Appendix L
Finley Creek Area

1. Methods

Photographs from ten years are shown in the accompanying figures, along with a hillshade that was made using Lidar data that were collected in 2002. For each year, the channels of Finley Creek were mapped. These are primarily unvegetated channels (water, if any, and unvegetated bars). Other narrow channels are likely present in the trees. In some places, a curving path in the trees is suggestive of a channel path. These were not mapped. Consequently, the actual number of paths is much higher than shown in these figures.

For the Quinault River, the active channel, unvegetated channel, and overflow channels through vegetated areas have been mapped. The active channel includes the low-flow channel and adjacent unvegetated areas that appear to carry the majority of flow and sediment. The unvegetated channel includes unvegetated areas that appear to carry water and sediment only at higher flows. Partially vegetated channels are shown also. These channels have some vegetation, but appear to carry flow water only at the highest flows. The flows must still have enough energy to disrupt vegetation. The overflow channels through vegetated areas may carry enough flow to disrupt vegetation, but are within vegetated areas, not in the area of the active channel. The overflow channels shown in the brighter blue in each figure are those that are narrower; the ones shown in the light blue are wider and often have unvegetated channels along with the low-flow path.

In 2002, we walked up Finley Creek and noted the remains of an engineered log jam (ELJ). The locations of these remains are shown by the green circles on each figure. We also noted the extent of a high eroding bank of glacial deposits along the east side of Finley Creek. The extent of these eroding banks is shown by the orange squares in each figure. Primary and secondary roads have been mapped from the aerial photographs. The white lines in each figure show the valley edge or bedrock. The section shown of the Quinault River is between about RK (river kilometer) 2.2 and 6.2. The labels in the pink squares are localities that are the same in each figure, so that they can be used to compare similarities and differences in the channel locations.

The conditions of the area of the ELJ and eroding bank were examined again in 2004. These observations are summarized in Attachment 1.

2. Summary

The following is a summary of the changes to Finley Creek and the adjacent section of the Quinault River between 1939 and 2002.

2.1. Upper Finley Creek

In 1939, upper Finley Creek flowed in two channels with the western channel being wider and probably carrying more flow than the eastern one. The western of these two channels and the channel in lower Finley Creek form a nearly straight path to the Quinault River. Development has already occurred on the east side of the Finley Creek

alluvial-fan complex. At some point an engineered log jam (ELJ) was placed at the head of the western path of the upper Finley Creek. We don't know when this occurred, but by 1952, the western path appears to carry only a small amount of water. The upstream half of the western path is mostly vegetated by 1952. In 1952, flow in upper Finley Creek is contained in the eastern path, which makes a sharp meander to the west and joins the 1939 path in lower Finley Creek. In 1958, this west meander is even more marked. However, in 1962, the meander appears to have been modified to direct flow back into the 1939 path in lower Finley Creek. By 1994, the main path of upper Finely Creek has migrated eastward and may have started incising the high exposure in glacial deposits along the east side.

2.2. Lower Finley Creek

Between 1939 and 1973, the path of lower Finley Creek is approximately in its 1939 path. On the 2002 hillshade, this channel appears to be incised into the alluvial-fan surface. The path becomes slightly more meandering over time and the position of its lower end, where it joins the Quinault River, changes position. Beginning by 1973, several unvegetated paths appear on the east side of the alluvial fan. These paths become wider and more continuous between 1982 and 2002. At some time, perhaps between 1973 and 1982 (although it could be earlier), the channel of Finley Creek near the bridge begins to be excavated, and levees are constructed on both sides of the channel. These levees direct the flow eastward into the multiple and branching east paths to the Quinault River. Some flow still reaches the river by the western path. Except in 1982, the paths of Finley Creek join the Quinault River in overflow channels of the Quinault River. The overflow channels carry water and sediment only in higher flows. Small unvegetated alluvial-fan deposits are visible at the mouths of the Finley Creek flow paths in several years.

2.3. Quinault River Between RK 2.2 and 6.2

Between 1939 and 2002, the Quinault River changes form and position many times along this section by Finley Creek. Two main overall changes occur. First, the active channel in 1939 cuts off to the north into a narrow overflow channel along the toe of the Finley Creek alluvial-fan complex. In 1952 and 1958, the active channel remains approximately along this same path. The downstream end of this path is mostly abandoned by 1962. By 1973, the north channel path is reoccupied by the active channel in which a meander forms and moves progressively downstream between 1973 and 1994. By 1998, this channel is abandoned, and becomes an unvegetated overflow channel that appears to decrease in width and continuity between 1998 and 2002. This abandoned channel becomes Taiber Slough, an area of sockeye spawning (B. Armstrong of Quinault Indian Nation, 2002, written commun.).

The second main change between 1939 and 2002 is that the channel of the Quinault River moves, through meander migration or cut offs, to the north. This is true not only in the Taiber Slough area, but also upstream. In the upstream section, an unvegetated overflow channel in 1939 and 1952 becomes part of the active channel by 1958, when the Quinault River has split flow paths. The north path widens and progressively carries more flow between 1958 and 1994. It also becomes more sinuous, so that part of this channel

migrates northward into the alluvial fan. By 1998, the north path is the only active channel path, which has straightened. An abrupt menader to the north has been cut off.

3. Changes Between Individual Years

The following sections discuss features of Finley Creek and the Quinault River that are present in each year shown, and changes from the previous and subsequent years.

3.1. 1939

3.1.1. Finley Creek

Finley Creek has two channels upstream of FC7 in upper Finley Creek (figure 1). The widest channel (carrying the most flow?) is the west path. Both paths are slightly meandering. The two paths join at FC7. The east path makes a fairly sharp west bend at FC6 to join the west path. The reason for the sharp turn is not known. An older channel is present west of the west active path. The older channel is indicated by low riparian vegetation between the trees on the higher slope to the west and the higher vegetation between the older channel and the west active channel.

Downstream of FC7 in lower Finley Creek, the creek flows in one primary channel. At FC8, the channel is braided. The Finley Creek channel joins the Quinault River between FC9 and C1. The Finley Creek channel at this point has several flow paths. All the Finley Creek paths flow into a narrow unvegetated overflow path of the Quinault River.

Note the amount of area that has been cleared or logged by 1939. Several residences are present on the west side of the creek. It doesn't appear that a bridge is present across Finley Creek in 1939. It may be that a bridge is present but just not visible on the aerial photographs (e.g., because of the photograph quality). In the photographs taken in the other years, the bridge is visible because of the shadow that it casts in the "white" channel bed. However, it appears in 1939 that the road from the west turns north just before reaching Finley Creek, and then the channel was driven across to the east and south to meet the road on the east side of the creek.

3.1.2. Quinault River

The active channel is slightly meandering in the Finley Creek area. One fairly abrupt meander in the active channel occurs at B1. A narrow unvegetated overflow channel extends between near B1 and D1, which is the one that the paths that Finley Creek joins. Note the relatively wide unvegetated overflow channel (shown in blue) that is present between V and Y, north of the unvegetated main channel.

