RECLAMATION

Managing Water in the West

Stormy 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 – Stormy Reach
Project Map Book

Introduction

The Stormy Reach of the Entiat River in central Washington consists of roughly 2.83 miles of channel between River Mile (RM) 18.02 and 20.85. This reach is within the "Stillwater area" of the Entiat River and is characterized by a sinuous, relatively low gradient, unconfined channel with a gravel-dominated bed and active floodplain. As a result of the Stormy 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) Reach Assessment (2009) and Update to the 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:

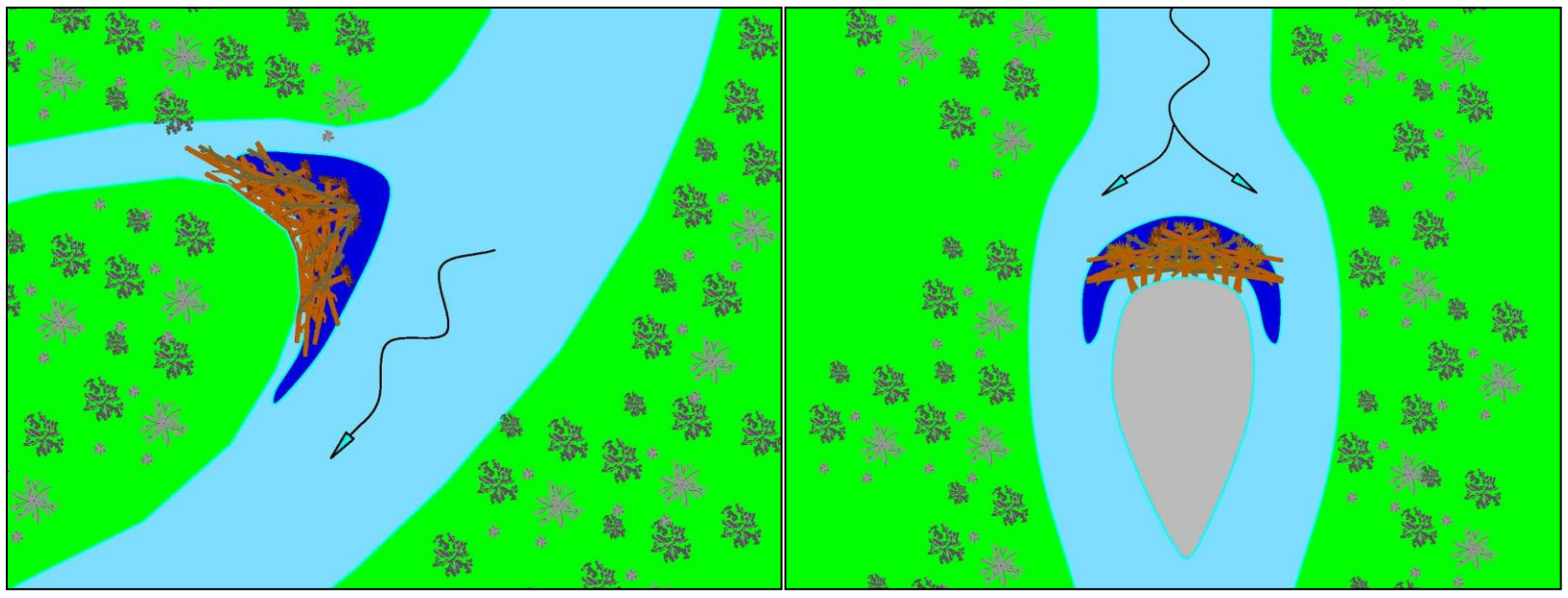
- Rob Richardson – Geomorphologist, US Bureau of Reclamation (meeting facilitator)
- Terril Stevenson – Geomorphologist, US Bureau of Reclamation
- Mike Knutson – Hydraulic Engineer, US Bureau of Reclamation
- Sean Welch – Fish and Wildlife Program Engineer, Bonneville Power Administration
- Brandon 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 Stormy 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.

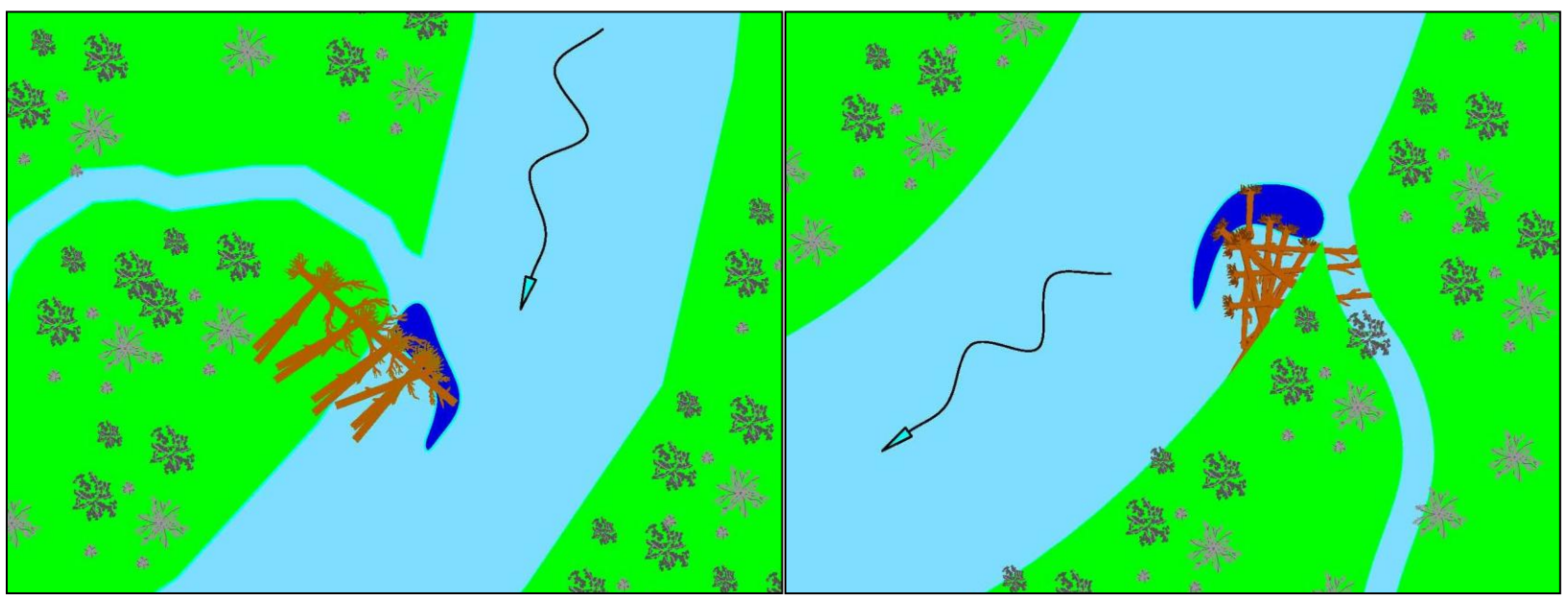
Apex Log Jams:

