The headwaters of the South Fork drain the Snoqualmie Pass area and the watershed boundary extends to the Cascade Crest. The watershed ranges in elevation from 6278 feet (1932 meters) on Snoqualmie Mountain down to 410 feet (125 meters) at the confluence with the Middle Fork Snoqualmie River. The South Fork has numerous, mostly high-gradient tributaries, including Denny Creek. Most of the ground surface in the South Fork basin is underlain by bedrock at shallow depth.

The upper valley of the South Fork was occupied and shaped by alpine glaciers, and it has the generally parabolic cross section typical of glaciated mountain valleys. The upper valley slopes are generally underlain by bedrock, and the valley floors by alpine glacial deposits and modern alluvium and colluvium. Near the Cascade Crest, the South Fork has a gradient of about 5 percent. Just above Twin Falls, the gradient has dropped to approximately 1 percent.

In its upper section, the South Fork Snoqualmie occupies a classic hanging valley. Twin Falls along with the steep channel sections above and below provide a vertical drop of approximately 600 feet (180 meters). Twin Falls marks the transition between topography sculpted by alpine glaciers upstream, and that created by erosion and deposition associated with the Puget lobe of the Cordilleran Ice Sheet below.

Below Twin Falls, the channel gradient decreases to 0.25 percent and natural valley confinement decreases dramatically. As a result, the river's ability to transport sediment is also dramatically decreased. The river deposits large volumes of sediment and begins to braid. Reid and Dunne (1996) report that the South Fork transports a mean annual bedload of 2600 tons (2400 metric tonnes), and that all of this sediment is deposited in the lower valley, upstream of the confluence with the mainstem. The floodplain in a broad area near the mouth of the South Fork shows remnants of numerous former channel locations (Figure 20), suggesting that the channel was highly mobile prior to human modification. An extensive levee system now constrains much of this channel's former mobility. Outside of this levee system, a significant area near the channel has been designated by King County as a channel migration hazard (Perkins, 1996).

6.1.4. Upper Mainstem

For the purposes of this report, the upper mainstem is the channel reach between the confluence of the Three Forks (river mile 45.0, river kilometer 72.4) and Snoqualmie Falls (river mile 40.3, river kilometer 64.8). This reach of channel is 3.4 miles (5.5 kilometers) long and flows through the City of Snoqualmie. Land use adjacent to this reach includes agriculture, scattered single-family residential housing, and higher density residential and commercial properties in the City of Snoqualmie.

The upper mainstem meanders through a broad, nearly level alluvial valley bottom originally known as the Salal Prairie. The character of this reach of river and of the surrounding alluvial fill is largely a result of the bed control provided by the bedrock shelf that forms Snoqualmie Falls.

The upper mainstem is a low-gradient channel with an average slope of 0.03 percent. Because of this low gradient, the channel moves almost no bedload through this reach. In marked contrast to the Three Forks area immediately upstream, the upper mainstem has no history and shows little evidence of active channel migration. This is also a reflection of its comparatively low-energy character, having neither competence to construct bars nor to erode banks. In the Montgomery and Buffington system, this reach of channel would be characterized as a dune-ripple channel. Kimball Creek is the largest tributary to the upper mainstem reach.

6.2. Snoqualmie Falls

Snoqualmie Falls is located on the Snoqualmie mainstem at river mile 40.3 (river kilometer 64.8). The Falls are 268 feet (82 meters) high, formed where the Snoqualmie River drops over a shelf of Tertiary volcanic rock. It is likely that, prior to the Vashon glacial advance, the Snoqualmie River flowed in a valley or canyon located south of its present location under the present Lake Alice Plateau. In the absence of the present bedrock control, the Snoqualmie River would presumably have a more continuous transition from alpine headwaters to the lower valley. The level alluvial valley now occupied by the Cities of Snoqualmie and North Bend would likely not exist, and the river would be located in a deep valley through this reach. The steeper gradient would have allowed bedload to move through this reach, filling and steepening the channel in the lower valley. In general, it is likely that, in the absence of Snoqualmie Falls, the overall character of the Snoqualmie Valley would be much more like that of the Skykomish Valley immediately to the north.

6.3. Lower Snoqualmie Watershed

6.3.1. Lower Mainstem

The lower mainstem of the Snoqualmie River extends from the base of Snoqualmie Falls at river mile 40.3 (river kilometer 64.8) downstream to the mouth of the Snoqualmie River. As shown on Figure 19, there has been extensive bank protection constructed on the lower Snoqualmie. A review of historical mapping revealed that the lower Snoqualmie showed relatively little evidence of channel movement, even prior to the construction of these armoring projects (Collins and Sheikh, 2002). These authors also evaluated the historical occurrence of LWD in the lower Snoqualmie. They concluded that LWD loadings were much higher under pristine conditions as compared with current conditions, but they also suggest that natural LWD loading in the Snoqualmie was lower than in some other Puget Lowland rivers. One possible explanation for this is the relatively low rate of channel migration in the lower valley. With less active channel migration, there would be less opportunity for trees in the riparian zone to be undermined by bank erosion and introduced into the river.

Booth et al. (1991) sampled streambed sediment, starting on the lower South Fork Snoqualmie and continuing down to the mainstem at its confluence with the Skykomish River. Figure 21 shows a clear and repeating pattern in which the streambed sediment coarsens abruptly at the confluence with high-gradient tributaries and then fines rapidly downstream. This pattern is evident below Tokul Creek, the Raging River, and the Tolt River. Booth et al. (1991) also evaluated how the sediment transport capability of the Snoqualmie River varies along the channel and found that for much of its length the lower Snoqualmie was largely incompetent to transport sediment larger than sand size. They concluded that larger sediments accumulate in relatively permanent fan and channel deposits, which are very slowly filling the lower Snoqualmie Valley.