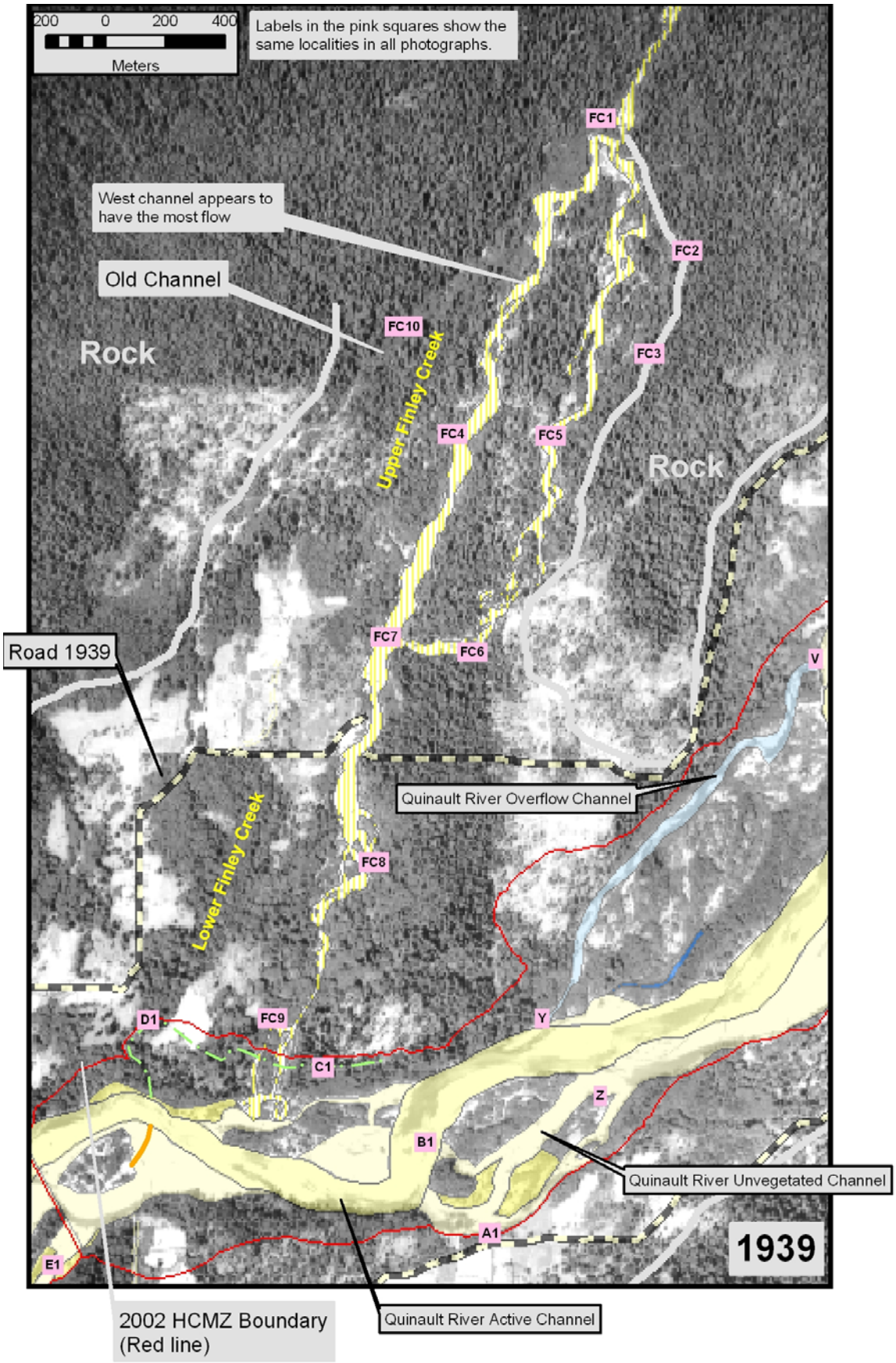

Figure 1. Finley Creek area in 1939. Note the amount of area that had been cleared by 1939.

3.2. 1952

3.2.1. Finley Creek

By 1952, the west path of upper Finley Creek that was present in 1939 appears to carry very little water and has nearly become vegetated (figure 2). We do not know when the ELJ was placed along Finley Creek, but it may have been what caused flow to cease in the west channel. Although the west path appeared to carry more water in 1939, all the Finley Creek flow is in the east path by 1952. The east path is wider, but has nearly the same alignment as it did in 1939. A new narrow path has developed to the east of the main 1952 path near FC2. This channel is along the bedrock along the east side of Finley Creek.

The abrupt bend is still present in the path of Finley Creek at FC6. This bend is now a meander bend in the now-single path of Finley Creek. The channel makes another abrupt bend in the opposite direction at FC7. The meander at FC7 has migrated outward (to the west) since 1939. In 1952, this meander makes a 90° bend.

The braided paths in lower Finley Creek that were present at FC8 in 1939 appear to be nearly a single path in 1952 and immediately east of the 1939 braided area, although at least one braid is visible. An unvegetated path is now visible in places through the vegetation between FC8 and D1.

Finley Creek appears to join the Quinault River in a single narrow channel between FC9 and C1, in the position of one of the multiple braids that was present in 1939. Finley Creek joins an unvegated overflow channel of the Quinault River.

The older channel path that was present in 1939 is still visible in the vegetation to the west of Finley Creek.

A bridge across Finley Creek is visible in 1952.

No levees are visible downstream of the bridge. Not much human activity in the channel near the bridge is visible either.

The amount of clearing on the west side of Finley Creek appears to be about the same as it was in 1939. The logged area on the east seems to be revegating.

3.2.2. Quinault River

The meander at B1 in the 1939 active channel has cut off and now flows in what was in 1939 a narrow unvegetated overflow channel along C1. The 1952 active channel in this section is straighter than it was in 1939. The 1939 active channel with the meander bend is now an unvegetated overflow channel. The 1952 active channel divides into two paths just upstream of D1. The 1952 active channel between V and Z is more meandering than this section of the 1939 active channel. The 1939 unvegetated overflow channels between Z and A1 have become narrow channels through vegetation except for one channel, which remains an unvegetated overflow channel. The relatively wide overflow channel between V and Y that was visible in 1939 is still present in 1952.

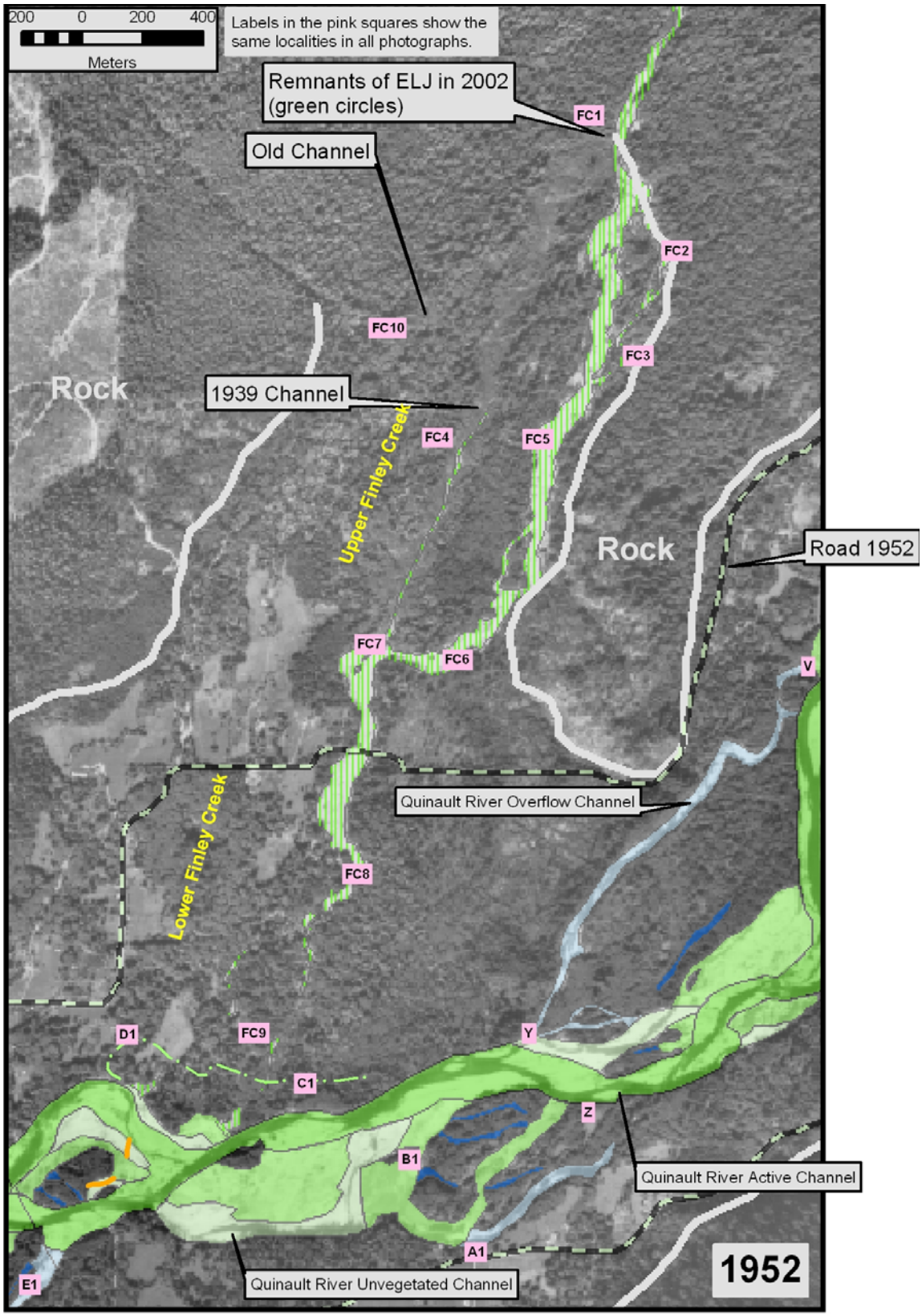

Figure 2. Finley Creek area in 1952.

3.3. 1958

3.3.1. Finley Creek

Flow in upper Finley Creek is in the same path as it was in 1952. Although photograph coverage is not continuous, it appears that the 1939 west path is now abandoned and is vegetated (figure 3). The 1958 path upstream of FC6 appears to be wider than it was in 1952. The narrow east path in 1952 at FC2 is in 1958 nearly continuous with the main path of Finley Creek.

The abrupt (nearly 90°) meander at FC7 has migrated farther outward (to the west).

In lower Finley Creek, the channel at FC8 has several braids, although the east path still seems to be the main one, as it was in 1952. The path downstream of FC7 is mostly in one channel, and this channel meanders to the west and enters the Quinault River near D1. This was a noncontinuous narrow path in 1952. The 1952 path appears to be abandoned or does not carry enough water to move sediment, so it is no longer visible through the vegetation. Finley Creek joins the Quinault River in an unvegetated channel path that was a meander in one of the split paths in the unvegetated channel in 1962.