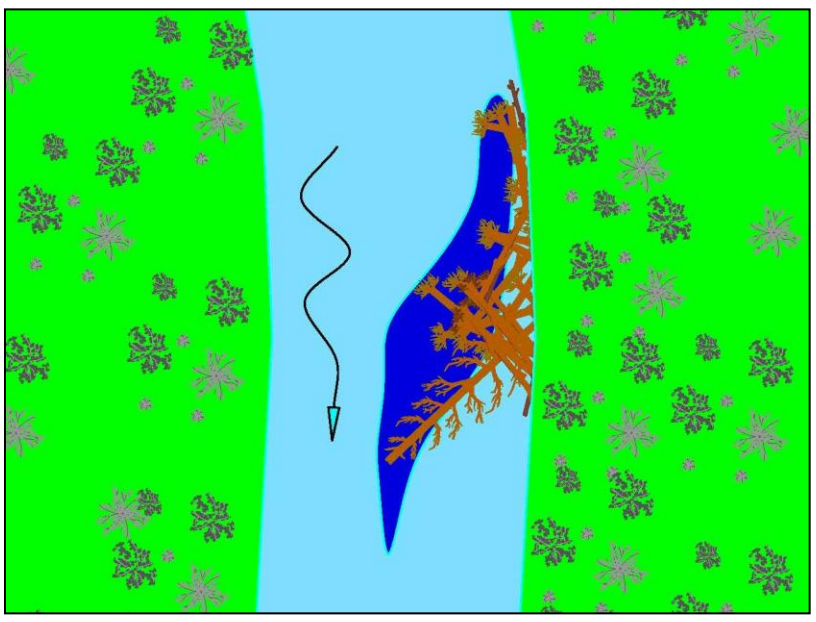
- Often relatively large log jams
- Located typically at the head of a mid-channel or point bar
- Split flow (high and/or low flow) to either side of the structure
- Typically create scour adjacent to and immediately upstream of the structure with significant deposition in the lee of the structure
-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



Barb Log Jams:

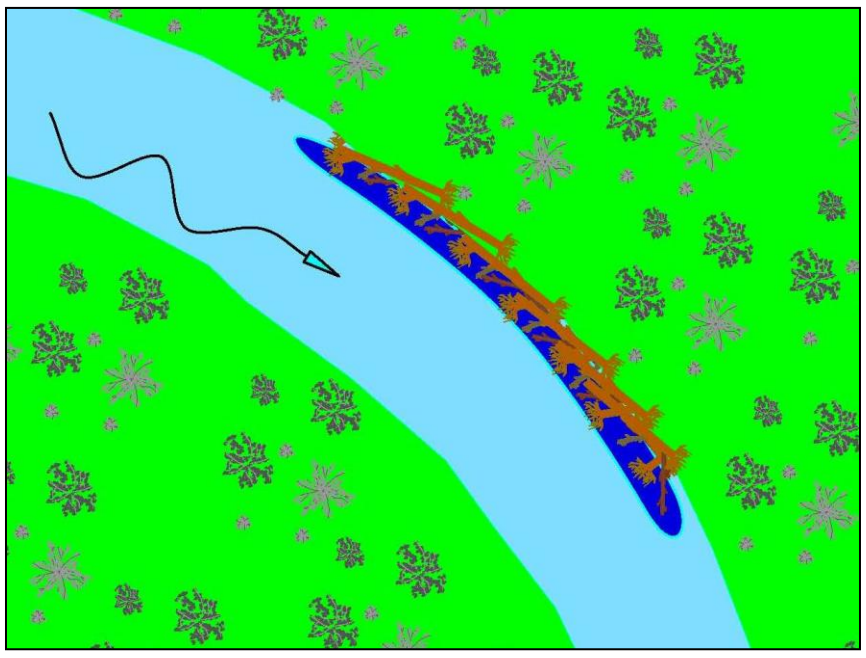
- Many different sizes
- Located on the bank, typically along the outside of a bend or in a relatively straight channel section
- Deflect and obstruct flow generally pushing the thalweg away from the bank
- Typically creates scour near the tip of the structure with deposition in the lee of the structure
- 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





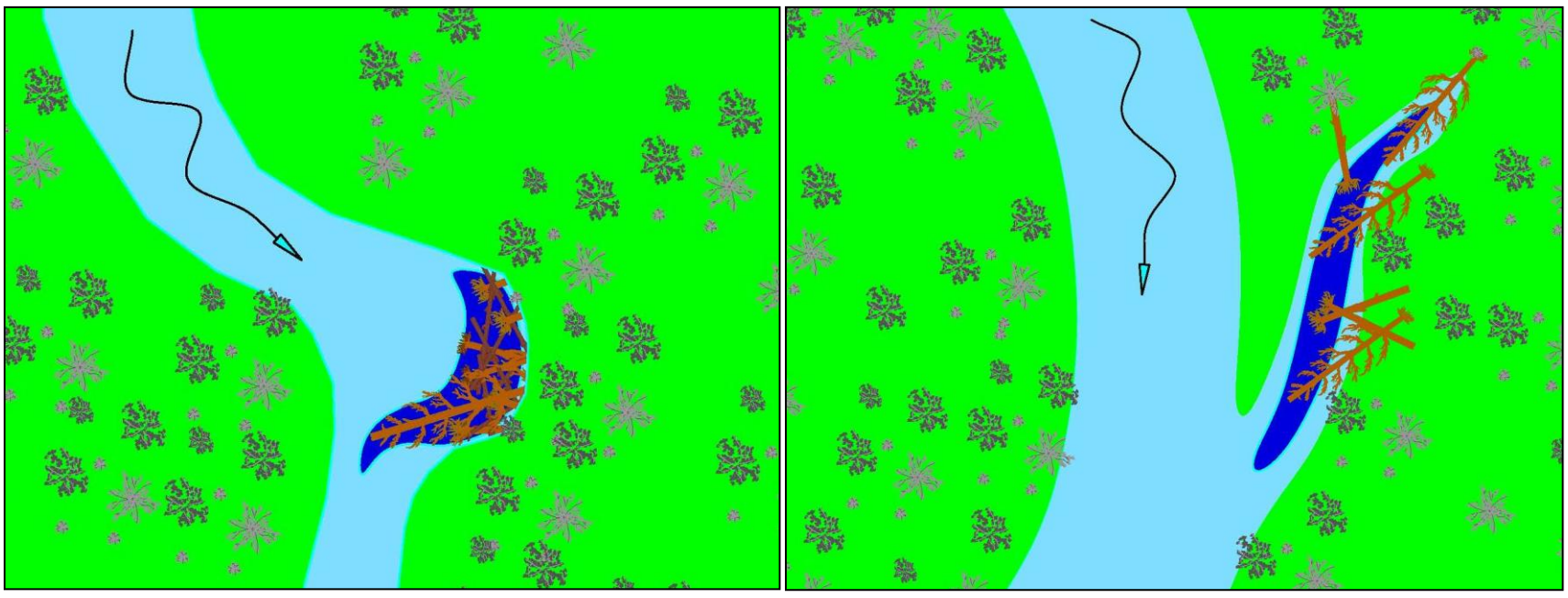
LWM Bank Stabilization:

