RECLAMATION

Managing Water in the West

Gray Reach Project Map Book

Entiat River Subbasin

Chelan County, Washington

May 2013

Prepared by the US Bureau of Reclamation Pacific Northwest Region in partnership with Bonneville Power Administration, Yakama Nation, US Fish and Wildlife Service, Natural Resources Conservation Service, Interfluve Inc, Upper Columbia Salmon Recovery Board

Entiat River – Gray Reach
Project Map Book

Introduction

The Gray Reach of the Entiat River in central Washington consists of roughly 1.8 miles of channel between River Mile (RM) 16.1 and 17.9. This reach is within the "Stillwater area" of the Entiat River and is characterized by a slightly to moderately sinuous, relatively low gradient, unconfined channel with a gravel-dominated bed and active floodplain. As a result of the Gray Reach's natural channel character, it possesses a high intrinsic habitat potential which is not currently fully utilized due in large part to human impacts on the landscape. This Map Book identifies geomorphically appropriate actions suitable for addressing those impacts and maximizing habitat potential.

Background

The Entiat River contains ESA-listed salmon and steelhead for which habitat improvement is a priority under the 2010 Federal Columbia River Power System Biological Opinion (BiOp). In an effort to address the BiOp requirements, the US Bureau of Reclamation (Reclamation) has prepared a Tributary Assessment (2009) and Reach Assessment (2013) examining watershed- and reach-scale river form and function including documentation of historic, existing, and target conditions, human impacts, and potential habitat improvement actions. This Map Book identifies, summarizes and illustrates appropriate habitat actions based on the cumulative information developed in previous studies such as the Tributary and Reach Assessments.

The map book process represents a collaborative, interdisciplinary effort beginning with the Tributary and Reach Assessments. The author of these assessments (Reclamation) compiled relevant imagery and spatial data from the reach (aerial photos, inundation maps, historic channel alignments, spawning areas, etc.) into a Geographic Information System (GIS) for presentation and real-time editing during the working group meeting described below. A small group of habitat project designers (physical scientists and engineers) who all work in and are familiar with the Subbasin were selected by the principal project funders (Reclamation, BPA, Tribe) and asked to participate in the development of the Map Book. An all-day meeting was scheduled in order to discuss and ultimately develop a list of physically appropriate habitat improvement projects for the reach. The Reach Assessment author facilitated the meeting and initiated project discussions based on proposed habitat actions from the existing assessments. Projects were identified and refined based primarily on geomorphic appropriateness, engineering feasibility, and risk. Biological benefit and landowner willingness were addressed only where understood, recognizing that the nuance of these criteria will be assessed in the future by the Upper Columbia Regional Technical Team and individual project sponsors respectively.

The result of the meeting included a list of habitat improvement projects for which there was consensus agreement amongst the team. The list and detailed notes from the meeting were used by the Reach Assessment Author to develop this map book including conceptual project maps, explanations for each project element, discussion regarding flexibility and/or variations in design and potential outcomes. The goal of the Map Book is to provide concise, functional, and vetted guidance to project sponsors in the Entiat River Subbasin in order to more effectively and efficiently develop habitat improvement projects for implementation.

The Map Book itself has been broken into several distinct project areas based on the spatial distribution of individual project elements and the relative interdependence between those elements. Each project area and its associated project elements are illustrated on two maps – a LiDAR-based 2-year flood inundation map and a high-resolution 2012 aerial photo map. Additionally, notes pertaining to the intent of various habitat elements and possible project outcomes are included on each map. Finally, a detailed discussion of the project area and its specific project elements is provided for each project area including paraphrased commentary regarding design decisions from the habitat designers' meeting.

The habitat designers' meeting was held in Wenatchee, WA on April 17th and included the following participants:

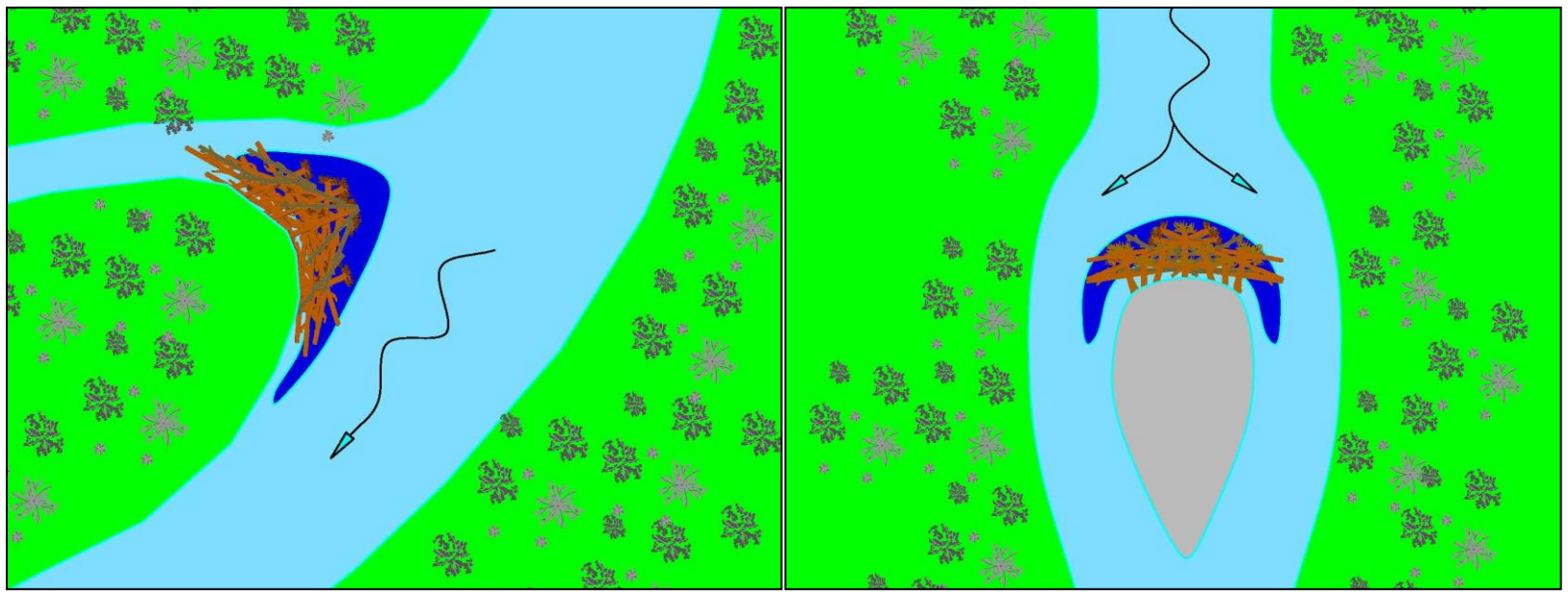
- Rob Richardson – Geomorphologist, US Bureau of Reclamation (meeting facilitator)
- Terril Stevenson – Geomorphologist, US Bureau of Reclamation
- Mike Knutson – Hydraulic Engineer, US Bureau of Reclamation
- Sean Welch – Fish and Wildlife Program Engineer, Bonneville Power Administration
- Brandon Rogers – Biologist, Yakama Nation
- Robes Parish – Hydrologist, US Fish and Wildlife Service
- Joe Lange – Civil Engineer, Natural Resources Conservation Service
- Gardner Johnston – Watershed Hydrologist, Interfluve Inc
- James White – Program Manager, Upper Columbia Salmon Recovery Board

Log Jam Definitions and Examples (typical)

Following are examples of several log jam structures proposed as part of the habitat project improvements on the Gray Reach. The different structure types consist of one or more examples which are shown below along with a brief and generalized explanation of the structure and its intended function. Additional examples and explanations not shown in this document are possible. Each of the log jams portrayed below is considered "typical" and shown only for visualization purposes. The illustrations are not intended to represent a design or a specific project site. Log jam function as it pertains to specific projects is outlined for each project later in the document.

