# LOWER PESHASTIN TRIBUTARY AND REACH ASSESSMENT

# APPENDIX A STREAM HABITAT REACH REPORTS

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## A-1 Reach 1

Location: Mouth of Peshastin Creek (RM 0) to RM 1.4

Survey Date: August 13, 2009

Survey Crew: Mark Sogge and Gardner Johnston (Inter-Fluve)

### A-1.1 Reach Overview

Reach 1 begins at the confluence of Peshastin Creek and the Wenatchee River (Figure 1) and extends up to river mile 1.4, which marks the transition of the Peshastin Creek Valley into the broad Wenatchee Creek Valley (Figure 2). The valley in this reach is unconfined. Highway 2 crosses Peshastin Creek in this reach and Highway 97 lies adjacent to the stream along much of the upstream portion of the reach. Land uses include agriculture and rural residential development. A summary of habitat characteristics for the reach can be found in Table 2 and Table 3 at the end of the Reach 1 section.

**Figure 1. Downstream view of junction of Peshastin Creek with the Wenatchee River.**


**Figure 2. Reach 1 locator and habitat unit composition map.**

### A-1.2 Channel Morphology

Channel morphology in Reach 1 is dominated by plane-bed segments with infrequent pool-riffle sequences (Figure 3). Although the valley is unconfined, the channel itself is confined due to hydromodifications and incision into glacial outwash material. Bed gradients range from 1% to 2%. In some areas, steep bed slopes may be attributed to historical channel straightening in this reach. Average channel widths are approximately 35 feet (wetted width at time of survey); bankfull widths are more than twice as wide (73.5 ft). The average floodprone width exceeds 400 feet and is the largest relative to the other 4 reaches.

**Figure 3. Downstream view in Reach 1 of Peshastin Creek. Approximate river mile 0.2.**

### A-1.3 Habitat Unit Composition

Pool frequency is 12.8 pools/mile or 1 pool every 6 bankfull widths. Pools comprise only 12% of the reach and do not exceed 2 feet in residual depth (Figure 4 and Figure 5). Pools lack habitat structure for cover and complexity. Riffles comprise 88% of the habitat area.

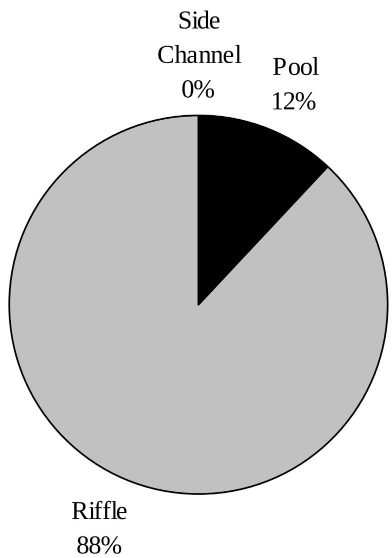



Figure 4. Habitat unit composition for Reach 1.

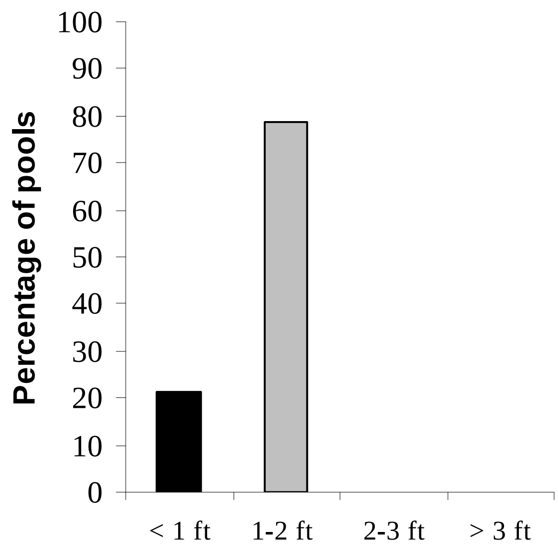



Figure 5. Reach 1 residual pool depths.

### A-1.4 Off-Channel Habitat

No side-channel habitat currently exists within this reach. Multi-thread channel segments are evident in this reach in the 1962 aerial photos and it is assumed that even greater channel diversity existed prior to the Highway 97 construction in 1956, which cut-off main channel and side-channel segments. The area of greatest loss in channel complexity is the lower 0.4 mile where the historical multi-thread channel system across the delta fan has been channelized into a uniform single-thread channel.

### A-1.5 Large Woody Debris

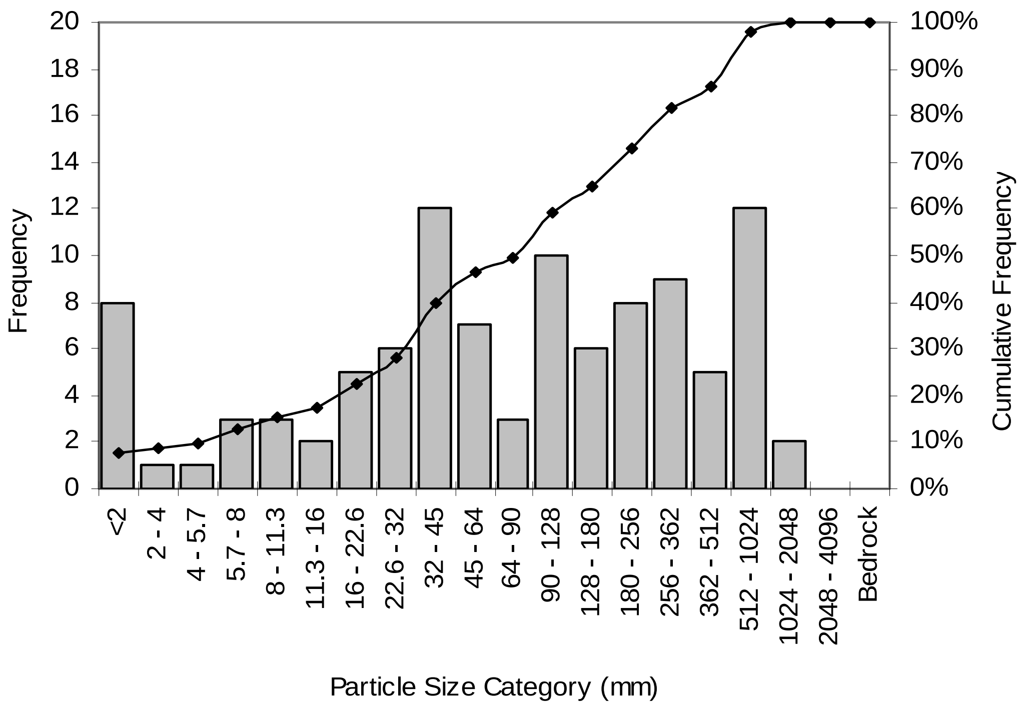
Wood loading is very low in this reach. Large wood frequency is 31 pieces/mile, with "small" pieces comprising 97% of all large wood counted in the reach. No wood in the "large" category was present in the reach (Table 1).

Table 1. Large woody debris quantities in Reach 1.

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in by 35 ft) | Total |
|---|---|---|---|---|
| Number of Pieces | 31 | 3 | 0 | 34 |
| Number of Pieces/Mile | 24 | 2 | 0 | 26 |

## A-1.6 Substrate and Fine Sediment

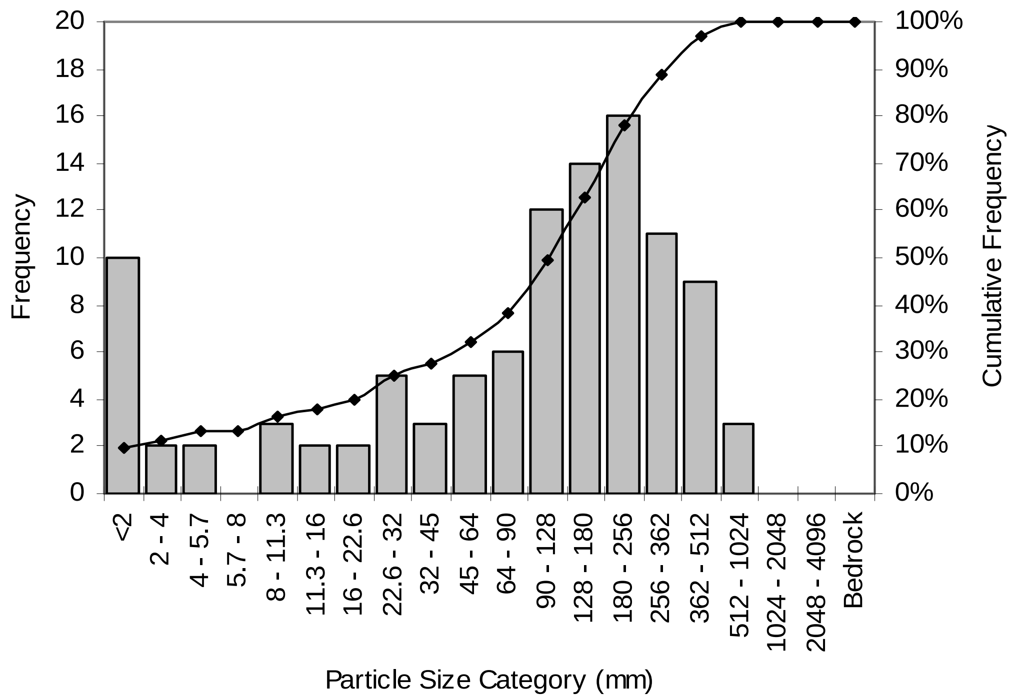
Bed substrate is dominated by cobbles, with gravels and boulders sub-dominant. Bedrock is relatively uncommon and sand makes up 10% or less of the distribution. The pebble count and size class data are depicted in Figure 6, Figure 7, and Figure 8.




| Material | Percent Composition |
|---|---|
| Sand | 8% |
| Gravel | 39% |
| Cobble | 26% |
| Boulder | 27% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 12 |
| D50 | 92 |
| D84 | 438 |
| D95 | 890 |

**Figure 6. Grain size distribution and particle size classes from pebble count taken at RM 0.25.**




| Material | Percent Composition |
|---|---|
| Sand | 10% |
| Gravel | 23% |
| Cobble | 46% |
| Boulder | 22% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 11 |
| D50 | 130 |
| D84 | 316 |
| D95 | 475 |

**Figure 7. Grain size distribution and particle size classes from pebble count taken at RM 0.8.**

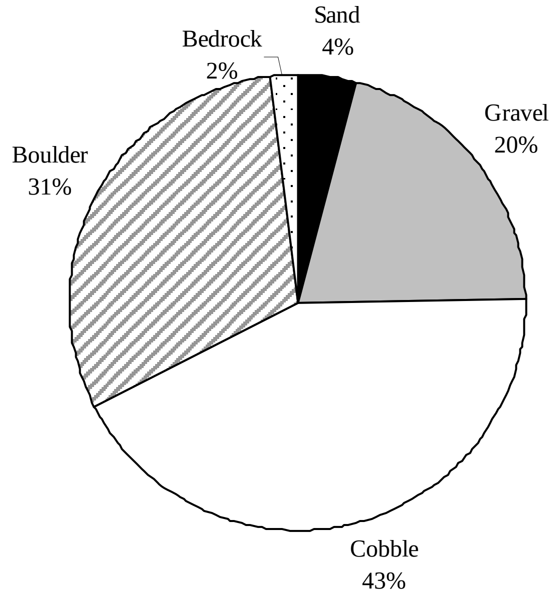



**Figure 8. Percent composition of bed substrate based on ocular estimates, Reach 1.**

### A-1.7 Instability and Disturbance

Streambanks consist of alluvial deposits that receive periodic scour from flooding and icing events. Numerous ice-damaged alders and cottonwoods were observed along the banks in many locations. No significant bank erosion outside the bankfull channel was observed. Channel straightening, artificial confinement, and incision have likely served to increase overall channel stability, thus reducing dynamic channel adjustments that would have existed historically.

Human activities have modified the channel and associated riparian corridor within this reach. There are levees/road embankments where Highway 97 or other roadways abut the channel. The channel is constricted at two bridge crossings (RM 0.4 and 0.7) (Figure 9); and the lower 0.4 mile has been straightened and is currently incised and disconnected from the floodplain.

**Figure 9. Hwy 97 Bridge at river mile 0.65.**

### A-1.8 Available Spawning and Rearing Habitat

There is limited spawning and rearing habitat in Reach 1. Riffles consist of long, coarse-bedded, plane-bed sections that lack good spawning substrate. Pool quantity is very low and the pools that are available have shallow residual depths and have high velocities at higher flows. Pool tail-outs with spawning-sized material and suitable depths and velocities are not present in the reach. LWD is nearly absent and there are no off-channel rearing areas available. Late summer instream flow levels may be a concern due to upstream flow diversions.

The coarse bed and high frequency of boulders provides areas of localized velocity refuge that may be utilized for rearing by juvenile steelhead and resident trout; but for most species, this reach is suitable only as a migration corridor. Historically, this reach likely played an important role in providing cool water rearing during the summer for Wenatchee River populations. However, reduced habitat complexity, flow withdrawals, and temperature impairments have reduced its ability to provide these functions.

### A-1.9 Fish Passage Barriers

There are no fish passage barriers in Reach 1. Mean riffle thalweg depth is at the minimum 0.8-ft threshold depth for passage by Spring Chinook (Thompson 1972), but is above the threshold for bull trout passage. The absence of adequate flow depths in riffles during summer time low flow is a potential constraint on passage of in-migrating spring Chinook.

### A-1.10 Riparian Corridor

Vegetation in the riparian zone is heavily modified with few large trees in either the inner (near-channel) or outer zones (Figure 10 and Figure 11). The riparian corridor is confined to a narrow buffer through most of the reach. Roadways, residential development, and orchards lie adjacent to the reach and have impacted the width and species composition of the riparian corridor (Figure 12). There is very little shade provided by riparian vegetation and the potential for large woody debris recruitment in this reach is low.