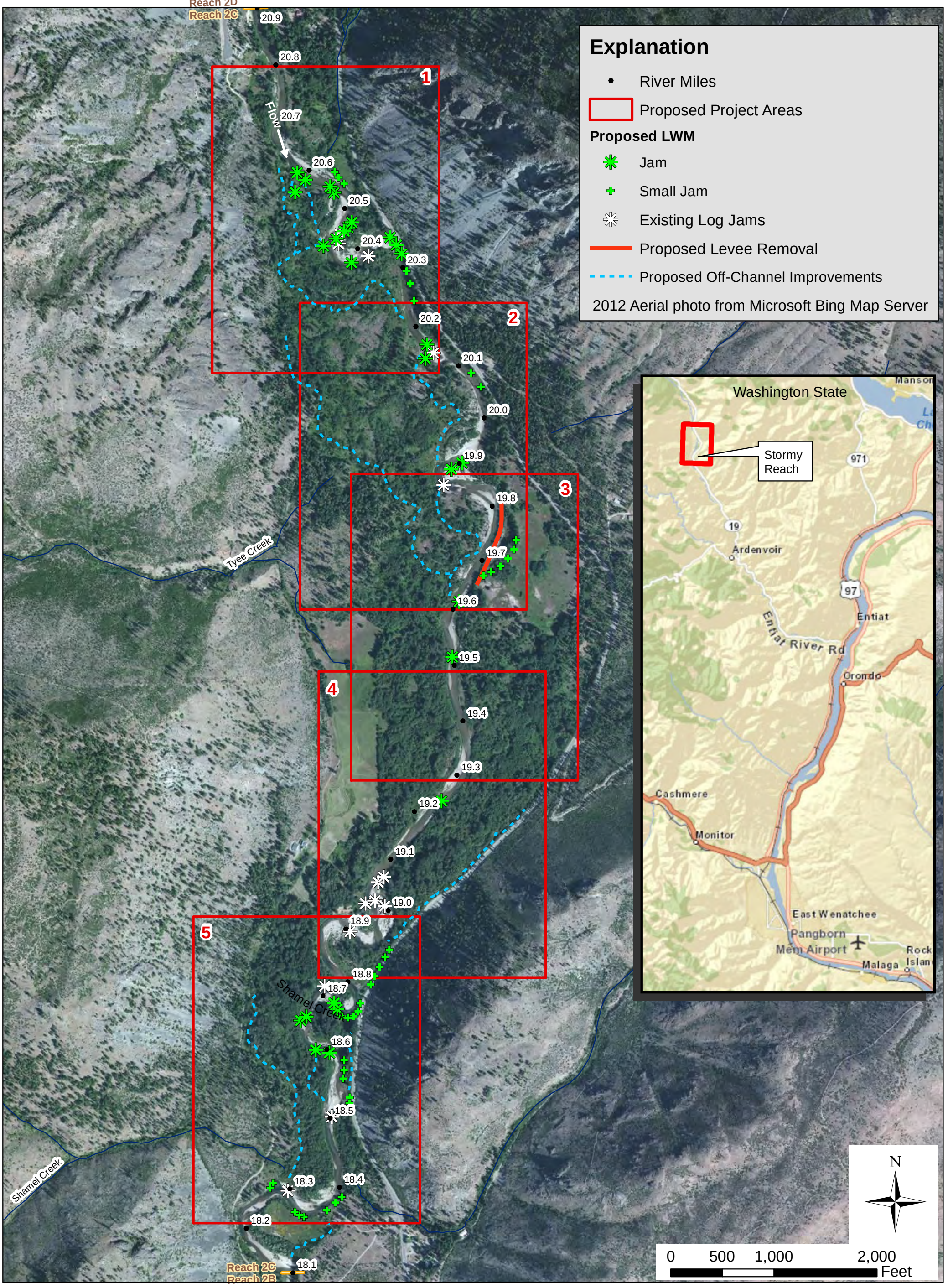
- Many different sizes and options
- Located on the bank, typically along the outside of a bend
- Increase roughness along the bank providing a buffer from erosive forces
- Typically promotes scour by translating lateral erosion into vertical erosion similar to a bank stabilized by mature riparian vegetation
- 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 -- Stormy Reach

Proposed Project Areas

Individual project areas have been identified in the following maps illustrating potential project actions to maximize habitat potential in the Stormy Reach of the Entiat River between River Miles (RM) 18-21. Project elements are considered to be geomorphically appropriate based on the Stormy Reach assessment (Reclamation, 2009), Stormy Reach Assessment Update (Reclamation, 2013) and 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

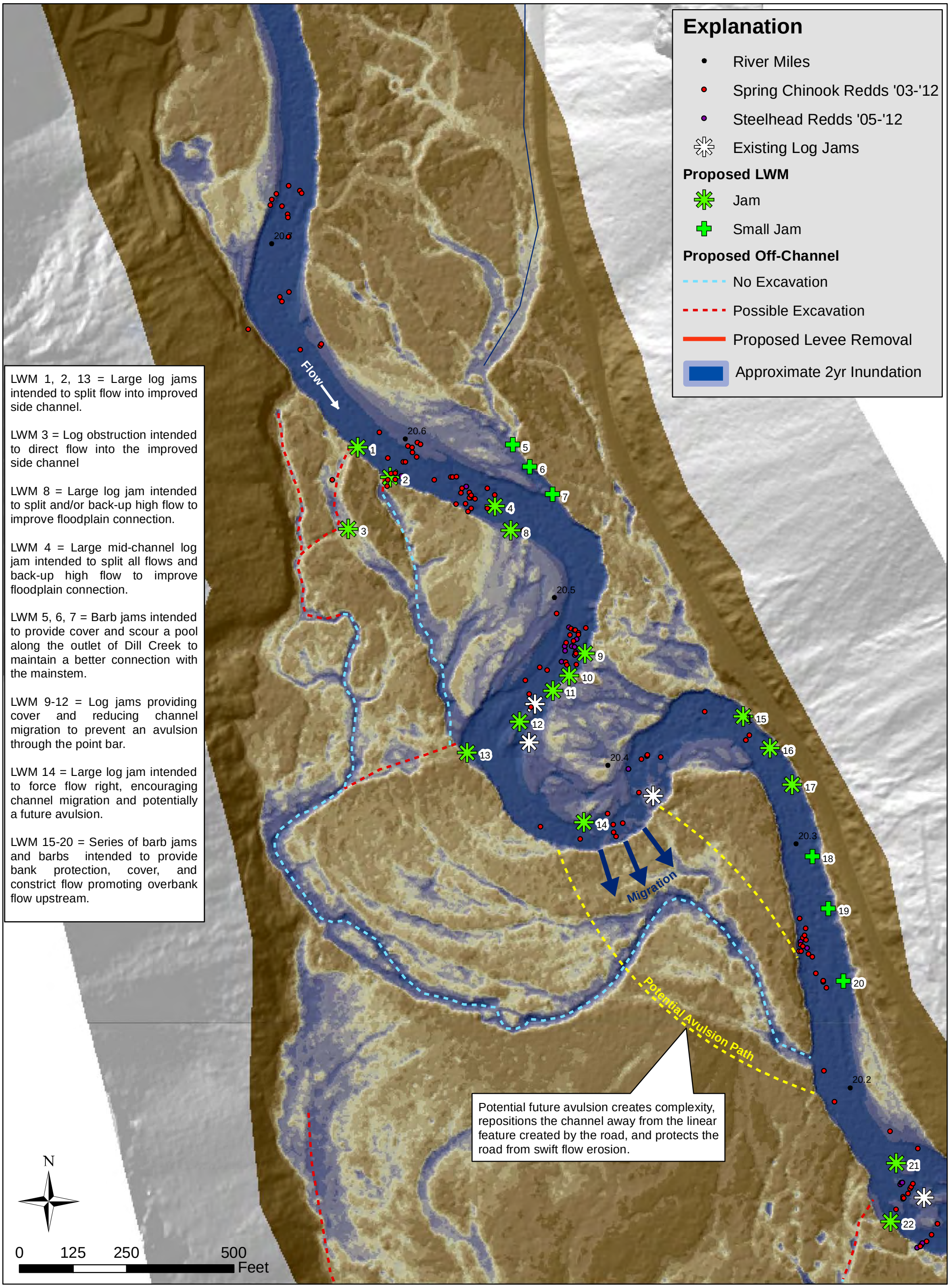
- Create a perennial side channel occupying existing low-lying topography on river right.
- Force channel migration to river right near RM 20.4 to increase sinuosity and overbank flow potentially resulting in an avulsion relocating the river away from the road.