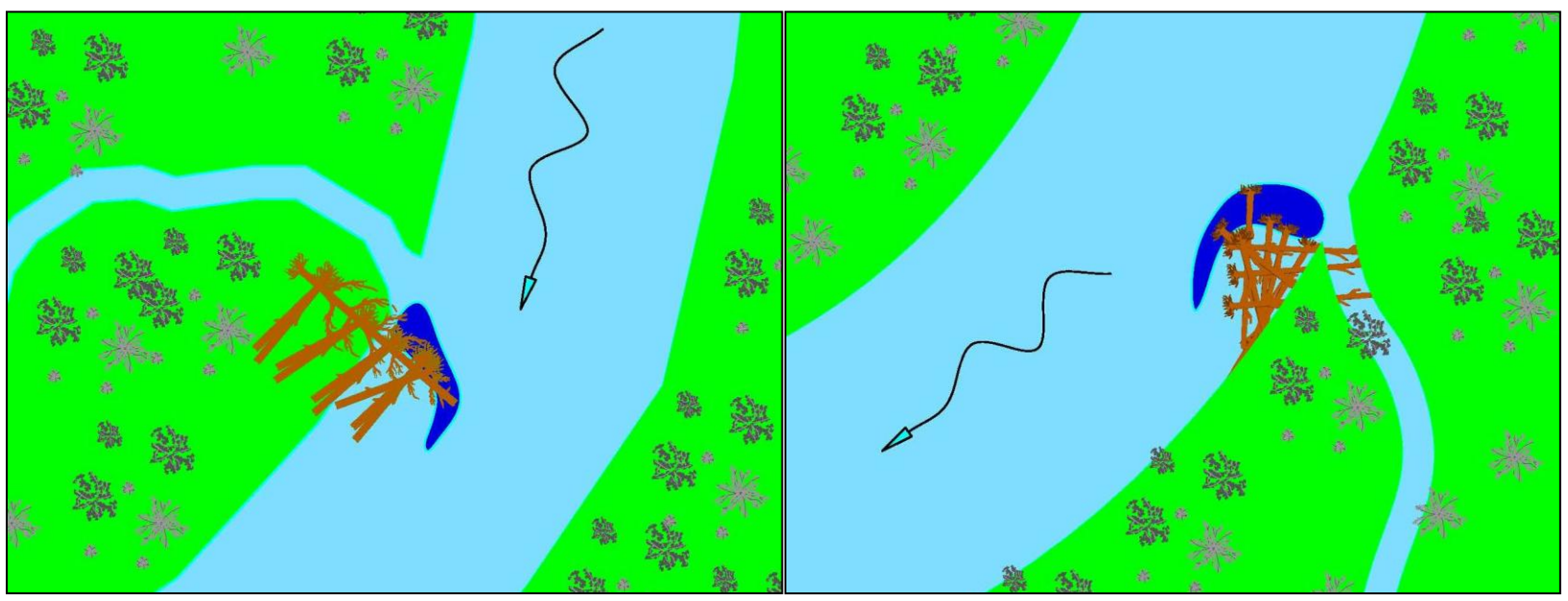
Apex Log Jams:

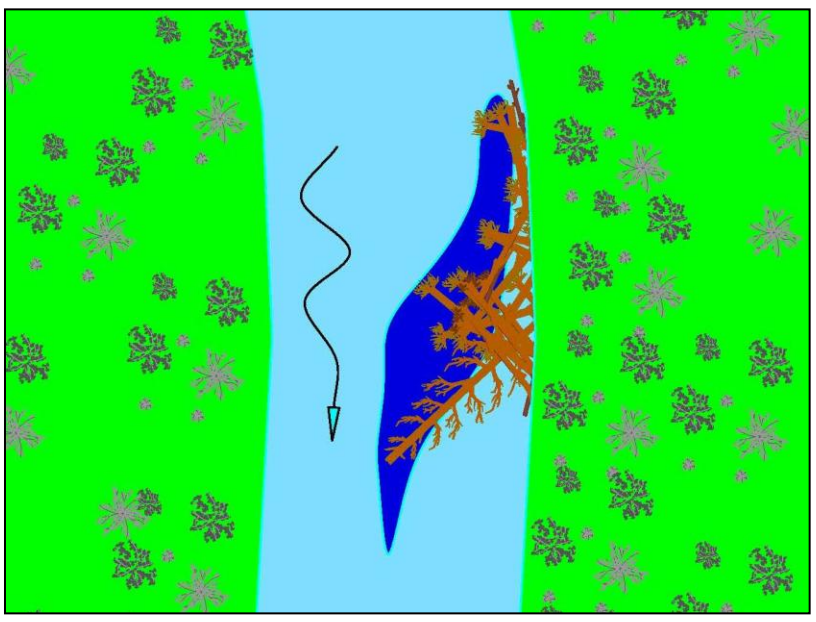
- Often relatively large log jams
- Located typically at the head of a mid-channel or point bar
- Split flow (high and/or low flow) to either side of the structure
- Typically create scour adjacent to and immediately upstream of the structure with significant deposition in the lee of the structure
- Obstruct flow potentially increasing floodplain connection and/or forcing bar development and lateral channel migration



Barb Log Jams:

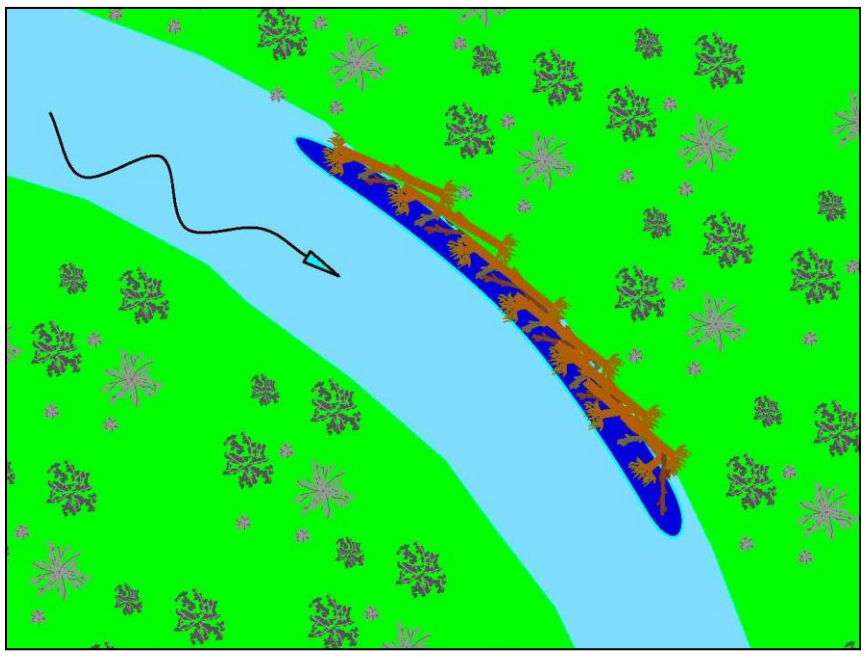
- Many different sizes
- Located on the bank, typically along the outside of a bend or in a relatively straight channel section
- Deflect and obstruct flow generally pushing the thalweg away from the bank
- Typically creates scour near the tip of the structure with deposition in the lee of the structure
- Can be built to significantly obstruct flow promoting floodplain connection, lateral channel migration and side channel activation
- When placed in series with proper spacing can be used to protect and stabilize banks





