APPENDICES

APPENDIX A. TRINITY RIVER RESTORATION PROGRAM CHANNEL REHABILITATION SITE DESCRIPTIONS.

A.1 Pear Tree

The Pear Tree Gulch site is located approximately 9.7 km (6 mi) downstream of the Canyon Creek confluence (Figure A-1), beginning at rkm 118.46 (rm 73.61) and extending 1.95 rkm (1.21 mi) downstream along the mainstem Trinity River (Figure A-2). Pear Tree Gulch flows into the mainstem Trinity River at the upstream end of the site. A right bank gravel bar formed at the upstream end of the site and a terrace (i.e., historical floodplain) occurred on the lower two thirds of the site. The left bank at Pear Tree Gulch is bedrock canyon wall. Pear Tree Gulch was one of the nine original pilot bank rehabilitation sites, built in 1993 (Hampton and Gilroy 1995). After construction in the early 1990s, the upstream edge of the point bar was mobilized frequently enough to prevent extensive development of riparian vegetation. However since 1998, flood flow conditions have been insufficient to prevent the re-encroachment of hardwoods along the 13 cms (450 cfs) water edge, and has resulted in the formation of a band of narrowleaf willow along the main-channel inhibiting flow connectivity between the main-channel and the right bank floodplain. Narrowleaf willow has always been the dominant riparian hardwood at the site, especially along the main-channel margin while non-native grasslands and yellow star-thistle grasslands have dominated terrace surfaces.

Pear Tree Gulch was constructed in fall 2006 as part of the Canyon Creek Suite (McBain & Trush 2007a). Construction at the Pear Tree Gulch site was broken into upland (U) and riverine (R) activity areas (Figure A-3). Hardwood pole cuttings were used in revegetation. Along the right bank the riparian berm was recontoured and existing vegetation removed (R4). At the downstream end of vegetation removal a feather edge was constructed (R6). The existing terrace behind the riparian berm was recontoured to facilitate inundation at 170 cms (6,000 cfs; R5). A high-flow scour channel was built through the newly constructed floodplain with a backwater alcove at the downstream end (R5 and R7). The high-flow scour channel was constructed to be inundated by 15.2 cm (6.0 in) of water at 187 cms (6,600 cfs). A terrace was constructed using the excavated materials along the right bank valley wall (U2). Constructed floodplains above 170 cms (6,000 cfs) were planted with black cottonwood, red willow, shiny willow, and arroyo willow (R5)

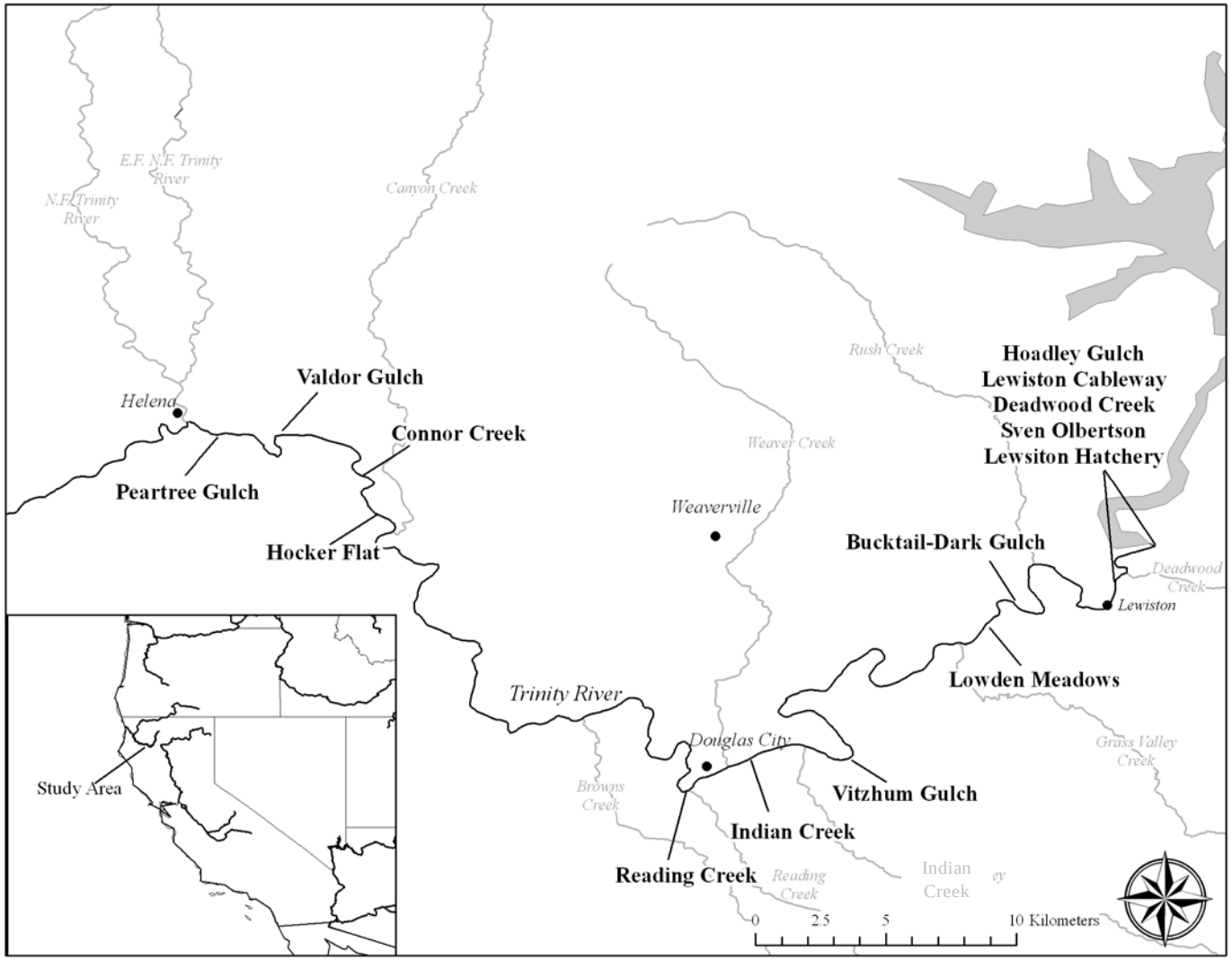


Figure A-1. Location of bank rehabilitation assessment sites, 2010.

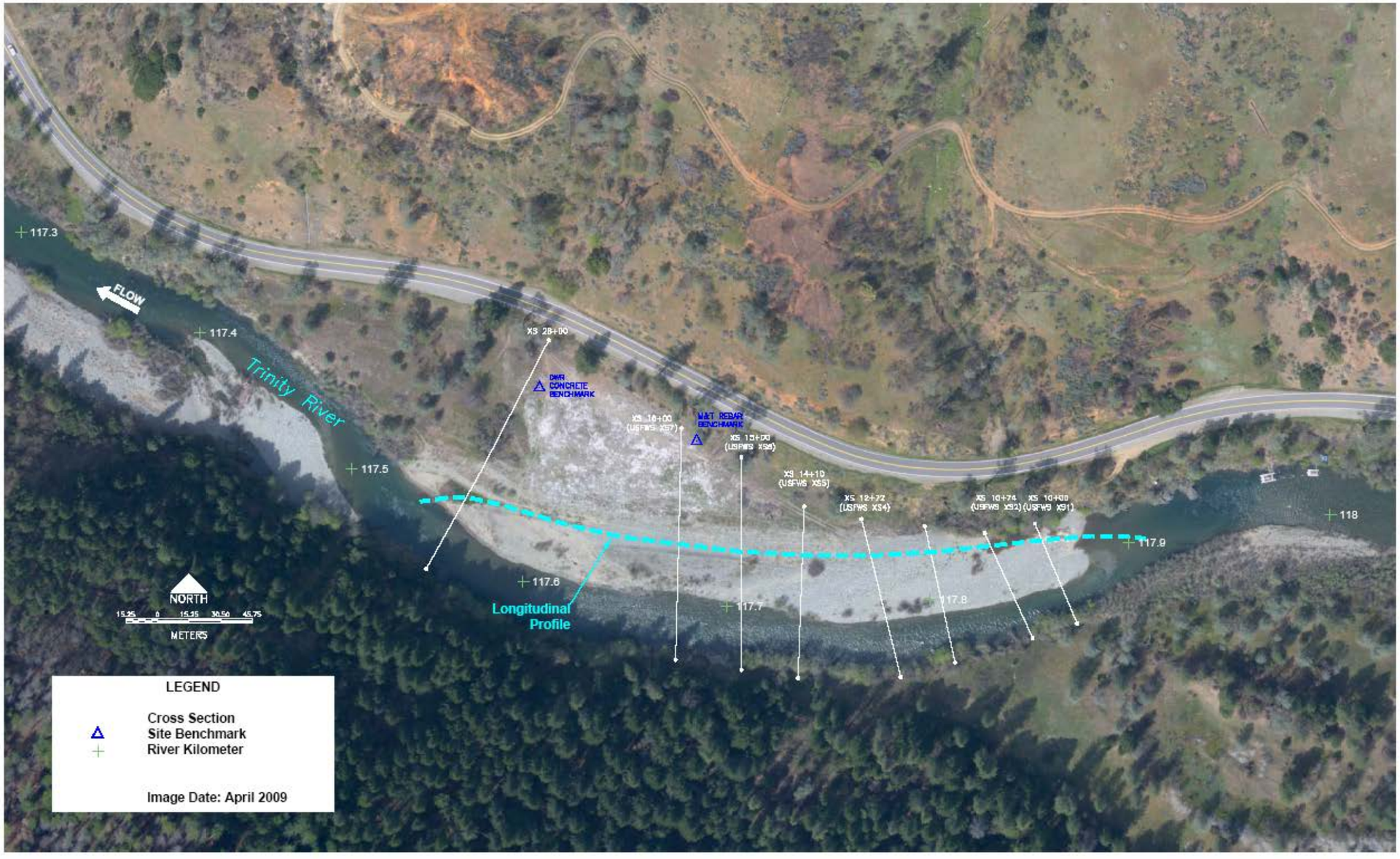


Figure A-2. Pear Tree site map. The longitudinal profile monitoring at the site begins at the upstream end of the bar feature and extends downstream through the constructed alcove.

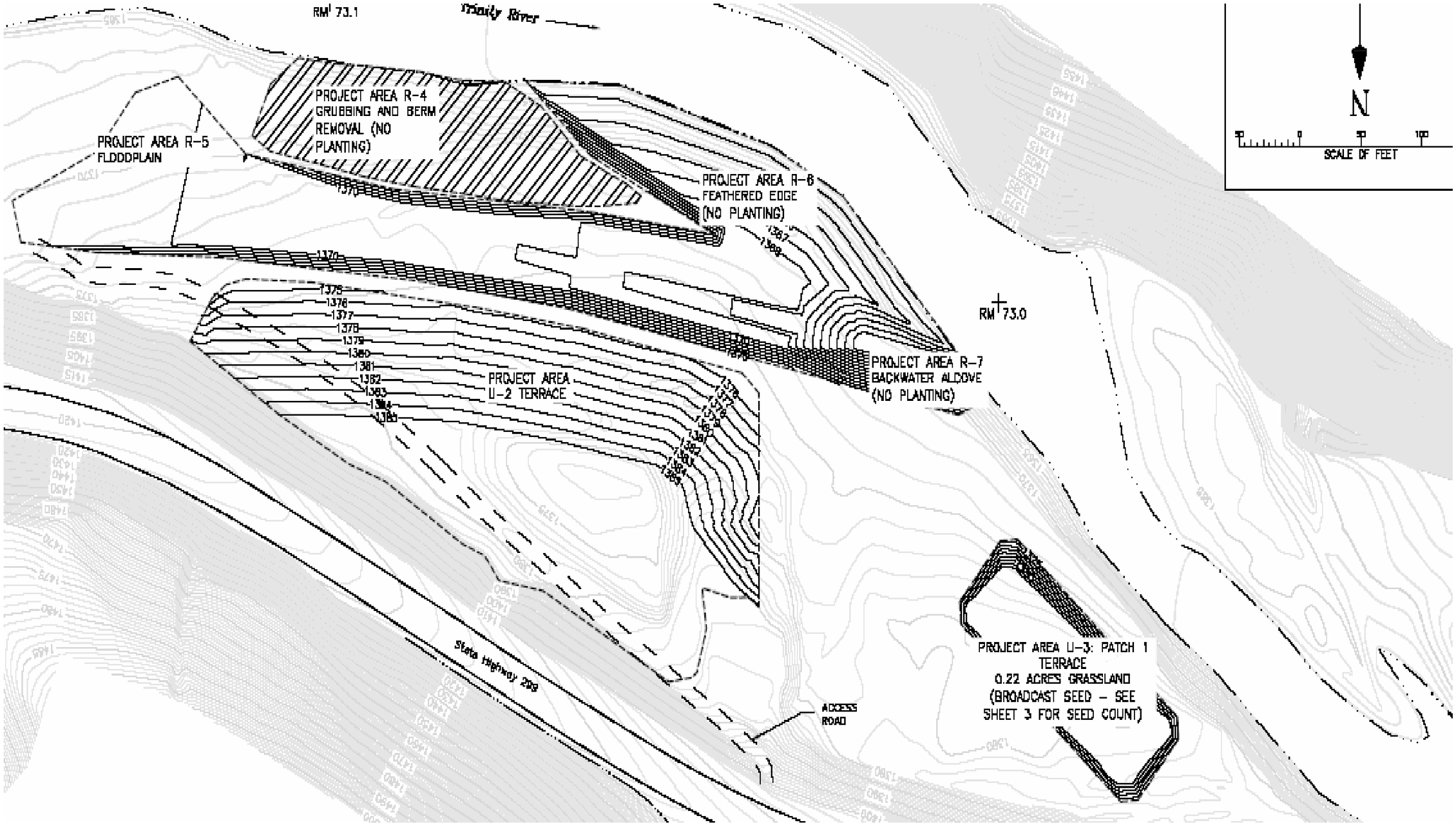


Figure A-3. Pear Tree 100% design drawing used for construction purposes. Primary constructions areas are indicated with R for riverine and U for upland.

