

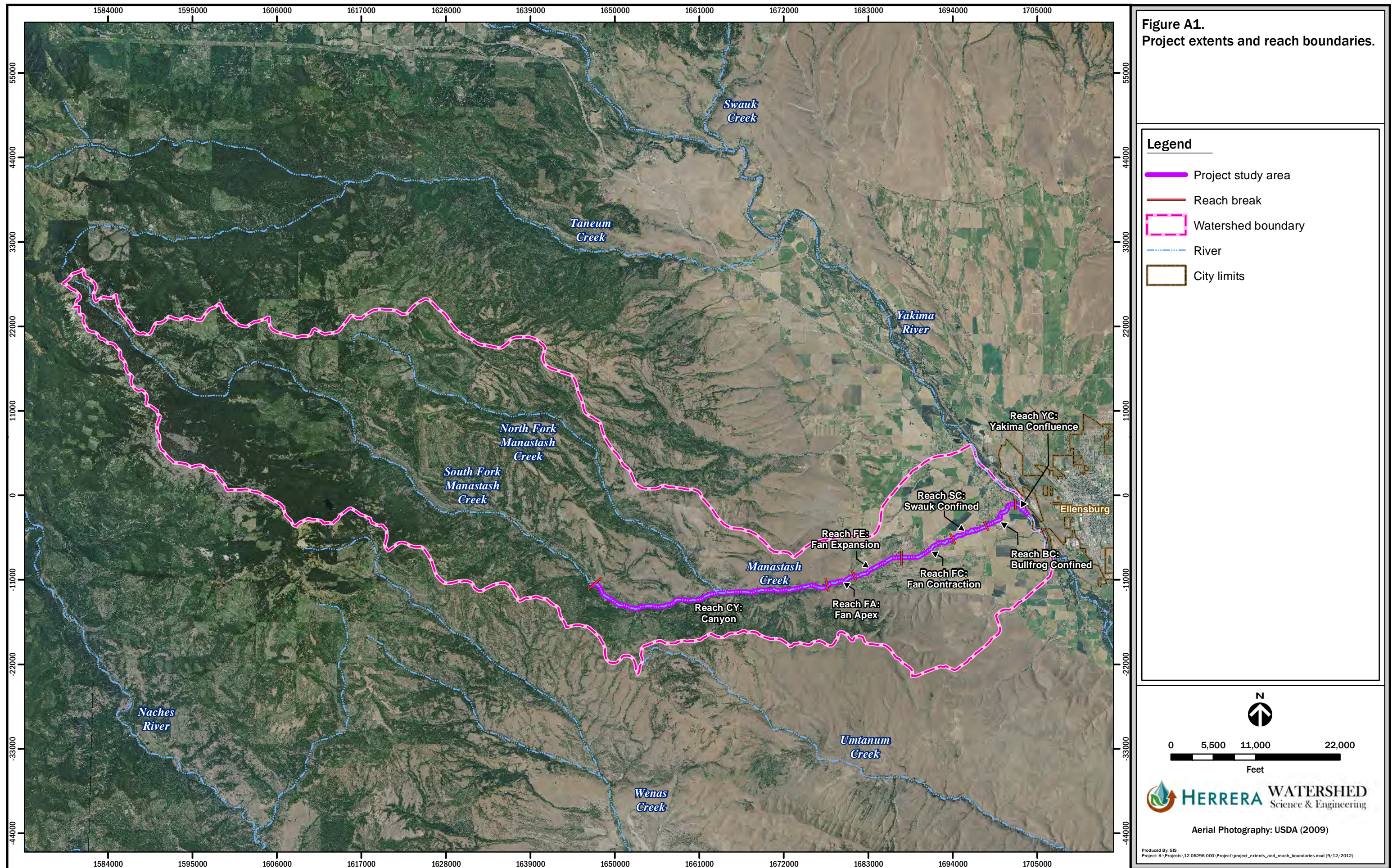
## APPENDIX A

---

# Habitat Assessment Figures













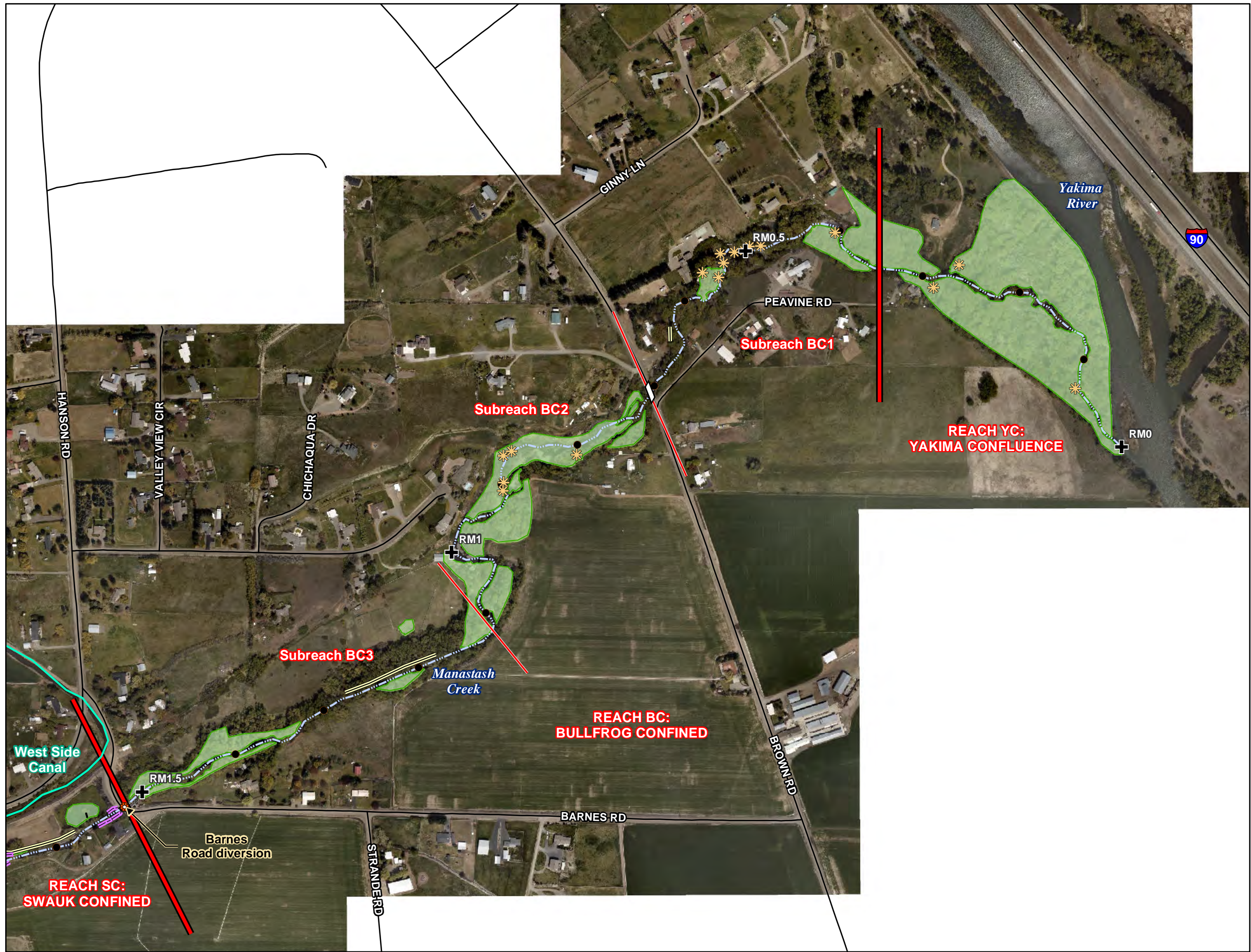


Figure A2.  
Yakima Confluence (Reach YC) and  
Bullfrog Confined (Reach BC) habitat  
conditions.

- Legend**
- Subreach break
  - Reach break
  - Irrigation system
  - Bridge
  - Irrigation diversion
  - Culvert
  - Half river mile
  - Large woody debris (LWD)
  - 1/10th river mile
  - Manastash Creek
  - Bank armor
  - Levee
  - Potential wetland habitat

N

0 250 500 1,000  
Feet

**HERRERA** WATERSHED  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets.mxd (9/11/2012)





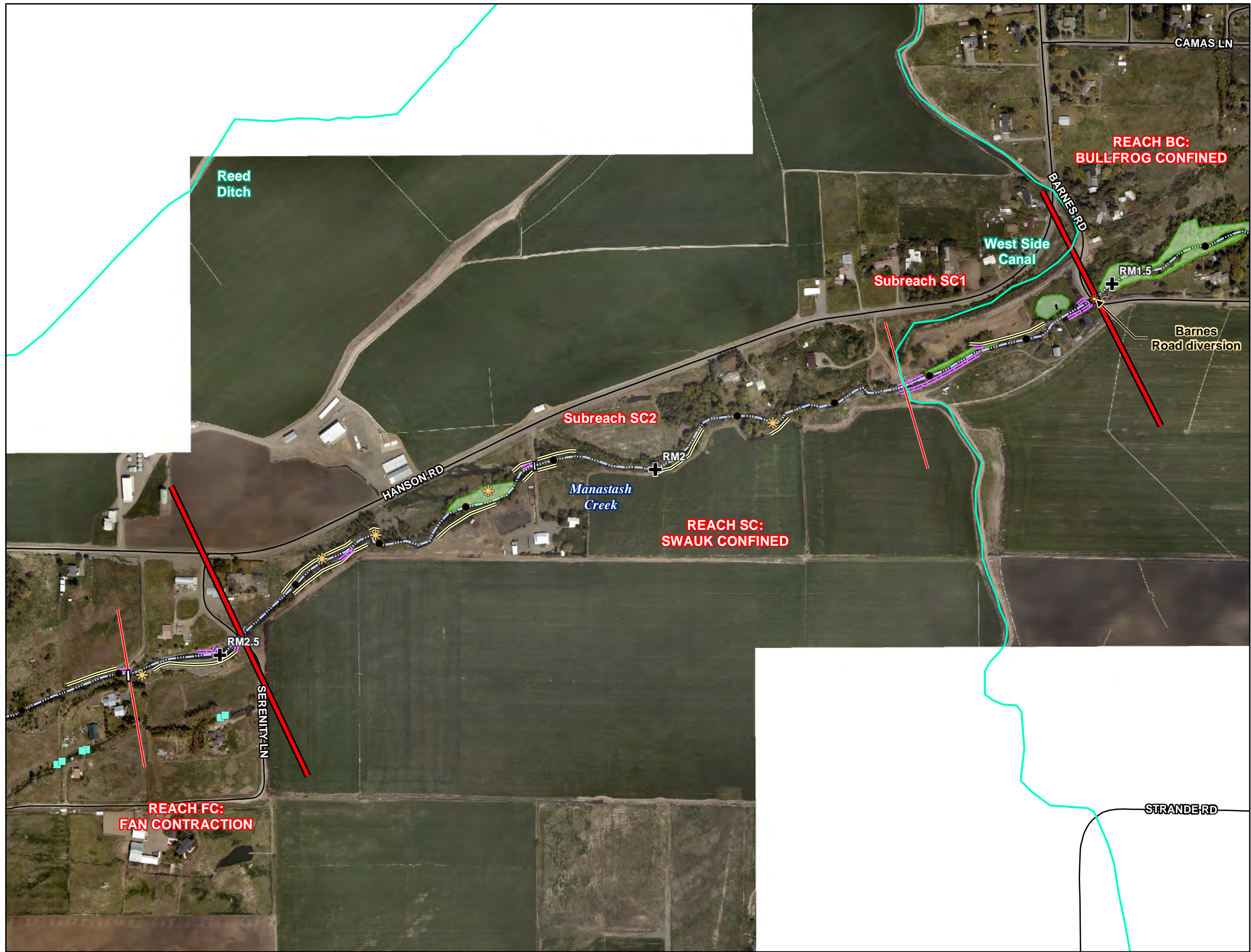


Figure A3.  
Swauk Confinement (Reach SC) habitat  
conditions.