Project Elements

- Side channel inlets
    - Excavate multiple pilot channel inlets, and include an additional hyporheic source (most northwesterly excavated channel) if groundwater analysis indicates it is feasible and advantageous. Multiple inlets will help support persistence of the side channel over time and may increase flow and shear through the channel enabling it to flush sediment more effectively. Groundwater inputs will improve thermal conditions and should be incorporated if/where possible.
    - Large log jams (#1, 2, 13) are proposed protruding from the bank immediately downstream of each side channel inlet to split flow into the side channel and create hydraulic conditions at the inlet(s) to maintain a perennial opening.
    - Secondary log jams are proposed (#4, 8) 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.
- Side channel
    - 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.
- Forced channel migration and possible avulsion
    - The intent of Log jam #14 is to force flow convergence against the right bank near RM 20.4 enhancing lateral channel migration and overbank flow with the potential of initiating an avulsion.
    - The intent of the barb jams and barbs (#15-20) along the road are to protect the road, but also constrict the channel forcing overbank flow near log jam #14 increasing the potential for an avulsion in this area. Larger jams are proposed at the narrowest channel section to maximize the constriction.
    - An avulsion in this location is considered a favorable, dynamic event that would add woody material to the system and move the channel away from the road. The road prism and associated riprap is a longitudinal, hydraulically smooth surface that increases stream local power, thereby increasing downstream migration, reducing lateral migration and reducing overall channel complexity and floodplain connection.
    - Log jams are proposed (#9-12) to add hydraulic roughness, deflect flow and prevent an avulsion through the left bank point bar at RM 20.45. The bend radius and meander wavelength at this site suggest the bend is susceptible to an avulsion in the near future. An avulsion in this location is considered unfavorable, because it would effectively focus flow against the road potentially resulting in a long, straight sub-reach that could incise and reduce floodplain connection. Maintaining more flow through the main stem in this location will enhance overbank flooding on river right and increase migration/avulsion potential where it is more favorable.
- Dell Creek habitat
    - Log structures (#5-7) are proposed along the left bank of Dell Creek at its confluence with the Entiat River in a location where Entiat floodwaters will converge against these obstructions scouring an alcove and improving access to Dell Creek. These elements are functionally separate from the others within this project area.

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.
- 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 are preferred for side channel excavations in order to reduce excavation spoils.
- Side channel excavation spoils 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.

