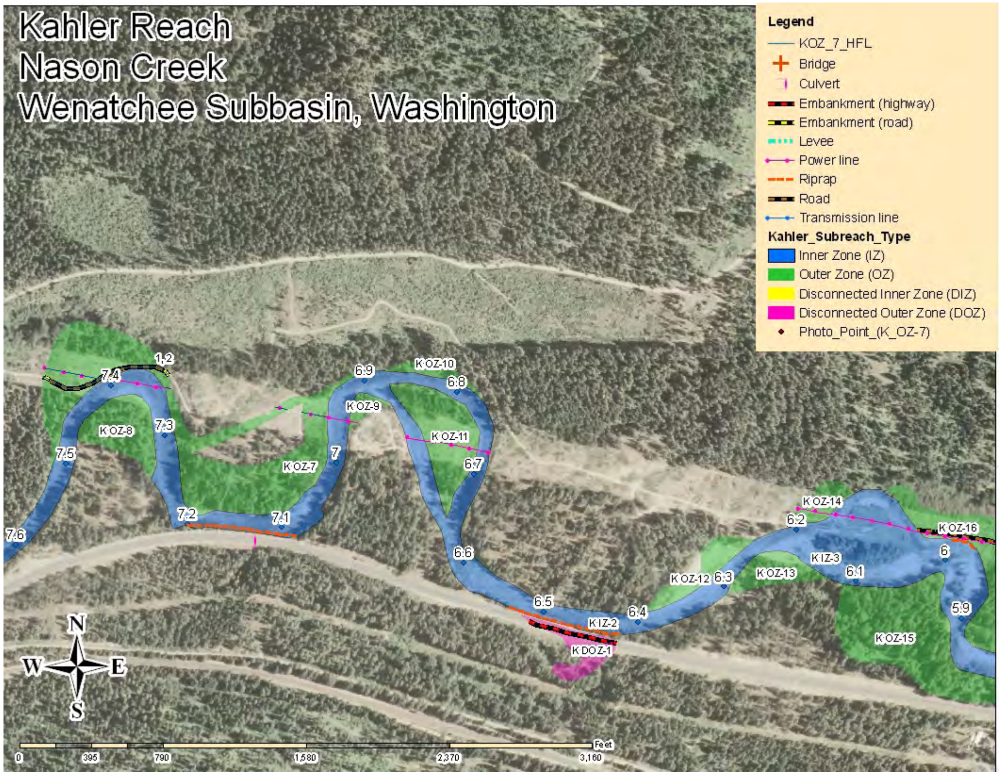


Figure 1. Image showing the location of subreach K OZ-7 and associated human features, in addition to adjacent subreaches.

Photograph No. 1. View to the north of a wetland area to the north of the main channel. Kahler Reach; Subreach OZ-7, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Photograph No. 2. View to the west of the ford crossing of the wetland area. Kahler Reach; Subreach OZ-7, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by R. McAffee, May 4, 2007.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-8

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- No human features disconnect the subreach from riverine and floodplain processes, or have disturbed more than 20 percent of the vegetation within the reach.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	3 Acre
	Total Area	3 Acre

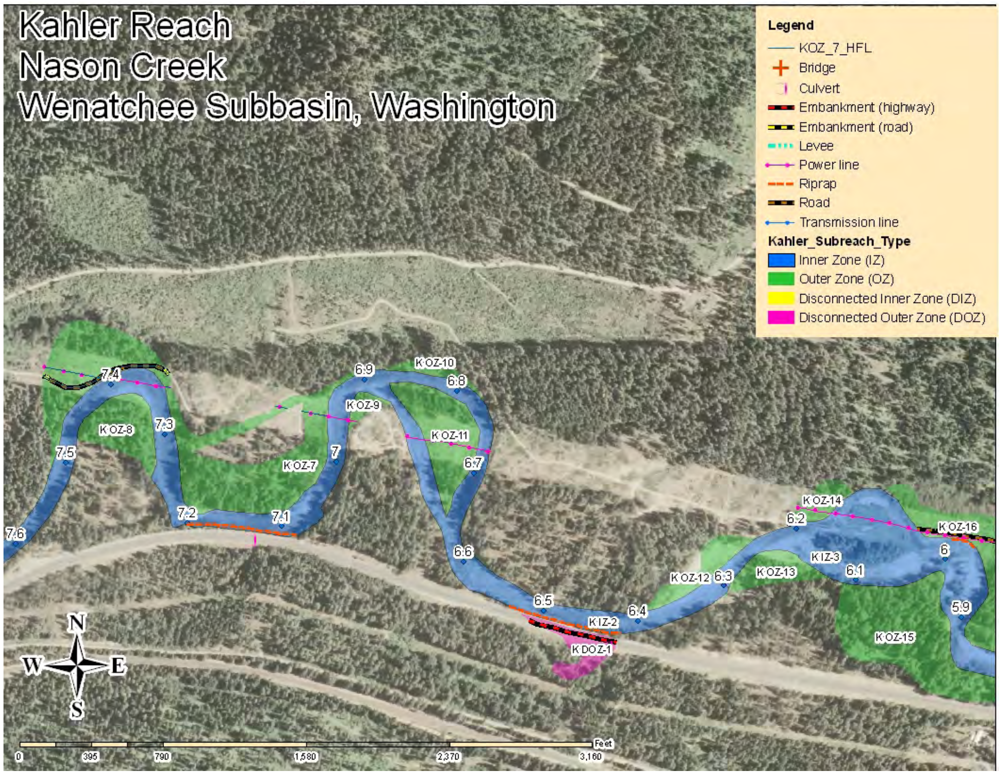


Figure 1. Image showing the location of subreach K OZ-8 and associated human features, in addition to adjacent subreaches.

Wenatchee Subbasin, Washington
Nason Creek Initial Site Assessment
K OZ-9

Personnel: PNRO Geologist E. Lyon, R. McAffee, D. Bennett

Purpose: Photo graphic documentation of baseline conditions and geologic mapping of anthropogenic features associated with floodplain connectivity. The location of the subreach is shown in figure 1.

Observations:

- About 40 % of the vegetation for the subreach has been altered for the powerline.

Summary Table: Features used in the Reach-based Ecosystem Indicators (REI)

Pathway:	**Indicator:**	**Feature:**
Habitat Access	Physical Barriers (mainstem)	None
Habitat elements	Wetlands	None
	Off-channel habitat	Historic overflow channels
	Refugia	Inundated at higher flows
Channel condition and floodplain dynamics	Floodplain connectivity	Connected
Watershed conditions	Road Density & Location (Floodplain)	1.1 mi/0.3 mi^2
	Riparian corridor	Varied diameter/ seral stage, 11% disturbed.
	Protection Area	0 Acre
	Total Area	0.5 Acre

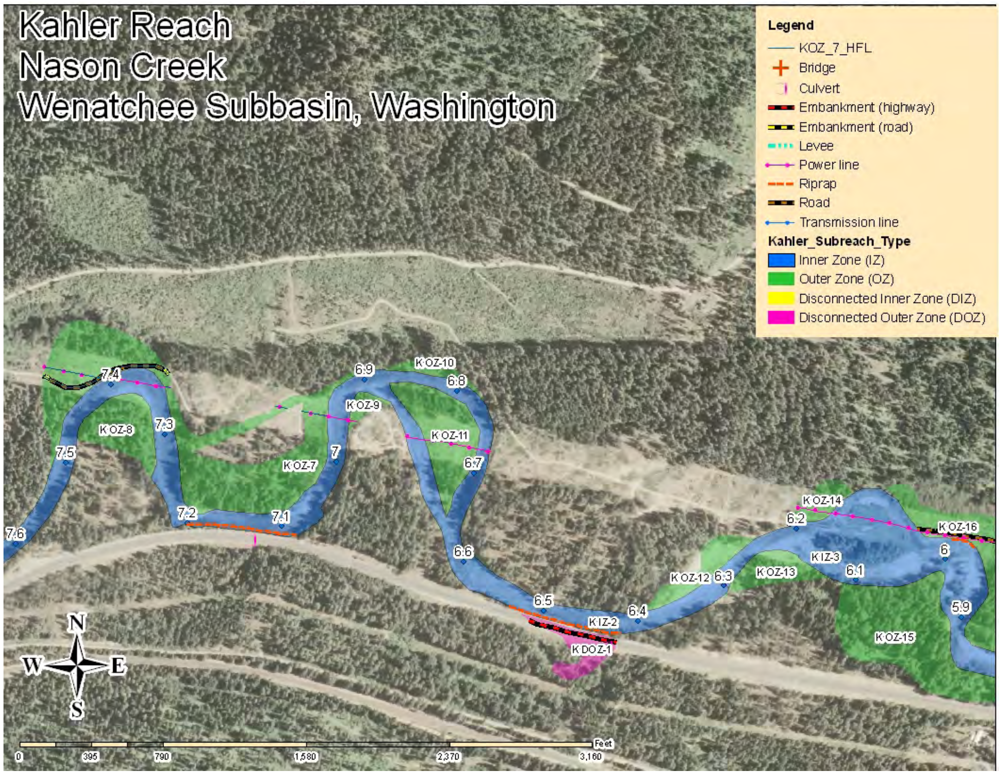


Figure 1. Image showing the location of subreach K OZ-9 and associated human features, in addition to adjacent subreaches.

NASON CREEK HABITAT ASSESSMENT
From the Bend at RM 4.6 to the Railroad Bridge Crossing at RM 14.2

Survey Dates:
September 17 to 19, 2007 AND September 24 and 25, 2007

Prepared by Dave Hopkins and Cameron Thomas
Okanogan-Wenatchee National Forest
October 15, 2007

Reviewed and Finalized by Cindy Raekes
Okanogan-Wenatchee National Forest
May 28, 2008

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References: USFS 1998. White and Little Wenatchee Rivers Watershed Assessment. Wenatchee National Forest, Lake Wenatchee Ranger District.

NASON CREEK HABITAT SURVEY REPORT
RM 4.6 to RM 14.2
September 2007

Methodology and Objectives: A modified Hankin-Reeves Level II habitat survey (USDA Forest Service *Stream Inventory Handbook, 2006, Version 2.6*, Pacific Northwest Region) was conducted on a 9.6 mile segment of Nason Creek located between a major bend in the creek at RM 4.6 and the railroad bridge crossing at RM 14.2. The survey was conducted to help determine fish habitat quantity and quality in the surveyed area. The surveyed stream area was broken into five segments, two located above the bridge crossing at RM 9.4 and three located below the bridge (the bridge crossing is about 0.1 miles below the Highway 2 bridge crossing). Floodprone widths were measured at each bankfull width sampling site.

-Reach 1: A 4.3 mile segment of creek located from a major bend in the creek at RM 4.6 to where the channel becomes constricted at RM 8.9 (BOR Reach NC1).
-Reach 2: A 0.5 mile segment in a naturally constricted area of the creek located between RM 8.9 and a bridge crossing located 0.1 miles below the Highway 2 bridge crossing (BOR Reach NC2).
-Reach 3: A 2.3 mile segment of the creek located from the bridge crossing at RM 9.4 to where the creek is constricted at RM 11.8 (just below the town of Merritt).
-Reach 4: From RM 11.8 to where the creek has been channelilzed to protect the railroad (river right bank) and power lines (left bank) at RM 13.4.
-Reach 5: From RM 13.4 to the railroad bridge crossing at RM 14.2.
Reaches 3 to 5 comprise BOR Reach NC3.

Habitat data was collected and compared in the five surveyed stream segment areas.

Data Attributes: The following data attributes were collected during the habitat survey conducted from September 17 and September 19, and on September 26 and September 27.

●Stream Habitat Type: Habitat in the main channel and all the wetted side channels was broken into 4 main habitat unit types; riffles, pools, runs (glides), and side channels. The % habitat type was compared in the three surveyed stream segments. Run (glide) habitat measured in the survey is non-turbulent riffle habitat (very low gradient slower moving riffles with little surface turbulence). The long tail-outs in the glide pools in Nason Creek were included as pool habitat.

●Habitat Area: The length and wetted width of all habitat units were measured. The % area (square footage) of all 4 habitat unit types was calculated.

●Pools: Pools were counted and pools per mile were calculated. The average maximum depth and average residual depth (max depth minus pool crest) were calculated. Pool data was compared in the surveyed stream segments between reaches and to similar Okanogan Wenatchee National Forest data sets when available and appropriate.

●Riffles and Runs: Habitat dimensions, average thalweg depth, and maximum thalweg depth in riffles and runs were measured.

●Large woody debris: Pieces of large wood that intersected the bankfull channel width were counted in three size categories; small (> 20' long with a diameter of at least 6"), medium (> 35' long with a diameter between 12" and 20"), and large (> 35' long with a diameter greater than 20").

●Bank Erosion: The linear distance of eroding banks above the bankfull width was measured and compared by stream segment (bank erosion per mile, % eroding banks).

●Substrate: Wolman pebble counts were conducted in each reach. Substrate composition was visually estimated in every habitat unit in 5 size categories (sand, gravel, cobble, boulder, bedrock) based on size categories from Wolman pebble counts.

●Chinook salmon redds: The number of spring Chinook salmon redds in the channel were counted during the survey.

●Bankfull width/depth measurements were taken in each surveyed stream segment. A total of 17 bankfull width/depth measurements and floodprone width measurements were taken during the survey at about ½ mile intervals (approximate).   The floodprone area was defined based on survey protocol (floodprone area is the elevation calculated at two times the maximum bankfull depth in each bankfull channel cross-section). Floodprone width measurements are compared to the low surface elevations estimated by the BOR in the reach summary segment of this report.

Stream Flow: The Washington State Department of Ecology operates a stream flow monitoring station at the mouth of Nason Creek. Stream flow from the gage measured 37 to 38 cfs on September 26 and 27, during the time of the survey. Stream flow in the Wenatchee River at a site located between Lake Wenatchee and Nason Creek measured 166 to 183 cfs on the same dates (Washington State Department of Ecology gage station 45A240 data, from the State DOE website).

Fish Distribution: Fish distribution surveys were not conducted in the survey area.

NASON CREEK HABITAT ASSESSMENT OVERVIEW

Although some high quality fish habitat currently exists in the surveyed segment of Nason Creek (i.e. RM 9.2-9.3, RM 11.1-11.4, RM 12.8-13.3), past human activities appear to have greatly simplified the stream segment that we surveyed. The railroad bed, Highway 2 and the power line right of way have disconnected much of the stream from its floodplain. As a result, very little off-channel habitat exists for rearing fish. At low flow, only about 1% of the habitat area in the surveyed segment of Nason Creek consists of side channels and off-channel habitat. Nason Creek is not properly functioning for off-channel habitat under USFWS Matrix of Pathways and Indicators (MPI), which was developed as a guide to help action and regulatory agencies (USFS, BLM, USFWS, NMFS)to standardize habitat quality determinations (USFWS, 1998).

In addition to providing rearing habitat for juveniles and holding habitat for adult salmonids, large wood sorts sediment and creates spawning gravels, channel complexity and dissipates stream energy, The construction and maintenance of the railroad bed, highway and power lines has straightened the stream channel, reducing the sinuosity and total stream length (BOR, 2007). The resulting simplified and constrained channel appears to have reduced both the amount of large wood in the channel and the future recruitment potential for large wood from the riparian corridor. The lack of wood has reduced both the quality and quantity of salmonid habitat in the main channel. Juvenile fish were most typically observed in close proximity to the few log jams that currently exist in the surveyed segment of Nason Creek. Spring Chinook salmon redds were also typically in close proximity to large pieces of wood in the channel (see details in reach summaries found later in this report). Fifteen pieces of wood per mile greater than 35' long with a diameter of at least 12" were counted in the surveyed segment of Nason Creek. Much of the wood was found along the channel margins and on bars. The MPI standards for large wood calls for a minimum of 20 pieces per mile greater than 35' long with a diameter of at least 12" for properly functioning habitat, with adequate sources of woody debris recruitment in riparian areas. Nason Creek is not functioning properly for large wood. Relatively "unimpacted" stream segments that are comparable to Nason Creek have LWD amounts that range from 19 pieces per mile to 70 pieces per mile (Appendix A on page 22).

Although pool habitat is abundant as a percentage of total habitat area in much of the surveyed segment of Nason Creek, channel constriction and the lack of wood in the channel appears to have reduced pool quality. About 10.6 pools per mile were counted, which is below the pool frequency standard in the MPI, but within the low range (10-24.6 pools per mile, see Appendix A) of similar stream segments that are considered to be relatively healthy (not impacted by management activities). Although most pools counted as part of our data set in Nason Creek are greater than 1 meter deep, holding pools for migratory spring Chinook are typically at least five feet deep and associated with wood and or bedrock. Although we completed surveys after the Nason Creek spring Chinook spawned in 2007 and therefore did not see holding adult salmon, we did observe most Chinook redds at the tail-outs and in proximity to deeper pools (5' or >). About three pools per mile in Nason Creek were deeper than five feet, likely below historic levels found before European development began in the late 1800's. In addition to needed cover, the deep pools may provide thermal refuge to a stream that likely has elevated water temperatures due to a lack of shade. Nason Creek is functioning at risk for pool quality.

Cobble and gravel are the dominant substrate types we documented in the surveyed reach, which in proper relation to other habitat elements, provides preferred spawning substrate for anadromous fish. In the channeled segment of the creek between RM 13.4 and 14.1, substrate was > than the cobble size class. Substrate embeddedness did not appear to be excessive in our ocular estimates, as very little of the substrate was judged by surveyors to be embedded. Fine sediments appeared to be a problem only in a few areas in Nason Creek (see attached reach summaries for details). The MPI has a properly functioning standard for fine sediments in spawning gravel (<12% fines < 0.85 mm), which is measured by using McNeil Core sampling. Surface fine sediments were measured during the survey by conducting 6 Wolman pebble counts, spaced throughout the survey. The MPI standard for an appropriately functioning stream is < 12% surface fines < 6 mm. Surface fine sediments < 6 mm averaged about 12% in the six Wolman pebble counts, with a range of 7% to 19% surface fine sediments < 6 mm. Nason Creek appears to be properly functioning for substrate and fine sediments in most of the surveyed segment of the stream.

About 6.5% of the stream-banks are actively eroding, below the 10% threshold in The MPI (streams with > 90% stable banks are considered properly functioning in the Matrix). Although bank erosion is caused by constrictions in the channel from the highway and railroad bridge and by the removal of vegetation to maintain the power line right of way, the human caused erosion is offset by the large amount of rip-rap on the banks in areas where natural bank erosion would be occurring (in the outer bends of the creek).

No physical barriers to upstream or downstream fish migration were observed in the surveyed segment of Nason Creek.

The habitat attributes measured in the survey and briefly discussed in this overview are presented in greater detail in the reach summaries on the following 13 pages of the report. A statistical summary by reach is found on pages 19-20 of this report.

1. HABITAT ASSESSMENT: NASON CREK REACH 1 (BOR Reach NC1)
From a major bend at RM 4.6 to where the creek becomes constricted at RM 8.9

Summary of Habitat Data:

●**Reach Description:** This 4.3 mile reach is a somewhat sinuous, low gradient (1%) channel segment comprised mainly of riffles and runs. U.S. Highway 2 parallels the right bank of the creek throughout the entire reach. The road has cut off the creek from its floodplain in some segments of the reach. Some stream segments within the reach are unconfined (Rosgen C3 channel type). There are both naturally confined stream segments within the reach and areas that have been confined by the road and occasionally, the BPA power line (Rosgen F3 channel type, with a small segment of F4 low gradient contained channel type at the end of the reach).