**Legend**

- Subreach break
- Reach break
- Irrigation system
- Bridge
- Irrigation diversion
- Culvert
- Half river mile
- Large woody debris (LWD)
- 1/10th river mile
- Manastash Creek
- Bank armor
- Levee
- Potential wetland habitat

N

0 250 500 1,000  
Feet

**HERRERA** WATERSHED  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets.mxd (9/11/2012)







Figure A4.  
Fan Contraction (Reach FC) habitat  
conditions.

#### Legend

- Subreach break
- Reach break
- Irrigation system
- Bridge
- Irrigation diversion
- Culvert
- + Half river mile
- ✱ Large woody debris (LWD)
- 1/10th river mile
- Manastash Creek
- Bank armor
- == Levee
- Potential wetland habitat



0 312.5 625 1,250  
Feet



Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets.mxd (9/11/2012)







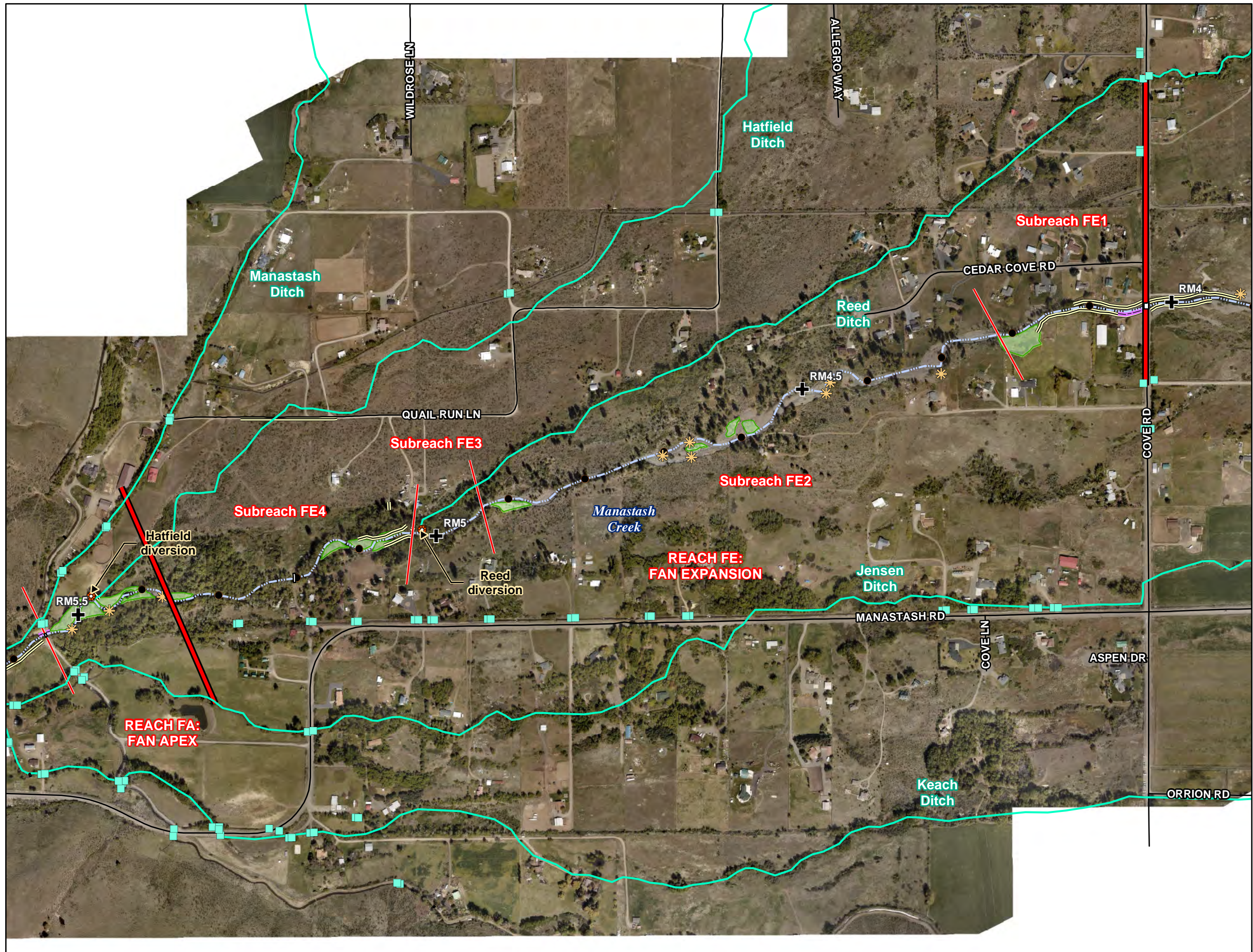
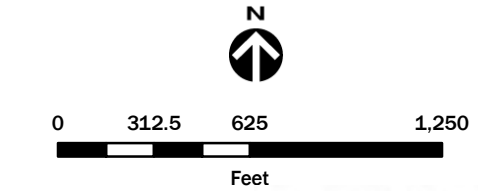


Figure A5.  
Fan Expansion (Reach FE) habitat  
conditions.

Legend

- Subreach break
- Reach break
- Irrigation system
- Bridge
- Irrigation diversion
- Culvert
- Half river mile
- Large woody debris (LWD)
- 1/10th river mile
- Manastash Creek
- Bank armor
- Levee
- Potential wetland habitat



**HERRERA** WATERSHED  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets.mxd (9/11/2012)







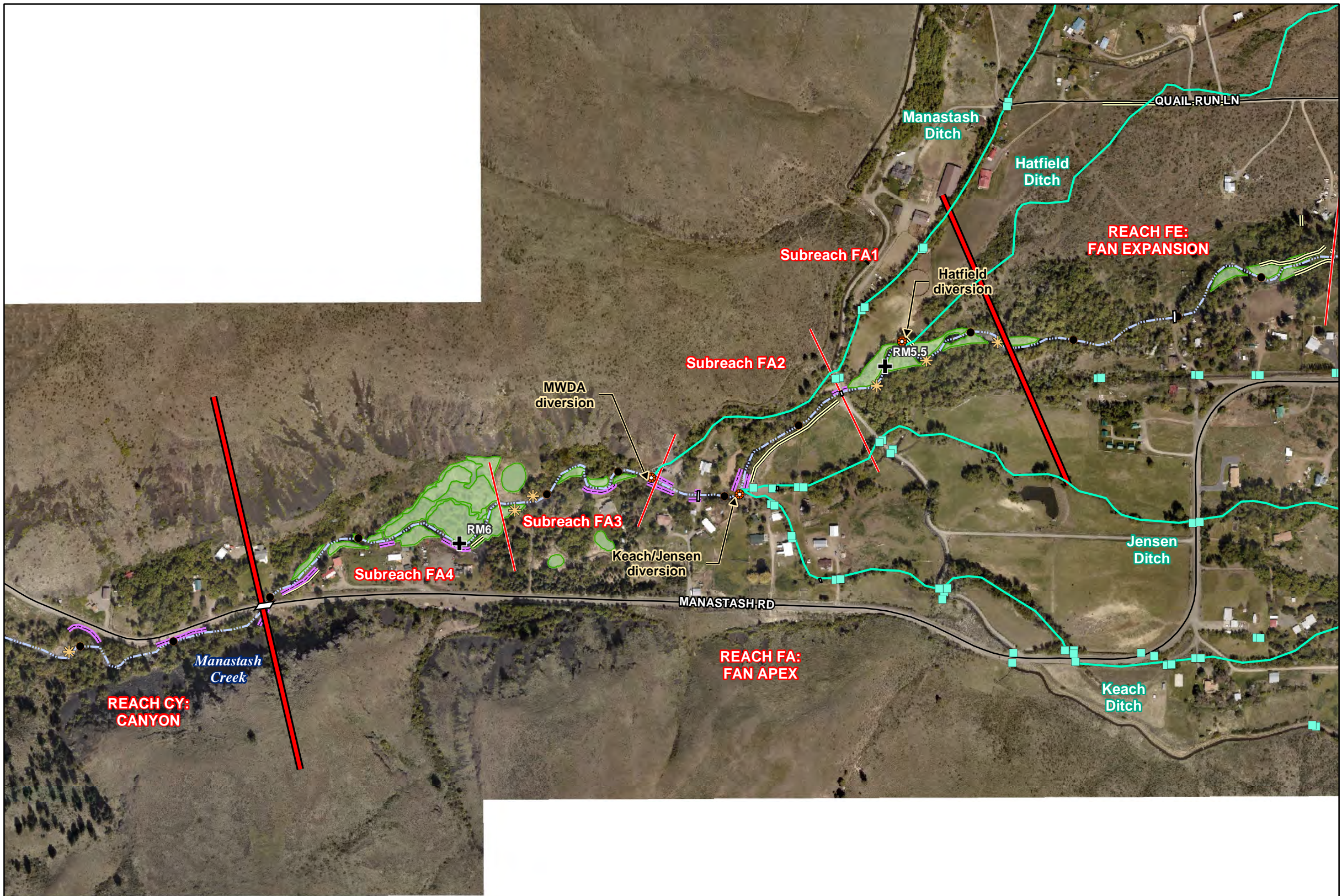
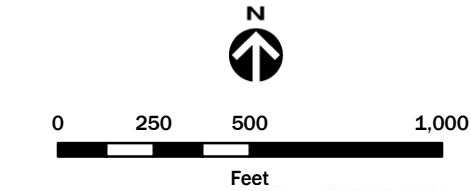


Figure A6.  
Fan Apex (Reach FA) habitat  
conditions.

**Legend**

- Subreach break
- Reach break
- Irrigation system
- Bridge
- Irrigation diversion
- Culvert
- + Half river mile
- ✱ Large woody debris (LWD)
- 1/10th river mile
- Manastash Creek
- - - Bank armor
- = = = Levee
- Potential wetland habitat



**HERRERA** WATERSHED  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets.mxd (9/11/2012)








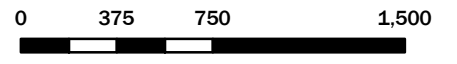


Figure A7.  
Canyon (Reach CY) habitat  
conditions (Sheet 1 of 4).

**Legend**


- Reach break
- Large woody debris (LWD)
- Irrigation diversion
- Culvert
- Bridge
- Bank armor
- Levee
- 1/10th river mile
- Half river mile
- Manastash Creek





0      375      750      1,500

Feet



Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets\_canyon.mxd (9/12/2012)







Figure A8.  
Canyon (Reach CY) habitat  
conditions (Sheet 2 of 4).

**Legend**

- Reach break
- Large woody debris (LWD)
- Irrigation diversion
- Culvert
- Bridge
- Bank armor
- Levee
- 1/10th river mile
- Half river mile
- Manastash Creek

N

0 375 750 1,500

Feet

**HERRERA** WATERSHED  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets\_canyon.mxd (9/12/2012)









Figure A9.  
Canyon (Reach CY) habitat  
conditions (Sheet 3 of 4).

**Legend**

- Reach break
- Large woody debris (LWD)
- Irrigation diversion
- Culvert
- Bridge
- Bank armor
- Levee
- 1/10th river mile
- Half river mile
- Manastash Creek

N

0 375 750 1,500

Feet

**HERRERA WATERSHED**  
Science & Engineering

Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets\_canyon.mxd (9/12/2012)



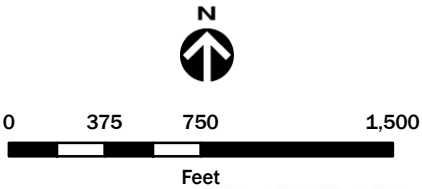




Figure A10.  
Canyon (Reach CY) habitat  
conditions (Sheet 4 of 4).

