RESURRECTION CREEK RESTORATION
2005 Channel Morphology Monitoring Report

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SUMMARY

This report is a compilation of monitoring data collected in 2005 during and following stream restoration activities on Resurrection Creek in 2005. Monitoring data include cross sections, a longitudinal profile, substrate characterization, channel geometry, fish data, and photo points. This document serves as a reference for this project, providing baseline data to evaluate future change, predictions of changes that are expected to occur, and recommendations that can be applied to this project during its completion in 2006 as well as future projects. The 2005 monitoring is well documented, and this document provides the information and data needed to duplicate these surveys during future monitoring.

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1 INTRODUCTION

The Chugach National Forest completed the first of two seasons of the Resurrection Creek Stream and Riparian Restoration project between mid-May and mid-July 2005, with complete channel and floodplain reconstruction from Palmer Creek to the Paystreke mining claim. The project area is located about 5 miles south of Hope, Alaska, on the Kenai Peninsula (**figure 1**). Project details are described in the Resurrection Creek Stream and Riparian Restoration Project Final Environmental Impact Statement (USDA Forest Service, 2004). The objective of this project is to restore a 1-mile placer mining-affected reach of Resurrection Creek to its natural condition by redistributing large tailings piles, constructing meanders, building a floodplain, decreasing the channel slope, and creating pool-riffle sequences with abundant slow water aquatic habitat. The 2005 restored reach is shown in **figure 2**.

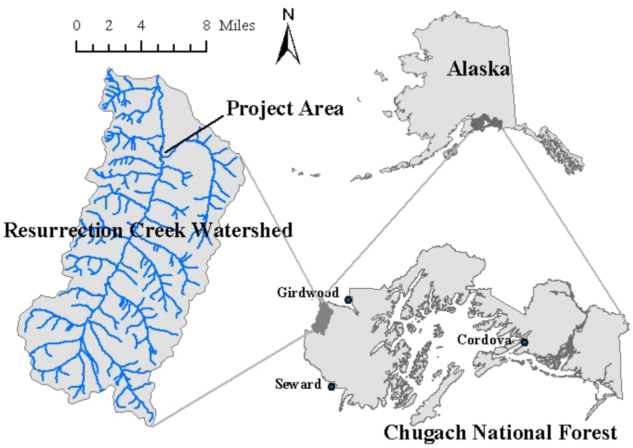


Figure 1: Location of the Resurrection Creek Restoration Project.

Figure 2: Resurrection Creek project reach before and after restoration in 2005.

Some of the specific quantitative objectives of the project include the following, as adapted from the pre-restoration analysis by Bair et al. (2002):

- Increase entrenchment ratios (floodprone width / bankfull width) from 1 to >6
- Decrease average slope from 1.7% to 1.3%
- Increase sinuosity from 1.1 to 1.4
- Increase channel length by 15%
- Increase the number of pools per river mile from 3 to 23
- Increase side channel flow from <1% to 20%
- Increase large in-stream wood from 8 to 330 pieces per river mile
- Increase spawning gravel from 160 to 2000 yd^2 per river mile
- Restore topsoil to the floodplain
- Decrease overstocked riparian tree densities, restore tree composition (50% spruce, 40% cottonwood, and 10% birch and hemlock), and reestablish ground cover
- Restore wildlife habitat by increasing floodplain coarse wood from 16 to 120 pieces per acre and the number of snags from 2 to 10 snags per acre.

Channel morphology monitoring of this restored reach was conducted between August and October 2005 in order to address the following needs:

- Provide a comparison of channel dimensions of the restored reach with the intended channel design by measuring variables such as slope, bankfull width, bankfull depth, and cross sectional area.
- Provide baseline data to measure future channel changes, including changes in channel width and pool volume from scour and deposition, changes associated with bank erosion, and changes in side channel morphology.
- Provide information that can be used to improve channel design conducted in the second season of the project (summer 2006), as well as potential future channel restoration projects elsewhere on Resurrection Creek and the Chugach National Forest.
- Provide information about channel dynamics as they relate to fish habitat, including sediment size and distribution, pool depths, and instream cover associated with engineered logjams.

This report presents the data that were collected, as well as comparisons between the restored reach and the pre-restoration reach, and addresses the above needs and potential channel changes that are expected to occur. Channel morphology monitoring was conducted on August 10, August 19, and September 2, 2005 by Bill MacFarlane, and on October 13 and 14, 2005 by Bill MacFarlane and Dave Blanchet. Fish escapement counts were conducted weekly in July and August by Aaron Martin, Sam Hochhalter, and Ryan Lothrop. Photo points were monitored throughout the summer by Bill MacFarlane, and aerial photography was taken on August 11, 2005 by Dave Blanchet. This report contains adequate information to duplicate surveys conducted for this monitoring. Watershed characteristics, hydrologic data, and detailed information on impacts to hydrologic processes are presented in the Resurrection Creek Watershed Association Hydrologic Condition Assessment (Kalli and Blanchet, 2001) and the Resurrection Creek Landscape Assessment (Hart Crowser, 2002). A full analysis of the project reach and the reference reach was also conducted prior to restoration (Bair et al., 2002).

2 METHODS

Longitudinal Profile: Using Rosgen stream survey techniques (Rosgen, 1996; Harrelson et al., 1994), a longitudinal profile was surveyed from Palmer Creek to the Paystreke property boundary. Channel distance was measured along the left bank (facing downstream), starting at the downstream end, and wood stakes were placed every 100 feet along the bank. Thalweg and water surface points were surveyed at such a frequency to capture the variability in bed features, including the start and end of each riffle, run, pool, and glide (**figure 3**). Data were stored and processed using Rivermorph Stream Restoration Software (Rivermorph LLC, 2004). Because of the deep flow depths and high velocities, the thalweg measurements were often estimated. Bankfull measurements were not taken because no reliable bankfull indicators exist in this reconstructed channel. The longitudinal profile point elevations were tied into existing benchmarks.

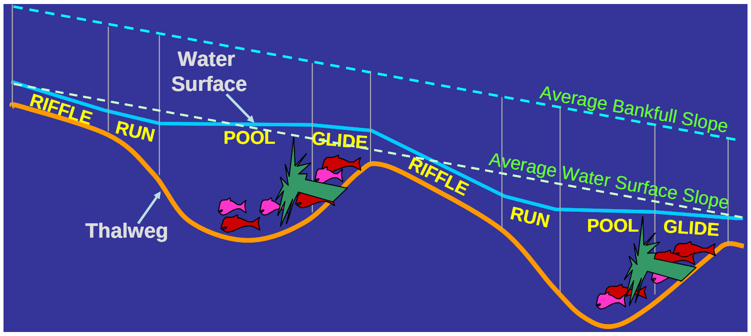


Figure 3: Typical pool-riffle channel morphology.

Cross sections: Using Rosgen stream survey techniques (Rosgen, 1996; Harrelson et al., 1994), a total of 11 cross sections were surveyed along the reach, including 2 cross sections at riffles, 2 cross sections at glides, 1 cross section at a run, and 6 cross sections at pools. Cross sections were surveyed in representative channel features, or in some cases, where monitoring of future channel changes is desired. At each cross section, a measuring tape was stretched tightly between two permanent rebar pins, with the zero-point on the tape at the left (facing downstream) pin. Elevations at points along the tape were measured using a laser level and rod. A canoe was utilized to measure the pool cross sections, as they were too deep for wading (**figure 4**). Rebar pins for each cross section were capped with blue caps and labeled. Data were stored and processed using Rivermorph Stream Restoration Software (Rivermorph LLC, 2004).

Figure 4: Surveying a pool cross section using a canoe.

Pebble Counts: Pebble counts were conducted at the two riffle cross sections and the two glide cross sections only. Pebble counts were not conducted at the pool and run cross sections because of deep flows and high velocities. For each pebble count, the intermediate axis was measured for 100 particles, taken at even intervals across the cross section line between the approximate locations of bankfull on each bank.

Fish Counts/Nutrients: Fish escapement counts were conducted as a part of a University of Alaska Fairbanks graduate study on marine-derived nutrients in Resurrection Creek. Weekly escapement counts were conducted in July and August using snorkel surveys. Fish carcass counts were also conducted.

Photo Points: Photo points were established at 26 locations along and upstream of the project reach during the spring and summer of 2005. Many of these photo points were monitored during and after the first phase of the project to show changes as a result of restoration. These photo points are permanently marked, generally with blue-capped rebar pins, and will continue to be monitored in the future.

Aerial Photos: Aerial photos of the project reach were taken in August 2005. These photos provide an accurate depiction of the work that was completed in 2005, as well as a comparison with low-level aerial photography collected in 2002.

3 LONGITUDINAL PROFILE

The surveyed reach is 4272 feet long, as measured with a tape measure along the left bank (**figure 5**). This includes the entire reach restored in 2005. The average water surface slope of the reach is 1.4%. The slope is slightly higher than the designed slope of 1.3% because some meander bends were not constructed exactly as designed. Riffle slopes range from about 2% to 4%, and pool slopes average less than 0.1%. The most well defined pools and riffles are located in the middle of the reach, in Meanders 2, 3, and 4. Longitudinal profile data are presented in **figure 37** and **table 3**, in Appendix A.

The upper 1000 feet of the reach, including Meander 5, has an average water surface slope of 1.7%, and the lower 800 feet of the reach, including Meander 1, has an average slope of 1.8%. The middle portion of the reach, including Meanders 2, 3, and 4, has an average slope of only 1.2%. This is because full meanders were created in the middle portion of the reach, but only partial or small meanders were created in the upper and lower ends of the reach. Riffle slopes are considerably steeper than the average slope, ranging from 1.4% to 3.9% and averaging 2.9%. The ratio of riffle slope to average slope ranges from 1.0 to 2.8, averaging 2.1. The ratio of riffle slope to valley slope ranges from 0.8 to 2.2, averaging 1.6. Pools in this reach are very low gradient, with water surface slopes approaching 0%. The variability in slopes in these pool-riffle sequences and in different portions of the reach contributes to a diversity of habitat and channel complexity in the reach.

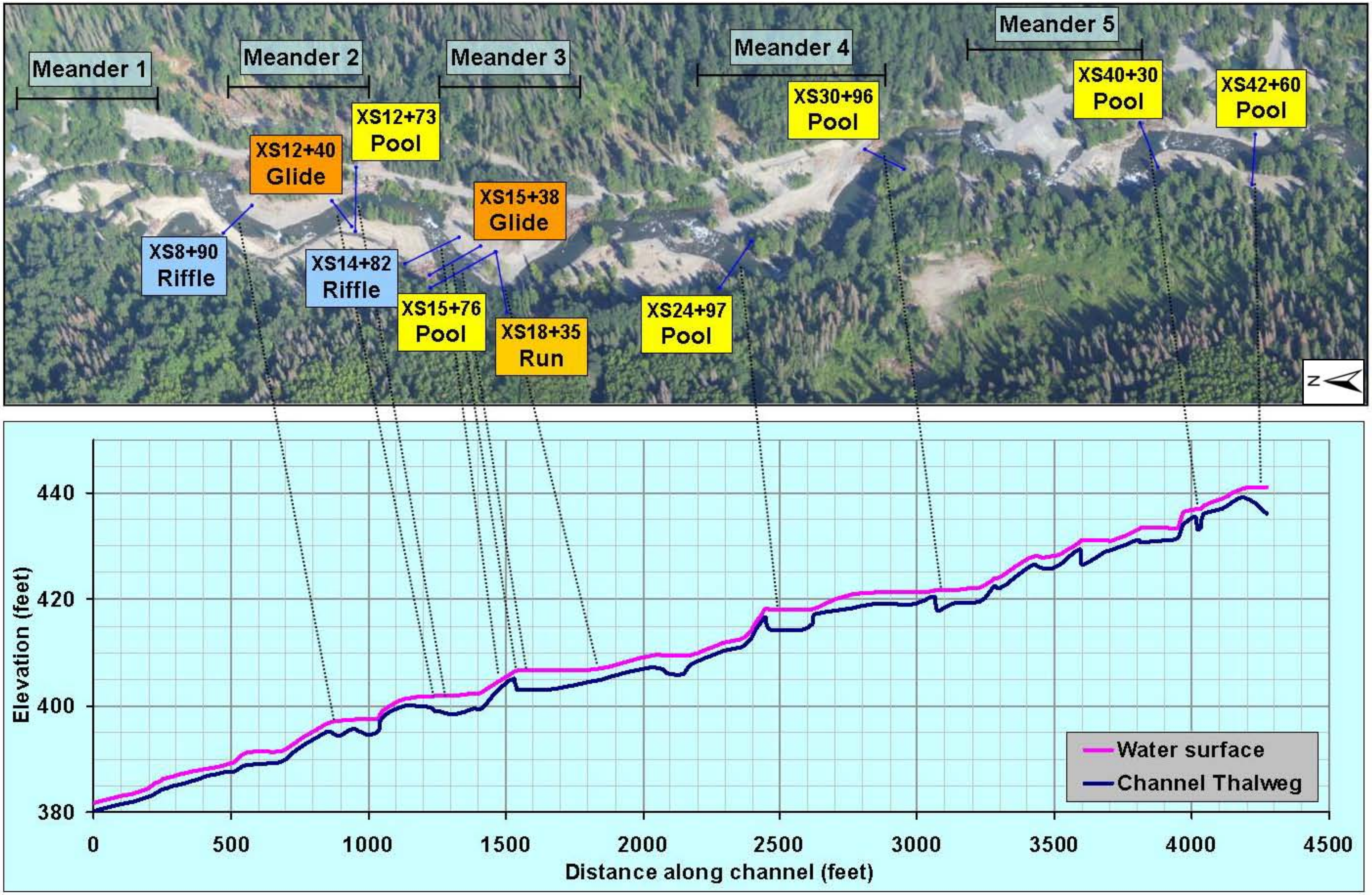


Figure 5: Longitudinal Profile for the Resurrection Creek 2005 project reach.

The pre-restoration and 2005 post-restoration channels are shown in **figure 6**. Simplified major habitat/bedform types were drawn over these images and are shown by color. Side channels shown in white will be constructed in 2006.

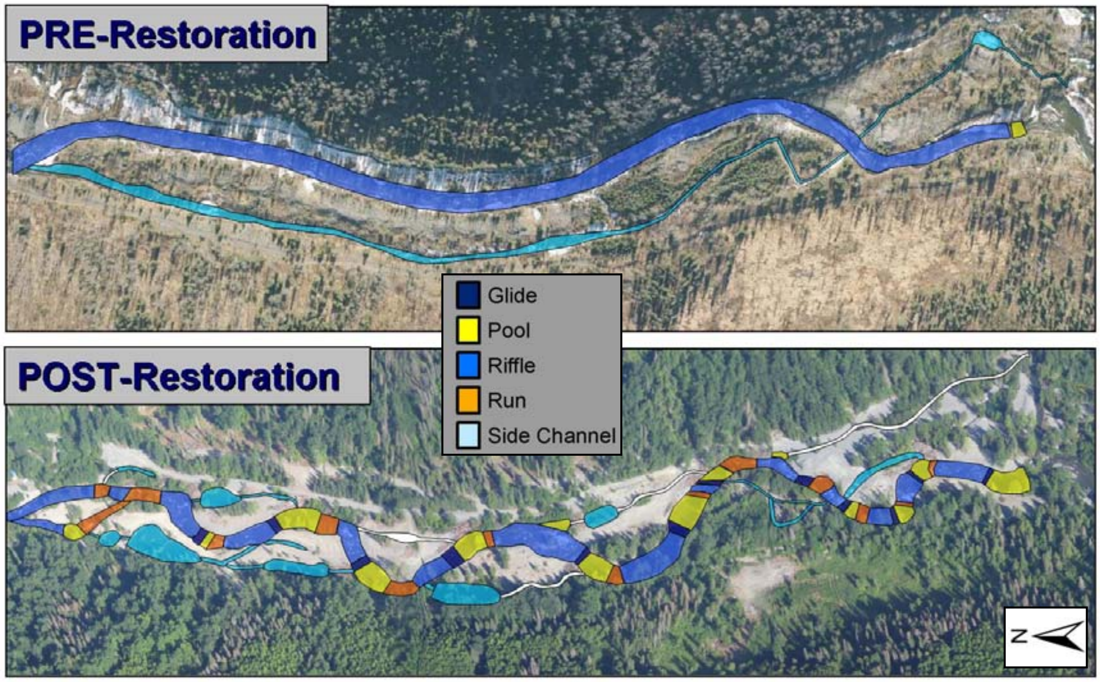


Figure 6: Pre-restoration and post-restoration habitat/bedform types.

A comparison of channel morphology variables between the pre-restoration and 2005 post-restoration reaches is presented in **table 1**. The creation of meanders in the channel added almost 700 feet of channel length (a 19% increase in channel length), increasing the sinuosity from 1.1 to 1.3 and decreasing the average slope from 1.7% to 1.4%.

Table 1: Pre-restoration and post-restoration channel morphology variables.

	Pre-Restoration	**Post-Restoration**
Channel Length	3600 ft	4272 ft
Sinuosity	1.1	1.3
Average Water Surface Slope	1.7%	1.4%
Percent of reach as riffles	99%	53%
Percent of reach as pools	1%	21%
Percent of reach as runs	-	19%
Percent of reach as glides	-	7%

Prior to restoration, riffles comprised nearly the entire reach, with major pools only comprising 1% of the reach. Construction of pool-riffle sequences in 2005 resulted in 12 major habitat-forming pools and an increase in the percentage of pools in the reach to 21%. The percentage of riffles decreased to 53%, runs increased to 19%, and glides increased to 7%. A total of about 22,500 square feet (2500 square yards) of glide habitat was created, providing abundant spawning gravel.

The percentage of the reach with slow water habitat (pools and glides) increased from 1% prior to restoration to 28% following restoration in 2005. Most importantly, this new configuration of bedforms creates a diversity of habitat for fish, with pools providing cover, glides providing spawning habitat, and riffles providing nutrients.

Restoration included the creation of numerous side channels in the project reach. Prior to restoration, a side channel existed but was separated from the main channel of Resurrection Creek by large tailing piles. Restoration created side channels within the active floodplain, as well as ponds, providing a variety of aquatic habitats. Many of these side channels will be completed during restoration activities in 2006. Future monitoring will examine how these side channels function and change over time.

4 CROSS SECTIONS

A total of 11 cross sections were established and surveyed in 2005. Locations of these cross sections are shown in **figure 5**. Raw cross section survey data are presented in **table 2** in Appendix A.

Bankfull widths were measured using aerial photography taken before and after restoration. These measurements were estimated and averaged at numerous locations throughout the reach. Channel restoration resulted in channel widening in the 2005 project reach from an average of 64 feet to an average of 71 feet. Entrenchment ratios (floodprone width divided by bankfull width) at the riffles increased as a result of restoration from about 1 prior to restoration, when the channel was laterally confined by tailings piles, to greater than 5 after restoration, as the channel is now able to utilize its new floodplain. Floodprone widths were estimated for some cross sections.

The new channel is no longer confined and constricted by tailings piles on both sides, and it also has more side pools, side channels, and a floodplain on which to spread out. These features allow the new channel to have more expansions and contractions in its width, which leads to more habitat features that are beneficial to aquatic ecosystems. These variations in the channel dimensions also increase channel roughness, which leads to localized sediment deposition and sorting, and decreases the shear stress against the banks.

The restored channel was generally constructed wider than the channel design. However, point bar development and sediment deposition are expected in many places, which will cause a reduction in channel width to a more natural channel width for this channel type. Channel depths in pools following restoration are considerably deeper than those prior to restoration. Bankfull depths in the pools reach up to 8 feet. These deep pools are expected to partially fill with gravel and fine sediment in the future. However, the meander hydraulics are expected to maintain pools in these locations in the long term (>10 years).