Cleared areas on the west side of Finley Creek appear to be about the same as they were in 1952. The logged areas on the east side continue to revegetate.

Levees are not visible downstream of the Finley Creek bridge. However, the channel has been altered near the bridge.

3.3.2. Quinault River

The wide unvegetated overflow channel between V and Y that was present in both 1939 and 1952 is part of the active channel by 1958 and appears to carry near half the flow and sediment of the Quinault River. The 1958 active channel just upstream of Z is in a path that was an unvegetated overflow channel in 1952. The 1939 meander path near B1 still receives some flow. The split path that in 1952 began just upstream of D1 now splits farther upstream at C1. The meander in the 1952 unvegetated channel at D1 is now an overflow channel.

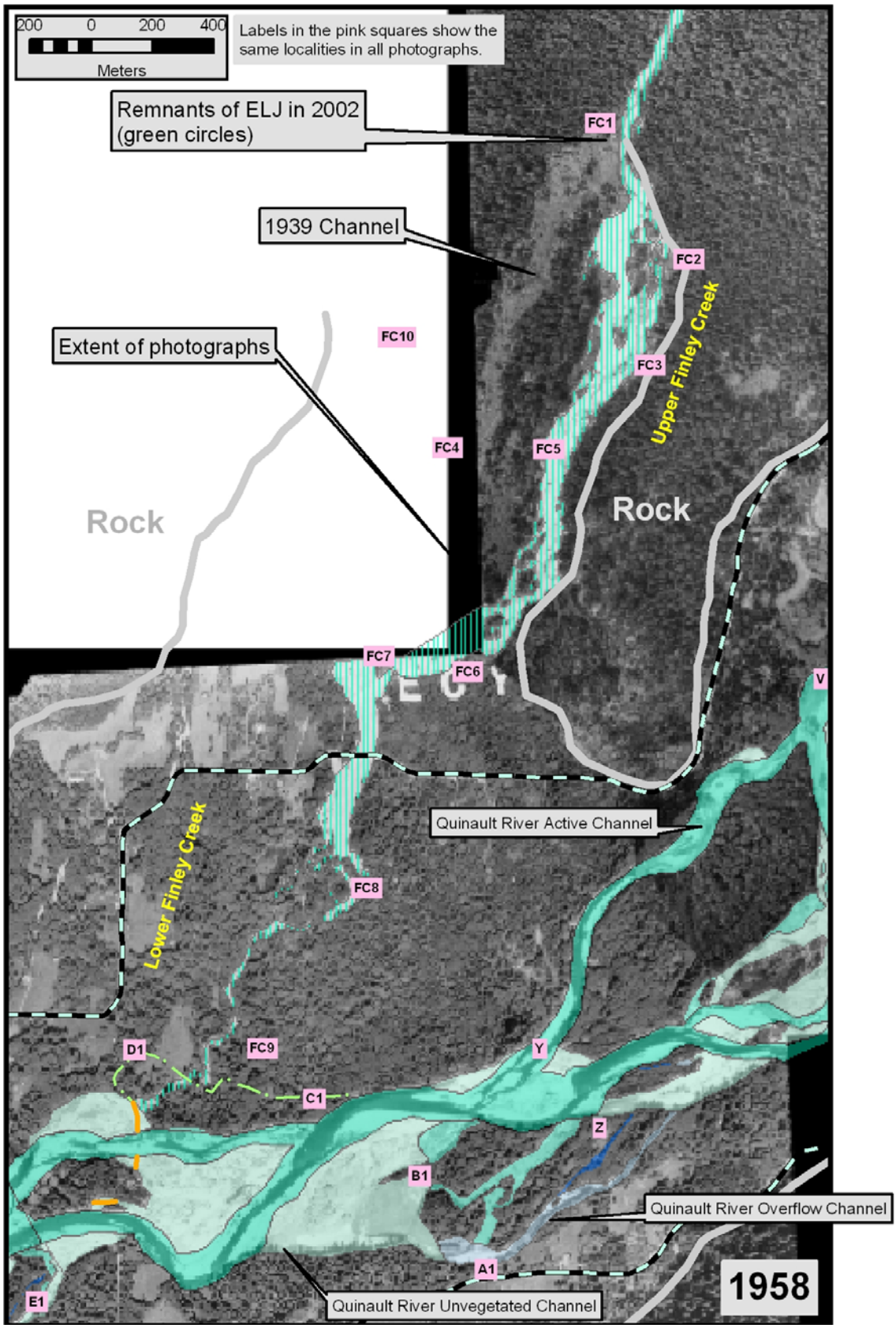

Figure 3. Finley Creek area in 1958.

3.4. 1962

3.4.1. Finley Creek

Our photograph coverage is not continuous for upper Finley Creek in 1962 (figure 4). The channel upstream of FC6 is still along the same general path as it was in 1958. The path meanders slightly more westward at FC2 than it did in 1958. The path appears to be about the same width. The meander at FC7 is not as pronounced as it was in 1952. This could be from human intervention (to keep the channel from the development downstream on the west), but nothing is obvious on the 1962 photographs.

In lower Finley Creek, the channel at FC8 is now in two distinct paths separated by a treed area. The path downstream of FC8 is mainly in a single, meandering path that is in a location about the same as it was in 1958. Finley Creek joins the Quinault River at the same location as it did in 1958. However, the unvegetated overflow channel of the Quinault River (near D1) is now partially vegetated, suggesting that this channel has received less flow than it did earlier.

Clearing on the west side looks about the same. Vegetation on the east side looks nearly the same, also.

Levees are not visible downstream of the Finley Creek bridge. However, the channel has been altered near the bridge.

3.4.2. Quinault River

The unvegetated channel path between V and Y has widened and become slightly more meandering. The path between Z and V may be slightly more meandering than it was in 1958, but it has not changed much. A narrow overflow channel between the two paths of the 1962 active channel has become more pronounced. (The narrow channel was first visible in the vegetation on the 1952 photograph.) The paths between Z and A1 continue to revegetate and are reduced to a couple of overflow paths within the vegetation. The 1939 meander bend near B1 has started to become vegetated. The meanders in the 1962 active channel between C1 and E1 have become more pronounced. It appears that more flow has been in the south path of this split in the 1962 active channel.

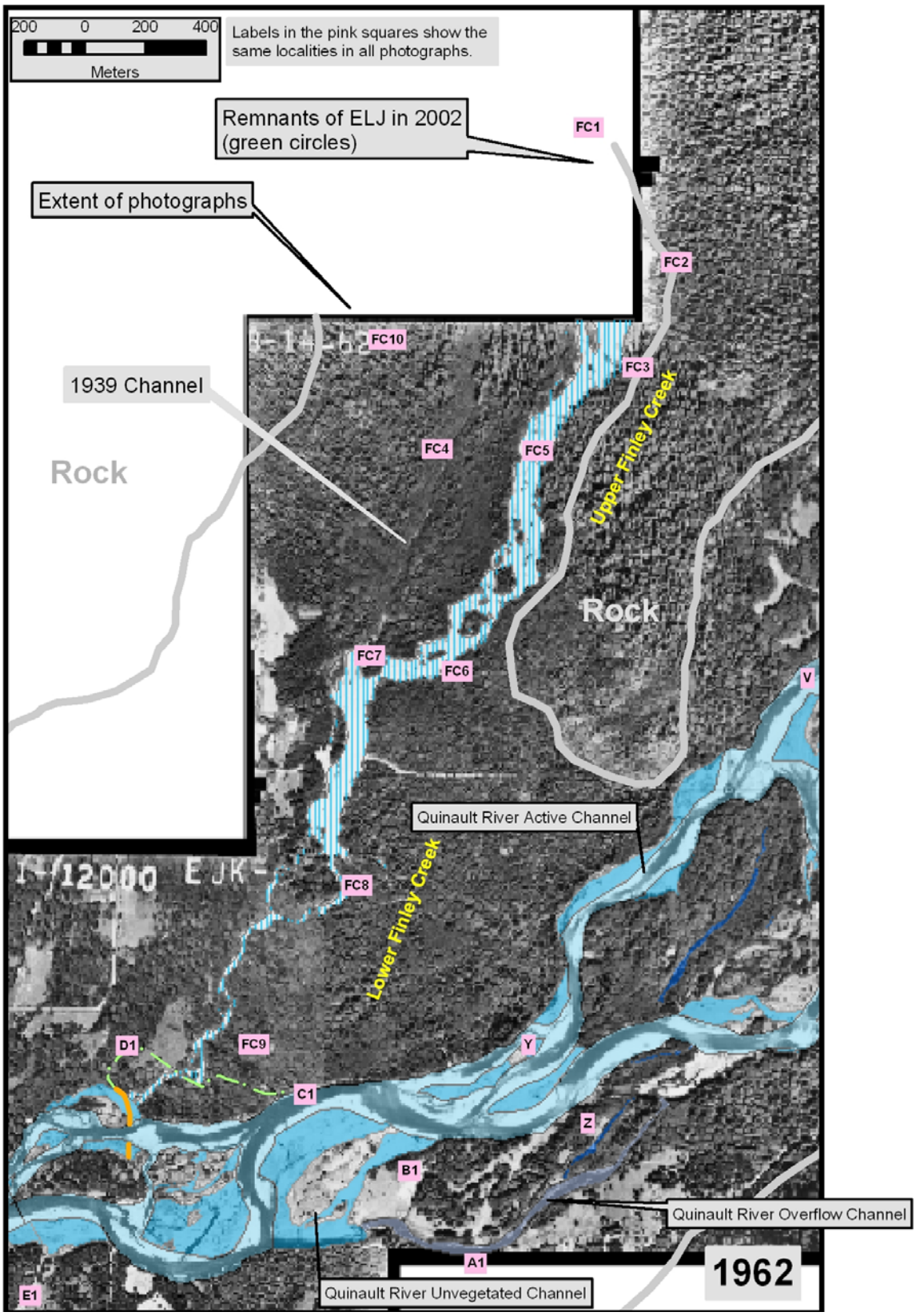

Figure 4. Finley Creek area in 1962.