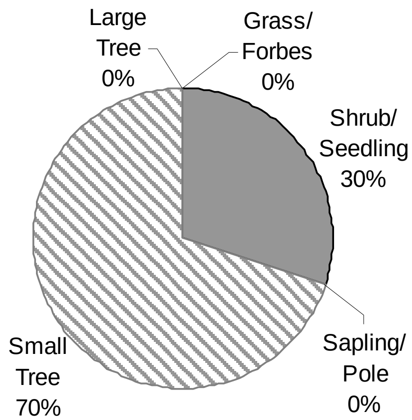



**Figure 10. Vegetation class by percentage in the riparian inner zone of Reach 1 of Peshastin Creek.**

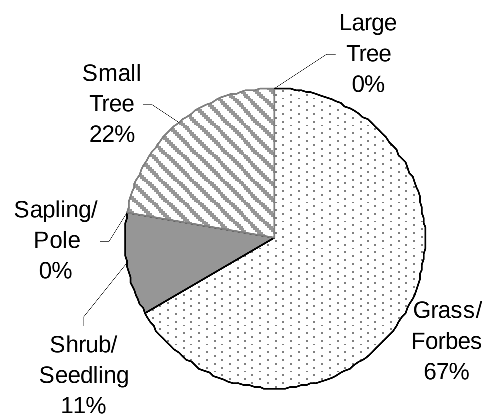



**Figure 11. Vegetation class by percentage in the riparian outer zone of Reach 1 of Peshastin Creek.**

**Figure 12. Impacted riparian corridor along the river left bank near river mile 1.2.**

**Table 2. Summary of channel geometry and spatial organization of habitat units in Reach 1.**

| Reach 1 Habitat Unit Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Reach Mileage Boundaries** | **Channel Morphology** | **Slope (ft/ft)** | | **Habitat Area %** | | | |
| 0-1.4 | Plane-bed | Average | 0.018 | Pool | 11.8 | | |
| | | Maximum | 0.309 | Riffle | 88.2 | | |
| | | | | Side Channel | 0.0 | | |
| **Reach-Average Characteristics** | | **Bankfull Characteristics** | | **Riffle Characteristics** | | **Pool Characteristics** | |
| *Wetted Width (ft)* | | *Width (ft)* | | *Riffle Wetted Width (ft)* | | *Pool Wetted Width (ft)* | |
| Mean | 34.6 | Mean | 73.5 | Mean | 38.1 | Mean | 29.7 |
| Median | 34.5 | Median | 74.0 | Median | 37.0 | Median | 30.5 |
| StDev | 11.5 | StDev | 11.1 | StDev | 13.0 | StDev | 7.0 |
| *Width:Depth Ratio* | | *Depth (ft)* Averaged over 3 depth measurements | | *Maximum Riffle Thalweg Depth (ft)* | | *Pool Maximum Depth (ft)* | |
| Mean | 15.1 | Mean | 4.9 | Mean | 1.7 | Mean | 2.2 |
| Median | 14.3 | Median | 5.2 | Median | 1.8 | Median | 2.1 |
| StDev | 2.7 | StDev | 0.9 | StDev | 0.3 | StDev | 0.4 |
| *Floodprone Width (ft)* | | *Maximum Depth (ft)* | | *Average Riffle Thalweg Depth (ft)* | | *Pool Residual Depth (ft)* | |
| Mean | 416 | Mean | 5.5 | Mean | 0.8 | Mean | 1.2 |
| Median | 500 | Median | 5.7 | Median | 0.8 | Median | 1.3 |
| StDev | 115 | StDev | 0.7 | StDev | 0.2 | StDev | 0.3 |
| *Channel Confinement (floodprone width / bankfull width)* | | | | | | *Residual depth/mile* | |
| Mean | 5.7 | | | | | Pools< 1 ft | 2.7 |
| | | | | | | Pools 1-2 ft | 10.0 |
| | | | | | | Pools 2-3 ft | 0.0 |
| | | | | | | Pools > 3 ft | 0.0 |
| | | | | | | *Pools per mile* | 12.8 |
| | | | | | | *Riffle:Pool Ratio* | 1.4 |
| | | | | | | *Mean Pool Spacing* | 473.1 |
| | | | | | | *Mean Pool Spacing/Mean Bankfull Width* | 6.4 |

**Table 3. Summary of environmental components of habitat units in Reach 1.**

| Reach 1 Habitat Component Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Large Wood** | | **Bank Erosion (ft/mile)** | | **Substrate** | | **Vegetation** | |
| *Number of Pieces* | | Total/Mile | 0.0 | Ocular Estimate | | Class (Percent of sampled units) | |
| Small (6 in x 20 ft) | 31.0 | Left Bank/Mile | 0.0 | *Total* | | *InnerZone* | |
| Medium (12 in x 35 ft) | 3.0 | Right Bank/Mile | 0.0 | | | | |
| | | | | % Sand | 4 | Grass/ Forbes | 0 |
| Large (20 in by 35 ft) | 0.0 | *Pool* | | % Gravel | 20 | Shrub/ Seedling | 5 |
| Total | 34.0 | Total/Mile | 0.0 | % Cobble | 43 | Sapling/ Pole | 0 |
| *Number of Pieces/Mile* | | Left Bank/Mile | 0.0 | % Boulder | 31 | Small Tree | 11 |
| Small (6 in x 20 ft) | 28.3 | Right Bank/Mile | 0.0 | % Bedrock | 2 | Large Tree | 0 |
| Medium (12 in x 35 ft) | 2.7 | *Riffle* | | *Pool* | | *OuterZone* | |
| Large (20 in by 35 ft) | 0.0 | Total/Mile | 0.0 | % Sand | 5 | Grass/ Forbes | 9 |
| Total | 31.0 | Left Bank/Mile | 0.0 | % Gravel | 25 | Shrub/ Seedling | 2 |
| | | Right Bank/Mile | 0.0 | % Cobble | 38 | Sapling/ Pole | 0 |
| | | *Percent Erosion (both banks)* | 0.0 | % Boulder | 32 | Small Tree | 3 |
| | | | | % Bedrock | 0 | Large Tree | 0 |
| | | | | *Riffle* | | | |
| | | | | % Sand | 4 | | |
| | | | | % Gravel | 18 | | |
| | | | | % Cobble | 45 | | |
| | | | | % Boulder | 30 | | |
| | | | | % Bedrock | 3 | | |
| | | | | Pebble Count | | | |
| | | | | % Sand | 9 | | |
| | | | | % Gravel | 31 | | |
| | | | | % Cobble | 36 | | |
| | | | | % Boulder | 25 | | |
| | | | | % Bedrock | 0 | | |

## A-2 REACH 2

Location: River mile 1.4 to River mile 5.0

Survey Date: August 14 – 16, 2009

Survey Crew: Mark Sogge and Gardner Johnston (Inter-Fluve)

*The staff gage at the Green Bridge Road crossing near river mile 1.5 (WA Dept of Ecology Gage) read 0.79 ft on the day of the survey (Aug 14).

### A-2.1 Reach Overview

Reach 2 is the longest reach within the study area. Reach 2 lies within an unconfined valley. Highway 97 abuts the river along much of this reach and has had significant impacts on channel planform and riparian conditions. Agriculture and residential development occur throughout the valley in this reach. The largest irrigation diversion is located within this reach (river mile 2.5) and consists of a low-head dam and associated headworks. The inflow pipe from Icicle Creek crosses the channel in this reach at approximately RM 2.0. A summary of habitat characteristics for the reach can be found in Table 2 and Table 3 at the end of the Reach 2 section.

**Figure 13. Aerial oblique upvalley view of Peshastin Creek Reach 2. Bottom of photo is river mile 1.6. Photo taken Sept 24, 2009.**

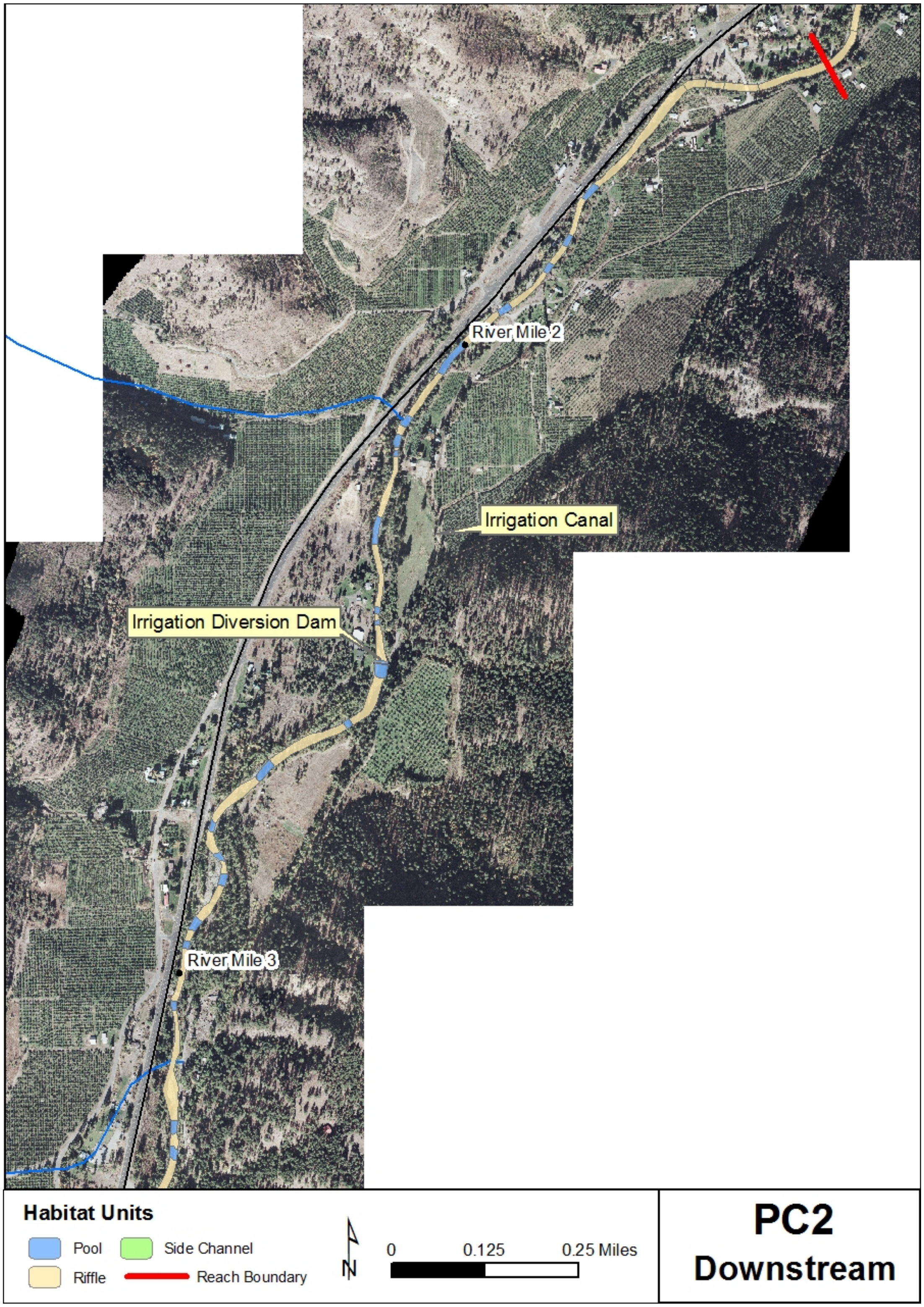



**Figure 14. Reach 2 – Downstream Portion locator and habitat unit composition map.**

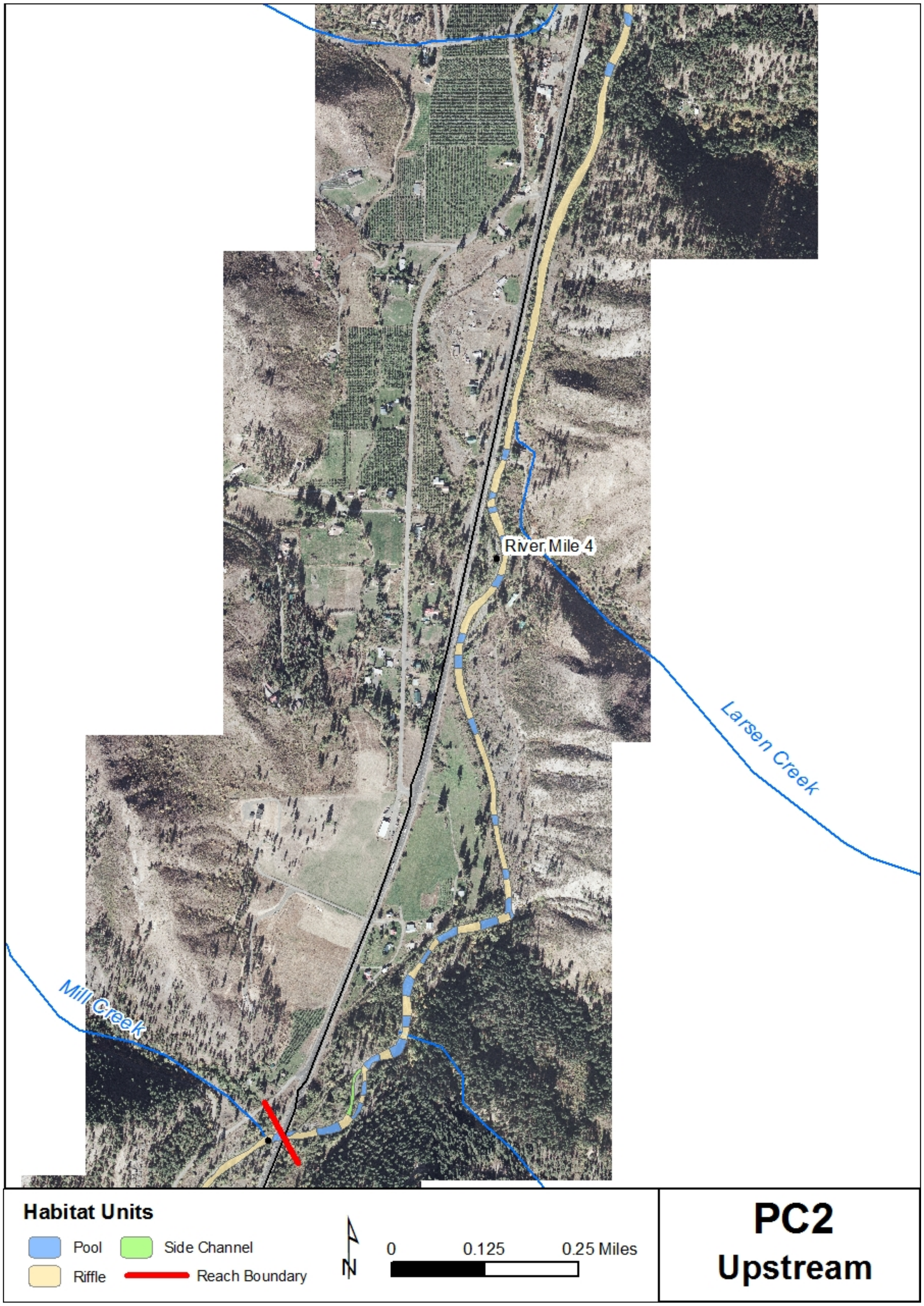



**Figure 15. Reach 2 – Upstream Portion locator and habitat unit composition map**

### A-2.2 Channel Morphology

Channel morphology is predominantly plane-bed, with intermittent pool-riffle and step-pool sequences. Although the valley is unconfined, the channel is largely confined due to hydromodifications and incision into glacial outwash deposits. Average bed slope is 1.4%. Average channel width is 38 feet (wetted width at time of survey) and mean bankfull width is 77 feet.