●**Habitat Area:** The habitat area in the reach is about 159,000 square yards (36,400 square yards per mile), consisting of about 70% riffle and run habitat, 28.5% pool habitat, and 1.5% side channel habitat. (See page 19 for a summary of attributes by reach.).

●**Large Wood:** Large wood is very scarce in the 4.3 mile segment of stream, likely due in part to past wood removal, U.S. Highway 2 and the power line construction . Flows have likely accelerated in the reach due to the highway, which may increase the transport of wood. A total of 46 pieces of wood (10.5 pieces per mile) greater than 35' long with a diameter of at least 12" were counted in the reach. Most of the wood was found along the channel margins and on bars. Four log jams were observed in the reach. Log jams at RM 5.3 and RM 7.0 are creating deep pools (the pool at RM 7 is estimated to be about 9' deep). Two log jams at RM 6.2 are creating side channels, which are scarce in the reach. The future recruitment potential (several decades from now) for large wood is fair in this stream segment despite the highway, houses and power lines, as the riparian area is often well forested with second growth conifers and cottonwood trees.

●**Pool Habitat:** The number of pools per mile is low, with about eight pools per mile counted in the reach. Although some deep pool habitat exists in the reach, pools generally do not have cover and lack complexity. A total of nine pools greater than five feet deep were observed in the reach (two per mile). The number of five foot deep pools per mile is less than half of the deep pools observed above RM 9.4, due mainly to the lower amount of wood in the channel below RM 9.4.

●**Riffle Habitat:** About 70% of the total habitat area consisted of riffles and runs. Hiding cover for juveniles in the riffles was fair in the higher gradient riffles, with boulders and large cobble providing pocket pools and cover. Hiding cover was poor in the riffles that did not have large substrate as there was almost no large wood, the channel bottom was uniform and there was little overhead cover above the stream surface. The average thalweg depth in the riffles was slightly above 1.3 feet, providing good passage for fish migration.

●**Side Channel and Off-Channel Habitat:** Very little side channel and off-channel habitat exist in the reach. About 1.5% of the total habitat area at low flow consists of side channel habitat, which is very low for a (natural) C3 stream type. U.S. Highway 2 has cut off the creek from segments of its floodplain along the right side of the channel. Rip-rap to protect houses and the power line has also reduced the availability of the floodplain to the creek, although to a lesser degree than the highway. Some backwater pools were observed in the reach, usually at the tops of pools at bends in the creek.

●**Fish Spawning Habitat:** A total of 17 spring Chinook salmon redds were observed in the reach. Eight of the redds were found in the upper half mile of the reach, which is lower gradient and gravel dominated. No redds were observed in the lower mile of the reach, where substrate is generally too coarse for spawning. Five redds were observed between RM 7.4 and RM 7.7. Pockets of good spawning habitat exist within this area of the creek.

●**Juvenile Salmonid Rearing Habitat:** Fish rearing habitat is limited in the reach due to the lack of off-channel habitat, lack of side channels, and lack of fish hiding cover (lack of wood). Salmonid juveniles were observed in the two side channels at RM 6.2. Boulders in some areas of the reach and rip-rap that is protecting U.S. Highway 2 are providing some hiding cover for rearing fish.

●**Substrate and Fine Sediment:** Two pebble counts were conducted in the reach. About 13% of the substrate at the pebble counts sites consisted of fine sediments < 6 mm, which is considered functioning at risk in the USFWS Matrix of Pathways and Indicators (12% to 20% surface fine sediments < 6 mm is considered at risk; The MPI does not have a standard for surface fines). Substrate embeddedness did not appear to be a problem in the reach, as very little of the coarse gravel/small cobble substrate was judged to be embedded by surveyors. Fine sediment does not appear to be negatively affecting spawning habitat in this reach.

●**Bank Erosion:** About 7% of the banks are actively eroding in the reach. While about half of the erosion appears to be naturally occurring, the remaining erosion is caused by the removal of vegetation for the construction/maintenance of power line corridors, private property development (home construction, and from the constriction of the channel due to the road.

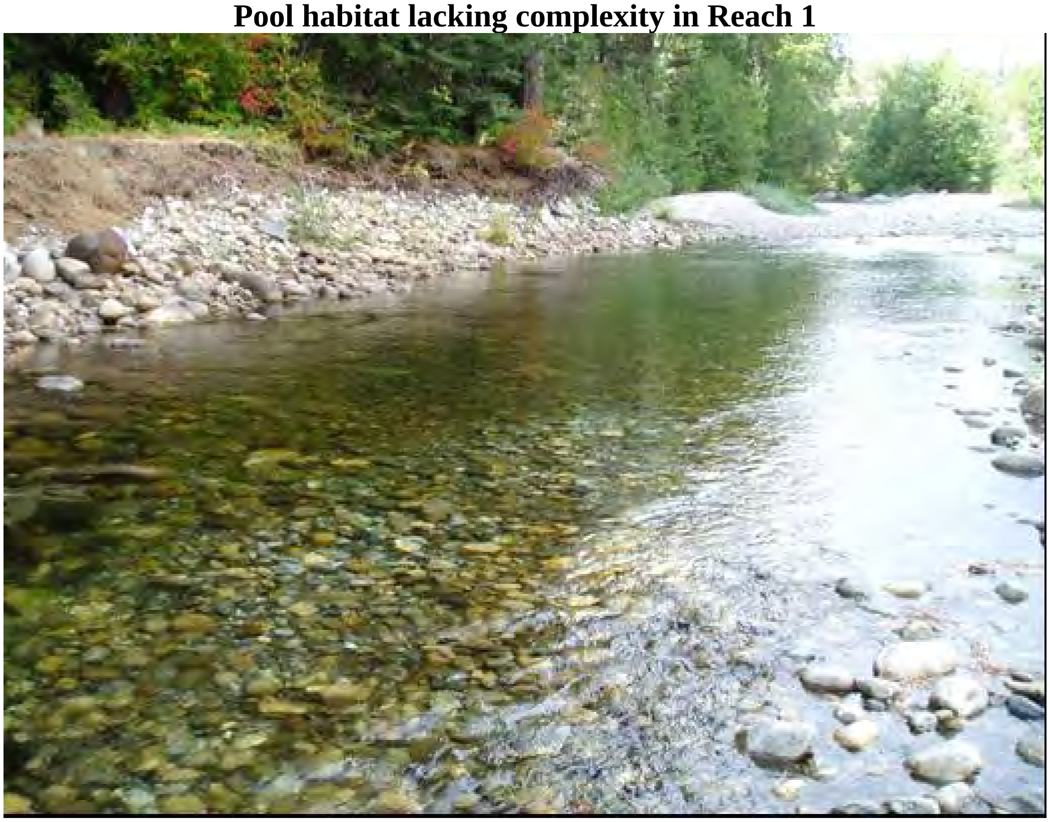
●**Bankfull Data:** A total of seven bankfull width measurements were taken in the reach. The bankfull width averaged 95', with a range of 82' to 120'. The average width/depth ratio in the reach was 44:1. The floodprone width varied from 92' (at the end of the reach) to greater than 500' in the middle of the reach. The lower five floodprone widths measured in the reach agree with the low surface elevations estimated by the BOR (at RM 4.8, 5.4, 6.3, 7.1 and 7.5). The upper two floodprone widths we measured (at RM 8.1 and 8.5) show a constricted channel, while BOR low surface elevations show that this segment of the channel is mainly unconstricted. The average wetted width in the stream reach at low flow is about 60'.

●**Stream Temperatures:** We did not install temperature monitors in Nason Creek during this survey. The Wenatchee River Ranger District and the Washington Department of Ecology have recorded extensive temperature data for several years. Summer temperatures typically exceed WDOE water quality standards in the lowest flows during late summer. This may have occurred naturally prior to development in low flow years because of natural conditions. We suspect channel alteration, harvest, and subsequent channel adjustments have exacerbated natural temperature exceedences.

Nason Creek alongside Highway 2 in Reach 1

Bank erosion from power line crossing at RM 6.2

Pool habitat lacking complexity in Reach 1



II. HABITAT ASSESSMENT: NASON CREK REACH 2 (BOR Reach NC2)
From where the creek becomes constricted at RM 8.9 to the bridge crossing at RM 9.4

Summary of Habitat Data:

●**Reach Description:** This 0.5 mile reach is a straight, low gradient (1%) channel segment with about equal amounts of pool and riffle habitat. The channel is naturally confined throughout the reach. The reach is mainly a F3 channel type under Rosgen's channel classification system, with a small amount of F4 channel at the top of the reach.

●**Habitat Area:** The habitat area in the reach is about 18,000 square yards (32,000 square yards per mile), consisting of about 54% pool habitat and 46% riffle and run habitat. There is no side channel habitat in the reach.

●**Large Wood:** Large wood is very scarce in the 0.5 mile segment of stream, likely due both to wood removal upstream for road and railroad construction and to the high energy, straight channel, which is transporting wood downstream. About 10.6 pieces of wood per mile greater than 35' long with a diameter of at least 12" counted in the reach (about the same as Reach 1). Smaller pieces of wood in this reach (>20', >6" diameter) were about 66% higher than in Reach 1. No log jams were found in the reach. The recruitment potential for large wood is fair to good, with conifers found above both banks.

●**Pool Habitat:** About 54% of the total habitat area in the main channel consisted of pools. Pool habitat in the reach was more shallow than in the other four reaches, due mainly to the lack of wood in the pools which deepens scour. About 10.5 pools per mile were counted in the reach, about 33% higher than in Reach 1. The number of pools may be near natural levels in this reach, although pools lack complexity (no wood). Pools were formed mainly at the bends in the creek and by the bridge at the end of the reach. Boulders provide some hiding cover in pools in the lower half of the reach.

●**Riffle Habitat:** About 46% of the total habitat area in the main channel consisted of riffles. Hiding cover in the riffles was fair in the higher gradient riffles found in the lower half of the reach, with boulders and large cobble providing pocket pools and cover for fish. Hiding cover was poor in the riffles that did not have large substrate as there was almost no large wood, the channel bottom was uniform and there was little overhead cover above the stream. The average thalweg depth in the riffles was 1.25', providing good passage for fish migration.

●**Side Channel and Off-Channel Habitat:** No side channel habitat exists in the reach due to the constricted channel. A large pond (human constructed, enhanced by beaver) above the left bank at the end of the reach may not be accessible to fish, as the dam is four feet high. No other off-channel habitat exists in the reach.

●**Fish Spawning Habitat:** Excellent fish spawning habitat is found in the gravel-dominated upper half of this reach. A total of 12 spring Chinook salmon redds were observed in the reach, all in the upper half of the reach. The redds were located above a bedrock constriction in the middle of the reach. Upwelling in the area of the bedrock may make this area attractive to spawning salmon. The 21.6 redds per mile was by far the highest number of redds per mile in the surveyed segment of Nason Creek. Pools greater than 450' long and about 4.5' deep are found at the upper and lower end of the spawning area.

●**Juvenile Salmonid Rearing Habitat:** Fish rearing habitat is limited in the reach due to the lack of off-channel habitat, lack of side channels, and lack of fish hiding cover (lack of wood). Some rearing habitat exists among the boulders in the slower water in the lower half of the reach.

●**Substrate and Fine Sediment:** Substrate consisted almost entirely of cobbles and gravels in the upper half of the reach, ideal for anadromous fish spawning. Substrate was too coarse in the lower half of the reach for anadromous fish spawning. One pebble count was conducted in the reach during the survey, about half way through the reach, where the substrate size is transitioning from cobble dominated to gravel dominated. Surface fine sediments were below the 12% threshold established by USFWS for good fish habitat. Substrate embeddedness did not appear to be a problem in the reach, as very little of the coarse gravel/small cobble substrate was judged to be embedded by the surveyors.

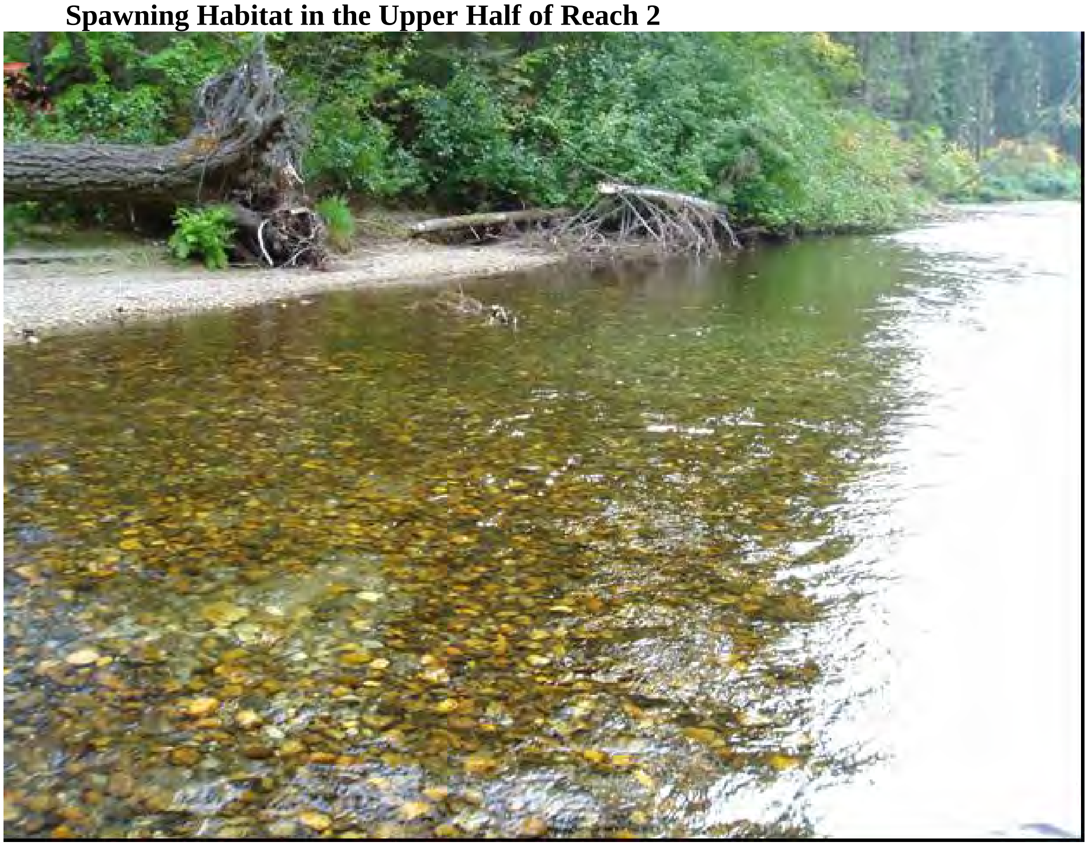
●**Bank Erosion:** About 7% of the stream banks are actively eroding, about the same as Reach 1. Nearly all of the bank erosion is from natural causes (bends in the constricted stream channel). Bank erosion in the reach does not appear to be affecting spawning habitat.

●**Bankfull Data:** Two bankfull width measurements were taken in the constricted reach. The bankfull width averaged 75' and the bankfull width/depth ratio averaged 27:1. The floodprone width was only 90', with steep slopes above both banks. Floodprone widths in the reach agree with the low surface elevations estimated by the BOR that show that the reach is naturally constricted. The average low flow wetted width is 54' in the reach.

●**Stream Temperatures:** We did not install temperature monitors in Nason Creek during this survey. The Wenatchee River Ranger District and the Washington Department of Ecology have recorded extensive temperature data for several years. Summer temperatures typically exceed WDOE water quality standards in the lowest flows during late summer. This may have occurred naturally prior to development in low flow years. We suspect channel alteration, harvest, and subsequent channel adjustments have exacerbated natural temperature exceedences.

●**Fish Passage:** There are no fish passage barriers in the reach.

Spawning Habitat in the Upper Half of Reach 2



III. HABITAT ASSESSMENT: NASON CREK REACH 3
From the bridge crossing at RM 9.4 to where the creek becomes constricted at RM 11.75

Summary of Habitat Data:

●**Reach Description:** This 2.35 mile reach is a moderately sinuous, very low gradient (< 0.5%) channel segment comprised mainly of pools. U.S. Highway 2 parallels the left bank of the creek and the railroad bed parallels the right bank of the creek throughout the entire reach. The railroad bed has cut off the creek from its floodplain. Segments of the stream from RM 10.1 to 10.7 and from RM 11 to 11.5 are unconfined and gravel dominated (Rosgen C4 channel type). The railroad bed, power line right of way and (to a lesser extent) highway 2 has confined most of the channel throughout the rest of the reach. The confined segments of the reach are an F4 Rosgen channel type.

●**Habitat Area:** The habitat area in the reach is about 79,000 square yards (32,500 square yards per mile), consisting of about 29% riffle and run habitat, 70% pool habitat, and 1% side channel habitat. (See page 19 for a summary of attributes by reach).

●**Large Wood:** Large wood is very scarce in the 2.35 mile segment of stream, likely due to the past removal of wood from the stream for flood control and during the construction of Highway 2, the railroad bed and the power lines. A total of 38 pieces of wood (15.7 pieces per mile) greater than 35' long with a diameter of at least 12" were counted in the reach. Almost half of this wood is found in a huge log jam at a bend in the river at RM 11.2. About 8.7 pieces of large wood per mile is found in the rest of this reach (without the jam), a very low amount of wood in such a low gradient, depositional stream segment. Large pieces of wood have been cabled or placed in the channel to prevent bank erosion at RM 9.5 and RM 10.3. Chinook redds were observed in areas of the reach that had pieces of wood. The future recruitment potential for large wood is very poor in this reach. Trees in the reach were harvested during the construction of the railroad bed and power lines, and are cut down on a regular basis to prevent damage to power lines and the railroad.

●**Pool Habitat:** The number of pools per mile and the % pool habitat is higher in this reach than any of the other reaches in the surveyed segment of Nason Creek. A total of 42 pools were counted (17.4 per mile). Although some deep pool habitat exists in the reach, pools generally do not have a lot of cover and lack complexity (due mainly to the lack of wood). A total of 11 pools greater than five feet deep were observed in the reach (4.5 pools per mile). Six of the 11 deep pools were formed by large wood.

●**Riffle Habitat:** About 29% of the total habitat area consisted of riffles and runs. Hiding cover in the riffles was poor as there was almost no large wood, the channel bottom was uniform and there was little overhead cover above the stream surface. The average thalweg depth in the riffles was about a foot deep, and considered adequate for fish migration.

●**Side Channel and Off-Channel Habitat:** Very little side channel and off-channel habitat exist in the reach as the railroad bed has cut off much of the floodplain on the south side of the creek. About 1.1% of the total habitat area at low flow consists of side channel habitat, which is very low for such a low gradient channel. A wetted side channel/wetland on the north side of the creek at river mile 11.3 was disconnected from the creek on both the upper and lower ends at low flow. A four foot berm at the mouth of the side channel prevented connection to the main channel. Some backwater pools were observed in the reach, usually at the tops of pools at bends in the creek.

●**Fish Spawning Habitat:** A total of 17 spring Chinook salmon redds were observed in the reach (7 per mile). Many of the redds were associated with pieces of large wood. Redds were observed in riffles and at pool crests near pools that had good hiding cover from wood. This reach likely had historically high numbers of spawning fish.