Cross Section 8+90 (Riffle)

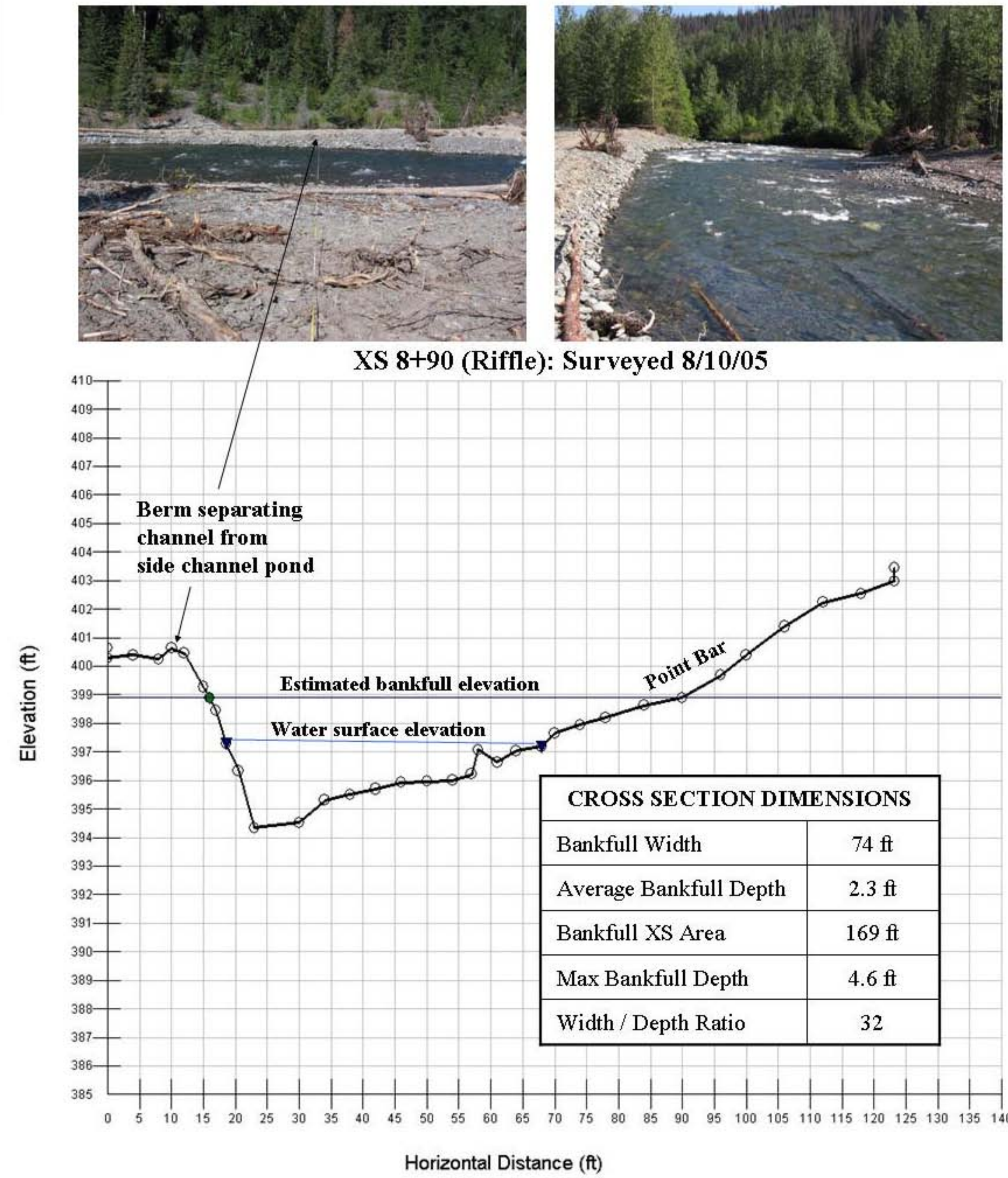
Cross Section 8+90 is located in the upper portion of the riffle at the downstream end of Meander 2 (**figure 7**). At this location, side channel ponds were constructed on both sides of the main channel. A narrow, 12-foot wide berm separates the main channel from the west side channel pond. This is a representative cross section and also serves to monitor bank erosion along the berm.

At this location, the thalweg is against the left bank, or the outside of the bend. This bank is the narrow berm that separates the main channel from the west side channel pond, as shown in the valley cross section (**figure 8**). During low flows initially following restoration, the water elevation of the pond was lower than the water elevation of the main channel. Although the pond outlet elevation is higher than the main channel, water seeps through the material and low flows do not maintain the pond at the elevation of the pond outlet. Pond and channel elevations will equilibrate during high flows when more water flows through the side channel, or when fine sediment fills and seals the pore space in the material comprising the berm at the pond outlet. The elevation of the berm between the channel and pond is higher than the bankfull elevation. This bank is composed of cobbles and gravel, and bank erosion is a concern, as high flows may create high shear stress against the bank. It is likely that the west side channel pond will gradually fill in with fine sediment in the future, and beaver activity is likely to occur in this area.

The bankfull channel width at cross section 8+90 is 74 feet. This is slightly greater than the design width of 60 feet, but some sediment deposition is expected to occur along the right bank. The channel slope at this riffle is 1 to 2%, steepening downstream of the cross section.

Bankfull elevations were not measured in the field because of a lack of bankfull indicators. A hydraulics approach using the Manning's equation was used to estimate the bankfull elevation throughout the reach. Assuming a bankfull discharge of 900-1000cfs, a water surface slope of 1.6%, and a Manning's n value of 0.055, the bankfull elevation is about 1.6 feet higher than the surveyed water surface elevation. This estimate is fairly consistent with the bankfull estimate at the other riffle cross section, and an estimated bankfull elevation of 1.6 feet above the surveyed water surface elevation was used throughout the reach. This is likely to be more accurate in the riffles than in the pools, glides, and runs, and should be considered an estimate.

A substrate analysis at this cross section showed a D_{50} of 103mm (**figure 9**). This is slightly finer than the D_{50} measured for the entire pre-project reach (122mm), and similar to the D_{50} measured for the entire reference reach (99mm).



CROSS SECTION DIMENSIONS	
Bankfull Width	74 ft
Average Bankfull Depth	2.3 ft
Bankfull XS Area	169 ft
Max Bankfull Depth	4.6 ft
Width / Depth Ratio	32

Figure 7: Cross Section 8+90 photos and details.

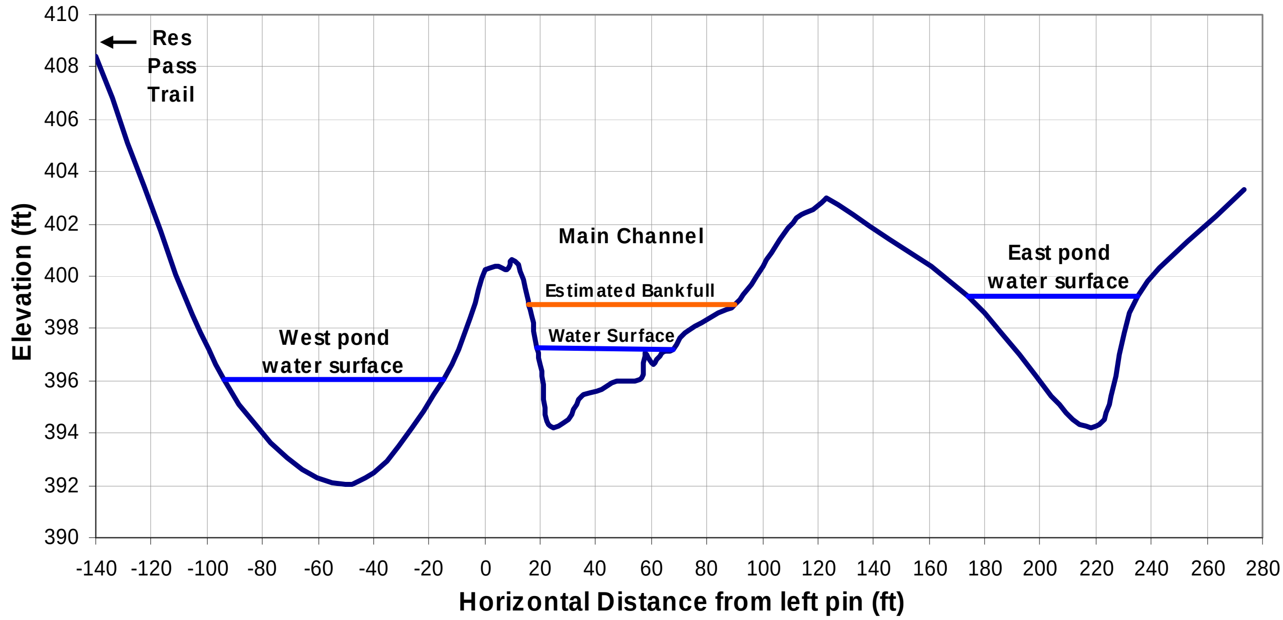


Figure 8: Valley cross section at Cross Section 8+90, surveyed 8/10/05.

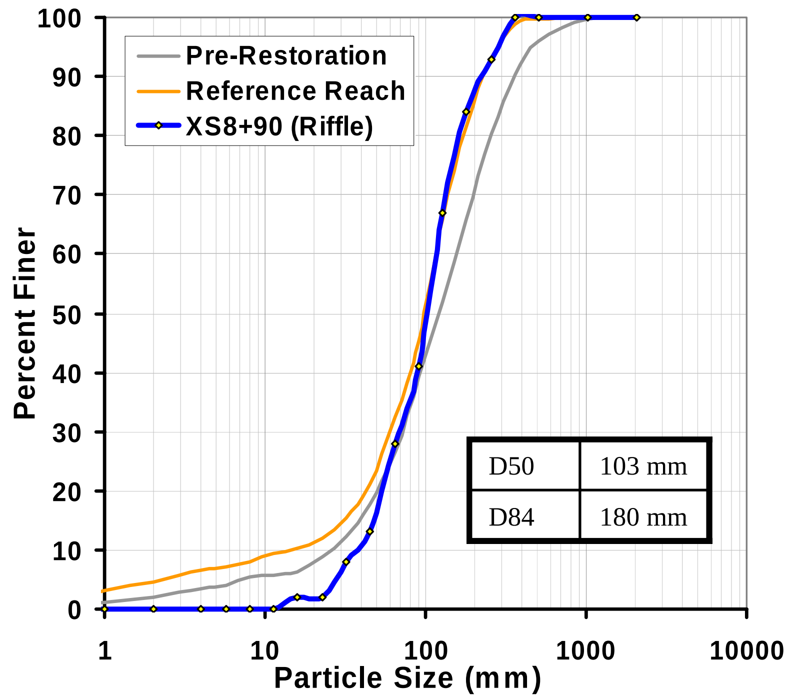


Figure 9: Substrate distribution at Cross Section 8+90, surveyed 8/10/05.

Cross Section 12+40 (Glide)

Cross Section 12+40 is located in a glide at the upstream end of Meander #2, at the point where Resurrection Creek was diverted out of its original channel into Meander #2 (**figure 10**). About 5 large boulders lie along the right bank, and a deep pool lies upstream of these boulders. This is a representative glide cross section.

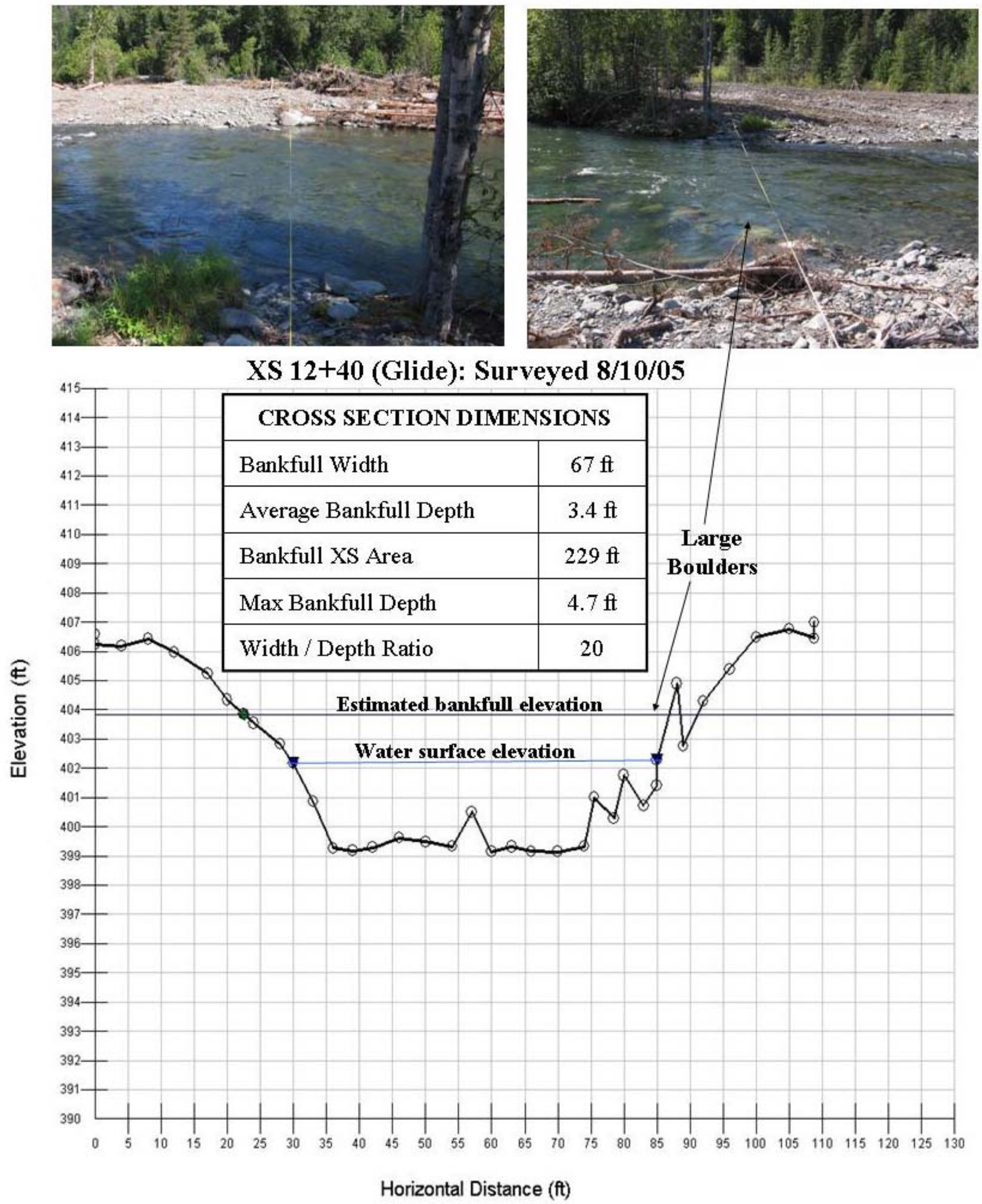


Figure 10: Cross Section 12+40 photos and details.

The bankfull width of 67 feet is similar to the design bankfull width of 66 feet. Because of the greater water depths in this glide, the cross sectional area is larger than that measured in the riffle cross sections. The D_{50} at this cross section is 66mm (**figure 11**). This is considerably finer than the D_{50} of the pre-restoration project reach (122mm) and the D_{50} of the reference reach (99mm). Finer gravel was placed in this glide during restoration, and this material was naturally sorted by the river.

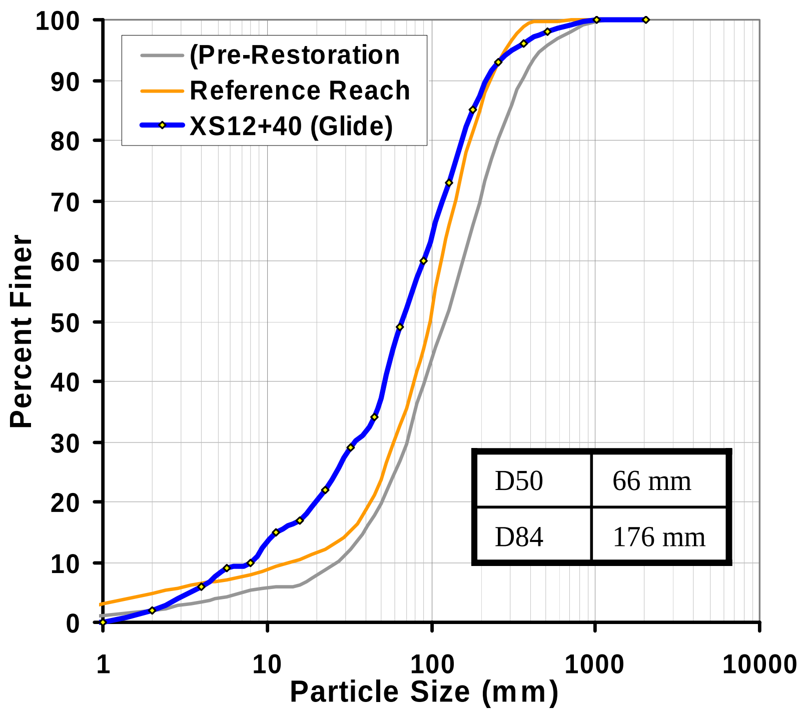


Figure 11: Substrate distribution at Cross Section 12+40, surveyed 8/10/05.

This glide provides good fish habitat, with spawning gravel as well as cover provided by the logjam and large boulders along the right bank. However, this glide is not well developed in terms of gravel sorting and fish habitat as compared to other glides upstream. Further development of the glide is expected to occur in the future. As more sediment is transported from upstream, gravel will sort itself in the glide. Deposition of gravel in a point bar will likely occur on the left bank.

Cross Section 12+73 (Pool)

Cross Section 12+73 is located in the pool at the upstream end of Meander #2 (**figure 12**). A large logjam was constructed on the right side of this pool, and a side channel diverges from the east (right) side of the main channel at this logjam. The cross section crosses the side channel. The pool is deep, with a substrate of mostly large boulders.