### A-2.3 Habitat Unit Composition

Pools comprise 19% of the habitat area (Figure 16). Pool frequency is 12 pools/mile, or one pool every four bankfull widths. Fifty nine percent (59%) of pools have residual depths between 1 and 2 feet (Figure 17). Only 4% of pools have residual depths that exceed 3 feet. Most of the pools lack adequate cover and habitat complexity (Figure 18). Riffles account for 80% of the habitat, many of which occur as long plane-bed segments. Riffles several hundred feet long are common, with one riffle nearly 2,000 feet long. Mean riffle depth is 0.7 ft.

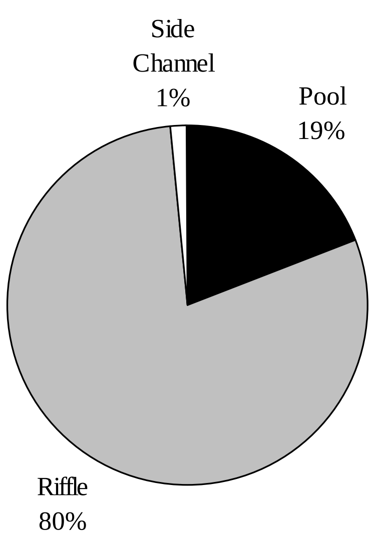



**Figure 16. Habitat unit composition for Reach 2.**

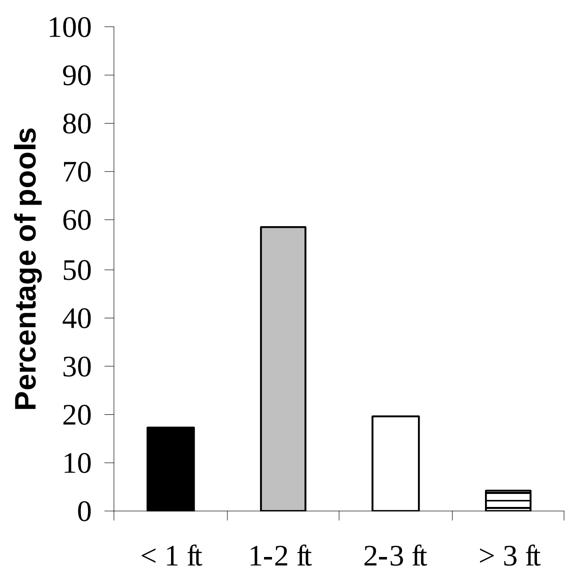



**Figure 17. Reach 2 residual pool depths.**

**Figure 18. Typical pool in Reach 2 with minimal cover or habitat complexity. River mile 2.0.**

### A-2.4 Off-Channel Habitat

Side-channel habitat comprises only 1% of habitat within the reach (Figure 16) and there was no evidence of accessible off-channel habitat at the flow level during the survey. Prior to historical channel manipulations and floodplain development, off-channel habitat was likely maintained by active channel dynamics and planform adjustments. The processes that create and maintain these types of habitats have been altered and off-channel habitat is now scarce.

### A-2.5 Large Woody Debris

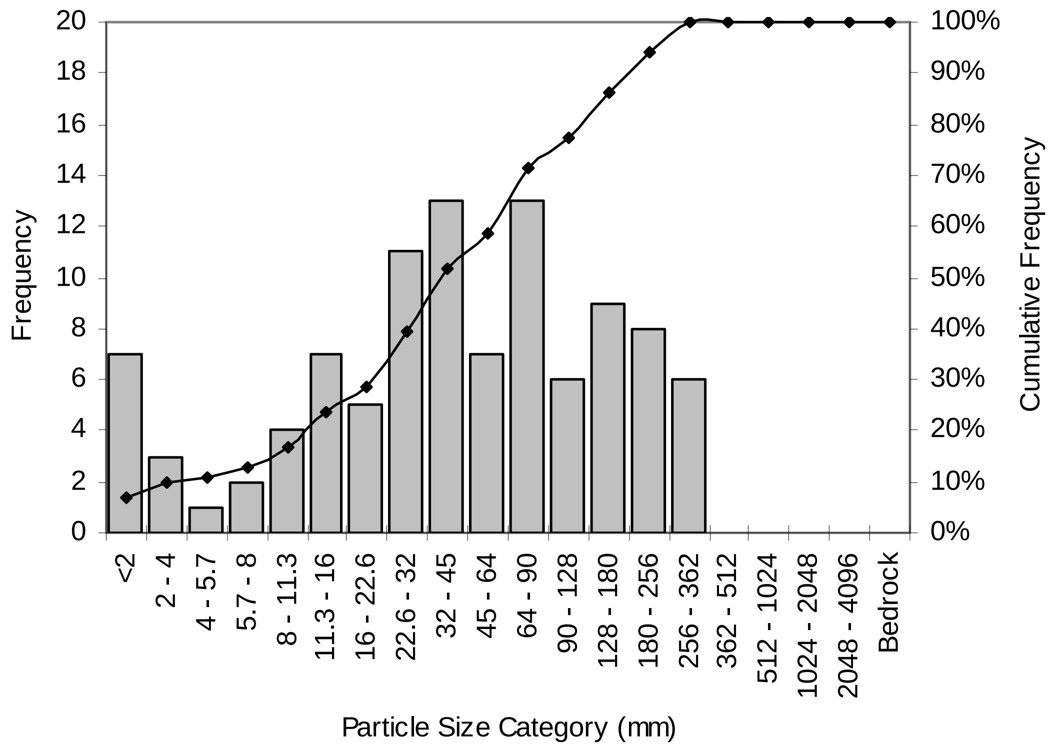
Wood loading in Reach 2 is low (Table 4). Large wood frequency is 40 pieces/mile, with small pieces comprising 65% of all wood counted in the reach. Medium and large pieces occured at a frequency of 6 pieces/mile and 8 pieces/mile, respectively. Removal of riparian trees and a reduction in natural channel dynamics have likely served to reduce LWD frequency compared to natural historical conditions.

**Table 4. Large woody debris quantities in Reach 2.**

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in by 35 ft) | Total |
|---|---|---|---|---|
| Number of Pieces | 102 | 23 | 31 | 125 |
| Number of Pieces/Mile | 26 | 6 | 8 | 40 |

## A-2.6 Substrate and Fine Sediment

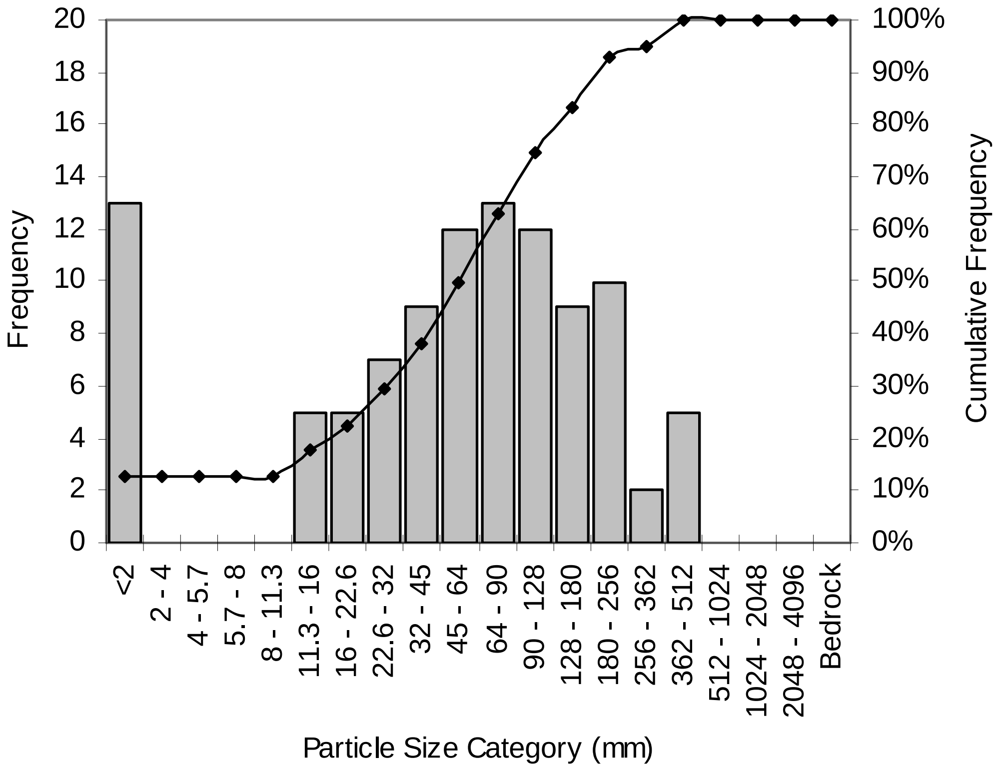
Dominant bed substrate ranges from large gravels to small boulders (Figure 19, Figure 20, and Figure 21). Ocular estimates generally agree with pebble counts except more boulders were recorded in ocular measures. The sand quantity is high (13%) in the river mile 4.1 pebble count but is less than 10% in the other pebble count and based on ocular measures.




| Material | Percent Composition |
|---|---|
| Sand | 7% |
| Gravel | 52% |
| Cobble | 35% |
| Boulder | 6% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 11 |
| D50 | 43 |
| D84 | 167 |
| D95 | 272 |

**Figure 19. Grain size distribution and particle size classes from pebble count taken at RM 2.6.**




| Material | Percent Composition |
|---|---|
| Sand | 13% |
| Gravel | 37% |
| Cobble | 43% |
| Boulder | 7% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 14 |
| D50 | 64 |
| D84 | 185 |
| D95 | 357 |

**Figure 20. Grain size distribution and particle size classes from pebble count taken at RM 4.1.**

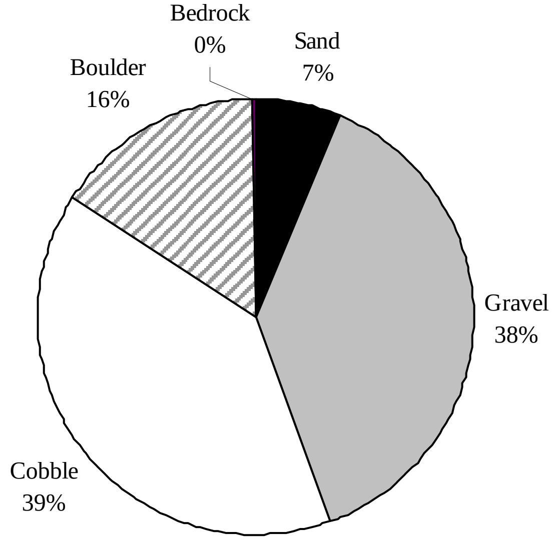



**Figure 21. Percent composition of bed substrate based on ocular estimates, Reach 2.**

### A-2.7 Instability and Disturbance

Streambanks consist of alluvial deposits that receive periodic scour from flooding and icing events. Bank erosion outside the bankfull channel was observed on approximately 1,200 feet of bank, comprising 3% of the total bank length (sum of both sides). The river right bank (facing downstream) contains the greatest amount of bank erosion (83%), which is attributable to (1) the location of the channel against the right valley wall toe, and (2) the high frequency of bank armoring along the left bank that limits bank erosion. Channel straightening, artificial confinement, and incision have likely served to increase overall channel stability at the expense of natural channel dynamics that are necessary to create habitat complexity, recruit LWD, and supply gravels.

Highway 97, numerous bridges, agriculture, and residential development/clearing are the predominant human disturbances in Reach 2. Highway 97 is adjacent to the channel along a continuous reach extending from RM 1.6 to 1.8 and RM 3.6 to 3.9, and abuts the channel over shorter lengths at several locations, accounting for approximately 30% of the total reach length. There is rip-rap associated with the road embankment in many locations. A large section of channel (RM 3.6 to 3.9) was abandoned and the channel straightened when the highway was constructed. Three bridge crossings occur within the reach (RMs 1.5, 2.0, and 3.2).

There is an irrigation diversion at the Tandy Ditch at RM 4.9, with possible fish entrainment impacts. The irrigation diversion dam at river mile 2.5 is another major impact and is discussed below under “Fish Passage Barriers”. There is an outfall into

Peshastin Creek on the river left bank at RM 2.1 via a 24-inch culvert and a 2-ft elevation drop. This is a return flow from an irrigation ditch.

### A-2.8 Available Spawning and Rearing Habitat

There is limited spawning and rearing habitat in Reach 2. Many of the riffles consist of long, coarse-bedded, plane-bed sections that lack good spawning substrate. Pools are infrequent and tend to be of low quality. Several pools have adequate depth and cover, and a few pools have long tail-outs with good spawning habitat (Figure 22); but the majority of pools have shallow residual depths and minimal cover and LWD habitat. Pool quality tends to be higher in the upstream portion of the reach. LWD quantities are very low throughout the reach and there is minimal side-channel habitat (1%). Summer instream flow levels may be reduced due to the Tandy Ditch (RM 4.9) and the Peshastin Canal (RM 2.5) irrigation diversions that occur within this reach. Water diversions and a lack of stream shade likely contribute to elevated summer water temperatures that may reduce the quality of summer rearing habitat.

The coarse bed and high frequency of boulders provides areas of localized velocity refuge that may be utilized for rearing by juvenile steelhead and resident trout. Steelhead and Chinook spawning may occur in the handful of suitable pool tail-outs. A few logs with rootwads have been placed near river mile 4.2 on the left bank, presumably to provide habitat-friendly streambank protection (Figure 23).

**Figure 22. Long pool with good overhanging bank vegetation cover and a long tail-out with spawning-sized material. Near river mile 4.9; Highway 97 Bridge in background.**

**Figure 23. Logs with rootwads placed for streambank protection and fish habitat near river mile 4.2.**

### A-2.9 Fish Passage Barriers

The irrigation diversion dam at RM 2.5 has recently (2005) undergone modification to provide fish passage. This structure now has a fish passage channel on the river left side of the dam (see Figure 24).

Mean riffle depth is 0.7 ft during low summer flows, which suggests there could be potential passage limitations for spring Chinook in some areas, based on Thompson (1972).

**Figure 24. Irrigation diversion dam and fish passage channel at river mile 2.5.**

### A-2.10 Riparian Corridor

Vegetation in the riparian zone is heavily modified. The riparian corridor is confined to a narrow buffer through most of the reach. Roadways, residential development, and orchards lie adjacent to the reach and have impacted the width and species composition of the riparian corridor (Figure 25). There are no large trees in either the inner (near-channel) or outer zones (Figure 26 and Figure 27). Shrub/seedling size classes dominate the inner zone and grass/forbes dominate the outer zone. There is inadequate riparian vegetation that is necessary to provide stream shade, bank stabilization, and LWD recruitment.