The longitudinal profile of the lower mainstem (Figure 18) is notable primarily for its low gradient, in marked contrast to the profiles of its tributaries and upstream forks. In the vicinity of Fall City, the average gradient is approximately 0.07 percent. The lowest reach of the river, just above the confluence with the Skykomish, has an average gradient of approximately 0.01 percent. This low gradient reflects the origin of the lower Snoqualmie Valley as a slowly filling glacial trough.

Through most of the lower valley, the Snoqualmie River has developed significant natural levees. These levees are broad elevated berms that parallel the river channel (Photo 19). Such levees form over the course of numerous floods as sand and silt are deposited on the floodplain immediately adjacent to the channel. Natural levees are a common characteristic of dune-ripple channels. Because of the elevation of these levees, the riverbanks in the lower valley are often significantly higher than areas of the floodplain farther from the river. As a result, large areas of the floodplain have very poor natural drainage. This circumstance accounts for the large areas of wetland that occupied the floodplain prior to non-native settlement (Collins and Sheikh, 2002).

Collins and Sheikh (2002) divide the lower Snoqualmie into seven reaches based on channel characteristics. These divisions are adopted with slight modifications for this discussion and are described from upstream to downstream.

6.3.1.1. Falls Reach: RM 39.5 – 40.3 (RK 63.6 - 64.8)

The upstream end of this short reach begins at Snoqualmie Falls and ends in the vicinity at the confluence with Tokul Creek. This section is relatively steep and sediment-starved because nearly all of the coarse sediment from the upper watershed is deposited in the low gradient channel reach immediately above the Falls. Much of the streambed in this reach is composed of gravel. Near the Falls, the streambed is composed of blocks of bedrock from the cliff face at the Falls.

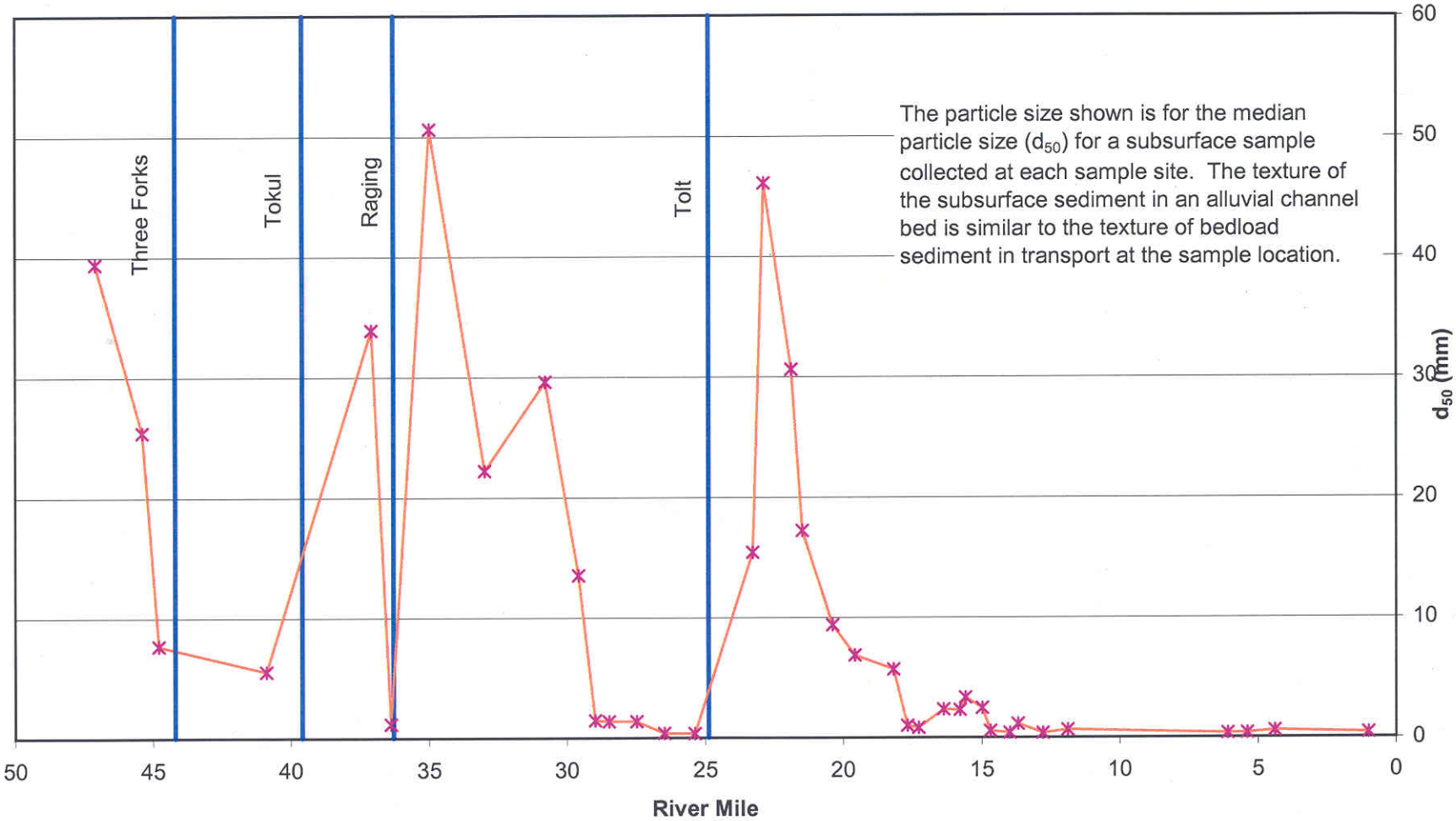

Figure 21: Snoqualmie Streambed Sediment Texture (Booth et al. 1991)

Photo19: Natural levees along the lower Snoqualmie River downstream of Duvall. Floodwaters cover the entire floodplain except for artificially constructed berms and the natural levees immediately adjacent to the channel.