●**Juvenile Salmonid Rearing Habitat:** Fish rearing habitat is limited in the reach due to the lack of off-channel habitat, lack of side channels, and lack of fish hiding cover (lack of wood). Salmonid juveniles were observed in the pool under the huge log jam at RM 11.2. Hundreds of half inch long fish fry (non-salmonid) were observed in a small side channel along the right bank at RM 10.3. The rip-rap protecting the railroad bed may provide some cover for fish rearing.

●**Substrate and Fine Sediment:** One pebble count was conducted in the reach. About 11% of the substrate at the pebble count site consisted of fine sediments < 6 mm, which is considered functioning appropriately in USFWS Matrix of Pathways and Indicators (12% to 20% surface fine sediments < 6 mm is considered at risk; the MPI does not have a standard for surface fines). Substrate embeddedness did not appear to be a problem in the reach, as very little of the coarse gravel/small cobble substrate was judged to be embedded by surveyors. Fine sediment does not appear to be negatively affecting spawning habitat in this reach.

●**Bank Erosion:** The amount of bank erosion is highest in this reach, with about 10% of the banks actively eroding in the reach. About 75% of the total bank erosion in the reach appeared to be naturally occurring. The remaining 25% of the bank erosion appeared to have been caused by the removal of vegetation for the construction of the railroad bed, houses and the power line right of way. Over 500' of meadow on the left bank of the creek is rapidly eroding above the huge log jam at RM 11.2. Large chunks of sod are falling into the creek bed.

●**Bankfull Data:** A total of 3 bankfull width measurements were taken in the reach. A bankfull width of 87 feet and floodprone width of 100 feet was measured at RM 9.6, where the channel has been constricted along the right bank by the railroad bed. The width/depth ratio at this location was about 45:1. The other two bankfull widths were measured at RM 10.4 and RM 11.3, where the channel is unconfined. The two bankfull widths averaged 105' wide, with a width/depth ratio of about 50:1. The floodprone width was greater than 500 feet at both of the upper sites. Floodprone widths at the upper two bankfull sites in the reach agree with the low surface elevations estimated by the BOR (channel is unconfined). BOR low surface elevation data shows less confinement at RM 9.6 than we measured using the stream survey protocol. The average wetted width in the stream reach at low flow is about 55'.

●**Stream Temperatures:** We did not install temperature monitors in Nason Creek during this survey. The Wenatchee River Ranger District and the Washington Department of Ecology have recorded extensive temperature data for several years. Summer temperatures typically exceed WDOE water quality standards in the lowest flows during late summer. This may have occurred naturally prior to development in low flow years. We suspect channel alteration, harvest, and subsequent channel adjustments have exacerbated natural temperature exceedences.

Nason Creek from top of Railroad Grade

Cabled Logs in Pool at RM 10.3

Riffle Habitat in Reach 3

IV. HABITAT ASSESSMENT: NASON CREK REACH 4
From RM 11.75 to where the creek has been channeled at RM 13.4

Summary of Habitat Data:

●**Reach Description:** This 1.6 mile reach is a moderately sinuous, low gradient (< 1%) channel segment comprised mainly of pools. U.S. Highway 2 parallels the left bank of the creek and the railroad bed parallels the right bank of the creek throughout the entire reach. While much of the channel in the lower segment of the reach (below RM 12.5) is confined by human features, most of the upper channel above RM 12.5 appears to be moderately naturally confined, with an entrenchment ratio of about 1.65 (Rosgen B3c channel type).

●**Habitat Area:** The habitat area in the reach is about 47,000 square yards (27,700 square yards per mile), consisting of about 27% riffle and run habitat, 72% pool habitat, and 1% side channel habitat. (See table page 19 for a summary of attributes by reach.).

●**Large Wood:** Amounts of large wood were higher in this reach than in any other stream segment within the surveyed area, with about 26 pieces per mile greater than 35' long with a diameter of at least 12". Wood is likely far below natural levels due to the past removal of wood from the stream for flood control and during the construction of Highway 2, the railroad bed and the power lines. Two log jams were observed in the channel in the reach, at RM 12.9 and RM 13.1. Both jams were at bends in the stream and both jams created deep pool habitat. Four of the eight Chinook redds observed in the reach were near the log jams. Although the future recruitment potential for large wood has been reduced in the reach by Highway 2, houses and power lines, the future wood recruitment potential is greater than in Reach 3.

●**Pool Habitat:** About 15 pools per mile were counted in the reach, higher than in any reach except Reach 3, which had 17 pools per mile. Pools were deeper than in any other reach in the surveyed stream segment, with an average maximum depth of 4.6' and an average residual depth of 3.6' (max depth minus depth at pool crest). Pool habitat generally lacked complexity below RM 12.8, but deep, complex pool habitat was observed in a half mile segment of the reach located between RM 12.8 and RM 13.3. A pool at least seven feet deep at RM 11.8 was formed at a stream bend and by rip-rap that protects houses and the bridge that spans Nason Creek at the town of Merritt. An 800 foot long, six foot deep pool formed by the constricted channel along Highway 2 (RM 12.4 to 12.6) lacked habitat complexity (no wood), although boulders (rip-rap) and depth in segments of the pool provide rearing habitat. A total of nine pools at least five feet deep were observed in the reach (5.3 pools per mile). Six of the nine pools were formed by or deepened by large wood.

●**Riffle Habitat:** About 27% of the total habitat area consisted of riffles and runs. Hiding cover in the riffles was generally poor as there was almost no large wood, the channel bottom was uniform and there was little overhead cover above the stream surface. The average thalweg depth in the riffles was about 1.1 feet deep, adequate passage for fish migration.

●**Side Channel and Off-Channel Habitat:** Very little side channel and off-channel habitat exist in the reach (at low flow), due both to human impacts (dikes, rip-rap, road fill) and to a naturally constricted channel in the upper half of the reach. A large wetland complex formed by beaver dams above the left bank at the end of the reach connects to the creek at higher flows. Much of this wetland complex has been cut off from the creek below RM 13.3 by a large dike built to protect power lines. A small side channel (3' wide) on the left bank at RM 12 could not be walked due to deep silt in the channel. The loose silt substrate was measured at 2.6 feet deep! The side channel appears to be storing large amounts of fine sediment and likely contributing to the higher fine sediment count in this reach.

●**Fish Spawning Habitat:** A total of eight spring Chinook salmon redds were observed in the reach (4.7 per mile). Four of the redds were near the two log jams in the reach. This reach likely had historically high amounts of fish spawning.

●**Juvenile Salmonid Rearing Habitat:** Fish rearing habitat is limited in the reach due to the lack of off-channel habitat, lack of side channels, and lack of fish hiding cover (lack of wood). Some good juvenile rearing habitat was observed in the pools formed by log jams and in the boulders (rip-rap) in the lower half of the reach.

●**Substrate and Fine Sediment:** One pebble count was conducted in the reach. About 19% of the substrate at the pebble count site consisted of fine sediments < 6 mm, which is considered at risk in USFWS Matrix of Pathways and Indicators (12% to 20% surface fine sediments < 6 mm is considered at risk; the MPI does not have a standard for surface fines). Substrate embeddedness did not appear to be a problem in the reach, as very little of the coarse gravel/small cobble substrate was judged to be embedded by surveyors. Although fine sediment does not appear to be negatively affecting spawning habitat in this reach, surface fine sediments are more abundant in this reach and could be more abundant in spawning gravels.

●**Bank Erosion:** The amount of bank erosion is low in this reach, with only 4% of the banks actively eroding. Much of the banks in the reach are armored with rip-rap to protect U.S. Highway 2 and houses at the town of Merritt.

●**Bankfull Data:** A total of three bankfull width measurements were taken in the reach. The bankfull width of 54 feet was measured in the lower segment of the reach (just above Merritt, next to Highway 2). Bankfull widths of 87 feet and 93 feet were taken in the upper half of the reach. The floodprone zone (elevation of two times the maximum bankfull depth), measured 142' and 153' in the upper half of the reach. The width/depth ratio at the bankfull site just above Merritt was 19:1. The width/depth ratio in the upper two sites averaged 48:1. Floodprone widths at the lower bankfull site (RM 12) and upper bankfull site (RM 13.2) in the reach agree with the low surface elevations estimated by the BOR, channel is confined (lower site) and moderately confined (upper site). BOR low surface elevation data shows less confinement at RM 12.7 than we measured using the stream survey protocol. The average wetted width in the stream reach at low flow is about 47 feet, narrower than downstream reaches, mainly due to channel constrictions.

●**Stream Temperatures:** We did not install temperature monitors in Nason Creek during this survey. The Wenatchee River Ranger District and the Washington Department of Ecology have recorded extensive temperature data for several years. Summer temperatures typically exceed WDOE water quality standards in the lowest flows during late summer. This may have occurred naturally prior to development in low flow years. We suspect channel alteration, harvest, and subsequent channel adjustments have exacerbated natural temperature exceedences.

●**Fish Passage:** There are no fish passage barriers in the reach.

Log jam and deep pool habitat in Reach 4

Pool formed by wood in Reach 4

V. HABITAT ASSESSMENT: NASON CREK REACH 5
From RM 13.4 to Railroad Bridge Crossing at RM 14.2

Summary of Habitat Data:

●**Reach Description:** This 0.8 mile reach is a straight, channeled segment of the stream comprised mainly of riffles and one ¼ mile long pool. This segment of the creek was moved from its original stream bed during construction of the railroad in the 1940s. The right bank consists of the railroad bed and the left bank has been rip-rapped to protect power lines. Both banks of Nason Creek have been cut off from its floodplain.

●**Habitat Area:** The habitat area in the reach is about 22,400 square yards (25,400 square yards per mile), consisting of 63% riffle and run habitat, 36% pool habitat, and 1% side channel habitat. (See table on page 19 for a summary of attributes by reach.).

●**Large Wood:** Large wood is nearly absent from the channel in the lower ¾ miles of the reach. A log jam at the top of the reach diverts flow into the one side channel in the reach (just above the channeled segment of stream). Future wood recruitment potential from the adjacent riparian corridor is poor due to the railroad grade and power lines. Wood delivered to the valley bottom from debris slides likely would not reach the current channel because of revetments in much of this section.

●**Pool Habitat:** Only three pools exist in the 0.8 miles of stream. A 1,350 foot long pool is found near the beginning of the reach, formed by the constricted channel. Pool habitat quality is poor, with little or no wood in the pools. No spawning gravel exists at the pool crests. This reach is not properly functioning for pools or for wood.

●**Riffle Habitat:** About 63% of the total habitat area consisted of riffles and runs. Nearly the entire reach above the 1,350 foot long pool consists of straight, deep riffle habitat. No spawning habitat exists in the riffles. Hiding cover is limited due to rip-rap along the sides of the channel, and to boulders in the upper half of the reach. The average thalweg depth in the riffles was about 1.5 feet deep (deepest in the survey) due to the narrow channel width.

●**Side Channel and Off-Channel Habitat:** One side channel exists in the reach, formed by a log jam on the right bank just below the railroad bridge. Juvenile salmonids were observed rearing in the pools in the side channel at the time of the survey (two, 2 foot deep pools were seen in the side channel). A wetland complex beyond the left bank of Nason Creek has been cut off from the creek by a dike built to protect the power lines.

●**Fish Spawning Habitat:** No spring Chinook salmon redds were observed in the reach. The reach has very little, if any, spawning habitat.

●**Juvenile Salmonid Rearing Habitat:** Fish rearing habitat is limited in the reach due to the lack of off-channel habitat, lack of side channels, and lack of fish hiding cover (lack of wood). Some rearing habitat exists in the rip-rap along the channel margins in the lower half of the reach and among the pocket pools created by boulders in the upper half of the reach.

●**Substrate and Fine Sediment:** One pebble count was conducted, a little more than half way through the reach. About 7% of the substrate at the pebble count site consisted of fine sediments < 6 mm. Fine sediments in the higher gradient upper half of the reach are being transported and deposited in the long pool at the bottom of the reach (and downstream reaches).

●**Bank Erosion:** Both banks are hardened, which prevents erosion. No notable erosion was observed in the reach.

●**Bankfull Data:** Two bankfull width measurements were taken in the reach. The average of the two bankfull width measurements was 47 feet; the average of the two width/depth measurements was 18:1. The entrenchment ratio (floodprone width divided by bankfull width) was 1.20. Floodprone widths in the reach agree with the low surface elevations estimated by the BOR that show that the reach is constricted. The average wetted width in the stream reach at low flow is about 43 feet, narrower than downstream reaches due to the constricted channel.

●**Stream Temperatures:** We did not install temperature monitors in Nason Creek during this survey. The Wenatchee River Ranger District and the Washington Department of Ecology have recorded extensive temperature data for several years. Summer temperatures typically exceed WDOE water quality standards in the lowest flows during late summer. This may have occurred naturally prior to development in low flow years. partly to natural conditions. We suspect channel alteration, harvest, and subsequent channel adjustments have exacerbated natural temperature exceedences.

●**Fish Passage:** There are no fish passage barriers in the reach.

●**Habitat above the Railroad Bridge:** The channel is constricted by bedrock and the road to the bridge crossing several hundred feet upstream. The channel is higher gradient in this area; a series of step pools was observed above the railroad bridge. No habitat was observed above the road crossing.

Nason Creek in channelized Reach 5

APPENDIX A: STREAM CONDITION ASSESSMENT

A statistical analysis (USFS 1998) of stream survey data within the Wenatchee Highlands Land Type Association found that a subset of fifth field watersheds within the Wenatchee Highlands subsection were relatively similar to each other. This relatively homogenous group included streams within the White, Little Wenatchee, Chiwawa, Nason, and Icicle watersheds. The analysis was conducted to determine if geomorphic, vegetative, climatic and/or channel variables could serve as predictive associations of pool and LWD abundance to identify "reference" parameter values (a natural range of stream condition). The ultimate goal of the analysis was the creation of categories, with reduced variation within category.

The tables below (Table 1 and Table 2) show the results of the analysis and the categories that can be used to assist in determining relative stream health. In Table 3, Nason Creek data is compared to a selected data set from relatively unimpacted streams within the fifth field watershed subset to consider how Nason Creek ranks within the pool and LWD categories.

Table 1. Channel categories for LWD.

LWD Size	Channel Type	Typical Range*	Mean	Median	Percentiles				Sample Size
					10th	25th	75th	90th	
LWD >12"	Pool-riffle	75-200	75	72	21	39	97	134	23
	other	25-200	65	60	24	37	81	110	47
	bedrock	15-200	59	40	10	19	97	164	17
	<10 ft. wide	5-100	33	18	5	10	64	72	5
LWD >20"	All other channels	15-100	31	25	8	16	43	66	56
	Bedrock	0-50	22	13	1	3	31	60	18
	No large riparian	0-35	12	9	0	1	21	32	34

Table 2. Channel categories for percent riffle area.

Channel Type	Typical Range*	Mean	Median	Percentiles				Sample Size
				10th	25th	75th	90th	
Pool-riffle	25-65	43	42	24	32	58	64	23
Low gradient plane-bed	45-70	61	61	47	48	67	88	19
Bedrock	55-95	72	69	57	59	82	94	18
Other	60-99	80	84	68	75	89	96	45

* 'Typical' was a subjective determination which took management history into account.

Table 3. NASON Creek LWD and pool data compared to 'unimpacted' river segments within the Wenatchee Highlands subsection.

	Nason Creek: RM 4.6 to RM 14.2	Little Wenatchee: RM 10.5 to 12.2	Chiwawa River: RM 13.8 to RM 17.5	Chiwawa River: RM 25.7 to RM 33.1
Est. Beginning Elevation of Reach	1960	2300	2400	2544
Est. Ending Elevation of Reach	2240	2330	2544	2772
Estimated Channel Gradient	0.5%	0.3%	0.2%	0.7%
Channel Type:	Pool-riffle	Pool-riffle	Pool-riffle	Pool-riffle
Rosgen Channel Type	C3, F3	C4	C4	C4
Habitat Area:				
% Pool	47%	34%	49%	34%
% Riffle and Glide	52%	61%	47%	51%
% Side Channel	1%	1%	4%	6%
Pools:				
Pools per mile in main channel	10.6	10.0	24.6	14.0
Pools > 3' deep per mile	9.0	10.0	24.6	13.5
Large Wood per Mile:				
>6 inches	23.8	51	238	116
>12 inches	10	39	35	16
>20 inches	5	31	6	3

NASON CREEK STREAM SURVEY DATA SUMMARY
Bend at RM 4.56 to Railroad Bridge at RM 14.20
09-17-07 to 09-19-07 AND 09-26-07 to 09-27-07

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Total
Reach Mileage Boundaries (BOR maps)	RM 4.56 to 8.90	RM 8.90 to 9.42	RM 9.42 to 11.75	RM 11.75 to 13.37	RM 13.37 to 14.20	RM 4.56 to 14.20
Reach Length (BOR maps)	4.34	0.52	2.33	1.62	0.83	9.64
Reach Length (measured miles)	4.37	0.56	2.42	1.70	0.88	9.93
Average Wetted Width:	61’	54’	55’	47’	43’	55’
Average Thalweg Depth (riffles):	1.32’	1.25’	1.01’	1.08’	1.46’	1.25’
Average Thalweg Depth (runs):	1.55’	1.40’	1.16’	1.25’	1.43’	1.38’
Habitat Area:						
% Pool	28.6%	54.3%	69.8%	72.6%	36.0%	46.9%
% Riffle	57.5%	35.1%	21.6%	22.3%	48.8%	41.8%
% Runs (non-turbulent riffles)	12.4%	10.6%	7.4%	4.6%	13.8%	10.1%
% Side Channel	1.5%	-	1.2%	0.5%	1.4%	1.2%
Pools:						
Pools per Mile	8.0	10.6	17.4	15.3	5.7	10.6
Pools > 3’ deep per mile	6.9	7.1	11.6	14.1	3.4	9.0
Total # of Pools > 1 meter deep	23	3	21	23	3	73
Pools > 1 meter deep per mile	5.2	5.3	8.7	13.5	3.4	7.4
Pools > 4’ deep per mile	3.2	5.3	7.4	11.7	1.1	5.6
Pools > 5’ deep per mile	1.8	0	4.5	5.3	1.1	2.9
Avg. Pool Maximum Depth	4.1’	3.5’	4.2’	4.6’	3.8’	4.1’
Avg. Pool Residual depth	**2.9’**	2.4’	3.4’	3.6’	**2.3’**	**3.1’**
Riffle to Pool Ratio	2.44 to 1	0.84 to 1	0.42 to 1	0.37 to 1	1.74 to 1	1.11 to 1
Large Wood per Mile:						
Small (>20’ Long, > 6” diameter)	18.1	30.1	21.9	37.6	26.2	23.8
Medium (>35’Long, 12-20” diam.)	8.7	8.8	10.3	12.3	9.1	9.8
Large (>35’ Long, >20” diameter)	1.8	1.8	5.4	13.5	5.7	5.0
Total Large and Medium (>35’ L)	10.5	10.6	15.7	25.8	14.8	14.8
Bank Erosion:						
Total Bank Erosion (both banks)	3,100’	400’	2,585’	695’	0’	6,780’
Linear Length per Mile	710’	708’	1,068’	408’	0’	682’
% Eroding Banks (both banks)	6.7%	6.7%	10.1%	3.9%	0%	6.5%
Bankfull Data:[1]						
-# Bankfull Measurements in Reach	7	2	3	3	2	
-Avg. Bankfull Width	95’	75’	99’	78’	47’	
-Avg. Bankfull Depth (avg. of 7 measurements per bankfull width)	2.15’	2.85’	2.07’	2.16’	2.59’	
-Avg. W/D Ratio	44.0	27.3	47.7	36.0	18.1	
-Avg. Entrenchment ratio[2]	2.38	1.20	4.55	1.55	1.20	