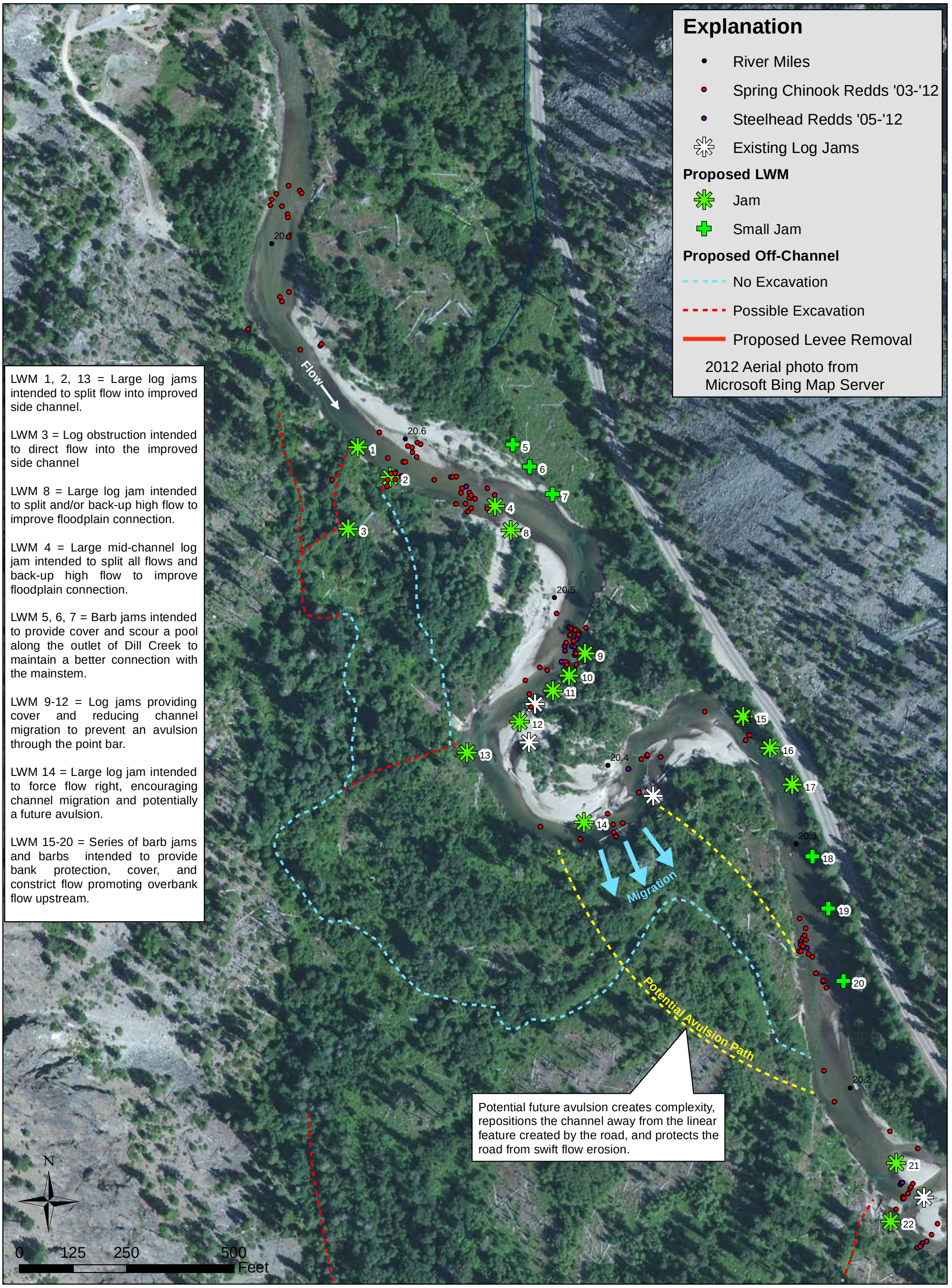


Entiat River -- Stormy Reach

Proposed Project Area #1

Project Description: Strategically placed engineered log jams and pilot channel excavations to create a perennial side channel in an abandoned meander oxbow. Multiple inlets to increase likelihood and longevity of perennial upstream connection. Possible groundwater inputs along the valley wall may moderate temperature and increase base flow. Additional wood placements are intended to improve overbank flow, cover, diversity, off-channel habitat, and reduce risk to infrastructure.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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 -- Stormy Reach

Proposed Project Area #1

Project Description: Strategically placed engineered log jams and pilot channel excavations to create a perennial side channel in an abandoned meander oxbow. Multiple inlets to increase likelihood and longevity of perennial upstream connection. Possible groundwater inputs along the valley wall may moderate temperature and increase base flow. Additional wood placements are intended to improve overbank flow, cover, diversity, off-channel habitat, and reduce risk to infrastructure.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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

- Obstruct instream flow forcing increased overbank flow and side channel activation.
- Deflect flow away from the road
- Improve alcove habitat

Project Elements

- Side channel with inlet near RM 20.15
    - Install an apex log jam obstruction (#21) on the riffle near RM 20.15 to backup flow and promote overbank flow enhancing the proposed side channel on river right.
    - A large log jam (#22) is proposed protruding from the bank immediately downstream from the side channel inlet near RM 20.15 to split flow into the side channel.
    - Excavate a pilot channel connecting low areas creating a downstream gradient throughout the length of the side channel
- Side channel with inlet near RM 19.85
    - Excavate a pilot channel at the inlet to enhance flow through the existing high-flow side channel.
    - Utilize the existing log jam to split flow into the side channel inlet.
    - Log jams (#25, 26) are proposed to add hydraulic roughness, deflect flow and prevent an avulsion through the left bank point bar at RM 19.9. The bend radius and meander wavelength at this site suggest the bend is susceptible to an avulsion in the near future. An avulsion in this location is considered unfavorable, because it would result in a long, straight sub-reach that could incise and reduce floodplain connection. Maintaining more flow through the main stem in this location will enhance overbank flooding and side channel activation on river right while increase migration/avulsion potential where it is more favorable.
- 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.

Considerations

- The alcove and both side channels in Project Area #2 are functionally independent from one another and can be designed or dropped without significantly affecting the other elements.
- 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 are preferred for side channel excavations in order to reduce excavation spoils.
- Side channel excavation spoils 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.
- Future channel alignment in the vicinity of the proposed levee removal should be considered for design elements in this area (see Project Area #3).

LWM 21 = Large mid-channel log jam intended to split and obstruct flow to create a backwater and improve floodplain connection.

LWM 22 = Large log jam intended to split flow into improved side channel.

LWM 23, 24 = Barb jams intended to provide bank protection, cover, and constrict flow promoting upstream floodplain connection.

LWM 25, 26 = Log jams intended to provide cover and reduce the avulsion potential through the point bar in this location.

0 125 250 500 Feet

N

Flow

20.2

21

22

20.1

23

24

20.0

25

26

Proposed alcove improvements:
upstream excavation extent depends on groundwater potential and disturbance limits

19.8

27

28

28

28

28

19.7

See Proposed Project Area #3

29

19.6

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

- No Excavation
- Possible Excavation
- Proposed Levee Removal
- Potential Excavation
- Approximate 2yr Inundation

Entiat River -- Stormy Reach

Proposed Project Area #2

Project Description: Strategically placed engineered log jams and pilot channel excavations to create potentially perennial side channels and a perennial groundwater-fed alcove channel. Additional wood placements are intended to improve overbank flow, cover, diversity, off-channel habitat, and reduce risk to infrastructure. Levee removal and associated log jams are discussed as part of Project #3.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

LWM 21 = Large mid-channel log jam intended to split and obstruct flow to create a backwater and improve floodplain connection.

LWM 22 = Large log jam intended to split flow into improved side channel.

LWM 23, 24 = Barb jams intended to provide bank protection, cover, and constrict flow promoting upstream floodplain connection.

LWM 25, 26 = Log jams intended to provide cover and reduce the avulsion potential through the point bar in this location.

0 125 250 500 Feet

N

Flow

20.2

21

22

20.1

23

24

20.0

25

26

Proposed alcove improvements:
upstream excavation extent depends on groundwater potential and disturbance limits

19.8

27

28

28

28

28

28

19.7

See Proposed Project Area #3

29

19.6

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

- No Excavation
- Possible Excavation
- Proposed Levee Removal
- Potential Excavation

2012 Aerial photo from Microsoft Bing Map Server

Entiat River -- Stormy Reach

Proposed Project Area #2

Project Description: Strategically placed engineered log jams and pilot channel excavations to create potentially perennial side channels and a perennial groundwater-fed alcove channel. Additional wood placements are intended to improve overbank flow, cover, diversity, off-channel habitat, and reduce risk to infrastructure. Levee removal and associated log jams are discussed as part of Project #3.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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

- Removing existing levee and associated riprap
- Place strategic log jams to aid in the reestablishment of an appropriate meander pattern

Project Elements

- Levee removal
    - Removal of the levee and associated riprap will enable the channel to migrate laterally and improve floodplain connection. It is assumed that the channel would rapidly adjust to levee removal, reoccupying a historic meander scar clearly visible behind the levee.
    - Levee removal may include complete excavation of the levee or partial breaching. A new channel may be fully excavated as proposed in the maps or the channel may be allowed to migrate into the newly exposed area behind the levee over time.
    - Bioengineering bank stabilization including placement of LWM (#28) may be necessary to prevent excessive lateral migration where riparian vegetation is absent.
- Log jam placement
    - Large log jam (#27) proposed near the apex of the point bar located at the upstream end of the levee removal and two or more large log jams (#29-30) proposed near the apex of two poorly defined point bars immediately downstream of the levee removal site. The purpose of the log jams is to force high flows laterally in order to encourage bar building in the lee of the structure and erosion on the opposite bank resulting in lateral migration and improved channel sinuosity. Log jam #27 is specifically intended to encourage flow into the area exposed by the levee removal project.

Considerations

- The levee removal and log jams are functionally independent although complimentary such that one should significantly enhance the other regarding channel process.
- Following levee removal, allowing the channel to adjust on its own without constructing a new channel will provide sediment to drive bar building and lateral migration at the log jam sites immediately downstream.
- 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.
- Future channel alignment in the vicinity of the proposed levee removal should be considered for design elements in this area.