6.3.1.2. Upper Fan Reach: RM 36 – 39.5 (RK 58 – 63.6)

Through this reach, the channel is relatively straight and confined by the Tokul Creek alluvial fan on the north side at the upstream end of the reach, and the Raging River fan on the south side at the downstream end.

6.3.1.3. Upper Meandering Reach: RM 27 – 36 (RK 43.5 – 58)

In this reach, the Snoqualmie exhibits a strongly meandering character, with a sinuosity of 2.0. At the upper end of this reach, the channel bed is gravelly as a result of the gravel supplied by the Raging River. Booth et al. (1991) documented a pronounced downstream fining of the streambed texture through this reach (Figure 21). Near the upstream end, immediately downstream of the Raging River confluence, the d_{50} of mobile streambed sediment was 77 mm (cobble). At the downstream end, just above the confluence with the Tolt, the d_{50} has dropped to 0.34 mm (medium sand). Numerous abandoned channels on the floodplain adjacent to this reach testify to a geomorphic history of active channel migration.

6.3.1.4. Tolt Fan Reach from RM 23 to 27 (RK 37 to 43.5)

In the vicinity of the city of Carnation, the Snoqualmie River flows in a distinctly straight channel immediately at the base of the west wall of the Snoqualmie Valley. The west valley wall adjacent to this reach shows evidence of oversteepened slopes and active instability. Both of these circumstances are atypical of the Lower Snoqualmie River and valley. This reach has a sinuosity of 1.06 and an average gradient of 0.04 percent. These characteristics are a result of displacement of the Snoqualmie River against the west valley wall by the fan constructed by the Tolt River. Immediately above the confluence, the Tolt has a gradient of approximately 0.5 percent, roughly 10 times steeper than the Snoqualmie in this reach. Because of the gradient differential, the Tolt drops sediment on its fan that the Snoqualmie is unable to move. As a result, the Snoqualmie is forced around the perimeter of the fan. The fan deposits now extend all the way across the floodplain, and the Snoqualmie River is trapped between the right bank fan deposits and the left bank valley wall. Leftward displacement of the Snoqualmie channel into the toe of the valley wall has resulted in the oversteepening and instability evident here.

6.3.1.5. Lower Meandering Reach: RM 12-23 (RK 19.3-37)

The upstream end of the lower reach begins at a prominent meander known as Chinook Bend. Beginning at this point, the valley bottom shows evidence of multiple abandoned meanders, suggesting that this has been an area of relatively active channel migration compared with much of the lower valley. It appears that the channel mobility evident in this reach is a consequence of reduced channel confinement and decreased gradient as the

river leaves the confining influence of the Tolt fan. The decreased gradient and decreased confinement mean that average basal shear stress and therefore the sediment transport capacity decrease significantly, moving from the Tolt Fan Reach to the Lower Meandering Reach. The increased rate of channel migration in this reach is presumably a result of the increased sediment deposition. The rate of channel migration appears to decrease downstream. This reach has a sinuosity of 1.8 and exhibits pool-riffle morphology near the upstream end where the streambed is gravelly and transitions to a dune-ripple morphology downstream.

6.3.1.6. Duvall Reach: RM 3 – 12 (RK 4.8 – 19.3)

Through this reach, the Snoqualmie River shows a less pronounced meandering pattern with a sinuosity of 1.6. With no high gradient tributary supplying coarse sediment, the streambed remains sandy and the channel retains a dune-ripple morphology through this reach. Tributaries in this reach include Tuck Creek and Cherry Creek.

6.3.1.7. Lower River: RM 0 – 3 (RK 0 – 4.8)

In the 3 miles (4.8 kilometers) of river immediately upstream from the confluence with the Skykomish River, the Snoqualmie River is again forced against the left (west) valley wall, this time by the sediment deposition from the steeper and more energetic Skykomish River. Abandoned channels on the wedge of floodplain separating the two rivers indicate that the location of the confluence changes over time. Tributaries to this reach include Peoples Creek and Ricci Creek.

6.3.2. Tributaries to Lower Mainstem

6.3.2.1. Tokul Creek

Tokul Creek is the first major tributary entering the Snoqualmie downstream of Snoqualmie Falls. It has a watershed area of 34 square miles (88 square kilometers) and ranges in elevation from 1722 feet (525 meters) to 105 feet (32 meters) at the confluence with the Snoqualmie River. Most of the land area in the Tokul Creek watershed is in timber production. There are a few scattered residences along the lower 1.5 miles (2.4 kilometers) of the river. The Tokul Creek hatchery is located a short distance upstream of the mouth of the creek.

Tokul Creek drains an elongated, relatively low gradient watershed. Between river mile 1.5 and 11.5 (river kilometer 2.4 and 18.5), the creek occupies a relict channelway. Figure 18 shows the longitudinal profile of Tokul Creek. The steep section at the lower end of the watershed marks the change in elevation between the channelway and the modern elevation of

the Snoqualmie River. Tertiary volcanic rocks are exposed in the creek channel as it drops from the channelway down to the river elevation.

6.3.2.2. Raging River

The Raging River has a basin area of 33 square miles (85 square kilometers). Elevation ranges from 3517 feet on Rattlesnake Mountain to 79 feet at the confluence with the Snoqualmie River at Fall City. The Raging River drains a west-trending projection of the Cascade foothills known locally as the Issaquah Alps. Prominent foothills bounding the Raging River watershed include Rattlesnake Ridge, Taylor Mountain, Tiger Mountain, and Mitchell Hill. Most of the land area in the watershed is either in timber production or publicly owned open space. There are scattered residences along the lower 7 miles (11 kilometers) of the river. More intensive land uses are limited to the communities of Preston and Fall City, and a portion of the Snoqualmie Ridge development on the Lake Alice Plateau. Interstate 90 bisects the watershed in an east-west direction. Major tributaries to the Raging River include Canyon Creek, Deep Creek, and Icy Creek.