3.5. 1973

3.5.1. Finley Creek

In upper Finley Creek, the creek in 1973 is in a single path approximately where it was in 1962 (figure 5). The meander at FC7 is broader in 1973 than it was in 1962.

In lower Finley Creek, the split flow at FC8 that was present in 1962 is in a main single channel by 1973. Multiple, unvegetated paths are visible for the first time to the east of FC8 and begin between FC7 and FC8.

Downstream of FC8, Finley Creek in 1973 is in a single path that is about in the same location as it was in 1962. The path to the Quinault River has lengthened a bit. Finley Creek enters an unvegetated overflow path of Quinault River, but this channel is south of the one where Finley Creek joined the Quinault River in 1962.

Some of the cleared areas on the west side of Finley Creek appear to be slightly less extensive than earlier. Not much change is apparent in the vegetation on east of Finley Creek.

Levees do not appear to be present downstream of the Finley Creek bridge, but work has occurred in the channel near the bridge.

3.5.2. Quinault River

The active channel between V and Y has straightened since 1962. It looks as if the meander upstream of Y cut off to the northwest into a channel that was not apparent in 1962. The south path that was between Z and V now begins farther upstream (out of the area shown), so that the 1973 active channel does not connect these two points. The narrow overflow channel through the vegetation between the two paths of the active channel that has been present in previous years now includes two additional channels that were wider overflow paths in 1962.

Between Y and E1, the active channel now meanders more tightly. The south path of the split 1962 active channel has been abandoned. This was the main path in 1962 and had a relatively tight meander. The tight meander is now an overflow channel. The active channel appears to have cut off into a path slightly north of the north path in the 1962. The north path then meanders into what was the south path near D1. Finley Creek joins the Quinault River near D1 and curves around the new meander in the active channel of the Quinault River before entering the river.

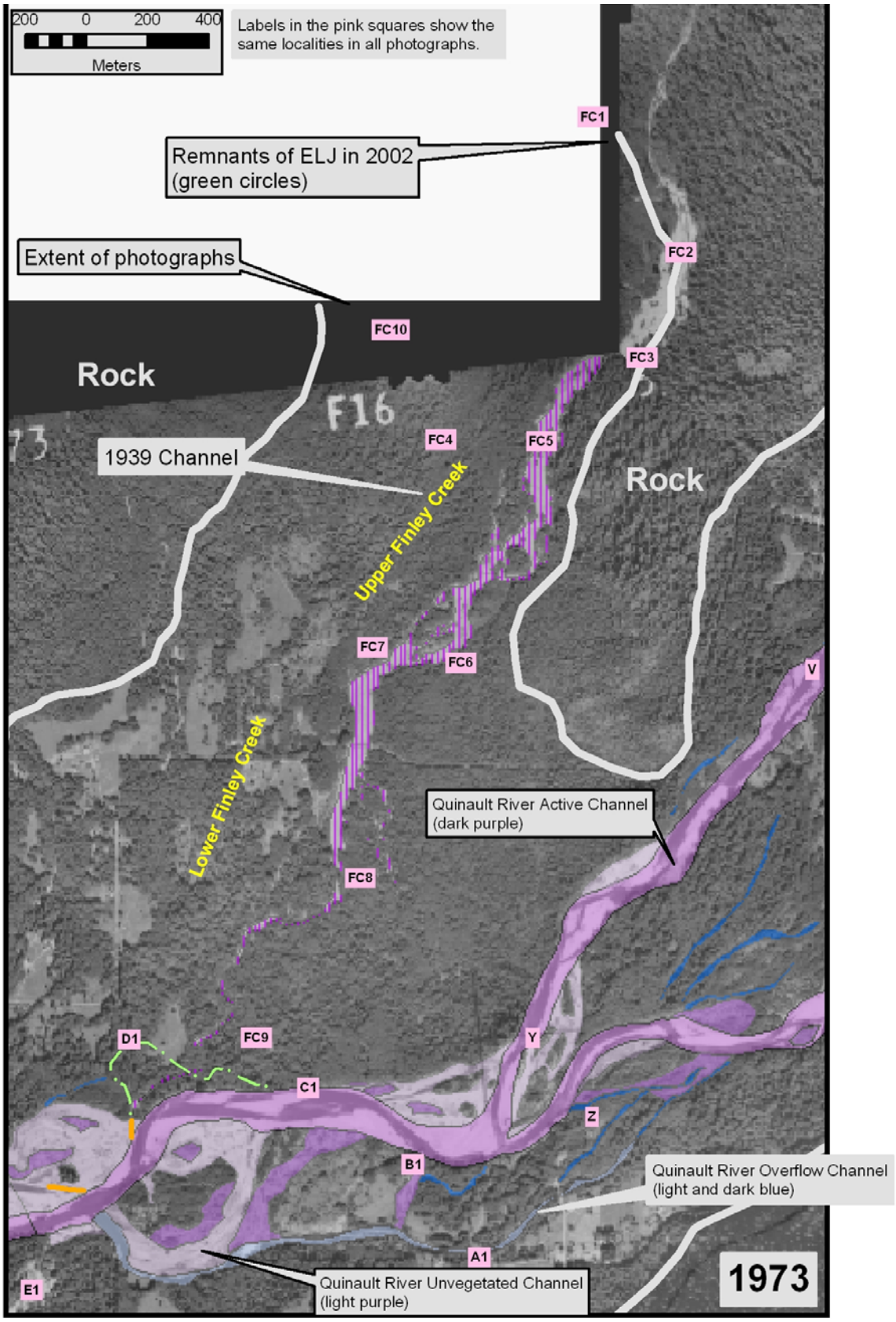

Figure 5. Finley Creek area in 1973.

3.6. 1982

3.6.1. Finley Creek

Photograph coverage in 1982 is limited to lower Finley Creek and the downstream portion of upper Finley Creek (figure 6).

Upper Finley Creek, upstream of FC6, is a braided channel. The meander at FC7 is much straighter than it has been in earlier years.

In lower Finley Creek, the east paths between FC7 and FC8 that were first visible in 1973 are more continuous and pronounced by 1982. One path extends to the Quinault River and joins its active channel downstream of Y. The path downstream of FC8 that was the single unvegetated path to the Quinault River in 1973 is not quite a continuous unvegetated path in 1982. This path joins the active channel of the Quinault River near FC9, upstream of where it joined the Quinault River in 1973.

The cleared areas on the west side of Finley Creek are more extensive than they were in 1973 in some areas, such as near D1 and along the valley edge. The area east of Finley Creek is vegetated by 1982.

It looks as if some work has begun in the area of the levees, but this is not clear on the photographs.

3.6.2. Quinault River

The unvegetated channel between V and Y is wider than it was in 1973. The unvegetated channel upstream of Z is narrower. The narrow overflow channels between these two unvegetated channel paths appear to be more extensive. A meander to the north has developed between C1 and FC9, so that the downstream portion of the Finley Creek fan has been eroded in this area. The meander between FC9 and D1 has moved outward and downstream since 1973. A wide overflow channel through vegetation is present downstream of B1 (shown in light blue). The upstream part of this overflow channel was the 1939 active channel. The downstream part was the active channel in 1962. Narrow overflow channels have developed through the vegetated area between C1 and the wide overflow channel downstream of B1.