**Figure 25. Impacted riparian corridor and rip-rap bank along Highway 97 near river mile 4.1 (river left bank).**

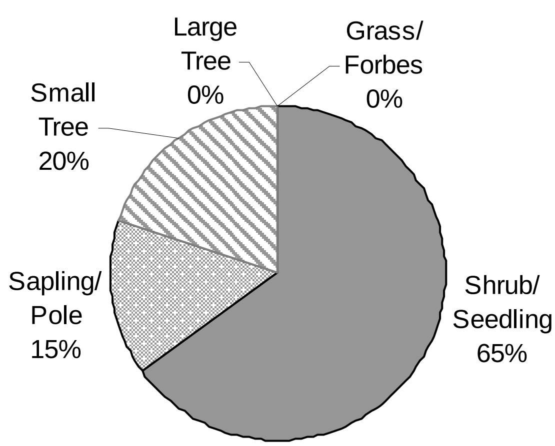



**Figure 26. Vegetation class by percentage in the riparian inner zone of Reach 2 of Peshastin Creek.**

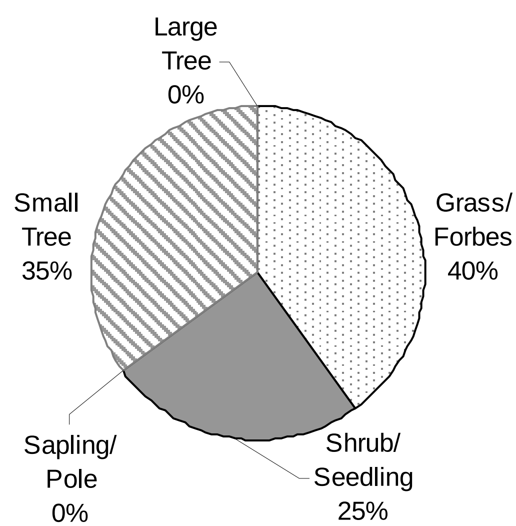



**Figure 27. Vegetation class by percentage in the riparian outer zone of Reach 2 of Peshastin Creek.**

**Table 5. Summary of channel geometry and spatial organization of habitat units in Reach 2.**

| Reach 2 Habitat Unit Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Reach Mileage Boundaries** | **Channel Morphology** | **Slope (ft/ft)** | | **Habitat Area %** | | | |
| 1.4-5.0 | Plane-bed | Average | 0.014 | Pool | 19.1 | | |
| | | Maximum | 0.202 | Riffle | 79.4 | | |
| | | | | Side Channel | 1.4 | | |
| **Reach Average Characteristics** | | **Bankfull Characteristics** | | **Riffle Characteristics** | | **Pool Characteristics** | |
| *Wetted Width (ft)* | | *Width (ft)* | | *Riffle Wetted Width (ft)* | | *Pool Wetted Width (ft)* | |
| Mean | 37.5 | Mean | 76.7 | Mean | 39.1 | Mean | 35.7 |
| Median | 37.0 | Median | 69.5 | Median | 40.0 | Median | 33.0 |
| StDev | 11.1 | StDev | 22.1 | StDev | 8.8 | StDev | 13.0 |
| *Width:Depth Ratio* | | *Depth (ft)* Averaged over 3 depth measurements | | *Maximum Riffle Thalweg Depth (ft)* | | *Pool Maximum Depth (ft)* | |
| Mean | 17.6 | Mean | 4.6 | Mean | 1.7 | Mean | 2.5 |
| Median | 16.0 | Median | 4.8 | Median | 1.6 | Median | 2.3 |
| StDev | 6.4 | StDev | 1.2 | StDev | 0.4 | StDev | 0.8 |
| *Floodprone Width (ft)* | | *Maximum Depth (ft)* | | *Average Riffle Thalweg Depth (ft)* | | *Pool Residual Depth (ft)* | |
| Mean | 334 | Mean | 5.4 | Mean | 0.7 | Mean | 1.5 |
| Median | 300 | Median | 5.8 | Median | 0.7 | Median | 1.4 |
| StDev | 141 | StDev | 1.3 | StDev | 0.2 | StDev | 0.8 |
| *Channel Confinement (floodprone width / bankfull width)* | | | | | | *Residual depth/mile* | |
| Mean | 4.4 | | | | | Pools< 1 ft | 2.1 |
| | | | | | | Pools 1-2 ft | 7.0 |
| | | | | | | Pools 2-3 ft | 2.3 |
| | | | | | | Pools > 3 ft | 0.5 |
| | | | | | | *Pools per mile* | 11.9 |
| | | | | | | *Riffle:Pool Ratio* | 1.1 |
| | | | | | | *Mean Pool Spacing* | 292.5 |
| | | | | | | *Mean Pool Spacing/Mean Bankfull Width* | 3.8 |

**Table 6. Summary of environmental components of habitat units in Reach 2.**

| Reach 2 Habitat Component Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Large Wood** | | **Bank Erosion (ft/mile)** | | **Substrate** | | **Vegetation** | |
| *Number of Pieces* | | Total/Mile | 315.2 | Ocular Estimate | | Class (Percent of sampled units) | |
| Small (6 in x 20 ft) | 102.0 | Left Bank/Mile | 52.5 | *Total* | | *InnerZone* | |
| Medium (12 in x 35 ft) | 23.0 | Right Bank/Mile | 262.7 | % Sand | 6.5 | Grass/ Forbes | 0.0 |
| Large (20 in by 35 ft) | 31.0 | *Pool* | | % Gravel | 38.0 | Shrub/ Seedling | 20.0 |
| Total | 125.0 | Total/Mile | 95.9 | % Cobble | 39.8 | Sapling/ Pole | 4.6 |
| *Number of Pieces/Mile* | | Left Bank/Mile | 31.3 | % Boulder | 15.5 | Small Tree | 6.2 |
| Small (6 in x 20 ft) | 26.4 | Right Bank/Mile | 64.6 | % Bedrock | 0.3 | Large Tree | 0.0 |
| Medium (12 in x 35 ft) | 5.9 | *Riffle* | | *Pool* | | *OuterZone* | |
| Large (20 in by 35 ft) | 8.0 | Total/Mile | 219.3 | % Sand | 7.5 | Grass/ Forbes | 12.3 |
| Total | 40.3 | Left Bank/Mile | 21.2 | % Gravel | 43.5 | Shrub/ Seedling | 7.7 |
| | | Right Bank/Mile | 198.1 | % Cobble | 37.5 | Sapling/ Pole | 0.0 |
| | | *Percent Erosion (both banks)* | 6.0 | % Boulder | 11.5 | Small Tree | 10.8 |
| | | | | % Bedrock | 0.0 | Large Tree | 0.0 |
| | | | | *Riffle* | | | |
| | | | | % Sand | 5.5 | | |
| | | | | % Gravel | 32.5 | | |
| | | | | % Cobble | 42.0 | | |
| | | | | % Boulder | 19.5 | | |
| | | | | % Bedrock | 0.5 | | |
| | | | | Pebble Count | | | |
| | | | | % Sand | 5.9 | | |
| | | | | % Gravel | 37.9 | | |
| | | | | % Cobble | 40.9 | | |
| | | | | % Boulder | 15.3 | | |
| | | | | % Bedrock | 0.0 | | |

## A-3 REACH 3

Location: River mile 5.0 to River mile 6.0

Survey Date: August 16 – 17, 2009

Survey Crew: Mark Sogge and Gardner Johnston (Inter-Fluve)

### A-3.1 Reach Overview

Reach 3 begins near the Highway 97 crossing at river mile 5.0 and extends one mile up to river mile 6.0 where the highway abuts the stream channel (Figure 29). The reach is bounded by the Mill Creek confluence at the downstream end and the Camas Creek confluence at the upstream end. This reach has a greater degree of valley confinement compared to other reaches, which limits the degree of agricultural uses. The primary land use is rural residential development. A summary of habitat characteristics for the reach can be found in Table 2 and Table 3 at the end of the Reach 3 section.

### A-3.2 Channel Morphology

The reach lies within a confined valley with a valley bottom width ranging from 300 to 500 feet. There is a valley constriction at the upstream end of the reach and a valley expansion at the downstream end. The stream channel is confined by Highway 97 at the upstream end and by the bridge crossing at the downstream end. Bed morphology consists of long plane-bed boulder-bed segments as well as step-pool segments (Figure 28). Bedrock is present throughout the reach and forms sculpted bedrock pools, especially near the upstream end of the reach. Average bed slope is 1%, and is the lowest relative to the other reaches. Average channel width is approximately 40 feet (wetted width at time of survey); mean bankfull width is 68.6 ft.

**Figure 28. Step-pool sequence with bedrock on river left bank. RM 5.6.**


**Figure 29. Reach 3 locator and habitat unit composition map.**

### A-3.3 Habitat Unit Composition

Pool frequency is 8 pools/mile, or 1 pool in every 6 bankfull widths. Pools comprise 21% of the total habitat area (Figure 30). There are no deep pools exceeding 3 ft. Forty-five percent of pools have residual depths of 1 – 2 ft and 33% have residual depths of 2 – 3 ft. Riffles comprise 73% of the habitat in this reach. Mean thalweg depth in riffles is 0.7 ft. Riffles and pools are lacking cover and complexity.

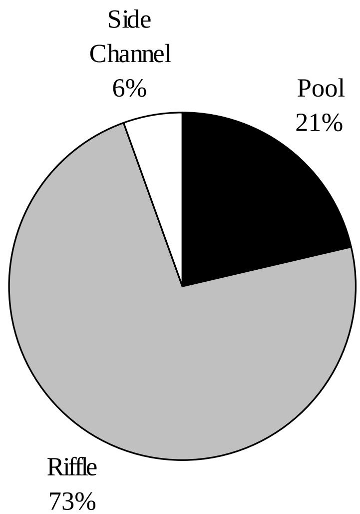



**Figure 30. Habitat unit composition for Reach 3.**

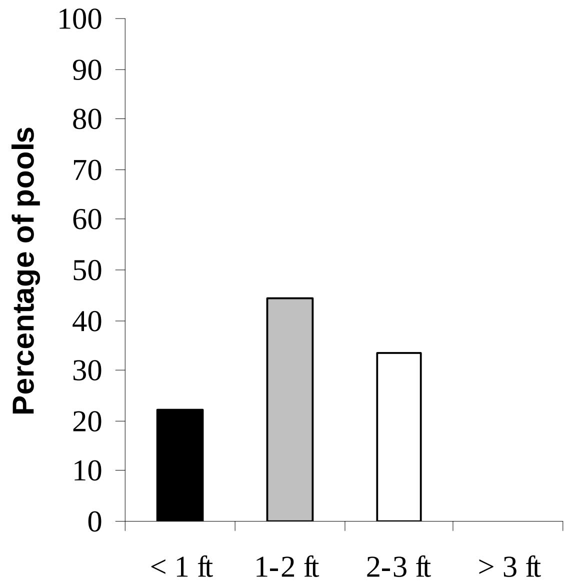



**Figure 31. Reach 3 residual pool depths.**

### A-3.4 Off-Channel Habitat

Side-channel habitat comprises 6% of habitat within the reach, which is the highest percentage relative to the other 4 reaches. There was no significant off-channel (i.e. backwater) habitat connected to the mainstem at the flow level during the survey. Availability of off-channel habitat may be naturally limited due to valley confinement and artificially limited as a result of the bridge crossing, Highway 97, and residential development.

### A-3.5 Large Woody Debris

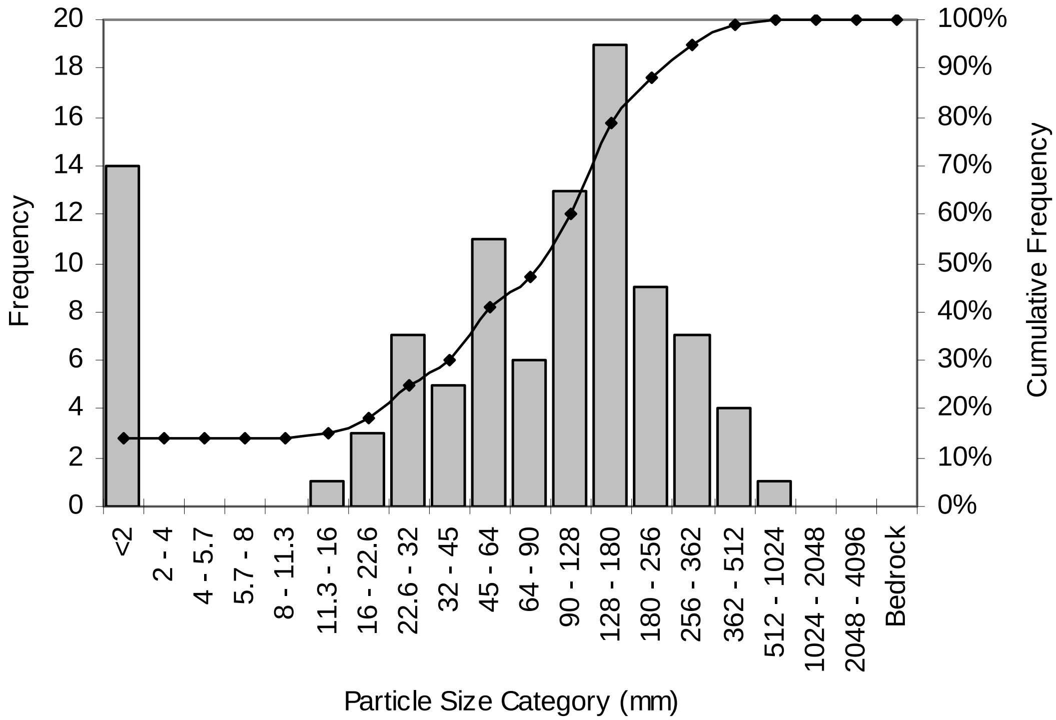
Reach 3 has the lowest amount of wood loading of all the reaches. Only 7 small pieces and 5 large pieces were counted in the reach (Table 7). This reach is largely a transport reach that does not favor wood retention. Furthermore, the riparian vegetation is dominated by scrub/shrub and sapling/pole size classes, and lacks the large tree component necessary for the local recruitment of wood into the channel.