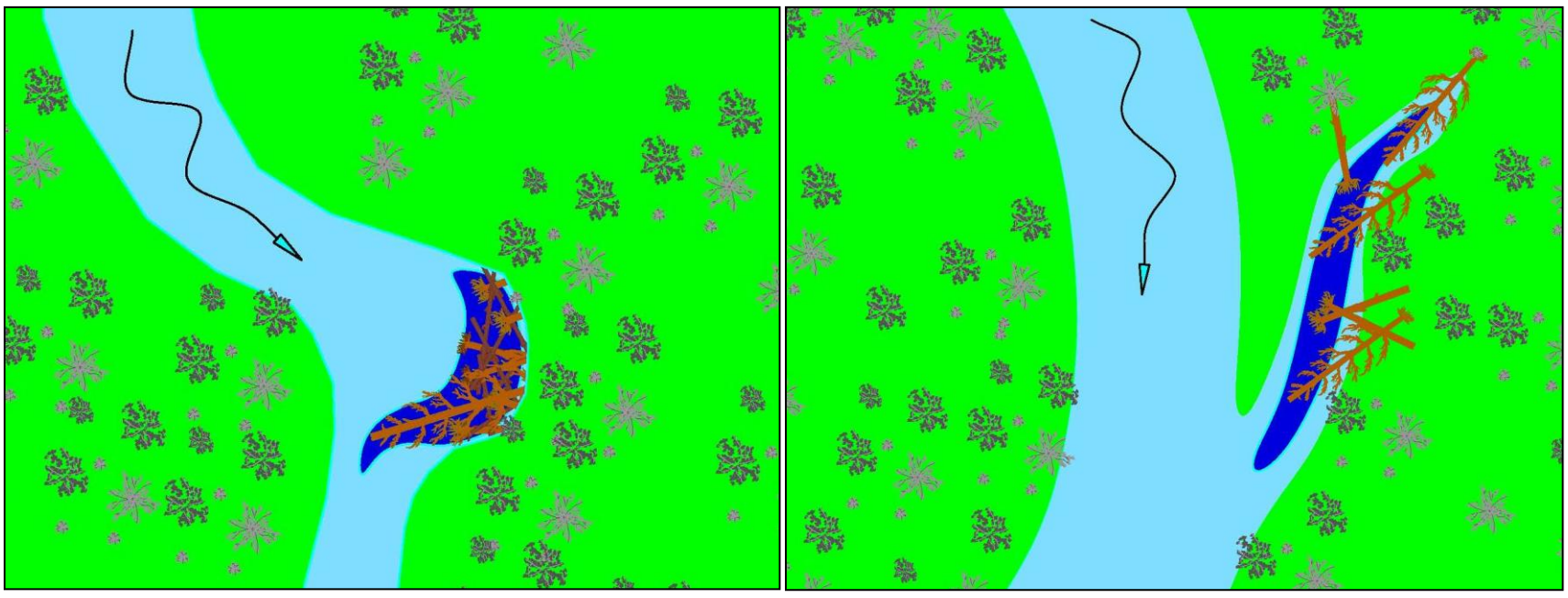
LWM Bank Stabilization:

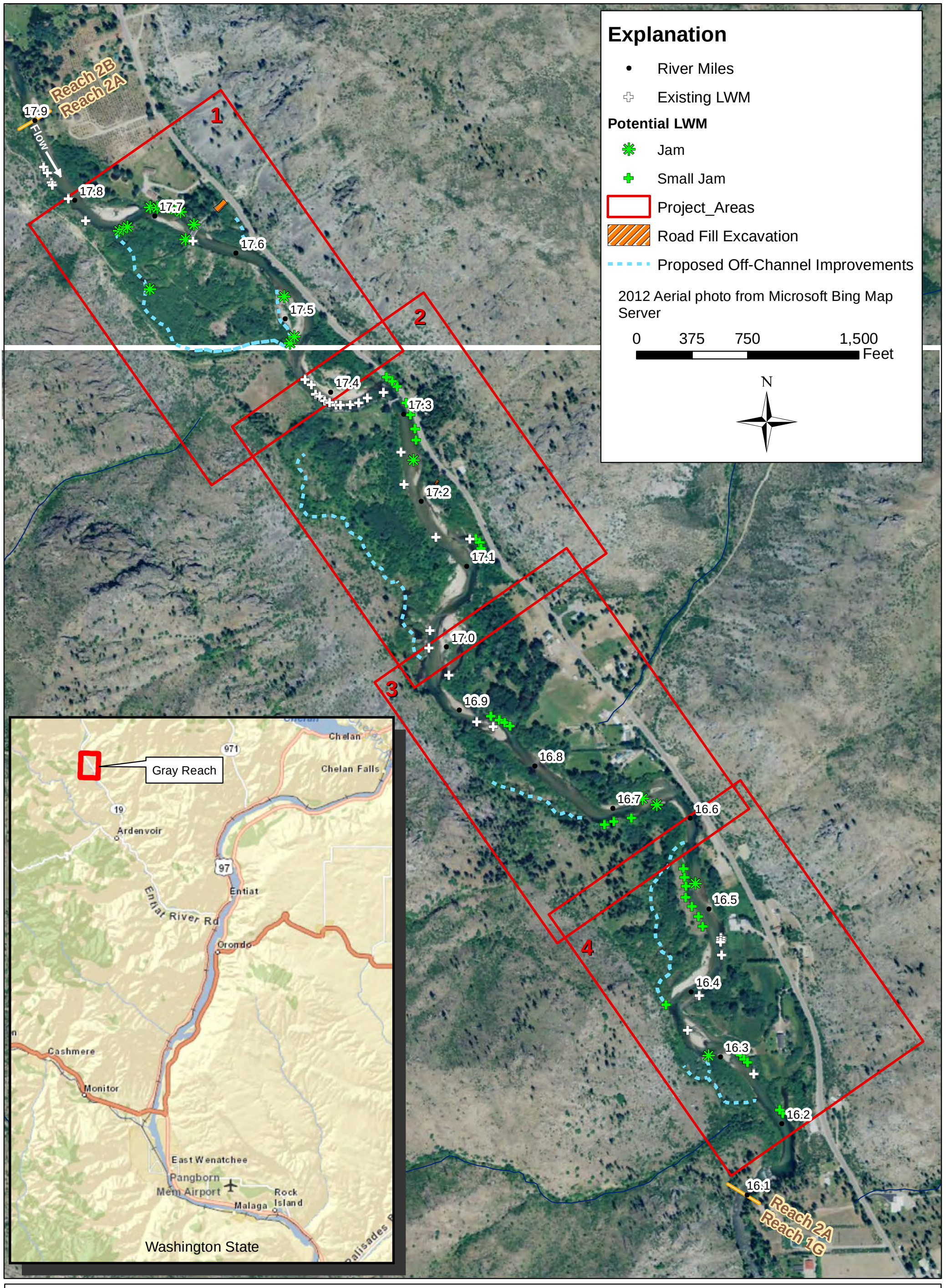
- Many different sizes and options
- Located on the bank, typically along the outside of a bend
- Increase roughness along the bank providing a buffer from erosive forces
- Typically promotes scour by translating lateral erosion into vertical erosion similar to a bank stabilized by mature riparian vegetation
- Provides cover and structure along the margin of the channel often enabling the establishment of riparian vegetation



LWM Structure and Cover:

- Many different sizes, shapes and orientations
- Located along the bank often adjacent pools or in low-velocity areas such as alcoves or backwater eddies
- Provide minimal hydraulic response
- Increase cover and structure primarily intended to improve habitat for juvenile fish
- May or may not need to be anchored or secured in place depending on site conditions





Entiat River -- Gray Reach

Proposed Project Areas

Individual project areas have been identified in the following maps illustrating potential project actions to maximize habitat potential in the Gray Reach of the Entiat River between River Miles (RM) 16.1-17.9. Project elements are considered to be geomorphically appropriate based on the Gray Reach Assessment (Reclamation, 2013) an a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, US Fish and Wildlife Services, Natural Resources Conservation Service, Upper Columbia Salmon Recovery Board and Interfluve Inc (4/17/2013). Actions proposed on the following maps are considered to be conceptual and will require additional project planning, stakeholder coordination, scientific and engineering evaluation, design, review, implementation and monitoring.