0 125 250 500 Feet

N

Potential future channel pattern and migration direction following proposed levee removal

LWM 27 = Large log jam intended to encourage ongoing point bar development, force flow left into the area opened up by levee removal, split high flows, increase lateral migration.

LWM 28 = Series of barbs intended to provide bank stabilization for potential future channel location while riparian vegetation matures.

LWM 29 = Large log jam intended to encourage ongoing point bar development, force flow right, split high flow, and ultimately increase lateral channel migration and overall reach sinuosity.

19.8
19.7
19.6
19.5
19.4
19.3
Flow

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

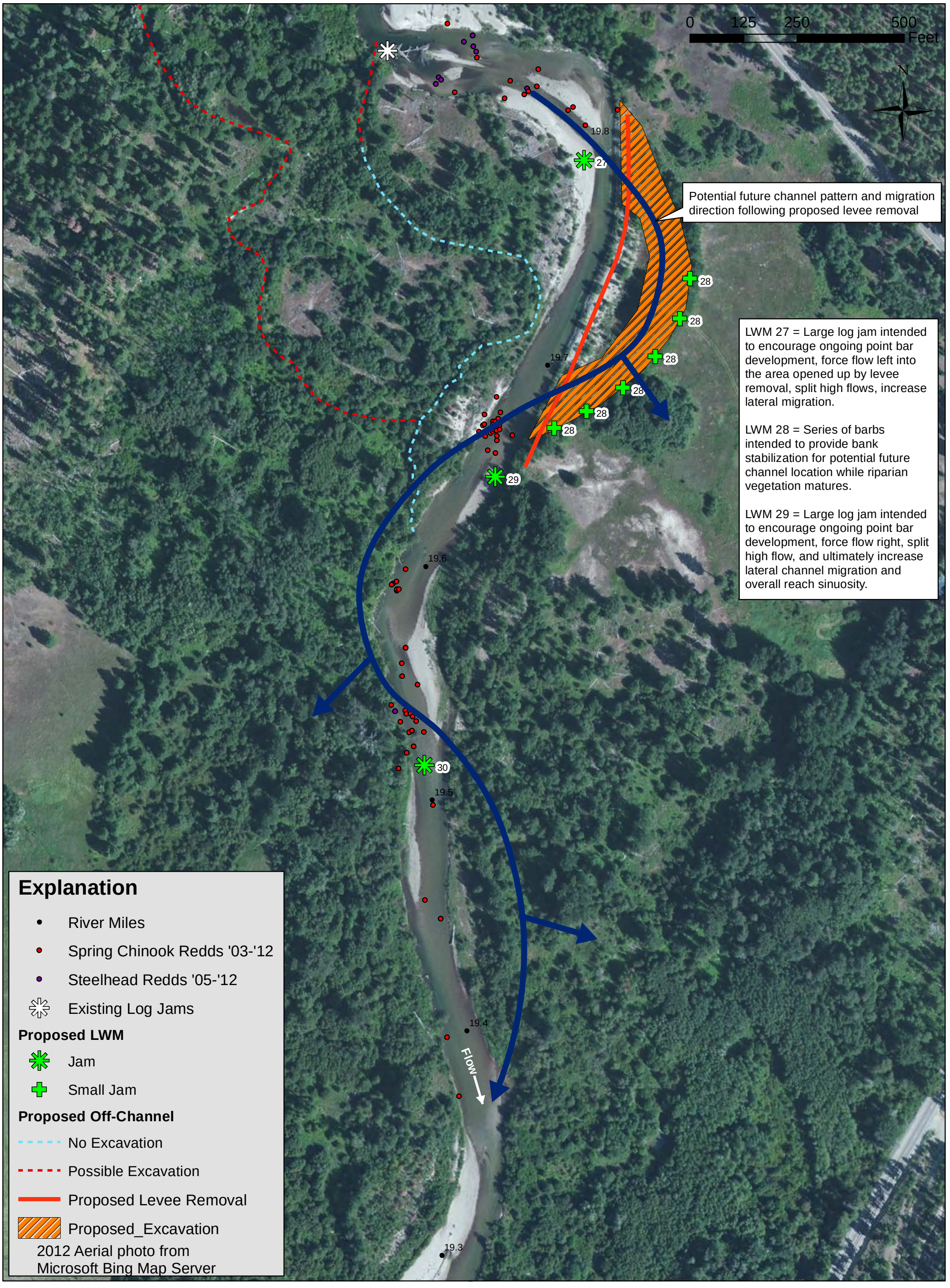
- No Excavation
- Possible Excavation
- Proposed Levee Removal
- Proposed_Excavation
- Approximate 2yr Inundation

Entiat River -- Stormy Reach

Proposed Project Area #3

Project Description: Project is focused around removal of a large levee and associated riprap. Levee removal will promote the reinstitution of a more natural, higher-sinuosity meander pattern that will in turn improve channel dynamics and floodplain connection. Strategically placed engineered log jams are intended to promote appropriate rates of lateral channel migration enabling the river to perform the majority of the earthwork associated with this project, although channel relocation behind the levee may be enhanced by excavation to shorten response time.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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 -- Stormy Reach

Proposed Project Area #3

Project Description: Project is focused around removal of a large levee and associated riprap. Levee removal will promote the reinstitution of a more natural, higher-sinuosity meander pattern that will in turn improve channel dynamics and floodplain connection. Strategically placed engineered log jams are intended to promote appropriate rates of lateral channel migration enabling the river to perform the majority of the earthwork associated with this project, although channel relocation behind the levee may be enhanced by excavation to shorten response time.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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

- Add log jams to improve floodplain connection and hydraulic diversity in an otherwise straight reach.

Project Elements

- Log jams
    - Install three (or more) log jam (#31-33) on cross-over riffles and point bars centered near RM 19.25 to obstruct flow, improve floodplain connection, increase side channel/alcove flow, and improve lateral channel migration.
    - Log jam placement can split flow or force flow laterally depending on the desired outcome.
    - The larger the obstruction, the greater the response.
- Alcove
    - Verify surface water connection throughout length of existing alcove; excavate as necessary to reestablish connection.
    - Log jam obstructions in the main stem are intended to force increased overbank flow which should improve alcove connection and high-flow sediment flushing.
    - Consider adding whole logs for cover and roughness as needed throughout the alcove.

Considerations

- Log jam placement near RM 19.25 will function largely independent of other proposed projects in the reach, although changes to channel form resulting from levee removal upstream may alter the hydraulics within Project Area 4 and should be considered during design.
- 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.
- Future channel alignment in the vicinity of the proposed levee removal should be considered for design elements in this area.

Flow

19.4

31

19.3

32

19.2

33

19.1

19.0

8.9

34

35

36

37

See Project Area 5

Verify alcove connectivity along its length; excavate where necessary; provide cover as needed.

LWM 31-33 = three or more large apex log jams intended to split flow, back-up flood waters promoting overbank flow, enhance side channel development, and promote lateral migration.