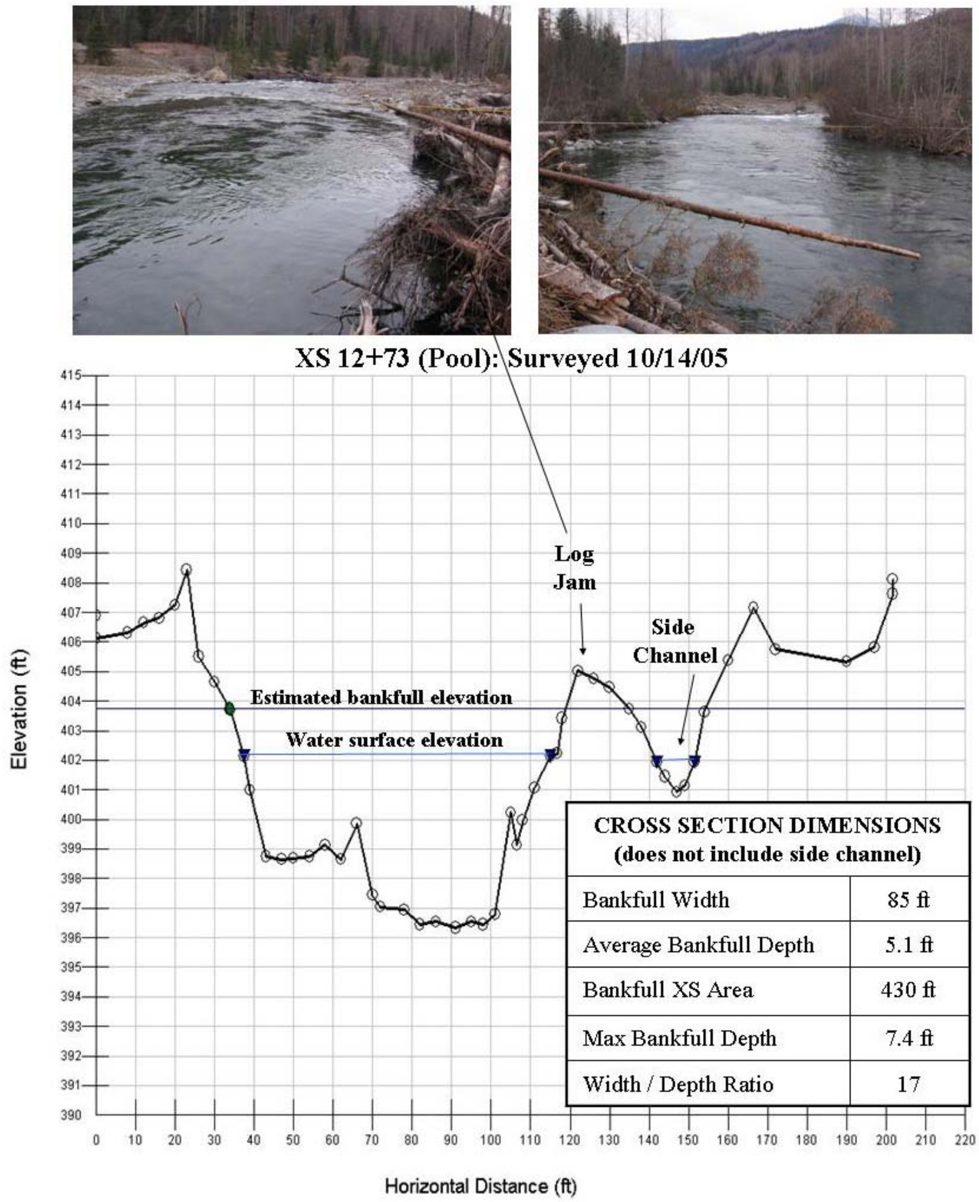


Figure 12: Cross Section 12+73 photos and details.

Considerable sediment deposition is expected in this pool in the future. Surprisingly little sediment was deposited in the pool in the first few months following restoration, and the substrate remains very coarse. It is likely that much of the future sediment deposition will come from larger flood events.

Cross Section 14+82 (Riffle)

Cross Section 14+82 is located in a riffle in the downstream half of Meander #3, about 35 feet downstream of the start of the riffle (**figure 13**). Low gradient floodplain surfaces exist on both banks. This is a representative riffle cross section.

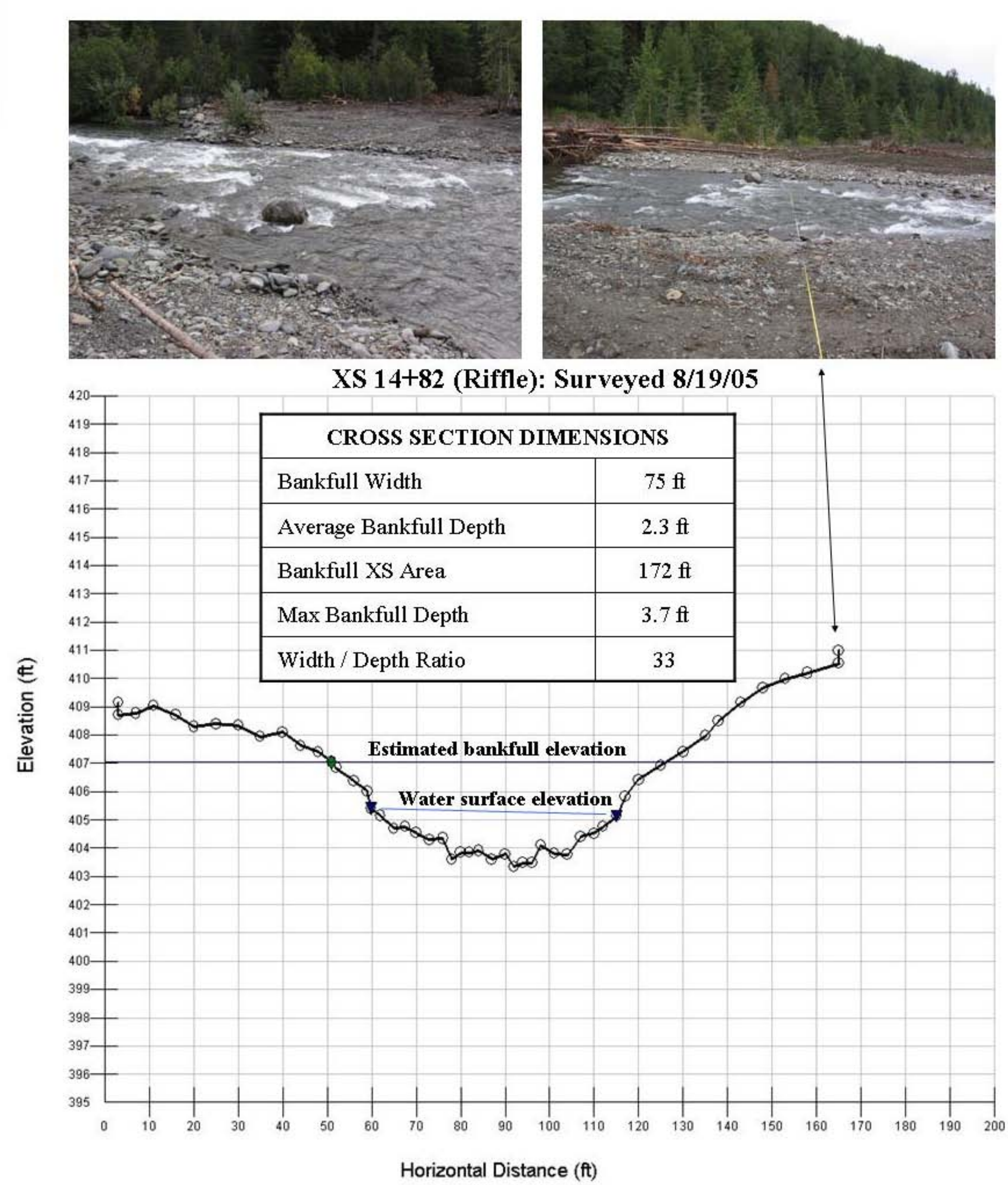


Figure 13: Cross Section 14+82 photos and details.

This cross section is not expected to change drastically in the future. The substrate is coarser than most other cross sections, shear stress along the banks is relatively low, and the low-angle banks are unlikely to sustain substantial erosion. The D_{50} in this riffle is 118mm (**figure 14**). This is similar to the D_{50} that was measured for the entire pre-project reach (122mm) and coarser than the D_{50} measured in the entire reference reach (99mm). However, this represents some of the coarsest bed material in the 2005 post-restoration reach.

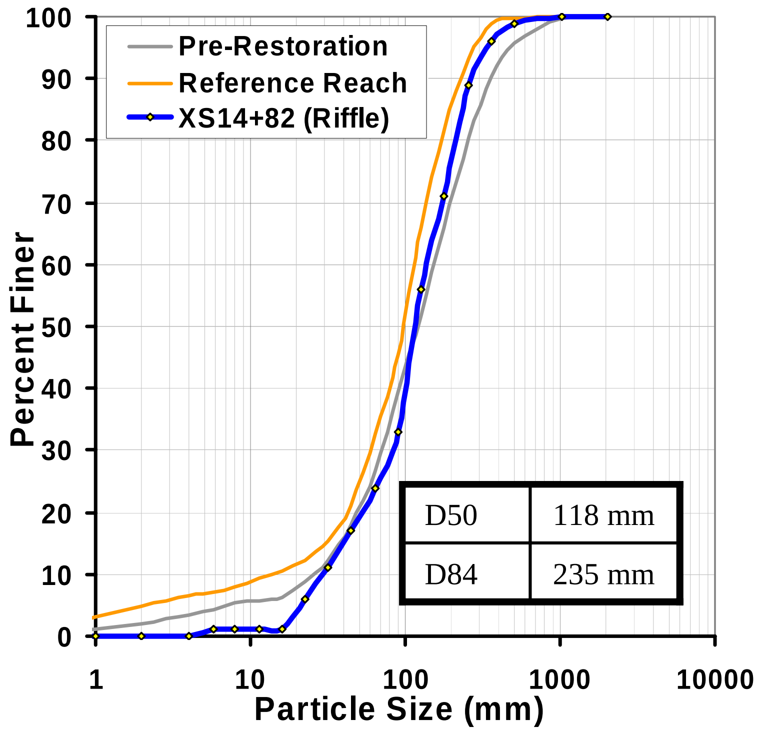
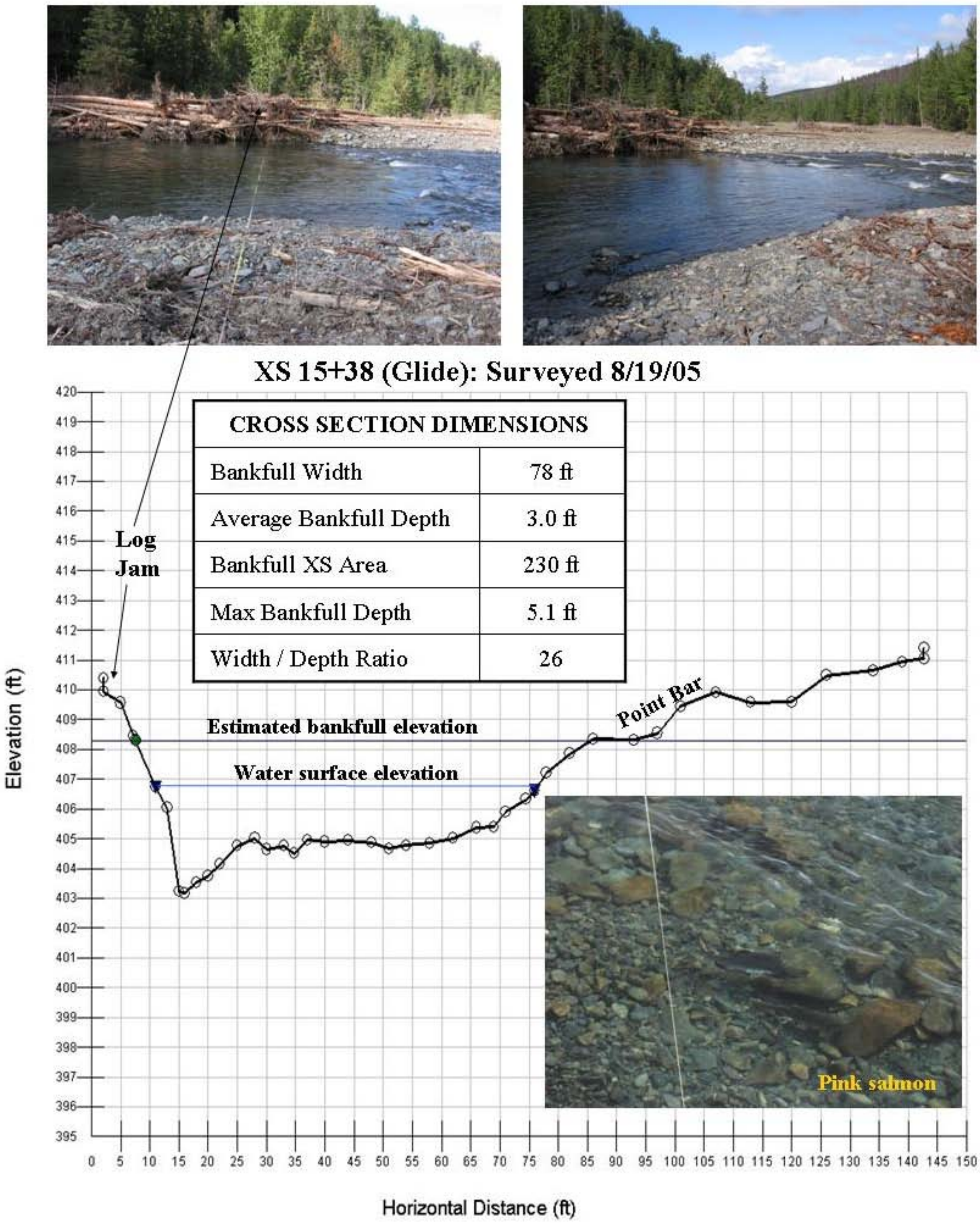


Figure 14: Substrate distribution at Cross Section 14+82, surveyed 8/19/05.

Assuming a bankfull discharge of 900-1000cfs, a water surface slope of 1.3%, and a Manning's *n* value of 0.050, the bankfull elevation is about 1.6 feet higher than the surveyed water surface elevation. This estimate was consistent with that measured in the riffle at Cross Section 8+90. An estimated bankfull elevation of 1.6 feet above the surveyed water surface elevation was assumed throughout the reach. This is likely to be more accurate in the riffles than in the pools, glides, and runs, and should be considered an estimate.

Cross Section 15+38 (Glide)

Cross Section 15+38 is located in a glide in the downstream half of Meander #3, about 10 feet upstream of the start of the riffle (**figure 15**). A logjam was constructed on the left bank along this glide and the pool just upstream. This glide includes a deep area against the logjam and has excellent fish habitat. This is a representative glide.



CROSS SECTION DIMENSIONS	
Bankfull Width	78 ft
Average Bankfull Depth	3.0 ft
Bankfull XS Area	230 ft
Max Bankfull Depth	5.1 ft
Width / Depth Ratio	26

Figure 15: Cross Section 15+38 photos and details.

This well-defined glide has excellent fish habitat. The gravel is well sorted, the glide is relatively uniform across the channel, and the adjacent logjam and upstream pool provide very good fish habitat and cover. The D_{50} at this cross section is 46mm (**figure 16**), which is considerably finer than the D_{50} of the pre-project reach (122mm) and the D_{50} of the reference reach (99mm). The substrate in this glide is finer than that of the other glides. Although gravel was placed in this glide during construction, much of the sorting occurred very quickly after the water was put into the channel. It is likely that sediment deposition will occur on this glide, leading to further sorting of gravel and some infilling on the left side against the logjam.

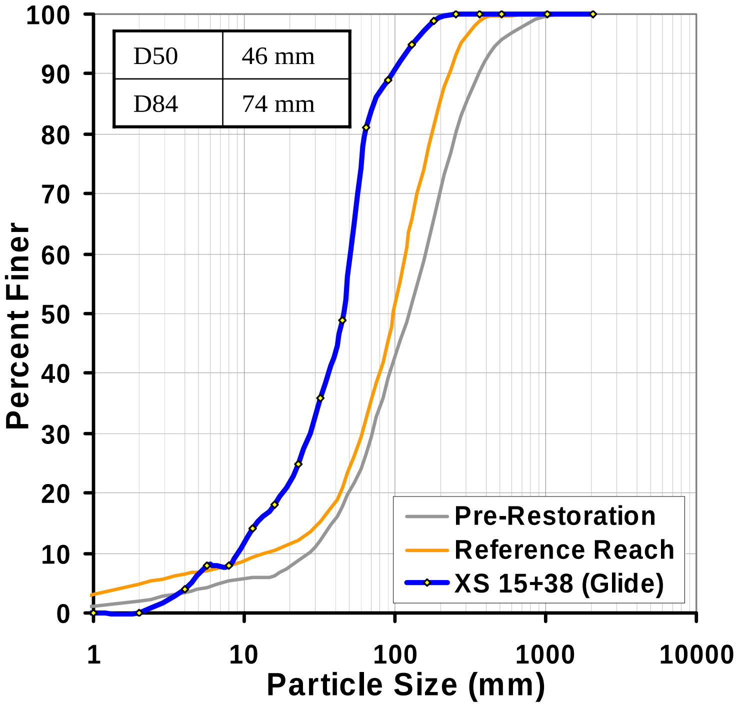


Figure 16: Substrate distribution at Cross Section 15+38, surveyed 8/19/05.

Cross Section 15+76 (Pool)

Cross Section 15+76 is located in a pool in the downstream half of Meander #3 (**figure 17**). A logjam was constructed on the left bank. The pool is deep against the logjam, and abundant fish habitat and cover are available. The right bank is a low-angle floodplain, and the left bank acts as a terrace. This is a representative pool cross section.

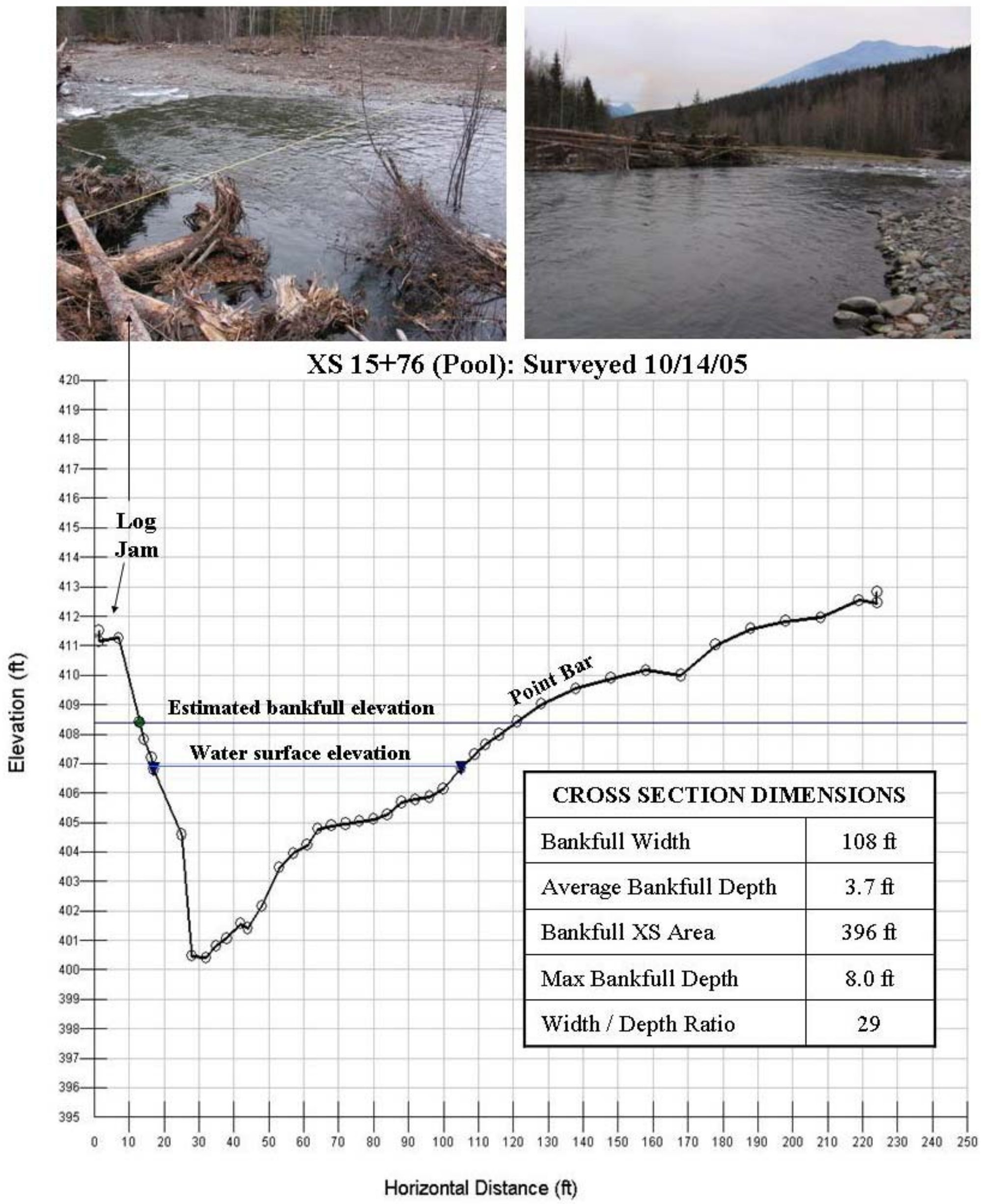


Figure 17: Cross Section 15+76 photos and details.