**Table 7. Large woody debris quantities in Reach 3.**

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in by 35 ft) | Total |
|---|---|---|---|---|
| Number of Pieces | 7 | 0 | 5 | 7 |
| Number of Pieces/Mile | 6 | 0 | 5 | 11 |

### A-3.6 Substrate and Fine Sediment

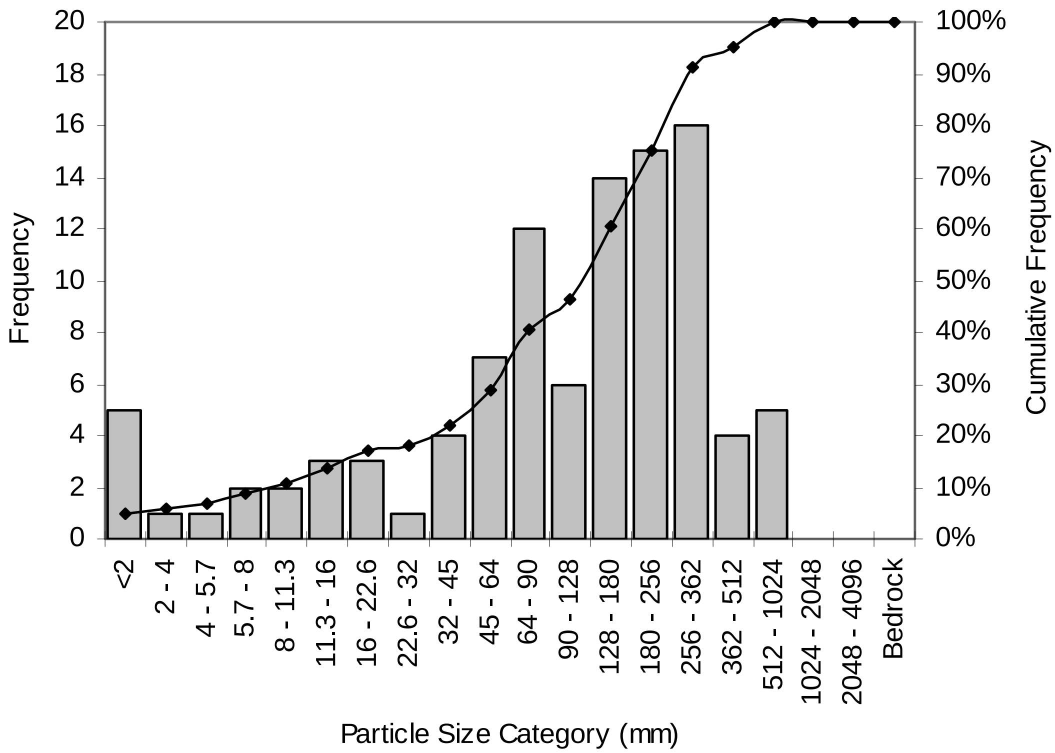
Bed substrate is dominated by cobbles, with boulder and gravels sub-dominant (Figure 32, Figure 33, and Figure 34). Fine sediment (<2 mm) represents 14% and 5% of the pebble count distributions; ocular estimates of fine sediment averaged 10%. The frequency of sand deposits may be related to the coarse and relatively complex boulder-bed channel that increases opportunities for sediment deposition and sorting. Bedrock was not present at the pebble count locations but made up 10% of the ocular estimates.



| Material | Percent Composition |
|---|---|
| Sand | 14% |
| Gravel | 27% |
| Cobble | 47% |
| Boulder | 12% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 18 |
| D50 | 99 |
| D84 | 222 |
| D95 | 362 |

**Figure 32. Grain size distribution and particle size classes from pebble count taken at RM 5.0.**




| Material | Percent Composition |
|---|---|
| Sand | 5% |
| Gravel | 24% |
| Cobble | 47% |
| Boulder | 25% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 21 |
| D50 | 141 |
| D84 | 315 |
| D95 | 510 |

**Figure 33. Grain size distribution and particle size classes from pebble count taken at RM 6.0.**

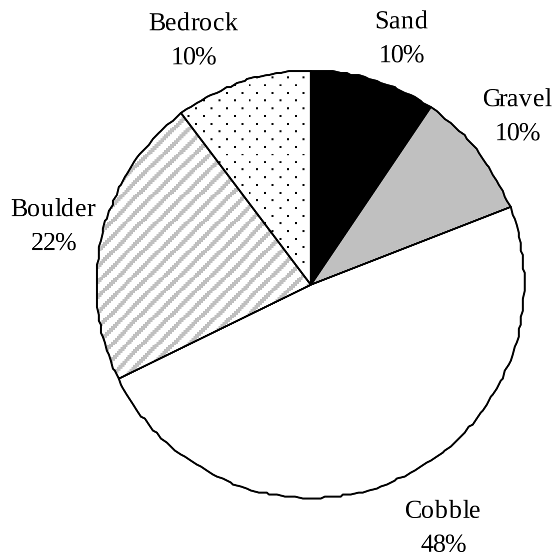



**Figure 34. Percent composition of bed substrate based on ocular estimates, Reach 3.**

### A-3.7 Instability and Disturbance

Less than 2% (167 feet) of the total streambank length (sum of both sides) is experiencing bank erosion above the bankfull stage. Isolated areas of bank erosion are related to clearing of riparian vegetation but in general bank erosion is not a habitat concern in this reach. Channel confinement related to Highway 97 (upstream end of the reach) and the bridge crossing at the downstream end have likely served to increase overall channel stability, thus reducing dynamic channel adjustments that would have existed historically.

Aside from the presence of Highway 97, general clearing and thinning of vegetation along the riparian corridor is the predominant human disturbance in this reach. There is a concrete bridge abutment at RM 5.25 (Figure 35) that extends for approximately 30 feet on river left.

**Figure 35. Concrete bridge abutment (no longer used) at river mile 5.3.**

### A-3.8 Available Spawning and Rearing Habitat

There is limited spawning and rearing habitat in Reach 3. Many of the riffles consist of long, coarse-bedded, plane-bed sections that lack good spawning substrate. Pools are infrequent but several pools are deep and have good tail-out habitat for spawning. In particular, a sequence of pools from river mile 5.4 to 5.6 have long tail-outs with suitable depth and velocity for Chinook and steelhead spawning (Figure 36). These same pools have good depth for juvenile rearing. Most of the other pools have shallow residual depths and all pools have minimal cover and LWD habitat. LWD quantities are very low throughout the reach.

The coarse bed and high frequency of boulders provides areas of localized velocity refuge that may be utilized for rearing by juvenile steelhead and resident trout. Steelhead and Chinook spawning may occur in the handful of suitable pool tail-outs near RM 5.5. Spawning habitat is limited throughout the remainder of the reach due to coarse substrate. This reach has the greatest amount of side-channel habitat (6%) of all of the reaches in the study area, and these localized areas likely provide diverse juvenile rearing opportunities.

**Figure 36. Long pool tail-out near river mile 5.5 with good spawning-sized substrate.**

### A-3.9 Fish Passage Barriers

There are no fish passage barriers in the reach. Mean riffle depth is 0.7 ft during low summer flows, which suggests there could be potential passage limitations for spring Chinook in some areas, based on Thompson (1972).

### A-3.10 Riparian Corridor

In general, riparian vegetation conditions are in a better condition in Reach 3 than in most of the other reaches (Figure 37 and Figure 38). However, many of the outer zone areas are dominated by grass/forbes due to land clearing, roadways, and residential development. In several areas, there are residences within the riparian corridor with associated landscaping/clearing up to the streambank edge.

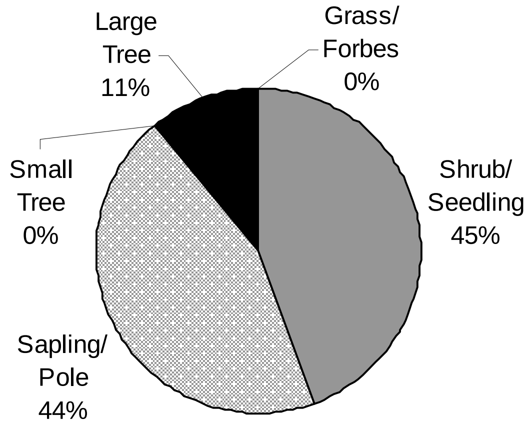



**Figure 37. Vegetation class by percentage in the riparian inner zone of Reach 3 of Peshastin Creek.**

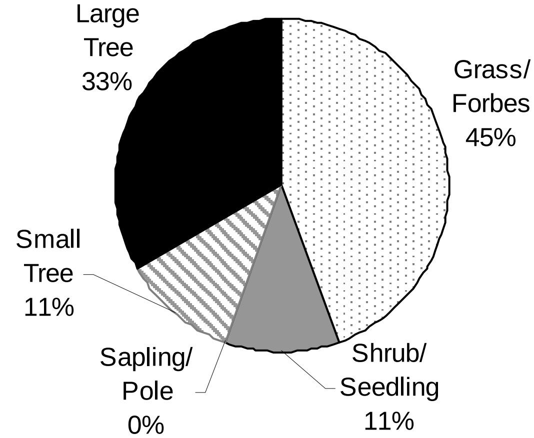



**Figure 38. Vegetation class by percentage in the riparian outer zone of Reach 3 of Peshastin Creek.**

**Table 8. Summary of channel geometry and spatial organization of habitat units in Reach 3.**

| Reach 3 Habitat Unit Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Reach Mileage Boundaries** | **Channel Morphology** | **Slope (ft/ft)** | | **Habitat Area %** | | | |
| 5.0-6.0 | Plane-bed/ Step-Pool | Average | 0.011 | Pool | 21.4 | | |
| | | Maximum | 0.068 | Riffle | 73.0 | | |
| | | | | Side Channel | 5.6 | | |
| **Reach Average Characteristics** | | **Bankfull Characteristics** | | **Riffle Characteristics** | | **Pool Characteristics** | |
| *Wetted Width (ft)* | | *Width (ft)* | | *Riffle Wetted Width (ft)* | | *Pool Wetted Width (ft)* | |
| *Total* | | Mean | 68.6 | Mean | 41.9 | Mean | 36.3 |
| Mean | 39.1 | Median | 71.0 | Median | 41.0 | Median | 36.0 |
| Median | 38.0 | StDev | 6.8 | StDev | 8.2 | StDev | 5.1 |
| StDev | 7.2 | *Depth (ft)* Averaged over 3 depth measurements | | *Maximum Riffle Thalweg Depth (ft)* | | *Pool Maximum Depth (ft)* | |
| *Width:Depth Ratio* | | Mean | 5.5 | Mean | 1.8 | Mean | 2.6 |
| Mean | 12.6 | Median | 5.5 | Median | 1.8 | Median | 2.5 |
| Median | 13.4 | StDev | 0.5 | StDev | 0.3 | StDev | 0.7 |
| StDev | 1.7 | *Maximum Depth (ft)* | | *Average Riffle Thalweg Depth (ft)* | | *Pool Residual Depth (ft)* | |
| *Floodprone Width (ft)* | | Mean | 6.4 | Mean | 0.7 | Mean | 1.6 |
| Mean | 323 | Median | 6.3 | Median | 0.6 | Median | 1.9 |
| Median | 350 | StDev | 0.6 | StDev | 0.2 | StDev | 0.8 |
| StDev | 129 | | | | | *Residual depth/mile* | |
| *Channel Confinement (floodprone width / bankfull width)* | | | | | | Pools< 1 ft | 1.8 |
| Mean | 4.6 | | | | | Pools 1-2 ft | 3.6 |
| | | | | | | Pools 2-3 ft | 2.7 |
| | | | | | | Pools > 3 ft | 0.0 |
| | | | | | | *Pools per mile* | 8.1 |
| | | | | | | *Riffle:Pool Ratio* | 1.2 |
| | | | | | | *Mean Pool Spacing* | 442.4 |
| | | | | | | *Mean Pool Spacing/Mean Bankfull Width* | 6.4 |

**Table 9. Summary of environmental components of habitat units in Reach 3.**

| Reach 3 Habitat Component Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Large Wood** | | **Bank Erosion (ft/mile)** | | **Substrate** | | **Vegetation** | |
| *Number of Pieces* | | Total/Mile | 166.9 | Ocular Estimate | | Class (Percent of sampled units) | |
| Small (6 in x 20 ft) | 7.0 | Left Bank/Mile | 0.0 | *Total* | | *InnerZone* | |
| Medium (12 in x 35 ft) | 0.0 | Right Bank/Mile | 166.9 | % Sand | 7.2 | Grass/ Forbes | 0.0 |
| Large (20 in by 35 ft) | 5.0 | *Pool* | | % Gravel | 7.2 | Shrub/ Seedling | 6.2 |
| Total | 7.0 | Total/Mile | 0.0 | % Cobble | 36.7 | Sapling/ Pole | 6.2 |
| *Number of Pieces/Mile* | | Left Bank/Mile | 0.0 | % Boulder | 16.7 | Small Tree | 0.0 |
| Small (6 in x 20 ft) | 6.3 | Right Bank/Mile | 0.0 | % Bedrock | 7.8 | Large Tree | 1.5 |
| Medium (12 in x 35 ft) | 0.0 | *Riffle* | | *Pool* | | *OuterZone* | |
| Large (20 in by 35 ft) | 4.5 | Total/Mile | 166.9 | % Sand | 10.0 | Grass/ Forbes | 6.2 |
| Total | 10.8 | Left Bank/Mile | 0.0 | % Gravel | 31.3 | Shrub/ Seedling | 1.5 |
| | | Right Bank/Mile | 166.9 | % Cobble | 32.5 | Sapling/ Pole | 0.0 |
| | | *Percent Erosion (both banks)* | 3.2 | % Boulder | 18.8 | Small Tree | 1.5 |
| | | | | % Bedrock | 7.5 | Large Tree | 4.6 |
| | | | | *Riffle* | | | |
| | | | | % Sand | 5.0 | | |
| | | | | % Gravel | 32.0 | | |
| | | | | % Cobble | 40.0 | | |
| | | | | % Boulder | 15.0 | | |
| | | | | % Bedrock | 8.0 | | |
| | | | | Pebble Count | | | |
| | | | | % Sand | 8.5 | | |
| | | | | % Gravel | 30.2 | | |
| | | | | % Cobble | 43.1 | | |
| | | | | % Boulder | 18.3 | | |
| | | | | % Bedrock | 0.0 | | |

## A-4 REACH 4

Location: River mile 6.0 to River mile 7.3

Survey Date: August 17, 2009

Survey Crew: Mark Sogge and Gardner Johnston (Inter-Fluve)

### A-4.1 Reach Overview

Reach 4 lies within a moderately confined valley with valley wall constrictions at the upstream and downstream ends. The reach is bounded by the Camas Creek confluence at the downstream end and the Allen Creek confluence at the upstream end. Highway 97 parallels the reach and lies adjacent to the channel in 2 locations. There is a private bridge crossing near river mile 6.5. There are residences along this reach although much of the reach is undeveloped. A summary of habitat characteristics for the reach can be found in Table 2 and Table 3 at the end of the Reach 4 section.

### A-4.2 Channel Morphology

Although the valley is relatively unconfined through this reach, the channel is mostly incised into glacial deposits and bedrock. The reach is primarily a boulder-bed step-pool channel with several coarse (large cobble/small boulder) plane-bed segments and several bedrock dominated segments. There is a ~4,000 ft long cutoff channel on the river right floodplain area that may have been the site of the main channel prior to the construction of the roadway. Bedrock limits the channel adjustment potential of the reach. Average wetted width is 36 ft (wetted width at time of survey) and average bankfull width is 67 ft. Mean channel bed slope is 1.4%.