Legend

- Reach break
- Large woody debris (LWD)
- Irrigation diversion
- Culvert
- Bridge
- Bank armor
- Levee
- 1/10th river mile
- Half river mile
- Manastash Creek



Aerial Photography: 3DiWest (May 2012)

Produced By: GIS  
Project: K:\Projects\12-05295-000\Project\reach\_detail\_sheets\_canyon.mxd (9/12/2012)







## APPENDIX B

---

# Habitat Conditions Described by Reach-Based Ecosystem Indicators





Table B-1. Habitat Conditions of Reach YC (Yakima Confluence Reach).			
General Characteristics	General Indicators	Specific Indicators	Reach YC Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach. Access from upstream of reach SC1 is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.
Hydrology	Stream flow	Alteration of peak or base flows	<b>Unacceptable Risk Condition</b> Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach. Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<b>At Risk Condition</b> Water quality limited by irrigation withdrawals and return flows.
Habitat Quality	Substrate	Dominant substrate/fine sediment	<b>Unacceptable Risk Condition</b> Substrate character is highly variable throughout the multi-thread channel network in this reach. Most active channels had substrate predominantly in the gravel size classes, while newly cut, abandoned, or less frequently activated channels had substrate in the sand and fines size classes. Cementation was fair, and embeddedness was 50-75% in this low-gradient, depositional environment.
	Large Woody Debris	Pieces per mile	<b>Adequate Condition</b> Numerous and significant accumulations of large (20" x 35'), medium (12" x 35') and small (6" x 20') woody debris were observed in a multi-thread, distributary fan setting. Mature riparian forest and significant LWD in upstream reaches provides adequate recruitment source. Rated as properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.
	Pools	Frequency and quality	<b>Adequate Condition</b> Though no formal pool count or habitat survey was conducted for this reach, numerous and highly variable pool environments were present throughout the distributary channel network in this reach. Observed pools ranged in size from approximately 5'x5'x2'deep to 50'x25'x5' deep, trending towards the smaller side. Overhead cover and complexity were both high, and the amount of fines in the pool bottoms varied significantly.
	Complexity	Variability and heterogeneity of habitat units	<b>Adequate Condition</b> Although no formal pool count or habitat survey was conducted for this reach, numerous and highly variable habitat unit environments were present throughout the distributary channel network in this reach. Abundant LWD provides significant overhead cover and complexity to habitat units.
	Off-Channel Habitat	Connectivity with main channel	<b>Adequate Condition</b> This reach has numerous distributary channels, abandoned channels, and low energy areas with significant LWD and overhead cover from vegetation. Off-channel areas are accessed by high flows of both Manastash Creek and the Yakima River. In addition, no anthropomorphic barriers limit access to off-channel habitat.
Channel	Dynamics	Floodplain connectivity	<b>Adequate Condition</b> Observation of indicators of overland flow on the floodplain and in high flow channels, as well as areas of floodplain wetlands and dense riparian vegetation, suggests that the floodplain is frequently inundated by Manastash Creek and/or the Yakima River.
		Bank stability/channel migration	<b>Adequate Condition</b> Bank erosion was observed on <5% of banks and riparian vegetation is abundant and of high quality. Bank stability was rated as stable (Booth and Henshaw 2001).
		Vertical channel stability	<b>Adequate Condition</b> Observed channel dynamics in this reach were within the normal range for a distributary fan environment at a confluence.
		Resiliency to Disturbance	<b>Adequate Condition</b> Significant and dense riparian forest, numerous LWD, and a wide active floodplain make this reach fairly resilient to disturbance from large flood events that carry significant bedload.
Riparian Vegetation	Condition	Structure	<b>Adequate Condition</b> Natural structure of 93% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b>Adequate Condition</b> 91% medium to large wood available in the riparian buffer; 7% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.
		Canopy Cover	<b>Adequate Condition</b> 93% medium to large wood available in the riparian buffer.





Table B-2. Habitat Condition Assessment of Reach BC (Bullfrog Confined Reach).					
General Characteristics	General Indicators	Specific Indicators	Subreach BC1 Condition	Subreach BC2 Condition	Subreach BC3 Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers.	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.  Access from upstream of Subreach SC1 is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.  Access from upstream of Sub reach SC1 is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.  Access from upstream of reach SC1 is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.
Hydrology	Stream flow	Alteration of peak or base flows	<b>Unacceptable Risk Condition</b> Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.	<b>Unacceptable Risk Condition</b> Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.	<b>Unacceptable Risk Condition</b> Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<b>At Risk Condition</b> Water quality limited by irrigation withdrawals and return flows.	<b>At Risk Condition</b> Water quality limited by irrigation withdrawals and return flows.	<b>Unacceptable Risk Condition</b> Water quality limited by irrigation withdrawals and return flows.  Field crews observed turbid, warm water in the reach from ditch return flows
Habitat Quality	Substrate	Dominant substrate/fine sediment	<b>At Risk Condition</b> Primary substrate is medium cobble. Secondary substrate is large gravel.  Reasonable diversity of substrate characteristics associated with sorting at LWD accumulations. Cementation was good and embeddedness was 25-50%.	<b>At Risk Condition</b> Primary substrate is medium cobble. Secondary substrate is large gravel.  Reasonable diversity of substrate characteristics associated with sorting at woody debris accumulations. Cementation was good and embeddedness was 0-25% in this reach. Substrate in the side channel that avulsed into the logged portion of the riparian area was predominantly fines, and the channel is a significant source of fine sediment to the creek.	<b>At Risk Condition</b> Primary substrate is large cobble. Secondary substrate is large gravel.  Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 25-50% in this reach.
	Large Woody Debris	Pieces per mile	<b>Adequate Condition</b> 1 piece of large (20" x 35'), 10 pieces of medium (12" x 35') and >50 and perhaps greater than 100 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 82 pieces (>12" diameter and 35' length) per mile. Numerous debris jams in reach. Mature riparian forest provides adequate recruitment source.  Rated as properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.	<b>Unacceptable Risk Condition</b> 0 pieces of large (20" x 35'), 0 pieces of medium (12" x 35') and 15 pieces of small (6" x 20') woody debris with more hidden in debris accumulations were observed in the sampling reach, which equates to 0 pieces (>12" diameter and 35' length) per mile. There was a significant quantity of woody debris that was very small, less than 6" diameter and less that 20' long, and accumulated in large jams in the mature floodplain vegetation. Sources of natural LWD recruitment greatly reduced by riparian logging.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.	<b>Unacceptable Risk Condition</b> 0 pieces of large (20" x 35'), 0 pieces of medium (12" x 35') and 3 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 0 pieces (>12" diameter and 35' length) per mile. Mature riparian forest provides adequate recruitment source.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.





Table B-2 (continued).      Habitat Condition Assessment of Reach BC (Bullfrog Confined Reach).

General Characteristics	General Indicators	Specific Indicators	Subreach BC1 Condition	Subreach BC2 Condition	Subreach BC3 Condition
Habitat Quality (cont'd)	Pools	Frequency and quality	<b>Adequate Condition</b>  Pool frequency is 45 pools per mile (extrapolated from the sampling reach data). Typical pools in the reach were formed by scour at LWD accumulations. Average dimensions were 25' long x 10' wide x 3' residual depth. Overhead cover and complexity were both high, and the amount of fines in the pool bottoms was low.	<b>Adequate Condition</b>  Pool frequency is 42 pools per mile (extrapolated from the sampling reach data). Typical pools in the reach were formed by scour at LWD accumulations or at tree roots in side channels/braids. Average dimensions were 15-20' long x 3-6' wide x 1.5-2.5' residual depth. Overhead cover was high and complexity was moderate, and the amount of fines in the pool bottoms was low.	<b>Adequate Condition</b>  Pool frequency is 22 pools per mile (extrapolated from the sampling reach data). Typical pools in the reach were formed by scour at tree root hard points. Average dimensions were 25' long x 8' wide x 2-2.5' residual depth. Overhead cover was high and complexity was moderate, and the amount of fines in the pool bottoms was low.
	Complexity	Variability and heterogeneity of habitat units	<b>Adequate Condition</b>  Habitat unit density is good, 135 habitat units per mile. Abundant LWD provides significant overhead cover and complexity to habitat units.	<b>At Risk Condition</b>  Habitat unit density is very good, 177 habitat units per mile. However, lack of LWD in the reach and logged portions of the floodplain limit the overhead cover and complexity to habitat units.	<b>At Risk Condition</b>  Habitat unit density is good,140 habitat units per mile. Abundant riparian vegetation provides overhead cover and tree roots provide complexity to habitat units, but overall lack of LWD limits complexity overall.
	Off-Channel Habitat	Connectivity with main channel	<b>Adequate Condition</b>  This reach has several high-flow channels, alcoves, and off-channel areas. Habitat features have significant LWD and overhead cover from vegetation. Off-channel areas are accessed by high flows, particularly where LWD accumulations create significant hydraulic roughness. In addition, no anthropomorphic barriers limit access to off channel habitat.	<b>At Risk Condition</b>  This reach has several channels, and off channel areas. Habitat features have minimal LWD and overhead cover from vegetation is limited in large portions of the reach. Some of the side channels flow directly through areas with limited vegetation, and habitat in those areas is severely degraded. Off channel areas are accessed by high flows, particularly where LWD accumulations create significant hydraulic roughness. In addition, no anthropomorphic barriers limit access to off channel habitat.	<b>Unacceptable Risk Condition</b>  Off channel habitat is primarily confined to wooded floodplain areas immediately adjacent to the channel. Few ponds, oxbows, or backwaters were observed. Channel is single threaded in this reach.  No manmade barriers limiting access to habitat.
Channel	Dynamics	Floodplain connectivity	<b>Adequate Condition</b>  Active high-flow channels and evidence of regular floodplain inundation were observed in the reach. Natural dynamics of aggradation and incision vary the degree of floodplain inundation.	<b>Adequate Condition</b>  Active high and low flow side channels and evidence of regular floodplain inundation were observed in the reach. Natural dynamics of aggradation maintain floodplain connectivity.	<b>At Risk Condition</b>  Floodplain inundation frequency is reduced somewhat due lack of hydraulic roughness from LWD accumulations in the channel. Still, evidence of floodplain activation was observed. Riparian vegetation is well supported.
		Bank stability/channel migration	<b>Adequate Condition</b>  Bank erosion was observed on 30-60% of banks. It is suspected that the majority of the erosion occurred during the large flood event of 2011. Still, riparian vegetation is abundant and of high quality and the erosion recruited large amounts of LWD to the channel, positively influencing habitat. Bank stability was rated as slightly unstable (Booth and Henshaw 2001).	<b>At Risk Condition</b>  Bank erosion was observed on 5-30% of banks. It is suspected that the majority of the erosion occurred during the large flood event of 2011. Still, riparian vegetation is abundant in much of the subreach. Bank stability was rated as slightly unstable (Booth and Henshaw 2001).  The risk of channel avulsion resulting in severe bank erosion and habitat degradation is significant in portions of the subreach that lack substantial vegetation.	<b>Adequate Condition</b>  Bank erosion was observed on 5-30% of banks. It is suspected that the majority of the erosion occurred during the large flood event of 2011, and banks are currently restabilizing. Riparian vegetation is abundant. Bank stability was rated as slightly unstable (Booth and Henshaw 2001).
		Vertical channel stability	<b>At Risk Condition</b>  Both aggradation and incision processes were evident in this reach. Significant aggradation was observed in the upstream portion of the reach, primarily as a result of a large channel spanned LWD jam. The downstream portion of the reach was more incised. Floodplain disconnection or large scale changes in channel planform were not observed.	<b>At Risk Condition</b>  Aggradation processes are evident in this reach resulting in a multi thread channel network. This is believed to be natural and expected and not in response to significant watershed disturbance.	<b>At Risk Condition</b>  Evidence of aggradation is present in the reach, but no visible change in channel planform has resulted. It is suspected that the majority of the aggradation occurred during the large flood event of 2011.