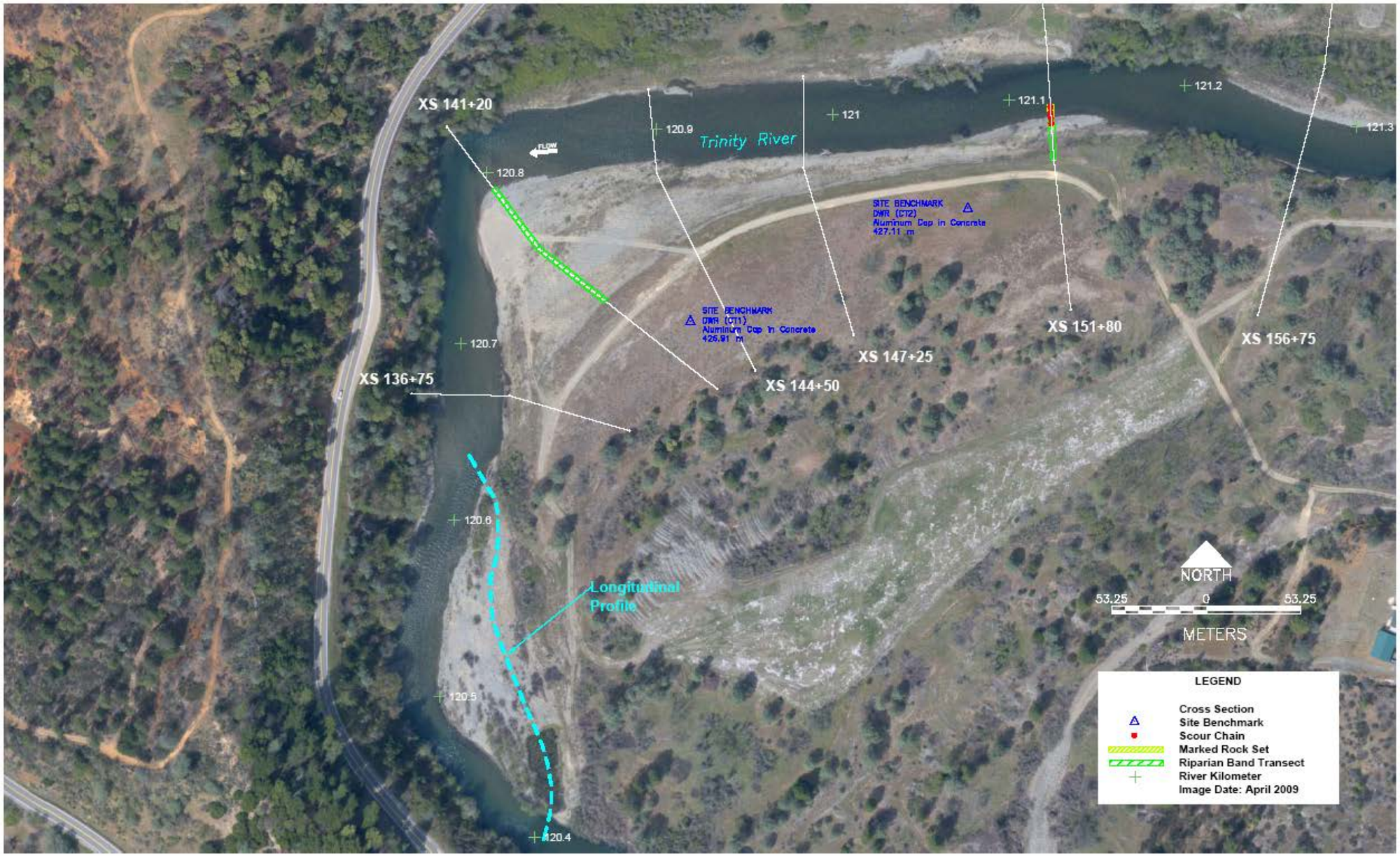


Figure A-4. Valdor Gulch site map, 1 of 2. The downstream extent of the longitudinal profile extended through the constructed alcove. Cross sections 141+20, 147+25 and 151+80 were monitored by geomorphic and riparian disciplines.

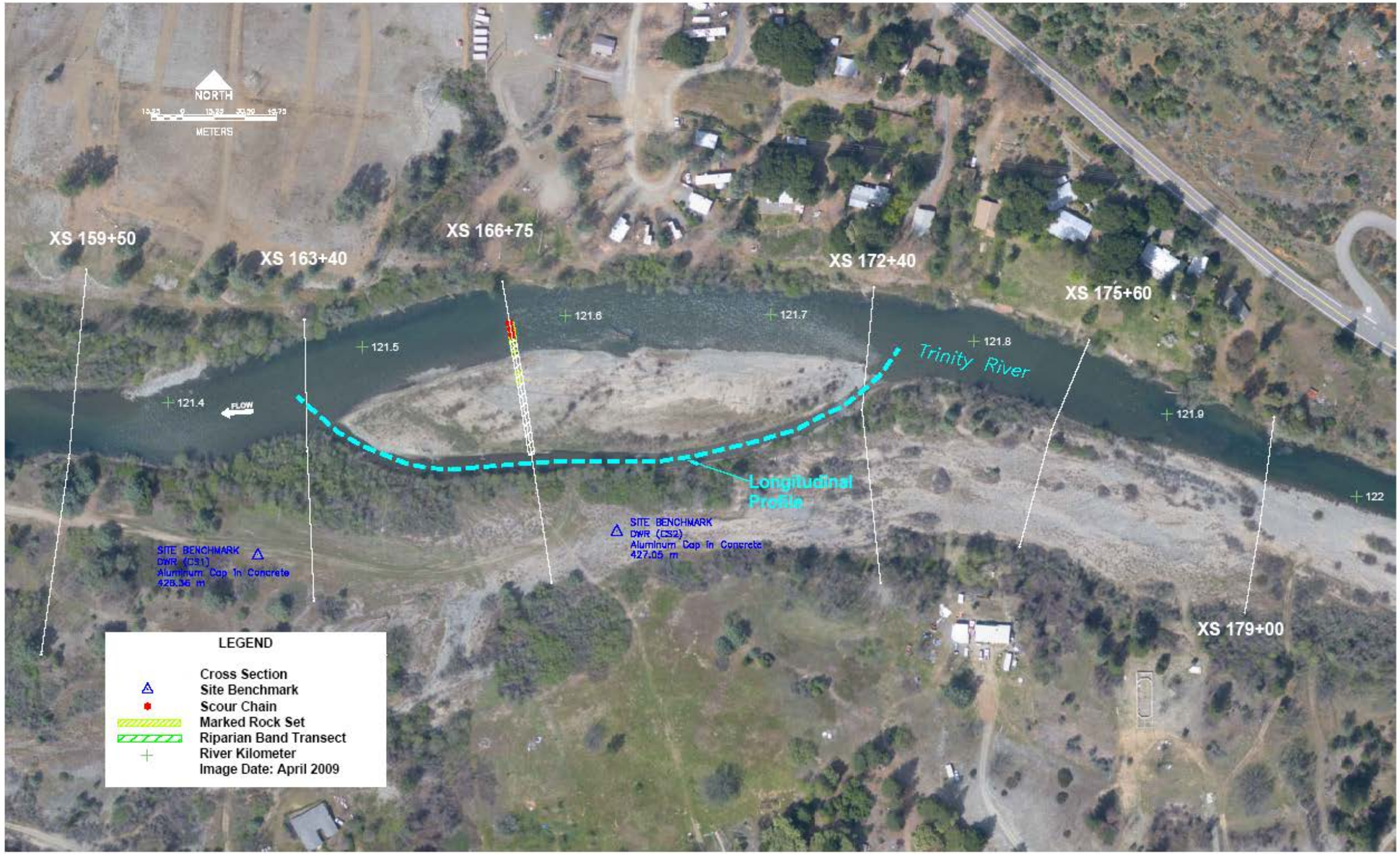


Figure A-5. Valdor Gulch site map, 2 of 2. The longitudinal profile extended throughout the entire constructed side channel along the medial bar. Cross section 166+75 was monitored by geomorphic and riparian disciplines.

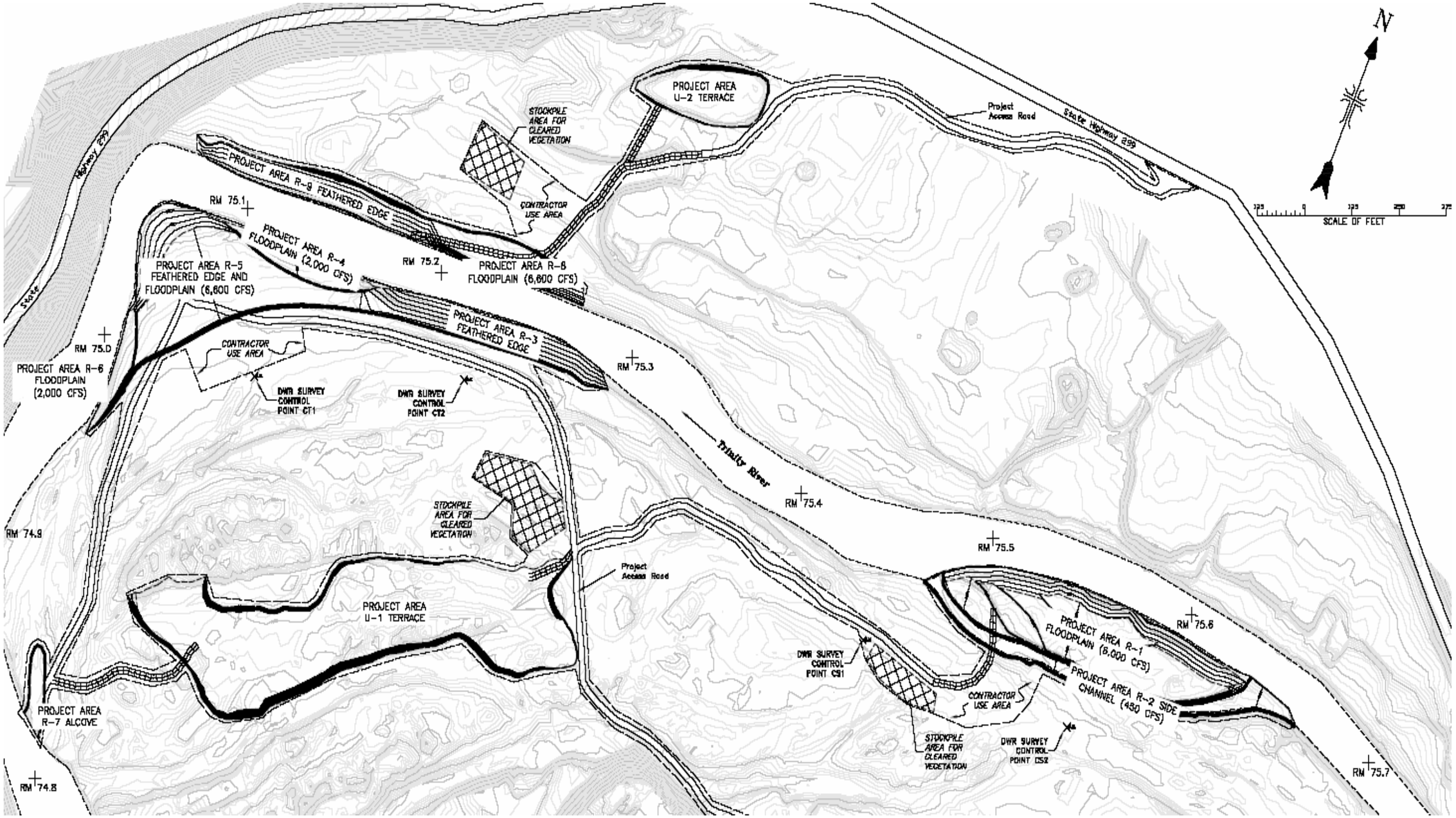


Figure A-6. Copy of Valdor Gulch 100% design used during construction implementation. Upland construction features are designated with a U. Riverine construction features are designated with a R.

A.1 Conner Creek

The Connor Creek site is located approximately 2.6 km (1.6 mi) downstream of the Canyon Creek confluence (Figure A-1) beginning at rkm 124.73 (rm 77.50) and extending 1.28 rkm (0.79 mi) downstream along the mainstem Trinity River (Figure A-7). Connor Creek occurs along the right bank on the inside of a large meander bend adjacent to Highway 299. Channel migration into the left bank is limited by human infrastructure and bedrock. Before rehabilitation, riparian vegetation on the right bank was diverse, though it grew on a distinct fine sediment berm. Behind the contemporary riparian berm was a fossilized floodplain (i.e., terrace) with both upland (e.g., non-native grassland) and riparian (e.g., narrowleaf – dusky willow) vegetation. Large stockpiles of unvegetated dredger tailings occur between the upland areas and Highway 299.

Connor Creek was constructed in fall 2006 as part of the Canyon Creek Suite (Figure A-8). Revegetation used hardwood pole cuttings. The riparian berm was recontoured (including existing vegetation removal) near the top third of the site and a bench that inundates at 13 cms (450 cfs) was constructed to provide slow water habitat at summer baseflows (R2). Behind and downstream of the low-flow bench, a 170 cms (6,000 cfs) floodplain with a feathered edge was constructed (R5). The existing terrace behind the riparian berm was recontoured and a high-flow scour channel that inundates at 187 cms (6,600 cfs) was built to provide connectivity between the upper part of the site and the lower constructed floodplain (R3, R4). Spoils from excavated areas were used to fill in dredger swales and construct a terrace (U1 and U2). Constructed floodplains were planted with black cottonwood, arroyo willow, shiny willow and red willow (R3, R4, R5). Large wood was placed along feathered edges and on constructed floodplains.

Figure A-7. Conner Creek site map. Monitored cross sections included 265+40, 260+05, 252+35, 247+40, and 241+60.

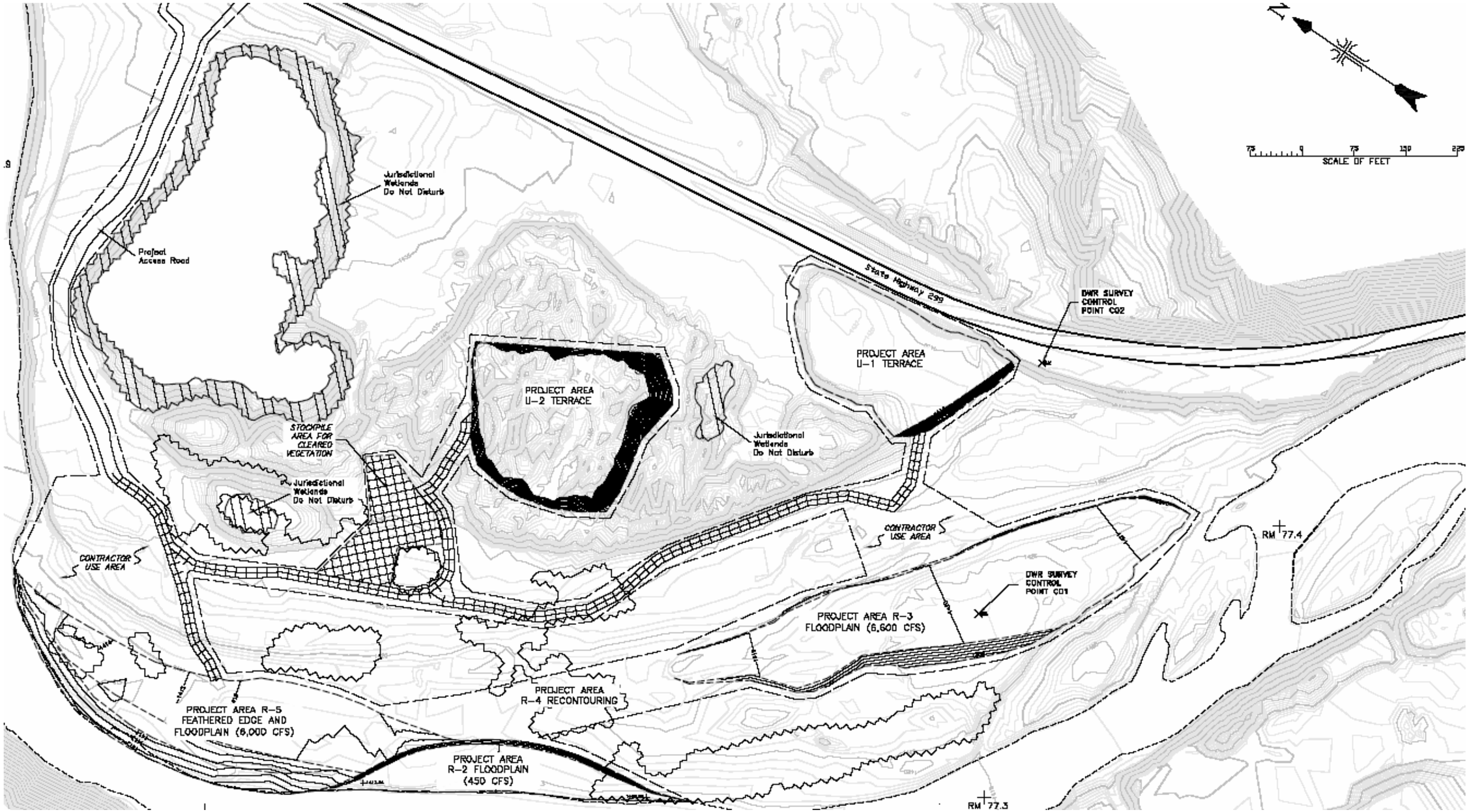


Figure A-8. Copy of Conner Creek 100% design used during construction. Upland construction features are designated with a U. Riverine construction features are designated with a R.