The glacial history of the Raging River is somewhat complicated. The entire basin was covered by ice during the Vashon glacial maximum. During ice retreat, the Preston Channel (the current location of the lower Raging River) served as one of the relatively early stage outlet channels for glacial Lake Snoqualmie (Stage 6-7 of Booth, 1990) (Figure 8). Water flowed south through this channel, then west along the alignment of the current East Fork of Issaquah Creek into the Lake Sammamish watershed. With further glacial retreat, a lower outlet became available and the Preston Channel was abandoned. Terrace remnants in the Preston area indicate that following abandonment of the Preston meltwater channel, the upper Raging River, upstream of the current site of Preston, continued to flow west along the present East Fork Issaquah Creek alignment. At some point between the current locations of Preston and Fall City, there would have been a drainage divide separating the Raging River watershed from the Snoqualmie River watershed. At some subsequent late-glacial or post-glacial time, headcutting of the north-flowing drainage through the Preston Channel progressed to the point that this drainage captured the Raging River and diverted it from the Sammamish watershed to the Snoqualmie watershed. With this increased flow, the Raging River incised to create the existing, relatively steep, confined channel between Preston and Fall City.

Tertiary volcanic and sedimentary rocks underlie the foothills bounding the Raging River basin. The entire watershed was covered by glacial ice during the Vashon glacial maximum and other previous glaciations of similar magnitude. Much of the bedrock at higher elevations is mantled with a discontinuous layer of glacial till. The Lake Alice Plateau is a typical till upland. The lower Raging River Valley incised through this till surface,

exposing a thick sequence of advance outwash overlying transitional beds. The narrow valley bottom along most of the length of the Raging River is floored with a discontinuous substrate of modern alluvium, colluvium, and landslide debris. Where the Raging River emerges from its valleys and flows onto the Snoqualmie Valley floor, the river has formed a large fan deposit. Fall City is located on the distal portion of this fan (Booth, 1990).

For much of its length, the Raging River exhibits plane-bed morphology (Photo 10). In the upper part of the watershed, the Raging River has a gradient of approximately 3 percent. From the upper crossing with Highway 18 downstream to the vicinity of Preston Channel, the river has a consistent gradient of approximately 1.5 percent. The lowest 4000 feet (1.2 kilometers) of channel, where it crosses its alluvial fan, has an average gradient of approximately 0.6 percent.

In this reach the channel is entirely confined by levees intended to protect development in and around Fall City. Under natural conditions alluvial fans are sites of rapid sediment deposition and consequent active channel migration. The levees along the lower Raging River prevent the channel from moving and confine deposition to the existing channel alignment. Figure 22 shows the rapid sediment deposition typical of this reach. Concerns regarding damage to riverine habitat have curtailed the frequent dredging that occurred here prior to the late 1960s. King County is considering management strategies to address channel aggradation in this reach of the Raging River.

6.3.2.3. Patterson Creek

Patterson Creek is the largest left bank tributary to the Snoqualmie River downstream of Fall City. It has a watershed area of 19 square miles (48 square kilometers). Patterson Creek originates in a series of wetlands on the glacial upland west of the lower Snoqualmie Valley. The stream drops from the till-mantled upland into a relict meltwater channel and follows that channel for 7 miles (11 kilometers) to the Snoqualmie River. This meltwater channel is identified as the Redmond Channel and served as the outlet from glacial Lake Snoqualmie during recessional interval 12 of Booth (1990). This relict channel feature is clearly a result of subaerial meltwater discharge during deglaciation, in contrast to the channelways east of the Snoqualmie Valley, apparently formed by subglacial flow. Patterson Creek drains the southeasterly end of this relict channel toward the Snoqualmie River, and Evans Creek drains the northwesterly end toward Bear Creek and the Sammamish River. Because of the low gradient and broad valley bottom width of the relict channel, lower Patterson Creek meanders through an extensive system of wetlands and, through this reach, has no significant capacity to erode or transport sediment (Figure 23).