Table B-2 (continued).      Habitat Condition Assessment of Reach BC (Bullfrog Confined Reach).					
General Characteristics	General Indicators	Specific Indicators	Subreach BC1 Condition	Subreach BC2 Condition	Subreach BC3 Condition
Channel (cont'd)	Dynamics (cont'd)	Resiliency to Disturbance	<b>Adequate Condition</b> Significant and dense riparian forest, numerous LWD, and a moderately wide active floodway make this reach fairly resilient to disturbance from large flood events that carry significant bedload.	<b>At Risk Condition</b> This reach shows strong resiliency to large flood events that carry significant bedload in areas with significant and dense riparian forest, but portion of the reach impacted by riparian logging have extremely low resiliency. Habitat in logged areas is poor and in danger of degrading even more.	<b>Adequate Condition</b> This reach shows strong resiliency to large flood events that carry significant bedload due to the presence of significant and dense riparian forest.
Riparian Vegetation	Condition	Structure	<b>At Risk Condition</b> Natural structure of 73% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>At Risk Condition</b> Natural structure of 73% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>At Risk Condition</b> Natural structure of 72% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b>At Risk Condition</b> 73% medium to large wood available in riparian buffer; 27% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 1.6 mi/mi <sup>2</sup> roads in riparian buffer.	<b>At Risk Condition</b> 46% medium-large wood available in riparian buffer; 27% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 0.5 mi/mi <sup>2</sup> roads in riparian buffer.	<b>Unacceptable Risk Condition</b> 64% medium-large wood available in riparian buffer; 28% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 8 mi/mi <sup>2</sup> roads in riparian buffer.
		Canopy Cover	<b>Adequate Condition</b> 94% medium to large wood available in riparian buffer.	<b>At Risk Condition</b> 66% medium-large wood available in riparian buffer.	<b>Adequate Condition</b> 86% medium-large wood available in riparian buffer.





Table B-3. Habitat Condition Assessment of Reach SC (Swauk Confined Reach).				
General Characteristics	General Indicators	Specific Indicators	Subreach SC1 Condition	Subreach SC2 Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers.	<b>At Risk Condition</b>  There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.  The exposed siphon pipe in the stream bed may act as a fish passage barrier to juvenile fish at extreme low flow conditions.  Year-round base flow returns at the upstream end of this reach at the West Side Irrigation Canal return.  Access from upstream of Subreach SC1 is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.	<b>At Risk Condition</b>  There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.  Access from downstream may be adversely affected by low flow conditions during some periods of heavy water withdrawals for irrigation. Year-round base flow returns at the downstream end of this reach at the West Side Irrigation Canal return.  Access from upstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.
Hydrology	Stream flow	Alteration of peak or base flows	<b>Unacceptable Risk Condition</b>  Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this subreach. Thissub reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.	<b>Unacceptable Risk Condition</b>  Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<b>Unacceptable Risk Condition</b>  Water quality limited by irrigation withdrawals and return flows.  Field crews observed turbid, warm water in the reach from ditch return flows	<b>At Risk Condition</b>  Water quality limited by irrigation withdrawals and return flows.
Habitat Quality	Substrate	Dominant substrate/fine sediment	<b>At Risk Condition</b>  Primary substrate is large cobble. Secondary substrate is large gravel.  Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.	<b>At Risk Condition</b>  Primary substrate is large cobble. Secondary substrate is small boulders.  Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was excellent and embeddedness was 0-25% in this reach.
	Large Woody Debris	Pieces per mile	<b>Unacceptable Risk Condition</b>  1 piece of large (20" x 35'), 0 pieces of medium (12" x 35') and 0 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 5 pieces (>12" diameter and 35' length) per mile. The one piece of LWD was placed by humans as bank toe scour protection and it provides little or no habitat value. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation and a straightened/armored channel.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.	<b>At Risk Condition</b>  0 pieces of large (20" x 35'), 9 pieces ofmMedium (12" x 35') and 10 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 46 pieces (>12" diameter and 35' length) per mile. The small pieces of woody debris were mainly distributed as single pieces rather than in debris jams.. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation and a relatively confined channel.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.
	Pools	Frequency and quality	<b>At Risk Condition</b>  Pool frequency is 15 pools per mile (extrapolated from the sampling reach data), which falls at the low end of the acceptable range. Typical pools in the reach were part of unforced riffle/pool sequences. Average dimensions of the 3 pools observed were 45' long x 15' wide x 2.5' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.	<b>At Risk Condition</b>  Pool frequency is 26 pools per mile (extrapolated from the sampling reach data), in the acceptable range, but overall quality is low. Typical pools in the reach were located at tree root or other bank hard points. Average dimensions of the pools observed were 50' long x 20' wide x 1.5' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.





Table B-3 (continued).      Habitat Condition Assessment of Reach SC (Swauk Confined Reach).				
General Characteristics	General Indicators	Specific Indicators	Subreach SC1 Condition	Subreach SC2 Condition
Habitat Quality (cont'd)	Complexity	Variability and heterogeneity of habitat units	<b><i>Unacceptable Condition</i></b>  Habitat unit density is a relatively low 44 habitat units per mile. Lack of LWD in the reach and sparse mature riparian vegetation limit the overhead cover and complexity to habitat units.	<b><i>At Risk Condition</i></b>  Habitat unit density is a relatively low 57 habitat units per mile. However, only riffles and pools were able to be logged because most of the sampling reach was completely dewatered at the time of sampling. Modest amounts of LWD in the reach and a limited corridor of mature riparian vegetation limit the overhead cover and complexity to habitat units.
	Off-Channel Habitat	Connectivity with main channel	<b><i>Unacceptable Risk Condition</i></b>  Off-channel habitat is almost completely absent. One small alcove with limited vegetation exists on the right bank. One constructed pond on the left bank floodplain excluded from the stream by levees. Channel is straightened and single-threaded in this reach.  Bank armoring and levees limit high flow access to the floodplain.	<b><i>At Risk Condition</i></b>  Several historic high flow channels that have mature vegetation along them are visible along this reach within the somewhat naturally confined floodway. However, channel incision appears to have limited or disconnected these channels at all but the highest peak flows.
Channel	Dynamics	Floodplain connectivity	<b><i>Unacceptable Risk Condition</i></b>  Channel has been mechanically straightened, and cleaned of LWD. Significant portions of the reach have been leveed, and many banks have been armored, severely reducing hydrologic connectivity between the channel and floodplain and riparian areas.	<b><i>Unacceptable Risk Condition</i></b>  Portions of the channel have been mechanically straightened, and leveed, and many banks have been armored. Channel incision is reducing hydrologic connectivity between the channel and historic high flow channels, floodplain and riparian areas is many areas. At one location I the reach a large debris jam resulted in significant flow of water and bedload onto the left bank floodplain.
		Bank stability/channel migration	<b><i>Unacceptable Risk Condition</i></b>  Bank erosion was observed on 5-30% of banks. Channel has been mechanically straightened, and bank armoring and levees maintain this generally stable configuration, limiting natural channel migration and LWD recruitment. There is some bank erosion in the downstream portion of the reach where the channel is beginning to naturally increase its sinuosity in areas where banks have not been armored.  Bank stability was rated as slightly unstable (Booth and Henshaw 2001).	<b><i>At Risk Condition</i></b>  Bank erosion was observed on 5-30% of banks. Channel has been mechanically straightened in portions but natural channel migration and mature riparian vegetation still exists in quantities to recruit new LWD to the channel. Over time, without improvement in floodplain connectivity, natural LWD debris recruitment sources will be exhausted as the channel migrates into adjacent agricultural fields.  Bank stability was rated as slightly unstable (Booth and Henshaw 2001).
		Vertical channel stability	<b><i>Unacceptable Risk Condition</i></b>  Channel has been mechanically modified in this reach to limit access of high flows to the floodplain. The current condition is vertically stable but incised.	<b><i>Unacceptable Risk Condition</i></b>  Channel incision has resulted in significant disconnection of floodplain and off channel habitat areas.
		Resiliency to Disturbance	<b><i>At Risk Condition</i></b>  This subreach has been mechanically altered and armored to be resilient to large flood events that carry significant bedload. However, minimal habitat or natural, dynamic processes are at work in this subreach.	<b><i>At Risk Condition</i></b>  This reach has incised and been altered in a way that habitat resiliency to large flood events that carry significant bedload has been reduced. As riparian conditions continue to degrade, resiliency will decrease even further.
Riparian Vegetation	Condition	Structure	<b><i>Unacceptable Risk Condition</i></b>  Natural structure of 38% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b>  Natural structure of 14% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b><i>Unacceptable Risk Condition</i></b>  34% medium to large wood available in riparian buffer; 62% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 0.4 mi/mi <sup>2</sup> roads in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b>  9% medium-large wood available in riparian buffer; 86% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 3.2 mi/mi <sup>2</sup> roads in riparian buffer.
		Canopy Cover	<b><i>At Risk Condition</i></b>  63% medium to large wood available in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b>  233% medium-large wood available in riparian buffer.





Table B-4. Habitat Condition Assessment of Reach FC (Fan Contraction Reach).							
General Characteristics	General Indicators	Specific Indicators	Subreach FC1 Condition	Subreach FC2 Condition	Subreach FC3 Condition	Subreach FC4 Condition	Subreach FC5 Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers.	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this subreach.</p> <p>Access from upstream and downstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.</p>	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>Access from upstream and downstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.</p>	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>Access from upstream and downstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.</p>	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>Access from upstream and downstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.</p>	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>Access from upstream and downstream is limited by low flow or dewatered conditions during periods of heavy irrigation water withdrawals.</p>
Hydrology	Stream flow	Alteration of peak or base flows	<p><b>Unacceptable Risk Condition</b></p> <p>Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Low/base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed</p>
Habitat Quality	Substrate	Dominant substrate/fine sediment	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was excellent and embeddedness was 0-25% in this reach.</p>	<p>Substrate was not surveyed in this subreach due to access restriction.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.</p>





Table B-4 (continued). Habitat Condition Assessment of Reach FC (Fan Contraction Reach).

General Characteristics	General Indicators	Specific Indicators	Subreach FC1 Condition	Subreach FC2 Condition	Subreach FC3 Condition	Subreach FC4 Condition	Subreach FC5 Condition
Habitat Quality (cont'd)	Large Woody Debris	Pieces per mile	<p><b>Unacceptable Risk Condition</b></p> <p>0 pieces of large (20" x 35'), 0 pieces of medium (12" x 35') and 0 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 0 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are absent due to lack of mature riparian vegetation.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>0 piece of large (20" x 35'), 1 pieces of medium (12" x 35') and 1 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 5 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation and a straightened channel.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	LWD was not surveyed in this subreach due to access restriction.	<p><b>Unacceptable Risk Condition</b></p> <p>LWD was not surveyed in this subreach due to access restriction. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation.</p> <p>Rated as not properly functioning for LWD via remote observation based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>0 piece of large (20" x 35'), 0 pieces of medium (12" x 35') and 1 piece of small (6" x 20') woody debris were observed in the sampling reach, which equates to 0 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are absent due to lack of mature riparian vegetation. Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>
	Pools	Frequency and quality	<p><b>Unacceptable Risk Condition</b></p> <p>Pool frequency is 19 pools per mile (extrapolated from the sampling reach data), which falls at the low end of the acceptable range. Typical pools in the reach were associated with riprap or rock groins. Average dimensions of the pools observed were 30' long x 15' wide x 1.5-2' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>	<p><b>At Risk Condition</b></p> <p>Pool frequency is 36 pools per mile (extrapolated from the sampling reach data). Typical pools in the reach were associated with the naturally forming pool/riffle sequence and relatively erosion resistant, consolidated bank materials. Average dimensions of the pools observed were 40' long x 15' wide x 1.5' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>	Pools and habitat units were not surveyed in this subreach due to access restriction.	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat units and pool frequency/quality were not surveyed directly in this subreach due to access restriction . Estimates of pool frequency based on aerial imagery suggest that pool frequency is approximately 20-25 pools per mile.</p> <p>Based on observations in adjacent reaches, it is assumed that overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Pool frequency is 7 pools per mile (extrapolated from the sampling reach data), which falls well below the acceptable range. The only pool observed in the reach was associated with a tree root hard point. Average dimensions of the pools observed were 35' long x 18' wide x 4' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>
	Complexity	Variability and heterogeneity of habitat units	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat unit density is a relatively low 48 habitat units per mile. Lack of LWD in the reach and a nearly total absence of mature riparian vegetation limit the overhead cover and complexity to habitat units.</p>	<p><b>At Risk Condition</b></p> <p>Habitat unit density is a moderate 82 habitat units per mile. Lack of LWD in the reach, and reduced levels of mature riparian vegetation limit the overhead cover and complexity to habitat units.</p>	Habitat units were not surveyed in this subreach due to access restriction.	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat units and pool frequency/quality were not surveyed directly in this subreach due to access restriction .</p> <p>Risk condition has been assigned based on aerial imagery and comparison with conditions in adjacent reaches that were surveyed.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat unit density is an extremely low 20 habitat units per mile. Dredging, other mechanical channel alterations, and a lack of LWD in the reach limit habitat diversity. A near total absence of mature riparian vegetation limits the overhead cover and complexity to habitat units.</p>





Table B-4 (continued). Habitat Condition Assessment of Reach FC (Fan Contraction Reach).