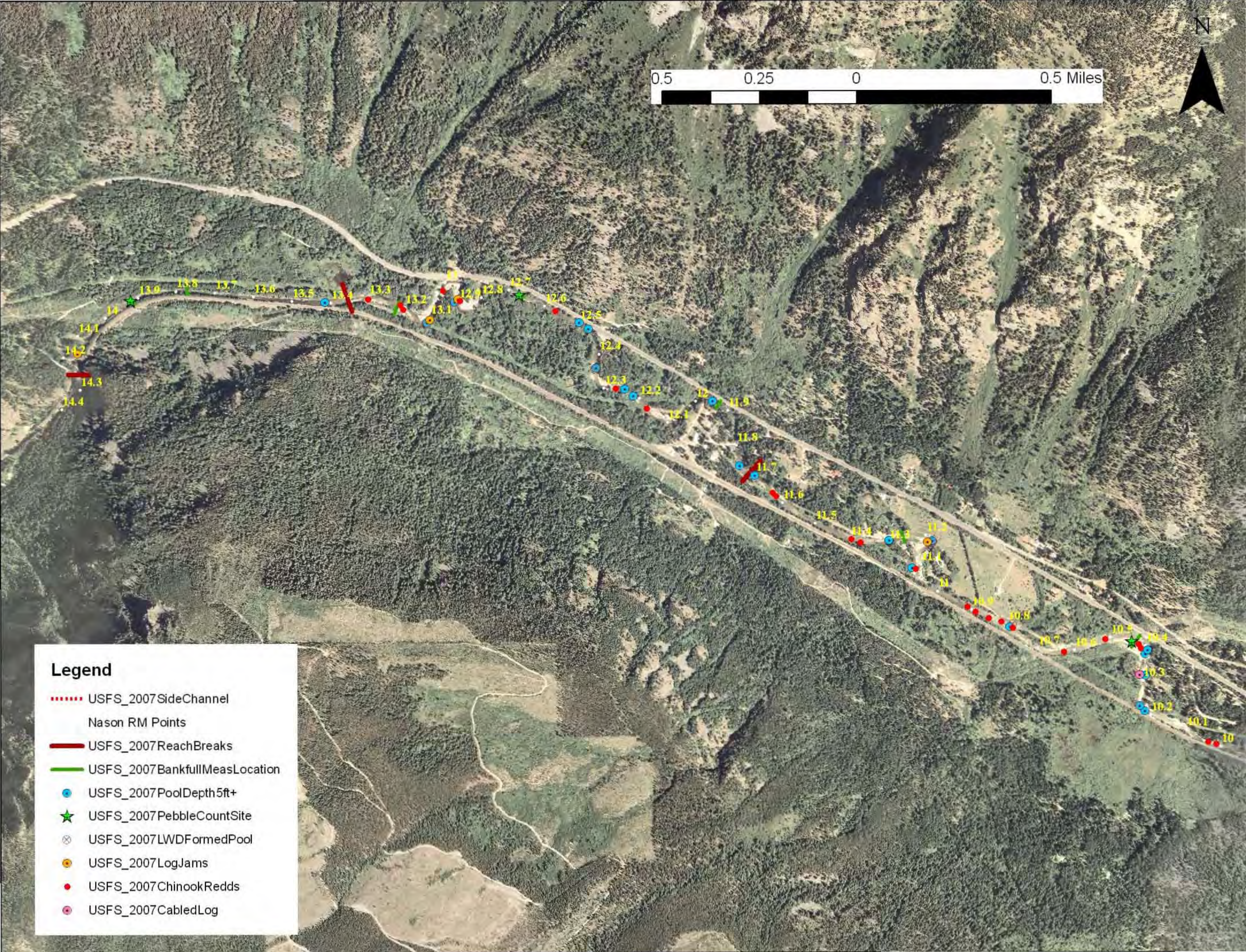
Nason Creek Survey Data page 2	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Total
Sinuosity (estimated from maps)	> 1.30	1.05	1.20	1.30	1.15	
Gradient (estimated)	1%	1%	< 0.5%	< 0.5%	1%	
Substrate (Pebble Count Data):						
-# of Pebble Counts in Reach	2	1	1	1	1	
-% Surface Fines < 6 mm	13%	11%	11%	19%	7%	
-D35	71	45	32	40	118	
-D50	123	103	47	58	171	
-D84	311	325	84	126	415	
Substrate % (Ocular Estimate)						
% Sand	10%	10%	10%	15%	15%	
% Gravel	25%	30%	57%	35%	15%	
% Cobble	40%	35%	30%	35%	40%	
% Boulder	25%	25%	3% (rip-rap)	15% (incl. rr)	30% (incl rr)	
Primary Rosgen Channel Types in Reach:	C3, F3	F3	C4, F4	F3, B3c	F3	
# of Chinook Salmon Redds	17	12	17	8	0	54
# Chinook Salmon Redds per mile	3.9	21.4	7.0	4.7	0	5.4

[1]Rough estimate, two to seven bankfull measurements were taken per reach.
[2]Floodprone width divided by bankfull width.

NASON CREEK POOL QUALITY BY AREA
September 2007 Survey

River Mileage	Length (Miles)	Description of Stream Segment	Pools per Mile	Pools > 5' Deep per Mile	Residual Depth	LWD per mile (pools)[1]	Assessment
4.6 to 5.3	0.70	Sinuous, bar formation, well-vegetated	12.8	2.85	2.4'	19, 5, 9	**At risk** due to lack of wood.
5.3 to 5.75	0.45	Straight channel, few bars, road above right bank	4.4	0	1.7'	45, 0, 0	**At unacceptable risk**
5.75 to 7.75	2.00	Sinuous, largely unconfined, some bar formation, ends at end of BOR subreach	6.0	1.5	3.3'	36, 25, 0	**At risk**
7.75 to 8.9	1.15	Very sinuous, well vegetated, ends at reachbreak.	10.4	2.6	3.0'	8, 3, 0	**At risk** due to lack of wood.
8.9 to 9.42	0.52	Confined, straight, away from road and railroad, ends at reachbreak.	10.6	0	2.4'	31, 9, 0	**At risk**.
9.42 to 10.2	0.78	Straight channel is locked against right back (railroad grade on right bank)	11.5	1.3	2.4'	12, 10, 0	**At unacceptable risk** due to lack of cover (lacks wood).
10.2 to 10.6	0.40	Sinuous, unconfined, large bars.	20.0	12.5	4.3'	20, 12, 5	**Adequate**, lots of deep pool habitat.
10.6 to 11.0	0.40	Straight channel is locked against right bank (railroad grade on right bank)	10.0	2.5	3.1'	18, 4, 0	**At unacceptable risk,** lack of wood.
11.0 to 11.35	0.35	Sinuous, unconfined, large bars, large log jam in channel.	20.0	8.5	3.5'	68, 38, 28	**Adequate**, lots of wood, deep pools.
11.35 to 11.7	0.35	Straight channel locked against R bank.	14.2	0	1.9'	5, 0, 5	**Unacceptable risk**
11.7 to 12.8	1.10	Moderately sinuous, well-vegetated, deep channel, starts just below town of Meritt. Deep pools from constrictions.	15.4	7.3	3.8'	22, 5, 8	**At risk** due to lack of large wood.
12.8 to 13.3	0.50	Sinuous, moderately confined, bars.	20.0	4.0	3.2'	59, 19, 24	**Adequate**
13.3 to 14.25	0.95	Straight, confined, altered channel.	5.7	1.1	2.3'	17, 6, 3	**Unacceptable risk**
Total	**9.65**		**10.6**	**2.9**	**3.1'**	**26, 11, 6**	**At Risk**

[1]Small, medium, and large size class, respectively, in table. Calculation is large wood per mile of pool habitat.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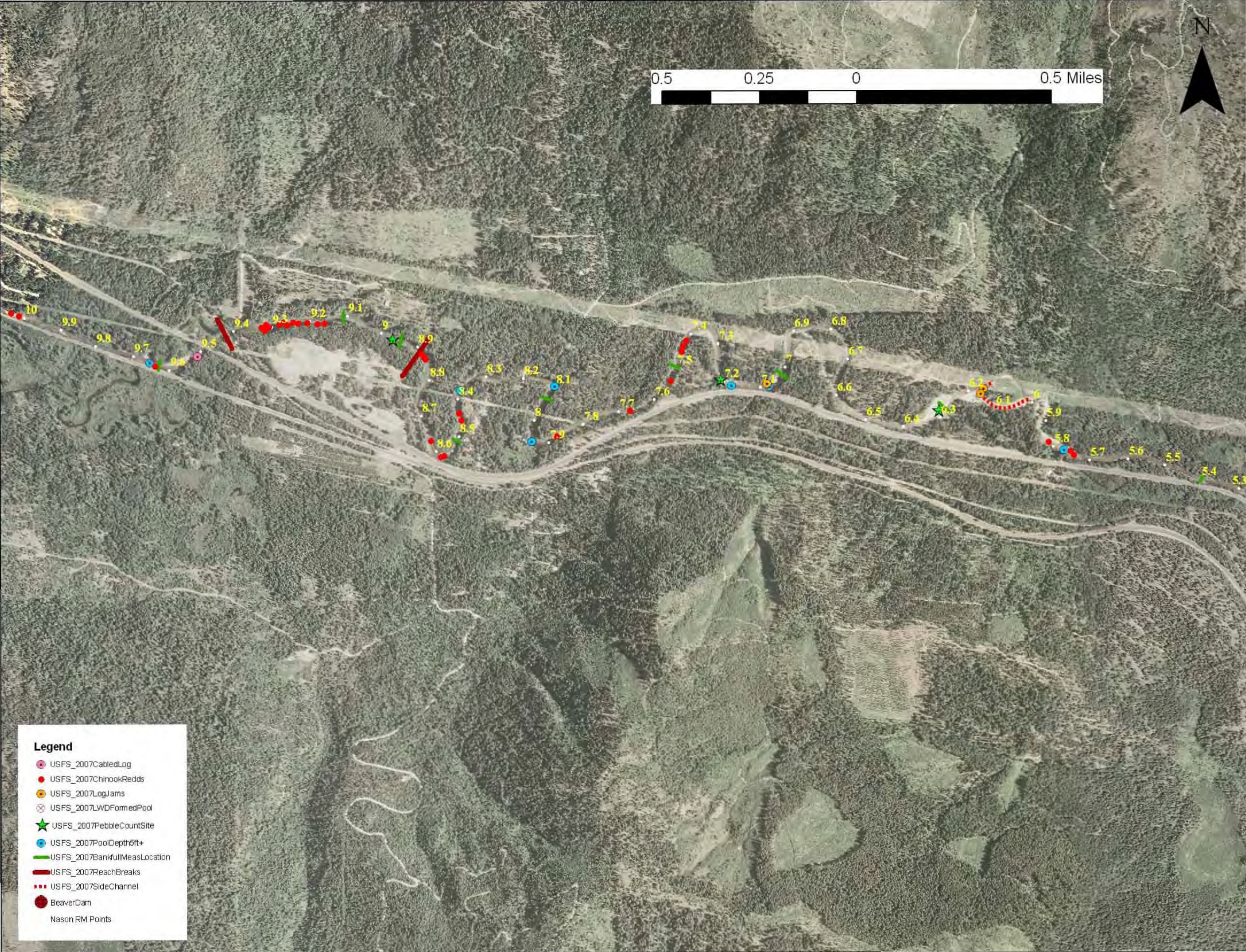
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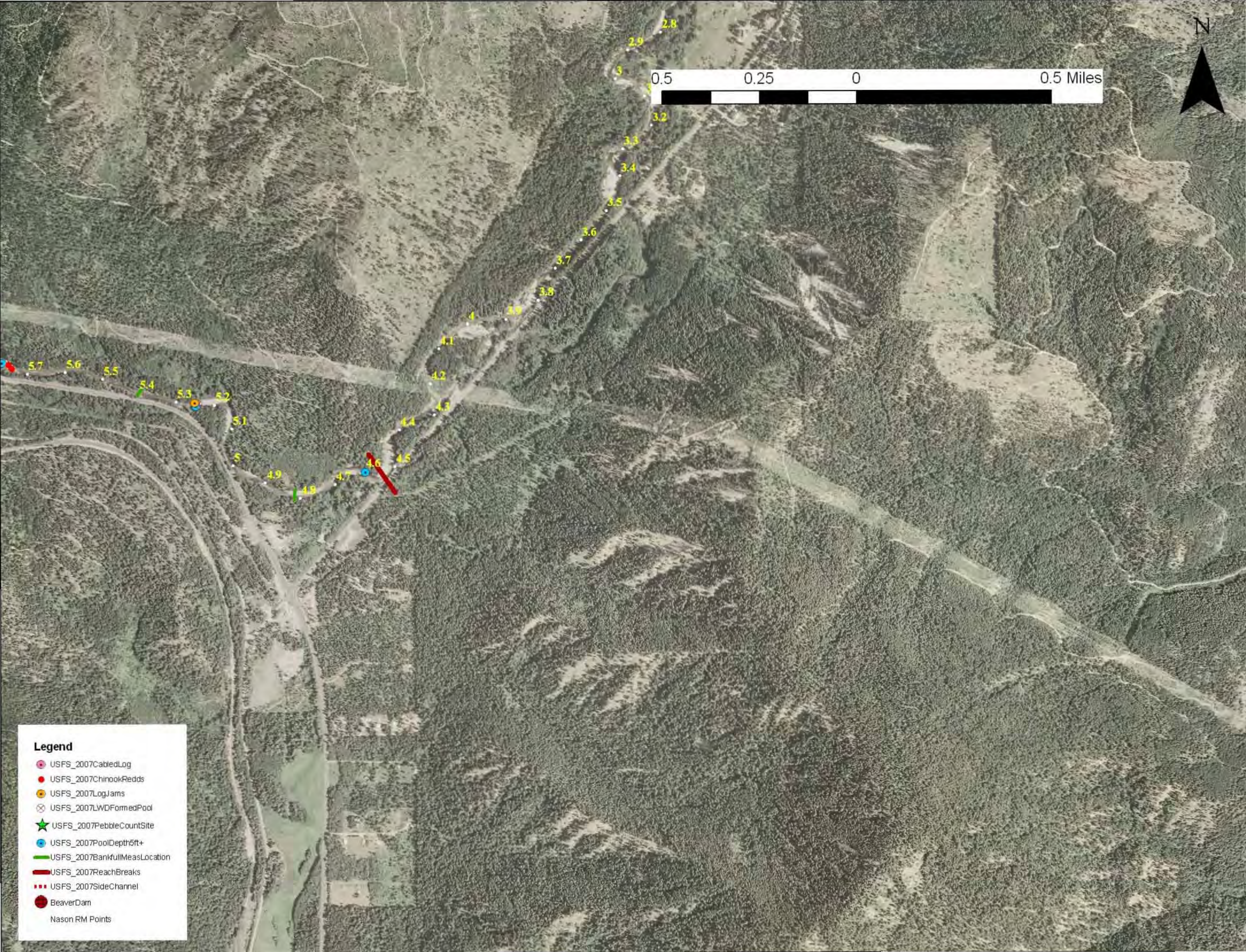
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BeaverDam
Nason RM Points

RECLAMATION

Managing Water in the West

Technical Memorandum 86-68220-08-05

2007 Nason Creek Floodplain Vegetation Assessment

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Environmental Applications and Research
Denver, Colorado

April 2008

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

BUREAU OF RECLAMATION
Technical Service Center, Denver, Colorado
Environmental Applications and Research (86-68220)

Technical Memorandum 86-68220-08-05

2007 Nason Creek Floodplain Vegetation Assessment

Prepared for:

Bureau of Reclamation
Technical Service Center
Sedimentation and River Hydraulics in Support of Geomorphic Assessments for the PN Regional Office

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Technical Service Center
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Denver, Colorado

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Contents

Tables

Figures

Executive Summary

The objective of the 2007 riparian vegetation assessment is to provide an understanding of the present vegetation conditions to be utilized for U.S. Bureau of Reclamation's Nason Creek tributary- and reach-scale assessments. A team of ecologist conducted field sampling and GIS analyses of remotely sensed data to create a GIS file containing polygons of vegetation units. Data from the vegetation assessment, along with other components of the geomorphic assessment, will be used for planning and prioritizing salmon recovery efforts in Nason Creek between river miles (RM) 4 and 14.

In August 2007 riparian vegetation was sampled throughout the assessment reach. Data collected included canopy cover and height for overstory and understory species and herbaceous species. These data were used in a GIS along with aerial photography and Light Detection and Ranging data to interpret riparian vegetation and create vegetation units within the reach. The vegetation units were classified into the Oregon/Washington U.S. Forest Service vegetation units for consistency with previous mapping available for lower Nason Creek RM 0 to 4.

Utilizing GIS, vegetation units were analyzed for the potential contribution of riparian vegetation for healthy salmon habitat. Analyses included natural species presence (potential natural community), large woody debris (LWD) trees, and shading (see table below). Areas of presently functioning vegetation were identified for potential easement or protection strategies. Presently functioning was generally defined as areas with native vegetation species that were at least several decades old (most areas were historically logged). Acres of LWD-sized trees—trees over 40 feet (12 meters) tall—from the riparian vegetation mapping were compiled for the entire floodplain and for an 82-feet (25-meters) buffer adjacent to the stream. Potential for thermal shading by the riparian vegetation within the 82-feet (25-meters) buffer was also quantified. Vegetation units were also ranked based on professional judgment for the level of effort needed to restore vegetation to a hypothesized natural condition.

The riparian vegetation along Nason Creek is generally in good health, and species are of potential naturally occurring species. Douglas-fir and grand fir are typically co-dominant in the canopy with vine maple being the common understory species. Black cottonwoods are present along the river and along abandoned river channels. Sand-bar willows and black cottonwood are present on gravel bars and cobble bars. Pacific willow and some alder species are found in wet areas. Limited amounts of western red cedar are mixed throughout the reach. Old growth (legacy) trees are absent from the reach and were most likely logged. A large amount of logging of the floodplain and log drives down the river

Summary of Nason Creek vegetation analysis results by geomorphic reach

Reach	Area (acres)	Presently impacted[1] (acres)	Natural species[2] (acres)	% Natural	% Impacted	LWD potential area[3] (acres)	% LWD potential area	% shaded[4]
1	334.9	54.69	280.1	84%	16%	206.2	62%	80%
2	13.6	0	13.6	100%	0%	9.2	68%	96%
3	607.6	128.27	479.3	79%	21%	255.4	42%	77%

[1] Impacted areas which are not potential natural community riparian vegetation but are anthropogenic land cover including railroad rights-of-way, roads, power line corridors, private and commercial property.
[2] Riparian areas which contain potential natural communities.
[3] Areas where the over 50 percent is covered by canopy of trees of LWD height [trees over 40 ft (12 m) tall] which could be potentially recruited into Nason Creek by either high flows or active river migration.
[4] Percent of main channel which is presently shaded by vegetation. Note that this estimate is based on a buffer width along the stream of 82 ft (25 m).

occurred along Nason Creek in the early 1900s, but the exact extent and impact is not documented. The riparian forest appears to be recovering back to the historic grand fir forest. Ponded areas containing wetland indicator plants were observed in the reach; however, wetlands delineation was not a part of this scope. A limited amount of mammalian herbivory was observed, most likely from deer. Tree diseases were not evaluated but do not appear to be a limiting factor for healthy riparian vegetation. The majority of the forest is recovering and appears to be trending back to historical conditions. However, localized areas of the floodplain vegetation have been completely cleared due to construction of the highway, railroad, power lines, and commercial and residential development. Active residential development is also occurring in the reach and would further impact the riparian vegetation if it continues to expand. Noxious weeds were found in limited areas such as under power lines and may increase over time if not controlled.