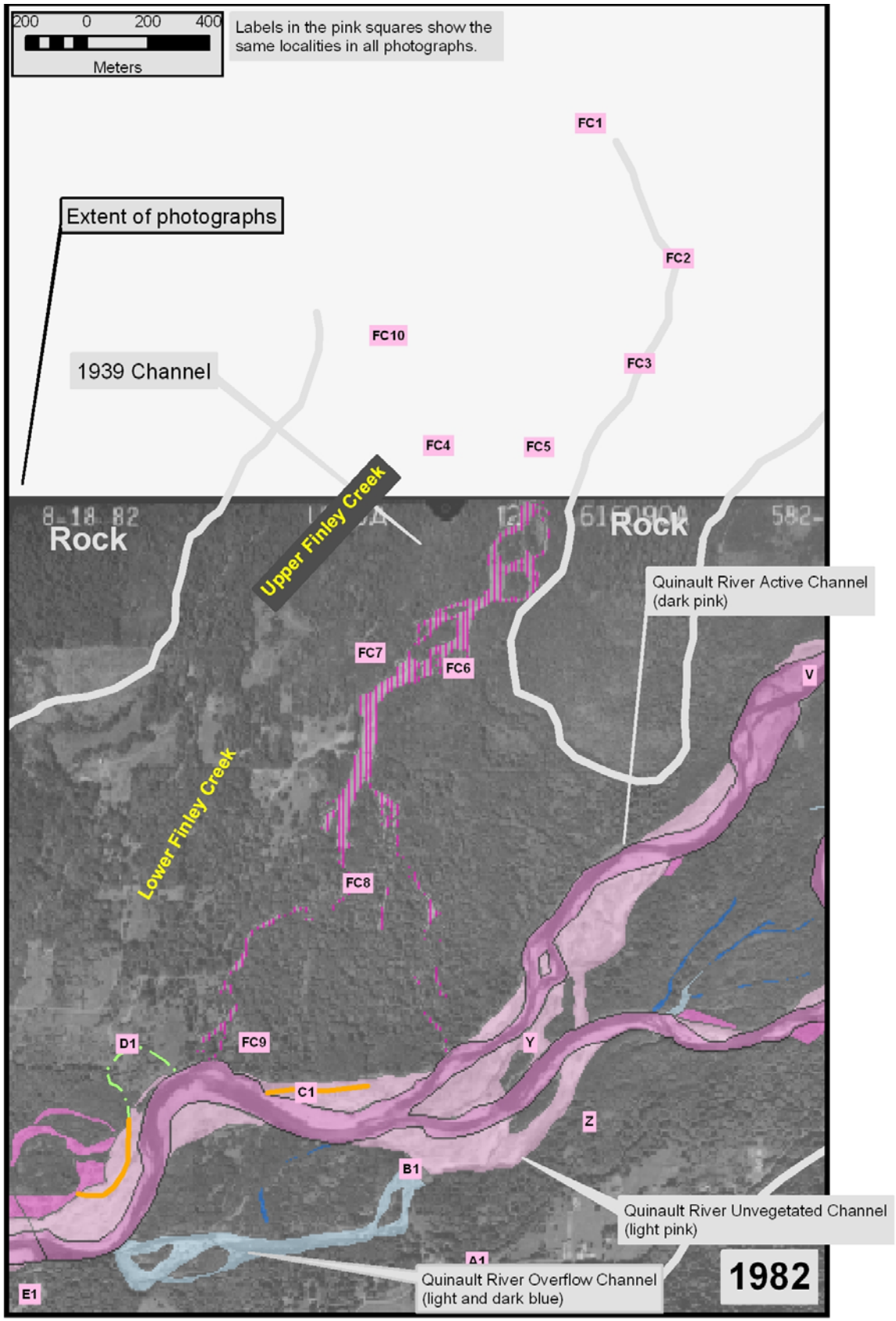

Figure 6. Finley Creek area in 1982.

3.7. 1994

3.7.1. Finley Creek

In upper Finley Creek, Finley Creek between FC1 and FC3 is now along bedrock in the narrow east path that was present in 1952 (figure 7). The 1952 and 1958 main paths can be seen in the vegetation as an abandoned path. The 1994 main path has a narrow branch near FC3. The path downstream of FC3 is a single fairly wide path. Just upstream of FC6 and FC7, the path splits. The west path is wider and probably carries more flow. The channel curves to the east in the area of the bridge. In this area, activity on the levees is visible. The position of the levees is not quite the same alignment as it will be in 2002.

In lower Finley Creek, the paths east of FC8 appear to be more in number and more continuous. The west path between FC8 and about D1 is no longer present as an unvegetated channel. A new west path has developed upstream of FC8. The now-active braided paths east of FC8 join the Quinault River in a narrow unvegetated overflow channel. A small alluvial-fan deposit is visible from Finley Creek in this overflow channel of the Quinault River.

The area west of Finley Creek appears to be more vegetated than it was in earlier years.

3.7.2. Quinault River

The north branch of the active channel between V and Y carries nearly all of the flow. This was an unvegetated overflow path in 1939. The south active channel path upstream of Y is very narrow. The main overflow path between these two active channel paths has widened. The north active channel path upstream of Y is now split into two main channels with a circular configuration. The north of these two flow paths has eroded the lower end of Finley Creek alluvial fan in this area.

Near Y, the active channel splits. The south active channel now flows between Z and B1 and downstream to E1 in what was a wide overflow path through vegetation in 1982. The north path of the active channel flows partially in what was the 1982 active channel. The meander between FC9 and D1 has moved farther downstream, now to D1. The 1973 active channel at D1 has revegetated.

The narrow unvegetated overflow channel, where Finley Creek joins the Quinault River, is in part a new path and was in part the 1982 unvegetated channel.

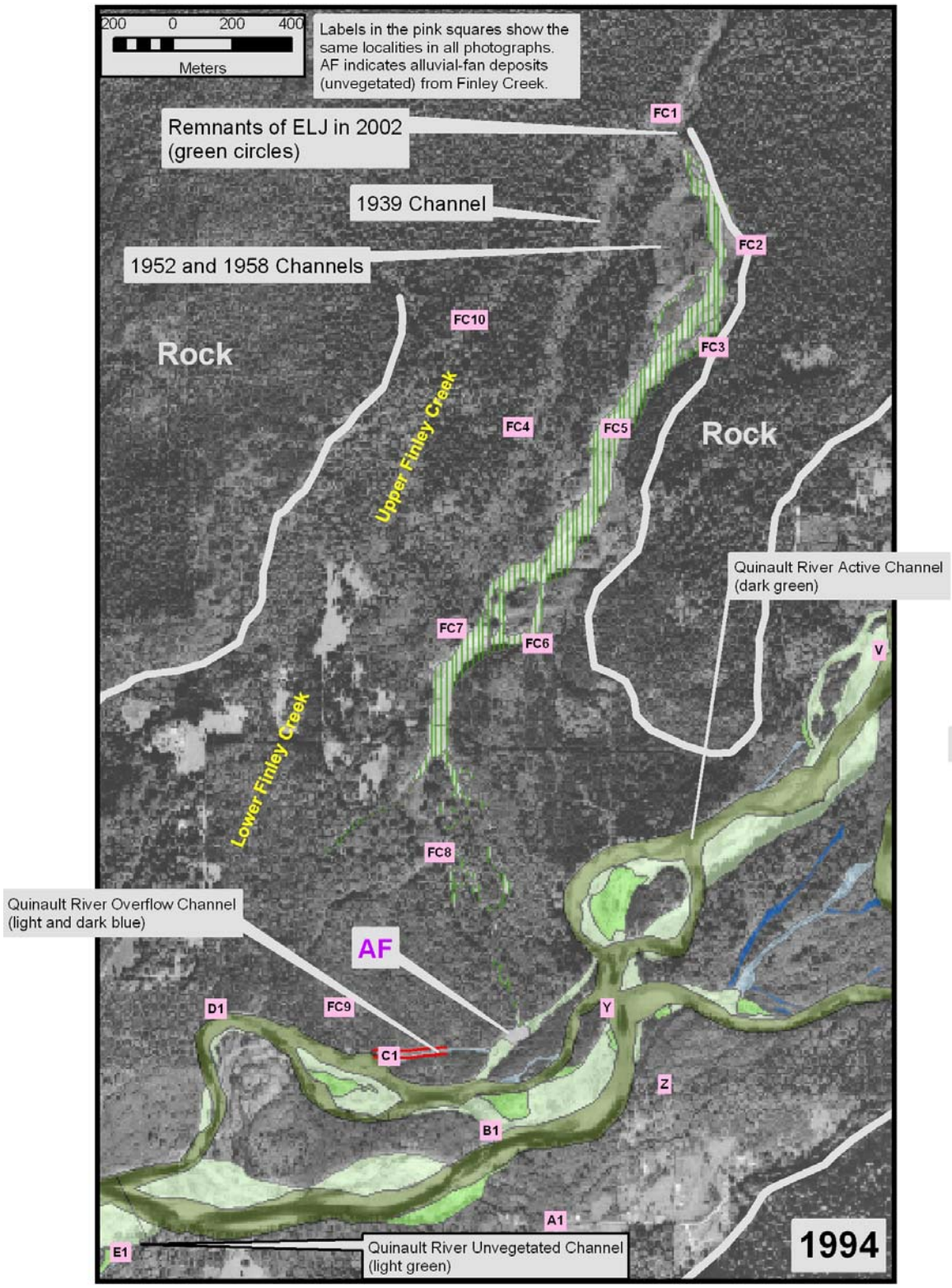

Figure 7. Finley Creek area in 1994.

3.8. 1998

3.8.1. Finley Creek

In upper Finley Creek, the creek in 1998 is entirely along what was the east path in previous years (figure 8). The east channel edge corresponds with the eroding bank that will be visible in 2002 (shown by the orange squares). The levees downstream of FC6 and FC7 are present along approximately the same alignment as they will be in 2002.