A.2 Hocker Flat

The Hocker Flat site begins at the confluence of Canyon Creek (Figure A-1) at rkm 127.63 (rm 79.31) and extends 2.01 rkm (1.25 mi) downstream (Figure A-9 -Figure A-11). Upper Hocker Flat occurs on the left bank of the mainstem Trinity River on the inside of a sharp meander bend (Figure A-9). The upstream end of the site was a fossilized point bar and dredger tailings prior to construction. Channel margins were by thin riparian berms. The right bank is armored with rip-rap along Highway 299. Behind the berm was a historic floodplain/terrace that was seldom inundated. The upland extent of the terrace/floodplain was marked by large dredger tailings piles. On the right bank of the mainstem Trinity River just downstream of upper Hocker Flat is the pilot bank rehabilitation site, Jim Smith (Figure A-10). The Jim Smith site occurred on the inside of a subtle meander bend and was subsequently encroached by a riparian berm. A continuation of the riparian berm at Hocker Flat occurs along the bottom of dredger tailing piles on left bank across from Jim Smith. The Jim Smith area had a thin riparian berm along the channel edge prior to construction, although the floodplain behind the berm was occasionally inundated and a high-flow scour channel had formed at the upland edge of the floodplain. Lower Hocker Flat occurs along the left bank directly downstream of Jim Smith. Before rehabilitation a floodplain was disconnected from the mainstem streamflows by a riparian berm and was seldom inundated (Figure A-11). Existing riparian vegetation was especially prevalent along the channel margins and grew on a distinct berm of fine sediments.

The Hocker Flat site was constructed in fall 2005, the first post-ROD site (Figure A-12). At the upstream end of the site, the existing riparian vegetation was removed and the riparian berm was recontoured (R2). Along the left bank the existing terrace was excavated down to be inundated 0.3 m (1 ft) deep at 170 cms (6,000 cfs) (R4). Excavated materials were placed in swales between dredger tailings and graded to create a terrace (U2). Along the right bank through the Jim Smith pilot feather edge, riparian vegetation was removed and the riparian berm recontoured. Dredger tailings were removed and a floodplain surface that was inundated by 170cms (6,000 cfs) constructed (R5). Excavated dredger tailings were used to fill off channel aggregate mining ponds and construct a terrace on the right bank along Highway 299 (U4). At the lower end of Hocker Flat along the left bank existing riparian vegetation was removed and the ground surface contoured to create a feathered edge and floodplain (R6). In addition, a small unnamed tributary on the left bank was enhanced through the construction of a shallow pan that would pond water when the tributary created a backwater during seasonal flood events (managed and unmanaged). Excavated materials were placed in swales between dredger tailings and graded to create a terrace (U3, U5, and U6). Hardwood pole cuttings and rooted nursery grown materials were used in revegetation. Constructed floodplains were planted with black cottonwood, arroyo willow, shiny willow, red willow, Oregon ash, and white alder (R2, R4, R5, R6, and R7). Hocker Flat was the only site where large wood was not placed during construction.

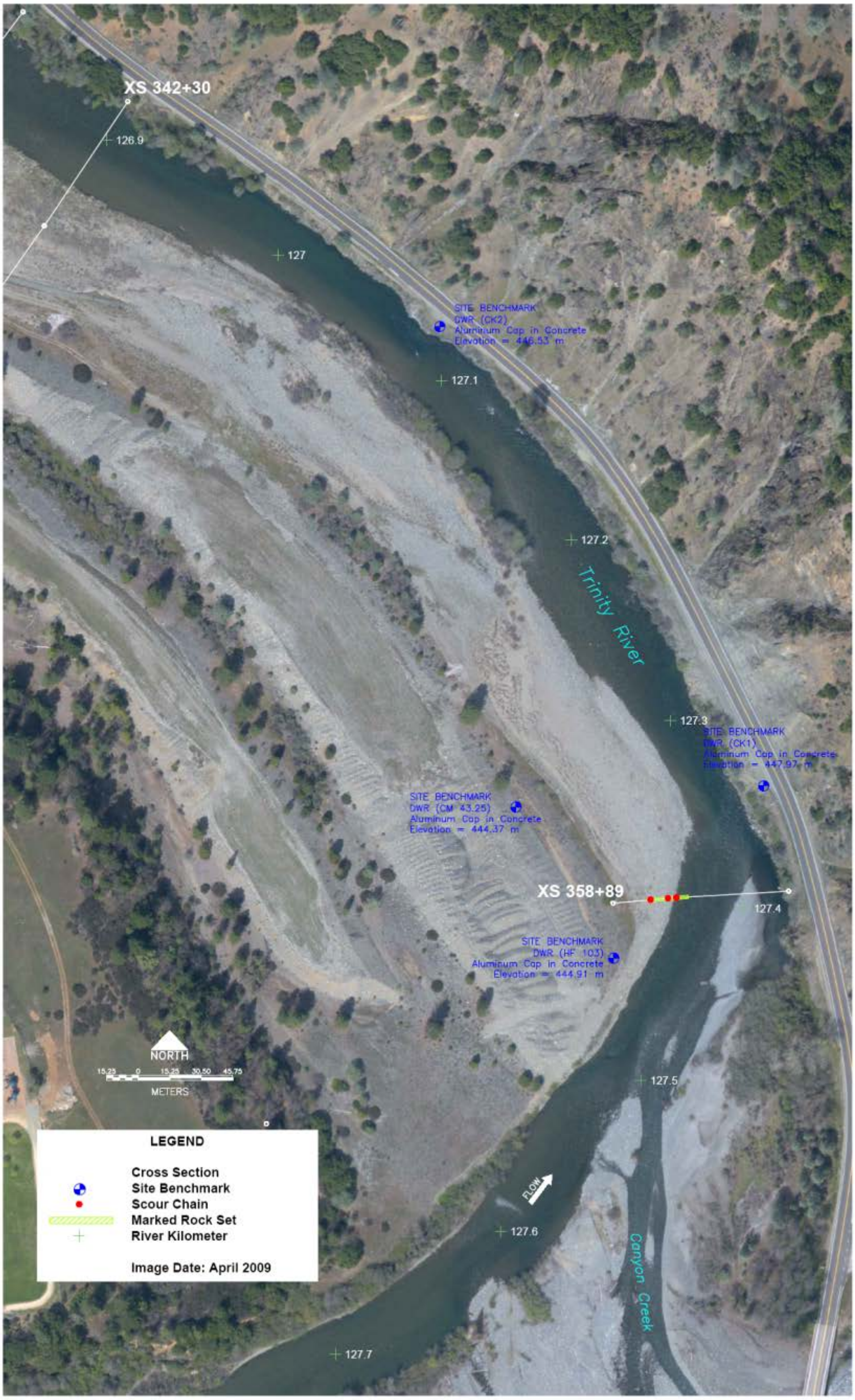


Figure A-9. Upper Hocker Flat site map, 1 of 3. Scour chains and marked rocks were placed at cross section 358+89, which was also monitored for changes in topography.

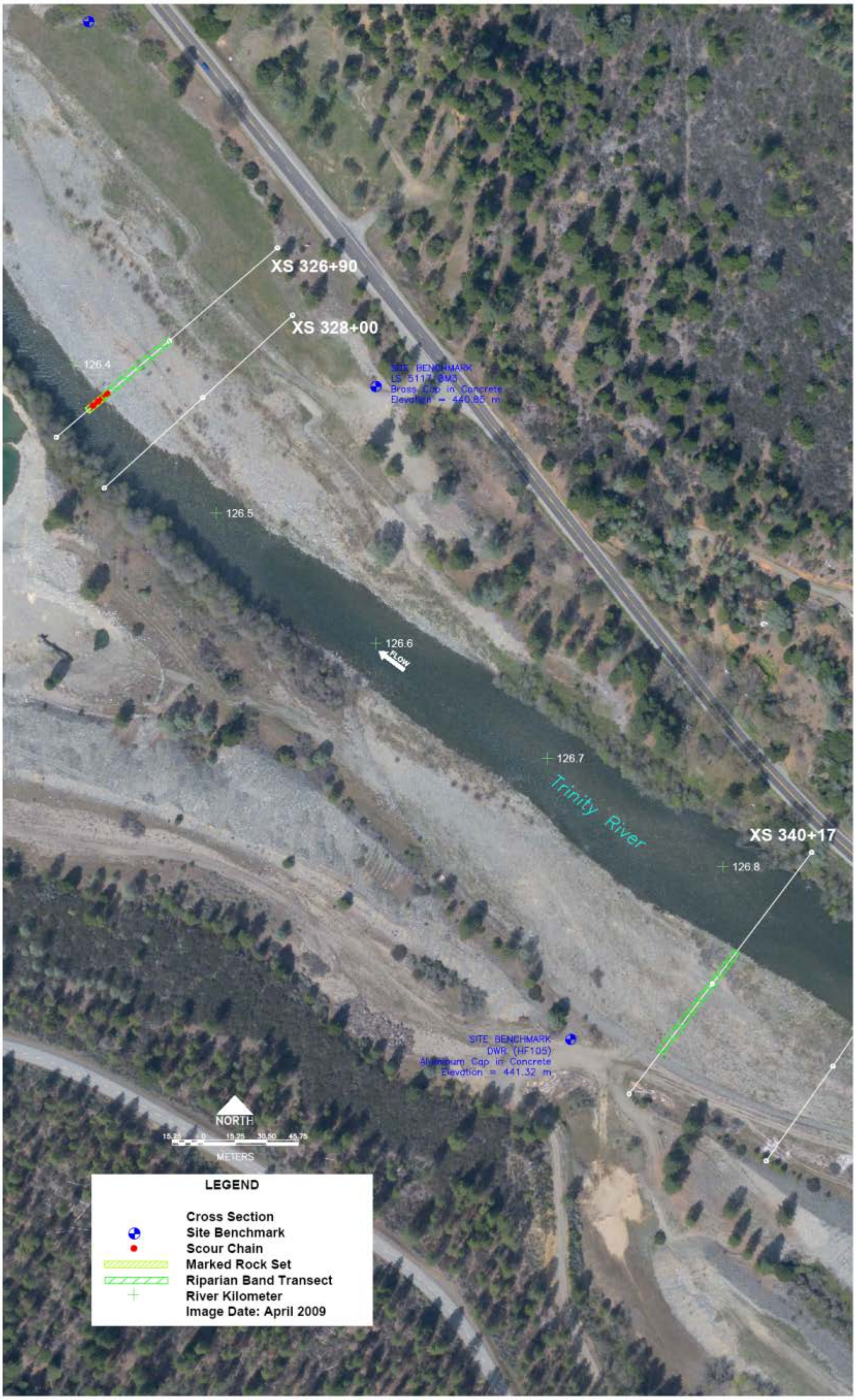


Figure A-10. . Hocker Flat (Jim Smith) site map, 2 of 3. Marked rocks and scour chains were monitored at cross section 326+90. Cross sections 326+90 and 340+17 were monitored as riparian band transects, as well as for documenting changes in topography.

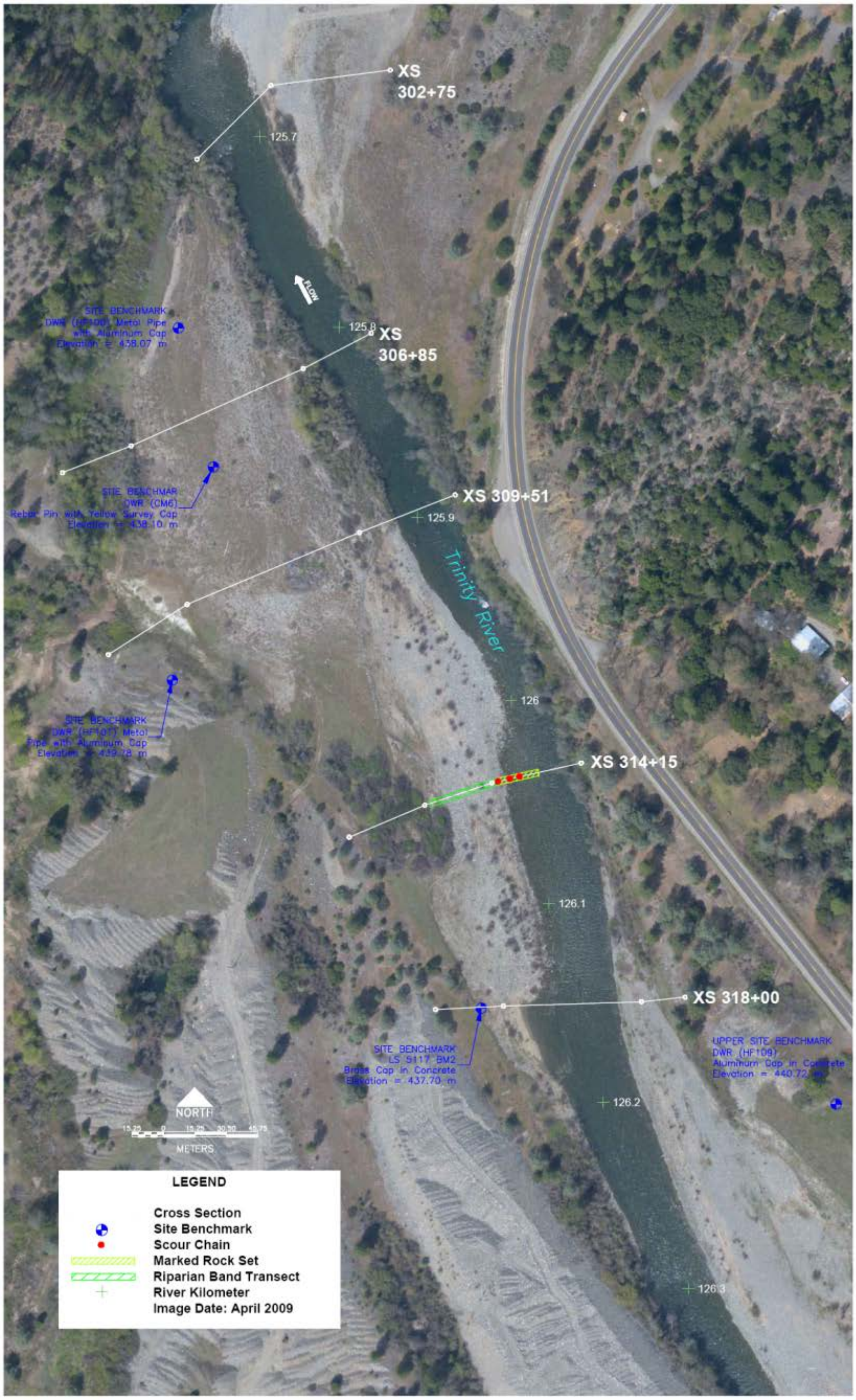


Figure A-11. Lower Hocker Flat site map, 3 of 3. Scour chains and marked rocks were monitored at cross section 314+15; cross section 314+15 was also monitored as a riparian band transect and for measuring changes in topography. Cross section 309+51 was monitored for changes in topography only.