Sediment deposition is expected to occur in this pool. A point bar will likely develop on the right bank, with some infilling of the deep pool against the left bank. Sediment deposition will provide additional gravel to be sorted in the glide just downstream (Cross Section 15+38). Because of the well-sorted substrate, the pool depth, and the abundant cover, this area is expected to continue to provide high quality fish habitat.

Cross Section 18+35 (Run)

Cross Section 18+35 is located in a run on the outside bend of Meander #3 (**figure 18**). A small logjam, consisting of about 5 large logs, lies on the left bank. Fast current flows along the thalweg in the center of the channel, and eddies exist along both banks, with a low-angle floodplain on the right bank. A high terrace and the Resurrection Pass Trail are on the left bank.

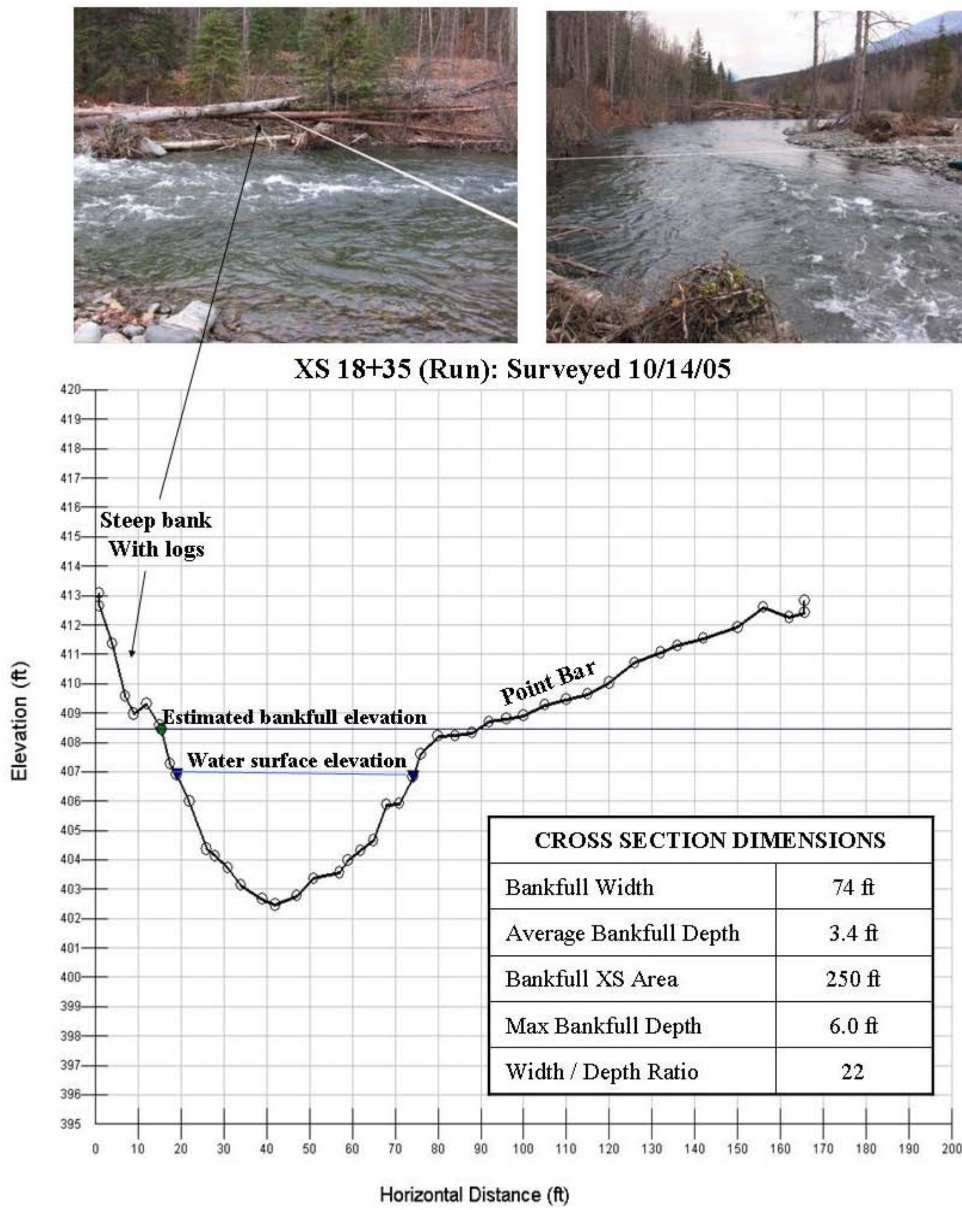


Figure 18: Cross Section 18+35 photos and details.

Few changes to this cross section are expected to occur in the long term (>10 years). The thalweg is in the center of the river, and extensive bank erosion is not likely to occur. Some localized erosion from eddy scour downstream of the logs on the left bank may occur as a result of flow deflected by the logs into the bank.

Cross Section 24+97 (Pool)

Cross Section 24+97 is located in a pool on the outside bend of Meander #4 (**figure 19**). A logjam was constructed on the left bank. The right side of the channel is mostly slack water, and a low floodplain with a small off-channel pond exists on the right bank. This small pond is groundwater-fed.

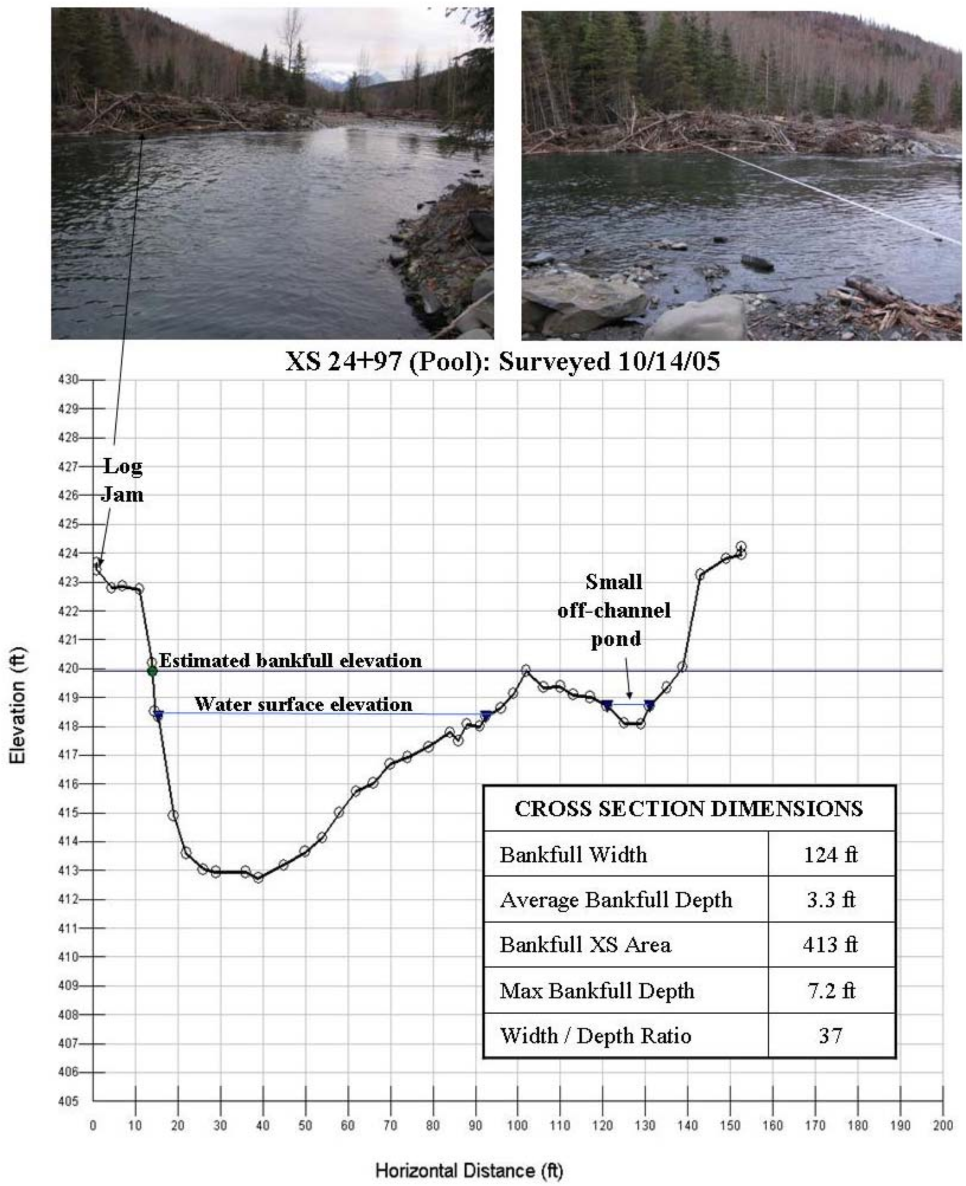


Figure 19: Cross Section 24+97 photos and details.

It is likely that the off-channel pond area on the right bank will develop into a floodplain over time. This is a low-energy environment with considerable roughness from the surrounding trees. The terrace surface to the right of the pond was preserved during construction in order to preserve the spruce forest. New floodplain deposits on the right bank are expected to build up against this terrace.

Cross Section 30+96 (Pool)

Cross Section 30+96 is located in a pool at the upstream end of Meander #4, at the point where the main channel was diverted into Meander #4 (**figure 20**). A logjam was constructed on the right bank terrace, and the left side of the channel is mostly shallow slack water. This cross section may be affected by channel restoration activities in 2006.

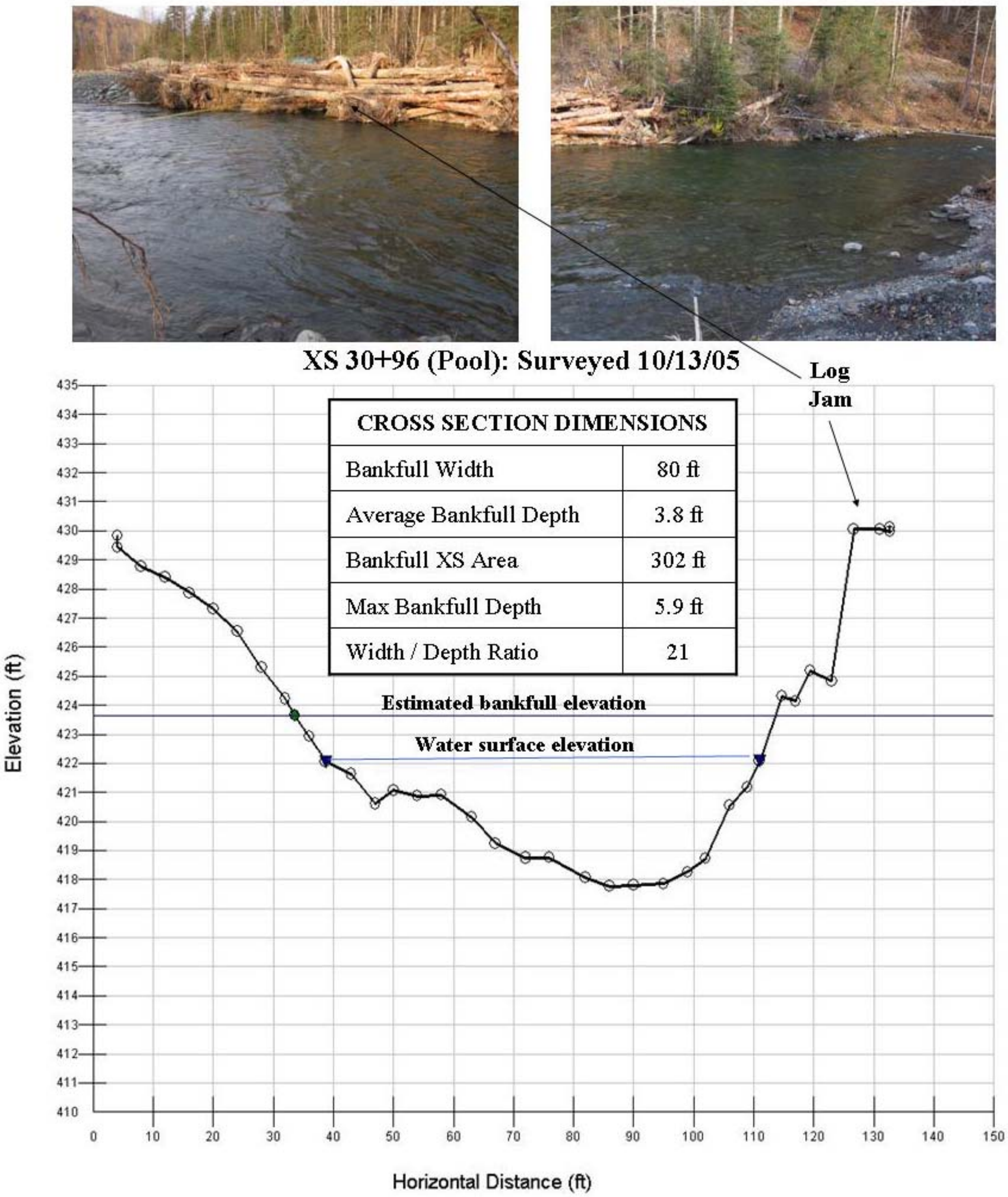


Figure 20: Cross Section 30+96 photos and details.

Pool volume is expected to decrease as a result of sediment deposition and infilling. The glide downstream of this pool is not well developed. A point bar is likely to develop on the left bank.

Cross Section 40+30 (Pool)

Cross Section 40+30 is located in a pool in the downstream half of Meander #5 and includes the main channel as well as the east (right) side channel where it diverges from the main channel (**figure 21**). A logjam was constructed on the right bank, on the outside of the bend, at the side channel inlet. High velocity flows and strong eddy currents exist against this logjam, and slack water exists on the left side of the channel.

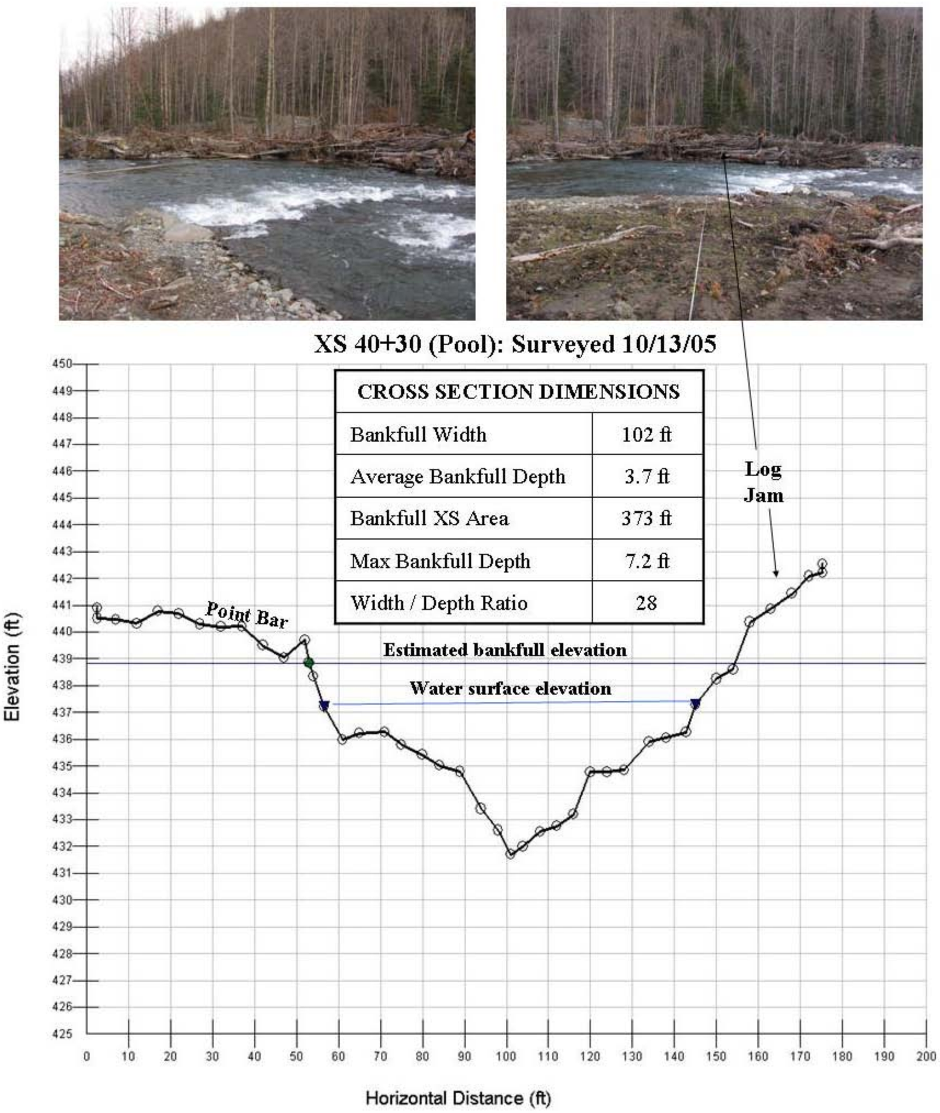


Figure 21: Cross Section 40+30 photos and details.

Sediment deposition is expected to alter the shape of this cross section in the short term (<5 years). This is a tight bend to the left. A point bar will develop on the left side of the channel, as most of the current flows against the right bank and the logjam. This short pool is followed by a short, steep riffle, which has the potential to be undermined, causing a headcut to advance upstream. If this happened, the pool elevation at Cross Section 40+30 would be lowered, and the amount of water that flows into the east side channel would decrease. Other factors can affect the dynamics of the side channel inlet, including sediment deposition and large woody debris. The flow that currently goes into the side channel is controlled by the existing logjam.

Cross Section 42+60 (Pool)

Cross Section 42+60 is located in a pool upstream of Meander #5, just downstream of the "new" Palmer Creek confluence (**figure 22**). The left bank is a terrace that grades into a floodplain further downstream. Many large boulders exist on the left side of the channel. The right bank is a moderately steep floodplain.