**Figure 39. Step-pool channel segment near RM 7.0.**

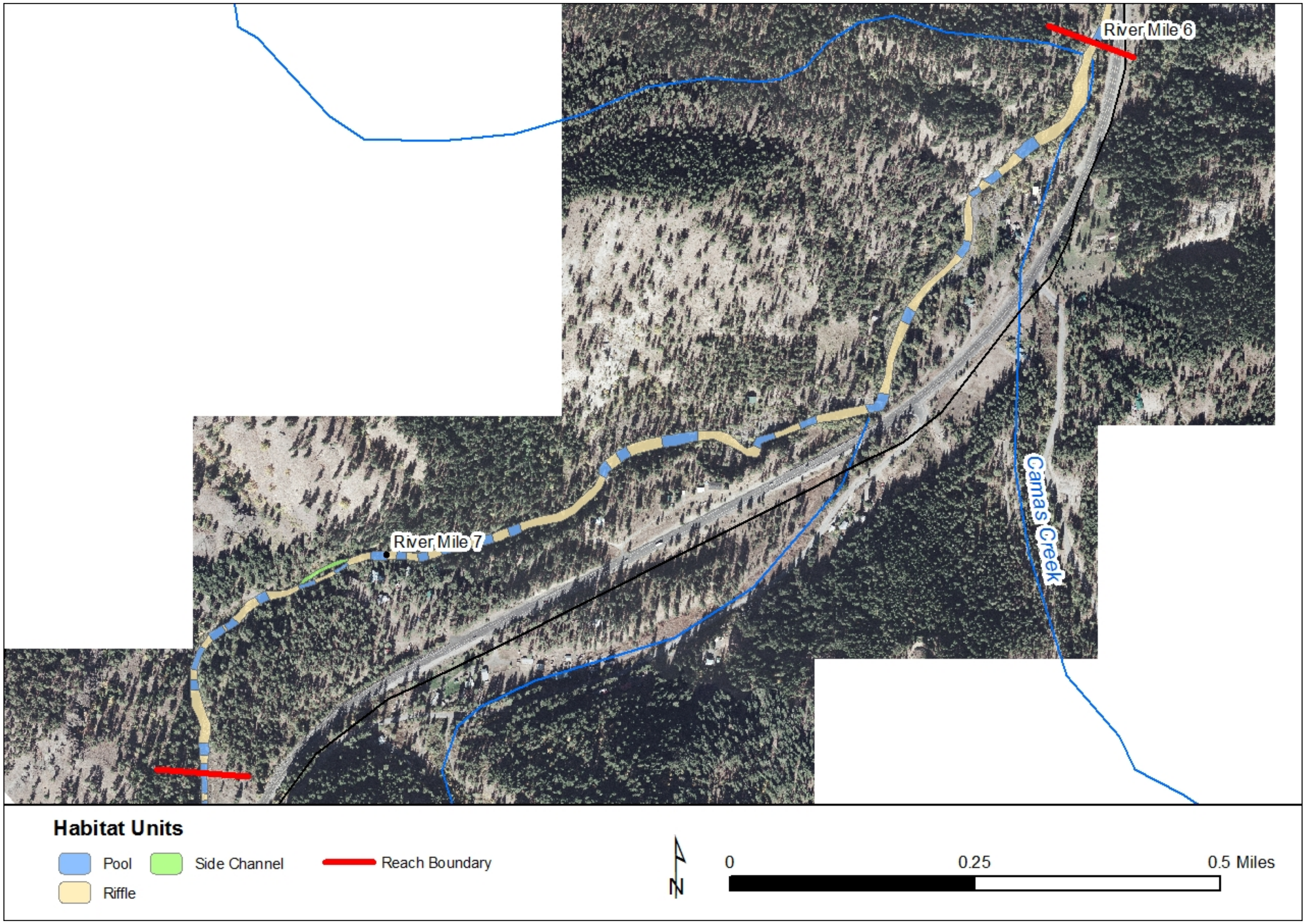



**Figure 40. Reach 4 locator and habitat unit composition map.**

### A-4.3 Habitat Unit Composition

Pools make up 32% of the habitat within the reach and occur at a frequency of about 18 pools/mile or 1 pool every 3 bankfull widths (Figure 41). Twenty-seven percent of pools exceed 3 ft in residual depth and 57% of pools have a residual depth between 1 and 2 feet (Figure 42). Riffles comprise 66% of the habitat and average riffle depth is 0.9 ft. Side-channels account for 2% of the habitat area.

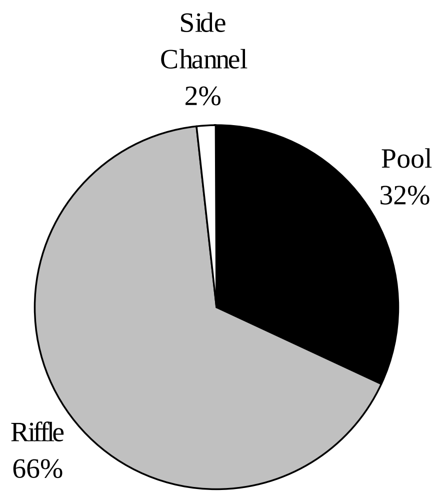



**Figure 41. Habitat unit composition for Reach 4.**

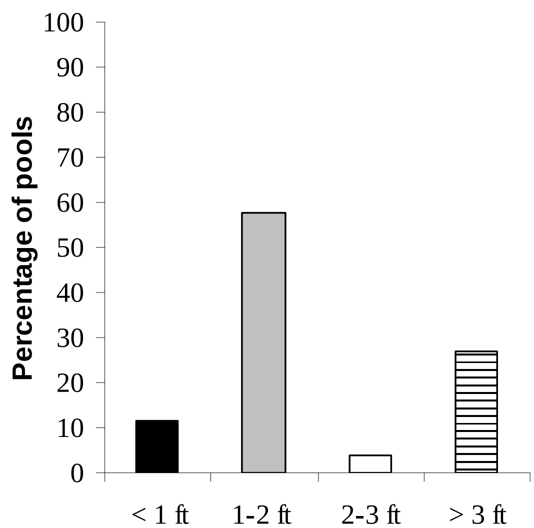



**Figure 42. Reach 4 residual pool depths.**

### A-4.4 Off-Channel Habitat

Only one side-channel, 280 ft long, was measured in this reach, accounting for 2% of the total habitat (Figure 43). No other significant off-channel habitat is available at low flow periods.

**Figure 43. Side-channel confluence near river mile 7.0.**

### A-4.5 Large Woody Debris

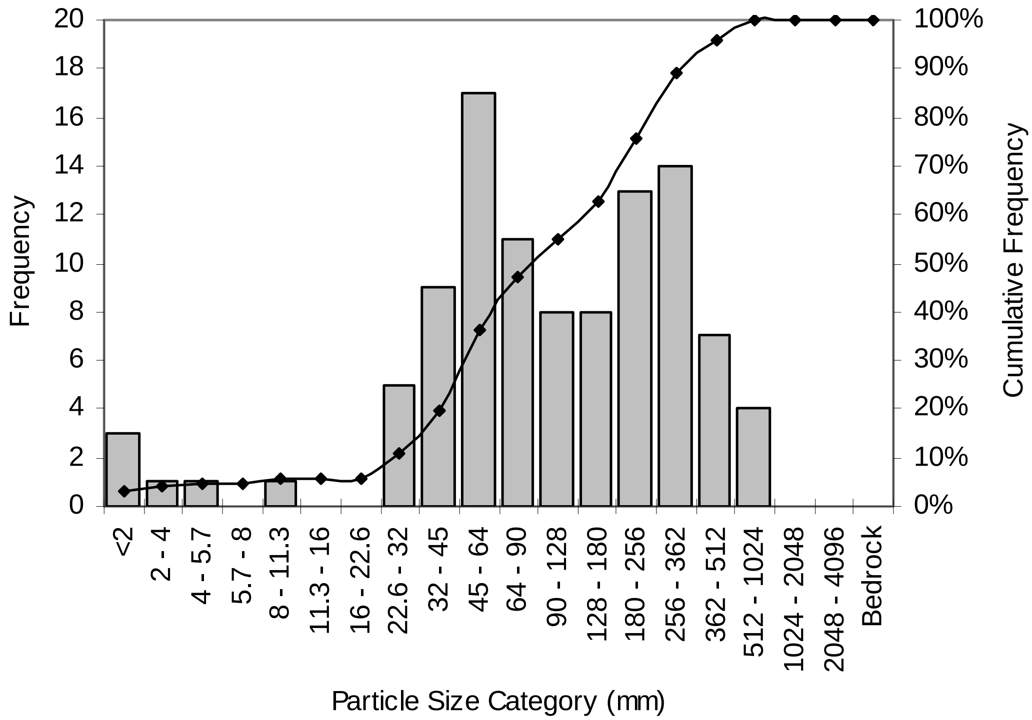
Wood loading in Reach 4 is low (43 pieces/mile) but is the highest of all the reaches in the study area (Table 10). More large trees in the riparian corridor were counted in this reach relative to other reaches, which may account for the higher number of in-channel large wood pieces.

**Table 10. Large woody debris quantities in Reach 4.**

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in by 35 ft) | Total |
|---|---|---|---|---|
| Number of Pieces | 33 | 13 | 17 | 46 |
| Number of Pieces/Mile | 23 | 9 | 12 | 43 |

### A-4.6 Substrate and Fine Sediment

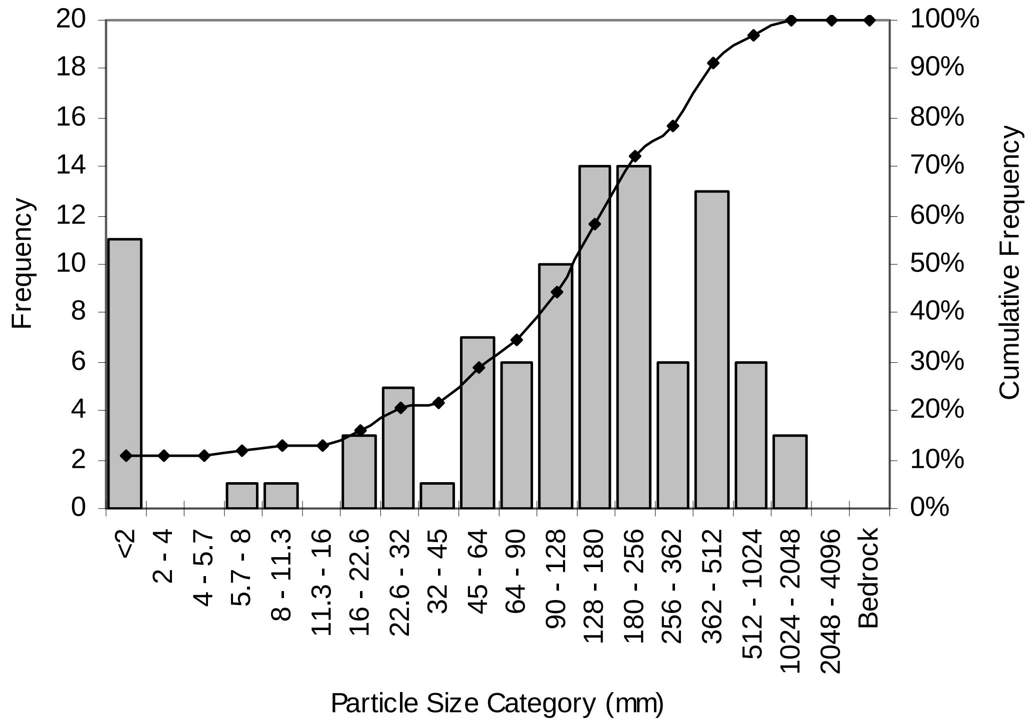
Substrate in Reach 4 is coarser than downstream reaches, which is consistent with the generally steeper character of the channel and step-pool morphology. The pebble counts and ocular estimates indicate a range of large gravels to small boulders. The D50 is medium to large cobble. Although one of the pebble counts contained a relatively large amount of sand (11%), excess fine sediment (>2mm) does not appear to be a concern in this reach based on results of the second pebble count and ocular estimates.




| Material | Percent Composition |
|---|---|
| Sand | 3% |
| Gravel | 33% |
| Cobble | 39% |
| Boulder | 25% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 8 |
| D16 | 40 |
| D50 | 104 |
| D84 | 322 |
| D95 | 488 |

**Figure 44. Grain size distribution and particle size classes from pebble count taken at RM 6.2.**




| Material | Percent Composition |
|---|---|
| Sand | 11% |
| Gravel | 18% |
| Cobble | 44% |
| Boulder | 28% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 23 |
| D50 | 148 |
| D84 | 429 |
| D95 | 849 |

**Figure 45. Grain size distribution and particle size classes from pebble count taken at RM 7.2.**

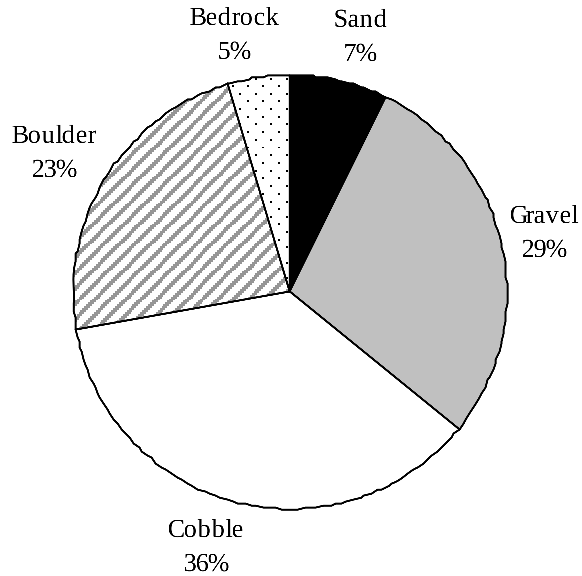



**Figure 46. Percent composition of bed substrate based on ocular estimates, Reach 4.**

### A-4.7 Instability and Disturbance

There was no bank erosion observed in this reach during the survey. Bank erosion is limited due to large substrate and bedrock.

Highway 97 parallels the reach and lies adjacent to the channel in 2 locations. There is a private bridge crossing near river mile 6.5 (Figure 47). There are residences along this reach although much of the reach is undeveloped.

LiDAR data reveals an approximately 4,000 ft long section of abandoned/disconnected channel within the river right floodplain between river miles 6.5 and 7.3. Although the available aerial photo record does not show the main river in this location, it is likely a section of channel that was disconnected to facilitate the building of the highway.

**Figure 47. Private bridge crossing near river mile 6.5.**

### A-4.8 Available Spawning and Rearing Habitat

Much of this reach is too coarse for high quality spawning habitat. Many of the riffles consist of long, coarse-bedded, plane-bed sections that lack good spawning substrate. There are, however, several pools with long tail-outs with suitable spawning material made up of gravels and small cobbles.

The coarse bed and high frequency of boulders provides areas of localized velocity refuge that may be utilized for rearing by juvenile steelhead and resident trout. There are also several deep pools that offer good juvenile rearing and adult holding habitat, although LWD cover is lacking.

### A-4.9 Fish Passage Barriers

No fish barriers were identified in this reach.