Proposed Project Area #1

Project Intent

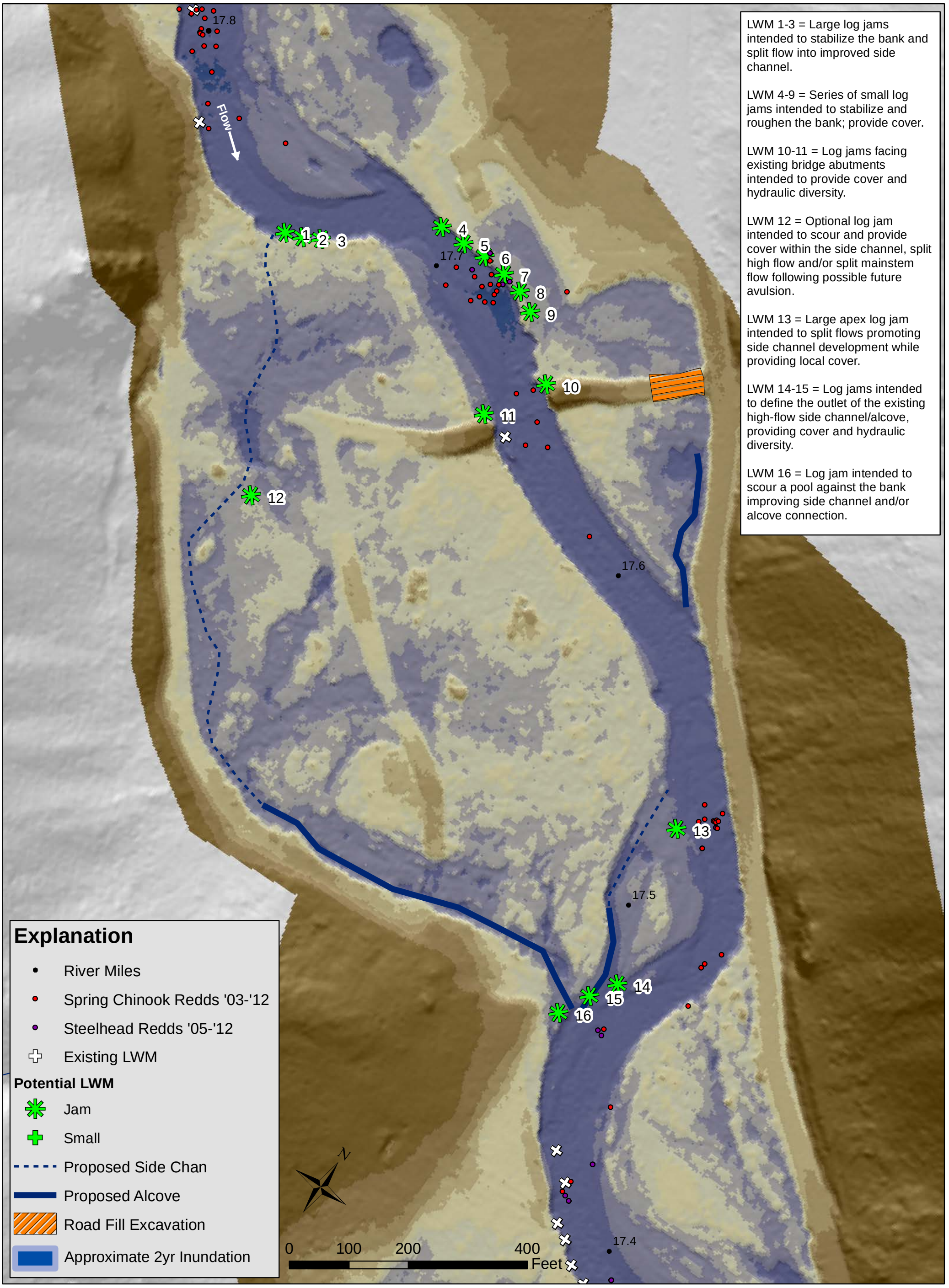
- Create one or more perennial side channels occupying existing low-lying topography on river right.
- Add roughness to banks to provide structure, cover and bank stabilization where riparian vegetation is lacking.

Project Elements

- Side channel inlets
    - Excavate one or more pilot channel inlets as necessary to achieve perennial flow.
    - Large log jams (#1-3, 13) are proposed protruding from the bank immediately downstream of side channel inlets to split flow into the side channels and create hydraulic conditions at the inlets to maintain a perennial opening.
    - Secondary log jams are proposed (#4-10) to obstruct flow and add hydraulic roughness with the intent of decreasing instream velocity thereby backing-up water and enhancing overbank and side channel flow. Log jams #10-11 specifically can be used to constrict and back-up flow considerably if desired, so long as adjacent landowners are not adversely effected.
- Side channels
    - Evaluate the gradient and channel geometry of the side channel to determine if/where additional excavation and/or structure placement will enhance side channel function and/or habitat.
    - Consider adding whole trees to provide cover within the side channel.
    - Consider simulating beaver dams or promoting beaver dams within the side channel.
    - Optional log jam (#12) is intended to split high flows passing through the side channel to increase complexity especially if a channel avulsion is anticipated in this location.
    - Proposed log jams (#14-15) are intended to define the side channel outlets potentially improving the downstream connection of each. Sediment transport will need to be carefully considered with the design of these structures, as improperly placed obstructions may result in deposition blocking the outlet of the side channel(s).
    - Proposed log jam (#16) is intended to scour a pool along the right bank effectively pulling the thalweg against the right bank and improving side channel or alcove connection. Structure size and placement will depend on the alignment and anticipated hydraulics associated with the proposed side channel and alcove.
- Possible channel avulsion
    - The size and shape of the inlet, log jams (#1-3), and pilot channel excavation may be oriented in such a way as to encourage an avulsion of the main stem into the location of the proposed large side-channel. Avulsion potential and perceived benefit versus impact should be evaluated during project development.
    - An avulsion in this location may be considered favorable because it would create diversity and move the channel away from the road. The road prism and associated riprap is a longitudinal, hydraulically smooth surface that increases local stream power, thereby increasing downstream migration, reducing lateral migration and reducing overall channel complexity and floodplain connection.
- Cottonwood Flats Bridge
    - Following the proposed removal of the bridge deck, the bridge abutments are perceived to provide important structure in the form of hard points on the floodplain.
    - Log Jams #10-11 are proposed to utilize existing bridge abutments as key members to be abandoned in place.
    - The road fill approaching the bridge on river left blocks floodplain access and is proposed to be excavated sufficiently to enable flood flow to the alcove near RM 17.5. Road fill on river right has a negligible impact to floodplain connection and function and is not proposed for excavation.
- Bank stabilization
    - Log jams (#4-9) are proposed to increase roughness and to stabilize the bank where riparian vegetation is lacking.

Considerations

- Project elements were developed to function interdependently unless otherwise stated, and exclusion or significant change to any element should be evaluated for potential effects to other elements and the overall project intent.
- The existing Cottonwood Flats Bridge and road structure provides a unique opportunity to access the side channel site(s) with standard equipment while minimizing impact to the existing river and floodplain.
- Pilot channels may be preferred for side channel excavations in order to reduce excavation spoils.
- Side channel excavation spoils may need to be side-cast onto existing high-ground to avoid excessive hauling. Excavation spoils should not result in continuous berms that function as levees.
- Minimize disturbance by using hand labor and/or walking equipment within excavation limits as much as possible.
- Additional elements may be appropriate and feasible.
- Small LWM structures including cover logs and bank fringe habitat elements are not shown in maps and may be appropriate in many locations – to be determined during project development.
- If design elements may increase the potential for an avulsion, future channel alignment should be anticipated and additional design elements considered for this future alignment.



LWM 1-3 = Large log jams intended to stabilize the bank and split flow into improved side channel.

LWM 4-9 = Series of small log jams intended to stabilize and roughen the bank; provide cover.

LWM 10-11 = Log jams facing existing bridge abutments intended to provide cover and hydraulic diversity.

LWM 12 = Optional log jam intended to scour and provide cover within the side channel, split high flow and/or split mainstem flow following possible future avulsion.

LWM 13 = Large apex log jam intended to split flows promoting side channel development while providing local cover.

LWM 14-15 = Log jams intended to define the outlet of the existing high-flow side channel/alcove, providing cover and hydraulic diversity.

LWM 16 = Log jam intended to scour a pool against the bank improving side channel and/or alcove connection.