N

0 125 250 500 Feet

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

- No Excavation
- Possible Excavation
- Proposed Levee Removal
- Approximate 2yr Inundation

Entiat River -- Stormy Reach

Proposed Project Area #4

Project Description: Improve alcove connectivity as necessary along the road and provide cover where needed – excavation may be required. Three or more large apex log jams are intended to split flow, back-up flood waters promoting overbank flow, enhance side channel and alcove development and promote lateral channel migration. Log jams should be placed according to hydraulic conditions favoring increased floodplain connection and hydraulic diversity.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) 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 -- Stormy Reach

Proposed Project Area #4

Project Description: Improve alcove connectivity as necessary along the road and provide cover where needed – excavation may be required. Three or more large apex log jams are intended to split flow, back-up flood waters promoting overbank flow, enhance side channel and alcove development and promote lateral channel migration. Log jams should be placed according to hydraulic conditions favoring increased floodplain connection and hydraulic diversity.

Project elements were generated from the Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).

Flow

19.4

31

19.3

32

19.2

33

19.1

19.0

8.9

34

35

36

37

LWM 31-33 = three or more large apex log jams intended to split flow, back-up flood waters promoting overbank flow, enhance side channel development, and promote lateral migration.

Verify alcove connectivity along its length; excavate where necessary; provide cover as needed.

See Project Area 5

N

0 125 250 500 Feet

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

- No Excavation
- Possible Excavation
- Proposed Levee Removal

2012 Aerial photo from Microsoft Bing Map Server

Proposed Project Area #5

Project Intent

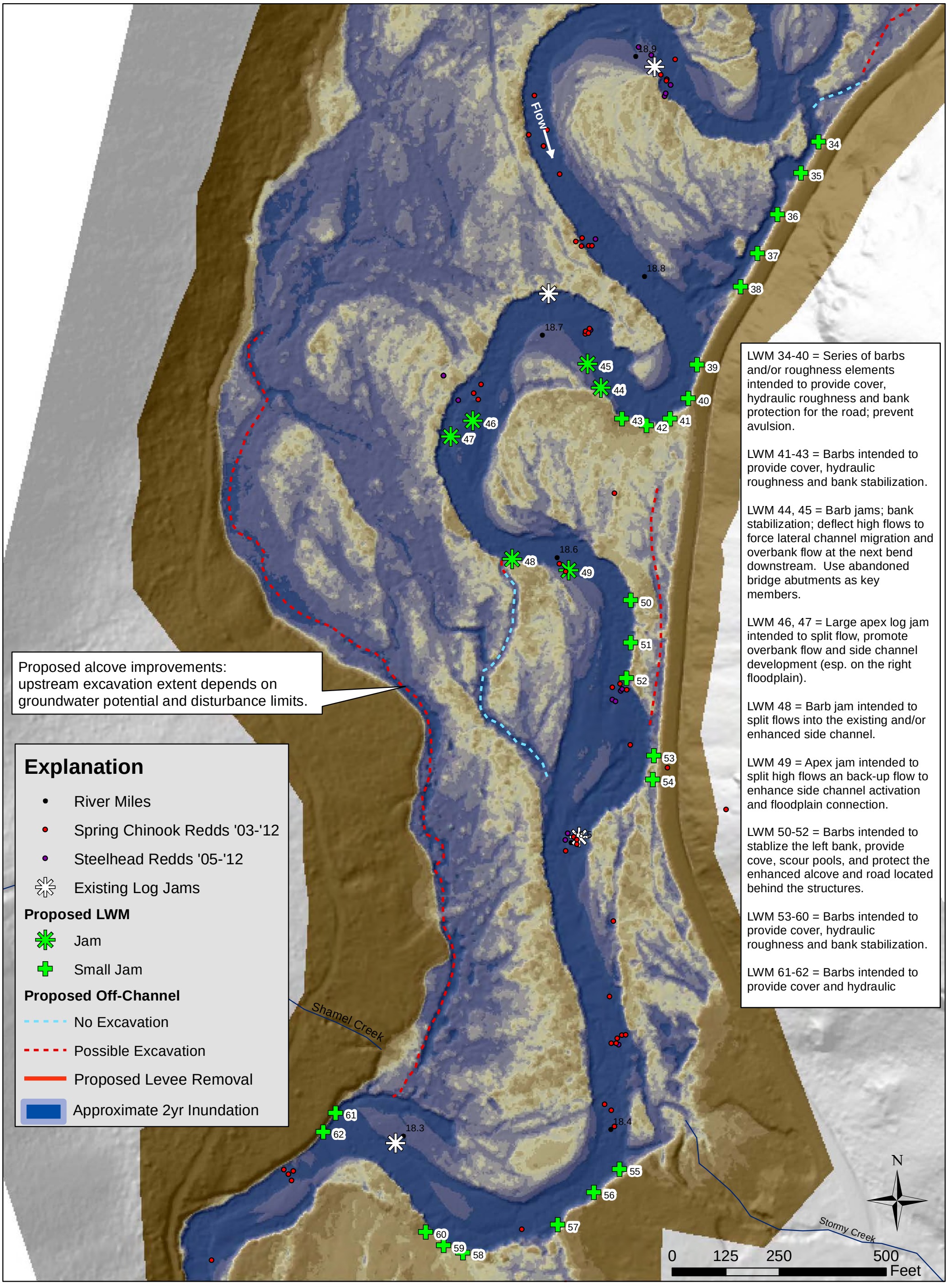
- Obstruct flow with log jams forcing increased lateral migration and floodplain connection including side channels and alcoves.
- Improve instream cover, hydraulic roughness and complexity
- Stabilize banks where riparian vegetation is lacking
- Provide roughness along the Entiat River Road.

Project Elements

- Bank roughness LWM
    - Install a series barb jams or similar roughness structures (#34-40) to add roughness and obstruct flow along the road in an existing side channel. Increased roughness and flow obstructions will reduce the risk of avulsion through the existing side channel, add protection to the adjacent road, and provide cover.
    - Install barb jams or similar structures (#41-45) to add roughness and stabilize the bank to prevent channel avulsion through the point bar centered at RM 18.65. Avulsion through this point bar would place the channel against the road for an extended length, potentially reducing lateral migration and overall instream complexity. Forcing flow to continue around the bend at RM 18.75 will enhance lateral migration potential on the right bank, directing flow away from the road and increasing overbank flow on the right floodplain. Abandoned rock and log bridge abutments may be used as key members to support log jam structure (#44).
    - Install barb jams or similar structures (#50-52) to add roughness, provide cover in an appropriate location and stabilize the bank protecting a proposed alcove enhancement between the structures and the road.
    - Install barb jams or similar structures (#53-54) to provide roughness and cover near the proposed alcove and to protect the road.
    - Install barb jams or similar structures (#55-60) to provide bank roughness and cover in an area where mature riparian vegetation is lacking. Also, barb jams will stabilize banks from excessive erosion and downstream channel migration.
    - Install barb jams or similar structures (#61-62) to provide roughness and cover near an alcove improvement.
- Right-bank alcove
    - Install log jams (#46-47) on an existing riffle to obstruct flow, improve floodplain connection, and potentially add more surface water at high flow and hyporheic water at low flow to the alcove on river right.
    - 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.
    - Add whole trees for cover as needed (not shown in maps).
- Left-bank alcove
    - 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.
    - Alcove longevity depends on bank stabilization along bends near RM 18.75 and near RM 18.55 and therefore should be considered in conjunction with barbs #41-43 and #50-52 respectively.
- Side channel
    - An existing high-flow channel on river right can be enhanced to create a perennial surface-water inlet connection with minimal excavation (pilot channel).
    - A strategically placed log jam (#48) is proposed protruding from the bank immediately downstream of the side channel inlet to split flow into the side channel and create hydraulic conditions at the inlet to maintain a perennial opening.
    - A strategically placed log jam (# 49) is proposed to split and obstruct flow on a point bar near RM 18.6. Obstructing flow will increase floodplain connection and improve side channel function.