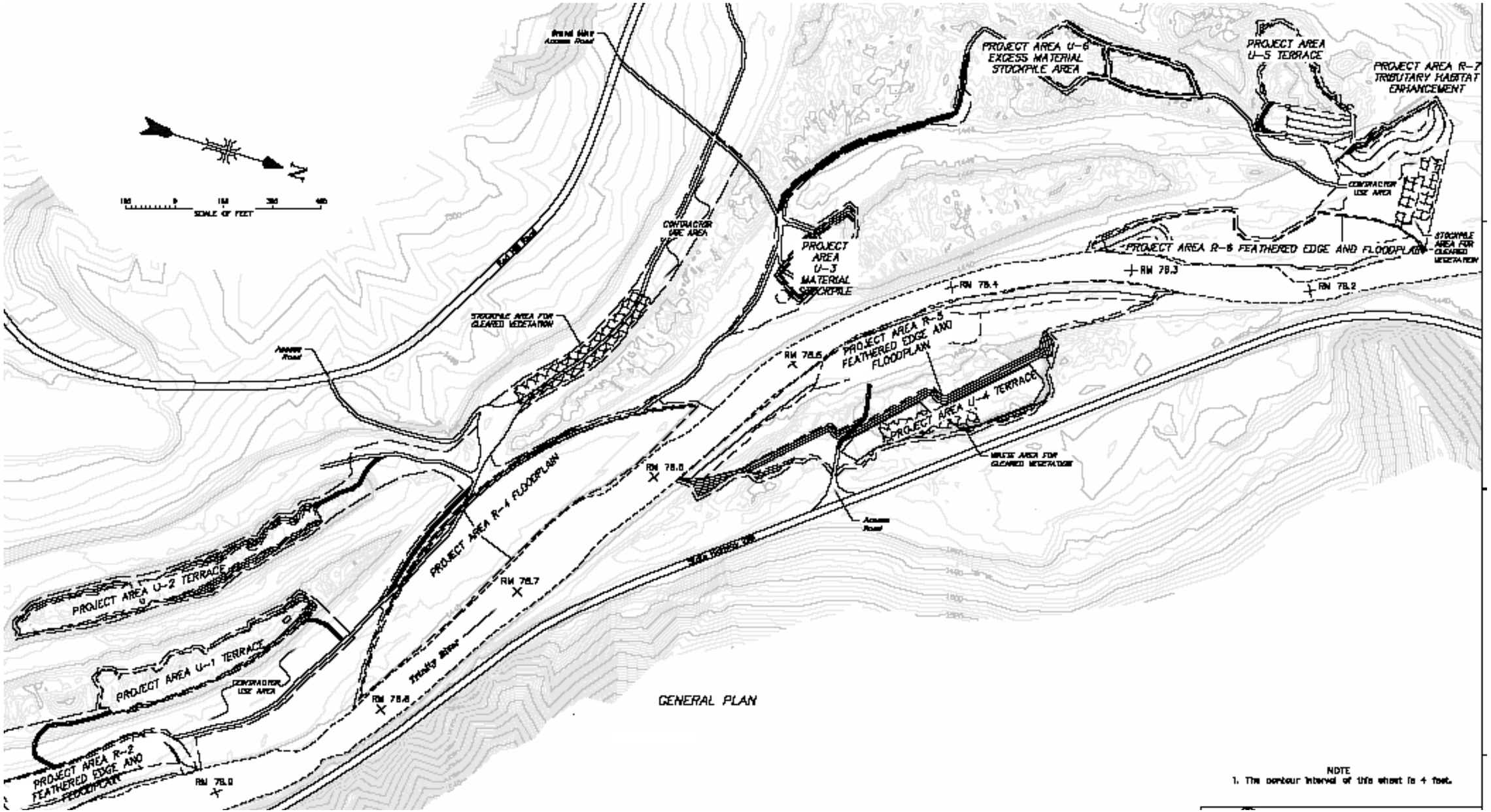


Figure A-12. Copy of the Hocker Flat 100% design used during construction. Upland construction features are designated with a U. Riverine construction features are designated with a R.

A.3 Lower And Upper Reading Creek

The Lower Reading Creek site is located contiguous to Upper Reading Creek, near the Douglas City campground (Figure A-1). Lower Reading Creek begins at rkm 149.19 (rm 92.2) and extends 0.8 rkm (0.5 mi) downstream along the mainstem Trinity River (Figure A-13). Pre-construction, the mainstem channel along the upper portion of the site was confined laterally and vertically by a variety of natural and manmade features, including riparian encroachment, mature riparian berms, valley walls, dredger tailings, and bedrock. White alder and narrowleaf willow were the prevalent riparian hardwood species (McBain & Trush and HVT 2010).

The Upper Reading Creek site is located approximately 0.8 km (0.5 mi) downstream of the Weaver Creek confluence. Upper Reading Creek begins at rkm 150.409 (rm 93.46) and extends 2.05 rkm (1.27 mi) downstream along the mainstem Trinity River (Figure A-14). The site begins upstream of the Reading Creek confluence and continues halfway through a forced bend. The 2009 IHAP monitoring captured pre-construction conditions at the site. The proposed rehabilitation site is located on both banks of the river. The right bank of the site is a depositional feature that results from the river being forced to the right by a bedrock valley wall. The left bank of the site is reworked dredger tailings. A dense band of riparian vegetation grows along the channel on a well defined sediment berm.

Channel rehabilitation at Lower and Upper Reading Creek is planned for implementation in Fall 2010, after the completion of monitoring by all disciplines (Figure A-15). Construction activities will include lowering floodplain surfaces on both banks, building transverse and point bars, and developing a new high-flow scour channel on the left bank, at the downstream end of the site (McBain & Trush and HVT 2010).

On the left bank, the existing forested terrace was excavated down to allow inundation at 170 cms (6,000 cfs; R1) with a 57 cms (2,000 cfs) side channel built through the newly constructed floodplain that connects with a backwater alcove at the downstream end (R1). Two large bars were constructed along the right bank with placed gravel (IC1 and IC2). Along the right bank the riparian berm was recontoured and much of the existing vegetation removed (R2). An existing high-flow scour channel was enhanced and connected into the mainstem channel (R2). One large bar was constructed along the left bank with placed gravel (IC3). Large wood was placed along feathered edges, in side channels and on constructed floodplains.

Figure A-13. Lower Reading Creek site map. Baseflow fish habitat surveys began at rkm 149.5 (Figure A-14) and extend downstream to approximately 148.85, as indicated on the map. Fish habitat surveys at multiple flows (flow to habitat) began at approximately rkm 149.48 (Figure A-14) and extended downstream to approximately rkm 149.3, as indicated on the map. Side channels were demarcated separately for fish habitat analysis purposes.

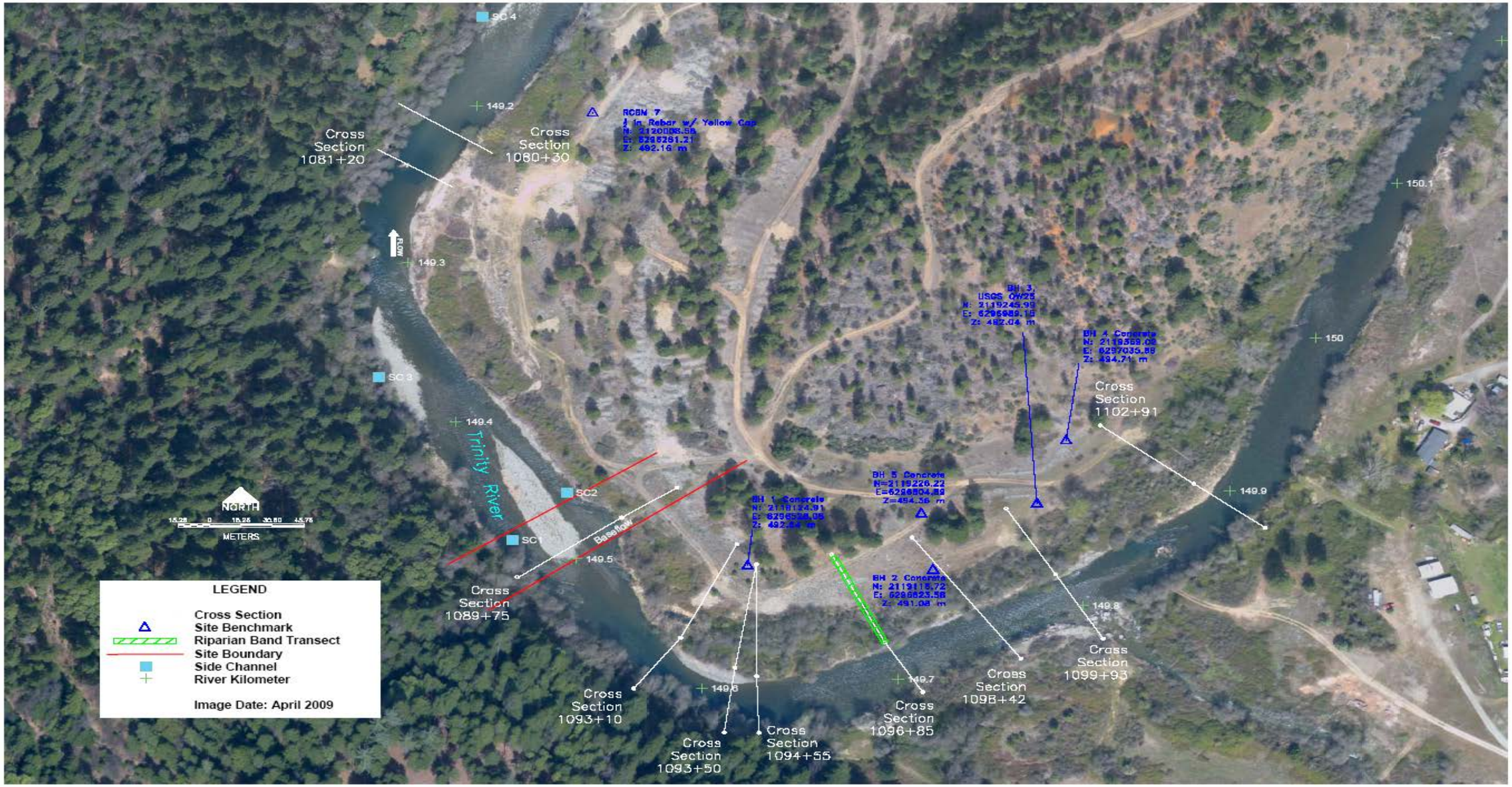


Figure A-14. Figure A-14. Upper Reading Creek site map. Cross section 1096+85 was monitored as a riparian band transect. Baseflow fish habitat surveys began at rkm 149.5 and extend downstream to approximately 148.85 (Figure A-13). Fish habitat surveys at multiple flows (flow to habitat) began at approximately rkm 149.48 and extended downstream to approximately rkm 149.3 (Figure A-13).Side channels were demarcated separately for fish habitat analysis purposes.

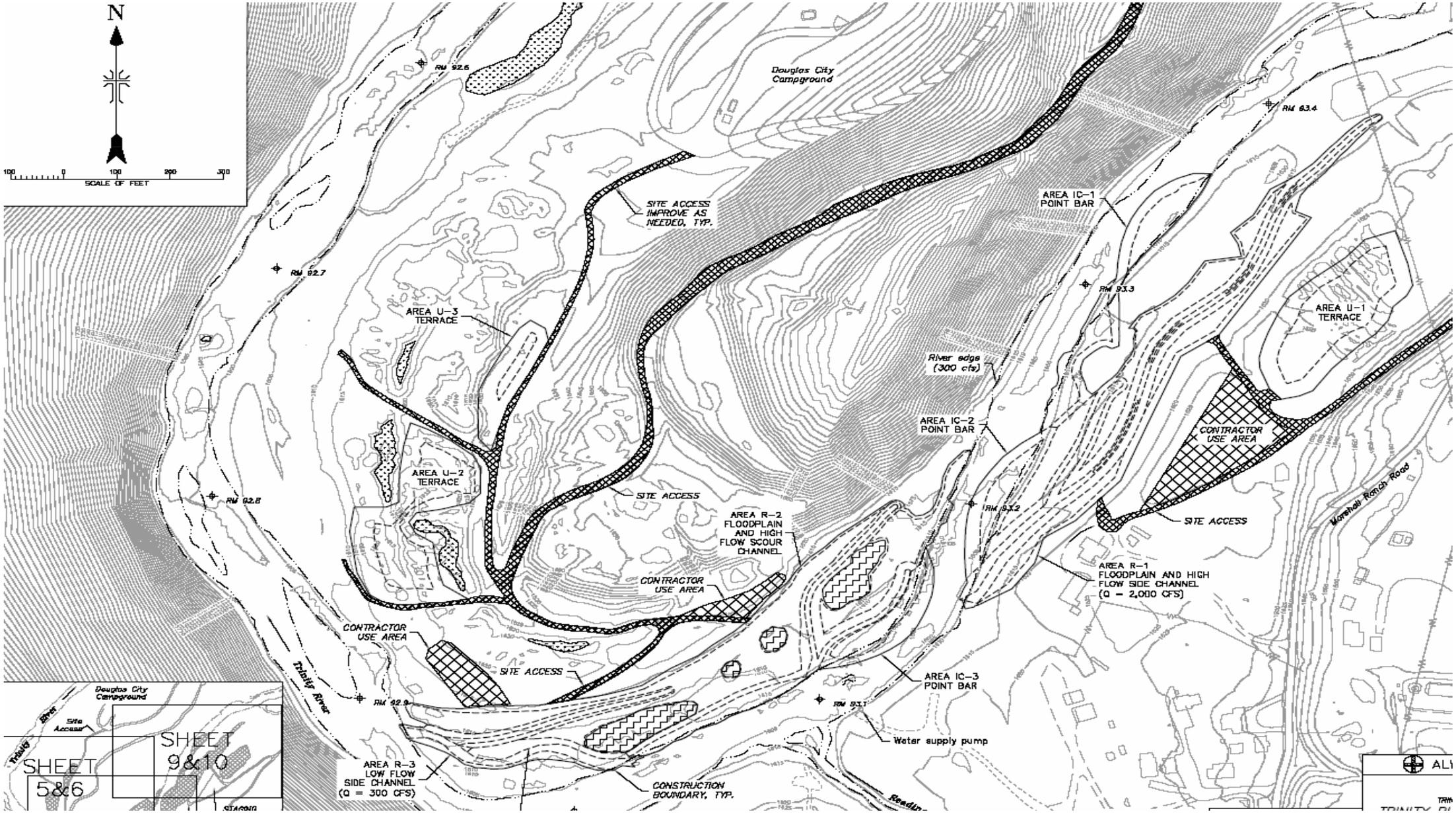


Figure A-15. Copy of Upper Reading Creek 100% design used for construction purposes. Upland features are designated with a U, riverine features are designated with an R, and in-channel features are designated with an IC.

A.4Lower And Middle Indian Creek

Lower Indian begins at rkm 151.16 (rm 93.92, Figure A-1). This site, along with Middle Indian Creek and Vitzthum Gulch (evaluated separately) and extend to rkm 156.27 (rm 97.1), all of which were constructed in 2007. Lower Indian Creek spans both sides of the main-channel and extends down to the confluence with Weaver Creek (Figure A-16). Pre-construction (2007) and post-construction (2008) fish habitat monitoring was conducted as part of Goodman et al. (2010). Before construction, the mainstem river was mostly straight with well developed riparian berms dominating both side of the river and on the right bank, behind the berm, a high-flow scour channel occurred.

The Middle Indian Creek site begins at the confluence of Indian Creek with the mainstem Trinity River. The site extends downstream on the left bank in a stretch of river characterized by subtle meanders and in-channel bars (Figure A-1). The Indian Creek fishing access area is a large feature within the site and contributes a significant area of human disturbance. Before construction, a well defined riparian berm was prevalent along the left bank. The mainstem follows the bedrock valley wall.

At the Middle Indian Creek site, the riparian berm was recontoured, understory vegetation cleared, and fishing access improved (R3 and R4; Figure A-18). At Lower Indian Creek, riparian vegetation was removed (R8, R9), the berm recontoured (R6) and floodplains lowered (R8), a high-flow scour channel (R7 and R8) and low water side channel (R8) constructed. Spoils from excavated areas were used to fill in dredger swales and construct a terrace (U3). A small wetland was enhanced on the right bank at the downstream end of the Lower Indian Creek site (R10). Constructed floodplains and the low-flow side channel margins were planted with black cottonwood, arroyo willow, shiny willow and red willow (R6, R8, and R9). Large wood was placed in the constructed side channel and along feathered edges.