Explanation

- River Miles
- Spring Chinook Redds '03-'12
- Steelhead Redds '05-'12
- Existing LWM

Potential LWM

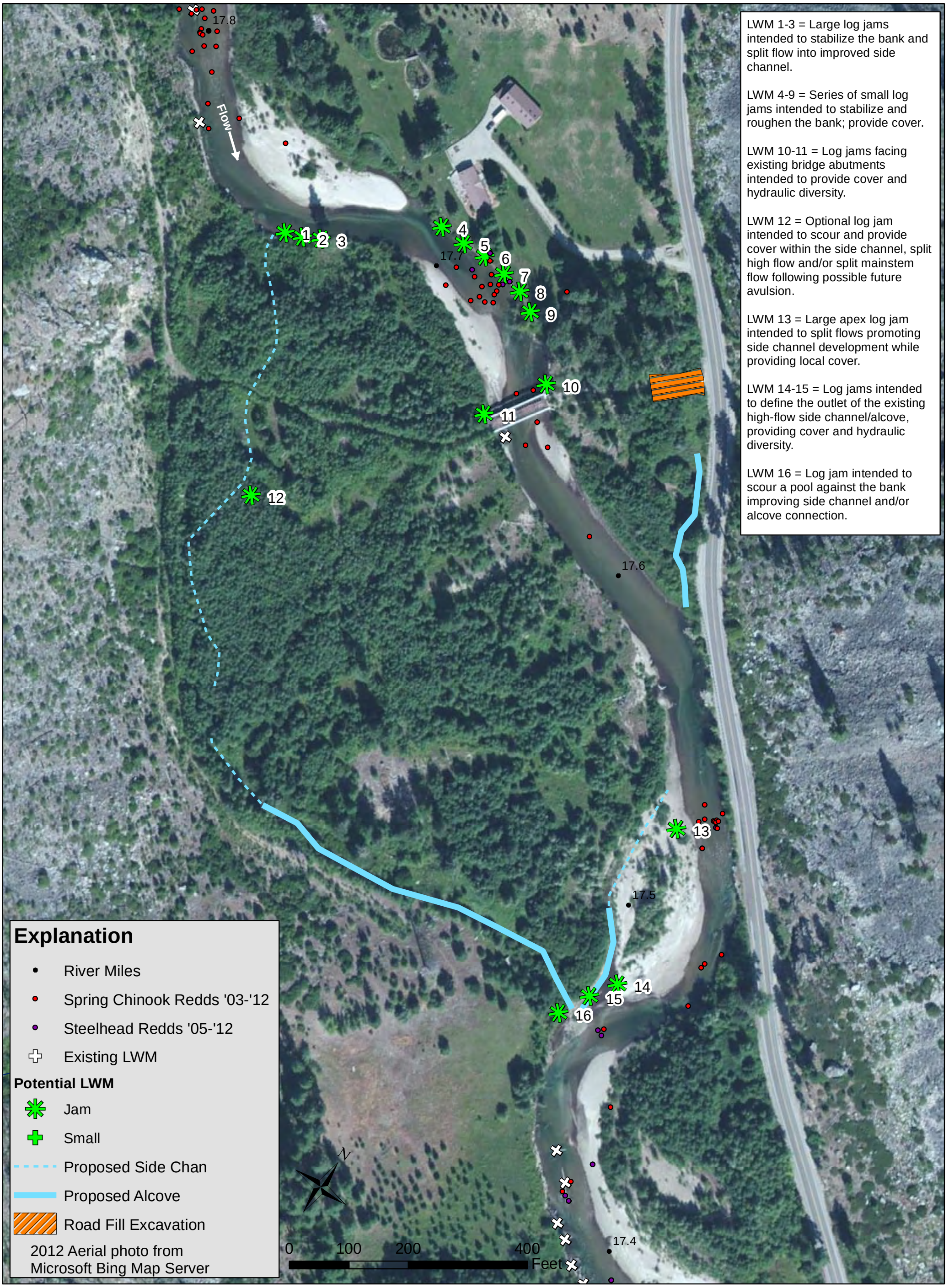
- Jam
- Small
- Proposed Side Chan
- Proposed Alcove
- Road Fill Excavation
- Approximate 2yr Inundation

Entiat River -- Gray Reach

Proposed Project Area #1

Project Description: Excavate the inlet and as necessary along the length of a proposed side channel located to take advantage of existing low-lying topography along the western valley wall. Side channel size and function can range from a small, contained channel, to a relatively large uncontained channel intended to capture the river over time. Channel avulsion into the side channel location would move the river away from infrastructure while providing dynamic habitat change. Additionally, strategically placed LWM structures are proposed to increase floodplain connection, lateral migration, in-stream roughness, bank stabilization, complexity and cover.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).



Entiat River -- Gray Reach

Proposed Project Area #1

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Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

Proposed Project Area #2

Project Intent

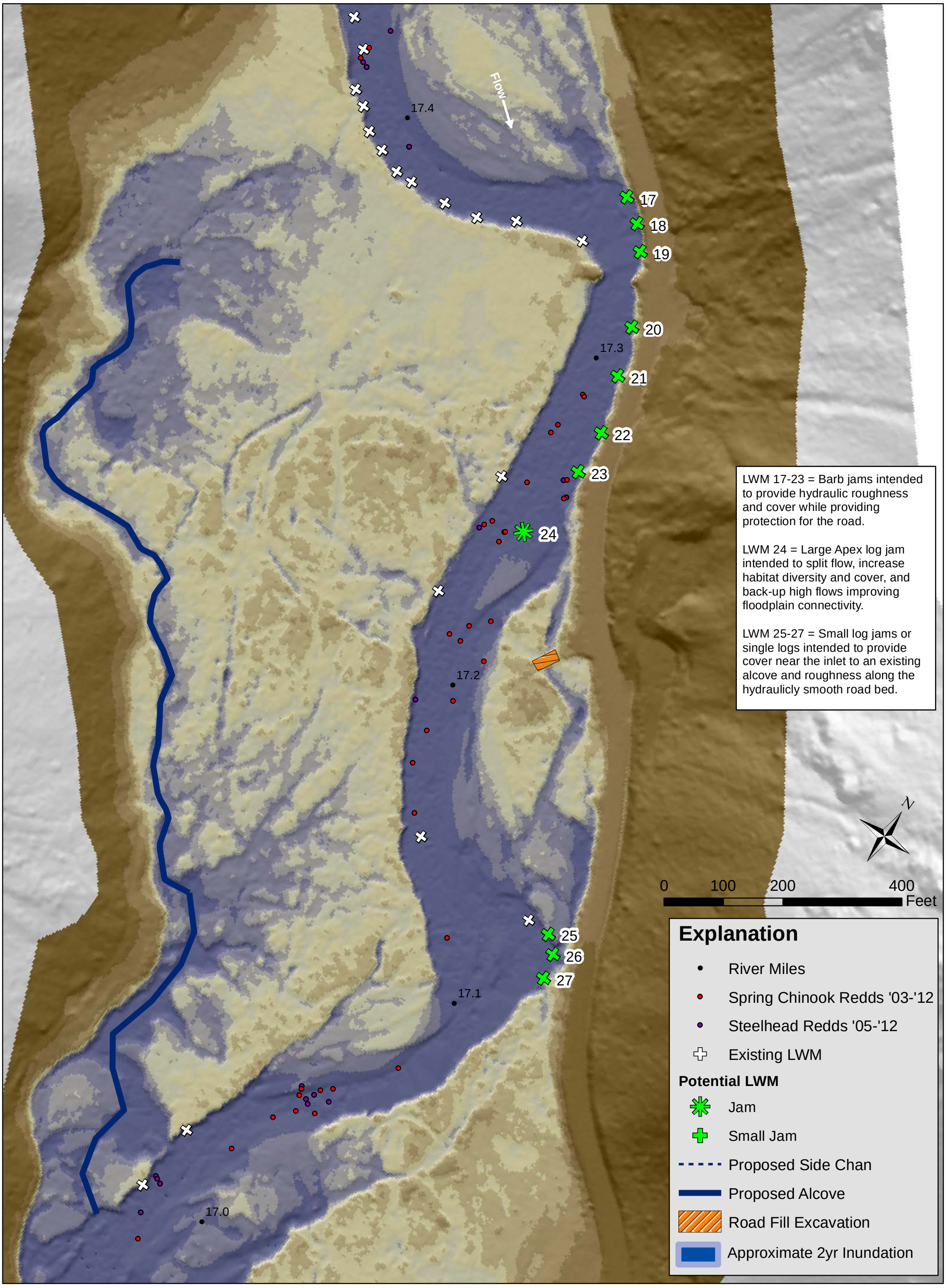
- Improve alcove habitat
- Add flow obstructions and increase roughness to promote habitat complexity

Project Elements

- Alcove along western valley wall
    - Evaluate groundwater conditions along the proposed alcove alignment to determine feasibility and excavation extent. Groundwater inputs will improve thermal conditions and should be incorporated if/where possible.
    - Consider adding whole trees for cover where appropriate (not shown in map figures).
- Bank roughness elements
    - Install proposed root wads and/or barb jams (#17-23 and 25-27) to increase roughness along the otherwise relatively smooth road. Increased roughness will reduce the risk of channel capture along the road resulting from increased velocity, shear and potential channel incision.
    - Barbs along the road will also provide bank protection and cover where riparian vegetation is severely lacking.
- Mid-Channel apex jam
    - Proposed apex jam (#24) is located at the head of an existing submergent mid-channel bar. The intent of this structure is to enhance the flow split and/or increase lateral migration while providing local hydraulic diversity and cover.
    - The flow split associated with the structure may be utilized to encourage flow through the side channel on river left immediately downstream.
- Road fill excavation
    - An existing roadway completely obstructs a high-flow side channel on river left near RM 17.2. Removal of the road fill will provide access to this high-flow channel and existing perennial alcove.