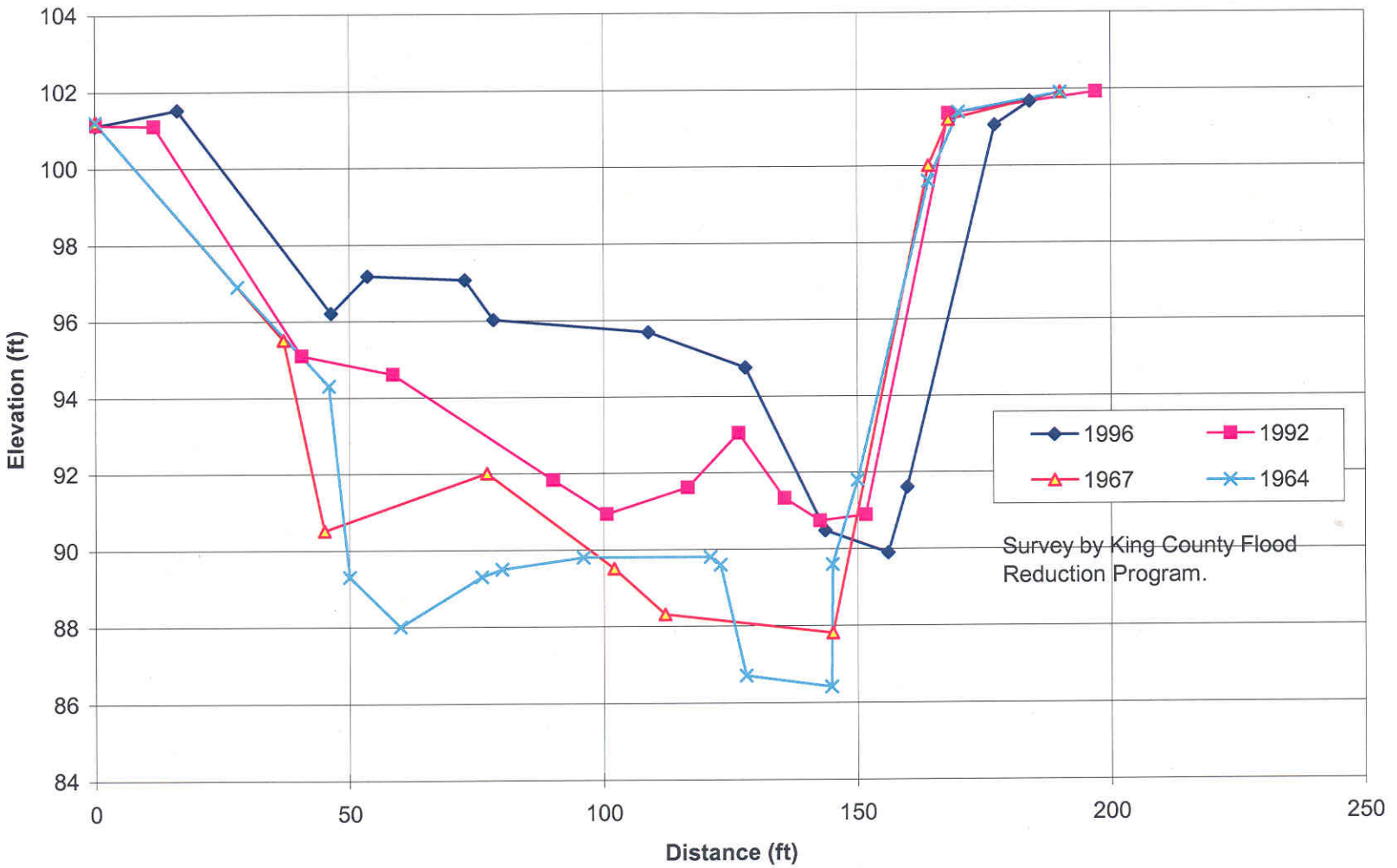

Figure 22: Historical cross-section surveys of the Raging River at a point approximately 1200 feet (350 meters) upstream of the confluence with the Snoqualmie. These sections show progressive sediment accumulation in this lowest reach of the river.

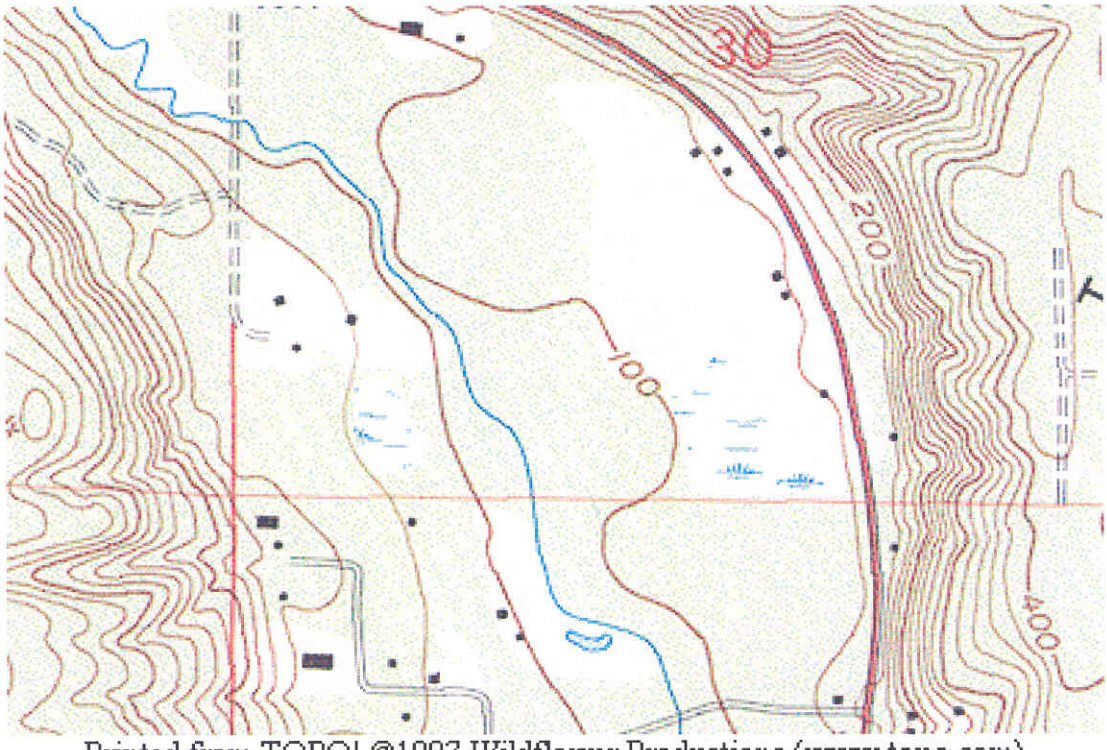

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Figure 23: The lower section of Patterson Creek is a classic underfit stream where it flows through a broad glacial meltwater channel.

6.3.2.4. Griffin Creek

Griffin Creek is a west-flowing tributary with a watershed area of 17 square miles (45 square kilometers). The Griffin Creek basin is largely underlain by glacial deposits. The lower portion of the channel is incised into the glacial surface. In the upper part of the watershed, the main channel, and many of the tributary channels, flow in a series of channelways.