Figure A-16. Lower Indian Creek site map. Cross sections 1157+90 and 1171+20 were monitored as riparian band transects, as well as for changes in topography.

Figure A-17. Middle Indian Creek site map. Cross sections in this reach were not monitored as part of the 2009 IHAP, but riparian mapping was conducted at this portion of the site.

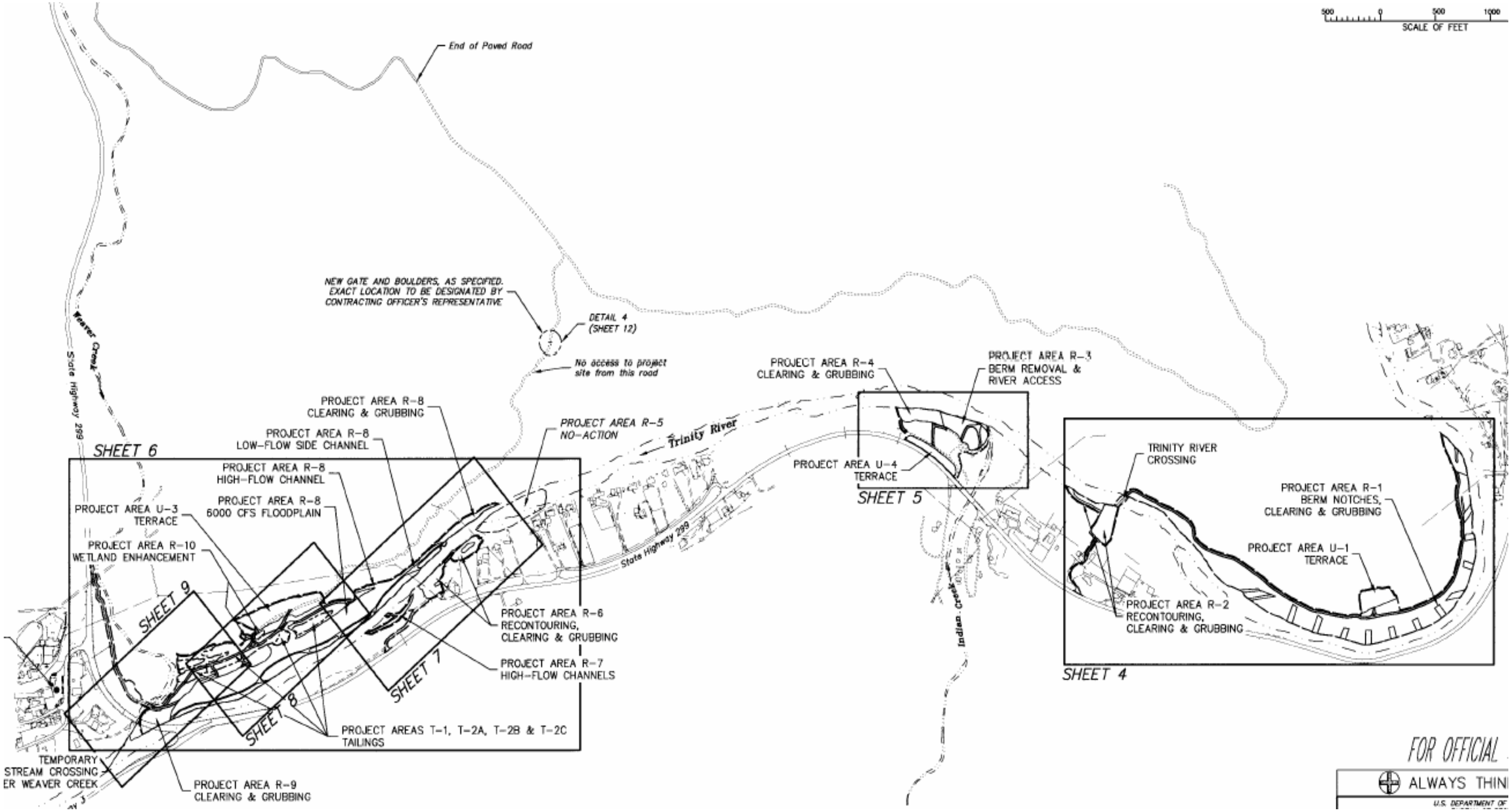


Figure A-18. Copy of the Indian Creek 100% design used for construction purposes. Upland features are designated with a U. Riverine features are designated with an R. The areas labeled as Sheet 9 and Sheet 8 detail the Lower Indian Creek portion of the site; Sheet 7 details the Middle Indian Creek portion of the site. Sheet 4 details the Vitzthum Gulch area.

A.5Vitzthum Gulch

The Vitzthum Gulch rehabilitation site begins at approximately rkm 156.27 (rm 96.5) and extends 1.2 km (0.75 mi) downstream (Figure A-1). Vitzthum Gulch is located on the inside (right bank) of a wide meander bend, which is constrained on the left bank by Highway 299 (Figure A-19). Before the Vitzthum Gulch site was rehabilitated, a dense riparian berm consisting mostly of white alder and narrowleaf willow grew along the right bank cutting off the historic floodplain from the river. The fossilized floodplain became a terrace that was colonized by herbaceous patch types (e.g., non-native grassland) and Ponderosa pine. A high-flow scour channel occurred behind the riparian berm.

Vitzthum Gulch was constructed in fall 2007 and represented a new rehabilitation approach (Figure A-18). A series of 13 selective berm removal sites, or “notches,” were constructed in the Vitzthum Gulch area (R1). Large wood was placed in the constructed side channel and along feathered edges. The site was constructed with the expectation that high magnitude managed streamflows would erode the notches further and cause the extensive riparian berm to “unravel.” Revegetation did not occur at Vitzthum Gulch.

Figure A-19. Vitzthum Gulch site map. Topographic surveys using a Total Station were conducted at each of the 13 yellow parallelograms.

A.6Lowden Meadows

The Lowden Meadows site begins at rkm 169.46 (rm 105.30 and extends downstream 1.44 km (0.89 mi) downstream, ending near the confluence of Grass Valley Creek (Figure A-1). The upper portion of the site is steep (slope = 0.0003) with bedrock and boulder grade controls Figure A-20). Bedrock on the right restricts valley width. Pre-construction, a floodplain-like surface on the left is inundated by 127 cms (4,500 cfs) and greater flows (CA DWR 2010). The middle section of the site is straight and low-gradient, containing a low gravel bar where spawning occurs. The valley bottom is composed of tailings arranged in irregular piles and pits. In the downstream section of the site, the river drops over a riffle and through the Grass Valley Creek delta. Much of the reach consists of a nearly-straight entrenched plane bed channel that is confined by tailings piles and terraces (CA DWR 2010). Lowden Meadows was constructed in 2010. Sites features included coarse sediment additions, constructed point bars, benches, floodplains, alcoves, and side channels, new off-stream rearing habitat, and a main-channel realignment (CA DWR 2010).

Figure A-20. Lowden Meadows site map. Baseflow fish habitat surveys were conducted between the two red lines labeled "Baseflow." Fish habitat surveys conducted at multiple flows (flow to habitat) were conducted between the two red lines labeled "Flowhab."

A.7Bucktail And Dark Gulch

The Bucktail-Dark Gulch site extends from rkm 172.33 - 169.74 (rm 107.08 - 105.47), beginning approximately 0.4 km (0.25 mi) downstream from the Salt Flat Bridge and extending downstream to the Bucktail Bridge (Figure A-1). The Bucktail-Dark Gulch site is generally separated into two areas: (1) Dark Gulch along the upstream right bank (Figure A-21) and (2) Bucktail along the downstream left bank (Figure A-22). Before rehabilitation, a band of riparian vegetation grew along the low water edge and the floodplain/terrace was wide, bounded by dredger tailings. Several brackish ponds occur on the right bank terrace surface at the downstream end of the dredger tailings. A medial bar occurs at the outside of a meander that is forced by a bedrock valley wall on the left bank. At the upstream end of Dark Gulch, human infrastructure is a potential constraint to channel migration along the left bank. At the downstream end of Dark Gulch along the right bank a riparian berm of variable width occurred through this reach before rehabilitation and a high-flow scour channel flowed through the floodplain/terrace behind the berm. The Dark Gulch bank rehabilitation site is located below Salt Flat and is subject to highly saline soil conditions.

The Bucktail area is located on the left bank of the main-channel on the inside of a meander forced by a bedrock valley wall along the right bank. A reclaimed gravel mine is the primary physical feature near the mainstem channel. Channel migration is constrained on the right bank by bedrock canyon walls. The historic pilot Bucktail bank rehabilitation site is located along the left bank where a naturally formed gravel bar was located before recent rehabilitation. Downstream of the pilot bank rehabilitation site a riparian berm with senescent alders runs the length of the left bank channel down to the Bucktail Bridge.

Bucktail-Dark Gulch was constructed in fall 2008 (Figure A-23). At Dark Gulch, gravel was placed in-channel to form transverse bars (IC5), the riparian berm was recontoured (R1), a terrace excavated (R1), and high and low-flow side channels (R1, R2, and R4) and floodplains that are inundated by the 170 cms (6,000 cfs) streamflow were constructed (R1, and R2). Spoils from excavated areas were used to fill in dredger swales and construct a terrace (U1). At Bucktail a pile of gravel was placed on top of the naturally formed self maintaining gravel bar (IC7), the wetland in the reclaimed gravel mine was enhanced (U2), and the existing riparian berm was notched in the downstream area. Logs were placed in the notches and augmented gravel placed on top of the logs (R3, and IC8). At the downstream end of Bucktail an existing side channel was enhanced along the right bank near the Bucktail Bridge. Large wood was placed in the constructed side channel and along feathered edges.

Figure A-21. Dark Gulch site map. Riparian band transect and topography monitored occurred at cross section 1821+30. The baseflow fish habitat survey began at rkm 172.2 and extended downstream, beyond the Bucktail Bridge to rkm 169.5 (Figure A-22). Fish habitat surveys were conducted at multiple flows (flow to habitat) between rkm 172.15 Side channels were demarcated separately for fish habitat analysis purposes.

Figure A-22. Bucktail site map. Riparian band transect and topography monitoring occurred at cross section 1779+90 and 1785+70. Cross sections 1789+30 and 1771+90 were monitored for changes in topography only. The baseflow fish habitat survey began at rkm 172.2 (Figure A-21) and extended downstream, beyond the Bucktail Bridge to rkm 169.). Fish habitat surveys were conducted at multiple flows (flow to habitat) between rkm 170.9 and rkm 170.5 (approximate). Side channels were demarcated separately for fish habitat analysis purposes.

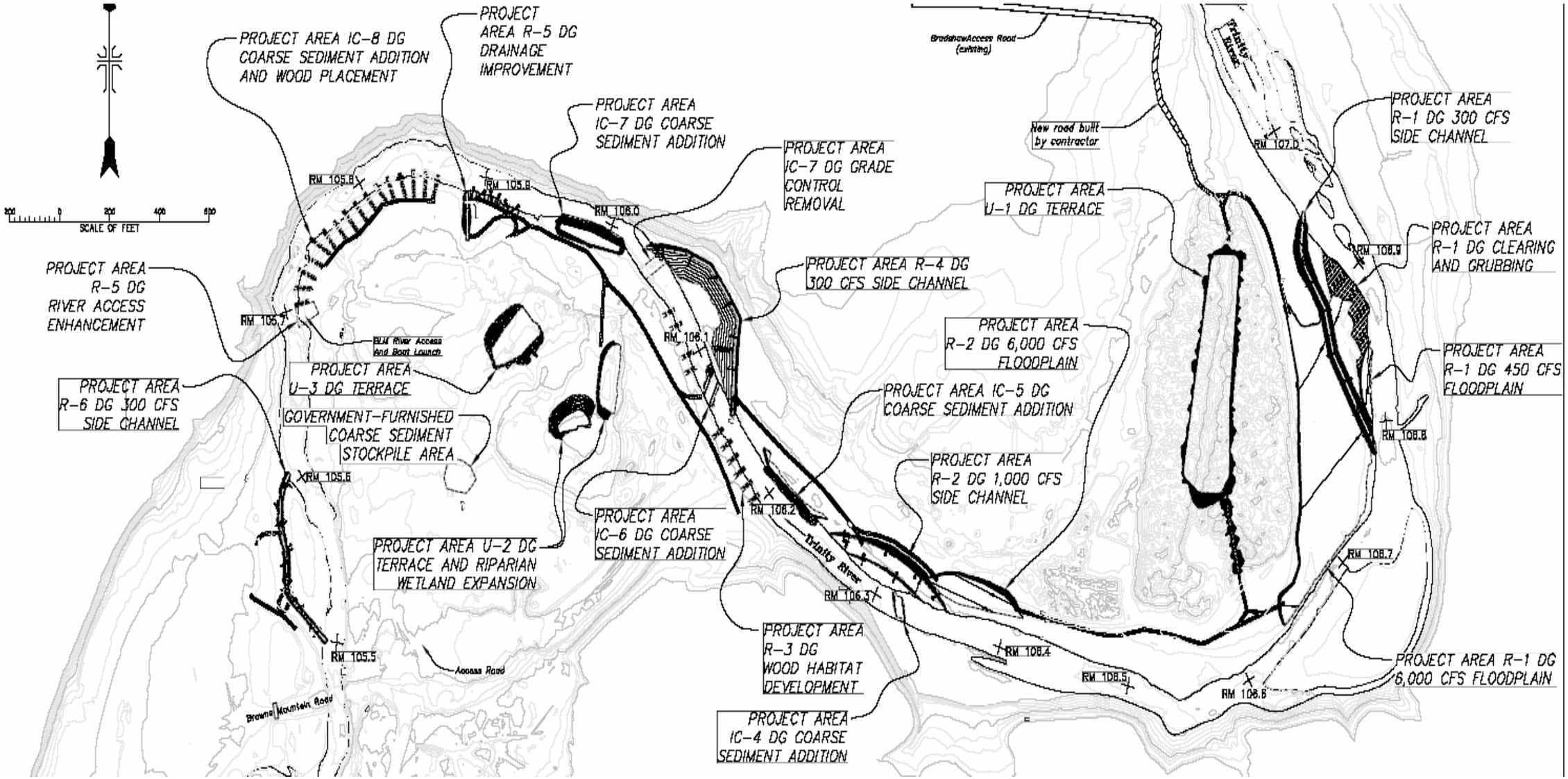


Figure A-23. Copy of the Bucktail-Dark Gulch 100% design used for construction purposes. Upland features are designated with a U, riverine features are designated with an R, and in-channel features are designated with an IC.

A.8Hoadley Gulch

The Hoadley Gulch site begins at rkm 177.19 (rm 110.10) and extends 0.4 km (0.25 mi) downstream (Figure A-1). The Hoadley Gulch rehabilitation area is located on the right bank in close proximity to the old Lewiston Bridge and the Old Lewiston fishing access area (Figure A-24). Before Hoadley Gulch site was rehabilitated in fall 2008, dense riparian vegetation consisting mostly of white alder and narrowleaf willow grew along the right bank with a terrace behind the riparian vegetation that was colonized by herbaceous patch types (e.g., non-native grassland) and Ponderosa pine. Hoadley Gulch was constructed in fall 2008 (Figure A-25). A bifurcated low-flow side channel (R5), a gravel bar (IC12), and floodplain that inundates at 170 cms (6,000 cfs; R5) were constructed. A grade control in the mainstem channel was also removed (IC11). Spoils from excavated areas were used to construct a terrace (U3). Constructed floodplains and the low-flow side channel margins were planted with black cottonwood, arroyo willow, shiny willow and red willow (R5). Large wood was placed in the constructed side channel.