Considerations

- The proposed alcove improvements, log structures and road fill excavation are generally considered independent projects not explicitly dependent on each other for proper function, although Apex Log Jam (#24) may be utilized to improve flow conditions at the inlet of the existing high-flow side channel at rive right. Barb structures (#17-23) are generally intended to function in series, and the appropriate spacing of each barb may increase or decrease the total number of proposed structures required to achieve the project intent.
- Logs placed in the alcove on river right may need to be placed using a helicopter to reduce equipment traffic and associated disturbance in the channel and on the floodplain.
- Small LWM structures including cover logs and bank fringe habitat elements are not shown in maps and may be appropriate in many locations – to be determined during project development.

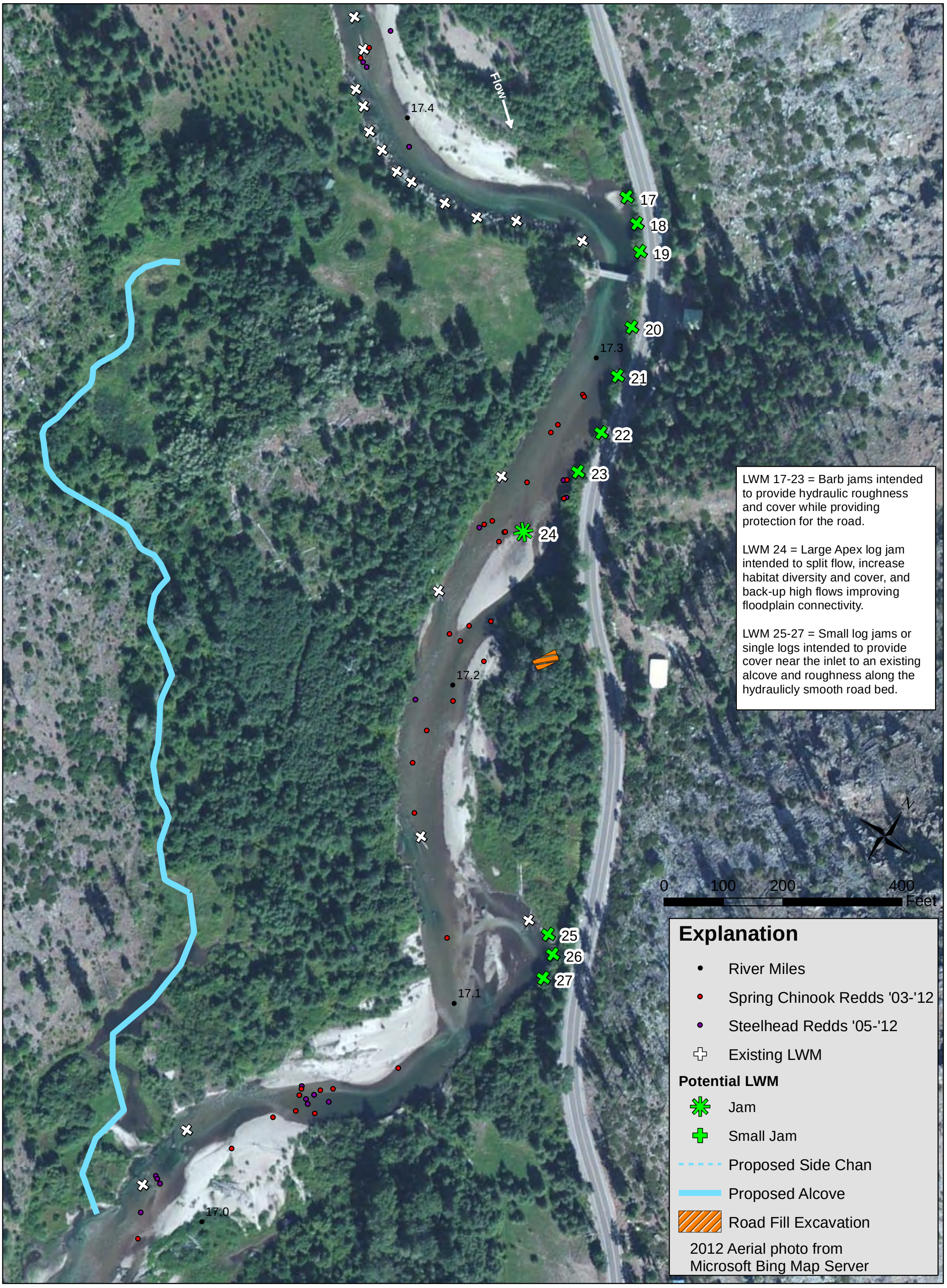


Entiat River -- Gray Reach

Proposed Project Area #2

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves and increase roughness while provide infrastructure protection along the Entiat River Road. Alcove improvements are proposed depending on the availability and volume of groundwater and the proposed disturbance limits of any necessary excavation. Road fill removal will re-connect an existing seasonally-active side channel and improve existing alcove function.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).



Entiat River -- Gray Reach

Proposed Project Area #2

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves and increase roughness while provide infrastructure protection along the Entiat River Road. Alcove improvements are proposed depending on the availability and volume of groundwater and the proposed disturbance limits of any necessary excavation. Road fill removal will re-connect an existing seasonally-active side channel and improve existing alcove function.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