6.3.2.5. Tolt River

The Tolt River has a tributary area of 97 square miles (251 square kilometers) and is the largest tributary to the Snoqualmie River downstream of Snoqualmie Falls. The watershed ranges in elevation from 5576 feet (1700 meters) on Red Mountain down to 55 feet (17 meters) at the confluence with the Snoqualmie River. The Tolt River has two major tributaries, the North and South Forks. The valleys of both forks were occupied and eroded by alpine glaciers and share the generally "U" shaped cross section typical of glaciated mountain valleys. Bedrock generally underlies the side slopes of these valleys, and the valleys are floored with alpine glacial deposits. A dam on the South Fork provides drinking water for the city of Seattle and provides some flood attenuation (Photo 20). The South Fork Reservoir collects runoff and traps sediment from about 20 percent of the Tolt River watershed.

Below approximately elevation 1100 feet (335 meters), both forks leave their relatively broad, low-gradient glacial valleys and descend through steep, narrow, partially bedrock canyons (Photo 21) to their confluence at river mile 8.8 (river kilometer 14).

From the confluence of the forks at river mile 8.8 (river kilometer 14), the mainstem flows through a steep-sided valley at a gradient of approximately 1 percent. In this reach, the Tolt varies between a single-thread and braided morphology. Historical research shows that the morphology and channel location in this reach are subject to rapid and dramatic shifts, sometimes during a single flood event (Shannon and Wilson, 1991). Because of the rapid rate of channel change in this area, King County has designated a broad belt adjacent to the channel as an area of "severe channel migration hazard." Stossel Creek is a major tributary to the Tolt River and enters at the head of this reach.

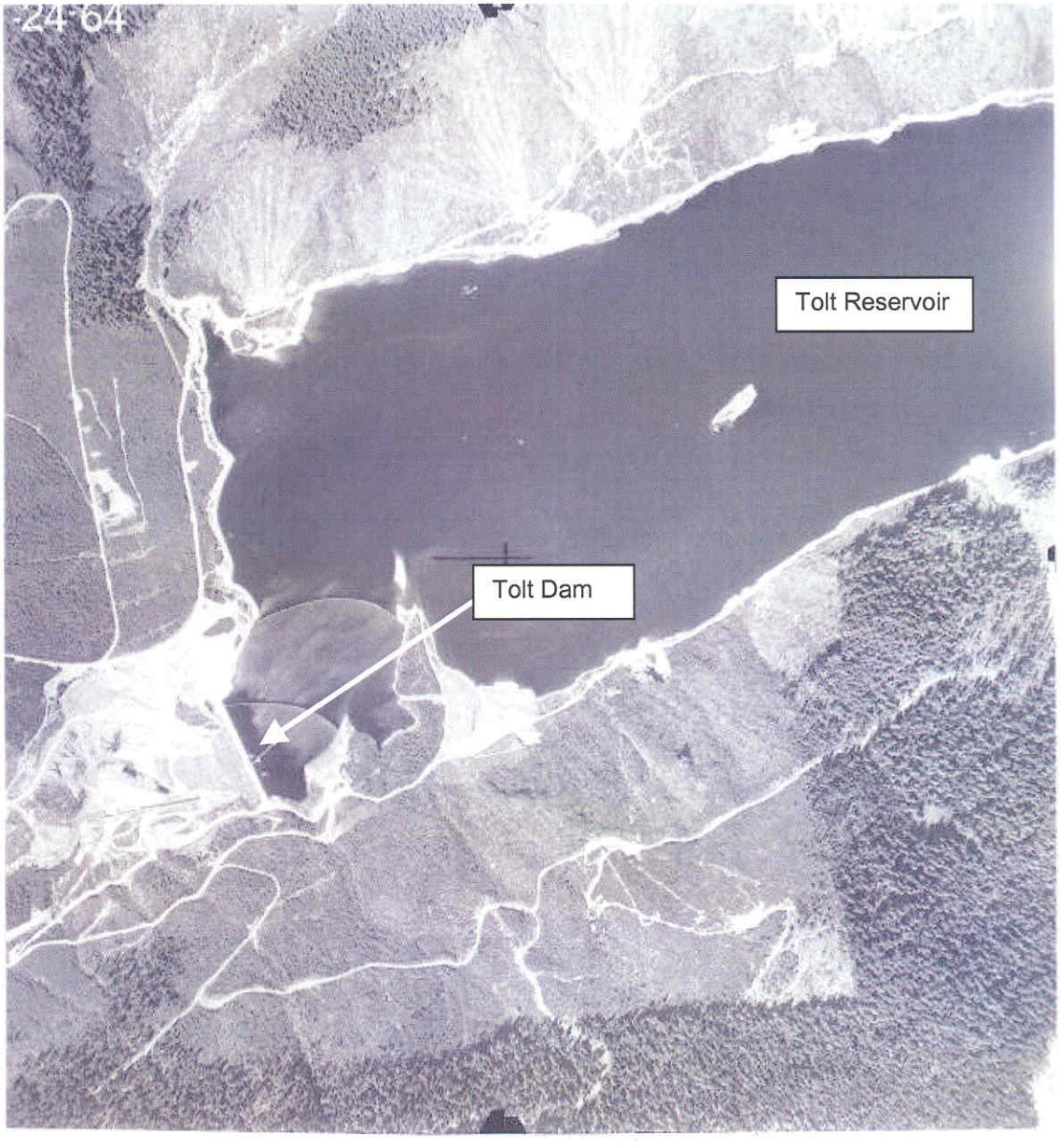

Photo 20: Seattle Public Utilities water supply dam and reservoir on the South Fork Tolt River.