### A-4.10 Riparian Corridor

This reach has experienced some of the least amount of riparian impairments in the study area. This is partially related to the steep left bank hillslope that provides difficult access and topography for residential development or road building. The riparian inner zone is well vegetated with shrubs and sapling/pole size classes (Figure 48). The riparian outer zone has a high amount of large trees (64%, Figure 49). The remainder of the outer zone is primarily grass due to either (1) forest clearing associated with streamside residences, or (2) steep grass slope on hillsides.

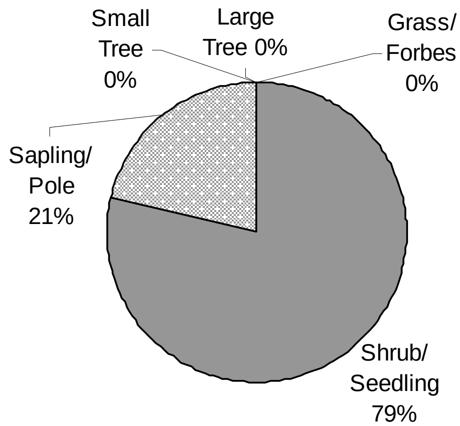



**Figure 48. Vegetation class by percentage in the riparian inner zone of Reach 4 of Peshastin Creek.**

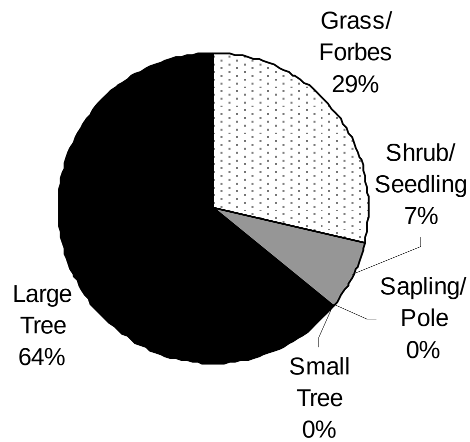



**Figure 49. Vegetation class by percentage in the riparian outer zone of Reach 4 of Peshastin Creek.**

**Table 11. Summary of channel geometry and spatial organization of habitat units in Reach 4.**

| Reach 4 Habitat Unit Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Reach Mileage Boundaries** | **Channel Morphology** | **Slope (ft/ft)** | | **Habitat Area %** | | | |
| 6.0-7.3 | Plane-bed/ Step-Pool | Average | 0.01 | Pool | 31.8 | | |
| | | Maximum | 0.09 | Riffle | 66.5 | | |
| | | | | Side Channel | 1.6 | | |
| **Reach Average Characteristics** | | **Bankfull Characteristics** | | **Riffle Characteristics** | | **Pool Characteristics** | |
| *Wetted Width (ft)* | | *Width (ft)* | | *Riffle Wetted Width (ft)* | | *Pool Wetted Width (ft)* | |
| *Total* | | Mean | 67.25 | Mean | 37.19 | Mean | 34.88 |
| Mean | 36.04 | Median | 65.00 | Median | 39.50 | Median | 34.00 |
| Median | 35.00 | StDev | 9.24 | StDev | 6.58 | StDev | 5.54 |
| StDev | 6.13 | *Depth (ft)* Averaged over 3 depth measurements | | *Maximum Riffle Thalweg Depth* | | *Pool Maximum Depth (ft)* | |
| *Width:Depth Ratio* | | Mean | 4.56 | Mean | 1.92 | Mean | 3.3 |
| Mean | 14.89 | Median | 4.62 | Median | 2.00 | Median | 2.9 |
| Median | 14.08 | StDev | 0.28 | StDev | 0.24 | StDev | 1.3 |
| StDev | 2.98 | *Maximum Depth (ft)* | | *Average Riffle Thalweg Depth* | | *Pool Residual Depth (ft)* | |
| *Floodprone Width (ft)* | 3.97 | Mean | 5.43 | Mean | 0.91 | Mean | 2.2 |
| Mean | 267.14 | Median | 5.40 | Median | 0.95 | Median | 1.6 |
| Median | 260.00 | StDev | 0.59 | StDev | 0.22 | StDev | 1.4 |
| StDev | 87.70 | | | | | *Residual depth/mile* | |
| *Channel Confinement (floodprone width / bankfull width)* | | | | | | Pools< 1 ft | 2.1 |
| Mean | 3.99 | | | | | Pools 1-2 ft | 10.3 |
| | | | | | | Pools 2-3 ft | 0.7 |
| | | | | | | Pools > 3 ft | 4.8 |
| | | | | | | *Pools per mile* | 17.9 |
| | | | | | | *Riffle:Pool Ratio* | 1.0 |
| | | | | | | *Mean Pool Spacing* | 187.9 |
| | | | | | | *Mean Pool Spacing/Mean Bankfull Width* | 2.8 |

**Table 12. Summary of environmental components of habitat units in Reach 4.**

| Reach 4 Habitat Component Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Large Wood** | | **Bank Erosion (ft/mile)** | | **Substrate** | | **Vegetation** | |
| *Number of Pieces* | | Total/Mile | 0.0 | Ocular Estimate | | Class (Percent of sampled units) | |
| Small (6 in x 20 ft) | 33.0 | Left Bank/Mile | 0.0 | *Total* | | *InnerZone* | |
| Medium (12 in x 35 ft) | 13.0 | Right Bank/Mile | 0.0 | % Sand | 7.3 | Grass/ Forbes | 0.0 |
| Large (20 in by 35 ft) | 17.0 | *Pool* | | % Gravel | 28.6 | Shrub/ Seedling | 16.9 |
| Total | 46.0 | Total/Mile | 0.0 | % Cobble | 36.3 | Sapling/ Pole | 4.6 |
| *Number of Pieces/Mile* | | Left Bank/Mile | 0.0 | % Boulder | 23.1 | Small Tree | 0.0 |
| Small (6 in x 20 ft) | 22.7 | Right Bank/Mile | 0.0 | % Bedrock | 4.8 | Large Tree | 0.0 |
| Medium (12 in x 35 ft) | 9.0 | *Riffle* | | *Pool* | | *OuterZone* | |
| Large (20 in by 35 ft) | 11.7 | Total/Mile | 0.0 | % Sand | 10.0 | Grass/ Forbes | 6.2 |
| Total | 43.4 | Left Bank/Mile | 0.0 | % Gravel | 33.3 | Shrub/ Seedling | 1.5 |
| | | Right Bank/Mile | 0.0 | % Cobble | 30.0 | Sapling/ Pole | 0.0 |
| | | *Percent Erosion (both banks)* | 0.0 | % Boulder | 20.8 | Small Tree | 0.0 |
| | | | | % Bedrock | 5.8 | Large Tree | 13.8 |
| | | | | *Riffle* | | | |
| | | | | % Sand | 5.2 | | |
| | | | | % Gravel | 24.8 | | |
| | | | | % Cobble | 41.2 | | |
| | | | | % Boulder | 24.8 | | |
| | | | | % Bedrock | 3.9 | | |
| | | | | Pebble Count | | | |
| | | | | % Sand | 7.9 | | |
| | | | | % Gravel | 24.9 | | |
| | | | | % Cobble | 39.7 | | |
| | | | | % Boulder | 27.0 | | |
| | | | | % Bedrock | 0.5 | | |

## A-5 REACH 5A

Location: River mile 7.3 to River mile 8.4

Survey Date: August 17 – 18, 2009

Survey Crew: Mark Sogge and Gardner Johnston (Inter-Fluve)

*The staff gage at the Ingalls Creek Road Bridge (near river mile 8.4) read 5.09 ft on the day of the survey.

### A-5.1 Reach Overview

Reach 5a begins at the confluence of the tributary Allen Creek and extends 1.1 miles upstream to just upstream of the Ingalls Creek Road crossing. Residential development is extensive along the valley bottom throughout the reach, with many streamside homes. There is a campground and trailer park that lies adjacent to the stream along the river right bank near river mile 8.0. A summary of habitat characteristics for the reach can be found in Table 2 and Table 3 at the end of the Reach 5a section.

### A-5.2 Channel Morphology

The reach lies within an unconfined valley that is confined by bedrock and alluvial fan deposits at the downstream end. The channel itself is moderately confined by old terraces and tributary alluvial fan deposits. Channel morphology is step-pool and plane-bed. Immediately upstream of the confluence with Allen Creek at RM 7.4, the channel is constricted by bedrock on river right and forms a steep bedrock controlled section for approximately 250 feet (Figure 50). Channel width during low flow conditions is the smallest for the study area; mean wetted width is approximately 31 feet (wetted width at time of survey). Average bankfull width is 72 feet. Streambed gradient is the steepest for the study area with an average bed slope of 2.0%.

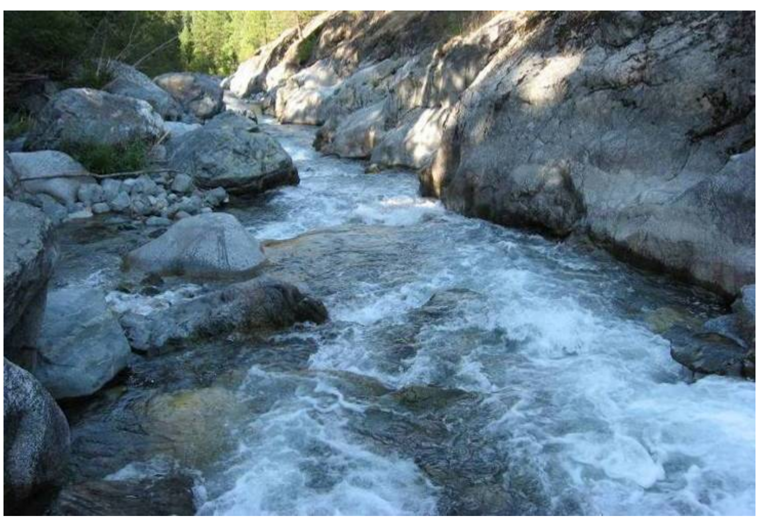


**Figure 50. Bedrock canyon at downstream end of Reach 5a. River mile 7.4.**


**Figure 51. Reach 5a locator and habitat unit composition map.**

### A-5.3 Habitat Unit Composition

Pools comprise 21% of the habitat area and riffles make up 79% (Figure 52). Pool frequency is the highest in the study area with approximately 19 pools/mile or 1 pool every 3 bankfull widths. Thus, pools occur frequently but are much shorter than the riffle units. Pools in excess of 3 ft deep make up 20% of all pools; however, the majority (75%) of pools are 2 ft deep or less (Figure 5). Pools generally lacked sufficient overhead cover and instream habitat structure and diversity. Average riffle depth is 0.9 ft.

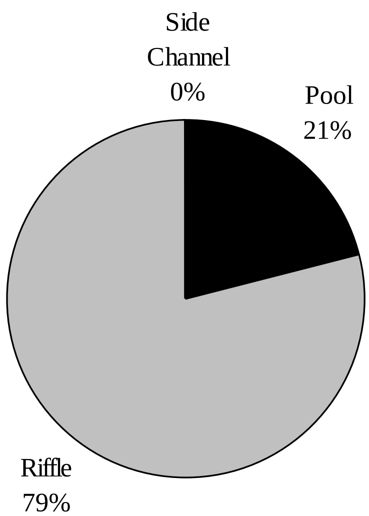



**Figure 52. Habitat unit composition for Reach 5a.**

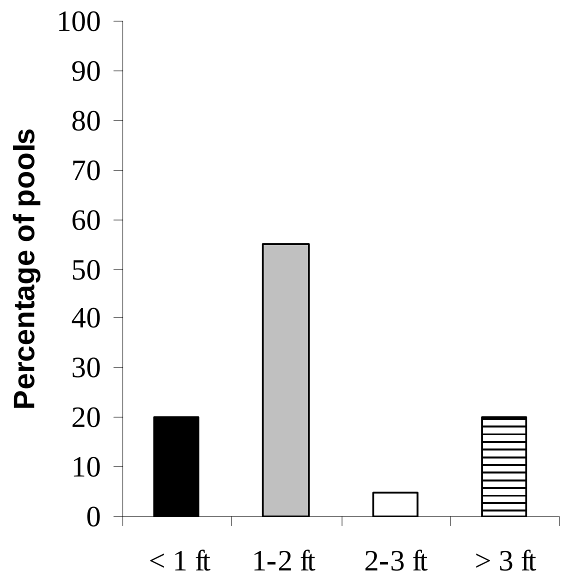



**Figure 53. Reach 5a residual pool depths.**

### A-5.4 Off-Channel Habitat

There were no active side-channels at the time of the survey. Off-channel habitat is naturally limited by the natural confinement of the channel. Off-channel habitat may be somewhat constrained by adjacent land-uses. A review of LiDAR data indicates a few areas where secondary channels may have been disconnected due to road construction and residential development.

### A-5.5 Large Woody Debris

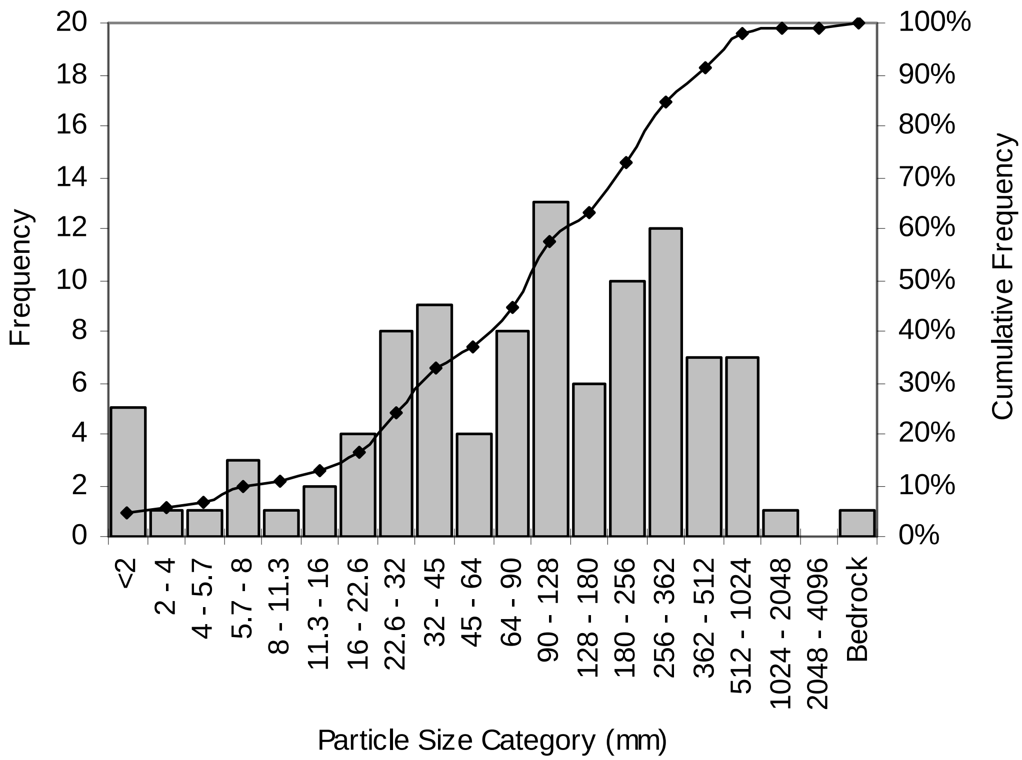
As with the rest of the study area, wood loading is very low in Reach 5a. The frequency of wood is 31 pieces/mile; and small pieces represent 85% of all pieces. A total of only 4 large pieces were counted in the reach and there were no medium-sized pieces. Clearing of the riparian corridor and residential development extending to the channel has substantially reduced wood recruitment potential in this reach. Furthermore, this reach is largely a transport reach that does not favor wood retention.