Proposed Project Area #3

Project Intent

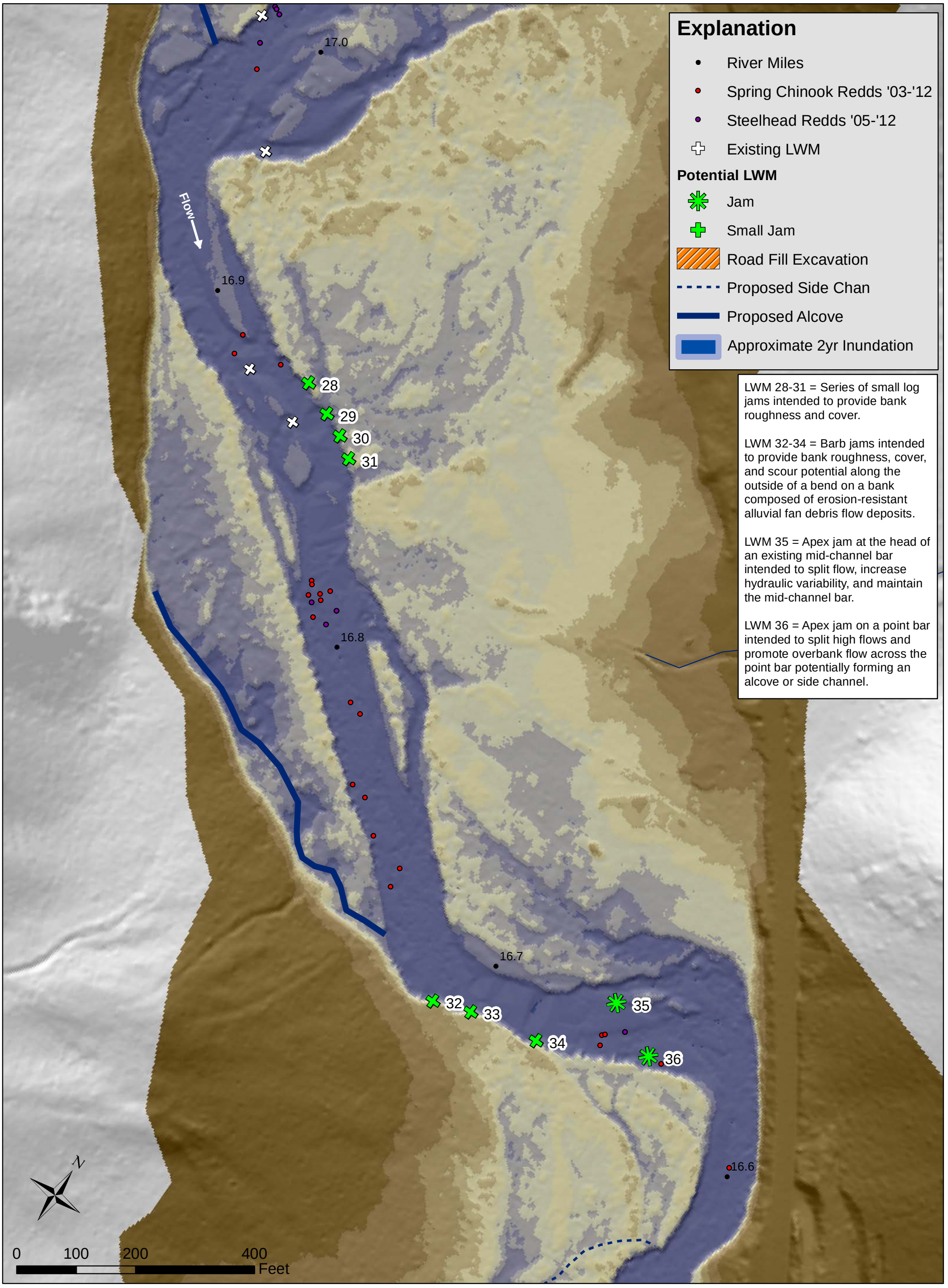
- Excavate an improved alcove
- Add flow obstructions and increase roughness to promote habitat complexity

Project Elements

- Alcove
    - Excavate an alcove generally along the valley wall taking advantage of existing low-lying topography and minimizing disturbance to existing riparian vegetation.
    - Evaluate groundwater conditions along the proposed alcove alignment to determine feasibility and excavation extent. Groundwater inputs will improve thermal conditions and should be incorporated if/where possible.
    - Alcoves tend to form where frequent flood waters concentrate against an obstruction (i.e.: valley wall) and scour a channel connecting to the main stem. The proposed alcove location suits this description very well and has a high likelihood of long-term function as a result.
- Bank roughness elements (optional)
    - Install proposed root wads and/or barb jams (#28-34) to increase roughness and provide structure and cover in a location where it is otherwise generally absent. LWM would have naturally accumulated in these locations had it been available. Consider the potential habitat gain from the wood structures (#28-31) versus the potential disturbance and natural LWM accumulation potential of this site prior to committing resources to the concept. Adding wood habitat structures along most banks of the Gray Reach is geomorphically appropriate, the potential fish benefit versus disturbance cost should decide the fate of this type of structure.
- Apex jams
    - Proposed apex log jam (#35) is intended to split flow around an existing emergent mid-channel bar. In so doing the jam would increase hydraulic variability, promote habitat complexity and provide cover.
    - Proposed apex log jam (#36) is intended to split high flows, forcing increased flow across the point bar in this location. By splitting flow in this location a side channel may develop across the point bar, flow that would otherwise impinge against the road will be diverted, and the structure itself will provide increased hydraulic diversity and cover.

Considerations

- The groups of elements proposed in this project area generally function independently from one another. Barb structures are proposed in groups and are generally intended to function in series. The appropriate spacing of each barb may increase or decrease the total number of proposed structures required to achieve the project intent.
- Logs may need to be staged using a helicopter to reduce equipment traffic and associated disturbance in the channel and on the floodplain.
- Additional elements may be appropriate and feasible.
- Small LWM structures including cover logs and bank fringe habitat elements are not shown in maps and may be appropriate in many locations – to be determined during project development.

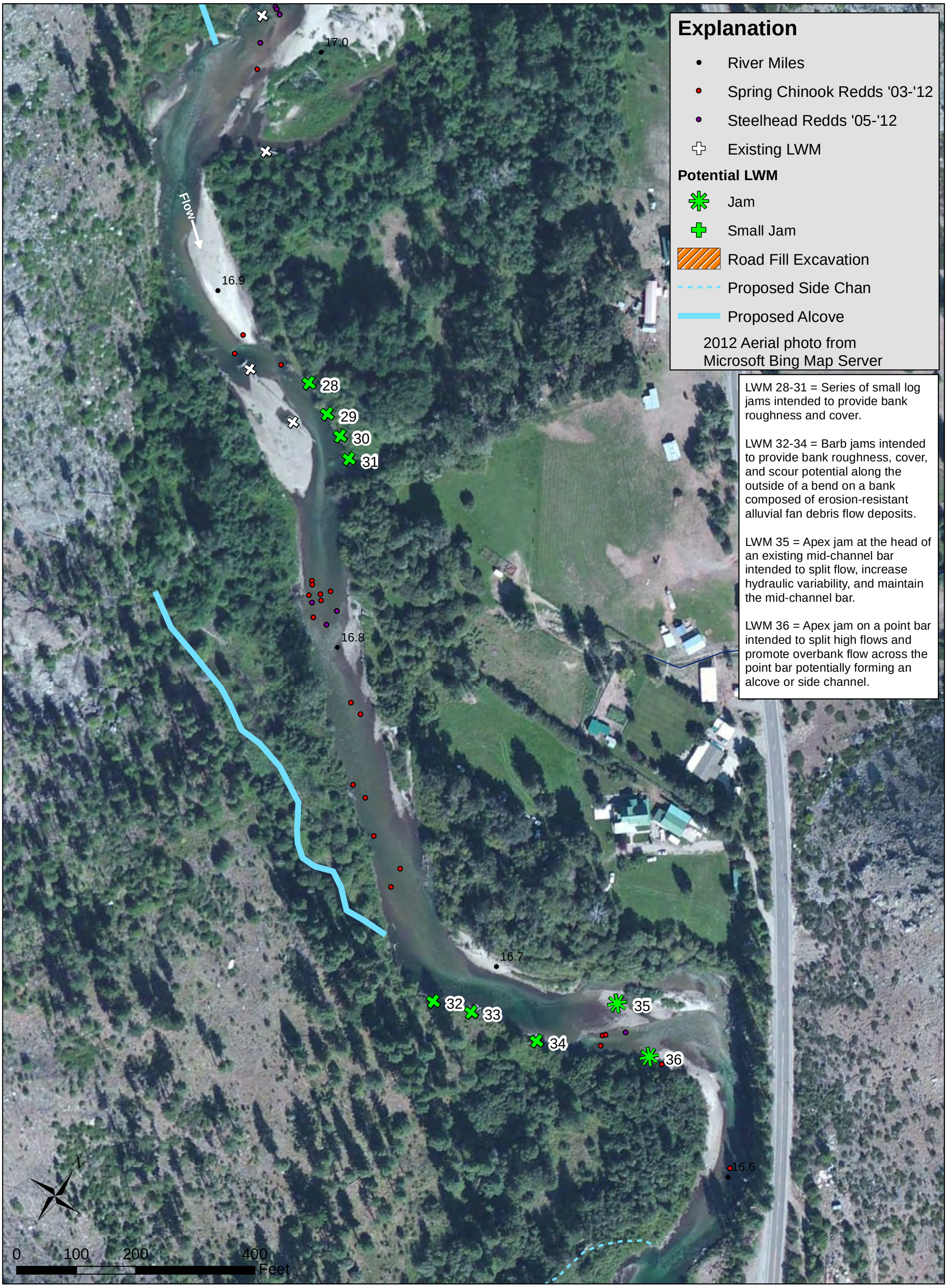


Entiat River -- Gray Reach

Proposed Project Area #3

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves, increase hydraulic roughness and variability, and stabilize unstable banks. Alcove improvements are proposed depending on the availability and volume of groundwater and the proposed disturbance limits of any necessary excavation.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).