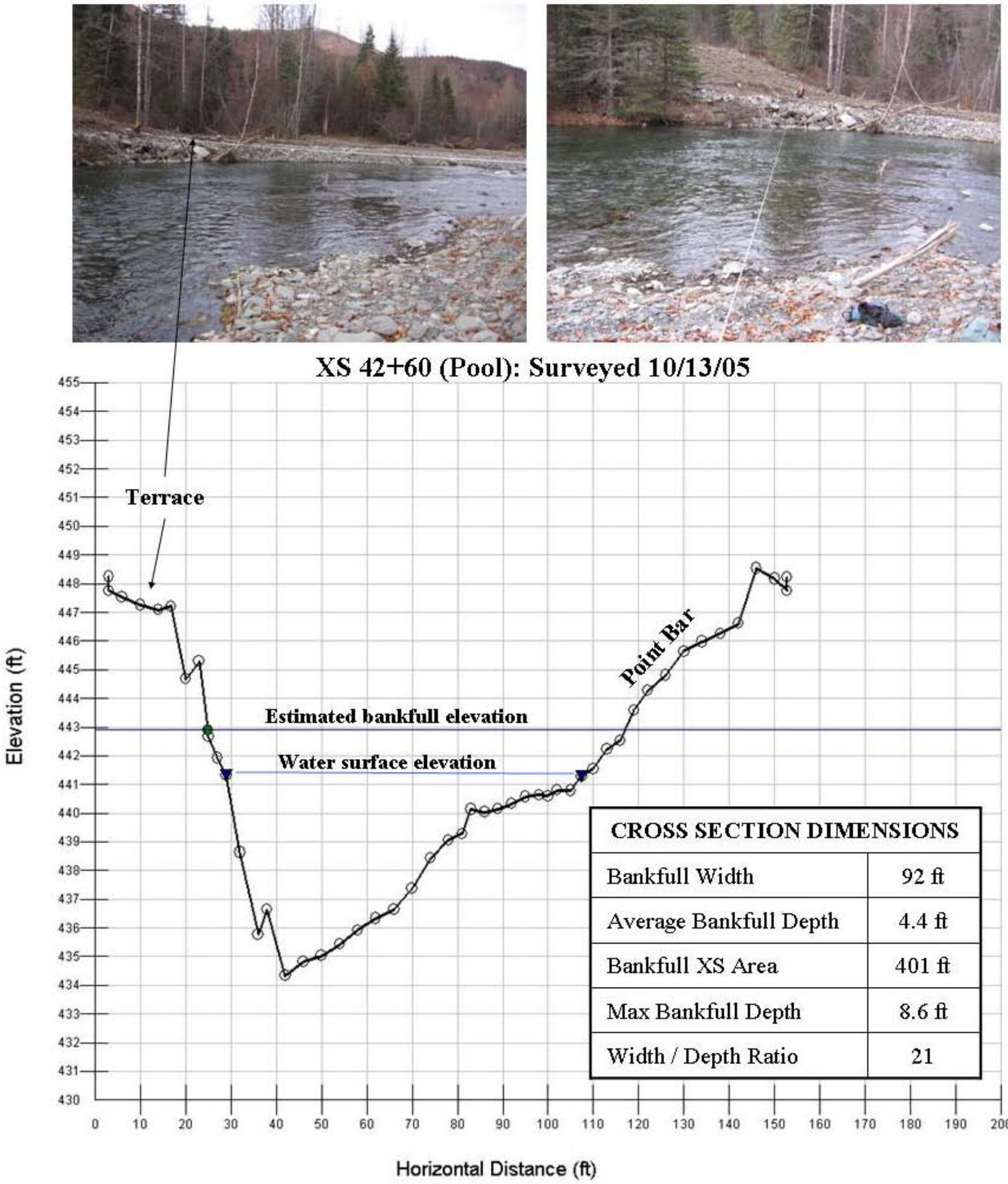


Figure 22: Cross Section 42+60 photos and details.

This pool is located just upstream of the diversion point where the main channel was diverted into Meander #5. It is likely that this pool will experience considerable infilling with sediment. This is a very low-energy environment, and the pool extends about 150 feet upstream. The substrate is currently very coarse. A point bar is likely to develop on the right bank. Channel changes may occur as a result of further channel restoration activities in 2006.

5 SUBSTRATE

Sediment distributions were characterized for the project reach and reference reach in August 2004, prior to restoration (**table 4** and **table 5**, in Appendix A). Sediment distributions were characterized for four of the cross sections following restoration in 2005 (**figure 23**), but the entire post-restoration reach was not characterized because of the difficulties associated with fast, deep water. Data show that grain sizes in the post-restoration riffle and glide cross sections are finer than the grain sizes of the entire reach prior to restoration. These grain sizes are similar to those measured in the reference reach. The restored reach has a greater diversity of substrate sizes, which are beneficial to providing a variety of different habitat types within the reach. Also, substrates in the glides are well sorted, providing high quality spawning gravel.

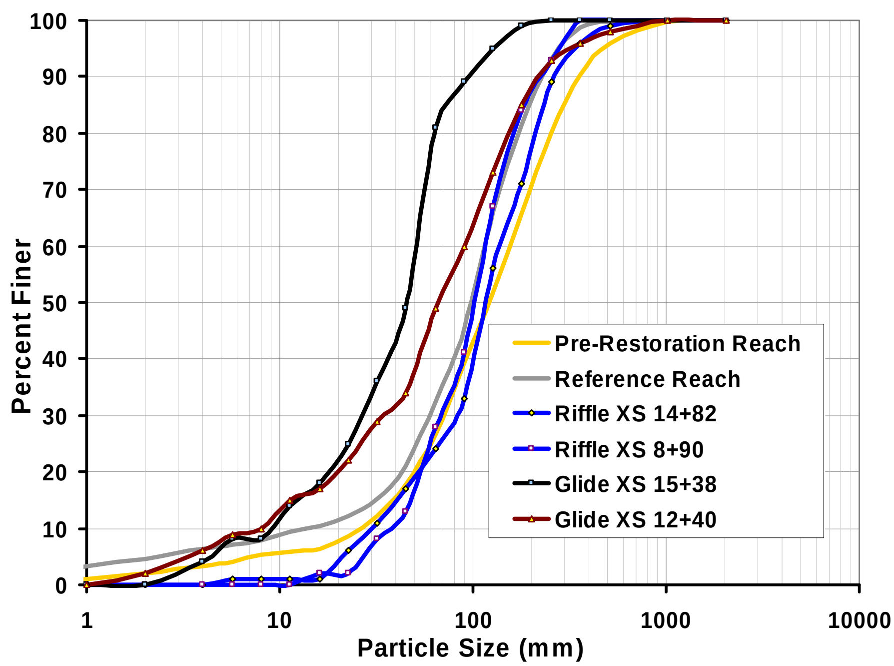


Figure 23: Substrate distributions for the reference reach, pre-restoration reach, and the 4 riffle and glide cross sections following restoration in 2005.

6 CHANNEL GEOMETRY

Channel geometry variables were measured using the August 2005 aerial photography in GIS (**figure 24**). The length of the main channel of the reach restored in 2005 increased from 3320 to 4272 feet. The sinuosity of the restored channel is 1.3. The average bankfull width (*Wbkf*) is 71 feet. Meander wavelengths (*Lm*) average 681 feet, with an average radius of curvature (*Rc*) of 196 feet. The belt width, or the valley width available for the channel meanders to utilize, averages 381 feet.

The meander wavelength to bankfull width ratio (*Lm/Wbkf*) is an important measure of meander geometry stability. In general, stable meander geometry occurs when *Lm/Wbkf* is between 10 and 14 (Leopold et al., 1964). In the Resurrection Creek 2005 restoration reach, meanders fall within this range, with the exception of Meander 5, which has a meander wavelength that is too small for the size of the channel. This can result in channel instability, leading to the potential for a meander cut-off to occur. However, it is important to note that the restored reach was constructed so that the channel geometry variables have a natural degree of variation, rather than strict uniformity. Also, the presence of side channels causes a reduction in flow volumes in the main channel, which can decrease bed shear and allow for tighter meanders.

The radius of curvature to bankfull width ratio (*Rc/Wbkf*) also indicates meander geometry stability. Highest channel stabilities occur when the *Rc/Wbkf* ratio is between 2 and 3 (Leopold et al., 1964). Meander cutoffs tend to occur when the ratio falls between 1 and 2. When this ratio is below 2, flow resistance increases and strong eddy currents tend to develop along the outside bank. With a ratio over 3, the channel will work to increase its sinuosity, if the banks are adjustable. In the Resurrection Creek 2005 restoration reach, the *Rc/Wbkf* ratio is 1.6 in Meander 5. This indicates that the meander may be too tight, and a meander cutoff could possibly occur. Strong eddy currents do occur on the outside of this bend, and the gradient is fairly steep here. The left bank downstream of Meander 5 is hardened by large boulders and is not likely to erode or migrate. However, the right bank is an erodible floodplain surface.

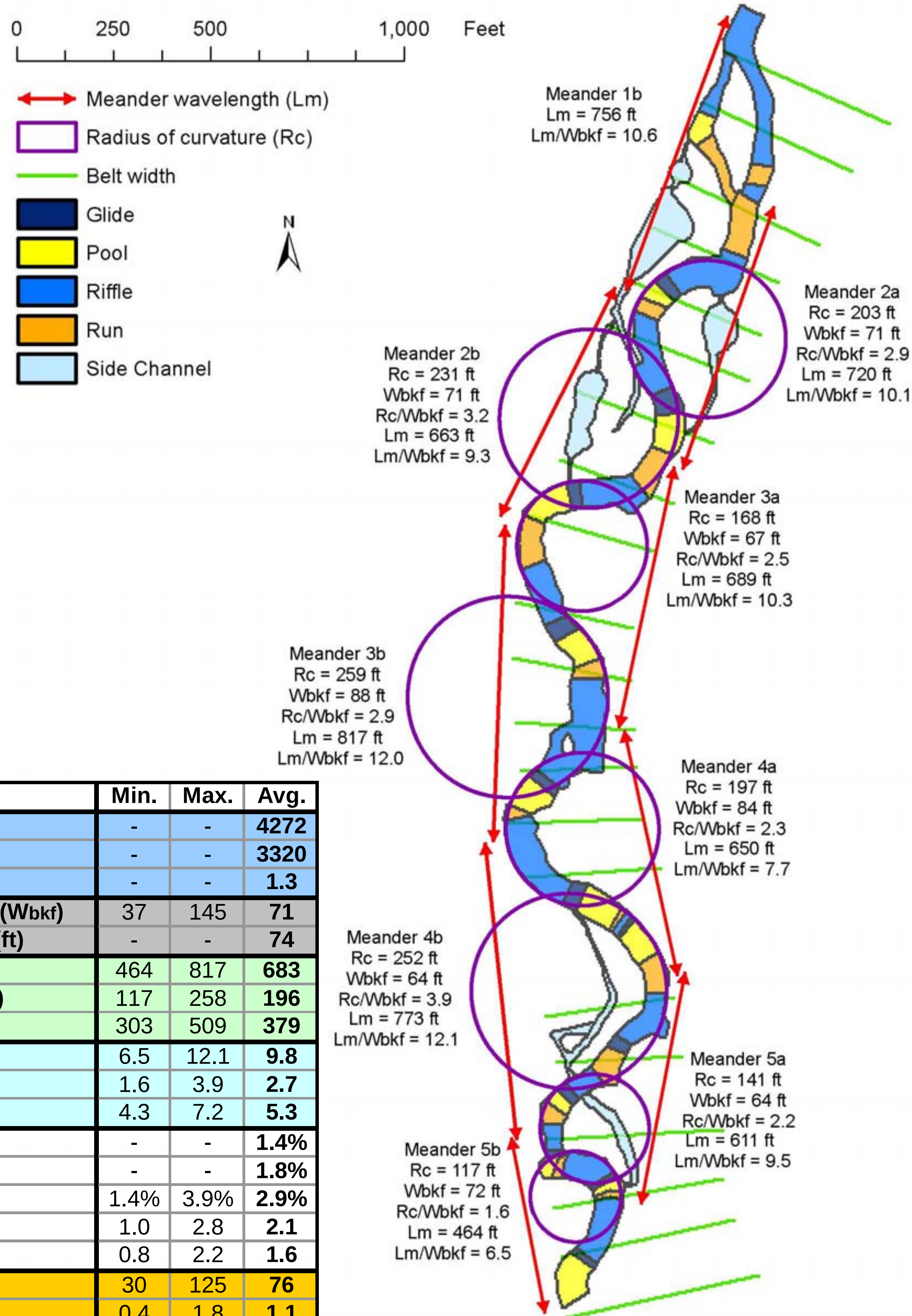


Figure 24: Measures of channel geometry in the 2005 restored reach of Resurrection Creek.

	Min.	Max.	Avg.
Channel Length (ft)	-	-	**4272**
Valley Length (ft)	-	-	**3320**
Sinuosity	-	-	**1.3**
Average Bankfull Width (ft) (W_{bkf})	37	145	**71**
Bankfull Width at Riffle XS (ft)	-	-	**74**
Meander Length (ft) (L_m)	464	817	**683**
Radius of Curvature (ft) (R_c)	117	258	**196**
Belt Width (ft) (W_{belt})	303	509	**379**
L_m/W_{bkf} (at each meander)	6.5	12.1	**9.8**
R_c/W_{bkf} (at each meander)	1.6	3.9	**2.7**
W_{belt}/W_{bkf} (at each meander)	4.3	7.2	**5.3**
Avg water surface slope	-	-	**1.4%**
Valley slope	-	-	**1.8%**
Riffle slope	1.4%	3.9%	**2.9%**
Riffle slope/Average slope	1.0	2.8	**2.1**
Riffle slope/Valley slope	0.8	2.2	**1.6**
Pool length (ft)	30	125	**76**
Pool length/W_{bkf}	0.4	1.8	**1.1**
Pool-to-pool spacing (ft)	175	540	**372**
Pool-pool spacing/W_{bkf}	2.5	7.6	**5.2**

7 FISH DATA

The project reach was divided into 4 reaches for fish surveys (**figure 25**). Data were collected by a three-person team snorkeling and wading upstream, with two people counting and one recording information. Final 2005 fish counts are presented in **Appendix B**. This fish monitoring program will be continued in the 2006 season.

Weekly escapement counts showed that the most fish were seen in Reach 3. Although the majority of the fish were pink salmon, all 5 species of Pacific salmon were seen in this reach. Reach 3 contains the largest, deepest pools, and the most well-defined glides in the project reach. Fewer fish were seen in Reach 2, which has a higher gradient and fewer pools. Fewer fish were also seen in Reach 1, upstream of the 2005 restored reach. Some pink and chinook salmon were seen in Palmer Creek.

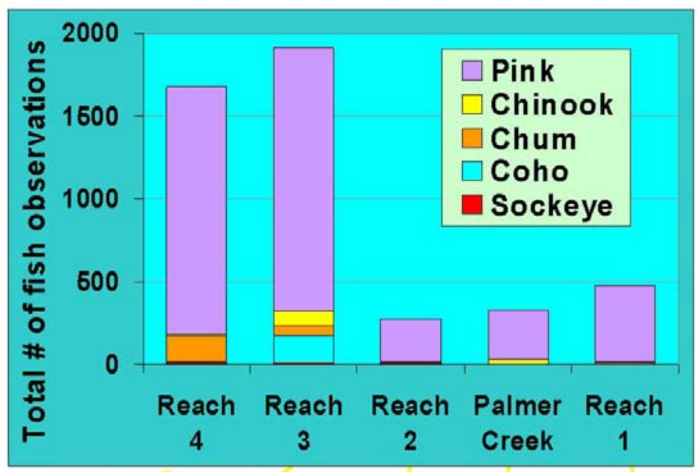
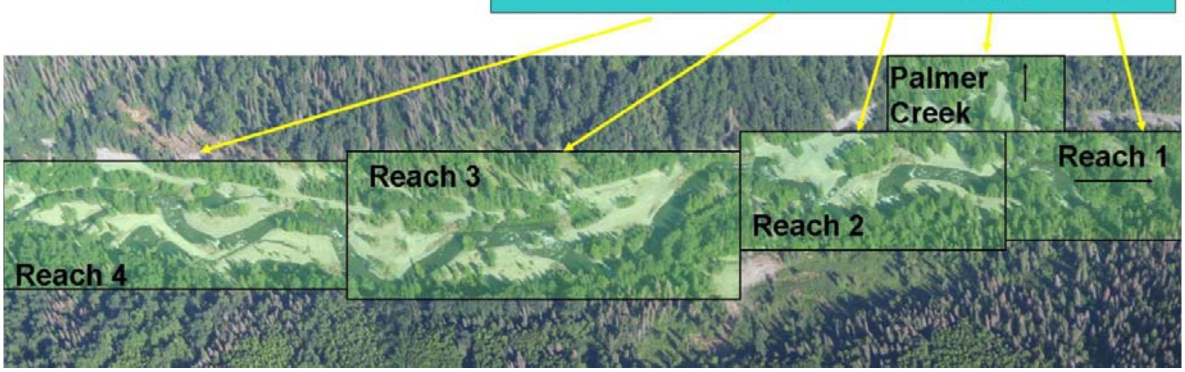


Figure 25: Total fish counts in the Resurrection Creek project reach, 2005.



Fish escapement counts also give an indication of the approximate timing of salmon runs in the project reach (**figure 26**). Chinook salmon were observed in the project reach in June and July. Many chinook were observed in the larger pools during construction in late June, occupying the pools almost immediately after they were built. Pink salmon came into the project area in July and August, peaking in early August. The largest number of pinks would likely have been counted on the August 5 sampling date, but sampling was missed that week. Pink salmon in Resurrection Creek typically have strong runs on even-numbered years. Although 2005 was an off-year for pinks, relatively large numbers still came into and spawned in the project reach. Smaller numbers of chum and coho salmon were observed in late July and August. Coho migration and spawning generally continue into September and October, but no sampling was conducted during these months.

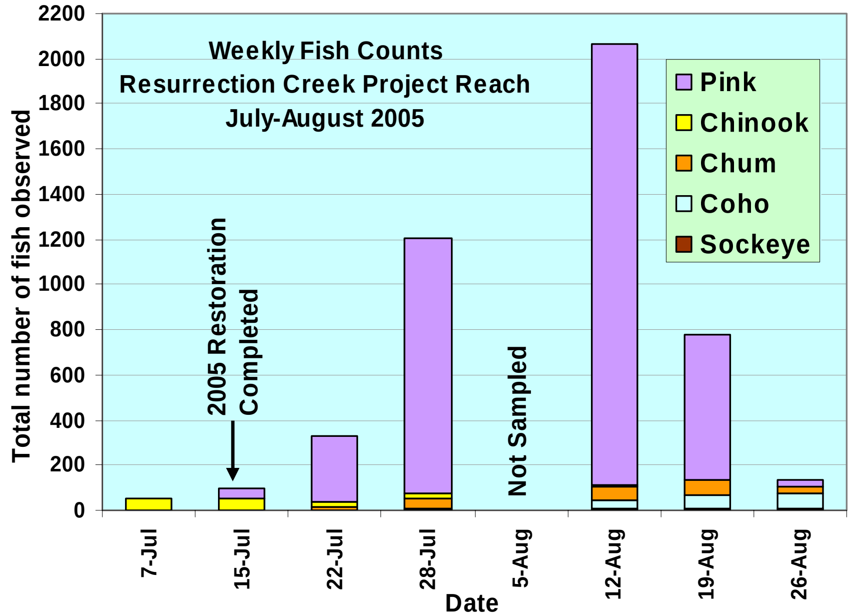


Figure 26: Fish escapement counts, July and August 2005.

The results of carcass counts reflect trends shown in the escapement data (**figure 27**). Mostly pink salmon carcasses were observed, beginning in late July, with the largest number of carcasses observed in late August, and presumably into September. Larger numbers of salmon carcasses are expected in this reach in 2006 with the likelihood of more spawning salmon.