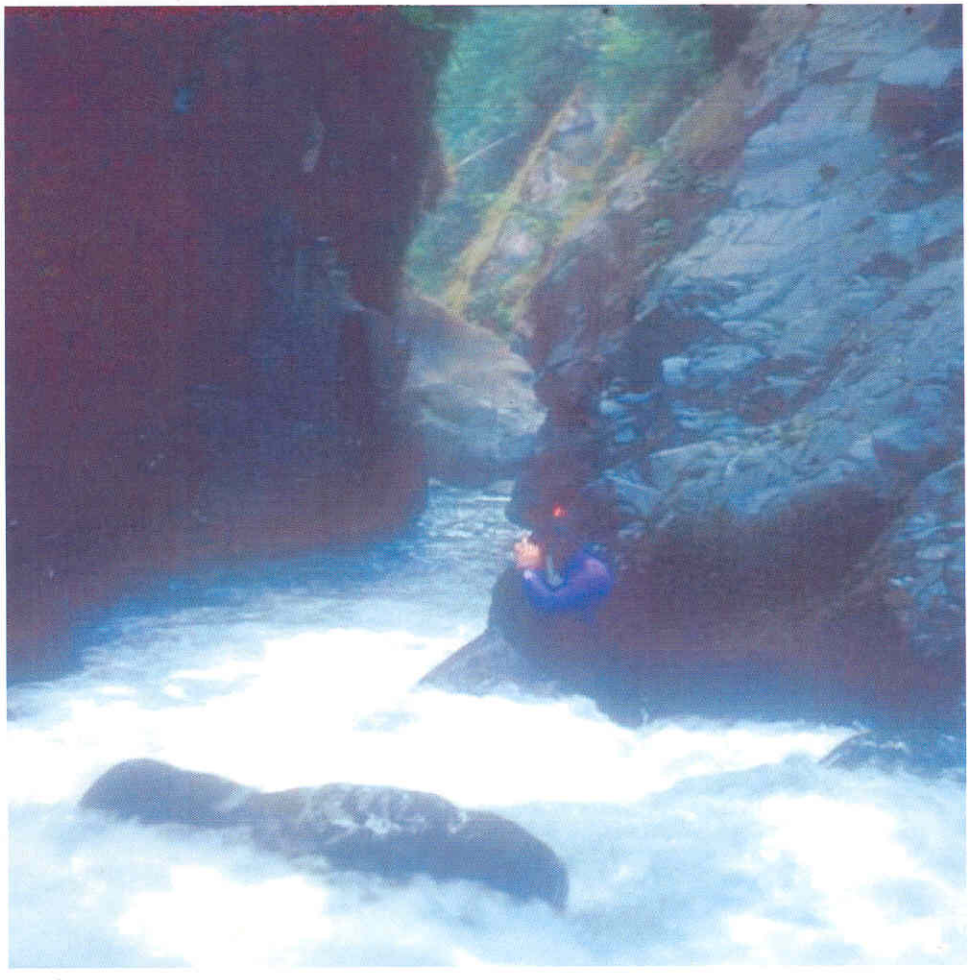

Photo 21: Bedrock canyon on the North Fork of the Tolt River. Photo Courtesy of Washington Trout.

At about river mile 2.0 (river kilometer 3.2), the Tolt emerges from its tributary valley into the mainstem Snoqualmie Valley. Deposition in this lowest section of the river has created a broad alluvial fan. The gradient of the channel crossing the fan is approximately 0.5 percent. The fan extends across the width of the Snoqualmie Valley and has forced the Snoqualmie River against the west valley wall. The modern Tolt is located on the southern edge of its alluvial fan. The city of Carnation occupies most of the center portion of the fan. Sediment aggradation, flooding, and channel migration are normal phenomena on alluvial fans. A levee system along the right bank of the Tolt extending from the mouth to river mile 1.7 (river kilometer 2.7) was constructed in the 1940s in order to protect the city of Carnation from flooding and channel migration.

6.3.2.6. Harris Creek

Harris Creek drains an area of 13.3 square miles (34.5 square kilometers) east of the Snoqualmie Valley. It originates from multiple wetlands located in channelways and depressions on the till surface. The channel descends to the Snoqualmie River floodplain through a steep ravine section. It crosses the floodplain in a low gradient channel, and then through a series of oxbow wetlands joining the Snoqualmie at river mile 22.7 (river kilometer 36.5). The Harris Creek basin ranges in elevation from 1060 feet (326 meters) down to 40 feet (12 meters) at its mouth on the Snoqualmie. The dominant land use in the Harris Creek basin is low-density, single-family housing. A small area in the eastern part of the basin remains in timber production.

6.3.2.7. Ames Creek

Ames Creek originates at Ames Lake on the west side (left bank) of the Snoqualmie River west of the city of Carnation. Ames Creek has a basin area of 7.7 square miles (20 square kilometers). Ames Lake and Ames Creek occupy a glacial recessional meltwater channel occupied during Booth's Stages 10 to 13 (Figure 8). Meltwater would have flowed through this channel from north to south during deglaciation. Subsequent channel incision has reversed the direction of flow (similar to the flow reversal described earlier in the Raging River valley), creating the present north-flowing drainage. Irregular topography in the vicinity of the lake and the presence of ice-contact deposits surrounding the lake (Booth, 1990) suggest that Ames Lake may have originated as a kettle, a depression left following melting of an isolated remnant of glacial ice.

As in other tributaries on the west side of the lower Snoqualmie Valley, the Ames Lake basin and the upland portions of the basin are pervasively developed with low to moderate densities of single-family housing. A ravine section between the lake and the Snoqualmie Valley floor is steep with more scattered development. The lowest 1.8 miles of Ames Creek flow through pasture on the Snoqualmie River floodplain. This entire length

of channel has been modified by dredging in order to improve drainage on adjacent agricultural land.

6.3.2.8. Cherry Creek

Cherry Creek has a watershed area of 25 square miles (79 square kilometers). Elevation ranges from 2760 feet (841 meters) on Drunken Charlie Mountain to 20 feet (6 meters) at the confluence with the Snoqualmie River, 3.0 miles (4.8 km) north of the city of Duvall. The headwaters of Cherry Creek drain a forested watershed underlain by glacial deposits and Tertiary bedrock. Bedrock is present at shallow depth over much of the upper watershed, even where there is a veneer of glacial deposits. This bedrock is exposed in the channel of the Cherry Creek watershed at numerous locations, creating a series of cascades and falls. The lowest of these, at river mile 6.8 (river kilometer 11), forms a natural upstream limit to anadromous fish access.