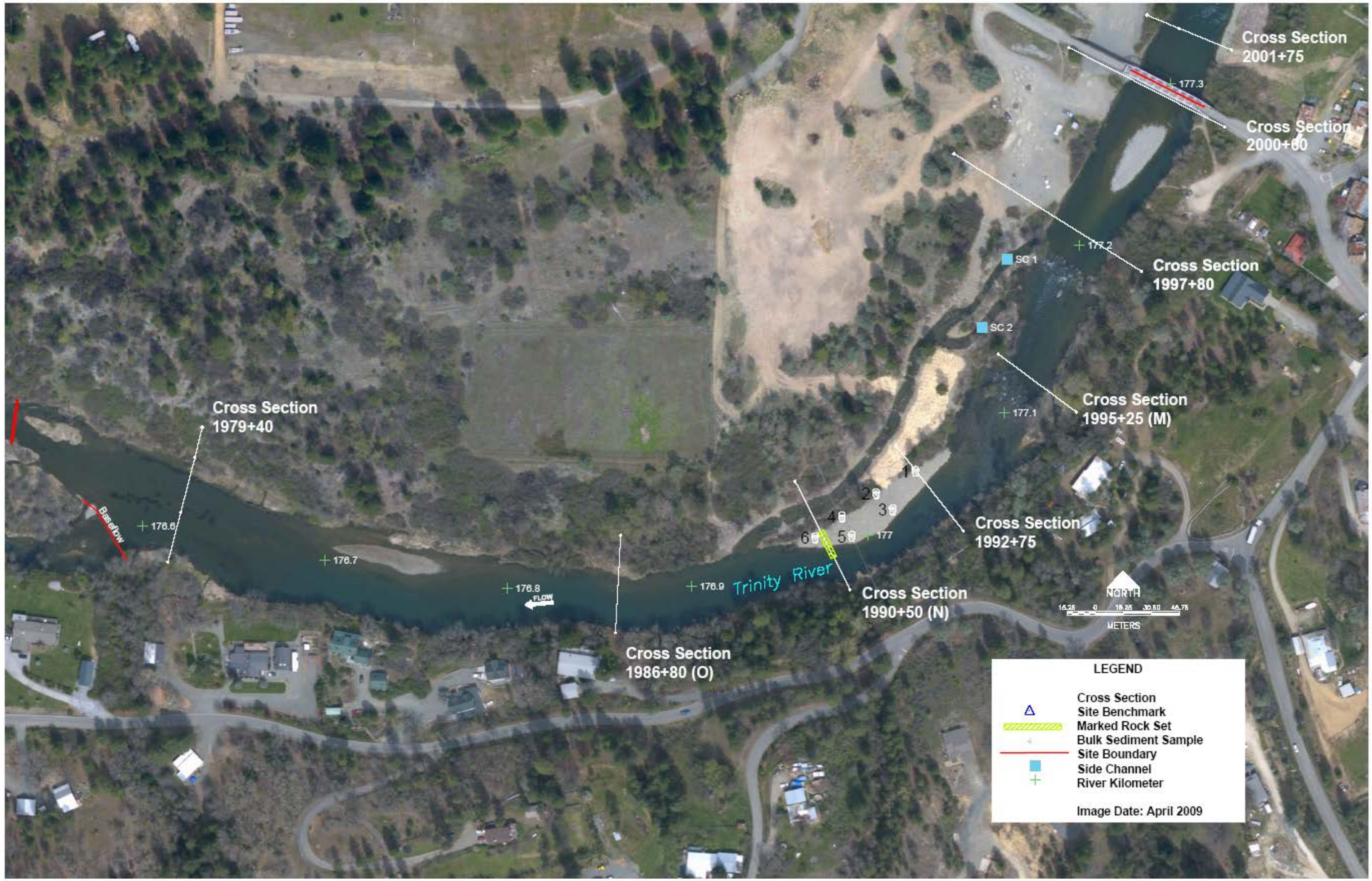


Figure A-24. Hoadley Gulch site map. Riparian band transect and topography monitoring occurred on cross section 1990+50. Baseflow fish habitat surveys began at Lewiston Bridge and extended downstream beyond rkm 176.6. Side channels were demarcated separately for fish habitat analysis purposes.

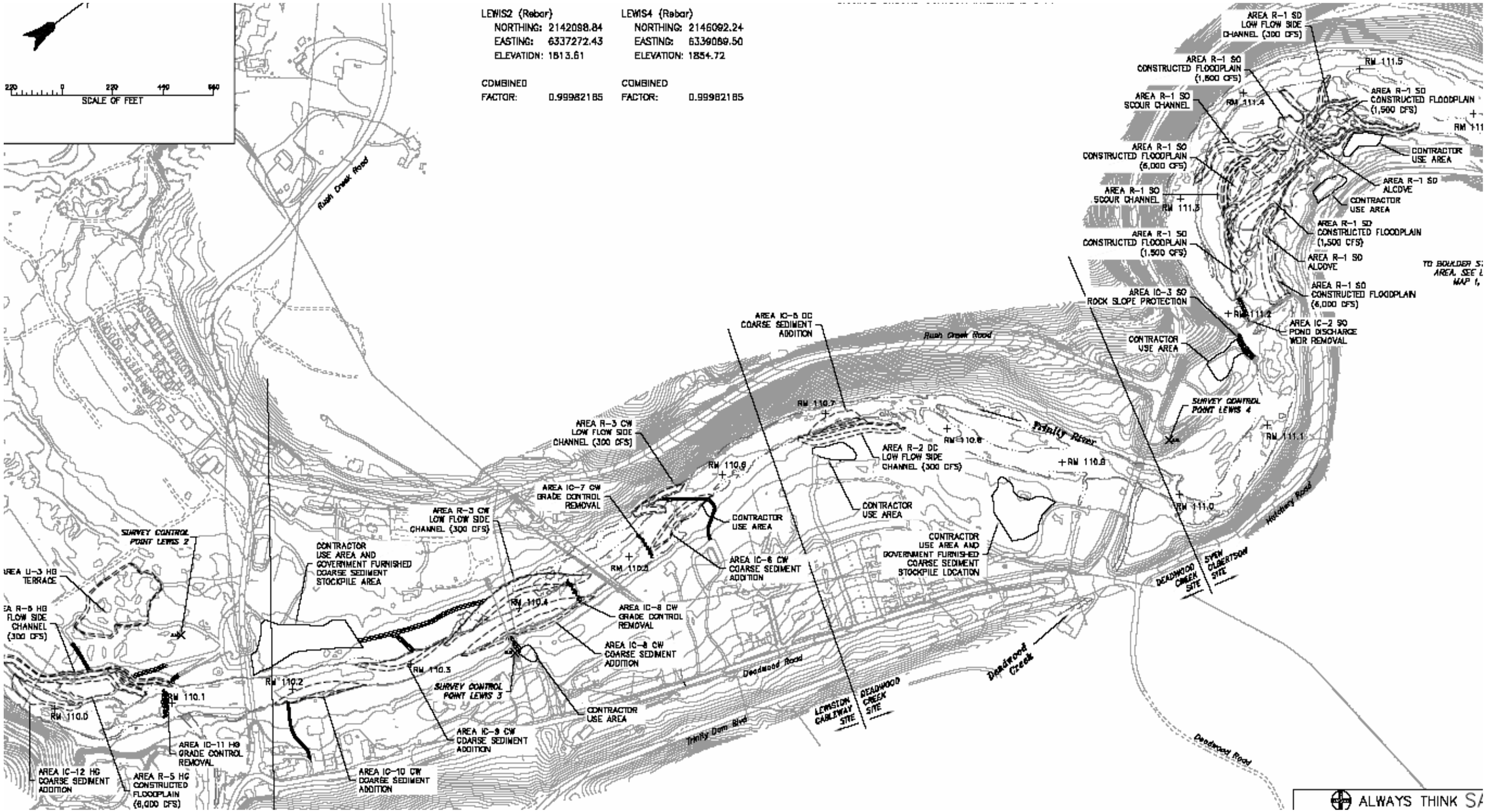


Figure A-25. Copy of construction drawings for Hoadley Gulch, Lewiston Cableway, Deadwood Creek, and Sven Olbertson 100% designs used during construction. Upland features are designated with a U, riverine features are designated with an R, and in-channel features are designated with an IC.

A.9Lewiston Cableway

The Lewiston Cableway site begins at approximately rkm 177.77 (rm 110.46) and extends 0.72 km (0.45 mi) downstream (Figure A-1). The Lewiston Cableway site is directly downstream of the Deadwood Creek site and upstream of the Old Lewiston Bridge (Figure A-26). Before the area was rehabilitated, the Lewiston Cableway was a long, straight reach with dense riparian vegetation along both banks, grade control structures in the mainstem channel, and a low-flow side channel along the right bank. Lewiston Cableway was constructed in fall 2008 (Figure A-25). An alternating bar sequence was constructed using placed gravel (IC8, IC9, and IC10) and several grade control structures in the mainstem channel were removed (IC8). The entrance at an existing low-flow side channel was to be enlarged and other portions constructed (R3). Rehabilitation avoided disturbing most of the existing riparian vegetation. Riparian revegetation did not take place at Lewiston Cableway, though large wood was placed on constructed bars.

Figure A-26. Lewiston Cableway site map. Riparian band transect and topographic monitoring occurred at cross sections 2012+10 and 2013+94.baseflow goes from most upstream line to bridge. Baseflow fish habitat surveys began at rkm 178.0 and extended downstream to the Lewiston Bridge. Fish habitat surveys were conducted at multiple flows (flow to habitat) beginning at rkm 177.9 and extending downstream to rkm 177.4 Side channels were demarcated separately for fish habitat analysis purposes.

A.10 Deadwood Creek

The Deadwood Creek site begins at approximately rkm 178.57 (rm 110.96) and extends 0.32 km (0.2 mi) downstream (Figure A-1).The Deadwood Creek site is located just downstream of Trinity Dam Boulevard bridge and the confluence of Deadwood Creek. The area rehabilitated is located on the left bank downstream of an established medial bar feature visible on the downstream side of Trinity Dam Boulevard (Figure A-27). A dense band of riparian vegetation grows along the channel and edges of the medial bar. Human disturbance and river access are prevalent on the left bank terraces. The dense band of riparian vegetation growing along the left bank steadily decreases in density downstream. Gravel was placed in the mainstem channel to construct a bar (IC5) and a low-flow side channel was constructed (R2). The low-flow side channel margins were planted with black cottonwood, arroyo willow, shiny willow and red willow (R2) and large wood was placed in the side channel (Figure A-25).

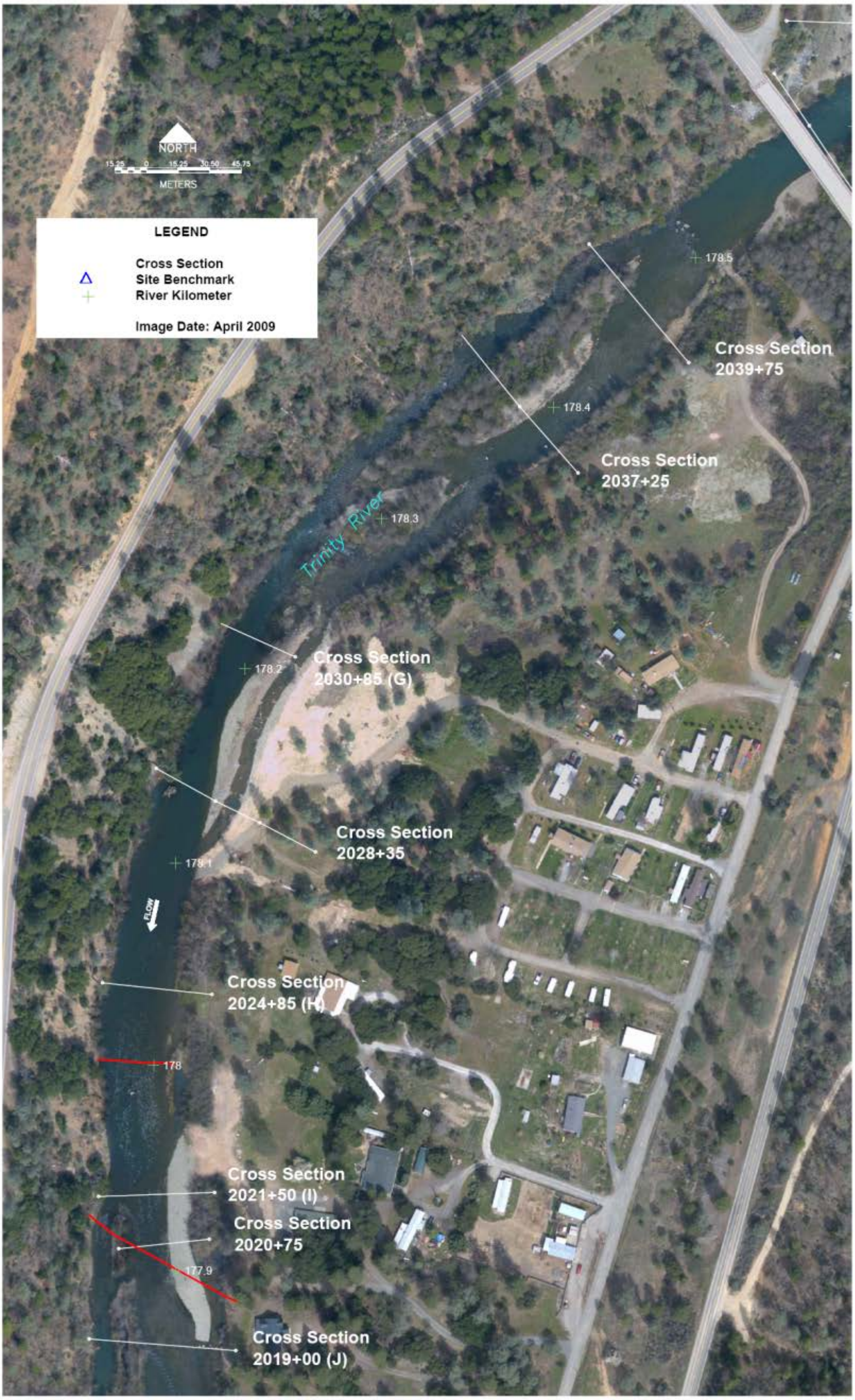


Figure A-27. Deadwood Creek site map.

A.11 Sven Olbertson

The Sven Olbertson site begins at approximately rkm 179.84 (rm 111.75) and extends 0.72 km (0.45 mi) downstream (Figure A-1). Sven Olbertson is located behind a wing dam on the left bank just downstream of the Trinity River Hatchery and upstream of Trinity Dam Boulevard (Figure A-28). Sven Olbertson was a location where a side channel linked ponds together in a constructed effort to improve waterfowl habitat. Riparian vegetation was able to survive and thrive along the low water edge and form a riparian berm. The lack of high flood peaks, coarse sediment and the presence of a wing dam at the downstream end of the site has impeded the ability of the river to create physical disturbances that would improve aquatic habitat. The existing low-flow side channel was enhanced and moved towards the mainstem channel slightly during construction and two high-flow scour channels were constructed to link the low-flow side channel to the mainstem at higher discharges (R1)(Figure A-25). The slope of the side channel was also steepened. Alcoves were constructed in two locations along the low-flow side channel (R1) and on both edges of the side channel, recontouring and vegetation removal created a series of constructed floodplains that inundate over a range of discharges (e.g., 28.3 - 170 cms [1,000 - 6,000 cfs]). Revegetation efforts used hardwood pole cuttings for riparian revegetation and rooted nursery grown plug for herbaceous wetland plants. Constructed floodplains and the low-flow side channel margins were planted with sedges, rushes, black cottonwood, arroyo willow, shiny willow and red willow (R1). Large wood was placed in the constructed side channel and along feathered edges and floodplains.