General Characteristics	General Indicators	Specific Indicators	Subreach FC1 Condition	Subreach FC2 Condition	Subreach FC3 Condition	Subreach FC4 Condition	Subreach FC5 Condition
Habitat Quality (cont'd)	Off-Channel Habitat	Connectivity with main channel	<b>Unacceptable Risk Condition</b> Off channel habitat is completely absent. Channel is mechanically altered, straightened, and single threaded in this reach.  Bank armoring and levees constructed from dredge spoils limit high flow access to the floodplain.	<b>Unacceptable Risk Condition</b> While a couple of historic high flow channels are visible in the lidar data along this reach, they exist exclusively outside of the modern floodway. Mechanical channel alterations and channel incision have disconnected these off channel habitats.	Off channel habitat could not be accurately assessed in this subreach due to access restriction.	<b>Unacceptable Risk Condition</b> Based on analysis of lidar data and aerial imagery, off channel habitat areas with significant cover and complexity are extremely limited. Only one side channel is apparent in the reach.	<b>Unacceptable Risk Condition</b> Off channel habitat is completely absent. Channel is mechanically altered, straightened, and single threaded in this reach.  Levees constructed from dredge spoils limit high flow access to the floodplain.
Channel	Dynamics	Floodplain connectivity	<b>Unacceptable Risk Condition</b> Channel has been mechanically straightened, and cleaned of LWD. Significant portions of the reach have been dredged, leveed, and some banks have been armored, severely reducing hydrologic connectivity between the channel and floodplain and riparian areas. The severely undersized bridge at Serenity Lane causes a major discontinuity in the system.	<b>Unacceptable Risk Condition</b> Portions of the channel have been mechanically straightened in the past. Channel incision is reducing hydrologic connectivity between the channel and historic high flow channels, and floodplain, severwely limiting the extent of riparian areas throughout the reach.	Floodplain connectivity could not be accurately assessed in this subreach due to access restriction.	Unable to adequately assess floodplain connectivity due to access restriction.	<b>Unacceptable Risk Condition</b> Channel has been mechanically straightened, and cleaned of LWD. The reach has been dredged and leveed, severely reducing hydrologic connectivity between the channel and floodplain and riparian areas.
		Bank stability/channel migration	<b>Unacceptable Risk Condition</b> Bank erosion was observed on 60-100% of banks. Channel has been mechanically straightened, and is dredged in an attempt to maintain capacity and mitigate for aggradation caused by the undersized bridge at Serenity Lane. The constriction, associated aggradation, and the overall lack of bank stabilizing riparian vegetation have created highly unstable conditions.  Bank stability was rated as completely unstable (Booth and Henshaw 2001).	<b>At Risk Condition</b> Bank erosion was observed on 30-60% of banks. Channel has been mechanically straightened in portions, limiting natural channel migration. Significantly reduced extent of mature riparian vegetation limits recruitment of new LWD to the channel. Over time, without improvement in dynamic channel processes and floodplain connectivity, natural LWD debris recruitment sources will be exhausted. Channel migration rate may then increase as the channel migrates into adjacent agricultural areas.  Bank stability was rated as moderately unstable (Booth and Henshaw 2001).	Bank stability was not surveyed in this subreach due to access restriction.	<b>At Risk Condition</b> Bank conditions were observed in a portion of this reach from the adjacent reach. Bank erosion appeared to be active on 30-60% of banks.  Significantly reduced extent of mature riparian vegetation limits recruitment of new LWD to the channel. Over time, without improvement in dynamic channel processes and floodplain connectivity, natural LWD debris recruitment sources will be exhausted. Channel migration rate may then increase as the channel migrates into adjacent agricultural areas.  Bank stability was rated as moderately unstable (Booth and Henshaw 2001).	<b>Unacceptable Risk Condition</b> Bank erosion was observed on 60-100% of banks. Channel has been mechanically straightened, and is dredged in an attempt to maintain capacity and mitigate for aggradation downstream of the Cove Rd bridge. The aggradation, and the overall lack of bank stabilizing riparian vegetation has created highly unstable conditions.  Bank stability was rated as completely unstable (Booth and Henshaw 2001).





Table B-4 (continued).      Habitat Condition Assessment of Reach FC (Fan Contraction Reach).							
General Characteristics	General Indicators	Specific Indicators	Subreach FC1 Condition	Subreach FC2 Condition	Subreach FC3 Condition	Subreach FC4 Condition	Subreach FC5 Condition
Channel (cont'd)	Dynamics (cont'd)	Vertical channel stability	<b>Unacceptable Risk Condition</b> Unnatural rates of bed aggradation in this reach are the result of the undersized bridge at Serenity Lane. This has forced the channel to respond by expanding laterally at unnatural rates, and landowners have combatted this undesirable scenario by dredging the channel.	<b>Unacceptable Risk Condition</b> Channel incision has resulted in significant disconnection of floodplain and off channel habitat areas, though the channel may be vertically stable in its current configuration.	Vertical channel stability could not be accurately assessed in this subreach due to access restriction.	Unable to adequately assess vertical channel stability due to access restriction.	<b>Unacceptable Risk Condition</b> Unnatural rates of bed aggradation in this reach are the result of the rapid decrease in sediment transport capacity downstream of the Cove Rd bridge. Landowners have combatted this scenario, which increases local flooding risk, by dredging the channel.
		Resiliency to Disturbance	<b>Unacceptable Risk Condition</b> Near total lack of bank stabilizing, mature riparian vegetation, coupled with the effects of the undersized crossing at Serenity Lane severely limit this reach's resiliency to large flood events that carry significant bedload.	<b>At Risk Condition</b> This reach has incised and been altered in a way that habitat resiliency to large flood events that carry significant bedload has been reduced. As riparian conditions continue to degrade, resiliency will decrease even further.	Resiliency to disturbance could not be accurately assessed in this subreach due to access restriction.	<b>Unacceptable Risk Condition</b> Based on analogs of similar reaches, near total lack of bank stabilizing, mature riparian vegetation severely limits this reach's resiliency to large flood events that carry significant bedload.	<b>Unacceptable Risk Condition</b> Near total lack of bank stabilizing, mature riparian vegetation, coupled with the effects of localized reduction of sediment transport capacity downstream of Cove Road, severely limits this reach's resiliency to large flood events that carry significant bedload.
Riparian Vegetation	Condition	Structure	<b>At Risk Condition</b> Natural structure of 67% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>At Risk Condition</b> Natural structure of 55% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>At Risk Condition</b> Natural structure of 74% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>At Risk Condition</b> Natural structure of 62% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b>Unacceptable Risk Condition</b> Natural structure of 35% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b>Unacceptable Risk Condition</b> 3% medium-large wood available in riparian buffer; 33% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 7 mi/mi <sup>2</sup> roads in riparian buffer.	<b>At Risk Condition</b> 29% medium-large wood available in riparian buffer; 46% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b>At Risk Condition</b> 47% medium-large wood available in riparian buffer; 26% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 7 mi/mi <sup>2</sup> roads in riparian buffer.	<b>At Risk Condition</b> 22% medium-large wood available in riparian buffer; 38% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b>Unacceptable Risk Condition</b> 3% medium-large wood available in riparian buffer; 65% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 6 mi/mi <sup>2</sup> roads in riparian buffer.
		Canopy Cover	<b>Unacceptable Risk Condition</b> 9% medium-large wood available in riparian buffer.	<b>Unacceptable Risk Condition</b> 44% medium-large wood available in riparian buffer.	<b>At Risk Condition</b> 64% medium-large wood available in riparian buffer.	<b>Unacceptable Risk Condition</b> 32% medium-large wood available in riparian buffer.	<b>Unacceptable Risk Condition</b> 9% medium-large wood available in riparian buffer.





Table B-5. Habitat Condition Assessment of Reach FE (Fan Expansion Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FE1 Condition	Subreach FE2 Condition	Subreach FE3 Condition	Subreach FE4 Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers.	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>This reach is known to become severely or completely dewatered during periods of heavy irrigation water withdrawals, limiting upstream and downstream passage.</p>	<p><b>At Risk Condition</b></p> <p>There are no anthropogenic barriers to fish migration in this reach or on the main channel downstream of this reach.</p> <p>This reach is known to become severely or completely dewatered during periods of heavy irrigation water withdrawals, limiting upstream and downstream passage.</p>	<p><b>At Risk Condition</b></p> <p>The Reed diversion Dam marks the upstream end of this subreach and is a known barrier to upstream passage for all life stages of salmonids.</p> <p>This reach is known to become severely or completely dewatered during periods of heavy irrigation water withdrawals, limiting downstream passage.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>The Reed diversion dam marks the downstream end of this subreach and is a known barrier to upstream passage for all life stages of salmonids.</p> <p>In addition, Manastash Creek is known to run dry downstream of the Reed diversion during periods of heavy irrigation water withdrawals.</p>
Hydrology	Stream flow	Alteration of peak or base flows	<p><b>Unacceptable Risk Condition</b></p> <p>Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to become completely dewatered during periods of heavy irrigation water withdrawals.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to retain at least some base flow year round, however.</p> <p>Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.</p>
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. Little to no flow observed.</p>	<p><b>At Risk Condition</b></p> <p>Water quality limited by irrigation withdrawals and return flows. This subreach is upstream of the Reed diversion, and flow was observed in the channel.</p>
Habitat Quality	Substrate	Dominant substrate/fine sediment	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was excellent and embeddedness was 0-25% in this reach.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is small boulder.</p> <p>Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is boulder.</p> <p>Cementation was excellent and embeddedness was 0-25% in this reach.</p>	<p><b>At Risk Condition</b></p> <p>Primary substrate is large cobble. Secondary substrate is gravel and small boulder.</p> <p>Reasonable diversity of substrate associated with sorting and hydraulic complexity. Cementation was excellent and embeddedness was 0-25% in this reach.</p>