Where riparian forest vegetation is present along the river, trees of adequate LWD size are available for future and immediate recruitment into the river if river migration processes are restored. Although cleared areas adjacent to the river had inadequate shading, aerial photography shows the majority of the river was shaded by tall trees. Further analyses should be completed to determine if the riparian vegetation provides adequate shading for the river. Large historical channel and floodplain areas presently cut off by the railroad and highway are now ponded. For example, the area to the south of the railroad between RM 9 and 11 is now disconnected from the river and contains several wetland-type species and naturally broken-off stumps where tall trees used to be present. This area might require major vegetation restoration efforts to restore it to historical conditions on a short timeframe of years.

High energy floods are also a concern in the reach, and have impacted vegetation adjacent to the river channel, reducing regrowth of trees and shrubs along with the presence of LWD in the main channel. In artificially confined reaches, there is limited bar development or floodplain surfaces for vegetation to establish. Most banks in these areas are riprap.

Additional analyses may be needed at project level scale to further develop riparian restoration strategies. More field measurements of tree age and species health may be of particular use at these smaller scales. High water temperatures are a concern on the river, and further study is recommended to better understand the contribution of riparian vegetation to the thermal regulation of the river.

2007 Nason Creek Floodplain Vegetation Assessment

Background/Objectives

The Nason Creek watershed is located on the eastern slope of the Cascade Mountains in central Washington. The headwaters of Nason Creek are at the crest of the Cascades Mountain Range and flow east for approximately 21 miles (34 kilometers) and then turn north for another 5 miles (8 kilometers) before emptying to the Wenatchee River at Lake Wenatchee. Past U.S. Forest Service (USFS) vegetation assessments indicated that the watershed is a vegetative transition zone, stretching from high elevation sub-alpine forest to dry forest environments.

The Nason Creek floodplain is currently occupied by sucessional coniferous forest. A mean annual precipitation of over 60 inches (1.5 meters) a year supports a grand fir/vine maple series as defined by Lillybridge et al. 1995. Douglas-fir and grand fir are typically co-dominant in the canopy with vine maple being the common understory species. Black cottonwood is present along the creek and along abandoned creek channels. Western red cedar is mixed throughout the floodplain. Ponderosa pine is scattered in the upstream portion of the watershed and becomes more dominate in the downstream direction. Monotypic ponderosa stands exist on higher and drier sites adjacent to the floodplain. A smaller percentage of the riparian vegetation is composed of riparian non-forest habitats consisting of hardwood stands, shrubs, wetlands, and meadow.

The objective of the 2007 vegetative assessment was to fill data gaps on U.S. Bureau of Reclamation's (Reclamation) Nason Creek tributary and reach assessments (two stages of analysis) in the vegetation component for river mile (RM) 4 to 14 (Coles Corner to White Pine Campground). For these analyses, the following vegetation products were needed:

1) Vegetation composition and structure of present (2006 to 2007) site conditions within the area of active channel migration and floodplain processes (low surface)
    a. Utilize initial vegetation mapping for Nason Creek by the USFS done solely with aerial photography
    b. Refine and expand USFS vegetation mapping to cover the newly mapped low surface
    c. Include mapping of impacted or cleared areas (e.g., power lines, developments, etc.), and of ponded and river areas

2) A conceptual model (hypothesis) of historic vegetation conditions prior to European settlement in the late 1800s for comparison to present conditions.
3) Identification of riparian reserves—defined as areas of functioning or at least semi-functioning vegetation that could provide a good source of shade, cover, and potential large woody debris (LWD).
4) Potential for the present vegetation to serve as a LWD source if eroded into the river through channel migration processes or windfall along Nason Creek.
5) Ranking of vegetation condition in terms of shade and cover along a defined buffer zone of 98 feet (30 meters) along the present main channel
6) Restoration recommendations and quantification of level of effort for restoration to be used in ranking and prioritizing of potential projects.

Data collected included information on LWD, LWD recruitment, diameter of LWD, types of conifers and deciduous trees, percentage of canopy coverage and relative foliage coverage in specific non-assessed area. The 2007 vegetation assessment covered low surface sites utilizing both 2006 GPS vegetation mapping (orthophotos and hardcopy aerial photographs) and LiDAR Detection and Ranging (LiDAR) data. In addition, field validations (ground truthing) were conducted to verify vegetation on GPS maps and photographs based on LiDAR technology.

Methods

A limited field inventory and mapping project was conducted to collect data on riparian vegetation for Nason Creek. Field assessments were conducted from August 6 to August 10, 2007, and from October 1 to October 4, 2007. Interpretation of aerial photographs and LiDAR data were used to create a GIS vegetation community map. Data will be used for analyses and project areas ranking within the assessment area for salmon recovery efforts.

Vegetation community classification

A classification system was selected which would best assess riparian vegetation for ecosystem health, creation, and restoration. This classification is based on various studies done by Robert D. Ohmart (Hink and Ohmart 1984). The classification method included categorizing vegetation polygons into community types and structure classes using an alphanumeric descriptive code. Each woody riparian plant species was assigned a letter code (the species code). The classification code (described in Figure 1) consisted of species codes for the canopy layer, species codes for the understory layer, and a number signifying the height of the canopy and thickness of the understory. This detailed classification was rolled into the more general USFS classification used for the lower Nason Creek study (RM 0 to 4) which was completed by Jones and Stokes for Chelan County (2003). See Figure 2 showing example map.

Example:

Canopy Layer / Understory Layer+Type Number (1-4)

Example: PP-GF/VM1

Ponderosa pine dominant with grand fir in overstory with understory of vine maple

Type Definitions:

Type 1- Tall trees with well developed understory. Tall or mature to mixed-aged trees [**>40 feet (12 meters)**] with canopy covering **>50 percent of area** of the community (polygon) **and** understory layer [**5 to 40 feet (1.5 to 12 meters)**] with covering **>25 percent of area** of the community (polygon).

Type 2 – Tall tree canopy with little or no understory vegetation. Tall or mature trees **[>40 feet (12 meters**)] with canopy covering **>50 percent of area** of the community (polygon) **and** understory layer [**5 to 40 feet (1.5 to 12 meters)**] with covering **<25 percent of area** of the community (polygon).

Type 3 – Intermediate-sized canopy with dense understory vegetation. Intermediate-sized trees [**(15 to 40 feet (4.6 to 12 meters)]** with canopy covering **>50%** of area of the community (polygon) **with** understory layer [**(5 to15 feet (1.5 to 4.5 meters)]** with canopy covering **>25 percent** of the area of the community (polygon).

Type 4 –Intermediate-sized trees openly spaced with little understory. Intermediate-sized trees [**15 to 40 feet (4.6 to 12 meters)]** with canopy covering > **50 percent** of the area of the community (polygon) understory [**5 to 15 feet (1.5 to 4.5 meters)**] layer covering **< 25 percent** of the area of the community (polygon).

Figure 1. Alphanumeric descriptive code and type definitions used to categorize vegetation polygons**.**

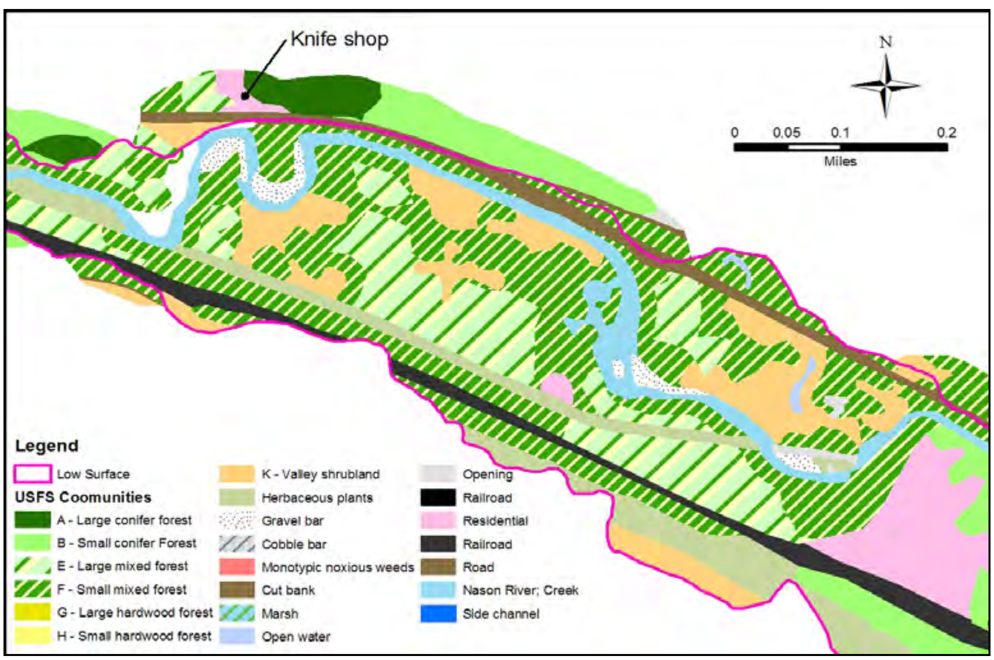

Figure 2. Example map showing USFS vegetation classes.

Preparatory field work

Prior to going to the field, orthophotos from October 2006 and hardcopy aerial photos were used to select vegetation data collection sites. Sites were selected which appeared to represent all possible vegetation communities, and focus was on areas which showed potential for reconnection of the floodplain to the creek. Coordinates for the points were generated using ArcGIS and loaded into GPS devices for use in the field.

Field work

During the August field work, an attempt was made to navigate as close as possible to each point using GPS and hardcopy aerial photos. An evaluation form (Figure 3) was completed to document percent cover, heights, and species of the canopy, herbaceous understory, woody debris and litter, wetland features, and hydrologic indicators. At each field site a photograph(s) was taken to document the vegetation species and structure. Table 1 lists the vegetation species observed and designated species code. In some instances where access was not possible due to thick vegetation, open water, and private lands, evaluations were conducted from a high overlook or from public roads.

Field data were entered in a spreadsheet (Appendix 1) for later use in developing alphanumeric classification codes. Plant species were recorded according to the relative abundance of the species cover within two layers. Species within a layer were separated by a "-". Canopy and understory layers were separated by a "/". Typically one or two species were recorded for each layer, but as many species as qualified (up to four) were recorded. For a species to be recorded in the code, they had to have 25-percent relative abundance. Plant species dominance (or relative abundance) was determined by visual estimation. Tree and shrub height, as well as plant cover, were also determined by visual estimates.

This detailed vegetation community class was rolled into the Oregon/ Washington/USFS watershed analysis model vegetation units (Table 2). The authors added additional fields for other land areas such as gravel bars, etc. Using this classification maintains consistency with the lower Nason Creek mapping done in 2003 for Chelan County. This classification was linked to the polygons in the GIS and added as an attribute field.

During the October 2007 field assessment, 2 days were spent measuring tree diameters at breast height (DBH) and tree heights for a sampling of the largest cottonwoods and conifers. Tree height was measured using a TruPulse Professional Laser Rangefinder (Laser Technology, Inc.). A meter tape was used to measure circumference from which the diameter was calculated. Tree height information was used in the interpretation of the tree LiDAR data to determine trees that had the required diameter for LWD potential. Thirty-eight trees were measured for DBH and 14 trees for height from various GPS locations.

Veg Classification Form						
Date						
Recorder, Phone #						
Polygon ID				**Photo Number**		
UTM WGS84 Coordinates		**X**				
		Y				
Waypoint #			**Time**			
Riparian Vegetation						
Species Codes		**Height and Cover**				
		Canopy Cover	>40 Ft	1-25%	25-75%	75-100%
			20-40 Ft	1-25%	25-75%	75-100%
	Canopy	%Dead	1-25%	25-50%	50-75%	75-100%
		Species (Relative foliage cover) - Circle one for each species				
			1-25%	25-50%	50-75%	*75-100%*
			1-25%	25-50%	50-75%	*75-100%*
	Understory	**Height and Cover**				
		Height	5-15 Ft	1-25%	25-75%	75-100%
			<5 Ft	1-25%	25-75%	75-100%
		%Dead	1-25%	25-50%	50-75%	75-100%
		Species (Relative foliage cover) - Circle one for each species				
			1-25%	25-50%	50-75%	*75-100%*
			1-25%	25-50%	50-75%	*75-100%*
			1-25%	25-50%	50-75%	*75-100%*
Ground Litter			1-25%	25-50%	50-75%	*75-100%*
Notes						
Wetland						
CM- Cattail Marsh		OW-Open Water		GM - Grass Meadow		
Other						
OA - Open Area		Ag-Agricultural		Road		
Hydrology Indicators (circle all that apply)						
Surface water present		Debris in vegetation			Watermarks on vegetation	
Sediment deposits		Drainage patterns			Back channel	

Figure 3. Evaluation form for Nason Creek vegetation assessments.

Table 1. Vegetation inventory from 2007 Nason Creek field assessment

Conifer/Deciduous Tree	**Scientific Name**	**Species Code**
Aspen	*Populus tremuloides*	A
Black cottonwood	*Populus balsamifera*	BC
Big Leaf maple	*Acer macrophyllum*	BM
Douglas-fir	*Pseudotsuga menziesii*	DF
Englemann spruce	*Picea engelmannii*	ES
Grand fir	*Abies grandis*	GF
Ponderosa pine	*Pinus ponderosa*	PP
Red cedar	*Thuja plicata*	RC
Sita alder	*Alnus crispa* spp.	SA
Shrubs/Terrestrial		
Bitter cherry	*Prunus emarginata*	BC
Black elderberry	*Sambucus racemosa* spp	BE
Black hawthorn	*Crataegus douglasii*	BH
Red-Osier dogwood	*Cornus stolonifera*	RD
Snowbrush	*Ceanothus velutinus*	NU*
False solomon	*Smilacina racemosa*	NU
Hardhack	*Spiraea douglasii*	Hh
Ocean spray	*Holodiscus discolor*	NU
Oxeye daisy	*Chrysanthemum leucanthemum* L.	NU
Sand bar willow	*Salix ssp.*	SBW
Pacific willow	*Salix lucida* spp. *lasiandra*	PW
Scouler willow	*Salix scouleriana*	SW
Skunk cabbage	*Lysichiton americanum*	NU
Timbleberry	*Rubus parviflorus*	NU
Vine maple	*Acer circinatum*	VM
Riparaian/Emergent Plants		
Duckweed	*Lemna* spp.	NU
Pondweeds	*Potomogeton* spp	NU
Vallsinera	*Vallisneria* spp.	NU
Reed canarygrass	*Phalaris arundinacea* L.	NU
Sedges	Family Cyperaceae	NU
Various grasses		NU

* NU=Not Used

Table 2. Oregon/Washington/USFS vegetation type unit descriptions for Nason Creek

Designation	Unit Name	Description
A	Large conifer forest	Mean DBH greater than 12 inches (30.4 centimeters). Mixed stands often include Douglas-fir, ponderosa pine, western red cedar, grand fir, or western larch. Crown closure usually greater than 50 percent
B	Small conifer forest	Same as large conifer forest but with smaller trees
E	Large mixed forest	Mean DBH greater than 12 inches (30.4 centimeters). Stand dominants almost always black cottonwood and mixed conifers, with an understory of smaller trees and shrubs
F	Small mixed forest	Same as large mixed forest but with smaller trees
G	Large hardwood forest	Mean DBH greater than 12 inches (30.4 centimeters). Nearly always consists of black cottonwood stands
H	Small hardwood forest	Comparable to large hardwood forest but with smaller trees
K	Valley shrub land	Dominated by deciduous woody vegetation (usually willows) less than 40 feet (12 meters) tall
Additional fields identified by Reclamation (authors)		
Co	Cobble bar	Riverine bar dominated by cobble sized material
Creek	Nason Creek	Main stem Nason Creek
Cutbank	Cutbank	Large bank cut by the creek during high flows
Go	Gravel bar	Gravel bar with less than 25 percent shrub cover
Garish	Gravel bar/shrub	Gravel bar with more than 25 percent scattered willow stands
Herb	Herbaceous	Dominated by herbaceous vegetation
MHz	Marsh	Wetted area containing marsh plants
NN	Noxious weeds	Area dominated by noxious weeds
Op	Opening	Open area, usually cleared areas adjacent to residential or commercial development
OW	Open water	Open water, usually ponded areas, which are now disconnected from the river by either the road or railroad
Railroad	Railroad	Railroad tracks and associated embankment
Res	Residential	Dominated by residential development
Riprap	Riprap	Bank dominated by riprap along the river
Road	Road	Highway
Side-Channel	Side channel	Creek side channel which contains, or may contain, water during high flows

Measurements of tree height were limited by denseness of tree stands, making it difficult to see both the top and the lower portions of trees. In addition, rain interfered with the laser rangefinder and limited the number of measurements taken.

Post field work aerial photograph and LiDAR data interpretation

Aerial photography was flown for the project in October 2006 and then orthorectified for the project (average flow in river of 40 cfs). LiDAR data were captured in October 2006, and first and second returns were used to create a grid containing tree height values. The LiDAR data and color aerial photography were used in GIS to interpret map vegetation not mapped in the field. The October aerial photos were useful for delineating hardwoods because yellow foliage was visible.

In ArcGIS 9.2, a 300-foot (91-meter) buffer from the rivers edge (as seen October 2006 photography) was created and merged with the geologic low surface provided by Reclamation hydrologists to create the study area polygon. The existing vegetation (provided by USFS) was incorporated. LiDAR data were grouped into height classifications, made semi-transparent, and overlain on 2006 aerial photography (Figure 4). Polygons of dominate canopy cover were created using heads-up (on screen) digitizing. Field assessment points were overlain on the photography. Data and detailed vegetation classification from the field assessments were tied to the polygons and used to visually interpret the areas not field assessed. Polygons were attributed with USFS unit and LWD categories (trees, small trees and shrubs, and low vegetation/openings) (Figure 4). Approximately 20 percent of the study area was assessed in the field, and the remaining 80 percent was visually interpreted using aerial photography and LiDAR data.

LWD and shading interpretation methods

Thirty-foot-long (9.1-meter-long) logs are the generally accepted minimum size for LWD in the stream. Forty feet (12 meters) was used in this study as a minimum size which, with accounting for some breakage of the tree or the small size of the top 5 feet (1.5 meters) of the trees, would provide LWD to the stream.