In lower Finley Creek, the multiple channel paths east of FC8 are wider and more continuous. The levees end at the upstream end of these channel paths, and appear to direct flow to the east into these channels. These channels join the Quinault River in at least two localities: one upstream of Y and one downstream of Y. A scar visible along the upstream path suggests bank erosion.

An additional unvegetated path is now present on the west in about the same location as channels have been in previous years. This channel joins the Quinault River west of FC9 into an unvegetated overflow channel. A small alluvial-fan deposit from the Finley Creek channel is present in the overflow channel (shown as AF on figure 8).

Cleared areas appear to be approximately the same as they were in 1994.

3.8.2. Quinault River

The active channel between V and Y has straightened. Only the north path of the split flow paths is now part of the active channel. The south path is now an unvegetated overflow path. The sharp meander and split path in the north path upstream of Y has been abandoned. This is the unvegetated overflow path that upstream east branches of Finley Creek enter. At Y, the active channel is partly within the narrow unvegetated overflow channel that was present in 1994.

Between B1 and E1, the active channel is solely within the south path of what was split flow in 1994. The active channel has branching flow paths. The former north path is now an unvegetated overflow channel. This the channel that the west branch of Finley Creek joins near FC9. Several narrow overflow channels have developed through the vegetation between these two former active channel paths of the Quinault River.

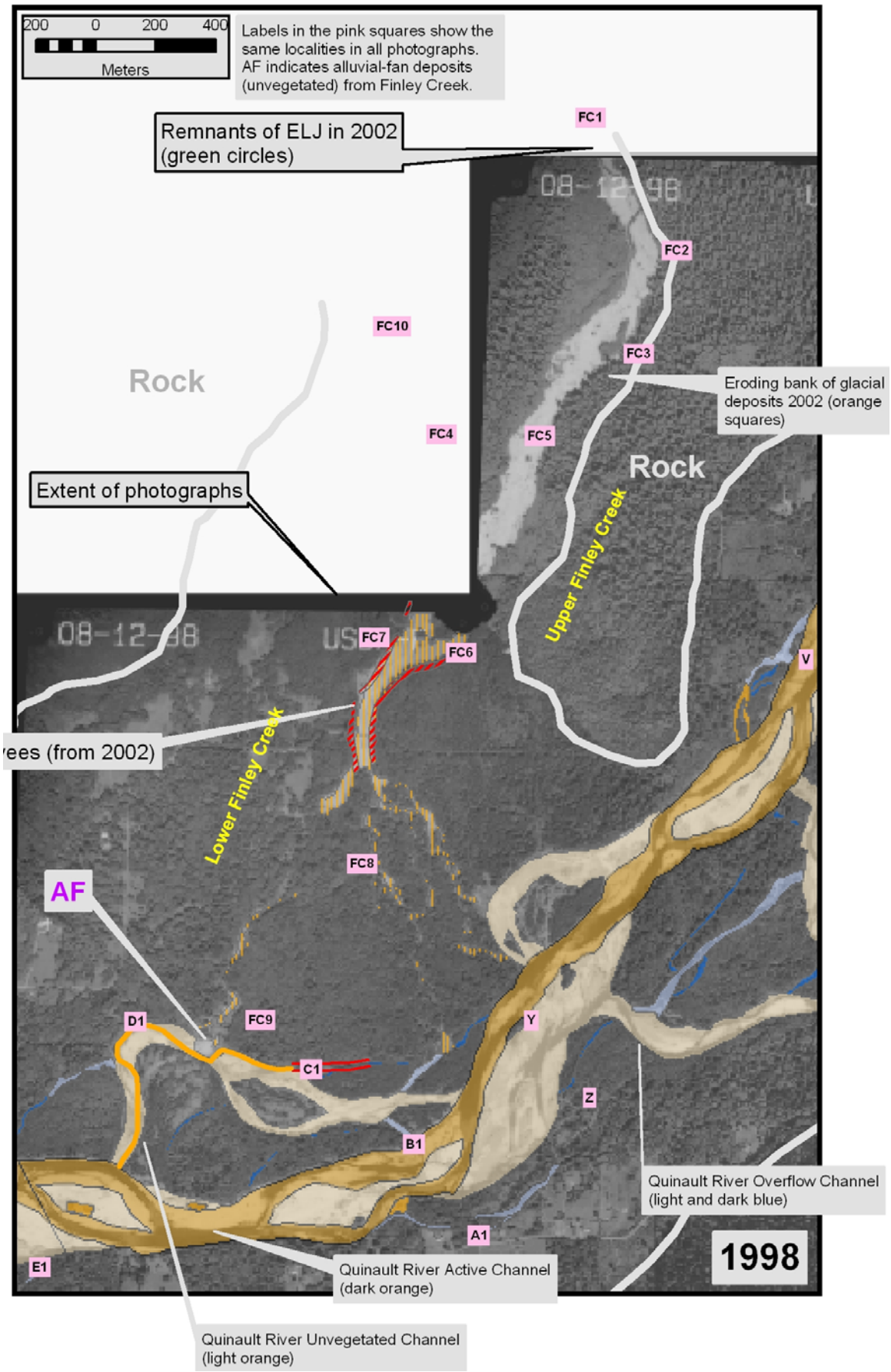

Figure 8. Finley Creek area in 1998.

3.9. 2001

3.9.1. Finley Creek

In upper Finley Creek, the creek is along bedrock and glacial deposits, where the eroding bank is likely present in 2002. This bank is visible on the 2002 hillshade. The older channel, 1939 channel, and main 1952 and 1958 channels are all still visible as differences in vegetation (figure 9).

The levees are readily visible near FC6 and FC7, and follow the alignment that they have in 2002. Flow splits into several narrow unvegetated channels downstream of the levees. The east flow path is in the same position as it was in 1998. A larger alluvial-fan deposit is present where it enters the overflow channel of the Quinault River (shown as AF on figure 9). The upstream and downstream ends of this overflow channel are now partially vegetated, suggesting less and (or) less frequent flows. The west unvegetated path of Finley Creek follows approximately the west path that was present in 1998. It enters an unvegetated overflow channel of the Quinault River, and also has an alluvial-fan deposit at its mouth.

Only a small portion of the Finely Creek alluvial fan is now cleared of vegetation.

3.9.2. Quinault River

The active channel is about the same as it was in 1998, except that the split flow paths are now a single path within which the low-flow channel meanders. The abandoned path upstream of Y (the old meander) was unvegetated in 1998, but now its upstream and downstream ends have some vegetation. This is the channel that one path of Finley Creek enters.

The abandoned path between Y and D1 appears about the same as it did in 1998, perhaps slightly narrower. This has become Taiber Slough, an area of sockeye spawning, by at least 2002 (B. Armstrong (Quinault Indian Nation), 2002, written commun.).