Table B-5 (continued).      Habitat Condition Assessment of Reach FE (Fan Expansion Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FE1 Condition	Subreach FE2 Condition	Subreach FE3 Condition	Subreach FE4 Condition
Habitat Quality (cont'd)	Large Woody Debris	Pieces per mile	<p><b>Unacceptable Risk Condition</b></p> <p>0 pieces of large (20" x 35'), 0 pieces of medium (12" x 35') and 1 piece of small (6" x 20') woody debris were observed in the sampling reach, which equates to 0 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation and a straightened/armored channel.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>0 piece of large (20" x 35'), 1 piece of medium (12" x 35') and 4 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 9 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are minimal due to lack of mature riparian vegetation and a straightened/armored channel.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>1 piece of large (20" x 35'), 0 pieces of medium (12" x 35') and 2 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 10 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are present.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>	<p><b>Adequate Condition</b></p> <p>0 pieces of large (20" x 35'), 4 pieces of medium (12" x 35') and 5 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 32 pieces (&gt;12" diameter and 35' length) per mile. Sources of natural LWD recruitment are present, and there is significant LWD in parts of the reach, but the reach is cleaned of LWD to reduce potential issues at the Reed diversion.</p> <p>Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.</p>
	Pools	Frequency and quality	<p><b>At Risk Condition</b></p> <p>Subreach habitat was observed while the channel was dry, therefore pool dimensions were estimated based on channel bed topography. Pool frequency is 32 pools per mile (extrapolated from the sampling reach data), which falls within acceptable range. However, the short sampling reach (due to access limitations) may skew the results to look more favorable than the reality. Typical pools in the reach were associated with riprap or rock groins. Average dimensions of the 3 pools observed were 25' long x 10' wide x 1.5' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>	<p><b>At Risk Condition</b></p> <p>Pool frequency is 35 pools per mile (extrapolated from the sampling reach data), which falls within acceptable range. Typical pools in the reach were associated with tree roots and other natural hard points. Average dimensions of the 3 pools observed were 35' long x 17' wide x 1.6' residual depth. Overhead cover, complexity, and the amount of fines in the pool bottoms were all low.</p>	<p><b>At Risk Condition</b></p> <p>Pool frequency is 52 pools per mile (extrapolated from the sampling reach data), which falls within acceptable range. Typical pools in the reach were associated with bank hard points. Average dimensions of the pools observed were 25' long x 10' wide x 2-2.5' residual depth. Overhead cover, and complexity are medium. The amount of fines in the pool bottoms was low.</p>	<p><b>Adequate Condition</b></p> <p>Pool frequency is 56 pools per mile (extrapolated from the sampling reach data), which falls within acceptable range. Typical pools in the reach were associated with tree root bank hard points. Average dimensions of the pools observed were 20' long x 8-10' wide x 2-3' residual depth. Overhead cover was high. Complexity was medium. The amount of fines in the pool bottoms was low.</p>
	Complexity	Variability and heterogeneity of habitat units	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat unit density was calculated at a moderate 82 habitat units per mile, though the short sampling reach (due to access limitations) may skew the results to look more favorable than the reality. Lack of LWD in the reach, widespread mechanical channel alterations, dredging, and reduced levels of mature riparian vegetation limit the overhead cover and complexity to habitat units.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Habitat unit density was calculated at a moderate 87 habitat units per mile, though the short sampling reach (due to access limitations) may skew the results to look more favorable than the reality. Lack of LWD in the reach, extreme rates of lateral channel migration, and reduced levels of mature riparian vegetation limit the overhead cover and complexity to habitat units.</p>	<p><b>At Risk Condition</b></p> <p>Habitat unit density is good, 145 habitat units per mile, despite the channelized and confined nature of the reach. Lack of LWD in the reach limit the overhead cover and complexity to habitat units to some extent.</p>	<p><b>Adequate Condition</b></p> <p>Habitat unit density is very good, 175 habitat units per mile. Riparian vegetation is relatively intact and LWD is present, providing significant complexity and cover.</p>



Table B-5 (continued). Habitat Condition Assessment of Reach FE (Fan Expansion Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FE1 Condition	Subreach FE2 Condition	Subreach FE3 Condition	Subreach FE4 Condition
Habitat Quality (cont'd)	Off-Channel Habitat	Connectivity with main channel	<p><b>Unacceptable Risk Condition</b></p> <p>The entirety of off channel habitat in the reach is represented by a single cutoff meander. Analysis of the lidar data suggests that the area is no longer connected to the main channel at high flows. Mechanical channel alterations and channel incision have disconnected these off channel habitats.</p>	<p><b>At Risk Condition</b></p> <p>Rapid rates of later channel migration and aggradation in this reach have resulted in the development of significant braiding of the channel. Unfortunately, lack of LWD and riparian vegetation in the active floodplain and on bars within the braided channel network severely limit the quality of habit in side channels and off channel habitat. Dewatering of the reach during summer months may be impeding the ability of vegetation to become established.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>This straight, entrenched reach has no off channel habitat.</p> <p>With significant effort, the Reed Ditch could potentially be reconnected to the Manastash Creek channel downstream of this reach, allowing the decommissioned ditch to serve as artificial side channel habitat.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Despite good in channel conditions, limited amounts of off-channel habitat exist in this reach. This is likely the result of residential development in the floodplain. While few/no high flow channels, oxbows, and backwater areas are apparent from the lidar data, the floodplain and riparian areas at least remain densely vegetated along most of the reach. Levees limit floodplain inundation immediately upstream of the Reed diversion.</p>
Channel	Dynamics	Floodplain connectivity	<p><b>Unacceptable Risk Condition</b></p> <p>Channel has been mechanically straightened, and cleaned of LWD. Significant portions of the reach have been dredged and leveed, severely reducing hydrologic connectivity between the channel and floodplain and riparian areas.</p>	<p><b>At Risk Condition</b></p> <p>Extreme widening of the active floodway and channel in response to large flow events has left a situation where the inset floodplain can be frequently activated by high flows, but the state of riparian vegetation is highly degraded or disturbed.</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Channel appears to have been mechanically straightened in the past and is extremely incised below the historic floodplain, starting at the longitudinal profile discontinuity at the Reed diversion. Even the highest flood flows are unable to access overbank areas from this reach.</p> <p>Some out of bank flows likely occur on the left bank when if flood flows are able to enter the Reed Ditch.</p>	<p><b>Adequate Condition</b></p> <p>While levees limit floodplain inundation immediately upstream of the Reed diversion, upstream landowners report overbank flows at regular intervals, though perhaps not every year. Channel and floodplain/riparian areas are in relatively good condition. Connectivity would likely improve if the practice of LWD removal was halted in the reach, though the existence of homes on the floodplain may make this infeasible from a flood risk standpoint. Private bridge may also limit floodplain connectivity to some extent.</p>
		Bank stability/channel migration	<p><b>Unacceptable Risk Condition</b></p> <p>Bank erosion was observed on &lt;5% of banks. Channel has been mechanically straightened, and is dredged in an attempt to maintain capacity and mitigate for aggradation caused by the Cove Road Briadge constriction. Mechanical armoring of the banks accounts for the lack of natural channel migration.</p> <p>Bank stability was rated as slightly unstable (Booth and Henshaw 2001).</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Bank erosion was observed on 60-100% of banks. Bed aggradation, highly erodible bank materials, and the overall lack of bank stabilizing riparian vegetation has created highly unstable conditions and a wide, largely unvegetated floodway. Rates of lateral cahnnel migration greatly exceed natural rates.</p> <p>Bank stability was rated as moderately unstable, with banks being held only by occasional hardpoints at tree roots and (Booth and Henshaw 2001).</p>	<p><b>Unacceptable Risk Condition</b></p> <p>Bank erosion was observed on 30-60% of banks. Erosion was typically not severe and little or no lateral migration is occurring in the reach, but banks were raw still from the effects of the 2011 flood. Channel has been mechanically straightened, limiting natural channel migration and LWD recruitment.</p> <p>Bank stability was rated as slightly unstable (Booth and Henshaw 2001).</p>	<p><b>Adequate Condition</b></p> <p>Bank erosion was observed on 5-30% of banks – in the low end of this range. The majority of the erosion occurred during the large flood event of 2011, and is associated with areas where bank vegetation was mechanically removed. Riparian vegetation is abundant and normal rates of channel migration recruit new LWD to the channel, though it is often removed.</p> <p>Bank stability was rated as slightly unstable (Booth and Henshaw 2001).</p>





Table B-5 (continued).      Habitat Condition Assessment of Reach FE (Fan Expansion Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FE1 Condition	Subreach FE2 Condition	Subreach FE3 Condition	Subreach FE4 Condition
Channel (cont'd)		Vertical channel stability	<b><i>Unacceptable Risk Condition</i></b> Unnatural rates of bed aggradation in this reach appear to be the result of the constriction at the Cove Road bridge combined with the fact that this is a naturally depositional alluvial fan reach. Landowners have combatted this undesirable scenario which increases flooding risk, by dredging the channel.	<b><i>Unacceptable Risk Condition</i></b> Aggradation is expected in the reach as it is located in a naturally depositional alluvial fan environment. However, due to an overall lack of mature riparian vegetation, rates of bed aggradation along with unchecked lateral migration rates, are negatively influencing habitat conditions.	<b><i>Unacceptable Risk Condition</i></b> This reach is confined and straightened reach as a result of mechanical alterations and the Reed diversion. The reach is likely still incision, though it is doing so at slow rates. At this point, the reach has incised enough that historic floodplain and off channel areas visible on the lidar coverage have been hydraulically disconnected.	<b><i>Adequate Condition</i></b> This reach shows some signs of aggradation, but not to a degree disproportionate with natural processes expected on a depositional alluvial fan.  Human caused incision into the reach from downstream is blocked by the grade control provided by the Reed Ditch diversion structure. Removal of that structure without regard to channel slope equilibrium could result in severe habitat degradation in this reach.
		Resiliency to Disturbance	<b><i>Unacceptable Risk Condition</i></b> Extreme reduction of bank stabilizing, mature riparian vegetation, coupled with the effects of the Cove Road crossing severely limit this reach's resiliency to large flood events that carry significant bedload.	<b><i>Unacceptable Risk Condition</i></b> Extreme reduction of bank stabilizing, mature riparian vegetation in a naturally depositional alluvial fan environment has all but eliminated this reach's resiliency to large flood events that carry significant bedload.	<b><i>Adequate Condition</i></b> In its current state, both peak flood flows and bedload are transported through this confined reach into the reach below. Habitat may be limited to some degree by the incised state, but the reach remains resilient to the effect of large flood events that carry significant bedload.	<b><i>Adequate Condition</i></b> Significant and dense riparian forest and an active floodplain make this reach fairly resilient to disturbance from large flood events that carry significant bedload. Encroachment of residential development on the channel may threaten this in time.
Riparian Vegetation	Condition	Structure	<b><i>Adequate Condition</i></b> Natural structure of 82% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Adequate Condition</i></b> Natural structure of 98% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Adequate Condition</i></b> Natural structure of 90% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b> Natural structure of 28% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b><i>Adequate Condition</i></b> 79% medium-large wood available in riparian buffer; 18% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b><i>Adequate Condition</i></b> 85% medium-large wood available in riparian buffer; 2% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b><i>At Risk Condition</i></b> 23% medium-large wood available in riparian buffer; 10% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b> 9% medium-large wood available in riparian buffer; 73% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.
		Canopy Cover	<b><i>Adequate Condition</i></b> 95% medium-large wood available in riparian buffer.	<b><i>Adequate Condition</i></b> 100% medium-large wood available in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b> 29% medium-large wood available in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b> 33% medium-large wood available in riparian buffer.





Table B-6. Habitat Condition Assessment of Reach FA (Fan Apex Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FA1 Condition	Subreach FA2 Condition	Subreach FA3 Condition	Subreach FA4 Condition
Habitat Access	Physical Barriers	Main channel barrier in reach or downstream. Includes full dewatering of the channel and thermal barriers.	<b>At Risk Condition</b> There are no documented anthropogenic barriers to fish migration in this reach. The siphon crossing at the upstream end of this reach may act as a partial barrier to juvenile salmonids at very low flow conditions. However, there is a total barrier to upstream migration on the main channel downstream of this reach (Reed diversion).	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach. The siphon crossing at the downstream end of this reach may act as a partial barrier to juvenile salmonids at very low flow conditions. However, there is a total barrier to upstream migration on the main channel downstream of this reach (Reed diversion).	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach. However, there is a total barrier to upstream migration on the main channel downstream of this reach (Reed diversion).	<b>At Risk Condition</b> There are no anthropogenic barriers to fish migration in this reach. However, there is a total barrier to upstream migration on the main channel downstream of this reach (Reed diversion).
Hydrology	Stream flow	Alteration of peak or base flows	<b>Unacceptable Risk Condition</b> Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.	<b>Unacceptable Risk Condition</b> Base flows are adversely affected by irrigation withdrawals at numerous diversion points upstream of this reach. This reach is known to have year-round base flow due to return from the West Side Irrigation Canal return at the upstream end of the reach.  Significant changes to peak flow timing, magnitude, duration, and frequency cannot be determined from the available stream flow record on Manastash Creek. However, many of the land use activities documented in the Manastash Creek basin are known to affect peak flow hydrology.	<b>Adequate Condition</b> No major diversions upstream of this reach	<b>Adequate Condition</b> No major diversions upstream of this reach
Water Quality	Temperature, Turbidity, Nutrients	Field observations, including warm, turbid water, and nuisance algae growth	<b>At Risk Condition</b> Water quality limited by irrigation withdrawals and return flows. This subreach is upstream of the Reed diversion, and flow was observed in the channel	<b>At Risk Condition</b> Water quality limited by irrigation withdrawals and return flows. This subreach is upstream of the Reed diversion and the KRD spill, and flow was observed in the channel	<b>Adequate Condition</b> No major diversions upstream of this reach	<b>Adequate Condition</b> No major diversions upstream of this reach
Habitat Quality	Substrate	Dominant substrate/fine sediment	<b>At Risk Condition</b> Primary substrate is large cobble. Secondary substrate is small boulder and gravel.  Cementation was excellent and embeddedness was 0-25% in this reach.	<b>At Risk Condition</b> Primary substrate is large cobble. Secondary substrate is gravel.  Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 25-50% in this reach.	Substrate was not surveyed in this subreach due to access restriction.	<b>At Risk Condition</b> Primary substrate is large cobble. Secondary substrate is gravel.  Minimal diversity of substrate associated with sorting and hydraulic complexity. Cementation was good and embeddedness was 0-25% in this reach.