LiDAR data were symbolized to group vegetation into areas with greater than 50-percent canopy cover of:

- Trees with potential LWD tree size over 40 feet tall (12 meters) = T
- Small trees and shrubs 5 to 40 feet (1.5 to 12 meters) tall = S
- Low vegetation (crops, herbaceous, low shrubs and open areas) 1 to 5 feet (30.4 centimeters to 1.5 meters) tall. = O

Polygons were attributed with the appropriate letter to be used in analysis.

In order to estimate shading and short-term (decades) LWD contribution of the riparian vegetation adjacent to the river, a buffer of 82 feet (25 meters) was

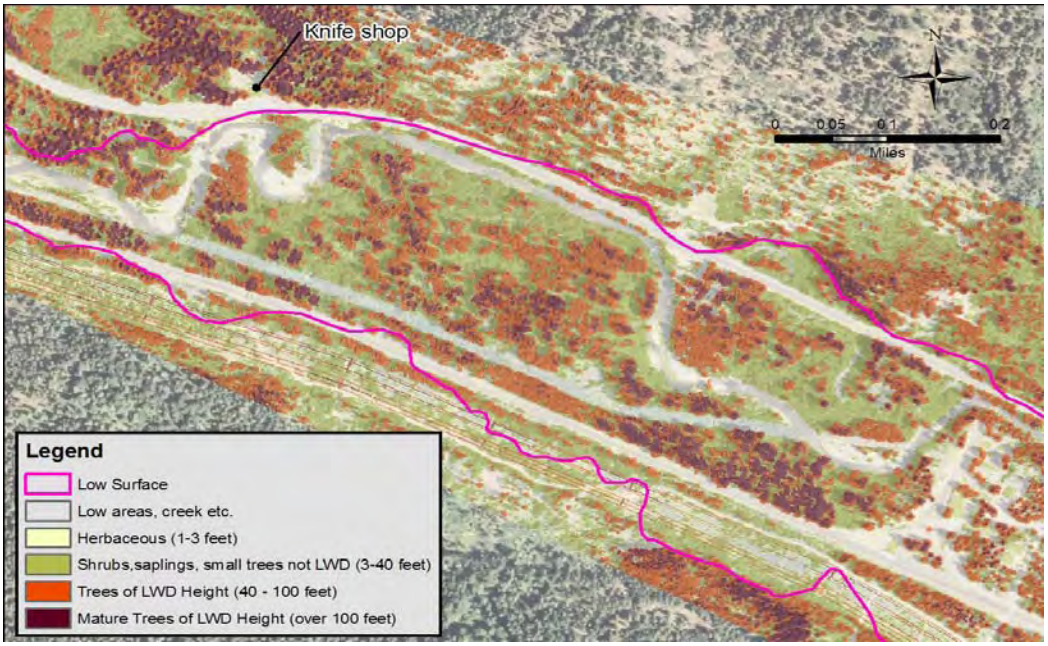

Figure 4. Example map showing LiDAR data shaded for tree heights and overlain on aerial photography.

chosen. McDade et al. (1990) used a 82-foot (25-meter) buffer as the minimum distance from the river that trees contributed LWD to the river. An 82-foot (25-meter) buffer from the river was created in GIS and intersected with the vegetation classification. Acres were calculated for all polygons and added as an attribute. The attribute table was exported to an excel file. The excel file was then imported into an Access database for summary reporting by reach. The summary reports were exported to an excel spreadsheet for distribution and formatting for reports.

Vegetation Summary and Results

The vegetation along Nason Creek is heavily influenced by the Cascade Mountains. Douglas-fir and grand fir are typically co-dominant in the canopy with vine maple being the common understory species. Black cottonwoods are present along the river and along abandoned river channels. Sand-bar willows and black cottonwood are present on gravel bars and cobble bars. Pacific willow and some alder species are found in wet areas. Limited amounts of western red cedar are mixed throughout the reach. Old growth (legacy) trees are absent from the reach and were probably logged in the 1900s for the railroad and for the fruit industry. The forest appears to be recovering back to the historic grand fir forest. Ponded areas containing wetland indicator plants were observed in the reach; however, wetlands delineation was not a part of this scope. A very limited amount of mammalian herbivory was observed, mostly likely from deer. Few deer tracks and limited amounts of deer scat were observed. One set of moose tracks was observed near White Pine. Signs of bear were observed at three locations during field surveys. Limited beaver activity was observed in the reach. Table 3 shows the acres of each USFS unit type for each reach (see Nason Creek tributary assessment).

Table 3. Acres of USFS units (See Table 2 for USFS type description)

USFS	Reach		
Unit	N1	N2	N3
A	46	6	14
B	88	4	27
E	15	0	33
F	25	0	120
G	13	0	6
H	20	0	56
K	32	0	164
Herb	16	0	39
Marsh	0	0	6
Gravel bar	5	0.2	7
Gravel bar/shrub	2	0.2	3
Noxious weed	4	0	2
Op	5	0	5
Railroad	0	0	20
Res	10	0	38
Co	4	0	0
Cutbank	1	0	0

Nason geomorphic reach 3

The forest in the low surface of reach 3 has good vertical and lateral complexity in the sites visited. Douglas-fir, ponderosa pine and grand fir are often mixed in the canopy. The understory is dominated by vine maple. Few high flow channels were observed in this area. Black cottonwood and aspen are found in abandoned river channels.

Nason geomorphic reach 2

In reach 2, the geology constrains the floodplain, keeping it narrow and in places where the soils are relatively dry. The dominate conifer tree is ponderosa pine, but in general the presence of vegetation is limited.

Nason geomorphic reach 1

The riparian vegetation in reach 1 tends to have less lateral and vertical complexity than in reach 3. The forest adjacent to the low surface at the meander at RM 6.6 has low vertical structural complexity due to dry soil conditions, and the dominate conifer trees is the ponderosa pine. The two meanders at RM 5.1 and 5.9 near Coles Corner contain older average age class trees including intermediate to mature grand fir, black cottonwood, and red cedar resulting in approximately 75 percent canopy closure. Young and intermediate age class trees were lacking, which may have been stripped in the 1990 flood. At those two sites there was extensive evidence of a high flow event forming many high flow channels. Piles of large woody debris were observed on the downstream portion of the meander.

Floodplain cut-off areas

Areas of floodplain presently cut off by railroad and highway embankments or other manmade features were specifically evaluated for vegetation condition. The majority of these areas are located in reach 3. Many of these areas contain small-to-medium size wetlands (in the former main channels) and are dominated by large shrubs extending in some cases up to 25 feet (7.6 meters) in height. Conifers, which at one time did exist in this area, have died (visual observations) because they do not tolerate the wet and standing water conditions. These shrubs are found either occupying the channel within the oxbows or found at the edge of open water (pond or oxbow) where they could potentially provide some shading. Shrubs and wetlands that currently exist in the cutoff areas would not contribute to short-term LWD recruitment if these areas are reconnected and accessed by the river. However, over longer time periods, riparian vegetation would be expected to re-establish if natural migration processes are restored, reconnecting these areas to the presently accessible channel and floodplain. Riparian and aquatic vegetation found in and surrounding these sites included equisetum, bulrush, pondweed species, vallisneria, duckweed, and grasses. At higher elevations on the perimeters of some of these moist sites are mature to intermediate deciduous and conifer trees.

There are additional moist sites outside the low surface, which were cut off by channelization. These areas are fed by seepage and groundwater flows where there are intermediate to mature conifers and deciduous trees including black cottonwood and grand fir. Understory in these areas is comprised mainly of various types of shrubs including vine maple up to 15 feet (4.5 meters) in length. In one particular area, there was a large monoculture of spyrea ranging up to 6 feet (1.8 meters) in height which was surrounded mainly by Pacific willow.

Power line corridors

Power and transmission lines run nearly parallel to the channel throughout the Nason assessment area, and often cross the main channel. Floodplain vegetation within these corridors and the vegetation adjacent to the corridors have been severely impacted by consistent clearing done to maintain the access right-of-way. Vegetation tends to be monocultures of differing species depending on the sites. Some areas are dominated by non-native and noxious weeds such as spotted knapweed and less desirable native plants such as common tansy. Other areas on the edges of these corridors have native vegetation such as black cottonwoods and aspen that are being limited in height by mowing to allow access into these corridors for operation and maintenance of the power lines. These trees are generally intermediate in height and are density packed (dog hair stands) which are an unnatural condition limiting diameter and tree height. In some areas dense shrub growth is found to the edge of the river but do not extend substantially over the river to provide adequate shading for fish.

Soils in these corridors appear more xeric with more cobble due to removal of endemic soils for the development of the corridor and right-of-way. This results in encroachment by non-native plants which were potentially transferred to the area from heavy equipment or by some other vector. These drier sites do not appear to be sustaining shrubs and tree growth. On the edge of the river within the power line corridor there are some areas that have limited amounts of LWD that could be recruited. Overall, when the power line corridor passes over Nason Creek potential LWD recruitment has been greatly reduced as is shading on the river.

IS Analysis of Natural Community, Potential LWD Sources and Shading

This report section documents methods used to accomplish GIS-based vegetation and LWD analysis needed to help populate a reach-based ecosystem indicator (REI) table, presented in a separate report.

Potential natural community (REI structure criteria)

Riparian vegetation which is consistent with its potential natural community is the desired condition for the riparian area. The potential natural community is a biotic community that would be established if all sucessional sequences were completed without the interference of human activities (Winward 2000). Table 4 shows the acres of the riparian area of potential natural community (natural species) and the acres of impacted areas which are anthropogenic land cover such as railroad rights-of-way, roads, power line corridors, and private and commercial property.

Table 4. Potential natural community vegetation analysis results by geomorphic reach

Reach	Area (acres)	Natural Species (acres)	% Natural	Impacted (acres)	% Impacted
1	334.9	280.1	84%	54.69	16%
2	13.6	13.6	100%	0	0%
3	607.6	479.3	79%	128.27	21%

LWD contribution and shading

Two important components riparian vegetation contributes to salmon habitat are large wood debris (LWD) and shading for the river channel. LWD creates and maintains spawning, rearing, and holding habitat for salmon and is part of the nutrient exchange necessary in a river system. Shading of the river channel has been shown to contribute by reducing water temperatures during hot summer months, particularly during low flow conditions.

These data were generated from the GIS analysis:

- Trees which could be **potentially** recruited into the stream and provide LWD by active river meanders accessing the trees at some point in the future (acres of polygons classified as dominated by trees within the low surface - **LWD potential analysis)**
- LWD which is **accessible** to the stream in the short-term because they are within a close proximity to the present river channel; the impact on present river channel migration rates due to levees, riprap, etc., was not taken into account in this analysis [acres of trees within 82 feet (25 meters) of the wetted river on 2006 aerial photography - **LWD accessible analysis**]
- Shading by trees and shrubs adjacent to the river [acres within 82 feet (25 meters) of the wetted river on 2006 aerial photography - **shading analysis**]

LWD potential analysis

A map (Figure 5) was produced with LWD classification of all vegetation in the study area.

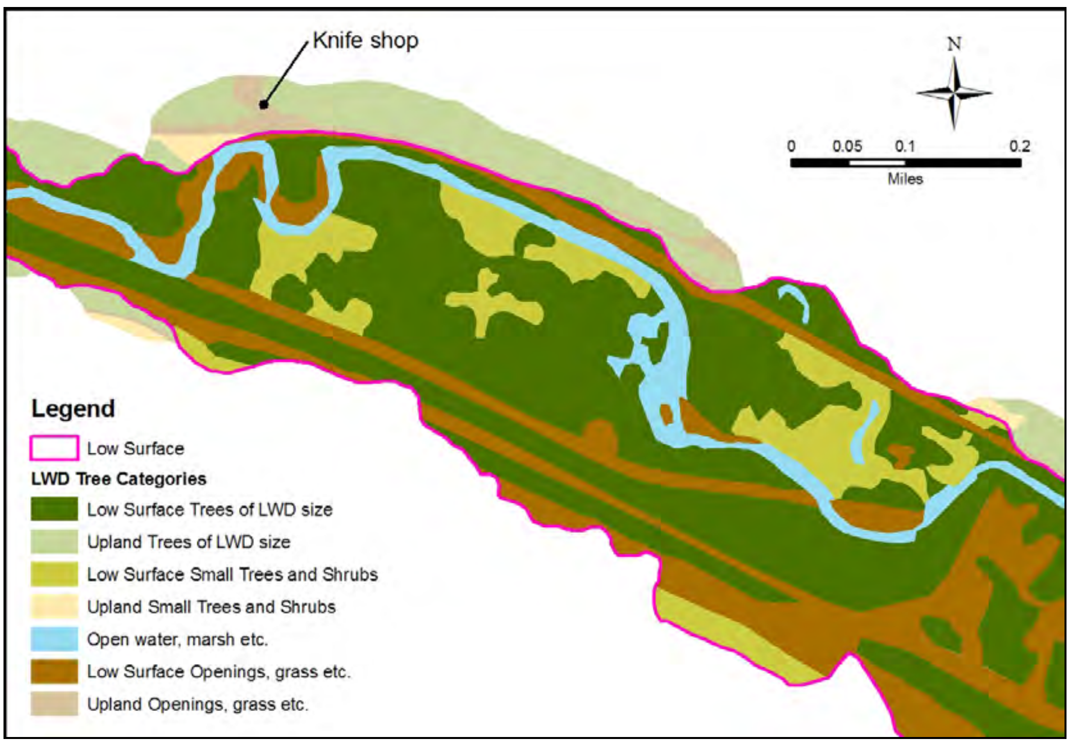

Figure 5. Example map showing LWD tree classifications.

Fifty-six percent of the assessment area (Table 5) has polygons which are dominated by LWD sized-trees. Polygons classified as LWD trees contain an

Table 5. Summary of vegetation classification for study area

Acres LWD trees	Acres small trees/ shrubs	Acres low vegetation/ openings	Total acres*
476	196	185	857
56%	23%	22%	100%

*Wetted areas including the river were not included in total acres.

average of 40 trees per acre. In areas cut-off from the river by the railroad shrubs dominated areas make up 23 percent of the study area. Twenty-two percent of the study area is classified as low vegetation/openings. Much of this area is private land.

LWD potential analysis by reach

Table 6 shows acres of trees that are currently of adequate size to provide LWD within the low surface (floodplain) for each reach. This represents the acres of LWD-sized trees that could be recruited if the river accessed them either through lateral erosion, flooding, or wind throw. Reach 2 is a very short, narrow reach and is constrained by the geology.

Table 6. Acres and percent of area of LWD-sized trees within the low surface by reach

Reach	LWD Trees (acres)
N1	208
N2	9
N3	259

LWD accessible analysis

The LWD accessibility analysis includes three general spatial areas: vegetation within 82 feet (25 meters) of the river centerline, the remaining low surface, and areas outside the low surface but still within a 300-foot (91-meter) distance from the river centerline. These areas could provide trees which could be recruited into the stream (Figure 6).

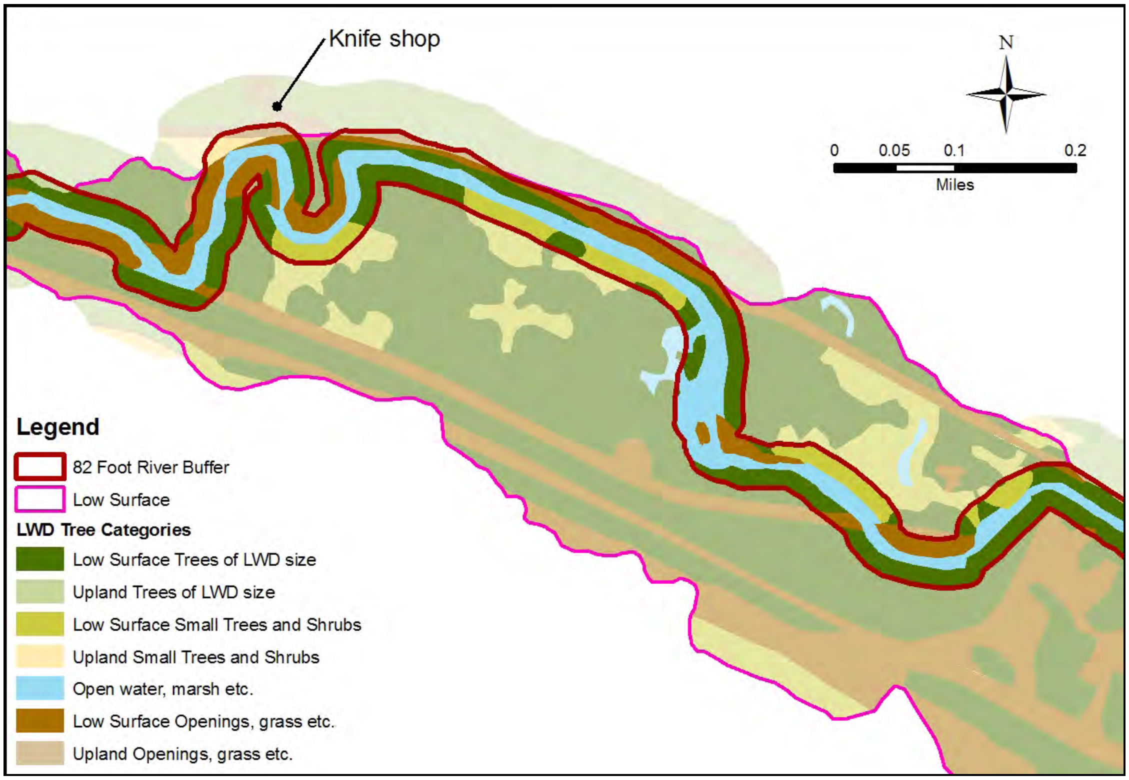

Figure 6. Example map showing buffer adjacent to the river and LWD tree categories.

LWD-sized trees adjacent to the river could be recruited into the river in the short term. Table 7 shows acres for each reach. Some acres are larger than the low surface LWD trees because of area outside the low surface, but within 82 feet (25 meters) of the river.

Table 7. Acres of LWD-sized trees within 82 feet (25 meters) of the river by reach within 82 feet (25 meters) of the river

Reach	LWD Trees (acres)
N1	64
N2	10
N3	51

Shading analysis

Seventy-eight (672 acres) percent of the study area is shaded by the riparian vegetation. The majority of this shading is by shadows of tall trees falling across the river. Table 8 shows the percent of the strip 82 feet (25 meters) wide along both sides of the river which contains trees and/or shrubs and which could provide shade to the river. Trees and shrubs outside the low surface, but within 82 feet (25 meters) are included.

Table 8. Percent of stream shaded by trees/shrubs by reach

Reach	% of stream shaded
N1	80%
N2	96%
N3	77%

Limitations and Future Work Recommendations

Future work should include more ground assessments to increase GIS mapping accuracy. If desired, measurements of large down wood per cubic/foot would yield information of the riparian area's ability to provide filtering of sediment and nutrients to the river. Additional analyses are needed to better understand the linkage between shading along the river by the riparian vegetation and influence on water temperature. Aerial photography or field surveys could be completed during the hottest times of the year, and measurements of actual shading by the vegetation would enhance the understanding of the contribution of the vegetation for thermal cover for the fish. Continued monitoring of vegetation structure could be done on a decadal scale to track recovery of logging from the turn of the century. Additional, more detailed vegetation mapping and monitoring may be important at a project scale as part of restoration actions and adaptive management.