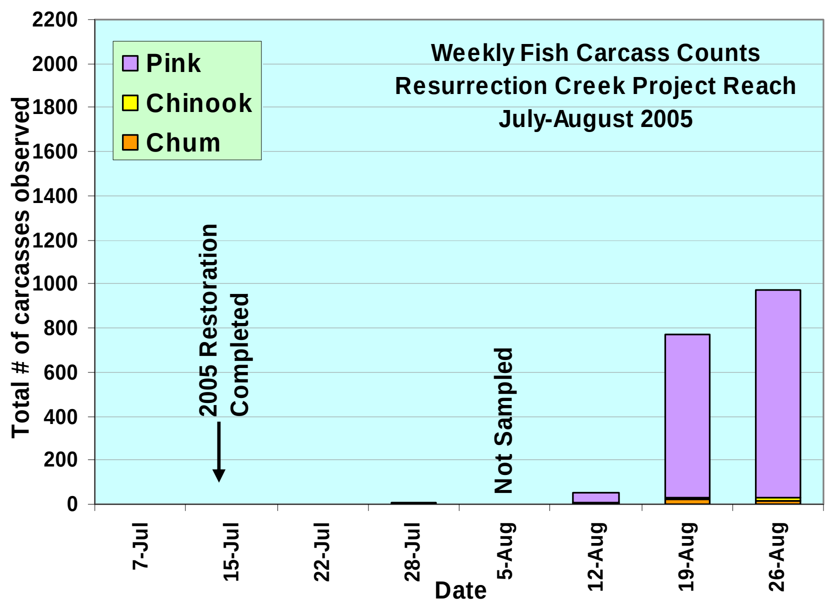


Figure 27: Fish carcass count data, July and August 2005.

8 PHOTO POINTS

A total of 26 photo points were established along the Resurrection Creek project reach during the summer of 2005. Photos were taken with a Canon Powershot A520 digital camera, at the maximum field of view. Six of these photo points (photo points 4, 5, 6, 9, 24, and 25) clearly demonstrate changes that occurred on the reach restored during the 2005 season (**figure 28-34**). Locations of all photo points and reference photos from all photo points are compiled in **figure 38** and **figure 39**, in Appendix C.

Figure 28: Locations of selected photo points on Resurrection Creek (2005 photo).

Photo Point #4: This photo point shows the lower part of Meander #3, as seen from the Resurrection Pass Trail (**figure 29**). Photos show old tailings piles, the channel diversion, creation of a side channel pond, and creation of a logjam.

5/10/05

6/2/05

6/15/05

6/29/05

Figure 29: Sequence of photos from Photo Point #4.

Photo Point #5: This photo point shows the creation of Meander #2, as seen from the Resurrection Pass Trail (**figure 30**). Photo points show old tailings piles, the channel diversion, floodplain smoothing and side channel creation, and logjam creation.

5/10/05

5/25/05

5/31/05

6/28/05

Figure 30: Sequence of photos from Photo Point #5.

Photo Point #6: This photo point shows the lower portion of Meander #2, as seen from the Resurrection Pass Trail (**figure 31**). Photos show old tailings piles, the channel diversion, and creation of the side channel pond.

5/10/05

5/25/05

6/2/05

6/28/05

Figure 31: Sequence of photos from Photo Point #6.

Photo Point #9: This photo sequence shows an upstream view of the old Palmer Creek confluence, as seen from above the east-side road (**figure 32**). Photos show construction of the Palmer Creek fill and creation of two small rapids and pools in the channel.

5/10/05

7/9/05

7/21/05

Figure 32: Sequence of photos from Photo Point #9.

Photo Point #24: This sequence of photos shows the construction of Meander #5, as seen from the right side of the channel (**figure 33**). Photos show the channel diversion, creation of the riffle, and smoothing of the floodplain.

7/5/05

7/7/05

7/9/05

7/11/05

7/21/05

Figure 33: Sequence of photos from Photo Point #24.

Photo Point #25: This sequence of photos shows the construction of Meander #5, as seen from the downstream end of the meander (**figure 34**). Photos show the creation of the riffle, the channel diversion, and smoothing of the floodplain.

7/09/05

7/11/05

7/11/05

7/11/05

7/21/05

Figure 34: Sequence of photos from Photo Point #25.

9 DISCUSSION

Channel type: The Resurrection Creek 2005 project reach can be classified as a C4 channel (Rosgen, 1996). Entrenchment ratios are generally about 6, the width-to-depth ratio in the riffles is about 33, the sinuosity is 1.3, the average water surface slope is 1.4%, and the average substrate is gravel. These channel types can have naturally high rates of lateral channel migration as a result of bank erosion on the cut banks and sediment deposition of the point bars. Erosion can be controlled by riparian vegetation, and large woody debris plays an important role in controlling channel morphology.

Restoration objectives: At this point in the project, with channel restoration nearly complete for about 75% of the length of the project reach, many of the morphologic objectives of the project (see Chapter 1 - Introduction) have been accomplished or nearly accomplished in the reach restored in 2005.

- Entrenchment ratios have increased from about 1 to greater than 5.
- The average water surface slope was decreased from 1.7% to 1.4%.
- Sinuosity was increased from 1.1 to 1.3.
- Channel length was increased by about 700 feet (19% increase).
- Large, habitat-forming pools were constructed on the outside of each bend, for a pool frequency of 15 pools per mile.
- Side channels were constructed at nearly every meander.
- Although the amount of instream wood was not quantified, large logjams at each meander bend provide geomorphic benefits as well as abundant cover for fish.
- Spawning gravel at the pool tails was increased substantially from pre-project conditions. The aerial extent of glides, where spawning gravel can potentially accumulate, has increased to about 22,500 square feet (2500 square yards), but the amount of spawning gravel has not been measured.

Potential maintenance areas: Based on the monitoring data collected in 2005, the following areas have potential instability as a result of a variety of factors. These areas should be monitored closely in the future.

- The berm on the outside of the bend at Meander 2, separating the main channel from the west side channel pond, is relatively narrow (**figure 35**). Although it is reinforced by boulders, high shear stresses along this berm during high flows can cause bank erosion. High flows would not pour over this berm because the water surface elevation of the pond would be equal to that of the channel. However, any erosion of the berm may damage the integrity of the berm until it becomes stabilized by vegetation.

Figure 35: Berm on outside bend of Meander 2.

- The lower ends of the riffles at Meander 2 and Meander 5 are very steep (**figure 36**). High energy flows in these locations have the potential to move enough sediment so that headcutting may occur in these locations. Headcutting and downcutting of the channel at each of these riffles would potentially alter the inlets of the side channels just upstream. These areas should be closely monitored in 2006 and possibly reinforced.

Figure 36: Lower end of riffle at Meander 5 (top), and lower end of riffle at Meander 2 (left).

- Meander 5 is a very tight bend, and the meander wavelength is short for the size of the channel. The left bank at the downstream portion of Meander 5 is fairly well protected by the steep hillside and terrace on the left, which includes a large pile of boulders. However, erosion may potentially occur on the floodplain area on the left bank point bar in the middle of the meander, or on the right bank point bar at the downstream end of the meander, possibly leading to a meander cutoff or realignment at some point in the future.

Future restoration: Based on the results of monitoring in 2005, the following issues should be considered during completion of the stream restoration work on the Resurrection Creek project reach in 2006:

- Bankfull elevations should be identified on the ground and constructed as the point of incipient flooding. Bankfull elevations can be refined during the shaping of the floodplain. In some cases, particularly on the insides of meander bends, the river will develop a floodplain up to the bankfull elevation.
- Based on initial observations of potential headcutting at over-steepened ends of riffles, the transition areas from riffle to pool should be further reinforced with large boulders, and the slope of the riffle terminus should be decreased.
- The best fish habitat and the largest numbers of fish were seen in deep pools with logjams where they lead into uniform, well-developed glides. In these locations, slow water habitat, well sorted gravel, and the abundant cover provided by the logjams attracted numerous fish.
- Variability in channel widths and depths provide more channel complexity, leading to improved fish habitat and flow hydraulics.

Future monitoring: Monitoring will continue during the second phase of channel restoration in 2006, and additional monitoring will continue in the years following restoration. Monitoring in 2006 will include the following:

- Monitor streamflows visually using a staff gauge.
- Monitor existing cross sections to determine how morphology has changed as the result of one cycle of the hydrograph, and get a better estimate of bankfull elevation.
- Establish 4 to 6 additional cross sections in the reach restored in 2005, and establish 6 to 8 new cross sections in the reach to be restored in 2006 upstream of Palmer Creek. These cross sections are important for baseline data and to monitor the results of the 2006 restoration.
- Monitor side channel morphology, in particular the infilling of sediment in the side channel ponds. Establish 5 to 10 permanent cross sections on the side channels and side channel ponds constructed in 2005 and 2006.
- Monitor flow volumes through the side channels to determine the effectiveness of the inlet structures in regulating flows and the potential for perennial flow.
- Characterize substrate more extensively in the reach, and repeat the measurements from 2005 in the riffles and glides to determine how the substrate maintains itself.
- Monitor areas of potential headcutting at the terminus of each riffle.
- Aaron Martin (University of Alaska Fairbanks) will continue to conduct fish counts as a part of the marine-derived nutrients study.
- Monitor the growth of vegetation on the floodplains and banks.
- Set up additional photo points and continue photo point monitoring.

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APPENDIX A: CHANNEL MORPHOLOGY DATA

Cross Sections: All cross sections surveyed on Resurrection Creek in 2005 are permanently marked with blue-capped rebar pins, and the locations of each cross section are shown in **figure 5**. All measurements are in feet, and elevations are linked to known elevations (**table 2**). Bankfull elevations were estimated using the Manning's equation with a known slope, bankfull discharge, and an estimated *n* value. Bankfull elevations are generally about 1.6 feet over the surveyed low-flow water surface elevation.

Table 2: Cross section data for Resurrection Creek 2005 surveys.

Cross Section 8+90 (Riffle): Surveyed 8/10/05			
Station	FS	Elevation	Notes
0	7.89	400.64	LPT
0	8.25	400.28	LPB
4	8.14	400.39	Berm
8	8.28	400.25	Berm
10	7.89	400.64	Berm - hight point
12	8.08	400.45	Edge of berm
15	9.26	399.27	LB (cobbles)
16	0	398.9	BKF - Estimated BKF
17	10.08	398.45	LB (cobbles)
18.6	11.25	397.28	LEW
20.5	12.18	396.35	Channel
23	14.19	394.34	TWG
30	14	394.53	Channel
34	13.22	395.31	Channel
38	13.02	395.51	Channel
42	12.83	395.7	Channel
46	12.6	395.93	Channel
50	12.56	395.97	Channel
54	12.53	396	Channel
57	12.31	396.22	Channel
58	11.45	397.08	Rock Bar
61	11.9	396.63	Channel
64	11.49	397.04	Channel
68	11.34	397.19	REW
70	10.87	397.66	Gravel Bar
74	10.58	397.95	Gravel Bar
78	10.33	398.2	Gravel Bar
84	9.9	398.63	Gravel Bar
90	9.63	398.9	Gravel Bar
96	8.84	399.69	Edge of soil (July'05)
100	8.14	400.39	Floodplain
106	7.15	401.38	Floodplain
112	6.29	402.24	Floodplain
118	5.99	402.54	Floodplain
123.2	5.55	402.98	RPB
123.2	5.1	403.43	RPT

Cross Section 12+40 (Glide): Surveyed 8/10/05			
Station	FS	Elevation	Notes
0	1.04	406.58	LPT
0	1.38	406.24	LPB
4	1.44	406.18	Floodplain with soil
8	1.2	406.42	Floodplain with soil
12	1.65	405.97	Floodplain with soil
17	2.38	405.24	Edge of spread soil
20	3.27	404.35	Cobbles
22.5	0	403.85	BKF - estimated
24	4.08	403.54	LB (gravel/cobble)
28	4.8	402.82	LB (gravel/cobble)
30	5.45	402.17	LEW
33	6.77	400.85	channel
36	8.35	399.27	channel
39	8.44	399.18	channel
42	8.33	399.29	channel
46	8.01	399.61	channel
50	8.13	399.49	channel
54	8.3	399.32	channel
57	7.11	400.51	channel
60	8.47	399.15	TWG
63	8.31	399.31	Channel
66	8.46	399.16	Channel
70	8.48	399.14	Channel
74	8.3	399.32	Channel
75.5	6.61	401.01	Boulder
78.5	7.33	400.29	Boulder
80	5.87	401.75	Boulder
83	6.9	400.72	channel
85	6.21	401.41	channel
85	5.32	402.3	REW (on boulders)
88	2.73	404.89	Top of boulder
89	4.86	402.76	RB
92	3.34	404.28	RB
96	2.23	405.39	Edge of soil
100	1.14	406.48	Floodplain
105	0.86	406.76	Floodplain
108.8	1.17	406.45	RPB
108.8	0.62	407	RPT

Cross Section 12+73 (Pool): Surveyed 10/14/05			
Station	**FS**	**Elevation**	**Notes**
0	8.52	406.89	XS 12+73 LPT
0	9.29	406.12	LPB
8	9.11	406.3	Floodplain
12	8.76	406.65	Floodplain
16	8.61	406.8	Floodplain
20	8.17	407.24	Floodplain
23	6.99	408.42	Floodplain
26	9.91	405.5	LB (at pipe)
30	10.76	404.65	LB
33.8	0	403.75	Estimated BKF
34	11.73	403.68	LB
37.5	13.27	402.14	LEW
39	14.42	400.99	Channel
43	16.67	398.74	Channel
47	16.77	398.64	Channel
50	16.72	398.69	Channel
54	16.67	398.74	Channel
58	16.27	399.14	Channel
62	16.77	398.64	Channel
66	15.57	399.84	Channel - on large boulder
70	17.97	397.44	Channel
72	18.37	397.04	Channel
78	18.47	396.94	Channel
82	18.97	396.44	Channel
86	18.87	396.54	Channel
91	19.07	396.34	Channel
95	18.87	396.54	Channel
98	18.97	396.44	Channel
101	18.62	396.79	Channel
105	15.17	400.24	Channel - on large boulder
106.5	16.27	399.14	Channel
108	15.45	399.96	Channel
111	14.35	401.06	Pool, between logs
115	13.27	402.14	REW - under log jam
116.7	13.19	402.22	RB - under log jam
118	11.99	403.42	RB - under log jam
122	10.4	405.01	TRB - cobbles
126	10.64	404.77	RB - btw channel and side channel
130	10.96	404.45	RB - btw channel and side channel
135	11.67	403.74	RB - btw channel and side channel
138	12.29	403.12	RB - btw channel and side channel
142	13.46	401.95	LEW of side channel (Crosses obliquely)
144	13.96	401.45	Side channel
147	14.49	400.92	Side channel
149	14.26	401.15	Side channel
151.5	13.46	401.95	REW of side channel
154	11.78	403.63	RB of side channel
160	10.03	405.38	RB of side channel
166.5	8.26	407.15	Berm on left side of lower road
172	9.67	405.74	Left edge of road
190	10.09	405.32	Right edge of road
197	9.58	405.83	Slope btw upper and lower roads
201.7	7.79	407.62	RPB
201.7	7.31	408.1	RPT

Cross Section 14+82 (Riffle): Surveyed 8/19/05			
Station	**FS**	**Elevation**	**Notes**
3	2.7	409.14	LPT
3	3.14	408.7	LPB
7	3.07	408.77	Floodplain
11	2.81	409.03	Floodplain
16	3.13	408.71	Floodplain
20	3.55	408.29	Floodplain
25	3.45	408.39	Floodplain
30	3.5	408.34	Floodplain
35	3.9	407.94	Floodplain
40	3.74	408.1	Floodplain
44	4.22	407.62	Edge of soil
48	4.44	407.4	LB
51	0	407.05	BKF - estimated
52	5.01	406.83	LB
56	5.46	406.38	LB
59	5.82	406.02	LB
59.8	6.44	405.4	LEW
62	6.69	405.15	Channel
65	7.14	404.7	Channel
67.5	7.08	404.76	Channel
70	7.3	404.54	Channel
73	7.54	404.3	Channel
76	7.5	404.34	Channel
78	8.24	403.6	Channel
80	8	403.84	Channel
82	8	403.84	Channel
84	7.94	403.9	Channel
87	8.24	403.6	Channel (main current)
90	8.06	403.78	Channel
92	8.49	403.35	TWG
94	8.37	403.47	Channel
96	8.37	403.47	Channel
98	7.75	404.09	Channel
101	8.03	403.81	Channel
104	8.07	403.77	Channel
107	7.43	404.41	Channel
110	7.32	404.52	Eddy
112	7.08	404.76	Eddy
115	6.72	405.12	REW
117	6.01	405.83	RB
120	5.43	406.41	RB
125	4.91	406.93	RB
126	0	407.05	BKF - estimated
130	4.43	407.41	RB
135	3.87	407.97	RB
138	3.35	408.49	Edge of soil
143	2.69	409.15	Floodplain
148	2.16	409.68	Floodplain
153	1.85	409.99	Floodplain
158	1.65	410.19	Floodplain
165	1.3	410.54	RPB
165	0.85	410.99	RPT

Cross Section 15+38 (Glide): Surveyed 8/19/05			
Station	FS	Elevation	Notes
2.1	2.45	410.39	LPT
2.1	2.9	409.94	LPB
5	3.28	409.56	Boulder
7.2	4.38	408.46	Under logs
7.6	0	408.3	BKF - estimated
11	6.11	406.73	LEW (under logs)
13	6.8	406.04	Channel
15	9.61	403.23	Pool
16	9.67	403.17	TWG (pool)
18	9.3	403.54	Pool
20	9.1	403.74	Pool
22	8.7	404.14	Pool
25	8.08	404.76	Pool
28	7.83	405.01	Channel (in current)
30	8.2	404.64	Channel
33	8.08	404.76	Channel
34.8	8.34	404.5	Channel
37	7.88	404.96	Channel
40	7.95	404.89	Channel
44	7.9	404.94	Channel
48	7.97	404.87	Channel
51	8.18	404.66	Channel
54	8.07	404.77	Channel
58	7.99	404.85	Channel
62	7.83	405.01	Channel
66	7.47	405.37	Channel
69	7.45	405.39	Channel
71	6.93	405.91	Channel
74.5	6.51	406.33	Channel
76	6.23	406.61	REW
78	5.62	407.22	RB
82	4.98	407.86	RB
86	4.5	408.34	RB
93	4.53	408.31	Edge of soil/est bkf
97	4.3	408.54	Floodplain
101	3.4	409.44	Floodplain
107	2.93	409.91	Floodplain
113	3.26	409.58	Floodplain
120	3.25	409.59	Floodplain
126	2.36	410.48	Floodplain
134	2.19	410.65	Floodplain
139	1.9	410.94	Floodplain
142.7	1.8	411.04	RPB
142.7	1.45	411.39	RPT

Cross Section 15+76 (Pool): Surveyed 10/14/05			
Station	FS	Elevation	Notes
1.4	7.66	411.5	LPT
1.4	8.01	411.15	LPB
7	7.9	411.26	Terrace, under logs
13	0	408.4	Estimated BKF
14.3	11.35	407.81	LB, under logs
16.4	11.95	407.21	LB, under logs
17	12.35	406.81	LEW
25	14.58	404.58	Channel - pool under logs
28	18.7	400.46	Channel - pool under logs
32	18.75	400.41	Channel - pool under logs
35	18.35	400.81	Pool - at end of root wad
38	18.1	401.06	Channel - in current
42	17.6	401.56	Channel - in current
44	17.75	401.41	Channel - in current
48	17	402.16	Channel - in current
53	15.7	403.46	Channel - in current
57	15.2	403.96	Channel - in current
61	14.93	404.23	Channel - in current
64	14.38	404.78	Channel - in current
68	14.27	404.89	Channel - in current
72	14.21	404.95	Channel - in current
76	14.12	405.04	Channel - in current
80	14.06	405.1	Channel - in current
84	13.9	405.26	Channel - in current
88	13.48	405.68	Channel - in current
92	13.38	405.78	Channel - in current
96	13.3	405.86	Channel - in current
100	13.02	406.14	Channel - in current
105	12.31	406.85	REW
109	11.85	407.31	G-bar
112	11.52	407.64	G-bar
116	11.18	407.98	G-bar
121	10.74	408.42	Edge of soil (July'05)/Est BKF
128	10.14	409.02	Floodplain
138	9.62	409.54	Floodplain
148	9.27	409.89	Floodplain
158	9	410.16	Floodplain
168	9.17	409.99	Floodplain
178	8.13	411.03	Floodplain
188	7.59	411.57	Floodplain
198	7.34	411.82	Floodplain
208	7.21	411.95	Floodplain
219	6.62	412.54	Floodplain
224.2	6.71	412.45	RPB
224.2	6.35	412.81	RPT