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. Barbs 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 may need to be staged using a helicopter to reduce equipment traffic and associated disturbance in the channel and on the floodplain.
- Pilot channels are preferred for side channel excavations in order to reduce excavation spoils.
- Side channel and alcove excavation spoils 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.
- Future channel alignment in the vicinity of the proposed levee removal should be considered for design elements in this area.

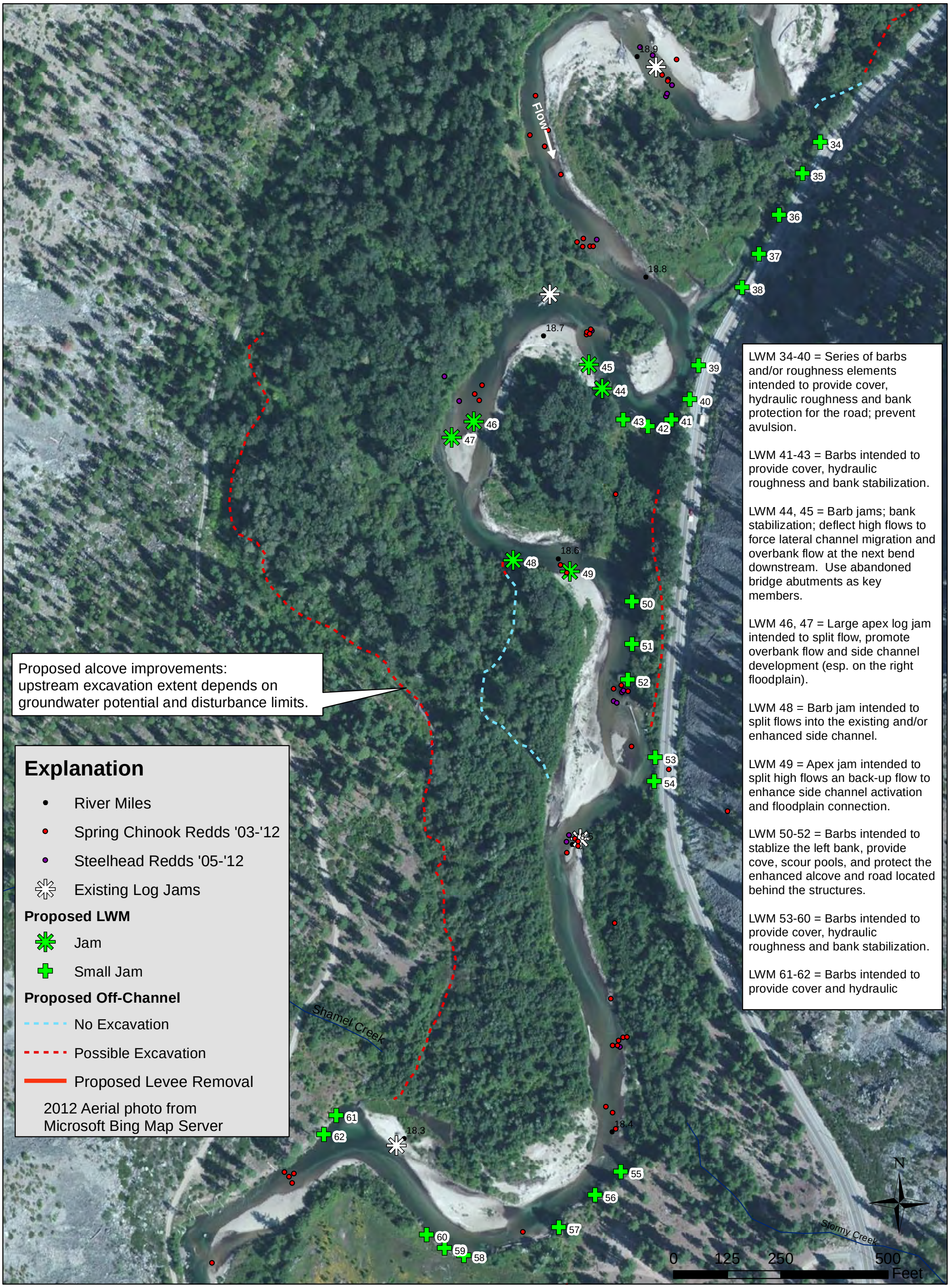


Entiat River -- Stormy Reach

Proposed Project Area #5

Project Description: Install strategically placed LWM structures to increase floodplain connection, lateral migration, in-stream roughness, complexity and cover. Additionally, bank stabilization and roughness along the road will protect infrastructure and limit the potential for the channel to lock-in against the road prism. 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 Stormy RA (Reclamation, 2009), Stormy RA Update (Reclamation, 2013) and a Technical Team meeting of interdisciplinary river design professionals from Reclamation, BPA, Yakama Nation, USFWS, NRCS, UCSRB and Interfluve (4/17/2013).



Proposed alcove improvements:
upstream excavation extent depends on groundwater potential and disturbance limits.

Explanation

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

Proposed LWM

- Jam
- Small Jam

Proposed Off-Channel

- No Excavation
- Possible Excavation
- Proposed Levee Removal

2012 Aerial photo from Microsoft Bing Map Server

LWM 34-40 = Series of barbs and/or roughness elements intended to provide cover, hydraulic roughness and bank protection for the road; prevent avulsion.

LWM 41-43 = Barbs intended to provide cover, hydraulic roughness and bank stabilization.

LWM 44, 45 = Barb jams; bank stabilization; deflect high flows to force lateral channel migration and overbank flow at the next bend downstream. Use abandoned bridge abutments as key members.

LWM 46, 47 = Large apex log jam intended to split flow, promote overbank flow and side channel development (esp. on the right floodplain).

LWM 48 = Barb jam intended to split flows into the existing and/or enhanced side channel.

LWM 49 = Apex jam intended to split high flows an back-up flow to enhance side channel activation and floodplain connection.

LWM 50-52 = Barbs intended to stablize the left bank, provide cove, scour pools, and protect the enhanced alcove and road located behind the structures.

LWM 53-60 = Barbs intended to provide cover, hydraulic roughness and bank stabilization.

LWM 61-62 = Barbs intended to provide cover and hydraulic

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