Table B-6 (continued).      Habitat Condition Assessment of Reach FA (Fan Apex Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FA1 Condition	Subreach FA2 Condition	Subreach FA3 Condition	Subreach FA4 Condition
Habitat Quality (cont'd)	Large Woody Debris	Pieces per mile	<b><i>Adequate Condition</i></b>  1 piece of large (20" x 35'), 10 pieces of medium (12" x 35') and 16 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 55 pieces (>12" diameter and 35' length) per mile. Mature riparian vegetation provides adequate LWD sources.  Rated as properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.	<b><i>Unacceptable Risk Condition</i></b>  0 pieces of large (20" x 35'), 0 pieces of medium (12" x 35') and 2 pieces of small (6" x 20') woody debris were observed in the sampling reach, which equates to 0 pieces (>12" diameter and 35' length) per mile. Sources of natural LWD recruitment are present, but armored bank conditions and active removal of LWD in reach limit function.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.	LWD was not surveyed in this subreach due to access restriction.	<b><i>Unacceptable Risk Condition</i></b>  0 pieces of large (20" x 35'), 2 pieces of medium (12" x 35') and 1 piece of small (6" x 20') woody debris were observed in the sampling reach, which equates to 9 pieces (>12" diameter and 35' length) per mile. Sources of natural LWD recruitment are present, but recruitment is limited by bank armoring that reduces channel migration.  Rated as not properly functioning for LWD based on adaptation of Ralph et al. 1994, Beechie and Sibley 1997, and Fox and Bolton 2007.
	Pools	Frequency and quality	<b><i>Adequate Condition</i></b>  Pool frequency is 50 pools per mile (extrapolated from the sampling reach data), which falls within acceptable range. Typical pools in the reach were associated with LWD jams. Average dimensions of the pools observed were 40' long x 12' wide x 3-4' residual depth. Overhead cover and complexity were high, while the amount of fines in the pool bottoms was low.	<b><i>Unacceptable Condition</i></b>  Pool frequency is 13 pools per mile (extrapolated from the sampling reach data), which is below acceptable range. Typical pools in the reach were associated with riprap/rock groin. Average dimensions of the pools observed were 45' long x 15' wide x 1.5' residual depth. Overhead cover was medium. Complexity and the amount of fines in the pool bottoms were low.	Pools and habitat units were not surveyed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b>  Pool frequency is 23 pools per mile (extrapolated from the sampling reach data), which is within acceptable range. Typical pools in the reach were associated with riprap/rock groin. Average dimensions of the pools observed were 50' long x 15' wide x 2.5' residual depth. Overhead cover and complexity were medium. The amount of fines in the pool bottoms was low.
	Complexity	Variability and heterogeneity of habitat units	<b><i>Adequate Condition</i></b>  Habitat unit density is very good, 155 habitat units per mile. Riparian vegetation is intact and LWD is abundant, providing significant complexity and cover.	<b><i>At Risk Condition</i></b>  Habitat unit density was calculated at a moderate 76 habitat units per mile. Lack of LWD in the reach, and reduced levels of mature riparian vegetation limit the overhead cover and complexity to habitat units.	Habitat units were not surveyed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b>  Habitat unit density was calculated at a low to moderate 63 habitat units per mile. Lack of LWD in the reach, and reduced levels of mature riparian vegetation associated with residential development on the right bank limit the overhead cover and complexity to habitat units.
	Off-Channel Habitat	Connectivity with main channel	<b><i>At Risk Condition</i></b>  Some backwater areas and excellent riparian/floodplain vegetation make the limited off-channel habitat in the reach very high quality. Two historic high flow channels/ditches on the left bank have been cut off by human alterations.	<b><i>Unacceptable Condition</i></b>  No off-channel habitat exists in this reach due to development of the floodplain and maintenance of the channel for irrigation water diversion and high flow conveyance.	Off channel habitat could not be accurately assessed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b>  High flow channel constructed for flood relief provide some low to moderate quality off-channel habitat in the reach, along with a large wetland/beaver complex on the left bank floodplain. However, residential development and manmade alterations have destroyed or cut off any off channel habitat that was present on the right bank floodplain.





Table B-6 (continued).      Habitat Condition Assessment of Reach FA (Fan Apex Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FA1 Condition	Subreach FA2 Condition	Subreach FA3 Condition	Subreach FA4 Condition
Channel	Dynamics	Floodplain connectivity	<b><i>At Risk Condition</i></b> Reach is somewhat incised the upstream end. Incision reduces and floodplain connectivity improves as it continues downstream. Floodplain inundation does occur, though not likely at Q2 or lower. Riparian/floodplain vegetation is in excellent condition.	<b><i>Unacceptable Condition</i></b> Mechanical alterations and maintenance of the channel in this reach all but eliminates overbank flows, and floodplain habitat has been degraded as a result of land use. The right bank floodplain floods from upstream Subreaches FA3 and FA4, according to landowners.	Floodplain connectivity could not be accurately assessed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b> Homeowners report regular overbank flows in this reach in areas where levees do not prevent overtopping. Significant channel modifications have been made in an attempt to increase flood flow capacity and direct high flows away from the houses on the right bank. However, natural processes of channel aggradation have worked against many of the attempts to reduce floodplain connectivity on the right bank. Riparian vegetation and wetland function remain in good condition where alterations have not isolated them hydraulically.
		Bank stability/channel migration	<b><i>Adequate Condition</i></b> Bank erosion was observed on 5-30% of banks. It is suspected that the majority of the erosion occurred during the large flood event of 2011. Still, riparian vegetation is abundant and of high quality and the erosion recruited large amounts of LWD to the channel, positively influencing habitat. Bank stability was rated as slightly unstable (Booth and Henshaw 2001).	<b><i>Unacceptable Risk Condition</i></b> Bank erosion was observed on <5% of banks. The channel in this reach is highly modified and maintained for irrigation water diversion and high flow conveyance. It has been mechanically straightened, and many banks have been armored, eliminating natural channel migration and LWD recruitment.  Bank stability was rated as armored (Booth and Henshaw 2001).	Bank stability was not surveyed in this subreach due to access restriction.	<b><i>Unacceptable Risk Condition</i></b> Bank erosion was observed on 30-60% of banks. Erosion was concentrated in areas where riparian vegetation was removed. Bank erosion and flooding concerns by homeowners in this dynamic reach have prompted significant channel modification in the form of bank armoring and construction of new channels to increase flood capacity. Channel has been mechanically straightened, limiting natural channel migration and LWD recruitment.  Bank stability was rated as moderately unstable (Booth and Henshaw 2001).
		Vertical channel stability	<b><i>At Risk Condition</i></b> This reach experiences some aggradation during flow events that mobilize significant bedload. Rates remain within levels that are not unexpected given the reach location in depositional alluvial fan.  Extreme changes in planform are not evident and habitat forming processes are at work in the reach.	<b><i>Unacceptable Risk Condition</i></b> This reach is confined and straightened as a result of mechanical alterations and maintenance of the channel for irrigation water diversion and high flow conveyance. The reach at this point appears to be vertically stable due to grade control at the irrigation diversion structures and the siphon crossing at the downstream end of the reach. At this point, the majority of the reach is incised enough that historic floodplain and off channel areas that once existed have been hydraulically disconnected.	Vertical channel stability could not be accurately assessed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b> This reach experiences regular aggradation during flow events that mobilize significant bedload. Rates remain within levels that are not unexpected given the reach location at the apex of a depositional alluvial fan.  Landowners have combatted this undesirable scenario which increases flooding risk, by dredging the channel, excavating additional high flow channels on the left bank, and armoring banks to limit lateral migration in response to natural channel aggradation.





Table B-6 (continued).      Habitat Condition Assessment of Reach FA (Fan Apex Reach).						
General Characteristics	General Indicators	Specific Indicators	Subreach FA1 Condition	Subreach FA2 Condition	Subreach FA3 Condition	Subreach FA4 Condition
Channel (cont'd)		Resiliency to Disturbance	<b><i>Adequate Condition</i></b>  Significant and dense riparian forest, numerous LWD, and a moderately wide active floodway make this reach fairly resilient to disturbance from large flood events that carry significant bedload.	<b><i>At Risk Condition</i></b>  Human channel alterations have all but eliminated natural habitat forming processes in this reach. The leveed and confined nature of the reach effectively transports peak flows and bedload through the reach, eliminating the chance for the channel and floodplain to respond.  Habitat is limited by human alterations, but the existing bed and banks remainartificially resilient to the effect of large flood events that carry significant bedload.	Resiliency to disturbance could not be accurately assessed in this subreach due to access restriction.	<b><i>At Risk Condition</i></b>  Removal of riparian vegetation and channel modifications associated with residential development on the right bank floodplain limit resiliency to disturbance by to large flood events that carry significant bedload.
Riparian Vegetation	Condition	Structure	<b><i>At Risk Condition</i></b>  Natural structure of 63% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Adequate Condition</i></b>  Natural structure of 85% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b>  Natural structure of 41% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.	<b><i>Adequate Condition</i></b>  Natural structure of 82% (total composition less roads, bare ground, grass, irrigation canals, and buildings) in riparian buffer.
		Disturbance (Human)	<b><i>Unacceptable Risk Condition</i></b>  49% medium-large wood available in riparian buffer; 37% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); 4 mi/mi <sup>2</sup> roads in riparian buffer.	<b><i>At Risk Condition</i></b>  55% medium-large wood available in riparian buffer; 15% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b><i>Unacceptable Risk Condition</i></b>  39% medium-large wood available in riparian buffer; 59% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.	<b><i>Adequate Condition</i></b>  82% medium-large wood available in riparian buffer; 18% disturbed cover (roads, bare ground, grass, irrigation canals, and buildings); no roads in riparian buffer.
		Canopy Cover	<b><i>At Risk Condition</i></b>  66% medium-large wood available in riparian buffer.	<b><i>At Risk Condition</i></b>  76% medium-large wood available in riparian buffer.	<b><i>At Risk Condition</i></b>  54% medium-large wood available in riparian buffer.	<b><i>Adequate Condition</i></b>  93% medium-large wood available in riparian buffer.