Cross Section 18+35 (Run): Surveyed 10/14/05			
Station	FS	Elevation	Notes
1	6.09	413.07	LPT
1	6.51	412.65	LPB
4	7.8	411.36	LB Slope
7	9.6	409.56	LB Slope
9	10.19	408.97	LB - under log jam
12	9.85	409.31	LB - under log jam
15	10.57	408.59	LB - under log jam
15.5	0	408.45	Estimated BKF
17.5	11.9	407.26	LB
19	12.27	406.89	LEW
22	13.18	405.98	Channel (eddy)
26	14.79	404.37	Channel (eddy)
28	15.03	404.13	Channel (eddy)
31	15.45	403.71	Channel (eddy)
34	16.03	403.13	Channel (eddy)
39	16.5	402.66	Channel (current)
42	16.7	402.46	Channel (current)
47	16.4	402.76	Channel (current)
51	15.8	403.36	Channel (current)
57	15.6	403.56	Channel (current)
59	15.19	403.97	Channel (eddy)
62	14.85	404.31	Channel (eddy)
65	14.5	404.66	Channel (eddy)
68	13.28	405.88	Channel (eddy)
71	13.25	405.91	Channel (eddy)
74.2	12.33	406.83	REW
76	11.57	407.59	G-bar
80	10.95	408.21	G-bar
84	10.93	408.23	G-bar
88	10.84	408.32	G-bar
92	10.46	408.7	G-bar
96	10.36	408.8	G-bar
100	10.25	408.91	G-bar
105	9.89	409.27	Edge of soil (July'05)
110	9.71	409.45	Floodplain
115	9.53	409.63	Floodplain
120	9.14	410.02	Floodplain
126	8.46	410.7	Floodplain
132	8.11	411.05	Floodplain
136	7.87	411.29	Floodplain
142	7.63	411.53	Floodplain
150	7.24	411.92	Floodplain
156	6.57	412.59	On slash/organics
162	6.91	412.25	On slash/organics
165.6	6.74	412.42	RPB
165.6	6.35	412.81	RPT

Cross Section 24+97 (Pool): Surveyed 10/14/05			
Station	FS	Elevation	Notes
1	5.57	423.65	LPT
1	5.8	423.42	LPB
4.5	6.43	422.79	Terrace/top of log jam
7	6.37	422.85	Terrace/top of log jam
11	6.48	422.74	Edge of terrace
14	9.04	420.18	LB
14.1	0	419.9	Estimated BKF
14.6	10.71	418.51	BLB
15.4	10.88	418.34	LEW
19	14.33	414.89	Channel
22	15.62	413.6	Channel
26	16.18	413.04	Channel
29	16.28	412.94	Channel
36	16.28	412.94	Channel
39	16.48	412.74	Channel
45	16.03	413.19	Channel
50	15.58	413.64	Channel
54	15.08	414.14	Channel
58	14.23	414.99	Channel
62	13.48	415.74	Channel
66	13.2	416.02	Channel
70	12.53	416.69	Channel
74	12.3	416.92	Channel
79	11.95	417.27	Channel
84	11.43	417.79	Channel
86	11.73	417.49	Channel
88	11.15	418.07	Channel
91	11.22	418	Channel
92.4	10.9	418.32	REW
96	10.59	418.63	G-bar
99	10.1	419.12	G-bar
102	9.3	419.92	G-bar with log
106	9.88	419.34	G-bar
110	9.85	419.37	G-bar
113	10.13	419.09	G-bar
117	10.22	419	G-bar
121	10.51	418.71	LEW of small off-channel pond
125	11.12	418.1	Small off-channel pond
129	11.14	418.08	Small off-channel pond
131	10.51	418.71	REW of small off channel pond
135	9.89	419.33	BRB
138.7	9.18	420.04	RB
143	5.98	423.24	TRB
149	5.41	423.81	Floodplain
152.6	5.28	423.94	RPB
152.6	5.01	424.21	RPT

Cross Section 30+96 (Pool): Surveyed 10/13/05			
Station	FS	Elevation	Notes
4	6.39	429.82	LPT
4	6.78	429.43	LPB
8	7.45	428.76	Fldpln-gravel/cobble/slash
12	7.81	428.4	Fldpln-gravel/cobble/slash
16	8.34	427.87	Fldpln-gravel/cobble/slash
20	8.89	427.32	Fldpln-gravel/cobble/slash
24	9.68	426.53	Fldpln-gravel/cobble/slash
28	10.92	425.29	Fldpln-gravel/cobble/slash
32	11.99	424.22	Fldpln-gravel/cobble/slash
33.5	0	423.65	Estimated BKFelevation
36	13.29	422.92	Fldpln-gravel/cobble/slash
38.7	14.15	422.06	LEW
43	14.58	421.63	Channel (clay pocket)
47	15.6	420.61	Channel
50	15.14	421.07	Channel - deposit of sm gravel
54	15.34	420.87	Channel - deposit of sm gravel
58	15.3	420.91	Channel - deposit of sm gravel
63	16.06	420.15	Channel - deposit of sm gravel
67	16.97	419.24	Channel - main current
72	17.47	418.74	Channel - main current
76	17.45	418.76	Channel - main current
82	18.15	418.06	Channel - main current
86	18.45	417.76	Channel - main current
90	18.4	417.81	Channel - main current
95	18.35	417.86	Channel - main current
99	17.95	418.26	Channel - main current
102	17.5	418.71	Channel - eddy by log jam
106	15.67	420.54	Channel - eddy by log jam
109	15.03	421.18	Channel - eddy by log jam
111	14.13	422.08	REW (under logs)
114.7	11.9	424.31	RB (on boulder, btw logs)
117	12.07	424.14	RB (btw logs)
119.4	11.02	425.19	RB (btw logs)
123	11.37	424.84	RB (btw logs)
126.7	6.15	430.06	Top of right bank (terrace)
131	6.16	430.05	Top of right bank (terrace)
132.7	6.25	429.96	RPB - on terrace
132.7	6.09	430.12	RPT - on terrace

Cross Section 40+30 (Pool): Surveyed 10/13/05			
Station	FS	Elevation	Notes
2.6	11.14	440.91	LPT - on floodplain
2.6	11.54	440.51	LPB - on floodplain
7	11.59	440.46	Floodplain (with soil)
12	11.74	440.31	Floodplain (with soil)
17	11.27	440.78	Floodplain (with soil)
22	11.37	440.68	Floodplain (with soil)
27	11.76	440.29	Floodplain (with soil)
32	11.86	440.19	Floodplain (with soil)
37	11.85	440.2	Floodplain (with soil)
42	12.55	439.5	Floodplain - edge of soil
47	13	439.05	LB
52	12.35	439.7	LB
53	0	438.85	Estimated BKF
54	13.71	438.34	LB
56.6	14.85	437.2	LEW
61	16.07	435.98	Channel
65	15.83	436.22	Channel
71	15.78	436.27	Channel
75	16.25	435.8	Channel
80	16.63	435.42	Channel
84	17.04	435.01	Channel
89	17.26	434.79	Channel
94	18.65	433.4	Channel
98	19.45	432.6	Channel
101	20.35	431.7	Channel
104	20.05	432	Channel
108	19.5	432.55	Channel
112	19.3	432.75	Channel
116	18.85	433.2	Channel - eddy
120	17.28	434.77	Channel - eddy
124	17.28	434.77	Channel - eddy
128	17.2	434.85	Channel - eddy
134	16.15	435.9	Edge of main channel
138	16	436.05	side channel, under logs
142.8	15.79	436.26	side channel, under logs
145	14.75	437.3	REW (of side channel)
150	13.8	438.25	RB - under logs
154	13.45	438.6	RB - under logs
158	11.69	440.36	RB - under logs
163	11.18	440.87	RB - under logs
168	10.62	441.43	Terrace
172	9.97	442.08	Terrace
175.3	9.84	442.21	RPB
175.3	9.51	442.54	RPT

Cross Section 42+60 (Pool): Surveyed 10/13/05			
Station	**FS**	**Elevation**	**Notes**
3.1	5.44	448.24	LPT, on terrace
3.1	5.93	447.75	LPB, on terrace
6	6.16	447.52	Terrace (with soil)
10	6.43	447.25	Terrace (with soil)
14	6.6	447.08	Terrace (with soil)
16.8	6.47	447.21	Edge of terrace/soil
20	9.01	444.67	Boulders
23	8.38	445.3	Boulders
24.9	0	442.9	Estimated BKF
25	11.01	442.67	Boulders
27	11.76	441.92	Boulders
29	12.35	441.33	LEW
32	15.05	438.63	Channel
36	17.9	435.78	Channel
38	17.05	436.63	Channel
42	19.35	434.33	Channel
46	18.85	434.83	Channel
50	18.65	435.03	Channel
54	18.25	435.43	Channel
58	17.75	435.93	Channel
62	17.35	436.33	Channel
66	17.05	436.63	Channel
70	16.3	437.38	Channel
74	15.25	438.43	Channel
78	14.62	439.06	Channel
81	14.4	439.28	Channel
83	13.55	440.13	Channel
86	13.65	440.03	Channel
89	13.54	440.14	Channel
92	13.36	440.32	Channel
95	13.11	440.57	Channel
98	13.05	440.63	Channel
100	13.09	440.59	Channel
102	12.88	440.8	Channel
105	12.89	440.79	Channel
107.4	12.39	441.29	REW
110	12.14	441.54	RB
113	11.45	442.23	RB
116	11.14	442.54	RB
119	10.08	443.6	RB
122	9.4	444.28	RB (cobbles, no soil)
126	8.87	444.81	RB (cobbles, no soil)
130	8.05	445.63	RB (cobbles, no soil)
134	7.7	445.98	RB (cobbles, no soil)
138	7.42	446.26	RB (cobbles, no soil)
142	7.07	446.61	RB (cobbles, no soil)
146	5.15	448.53	Rock berm at edge of spruce
150	5.51	448.17	Rock berm at edge of spruce
152.7	5.93	447.75	LPB, slightly in spruce woods
152.7	5.46	448.22	LPT, slightly in spruce woods

Longitudinal Profile: Distances were measured along the left bank, and wooden stakes were placed every 100 feet along the left bank (**figure 37**). A graph of the longitudinal profile is shown in **figure 5**. All measurements are in feet, and elevations are linked to known elevations (**table 3**).

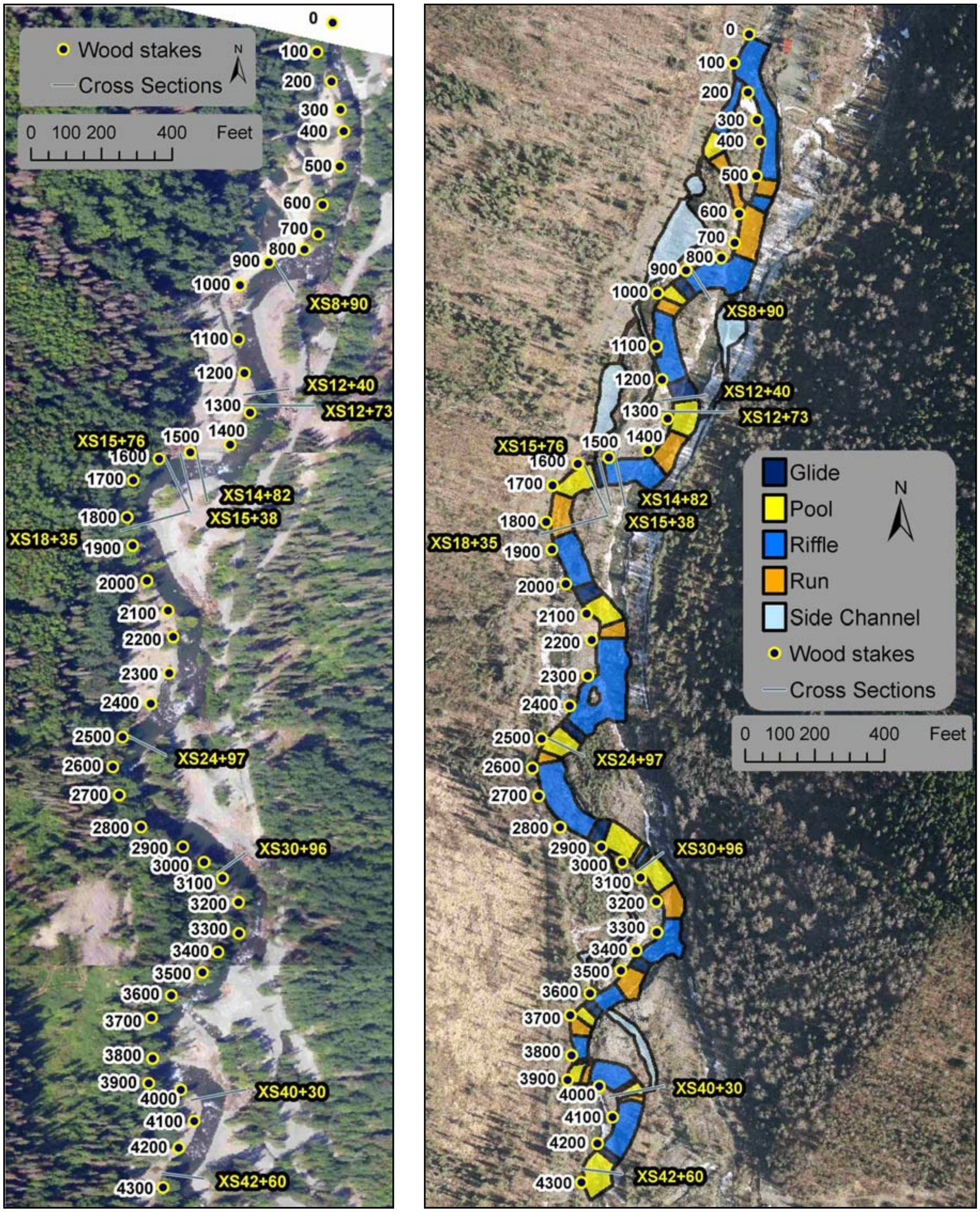


Figure 37: Locations of wooden stakes and cross sections in the Resurrection Creek project reach on the 2005 image (left) and 2002 image with bedforms shown (right).

Table 3: Longitudinal Profile data for 2005 survey of the Resurrection Creek post-restoration project reach.

Resurrection Creek Longitudinal Profile - 2005 Project Reach - Surveyed 9/2/2005							
Distance	Channel	Water Surface	Side Ch - Channel	Side Ch-Wtr Surf	Pin	Bank	Notes
-4272	436.14	441.14					Mid pool, at Palmer Cr confluence
-4188	439.24	440.84				443.84	Start riffle / TLB
-4110	437.03	438.93					Mid riffle
-4042	436.2	437.6					Start run (pool tail)
-4033	433.58	437.08					Start pool (on outside corner)
-4021	433.07	437.07					Start glide
-4012	435.51	437.05					Start riffle
-3964	434	436.2					Mid riffle (start steep part)
-3948	431.5	433.5					Start run
-3900	431.18	433.48					Start pool
-3815	430.78	433.48					Start glide
-3800	431.1	433.1					Start riffle (cross vein top)
-3715	429.33	431.23					Start Run
-3676	428.78	431.22					Start Pool
-3600	426.7	431.2					Start glide
-3590	429.41	430.91					Top of rapid
-3580			434.15	435.35			100 ft up side channel (top of steps)
-3575			428.93	430.13			End of side channel (WS= main ch)
-3570		430.13					Main ch confluence w side ch
-3510	426.4	428.3					Start run (no pool)
-3460	425.76	427.96					Start glide
-3415	426.32	427.92					Start riffle
-3300	422.11	424.11					Old Palmer Cr confluence - sm pocket pool/eddy on right
-3280	422.58	424.08					Riffle continues
-3230	419.75	422.25					Start run
-3130	419.33	421.93					Start pool
-3075	417.93	421.93					Start glide
-3060	420.51	421.71					Start riffle (small)
-3015	419.57	421.37					Start run
-2970	419.05	421.35					Start pool
-2910	419.25	421.35					Start glide
-2890			420.75	421.35			Outlet of left side channel (at 2890)
-2850	419.3	421.3					Start riffle
-2733	418.21	420.51					Mid riffle
-2630	417.22	418.42					Riffle (pool head)
-2615	415.25	418.25					Start run
-2575	414.14	418.14					Start pool
-2462	414.44	418.14					Start glide
-2442	416.63	418.13					Start riffle (pool tail)
-2370	411.39	412.89					Start of pocket pool on RB in main (rt) channel - riffle continues
-2290	410.32	411.82					Mid-riffle
-2175	407.67	409.47					Start run
-2165					431.8		BM2: SRD3137 (across trail)
-2150	405.96	409.46					Start pool
-2100	405.95	409.45					Start glide

Distance	Channel	Water Surface	Side Ch - Channel	Side Ch-Wtr Surf	Pin	Bank	Notes
-2036	407.37	409.47					Start riffle
-1825	404.81	406.81					Start run
-1680	403.09	406.69			409.64		Start pool (at gauge stake) / gauge stake
-1556	402.94	406.64					Start glide
-1538					411.39		XS 15+38 (glide) / RPT
-1532	405.2	406.5					Start riffle
-1482					409.14		XS 14+82 (riffle) / LPT
-1415	399.58	402.58					The Jet riffle - top of RB pocket pool
-1385	399.6	402.3					Start run / end of RB pocket pool
-1350				403.74			WS of pond at meander 2/3
-1315	398.48	401.98					Start pool
-1254	399.01	401.91					Start glide
-1222	399.73	401.63					Start riffle
-1126	399.99	401.29		401.29			Mid-riffle / LB side ch entrance
-1050	397.85	399.05					Pool head rock structure at log jam
-1040	395.3	397.8					Start run - at log jam
-1000	394.46	397.66					Start pool (sm, left bank) - at lone spruce tree
-988	394.8	397.6					Start glide
-940	395.67	397.27				399.97	Start riffle / TLB - low pt in berm
-900				395.21			WS - LB side ch pond - 1/2 cfs flowing
-890		397.02			400.64		XS 8+90 (riffle) / LPT
-848	395.1	396.6					Start steep part of riffle
-800				398.65			WS of right SC pond
-780						397.93	Left SC - Upper pond berm outlet elev (no flow)
-750						399.22	Right SC outlet berm elev (no flow) - at 7+50
-745	391.83	393.33					Mid-riffle
-700				391.2			Left SC - Lower pond WS elev
-685	389.57	391.57					Start run (no pool)
-600						395.58	Left SC - Lower pond berm outlet elev (no flow)
-570				390.32			WS at left SC outlet where it meets left half-channel below
-565			389.8	391.3			Spawning channel entrance at 5+60
-560	388.9	391.3					Start boulder rapid (at channel split)
-510	387.57	389.37					Start run/ end rapid
-464	387.44	388.74					Start riffle
-270	384.47	386.47				386.41	Top of steeper riffle / Culvert entrance
-220			386.72	387.53			Top of grade control structure - spawning channel
-182	382.55	384.05					End of vegetated island/riffle - Side channel confluence
0	380.19	381.69			384.31		End of reach - top of steeper riffle / 0+00 stake
#				391.21			WS of pond by parking area
#						393.08	Low pt of road at entrance to parking area
#				403.69			WS of pond by parking area
#						405.56	Low pt of road at entrance to parking area

Substrate: Post-restoration pebble count data from 2005 are presented in **table 4**, and pre-restoration pebble count data from 2004 are presented in **table 5**.