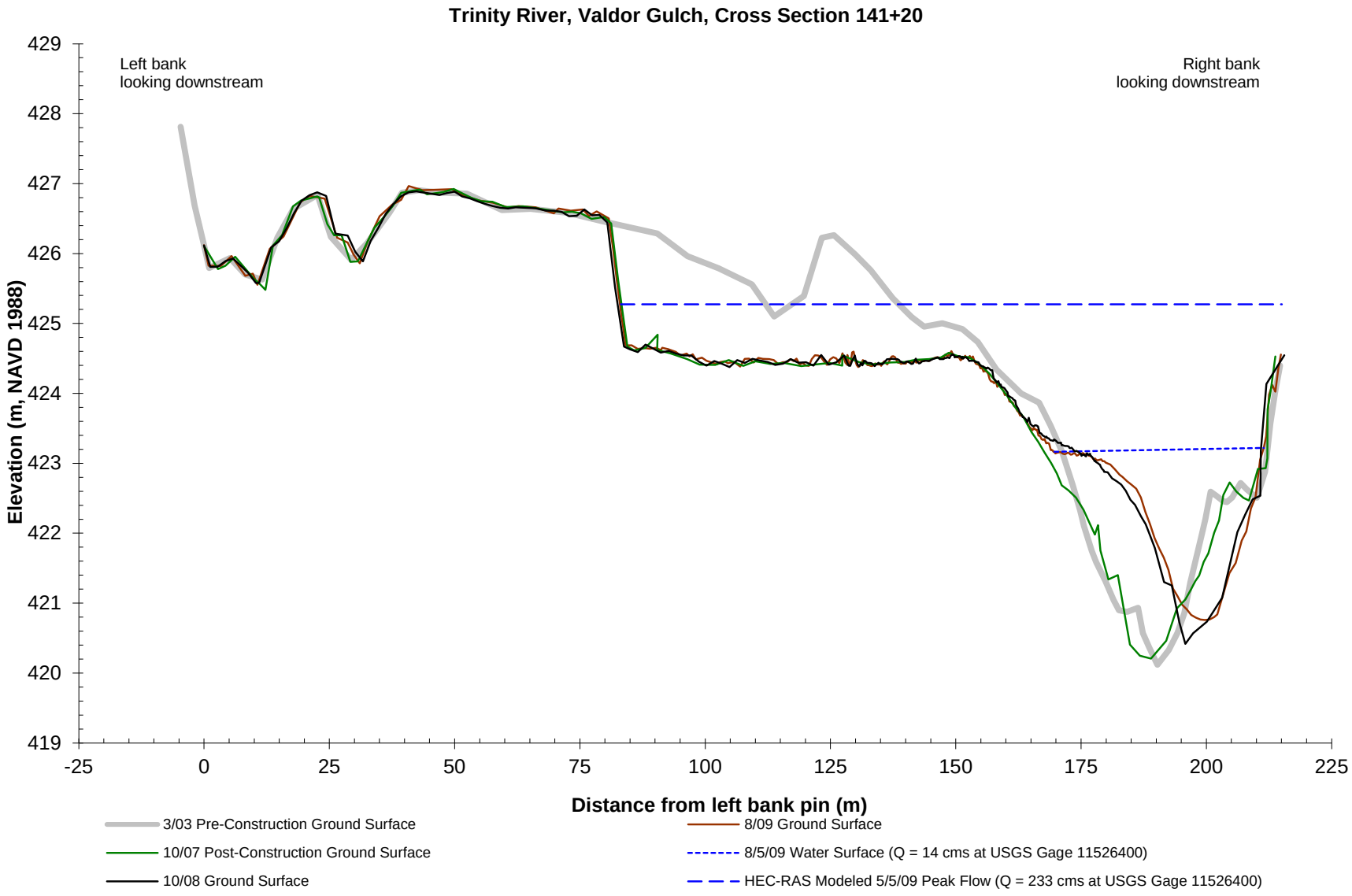
Figure A-28. Sven Olbertson site map. Riparian band transect and topographic monitoring occurred at cross sections 2069+80 and 2060+25. Baseflow fish habitat surveys began at rkm 179.6 and continued downstream to the dam at the downstream end of the site. Side channels were demarcated separately for fish habitat analysis purposes.

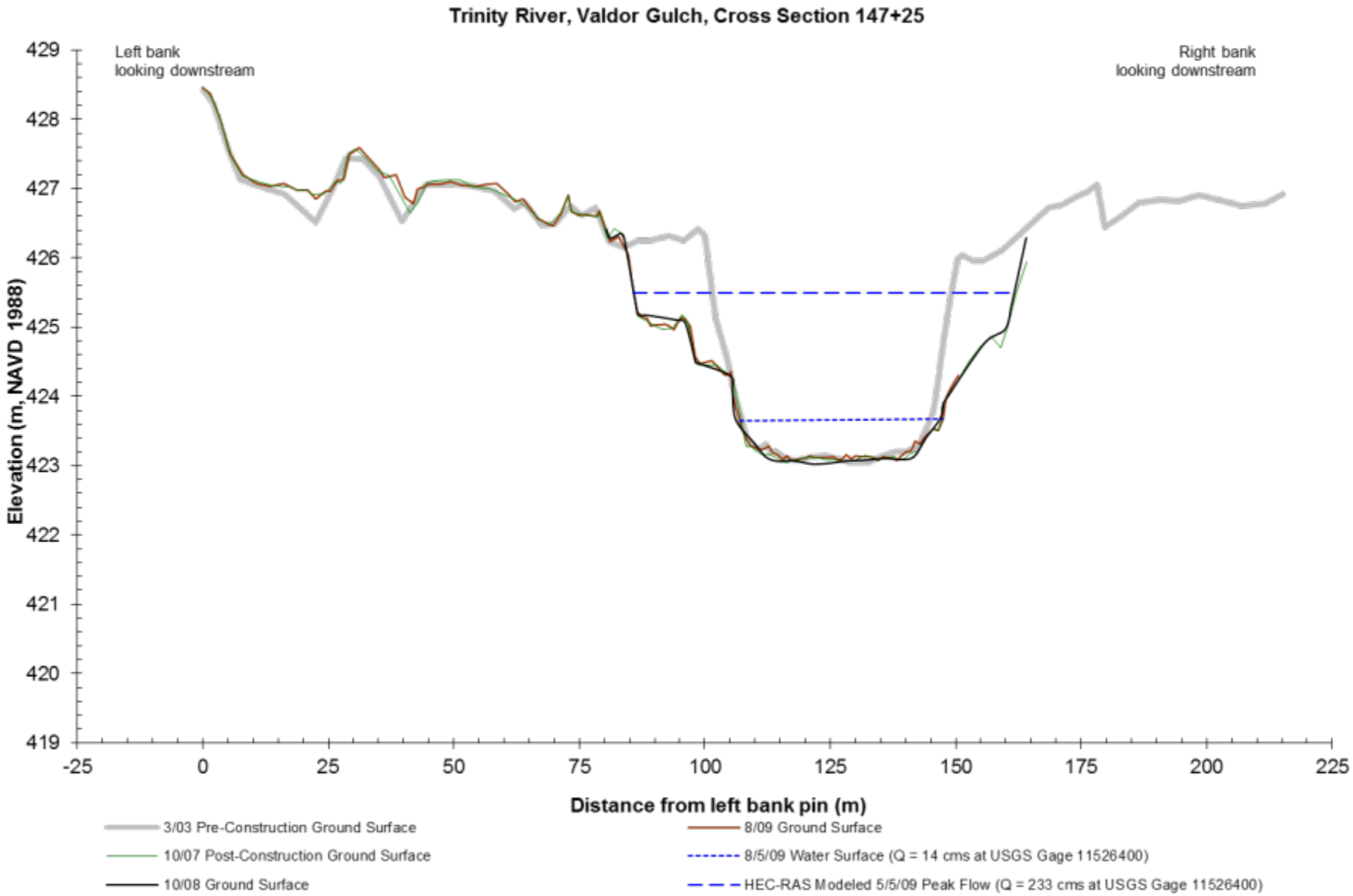
A.12 Lewiston Hatchery

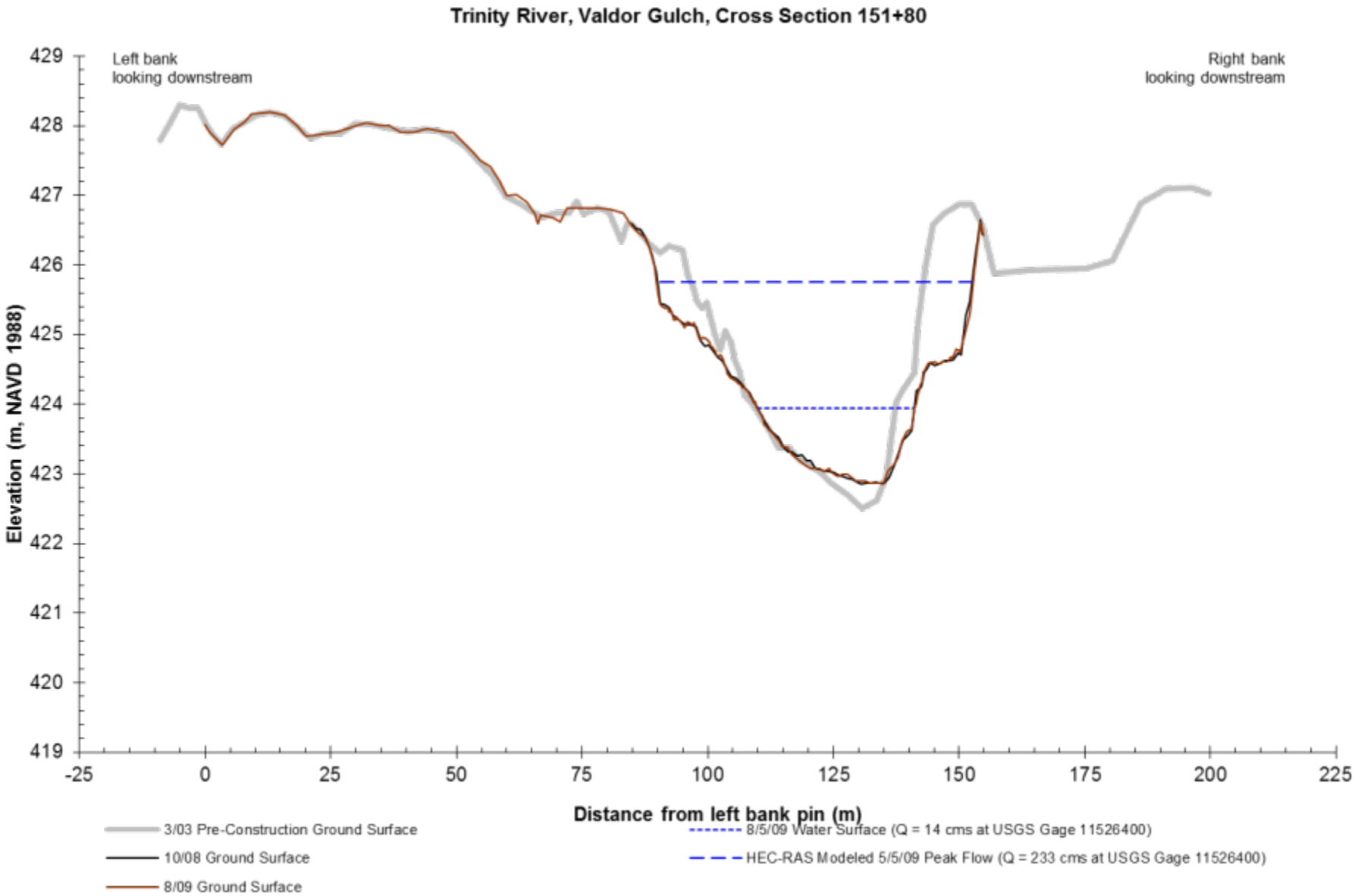
The Trinity River hatchery site begins at rkm 180.5 (rm 112.16) and extends 0.66 km (0.41 mi) downstream (Figure A-1). The Trinity River hatchery gravel augmentation site is located immediately downstream of Lewiston Dam in a location where instream habitat structures have been constructed and is a frequent gravel augmentation location (Figure A-29).

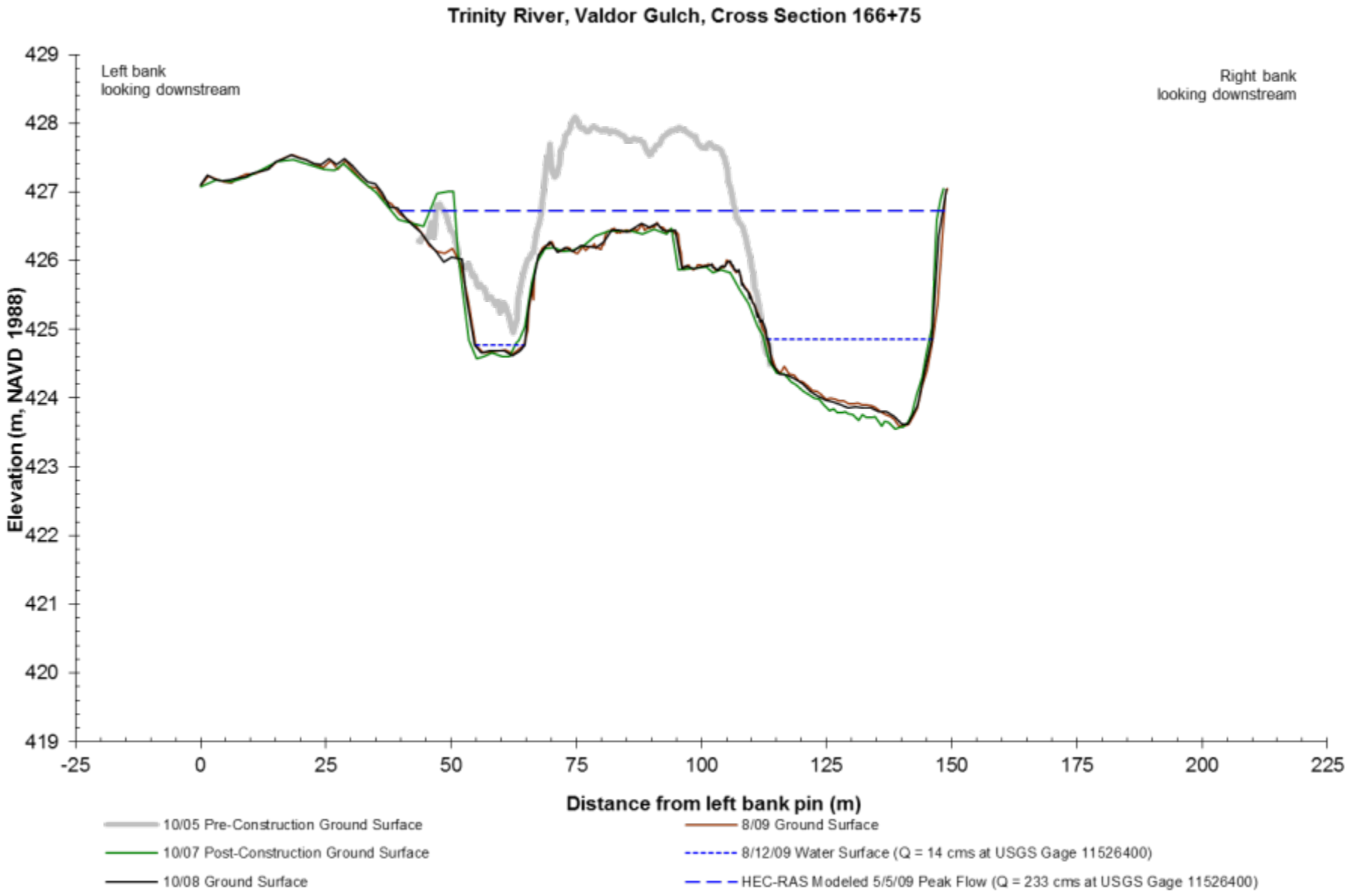
Figure A-29. Lewiston Hatchery site map. The mapping extent of the topographic survey is bounded in yellow. Additional monitoring did not occur at this site.