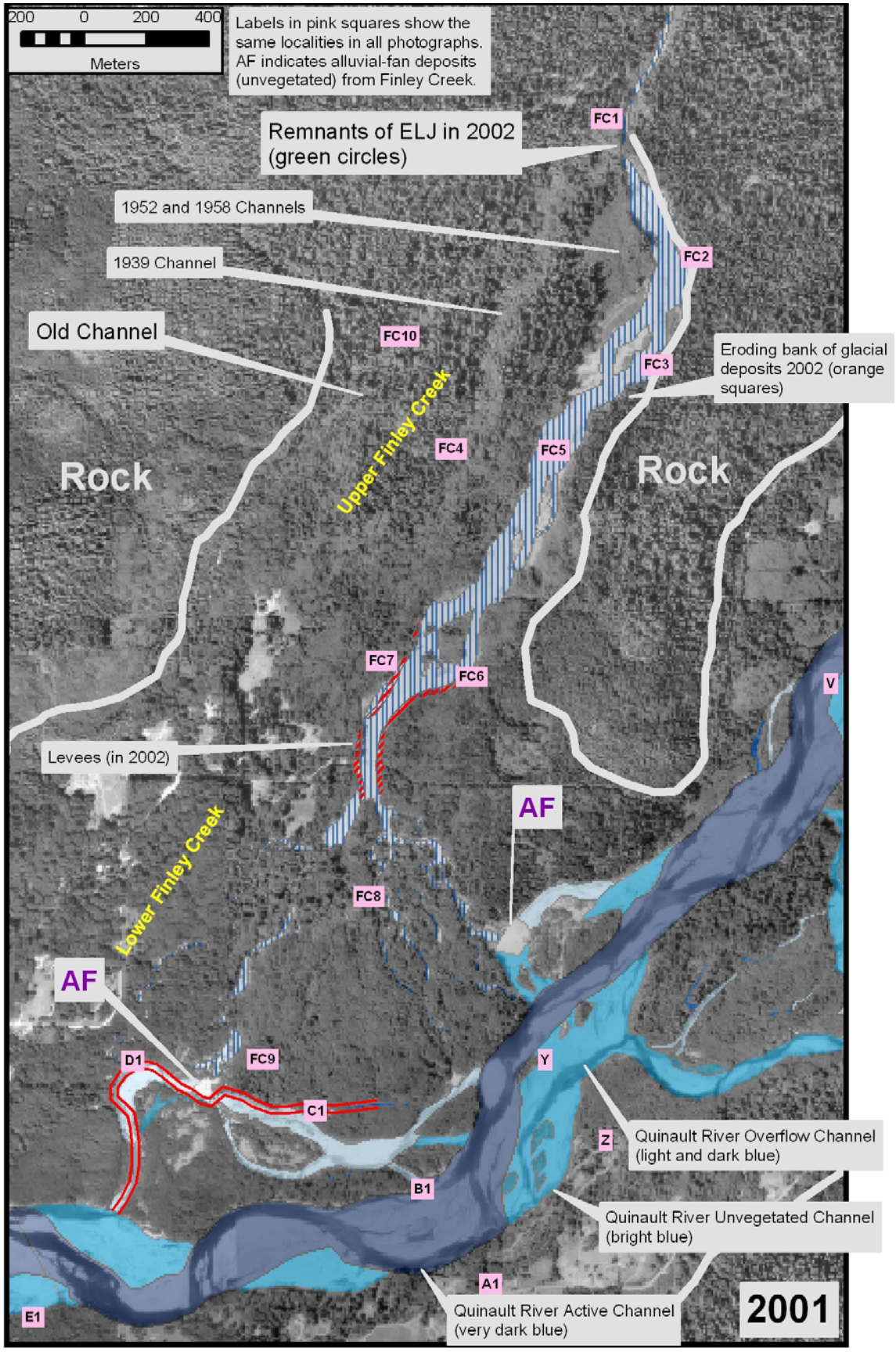

Figure 9. Finley Creek area in 2001.

3.10. 2002

3.10.1. Finley Creek

In upper Finley Creek, the channel path is not much different from what it was in 2001 (figure 10).

In lower Finley Creek, the easternmost channel path downstream of the levees may be slightly more pronounced than it was in 2001. An alluvial-fan deposits (unvegetated) still is present where this channel enters the overflow channel of the Quinault River (shown as AF). The upstream end of the Quinault River overflow channel appears to be unvegetated, whereas it had some vegetation in 2001. The west channel at the downstream end of Finley Creek is about the same as it was in 2001. It still enters the overflow channel of Quinault River, now called Taiber Slough. The west channel can be seen on the hillshade as an incised channel between FC8 and FC9. In contrast, the eastern channel paths are only barely visible on the 2002 hillshade.

The levees near FC6 and FC7 are prominent. They are readily visible on the 2002 hillshade. These levees direct flow to the east. The west levee cuts off flow to the west path of lower Finley Creek.

3.10.2. Quinault River

The active channel path is similar to what it was in 2001. However, the low-flow channel is straighter, especially downstream of Y, where the path has moved to the south. Several narrow overflow channels are visible through the vegetated surface upstream of Y.

The unvegetated overflow channel downstream of Y (Taiber Slough) appears narrower and more braided than it did in 2001, suggesting that the channel receives less flow. This may be because the low-flow main channel has moved to the south downstream of Y. This remains the active channel path of the Quinault River to 2002. Because of the cut offs and changes in the location of the active channel, the toe of the Finley Creek alluvial-fan complex has progressively eroded between 1939 and 2002.

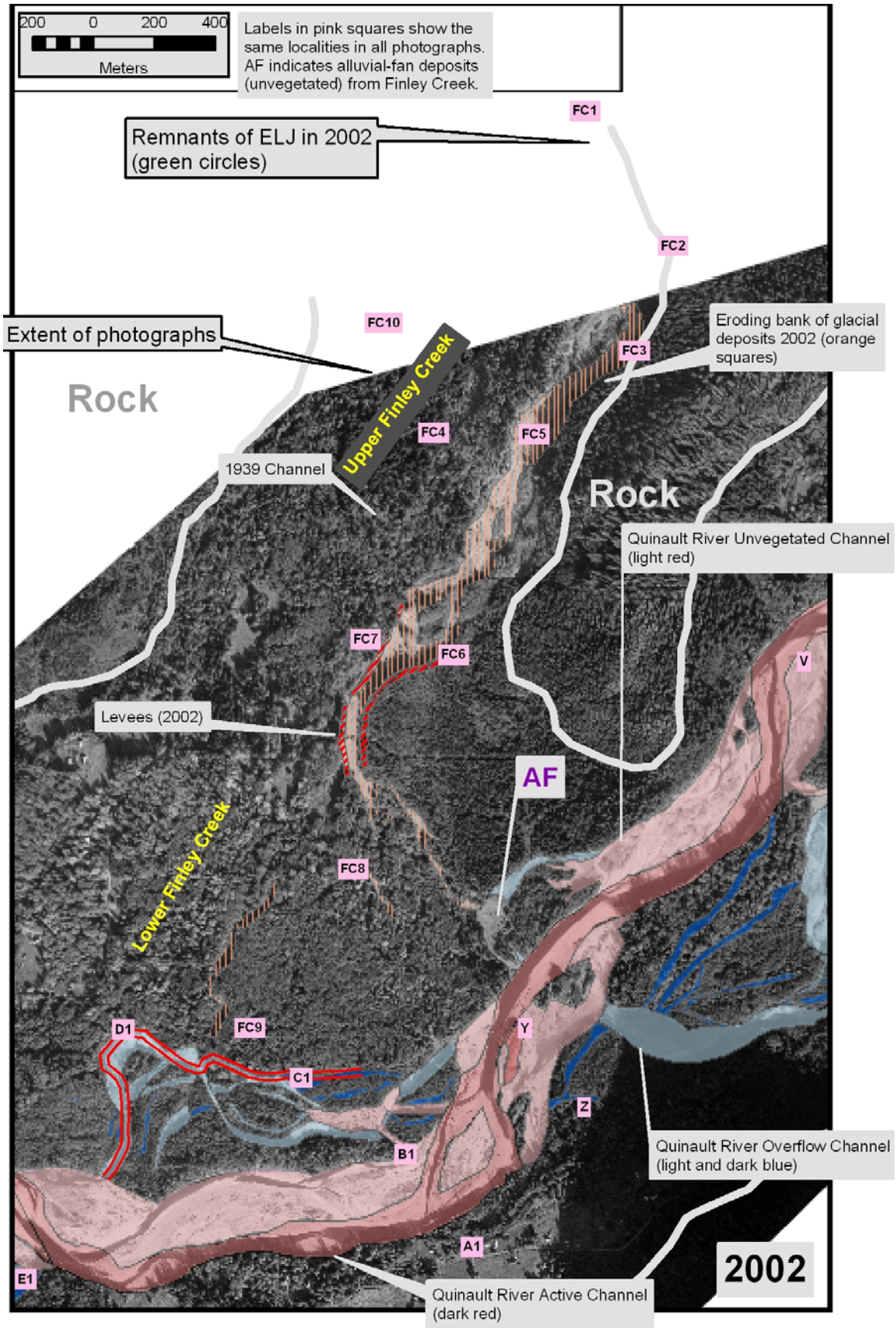

Figure 10. Finley Creek area in 2002.