**Table 13. Large woody debris quantities in Reach 5a.**

| | Small (6 in x 20 ft) | Medium (12 in x 35 ft) | Large (20 in by 35 ft) | Total |
|---|---|---|---|---|
| Number of Pieces | 28 | 0 | 4 | 28 |
| Number of Pieces/Mile | 27 | 0 | 4 | 31 |

### A-5.6 Substrate and Fine Sediment

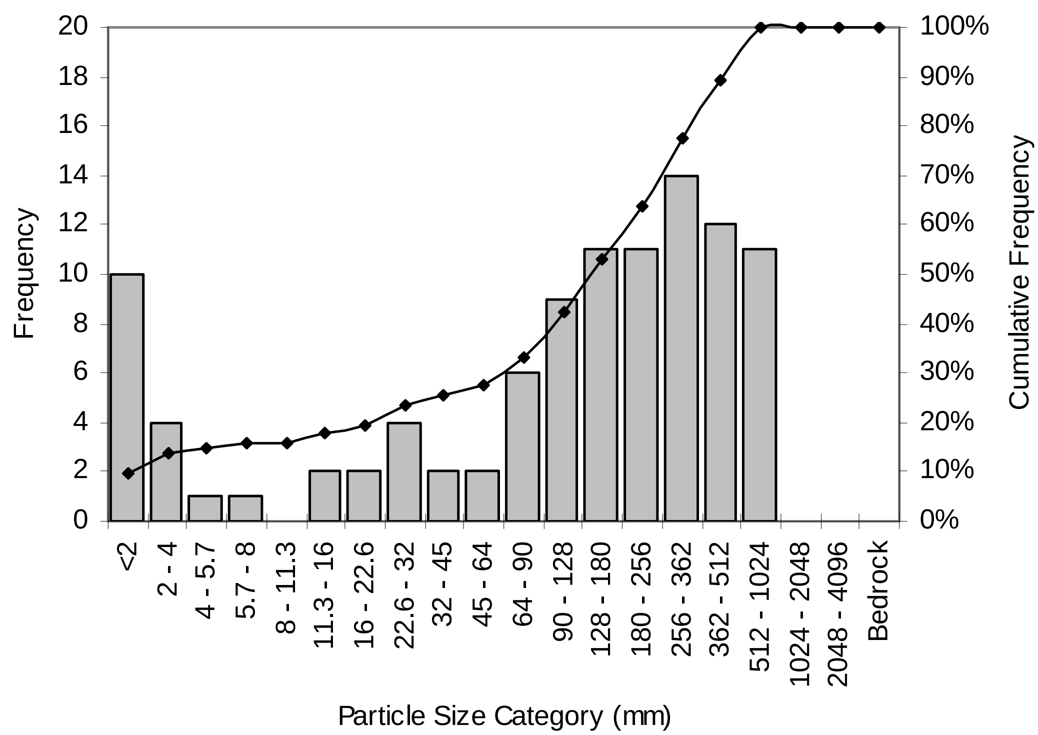
Reach 5a is dominated by cobbles, with gravels and boulders sub-dominant (Figure 54, Figure 55, and Figure 56). The D50 from the pebble counts is medium to large cobble. This reach has the coarsest bed material in the study area. Fine material (<2mm) accounts for 5 – 10% of the bed material. The frequency of sand deposits may be related to the coarse and relatively complex boulder-bed channel that increases opportunities for sediment deposition and sorting.



| Material | Percent Composition |
|---|---|
| Sand | 5% |
| Gravel | 32% |
| Cobble | 36% |
| Boulder | 26% |
| Bedrock | 1% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 22 |
| D50 | 106 |
| D84 | 358 |
| D95 | 794 |

**Figure 54. Grain size distribution and particle size classes from pebble count taken at RM 7.5.**




| Material | Percent Composition |
|---|---|
| Sand | 10% |
| Gravel | 18% |
| Cobble | 36% |
| Boulder | 36% |
| Bedrock | 0% |

| Size Class | Size percent finer than (mm) |
|---|---|
| D5 | 2 |
| D16 | 12 |
| D50 | 166 |
| D84 | 446 |
| D95 | 787 |

**Figure 55. Grain size distribution and particle size classes from pebble count taken at RM 8.2.**

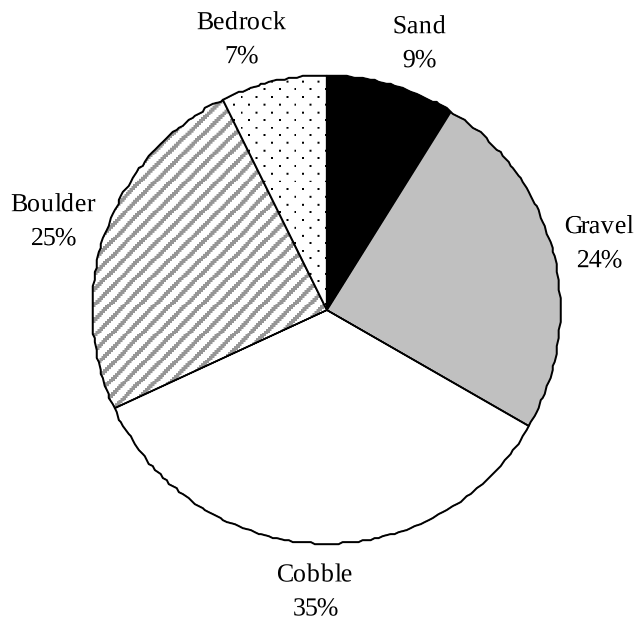



**Figure 56. Percent composition of bed substrate based on ocular estimates, Reach 5a.**

### A-5.7 Instability and Disturbance

Approximately 425 feet of stream channel were identified as actively eroding, accounting for 4% of the total streambank length (sum of both sides). There is some bank erosion associated with private residences and the trailer park/campground near river mile 8.0.

The valley bottom in this reach has been extensively modified by residential development. Houses extend to the channel's edge in several locations and there are numerous developed and undeveloped access points to the river. Houses, cleared vegetation, and grass lawns are common in the riparian corridor. There is a rip-rap and concrete wall that extends over 100 feet on the river left bank near river mile 8.1 (Figure 57). Ingalls Creek Road crosses Peshastin Creek at RM 8.4.

Figure 57. Bank armoring on river left bank near river mile 8.1.

### A-5.8 Available Spawning and Rearing Habitat

Much of this reach is too coarse for high quality spawning habitat. Many of the riffles consist of long, coarse-bedded, plane-bed sections that lack good spawning substrate. There are a few pools with suitable tail-outs for spawning, but even in these locations substrate may be too coarse for spawning.

The coarse bed and high frequency of boulders provides areas of localized velocity refuge that may be utilized for rearing by juvenile steelhead and resident trout. There are also several deep pools that offer good juvenile rearing and adult holding habitat, although LWD cover is lacking. The bedrock controlled, narrow meandering section near RM 7.7 provides diverse pool-riffle and alcove habitat that likely supports juvenile rearing, adult holding, and spawning.

### A-5.9 Fish Passage Barriers

There are no fish passage barriers on mainstem Peshastin Creek in this reach. There is a culvert that enters the mainstem near river mile 8.1 that may be a passage barrier, but the source of the flow and the upstream habitat potential is unknown.

**Figure 58. Culvert entering the mainstem on the river right bank near river mile 8.4.**

### A-5.10 Riparian Corridor

In general, the riparian inner zone is well vegetated in this reach (Figure 59). There are, however, numerous locations where residential development and associated vegetation clearing affect both the inner and outer zone riparian areas. Much of the outer zone is dominated by grass (Figure 60), which is largely attributable to streamside residential uses (i.e. view clearing and lawns). Most areas lack the large tree component necessary to provide stream shade, bank stability, and a source for LWD recruitment.

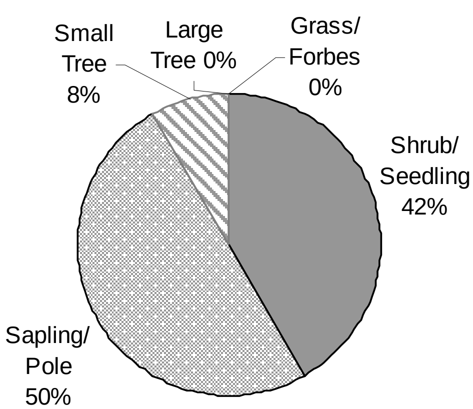



**Figure 59. Vegetation class by percentage in the riparian inner zone of Reach 5a of Peshastin Creek.**

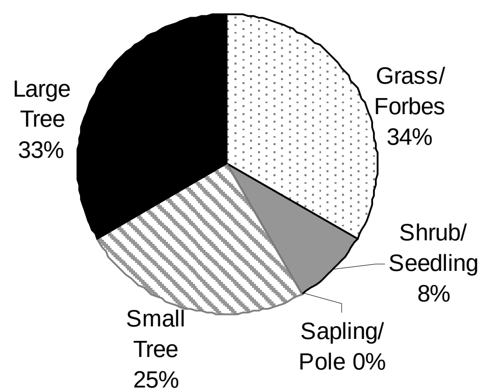



**Figure 60. Vegetation class by percentage in the riparian outer zone of Reach 5a of Peshastin Creek.**

**Table 14. Summary of channel geometry and spatial organization of habitat units in Reach 5a.**

| Reach 5 Habitat Unit Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Reach Mileage Boundaries** | **Channel Morphology** | **Slope (ft/ft)** | | **Habitat Area %** | | | |
| 7.3-8.4 | Plane-bed/ Step-Pool | Average | 0.020 | Pool | 21.1 | | |
| | | Maximum | 0.245 | Riffle | 78.9 | | |
| | | | | Side Channel | 0.0 | | |
| **Reach Average Characteristics** | | **Bankfull Characteristics** | | **Riffle Characteristics** | | **Pool Characteristics** | |
| *Wetted Width (ft)* | | *Width (ft)* | | *Riffle Wetted Width (ft)* | | *Pool Wetted Width (ft)* | |
| *Total* | | Mean | 72.0 | Mean | 32.4 | Mean | 29.2 |
| Mean | 30.8 | Median | 72.0 | Median | 30.8 | Median | 28.5 |
| Median | 29.5 | StDev | 12.7 | StDev | 8.9 | StDev | 5.4 |
| StDev | 8.2 | *Depth (ft)* Averaged over 3 depth measurements | | *Maximum Riffle Thalweg Depth* | | *Pool Maximum Depth (ft)* | |
| *Width:Depth Ratio* | | Mean | 3.7 | Mean | 2.0 | Mean | 3.0 |
| Mean | 19.8 | Median | 3.8 | Median | 1.9 | Median | 2.6 |
| Median | 18.6 | StDev | 0.5 | StDev | 0.3 | StDev | 1.1 |
| StDev | 5.8 | *Maximum Depth (ft)* | | *Average Riffle Thalweg Depth* | | *Pool Residual Depth (ft)* | |
| *Floodprone Width (ft)* | | Mean | 11.3 | Mean | 0.9 | Mean | 1.8 |
| Mean | 253 | Median | 5.4 | Median | 1.0 | Median | 1.5 |
| Median | 198 | StDev | 14.1 | StDev | 0.3 | StDev | 1.2 |
| StDev | 167 | | | | | *Residual depth/mile* | |
| *Channel Confinement (floodprone width / bankfull width)* | | | | | | Pools< 1 ft | 3.9 |
| Mean | 4.1 | | | | | Pools 1-2 ft | 10.6 |
| | | | | | | Pools 2-3 ft | 1.0 |
| | | | | | | Pools > 3 ft | 3.9 |
| | | | | | | *Pools per mile* | 19.3 |
| | | | | | | *Riffle:Pool Ratio* | 1.0 |
| | | | | | | *Mean Pool Spacing* | 195.0 |
| | | | | | | *Mean Pool Spacing/Mean Bankfull Width* | 2.7 |

**Table 15. Summary of environmental components of habitat units in Reach 5a.**

| Reach 5 Habitat Component Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Large Wood** | | **Bank Erosion (ft/mile)** | | **Substrate** | | **Vegetation** | |
| *Number of Pieces* | | Total/Mile | 410.5 | Ocular Estimate | | Class (Percent of sampled units) | |
| Small (6 in x 20 ft) | 28.0 | Left Bank/Mile | 188.3 | *Total* | | *InnerZone* | |
| Medium (12 in x 35 ft) | 0.0 | Right Bank/Mile | 222.1 | % Sand | 8.9 | Grass/ Forbes | 0.0 |
| Large (20 in by 35 ft) | 4.0 | *Pool* | | % Gravel | 24.5 | Shrub/ Seedling | 7.7 |
| Total | 28.0 | Total/Mile | 101.4 | % Cobble | 34.6 | Sapling/ Pole | 9.2 |
| *Number of Pieces/Mile* | | Left Bank/Mile | 72.4 | % Boulder | 24.9 | Small Tree | 1.5 |
| Small (6 in x 20 ft) | 27.0 | Right Bank/Mile | 29.0 | % Bedrock | 7.2 | Large Tree | 0.0 |
| Medium (12 in x 35 ft) | 0.0 | *Riffle* | | *Pool* | | *OuterZone* | |
| Large (20 in by 35 ft) | 3.9 | Total/Mile | 309.1 | % Sand | 10.1 | Grass/ Forbes | 6.2 |
| Total | 30.9 | Left Bank/Mile | 115.9 | % Gravel | 26.1 | Shrub/ Seedling | 1.5 |
| | | Right Bank/Mile | 193.2 | % Cobble | 33.6 | Sapling/ Pole | 0.0 |
| | | *Percent Erosion (both banks)* | 7.8 | % Boulder | 22.7 | Small Tree | 4.6 |
| | | | | % Bedrock | 7.6 | Large Tree | 6.2 |
| | | | | *Riffle* | | | |
| | | | | % Sand | 7.6 | | |
| | | | | % Gravel | 22.9 | | |
| | | | | % Cobble | 35.6 | | |
| | | | | % Boulder | 27.1 | | |
| | | | | % Bedrock | 6.8 | | |
| | | | | Pebble Count | | | |
| | | | | % Sand | 11.3 | | |
| | | | | % Gravel | 27.5 | | |
| | | | | % Cobble | 39.7 | | |
| | | | | % Boulder | 21.6 | | |
| | | | | % Bedrock | 0.0 | | |