Entiat River -- Gray Reach

Proposed Project Area #3

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves, increase hydraulic roughness and variability, and stabilize unstable banks. Alcove improvements are proposed depending on the availability and volume of groundwater and the proposed disturbance limits of any necessary excavation.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

Proposed Project Area #4

Project Intent

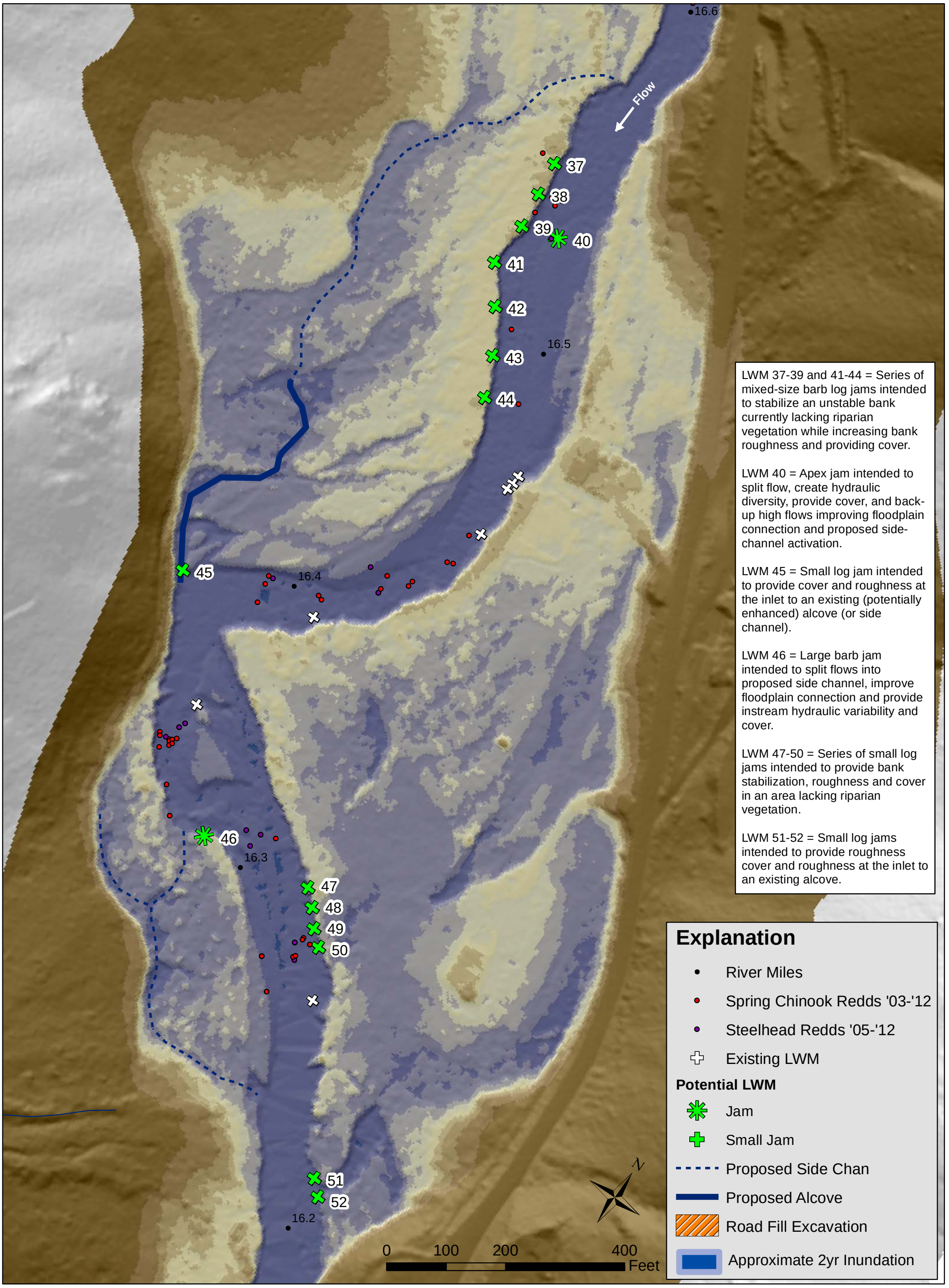
- Create one or more perennial side channels or alcoves
- Install log structures to obstruct flow, increase floodplain and side channel connection, stabilize unstable banks, and provide cover

Project Elements

- Side channel with inlet near RM 16.57
    - Determine feasibility of perennial versus seasonal upstream connection by evaluating hydraulic conditions, groundwater potential, excavation requirements, biological benefit and landowner/stakeholder acceptance.
    - Evaluate the gradient and channel geometry of the side channel to determine if/where additional excavation and/or structure placement will enhance side channel function and/or habitat.
    - Potentially excavate a pilot channel along the alignment to minimize excavation requirements.
    - Consider adding whole trees to provide cover within the side channel.
    - Proposed LWM (#40) is intended to obstruct flow providing hydraulic and habitat diversity locally and potentially back-up flow to encourage floodplain connection and side channel activation.
    - Proposed LWM (#45) is intended to provide structure and cover near the side channel/alcove outlet
- Side channel with inlet near RM 16.32
    - Split flow into the side channel with a large log jam (#46) placed immediately downstream of the proposed side channel inlet. This location racked a large but short-lived log jam visible in 2006 aerial photos.
    - Excavate a pilot channel inlet adjacent log jam #46. Evaluate the gradient and channel geometry downstream of the inlet to determine if/where additional excavation and/or structure placement will enhance side channel function and/or habitat.
    - Evaluate the groundwater potential along the valley wall to aid the establishment of excavation extents and the need (or lack of need) for a perennial upstream connection.
- Bank roughness elements
    - Add roughness elements in the form of small barbs or similar structures (#37-39, 41-44, 47-50) to stabilize unstable banks currently lacking riparian vegetation and exhibiting excessively high rates of channel migration. Short-term bio-engineered bank stabilization is required in order for riparian vegetation to mature and provide natural bank stabilization over the long-term.
    - Add small log jams (#45, 51-52)for roughness and cover near the outlet of side channels and/or alcoves to encourage juvenile fish use of the enhanced off-channel habitat.

Considerations

- Most of the proposed elements in Project Area #4 are intended to function independently with the exception of those interdependent elements mentioned above. Exclusion or significant change to any interdependent elements should be evaluated for potential effects to other elements and the overall project intent.
- Logs may need to be staged using a helicopter to reduce equipment traffic and associated disturbance in the channel and on the floodplain.
- Pilot channels may be preferred for side channel excavations in order to reduce excavation spoils.
- Side channel excavation spoils may need to be side-cast onto existing high-ground to avoid excessive hauling. Excavation spoils should not result in continuous berms that function as levees.
- Minimize disturbance by using hand labor and/or walking equipment within excavation limits as much as possible.
- Additional elements may be appropriate and feasible.
- Small LWM structures including cover logs and bank fringe habitat elements are not shown in maps and may be appropriate in many locations – to be determined during project development.
- If design elements may increase the potential for an avulsion, future channel alignment should be anticipated and additional design elements considered for this future alignment.



Entiat River -- Gray Reach

Proposed Project Area #4

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves, increase hydraulic roughness and variability, and stabilize unstable banks. Proposed side channel/alcove improvements may include a perennial or high-flow upstream connection depending on site-specific hydraulics and groundwater potential.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

Entiat River -- Gray Reach

Proposed Project Area #4

Project Description: Strategically placed LWM structures are proposed to split flow, improve floodplain connection, provide cover to existing and improved alcoves, increase hydraulic roughness and variability, and stabilize unstable banks. Proposed side channel/alcove improvements may include a perennial or high-flow upstream connection depending on site-specific hydraulics and groundwater potential.

Project elements were generated from the Gray RA (Reclamation, 2012) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).