Table 4: Resurrection Creek substrate data from 2005.

Resurrection Creek - 2005 Pebble Count Data - Post restoration monitoring 2005												
Size Class	**XS 8+90 (Riffle) 8/10/2005**			**XS 12+40 (Glide) 8/10/2005**			**XS 14+82 (Riffle) 8/19/2005**			**XS 15+38 (Glide) 8/19/2005**		
	Count	**%**	**Cum %**	**Count**	**%**	**Cum %**	**Count**	**%**	**Cum %**	**Count**	**%**	**Cum %**
0 - 0.062	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.062 - 0.125	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.125 - 0.25	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.25 - 0.5	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.5 - 1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
1 - 2	0	0.0	0.0	2	2.0	2.0	0	0.0	0.0	0	0.0	0.0
2 - 4	0	0.0	0.0	4	4.0	6.0	0	0.0	0.0	4	4.0	4.0
4 - 5.7	0	0.0	0.0	3	3.0	9.0	1	1.0	1.0	4	4.0	8.0
5.7 - 8	0	0.0	0.0	1	1.0	10.0	0	0.0	1.0	0	0.0	8.0
8 - 11.3	0	0.0	0.0	5	5.0	15.0	0	0.0	1.0	6	6.0	14.0
11.3 - 16	2	2.0	2.0	2	2.0	17.0	0	0.0	1.0	4	4.0	18.0
16 - 22.6	0	0.0	2.0	5	5.0	22.0	5	5.0	6.0	7	7.0	25.0
22.6 - 32	6	6.0	8.0	7	7.0	29.0	5	5.0	11.0	11	11.0	36.0
32 - 45	5	5.0	13.0	5	5.0	34.0	6	6.0	17.0	13	13.0	49.0
45 - 64	15	15.0	28.0	15	15.0	49.0	7	7.0	24.0	32	32.0	81.0
64 - 90	13	13.0	41.0	11	11.0	60.0	9	9.0	33.0	8	8.0	89.0
90 - 128	26	26.0	67.0	13	13.0	73.0	23	23.0	56.0	6	6.0	95.0
128 - 180	17	17.0	84.0	12	12.0	85.0	15	15.0	71.0	4	4.0	99.0
180 - 256	9	9.0	93.0	8	8.0	93.0	18	18.0	89.0	1	1.0	100.0
256 - 362	7	7.0	100.0	3	3.0	96.0	7	7.0	96.0	0	0.0	100.0
362 - 512	0	0.0	100.0	2	2.0	98.0	3	3.0	99.0	0	0.0	100.0
512 - 1024	0	0.0	100.0	2	2.0	100.0	1	1.0	100.0	0	0.0	100.0
1024 - 2048	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
2048 - 0	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
Total	100			100			100			100		

Table 5: Resurrection Creek substrate data collected in 2004.

Resurrection Creek - 2004 Pebble Count Data - Pre Restoration									
Size Class	**Total for Entire Project Reach 8/24/2004**			**Total for 2005 section of project reach 8/24/2004**			**Total for reference reach 8/23/2004**		
	Count	**%**	**Cum %**	**Count**	**%**	**Cum %**	**Count**	**%**	**Cum %**
0 - 0.062	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.062 - 0.125	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
0.125 - 0.25	2	0.2	0.2	0	0.0	0.0	0	0.0	0.0
0.25 - 0.5	2	0.2	0.5	0	0.0	0.0	5	1.2	1.2
0.5 - 1	5	0.6	1.1	3	0.7	0.7	8	2.0	3.2
1 - 2	8	1.0	2.1	3	0.7	1.5	6	1.5	4.7
2 - 4	11	1.3	3.4	5	1.2	2.7	7	1.7	6.4
4 - 5.7	6	0.7	4.1	5	1.2	4.0	3	0.7	7.2
5.7 - 8	10	1.2	5.3	5	1.2	5.2	3	0.7	7.9
8 - 11.3	4	0.5	5.8	2	0.5	5.7	6	1.5	9.4
11.3 - 16	4	0.5	6.3	2	0.5	6.2	4	1.0	10.4
16 - 22.6	20	2.4	8.7	9	2.2	8.4	7	1.7	12.1
22.6 - 32	28	3.4	12.1	6	1.5	9.9	13	3.2	15.3
32 - 45	47	5.7	17.8	17	4.2	14.1	23	5.7	21.0
45 - 64	73	8.8	26.6	29	7.2	21.3	47	11.6	32.6
64 - 90	105	12.7	39.4	43	10.6	31.9	52	12.8	45.4
90 - 128	103	12.5	51.8	57	14.1	46.0	83	20.5	65.9
128 - 180	116	14.0	65.9	54	13.4	59.4	63	15.6	81.5
180 - 256	119	14.4	80.3	59	14.6	74.0	47	11.6	93.1
256 - 362	83	10.1	90.3	52	12.9	86.9	23	5.7	98.8
362 - 512	46	5.6	95.9	34	8.4	95.3	4	1.0	99.8
512 - 1024	31	3.8	99.6	18	4.5	99.8	1	0.3	100.0
1024 - 2048	3	0.4	100.0	1	0.3	100.0	0	0.0	100.0
2048 - 0	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TOTAL	826			404			405		

APPENDIX B: FISH DATA

Table 6: Fish escapement data summary for Resurrection Creek, following restoration in 2005 (data collected by A. Martin et al.).

Total number of fish observations by date and reach						
Date	**Palmer Cr**	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Grand Total**
7/7/2005		3		44	4	51
7/15/2005	13	6	9	37	30	95
7/22/2005	4	5	13	125	183	330
7/28/2005	58	65	65	565	454	1207
8/5/2005						
8/12/2005	172	321	144	800	627	2064
8/19/2005	74	71	34	271	327	777
8/26/2005	7	3	5	69	50	134
Grand Total	328	474	270	1911	1675	4658

Total number of carcasses observed by date and reach						
Date	**PR1**	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Grand Total**
7/7/2005		0	0	0	0	0
7/15/2005	0	2	1	0	0	3
7/22/2005	0	0	3	0	0	3
7/28/2005	0	2	3	2	1	8
8/5/2005						
8/12/2005	1	26	7	11	6	51
8/19/2005	11	236	190	285	51	773
8/26/2005	17	217	356	242	143	975
Grand Total	29	483	560	540	201	1813

Total number of fish observations by date and species						
Date	**Chum**	**Chinook**	**Coho**	**Pink**	**Sockeye**	**Grand Total**
7/7/2005		50		1		51
7/15/2005		50		45		95
7/22/2005	12	26		292		330
7/28/2005	48	25		1129	5	1207
8/5/2005						
8/12/2005	62	2	42	1954	4	2064
8/19/2005	70		61	642	4	777
8/26/2005	26		71	32	5	134
Grand Total	218	153	174	4095	18	4658

Total number of carcasses by date and species				
Date	**Chum**	**Chinook**	**Pink**	**Grand Total**
7/7/2005				0
7/15/2005		3		3
7/22/2005		3		3
7/28/2005		8		8
8/5/2005				
8/12/2005	1	3	47	51
8/19/2005	25	7	741	773
8/26/2005	14	17	944	975
Grand Total	40	41	1732	1813

Total number of fish observed by species and reach (7/7/05 - 8/26/05)						
Species	**Reach 4**	**Reach 3**	**Reach 2**	**Palmer Cr**	**Reach 1**	**Grand Total**
Chum	157	56			5	218
Chinook	11	95	10	25	12	153
Coho	10	162	2			174
Pink	1493	1588	254	303	457	4095
Sockeye	4	10	4			18
Grand Total	1675	1911	270	328	474	4658

APPENDIX C: PHOTO POINTS

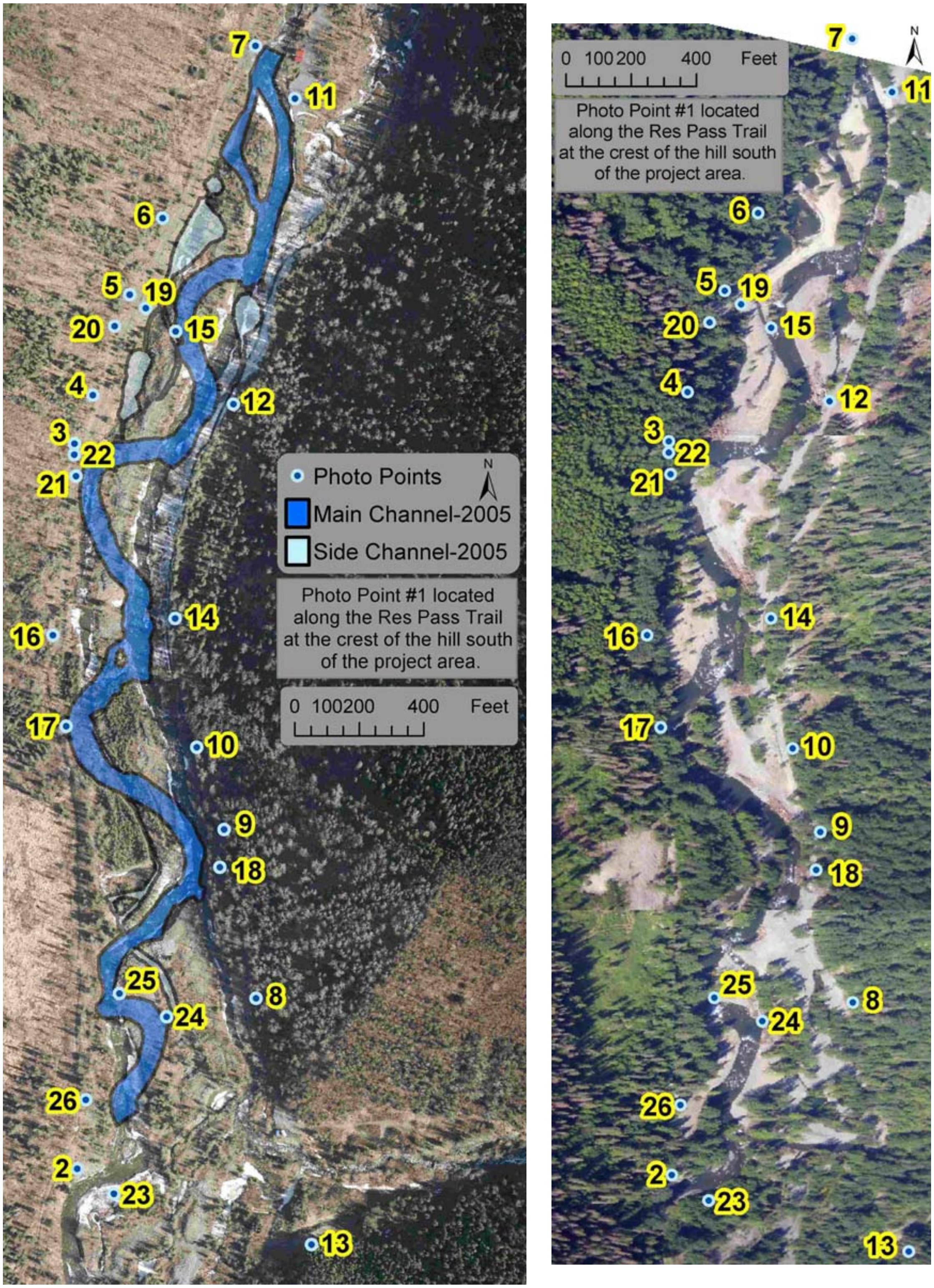
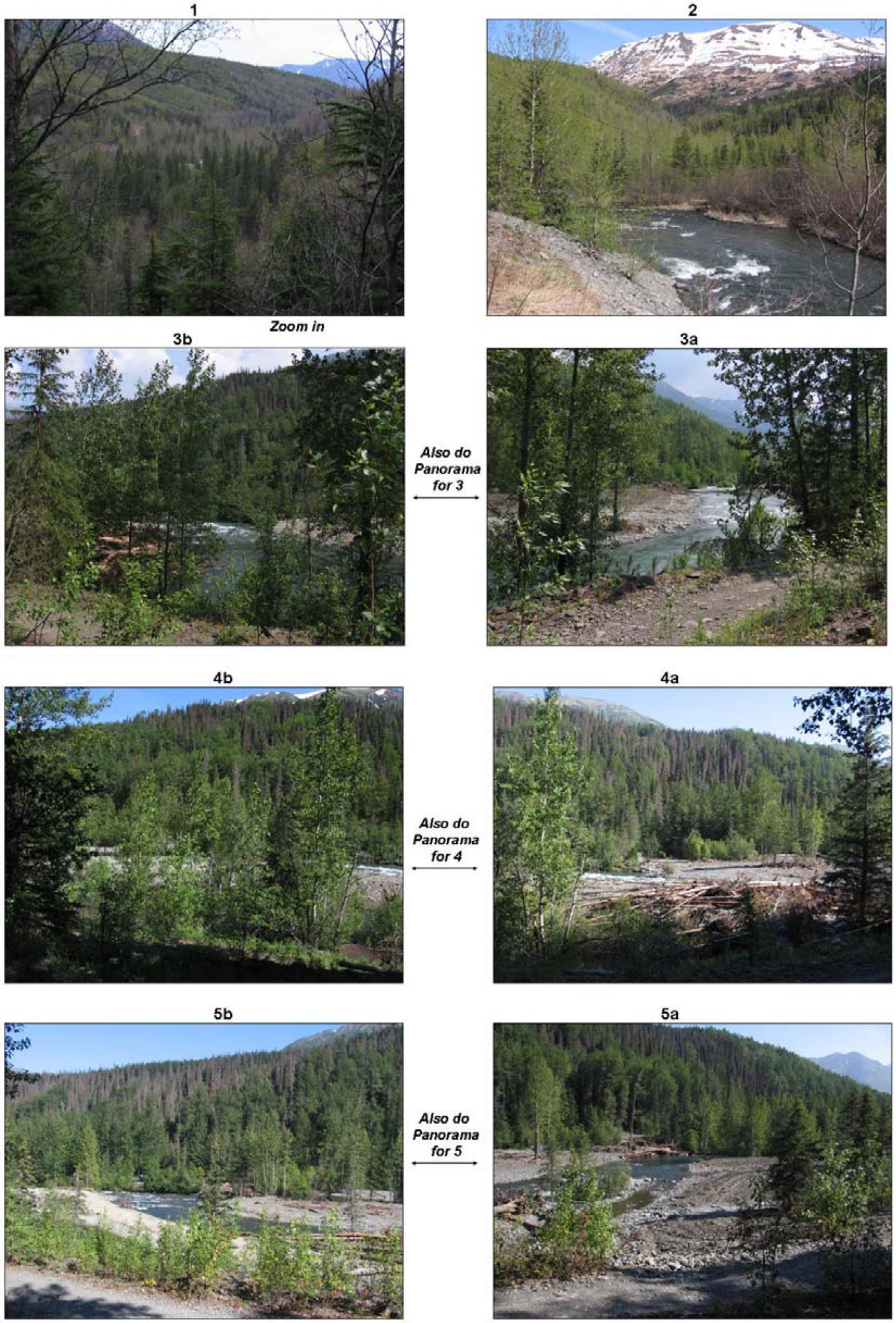


Figure 38: Resurrection Creek restoration photo points, established in 2005, on 2002 image (left) and 2005 image (right).

Resurrection Creek photo point location descriptions:

1. From top of hill ~¼ mile S of project area – overview from lookout point at crest of hill just off Res Pass Trail, view through gap in trees.
2. From high terrace E of Res Pass Trail, 6ft from edge of high eroding bank, view d/s at new Palmer Cr confluence.
3. From tailings pile 20ft W of Res Pass Trail, 2190ft u/s of Paystreke Bridge, at lower end of Meander 3 (3a, 3b, 3c, 3pan).
4. From tailings pile 20ft W of Res Pass Trail, 2040ft u/s of Paystreke Bridge, 150ft d/s of PP3, at Meander 2-3 (4a, 4b, 4pan).
5. From tailings pile 24ft W of Res Pass Trail, 1710ft u/s of Paystreke Bridge, 330ft d/s of PP4, at Meander 2 (5a, 5b, 5pan).
6. From tailings pile 20ft W of Res Pass Trail, 1440ft u/s of Paystreke Bridge, 270ft d/s of PP5, at Meander 1-2 (6a, 6b, 6c, 6pan).
7. From high bank 25ft E of Res Pass Trail, straight across from twin cabins, 840ft u/s of Paystreke Bridge, view upstream.
8. From east side of valley, at apex of clearing below small hollow along old Palmer Cr, 2610 ft u/s of USFS boundary (8a, 8b).
9. From steep hillslope 30ft east of east-side road, 2070 ft u/s of USFS boundary, 200ft d/s of old Palmer Cr confluence, view u/s.
10. From lower hillside 1800ft u/s of USFS boundary, 270ft d/s of PP9, Meander 4, btw upper and lower roads, view u/s.
11. From S end of Paystreke property, S of twin cabins, view u/s (11, 11pan).
12. From lower hillside, 600ft u/s of staging area, 15ft E of lower road, at SRD3144 BM, Meander 2-3 (12a, 12b, 12pan)
13. From steep hill SE of Palmer Cr, 12ft S of SRD3143 BM, on 6in-diam stump (13a, 13b).
14. From lower hillside between upper and lower roads, just downhill from SRD 3142 BM, 90ft upstream of connector rd, on 1.5ft-diam stump, Meander 3-4, view W.
15. From flat surface on upstream side of large pointy boulder at Meander 2 (15a-d/s, 15b-u/s, 15a-pan, 15b-pan).
16. From hillside just west of Res Pass Trail, 600ft u/s of PP3, through gap in trees at Meander 3-4, at SRD3137 BM, view E.
17. From cut bank on left bank of Meander 4 (17a-d/s, 17b-u/s).
18. From east-side road, 3ft E of road, 50ft d/s of old JD Hahn mining road, view d/s through gap in trees at Meander 4.
19. From bench just below Res Pass Trail, near side ch entrance of Meander 2, view u/s.
20. From tailings pile W of Res Pass Trail, view d/s over d/s half of Meander 2.
21. From high terrace just E of Res Pass Trail, at apex of Meander 3, view u/s through large gap in Cottonwoods.
22. From tailings pile W of Res Pass Trail, under Cottonwood grove, view straight across valley out over lower Meander 3 (22, 22pan to left).
23. From low floodplain on E side of Res Creek, 3ft from active channel, across from lg boulder in river, view d/s into Meander 5 through meander cutoff.
24. From logjam on right bank of Meander 5, on point of land between side channel entrance and main channel, at base of birch tree (24a, 24b, 24pan).
25. From point bar on right bank at d/s end of Meander 5, on boulder just right of first tree on point bar, by cross vein structure (25a, 25b, 25pan).
26. From hillside/tailings pile 30ft downslope (E) from Res Pass Trail at edge of cleared area, 30ft upvalley from edge of trees, view across river and d/s.

Figure 39: Photo point reference photos, taken on various dates in 2005, used to duplicate the field of view at all photo points established on the Resurrection Creek 2005 project reach. Locations of these photo points are shown in **figure 38**.



6c

6b

6a

Also do Panorama for 6

7

8a *(discontinued)*

8b

9

10

11

Also do Panorama for 11

12a

Also do Panorama for 12

12b

13a

13b

14

15a

15b

For 15a and 15b, start at this photo and also take panorama to the right

16

18

17a

17b

19

20

21

22

Also panorama to the left

23

24a

24b

← Also do Panorama for 24 →

25a

25b

26

← Also do Panorama for 25 →