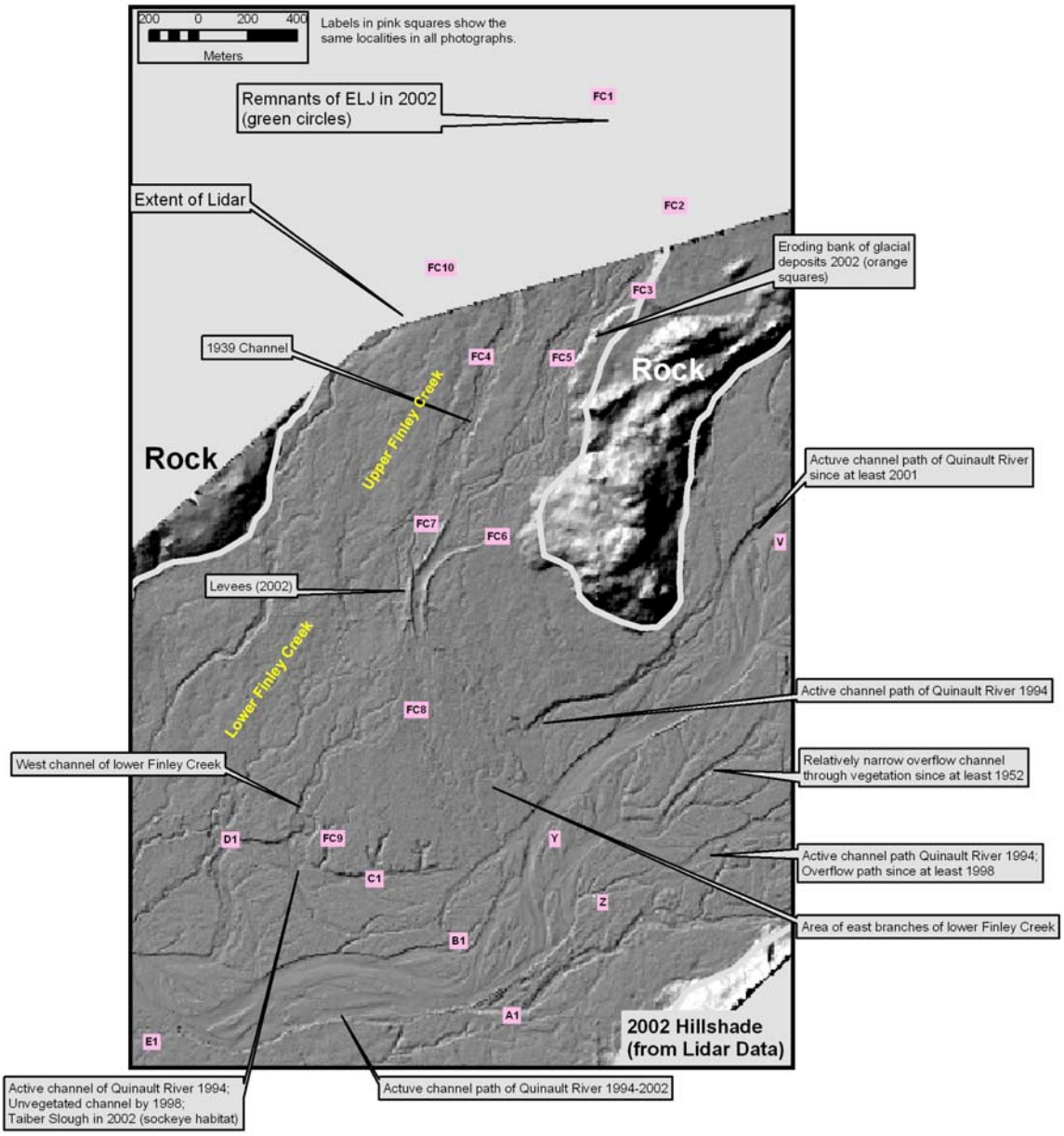

Figure 11. Finley Creek area shown on the hillshade calculated from the Lidar data collected in 2002. Evidence of former channels of both Finley Creek and the Quinault River are still visible in the landscape in 2002 as shown by the notes.

Finley Creek, Upper Quinault River Valley, Washington
Summary of Observations

E. Lyon and L. Piety, USBR Geologists

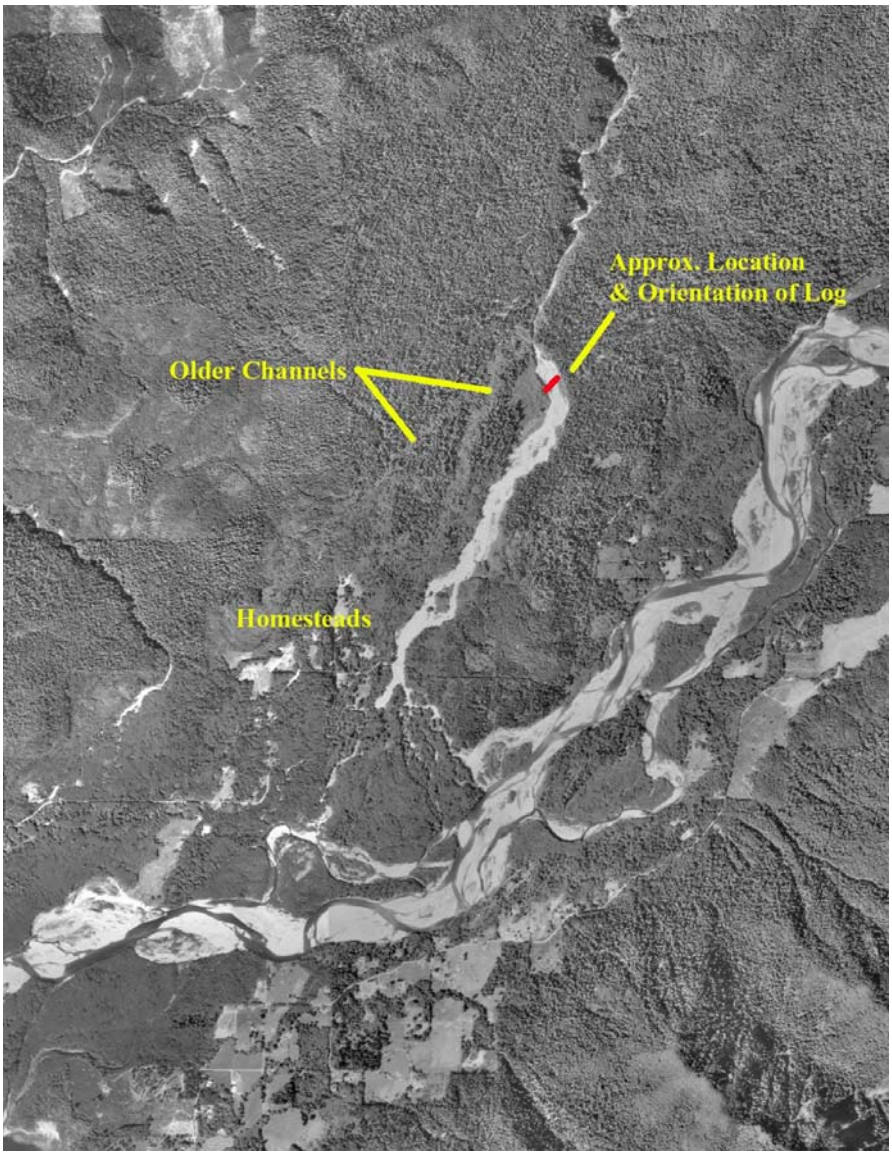

Figure 1. 2001 Aerial photograph of Finley Creek drainage showing the location of a recently fallen Sitka Spruce which is partially elevated above the active Finley Creek channel, but as the west bank erodes the tree will enter the active channel and adversely direct flows toward older channels (unfortunately a photo is unavailable). These older channels are directed towards the homesteads downstream.

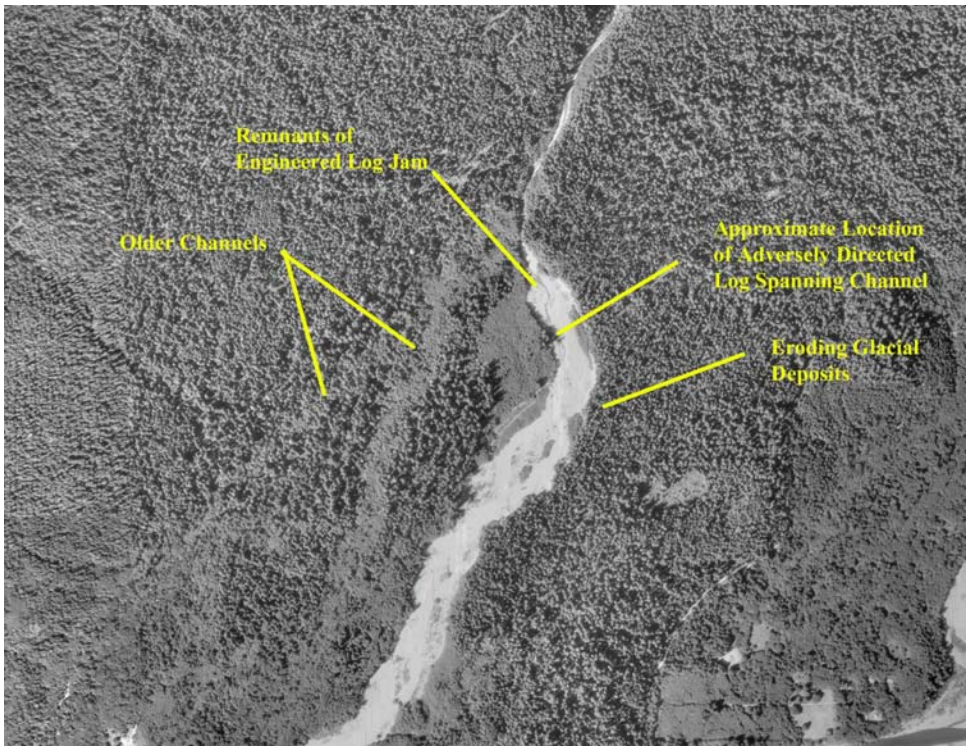

Figure 2. 2001 Aerial photograph showing location of old engineered log jam (ELJ) which was put in-place between 1939 and 1952. The ELJ directs flow away from the older western channels and eastward into the glacial bluff. Erosion of the bluff has introduced copious amounts of coarse sediment into the system.

Figure 3. Glacial bluff along the eastern bank of Finley Creek. These glacial deposits are composed of delta foresets indicating the Late Pleistocene highstand of Lake Quinault.

Figure 4. Remnants of the ELJ that directed the Finley Creek flows towards the eastbank between 1939 and 1952, note the eroding glacial bluff in the background. Most of the logs are now separated with cables still attached.

Figure 5. Log and cable protruding from right streambank (left side in photo) is a remnant of the ELJ that directed the channel to the east.