## APPENDIX C

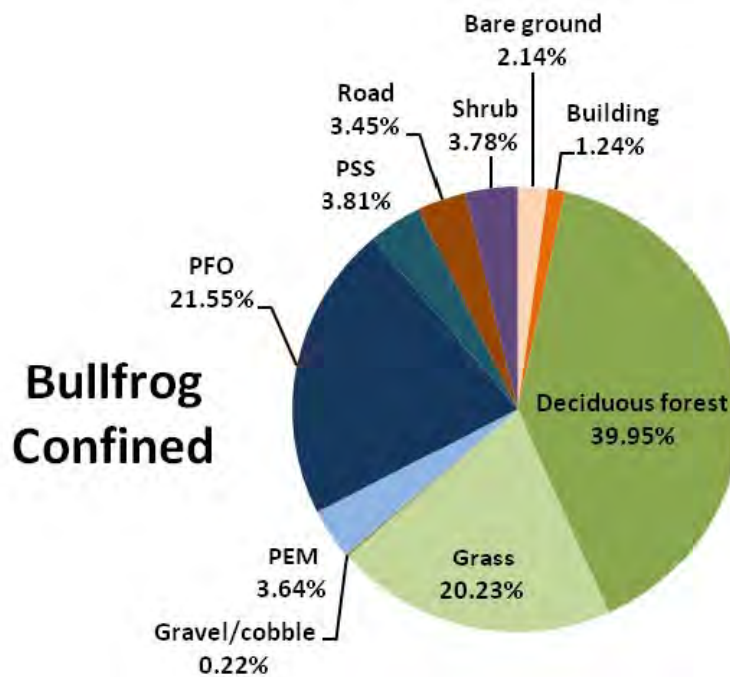
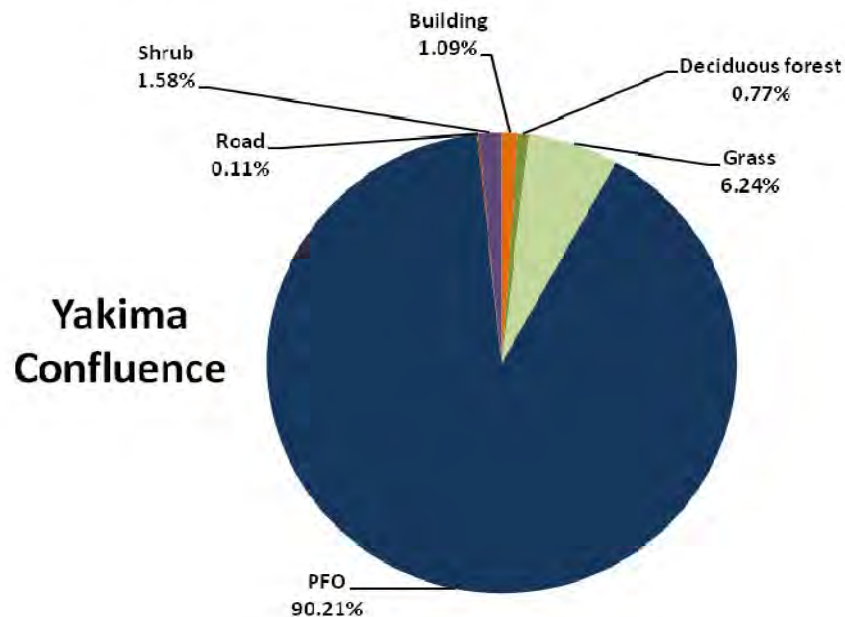
---

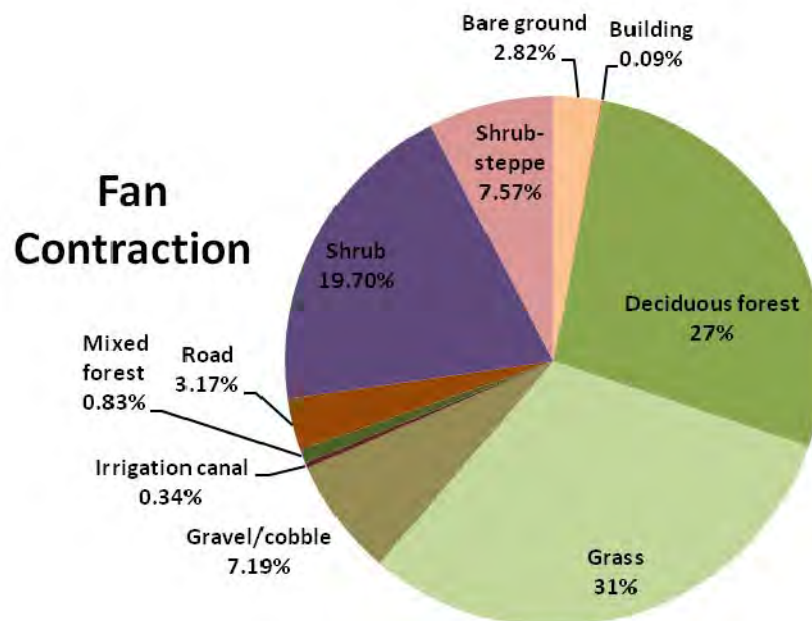
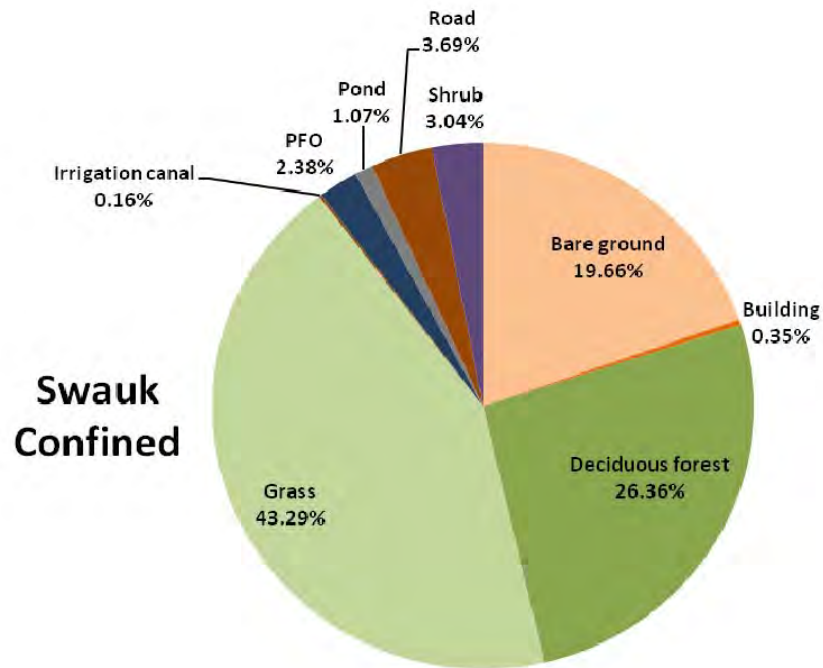
# Vegetation Community Composition in Riparian Zone





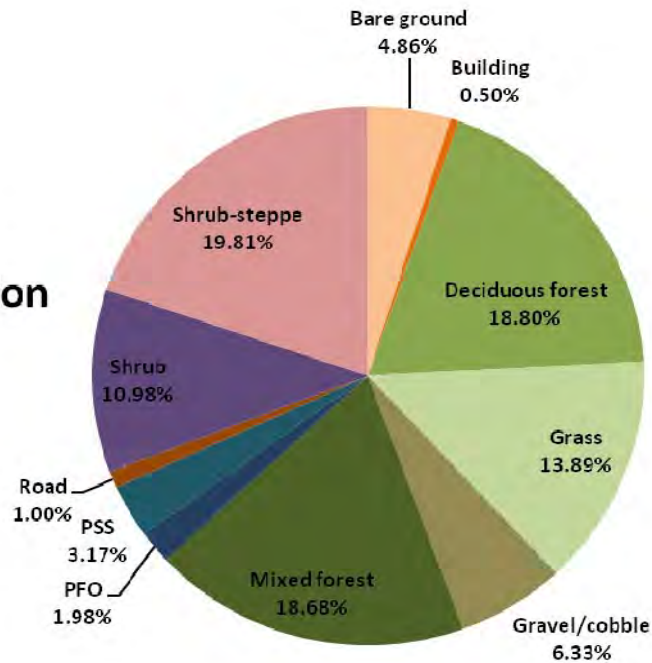
Riparian zone composition (within 30 meter belt along each bank) for each non-canyon reach in the Manastash Creek Corridor Habitat Enhancement and Flood Hazard Reduction Plan. [PFO = forested wetland; PSS = scrub-shrub wetland; PEM = emergent wetland (Cowardin et al. 1979)]. See main text for definition of vegetation types and constituent species.



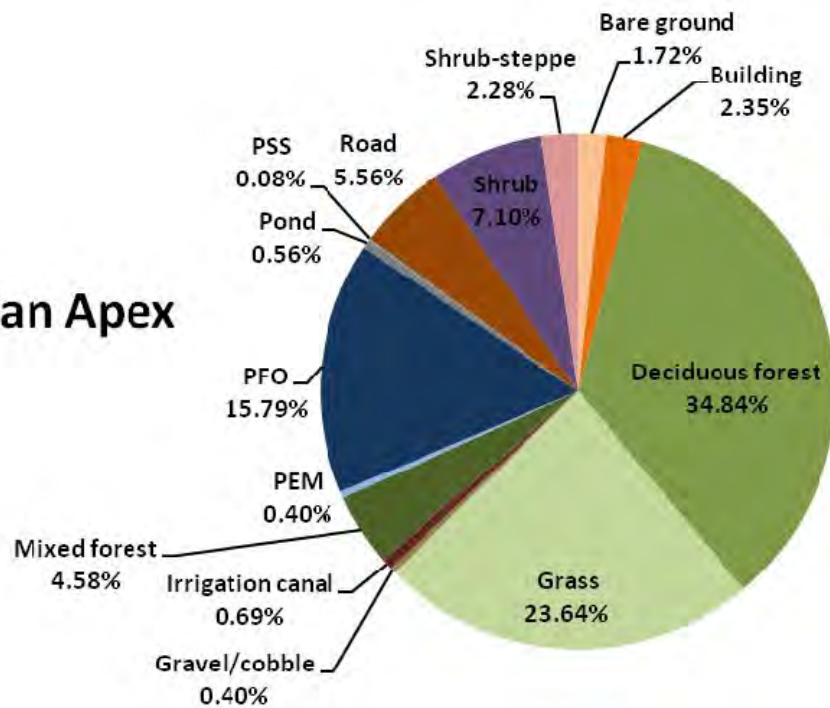




## Fan Expansion



## Fan Apex





## APPENDIX D

---

# Photographic Documentation of Habitat Conditions





## YAKIMA CONFLUENCE REACH



Photo D1. Stream channel and riparian habitat conditions in Reach YC.

## BULLFROG CONFINED REACH



Photo D2. Stream channel and riparian habitat conditions in Reach BC1 downstream of Brown Road.



Photo D3. Large wood accumulation in Reach BC1.





Photo D4. Algae growth in stream channel and riparian habitat conditions in Subreach BC3.

## SWAUK CONFINED REACH



Photo D5. Turbid water and algae in stream channel in Subreach SC1.



Photo D6. Dry stream channel conditions in Subreach SC2.



## FAN CONTRACTION REACH



Photo D7. Dry stream channel, gravel berms, and unvegetated riparian conditions in Subreach FC1.



Photo D8. Groundwater fed base flow within confined stream channel in Subreach FC2.



Photo D9. Dry stream channel and riparian habitat conditions in Subreach FC4.



Photo D10. Dry stream channel and riparian habitat conditions in Subreach FC5.



## FAN EXPANSION REACH



Photo D11. Dry stream channel and berm/revetment upstream of Cove Road in Subreach FE1.



Photo D12. Stream channel and riparian habitat conditions in Subreach FE2.



Photo D13. Entrenched stream channel and riparian habitat conditions downstream of Reed diversion in Subreach FE3.



Photo D14. Stream channel and riparian habitat conditions in Subreach FE4.



## FAN APEX REACH



Photo D15. Stream channel and riparian habitat conditions in Subreach FA1.



Photo D16. Stream channel and bridge in Subreach FA2.



Photo D17. Stream channel and riparian habitat conditions in Subreach FA4.



## CANYON REACH



Photo D18. Stream channel and riparian habitat conditions in Reach CY.



Photo D19. Stream channel and riparian habitat conditions in Reach CY.



Photo D20. Gravel berm along Manastash Road in Reach CY.