Cherry Creek originates in a series of lakes and wetlands occupying a complex topography of intersecting channelways. The channel then follows a single channelway for 5 miles (8 kilometers). Through this reach, the channel flows mostly over glacial sediments, although bedrock is commonly exposed in the channel. At river mile 2 (river kilometer 3.2), Cherry Creek emerges abruptly from this incised valley and flows into a broad lateral extension of the Snoqualmie River floodplain. At this location, channel gradient and confinement decrease rapidly, leading to localized sediment aggradation and formation of an alluvial fan. Aggradation and flooding threaten several houses built on the alluvial fan in this area.

For the lower 2 miles (3.2 kilometers), Cherry Creek flows through a broad, low-gradient reentrant into the surrounding glacial and bedrock uplands. The alluvium filling the bottom of this reentrant is a lateral extension of the Snoqualmie floodplain, and this area is inundated by even modest flood events on the Snoqualmie River. Prior to human modification, Cherry Creek followed a meandering alignment through this valley. In common with most of the rest of the Snoqualmie floodplain, this area was cleared for agriculture early in the twentieth century. Cherry Creek was relocated into a straight, excavated channel. Recent survey work by Washington Trout revealed that much of the original, meandering channel is still present adjacent to the existing excavated channel (Figure 24).

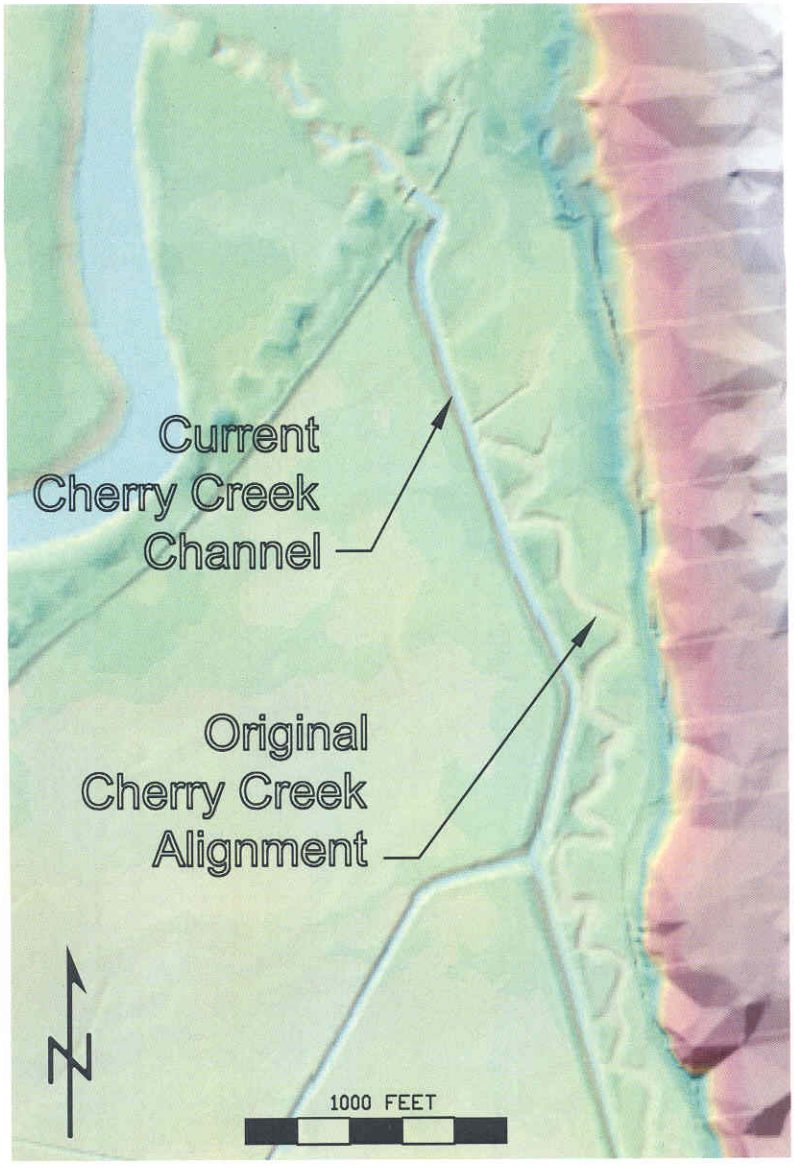

Figure 24: This shaded relief drawing shows the current, straight, excavated channel of Cherry Creek, next to the meandering, currently unoccupied original alignment. (Figure Courtesy of Washington Trout).

6.3.2.9. Small Tributaries to Lower Mainstem

There are a number of smaller tributaries to the lower Snoqualmie River, including Harris Creek, Tuck Creek, Weiss Creek, Langlois Creek, Adair Creek, Peoples Creek, and Ricci Creek, and numerous small unnamed tributaries. Many of these tributaries have common characteristics. For the most part, they originate as low-gradient streams on the rolling till uplands bordering the lower valley, often in headwater wetlands. Most of these streams flow through a steep reach that descends from the till upland to the valley bottom. This steep reach is generally located in a post-glacially incised ravine on the valley wall and is the primary source of sediment in these streams, often exhibiting channel erosion in response to development-related hydrologic changes. The steep incised ravine sections of these tributaries often intersect groundwater emerging from the valley wall, providing cool clean perennial base flow to the lower stream reaches. Typically, an alluvial fan has formed where these steep ravines open out onto the floor of the Snoqualmie Valley. Prior to non-native settlement, many of these streams flowed through valley-bottom wetlands as they crossed the floodplain to join the river. These valley-bottom reaches have generally been straightened and deepened in order to drain adjacent land for agriculture.