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APPENDIX 1

Appendix 1. Field Form Data

SurveyPt	Photo	Comments	Canopy Avg Hight	Canopy % Cover	% Canopy Dead	Canopy Species 1	Canopy 1 Species % abundance	Canopy Species 2	Canopy 2 Species % abundance	Canopy Species 3	Canopy 3 Species % abundance	Canopy Species 4	Canopy 4 Species % abundance	Understory Avg Height	% understory cover	% understory dead	Recruitment species	understory species 1	% understory species 1 abundance	understory species 2	% understory species 2 abundance	understory species 3	% understory species 3 abundance	understory species 4	% understory species 4 abundance	understory species 5	% understory species 5 abundance	understory species 6	% understory species 6 abundance	understory species 7	% understory species 7 abundance	understory species 8	% understory species 8 abundance	understory species 9	% understory species 9 abundance	Wetland area plants	Wetland area characteristics
01A	DSCN1275.JPG	Black Cottonwood, Intermediate age	>40 FT	25-75%	1-25%									5-15 FT	25-75%	1-25%		D.W.		Willow		black cottonwood															
01B	DSCN1278.JPG	Underneath Power Lines, no trees, brush species, area approx. 200 yds long x 40 yds wide, spotted knapweed and grasses found underneath power lines. Small,bc maples dw and elderberry												5-15 FT	1-25%	1-25%		BC	25-50%	Vine Maple	25-50%	D.W.	1-25%	Spotted Knapweed	75-100%	grasses	25										
02A	DSCN1280.JPG	Looking downstream, Mixed conifers, mixed shrubs, this view some cottonwoods taller than conifers	>40 FT	75-100%	1-25%	DF	25-50%	BC	25-50%																												
02B	DSCN1283.JPG	Looking upstream, Mixed conifers, mixed shrubs, this view conifer taller than cottonwoods	>40 FT	75-100%	1-25%	BC	25-50%	BC																													
03A	DSCN1286.JPG	G.F., BC site, Intermediate, Moist	>40 FT	75-100%	1-25%	GF	25-50%	BC	25-50%					5-15 FT	25-75%	1-25%		VM																			
03B	DSCN1285.JPG	Looking north to 03A site, open water, tall grasses,moist soils, dead trees			1-25%																															grasses	open pond
04A	DSCN1292.JPG	Good BC recruitment in creek channel. Intermediate age BC both side of creek.	>40 FT	75-100%	1-25%	BC	50-75%	PP	25-50%	DF	25-50%			5-15 FT	25-75%	1-25%		S.W.	25-50	Dogwood	25-50																
04B	DSCN1290.JPG	BC lining both sides of right of way ,BC approx 40-60 year old	>40 FT	75-100%	1-25%	BC	50-75 %	GF	1-25%	BC	1-25%	Aspen	1-25%	5-15 FT	75-100	1-25%																					
05A	DSCN1302.JPG	Open area 2 acres approx.with dense spyrea shrubs up to 6 ft tall, area wet														1-25%		Spyrea	75-100%	Pacific Willow	25-50%	Hawthorne	1-25%														
05B	DSCN1307.JPG	Oxbow on north side of road with pondweed(P.S), standing water	>40 FT	75-100%	1-25%	E.S.	25-50%	PP	25-50%	GF	1-25%	BC	1-25%	5-15 FT	75-100%	1-25%		VM	25-50 %	Dogwood	25-50%	Hawthorne	1-25%	Spyrea	1-25%												
06A	DSCN1313.JPG	Site appears to flood periodically, with cobble and woody debris BC recruitment high for this area	>40 FT	75-100%	1-25%	BC	75-100%	GF	1-25%	PP	1-25%			5-15 FT	75-100%	1-25%		Willow Sapling	25-50%	VM	25-50%	D.W.	1-25%														
06B	DSCN1315.JPG	Oxbow evaluated from high point on south side, looking east	>40 FT	1-25%	1-25%	BC	1-25%	DF	1-25%	PP	1-25%	GF	1-25%	5-20 FT	75-100%	1-25%		S. Willow	50-75%	VM	25-50%	BC	1-25%	Hawthorne	1-25%											grasses, PS, vallisneria	
07A	DSCN1320.JPG	Looking west to oxbow, photo from high overlook on south side of oxbow	>40 FT	25-75%	1-25%	BC	25-50%	GF	1-25%	E.S.	1-25%	DF	1-25%	5-20 FT	75-100%	1-25%		VM	25-50%	Dogwood	25-50%	Bitter Cherry	1-25%	Willow (P.S)	1-25%											grasses,PS, vallisneria	
07B	DSCN1321.JPG	Looking north into woods from Highway 2, some dead LWD, private property	>40 FT	25-75%	1-25%	BC	50-75%	BC	1-25%	Aspen	1-25%			5-15 FT	75-100%	1-25%		Dogwood	50-75%	BC	25-50%	Spyrea	1-25%	Aspen	1-25%												
08A	DSCN1323.JPG	Standing water between Highway 2 and dirt road to the north	>40 FT	1-25%	1-25%	BC	25-50%	PP	25-50%	DF	1-25%			5-15 FT	75-100%	1-25%		Dogwood	1-25%	Hawthorne	1-25%															grasses,PS, vallisneria	open pond
08B	DSCN1326.JPG	Dense tree and shrub growth,tree young intermediate, ferns	>40 FT	25-75%	1-25%	BC	25-50%	VM	25-50%	BC	1-25%	Aspen	1-25%	5-15S	25-75%	1-25%		VM	50-75% %	Ferns	25-50%	Wild Rose	1-25%	False Solomon Seal	1-25%												
09A	DSCN1328.JPG	Open pond area, riparian plants on edge, trees & shrubs on west,north,east	>40 FT	25-75%	1-25%	PP	50-75%	BC	1-25%	GF	1-25%			5-15 FT	25-75%	1-25%		Dogwood	25-50%	VM	25-50%	Hawthorne	1-25%	False Solomon Seal	1-25%	Spyrea	1-25%									grasses,equisetum,reed canarygrass, bulrush	Yes, open pond,1 acre
09B	DSCN1329.JPG	Looking at WP 160 (9A) from paved road, looking north from Highway 2	9A & 9B same site																																		
10A	DSCN1331.JPG	site off of grand bar,mature BC,dead BC, young bc recruitment area	>40 FT	25-75%	1-25%	BC	25-50%	Aspen	25-50%					5-15 FT	25-75%	1-25%		BC	25-50%	VM	25-50%	aspen	1-25%	Red elderberry	1-25%	snow Berry	1-25%	Ferns	1-25%	Tansy	1-25%	fireweed	1-25%	golden rod	1-25%		
10B	DSCN1332.JPG	Oxbow to south of wypt, off of RR.	>40 FT		1-25%	BC	50-75%	BC	1-25%	PP	1-25%	GF	1-25%	5-15 FT	50-75%	1-25%		Willow(P)	50-75%	Dogwood	1-25%	BC	1-25%	hawthorne	1-25%	spyrea	1-25%									grasses, equisetum, PS,cat tails	Yes, open pond
11A	DSCN1336.JPG	Old beaver dam, dense monotypic willow.	>40 FT	1-25%	1-25%	BC	1-25%							5-15 FT	75-100%	1-25%		Willow (P)	75-100%	Spyrea	1-25%	Hawthorne	1-25%													PS	Yes, standing water
11B	DSCN1337.JPG	Decommissioned bridge.	20-40 FT	25-50%	1-25%	PP	25-50%	BC	1-25%					5-15 FT	1-25%	1-25%	Willow on sandbar	Willow (P)	25-50%	Alder(white, mountain)	1-25%	BC	25-50%	spyrea	1-25%	dogwood	1-25%	hawthorne	1-25%								
12A	DSCN1340.JPG	B02 Bridge	>40 FT	1-25%	1-25%	PP	25-50%	GF	25-50%					5-20 FT	25-75%	1-25%		VM	25-50%	Willow(S)	25-50%	Dogwood	25-50%														
12B	DSCN1341.JPG	LBC	>40 FT	50-75%	1-25%	PP	50-75%	BC	25-50%	DF	1-25%	BC	1-25%	5-15 FT	75-100%	1-25%		VM	75-100%	Oregon Grape	1-25%	Snowberry	1-25%														
13A	DSCN1344.JPG	Power line cutting across Nason 2X, large mature aspens	>40 FT	25-75%	1-25%	PP	50-75%	BC	25-50%	DF	1-25%	GF	1-25%	5-15 FT	25-50%	1-25%		dogwood	30-50%	VM	30-50%	hawthorne	1-25%	ferns	1-25%	black elderberry	1-25%	snowberry	1-25%								
13B	DSCN1346.JPG	LWD (BC), Moist site	>40 FT	50-75%	1-25%	DF	50-75%	BC	25-50%	Aspen	1-25%	GF	1-25%	5-25 FT	25-75%	1-25%		VM	75-100%	Giant Skunk Cabbag	1-25%	willow(S)	1-25%	dogwood	1-25%	snowberry	1-25%										yes
14A	DSCN1348.JPG	Shrub area, moist site, trees in semi circle	>40 FT	75-100%	1-25%	PP	75-100%	DF	25-50%					5-20 FT	50-75%	1-25%		willow(P)	50-75%	Alder(white, mountain)25-50%	1-25%	Hawthorne	1-25%	service berry	1-25%	spyrea	1-25%										
14B	DSCN1350.JPG	Wypt on edge of creek,cobble,sand	>40 FT	50-75%	1-25%	PP	50-75%	BC	50-75%	Aspen	1-25%	GF	1-25%	5-20 FT	25-50 %	1-25%	Willow on sandbar	Dogwood	25-50%	VM	1-25%	willow(S)	1-25%	alder	1-25%	black elderberry	1-25%	BC	1-25%								
15A	DSCN1354.JPG	West wypt to island, LBC	>40 FT	25-50%	1-25%	BC	25-50%	PP	25-50%	DF	1-25%			5-25 FT	25-75 %	1-25%		Willow (P)	25-50 %	Alder	50-75%	Dogwood	1-25%														
15B	DSCN1356.JPG	Under power lines,s. & n views	>40 FT	1-25%	1-25%	PP	25-50%	DF	25-50%	BC	1-25%			5-20 FT	75-100%	1-25%		Sitka Alder	50-75%	Willow (P)	50-75%	Dogwood	1-25%	VM	1-25%	snowberry	1-25%	mares tail	1-25%								
16A	DSCN1360.JPG	wypt174 looking north from northside of N.C.,significant amounts of cobble on site	>40 FT	25-75%	1-25%	PP	50-75%	BC	50-75%	DF	1-25%	BC	1-25%	5-15 FT	25-75%	1-25%		G.F.	50-75%	Dogwood	1-25%	Service berry	1-25%	VM	1-25%	BC	1-25%										
16B	DSCN1361.JPG	Wypt looking sw to Island, c.o.w. through island, open ground on Island, plants among stones	>40 FT	25-75%	1-25%	PP	50-75%	BC	25-50%	DF	1-25%			5-20 FT	25-75%	1-25%		Sitka Alder	50-75%	BC	25-50%	Dogwood	1-25%	PP	1-25%	Tansy	1-25%	Bitter Cherry	1-25%	Ocean Spray	1-25%						
17A	DSCN1368.JPG	Trees,shrubs on south side of power line, dry high flow channel, little gd cover in low site	>40 FT	50-75%	1-25%	DF	25-50%	PP	25-50%					5-15 FT	1-25%	1-25%	Potential for Willow		0 1-25%	Kinnikinick	1-25%	ceanothus	1-25%	DF	1-25%												
17B	DSCN1369.JPG	Wypt taken underneath power line, looking north, decline of large BC, potential BC recruitment	> 40 FT	25-75%	1-25%	PP	25-50%	BC	25-50%	DF	1-25%			5-20 FT	25-75%	1-25%	r	Sitka Alder	25-50%	Dogwood	25-50%	Spyrea	1-25%	Willow (S)	1-25%	BC	1-25%	VM	1-25%								
18A	DSCN1373.JPG	old channel on west side of creek, willow, BC intermediate tree growth	>40 FT	25-75%	1-25%	PP	25-50%	BC	25-50%	DF	1-25%			5-20 FT	25-75%	1-25%		VM	1-25%	BC	1-25%	Dogwood	1-25%	Willow (S)	1-25%	Ferns	1-25%										
18B	DSCN1377.JPG	Some grass, fairly bare below shrub/tree canopy, LWD on inside of stream curve, willow recruitment	>40 FT	50-75%	1-25%	PP	25-50%	BC	25-50%	GF	1-25%			5-15 FT	50-75%	1-25%	Potential for Willow	Sitka Alder	25-50%	Dogwood	25-50%	Willow(S, P?)	1-25%	VM	1-25%	Spyrea	1-25%	Service Berry	1-25%	BC	1-25%						
19A	DSCN1380.JPG	Site a mixture of PP and DG and ground cover predominately service berry and snowberry	>40 FT	25-75%	1-25%	PP	50-75%	DF	25-50%	Aspen	1-25%	BC	1-25%	5-15 FT	25-75%	1-25%		Service berry	25-50%	Snowberry	25-50%	Wild Rose	1-25%	False Solomon Seal	1-25%												
19B	DSCN1381.JPG	Site contains signif amounts of down woody debris, LM BC. Site of potential recruitment of BC &DF, older side canal-like during runoff photo 1383?	>40 FT	25-75%	1-25%	PP	25-50%	DF	25-50%	BC	25-50%	Aspen	1-25%	5-20 FT	50-75%	1-25%		Sitka Alder	50-75%	Dogwood	25-50%	BC	25-50%	Spyrea	1-25%	black elderberry	1-25%	DF	1-25%	PP	1-25%	snowberry	1-25%				

Appendix 1. Field Form Data

SurveyPt	Photo	Comments	Canopy Avg Hight	Canopy % Cover	% Canopy Dead	Canopy Species 1	Canopy 1 Species % abundance	Canopy Species 2	Canopy 2 Species % abundance	Canopy Species 3	Canopy 3 Species % abundance	Canopy Species 4	Canopy 4 Species % abundance	Understory Avg Height	% understory cover	% understory dead	Recruitment species	understory species 1	% understory species 1 abundance	understory species 2	% understory species 2 abundance	understory species 3	% understory species 3 abundance	understory species 4	% understory species 4 abundance	understory species 5	% understory species 5 abundance	understory species 6	% understory species 6 abundance	understory species 7	% understory species 7 abundance	understory species 8	% understory species 8 abundance	understory species 9	% understory species 9 abundance	Wetland area plants	Wetland area characteristics
20A	DSCN1305.JPG	Major old meander (wet side), thickly covered with shrubs, standing water in meander.	>40 FT	25-75%	1-25%	DF	25-50%	GF	25-50%	PP	1-25%	BC	1-25%	5-15 FT	50-75%	1-25%		VM	25-50%	Dogwood	25-50%	Sitka Alder	25-50%	Fern	1-25%	snowberry	1-25%									water hemlock, [illegible]	yes
20B	DSCN1306.JPG	Major old meander (same site), thickly covered with shrubs, standing water in meander. Large dia alders (8 inch)	>40 FT	25-75%	1-25%	DF (I)	50-75%	PP(I)	25-50%					5-25 FT	25-75%	1-25%		Sitka Alder	25-50%	Spyrea	1-25%	Water Hemlock	1-25%	Skunk Cabbage	1-25%	bulrush	1-25%	Equisetum	1-25%	VM	1-25%					water hemlock, equisetum, cattail	yes
21A	DSCN1307.JPG	Site contains signif amounts of down wood limbs and tree trunks, lots of woody debris from flooding, very little undergrowth	>40 FT	50-75%	1-25%	GF (I&M)	25-50%	BC (I&M)	1-25%	RC (I&M)	1-25%	DF	1-25%	5-20 FT	25-75%	1-25%		VM	25-50%																		
21B	DSCN1303.JPG	Young GF/PP/DF on edge of river, I&M BC, old bridge structure at this site.	>40 FT	25-50%	1-25%	BC	25-50%	PP	25-50%					5-20 FT	25-75%	1-25%		Sitka Alder	50-75%	Willows(3)	25-50%	BC	1-25%	Tansy	1-25%	Spyrea	1-25%										
22A	DSCN1296.JPG	Broken standing PP &BC trees close to water one dead (DF) fairly tall, some bank erosion, small fish	>40 FT	25-75%	1-25%	BC	50-75%	PP	50-75%	GF	1-25%	DF	1-25%	5-15 FT	75-100%	1-25%		Dogwood	25-50%	Sitka Alder	25-50%	VM	1-25%	BC	1-25%	Bitter Cherry	1-25%										
22B	DSCN1297.JPG	I &M BC, wet soil at this site, sign amount of young willow, dense vegetation	>40 FT	25-75%	1-25%	BC	25-50%	GF	1-25%	DF	1-25%	BC	1-25%	5-20 FT	50-75%	1-25%		Sitka Alder	50-75%	Willows (P&S)	25-50%	Skunk Cabbage	1-25%	VM	1-25%	Ferns	1-25%	snowberry	1-25 %	service berry	1-25%	Thimble berry	1-25%				
						I = Intermediate																															
						M=Mature																															

PEER REVIEW DOCUMENTATION
PROJECT AND DOCUMENT INFORMATION

Project Name: Wentachee Watershed Plan

WOID: WEWAP

Document: 2007 Nasson Creek Floodplain Vegetation Assessment

Date: March 26, 2008 Date Transmitted to March Client: March 27,2008

Team Leader: David Sisneros Leadership Team Member__________
(Peer Reviewer of Peer Review/QA Plan)

Document Author(s)/Preparer(s): David Sisneros, John Boutwell, Debra Callahan

Peer Reviewer: Denise Hosler

REVIEW REQUIREMENT

Part A: Document Does Not Require Peer Review

Explain____

Part B: Document Requires Peer Review: SCOPE OF PEER REVIEW
Peer Review restricted to the following Items/Section(s): Reviewer:
Entire
Entire

REVIEW CERTIFICATION

Peer Reviewer - I have reviewed the assigned Items/Section(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer: Denise M Hosler Review
Date: March 26, 2008 Signature

Reviewer:________________ Review
Date:________________ Signature

Preparer - I have discussed the above document and review requirements with the Peer Reviewer and believe that this review is completed, and that the document will meet the requirements of the project.

Team Member: David Sisneros
Date: April 2, 2008 Signature

Draft Memorandum

To: MaryJo Sanborn, Wenatchee Habitat Subcommittee
From: Casey Baldwin, RTT Chair (509-664-3148; baldwcmb@dfw.wa.gov)
Date: 04/11/2008
Subject: Nason Creek Biological Benefit Assessment

The RTT appreciated the opportunity to work on the biological benefit portion of the Nason Creek prioritization and we look forward to continuing to assist with this process. As you know, the USBR has developed a very detailed geomorphic assessment of approximately 2/3 of the anadromous zone of Nason Creek (RM 4.6-14.3). Due to the impressive quantity and quality of information provided by the USBR, and the complexities of the social aspects and considerations outlined in the *Draft Prioritization Framework for Nason Creek Restoration Projects* (herein referred to as the *Prioritization Framework*), the RTT has developed a phased approach to evaluating the biological benefits of potential restoration actions in Nason Creek. In this memo, we outline our recommendations from Phase I of the biological benefit assessment and our intended approach to Phase II of the assessment.

The USBR assessment provided information at multiple spatial scales: 1) three Geomorphic Reaches 2) nine Project Areas and 3) 84 Project Subareas. We realize that the ultimate goal may be to have a single prioritized list of the 84 Project Subareas; however, due to the variability of the conditions and the interconnectedness of the information provided by USBR within each Project Area the RTT did not believe that we could effectively rank all of the Project Subareas at this time. Our approach was to evaluate the project types independently, beginning with the channel reconnection projects.

Phase I

Project Type Prioritization

There are four basic project types that are considered a priority in Nason Creek, protection, channel reconnection (including floodplain), and habitat diversity, and riparian restoration. The first three actions were rated as Tier 1 in the RTT *Biological Strategy* so we certainly believe all three should occur and all three are of very high importance to the recovery and long-term viability of salmonids in Nason Creek. Riparian planting was considered a Tier 2 action in the RTT *Biological Strategy*, making it still very important to accomplish, but not as high a priority as the other actions in Nason Creek.

Protection certainly needs to occur in Nason Creek to be sure that the functional areas remain functional and that impacted areas are allowed to heal and recover from past land management practices. An effort needs to be undertaken to identify the areas in Nason Creek that are at the greatest risk and therefore in the greatest need of protection. We believe that is a separate task from what has been asked of us at this time. Its possible that Phase II of this assessment could include an RTT prioritization of the protection areas in Nason Creek. The USBR assessment goes a long way towards identifying areas that need to be protected, but we think that the lower 4.6 miles of Nason Creek also need to be included in an analysis of risks and benefits for the entire anadromous section.

The RTT supports the concept from the *Prioritization Framework* that states "habitat diversity projects should not proceed prior to connectivity projects unless the main channel of the stream is unconstrained" and we would add that the risks of failure for the complexity project should be relatively low. Additionally, we recommend looking at the proportion of each project area that is disconnected from the channel migration zone and floodplain as a course filter for where habitat complexity projects may be appropriate (Table 1). Project Areas 13.3, 8.9, and 7.75 are all less than 10% disconnected from their channel migration zone and floodplain and may be appropriate areas to consider habitat complexity actions.

Reach Level Prioritization

The RTT utilized the Interior Columbia Technical Recovery Team's evaluation of intrinsic potential (ICTRT 2007) to determine if there would be greater biological benefits to working in one reach of Nason Creek over the other reaches. To evaluate intrinsic potential, the ICTRT developed a model to predict areas of high quality habitat based on empirically derived relationships between salmon spawner densities and channel characteristics (i.e. gradient, stream width, valley width, and confinement).

The RTT took a qualitative look at the intrinsic potential maps for spring Chinook (Figure 1) and steelhead (Figure 2) to determine which reaches had the most intrinsic potential. From this analysis, it was evident that the lower 4.6 miles and reaches 1 (rm 4.6 to 8.9) and 3 (9.4 to 14.3) all had similar high levels of intrinsic potential. Reach 2 (rm 8.9 to 9.4) has a higher gradient and is naturally confined and is therefore the only reach that stands out as having lower restoration potential. Due to the course scale of the intrinsic potential analysis the RTT did not believe that it could be used to further prioritize between reaches, but that it was a useful analysis to evaluate if there was a reach scale justification for biological benefit prioritization. The RTT did not try to further differentiate the priority between reaches but recommends that prioritizations occur at the smaller spatial scales of the Project Areas and Project Subareas.

Channel Connectivity

We believe that, over the long term, channel reconnection projects will achieve the greatest improvements to biological benefits to listed salmonids in Nason Creek. Protection projects will help maintain what is currently functioning and secure that form and function for the future, but improvements to juvenile survival and habitat capacity are needed in order to recover listed salmonids. Restoring natural processes, channel form, and floodplain function will allow for the natural recruitment of spawning gravels, large woody debris complexes, and pool formation that are so critical to all life stages of salmonids. This concept is already well imbedded in both the *Prioritization Framework* as well as the Technical Sequencing section of the USBR *Draft Findings and Restoration Concepts for Nason Creek Between RM 4.6 to 14.4.*

The USBR Assessment describes two levels of channel connection, the historic channel migration zone (HCMZ) and the floodplain. The HCMZ is the area within the valley bottom where the main river channel typically migrated when unimpeded by human impacts. The floodplain is the remainder of the low elevation valley bottom that was (and should be) accessed during high water events.

Project Area Prioritization

We evaluated the data provided by the USBR regarding the quantity of each habitat type (HCMZ and floodplain) that has been altered by manmade features (Figure 3). Biological benefit preference was not given to one habitat type (HCMZ vs. floodplain) over the other. From this evaluation, it became evident that Project Area 11.62 has, by far, the greatest quantity (227 acres) of disconnected habitat (Table 1). The five largest Project Subareas in the USBR assessment (33.8 to 80.2 acres) fall within this project area. The project areas with the next highest quantity of disconnected habitat were Project Areas 14.3 and 12.47 with approximately 53 acres each (Figure 3, Table 1). We concluded that the connectivity actions outlined by the USBR within these Project Areas that recapture the greatest quantity of HCMZ and floodplain habitat would have the greatest biological benefit for the restoration of Nason Creek. We also recommend generally following the technical sequencing suggested by the USBR within each Project Area. Within this first group of Project Areas, we recommend conducting a course scale social, economic, and feasibility assessment to narrow down the options and possibilities in terms of specific projects in each of the Project Subareas. After sequencing the list within this first group of project areas we recommend revisiting the biological benefit assessment during phase II.

A second group of project areas with substantial opportunity for channel connection include Project Area 6.6 with 31 acres, Project area 5.2 with 16 acres, Project Area 13.3 with 9 acres, Project Area 8.9 with 7 acres, and Project Area 7.75 with 6 acres (Table 1). After sequencing the list within this second group of project areas, we recommend revisiting the biological benefit assessment during phase II.

Table 1. Summary of the total and currently disconnected Historic Channel Migration Zone (HCMZ) and Floodplain in Nason Creek between river mile 4.6 and 14.3. Data generated by the USBR Nason Creek Geomorphic Reach Assessment.

Reach	Project Area Name	Qty of HCMZ	Qty HCMZ disconnected	% HCMZ disconnected	Qty Floodplain	Qty Floodplain disconnected	% floodplain disconnected	Sum of disconnected HCMZ and floodplain	% floodplain and HCMZ disconnected
3	PrjArea_14.3	40.9	31.1	76%	66.1	22.3	34%	53.4	50%
3	PrjArea_13.3	30.7	3.2	10%	65.6	5.9	9%	9.1	9%
3	PrjArea_12.47	45.1	14.6	32%	100.2	37.8	38%	52.4	36%
3	PrjArea_11.62	167.8	90.0	54%	372.2	136.9	37%	226.9	42%
2	PrjArea_9.42	10.1	0.0	0%	13.6	0.05	0%	0.1	0%
1	PrjArea_8.9	45.0	7.0	16%	86.3	0	0%	7.0	5%
1	PrjArea_7.75	42.2	6.2	15%	57.7	0	0%	6.2	6%
1	PrjArea_6.6	52.2	9.6	18%	122.1	21.2	17%	30.8	18%
1	PrjArea_5.2	38.5	3.2	8%	68.9	12.3	18%	15.5	14%
	Sum =	472.5	164.9	35%	952.7	236.5	25%		28%
	Mean =	52.5	18.3		105.9	26.3			
	Median =	42.2	7.0	16%	68.9	12.3	17%		14%

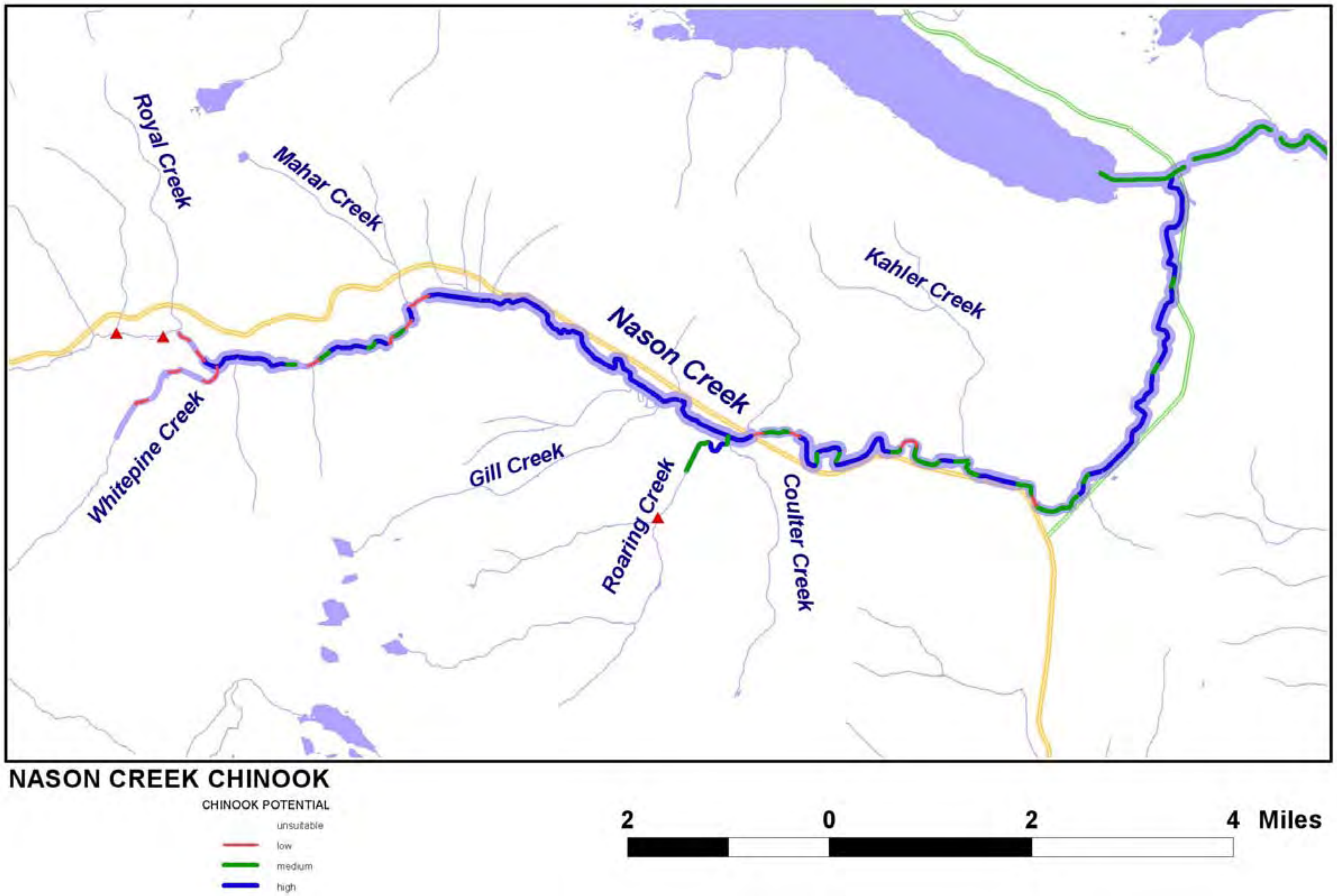

Figure 1. Map of spring Chinook habitat Intrinsic Potential (ICTRT 2007) in Nason Creek, Washington.

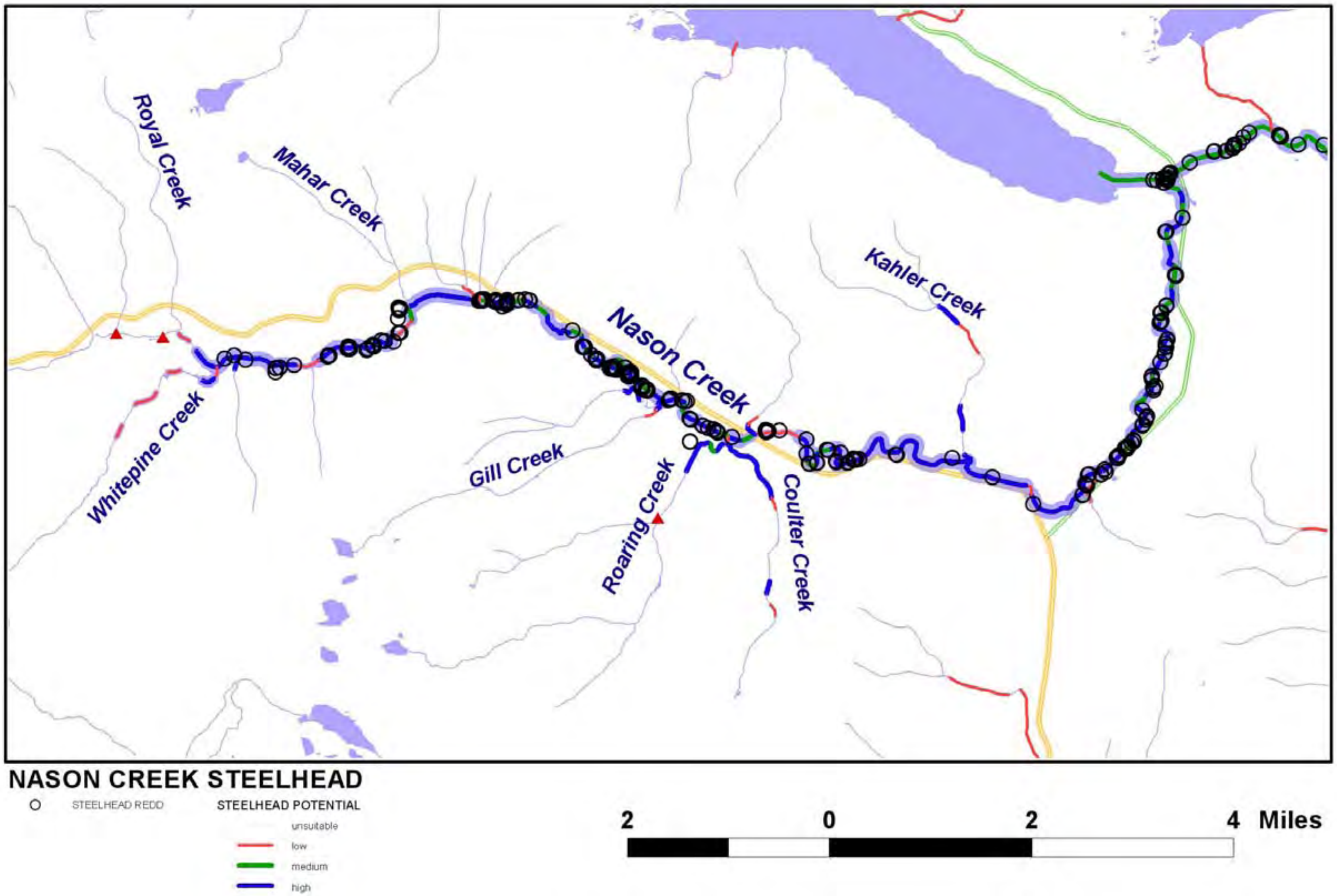

Figure 2. Map of steelhead habitat Intrinsic Potential (ICTRT 2007) and steelhead redd locations (2004-2005?) in Nason Creek.

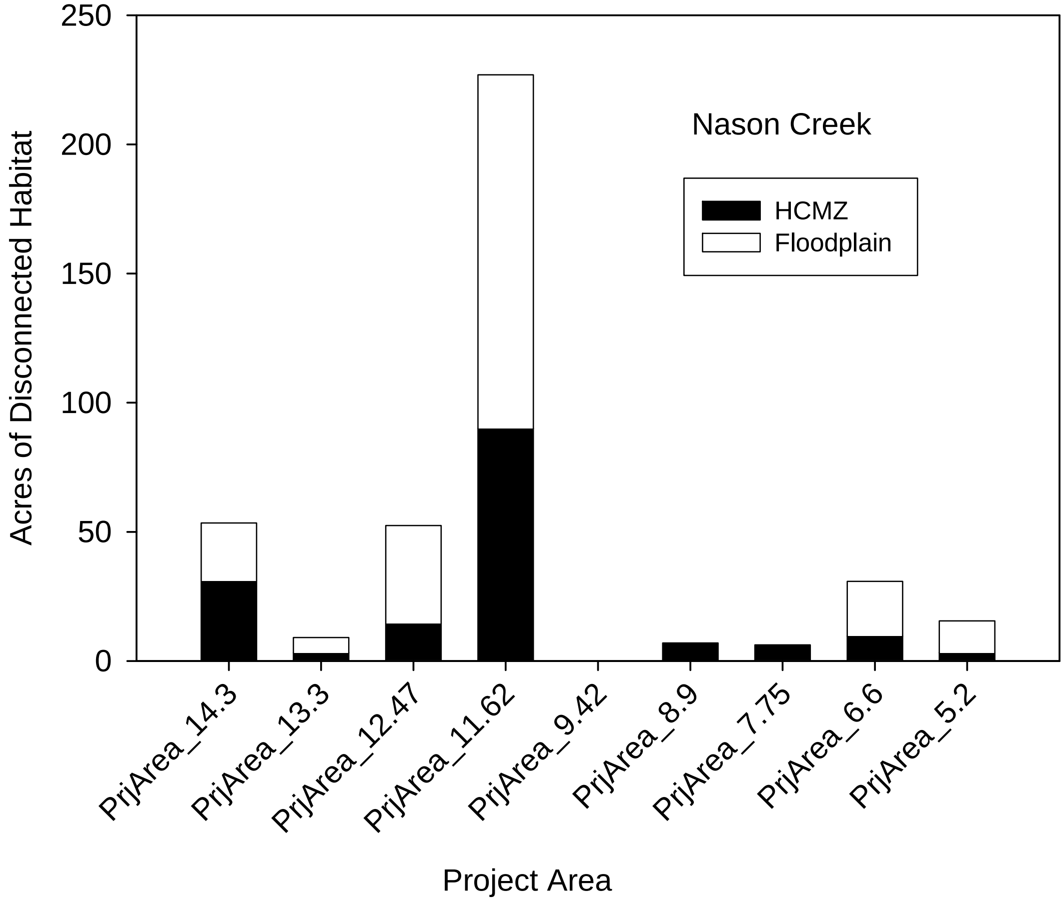

Figure 3. Quantity of historic channel migration zone (HCMZ) and floodplain disconnected within each Project Area of Nason Creek between river mile 4.6 and 14.3. Data source: USBR *Draft Findings and Restoration Concepts for Nason Creek Between RM 4.6 to 14.4.*

Phase II.

Project Subarea Prioritization

The RTT has not yet conducted a comprehensive evaluation of all the Project Subareas.

After the initial course screen feasibility is applied from the Prioritization Framework and there are Project Subareas of similar size and feasibility then we would consider:

1) Quality of the habitat in the reconnected floodplain. Quality is defined by:
   a) The density and complexity of sidechannels.
      a. Complexity of floodplain interaction with sidechannels versus total area (is it locked in an incised sidechannel?)
   b) If there is upwelling or other cold water inputs (tributary streams) into the area. *This will be determined using the FLIR surveys from 2001 and 2003 and by evaluating the quantity of standing water in the recaptured floodplain*.
   c) The quality of existing riparian condition in the recaptured floodplain.
   d) Existing instream diversity

2) Relationship to secondary and tertiary opportunities in the Project Area