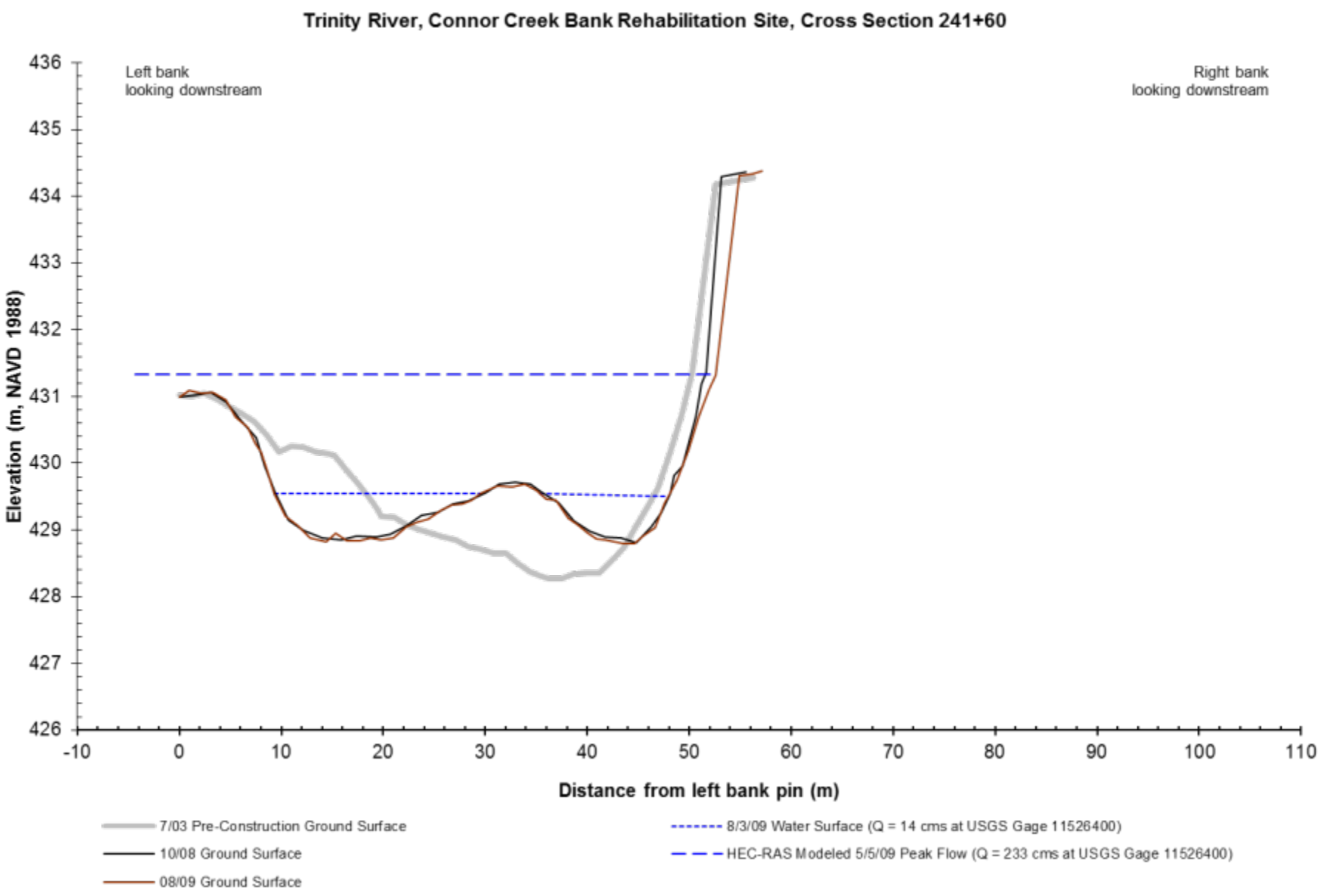
APPENDIX B. CROSS SECTIONAL SURVEYS

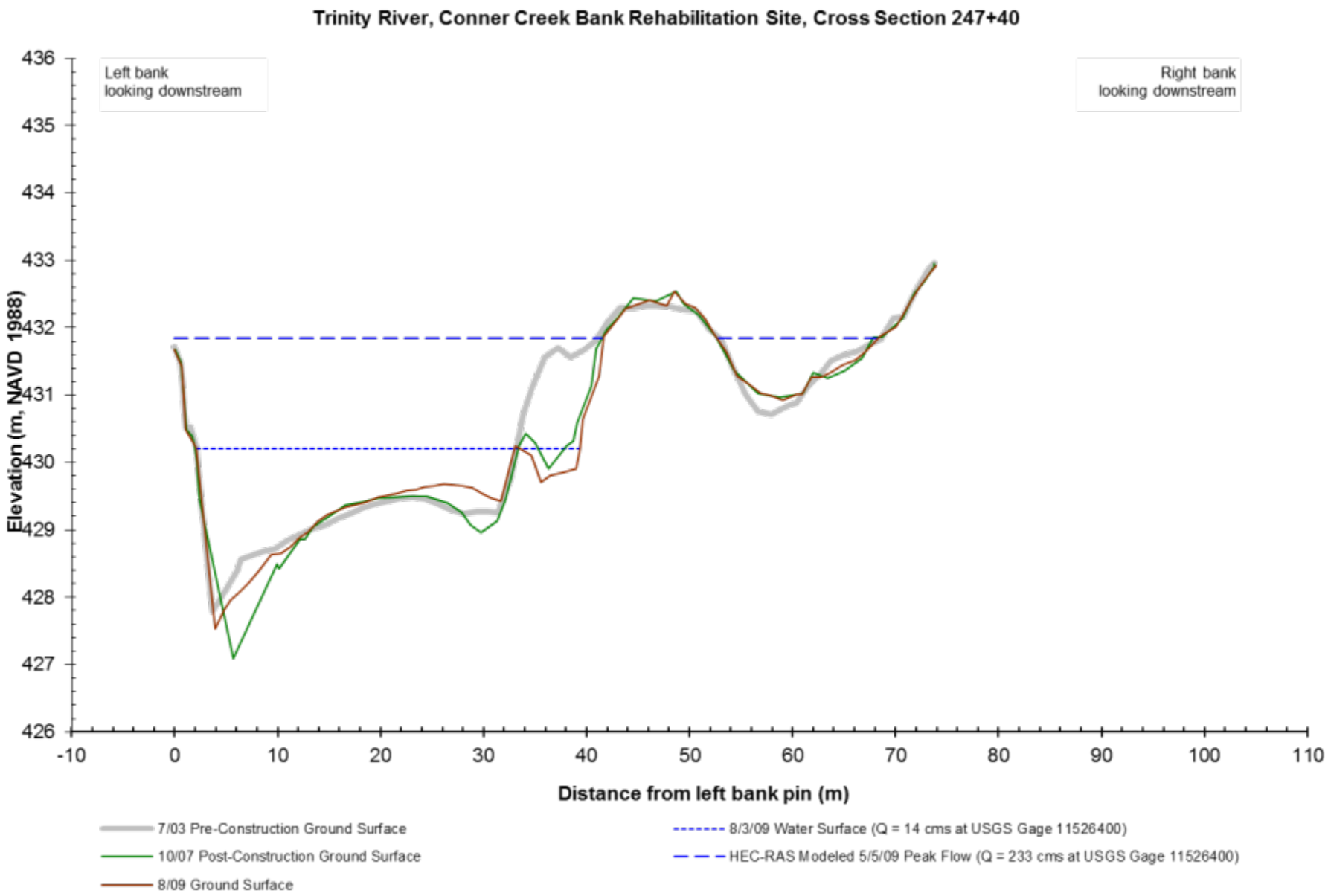

Trinity River, Valdor Gulch, Cross Section 141+20
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
429
428
427
426
425
424
423
422
421
420
419
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
3/03 Pre-Construction Ground Surface
8/09 Ground Surface
10/07 Post-Construction Ground Surface
8/5/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
10/08 Ground Surface
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

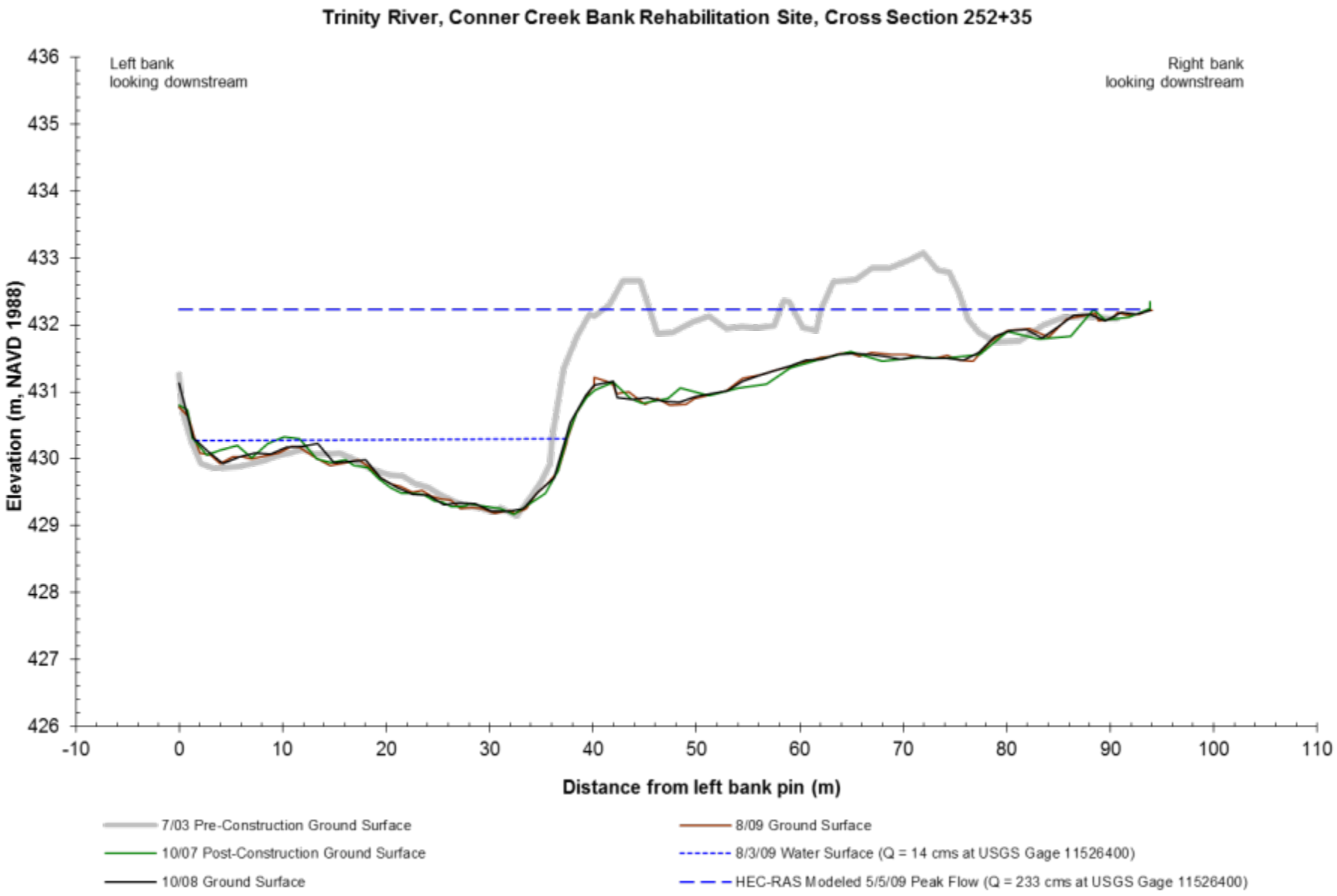

Trinity River, Valdor Gulch, Cross Section 147+25
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
429
428
427
426
425
424
423
422
421
420
419
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
3/03 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
8/5/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

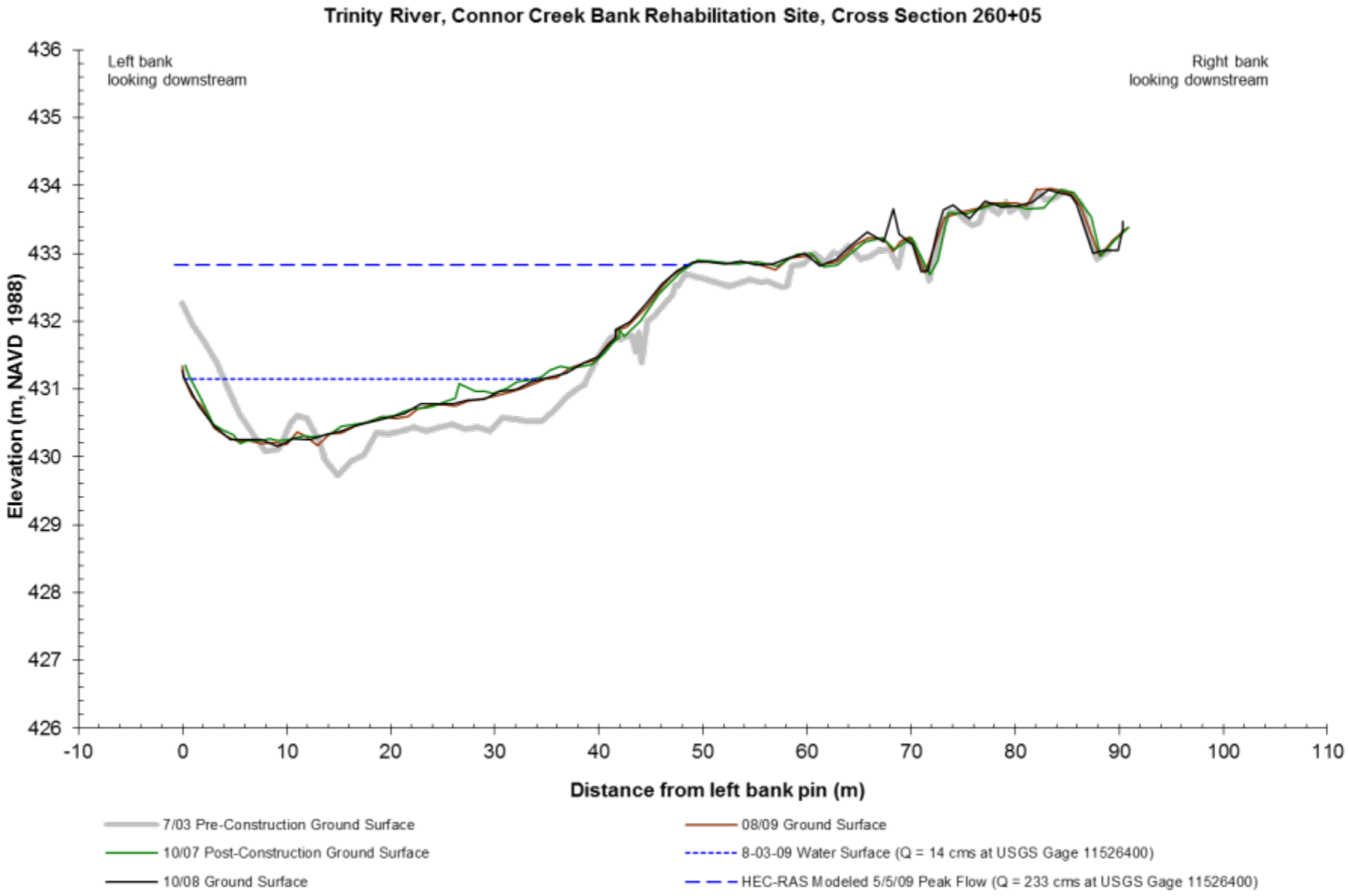

Trinity River, Valdor Gulch, Cross Section 151+80
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
429
428
427
426
425
424
423
422
421
420
419
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
3/03 Pre-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
8/5/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

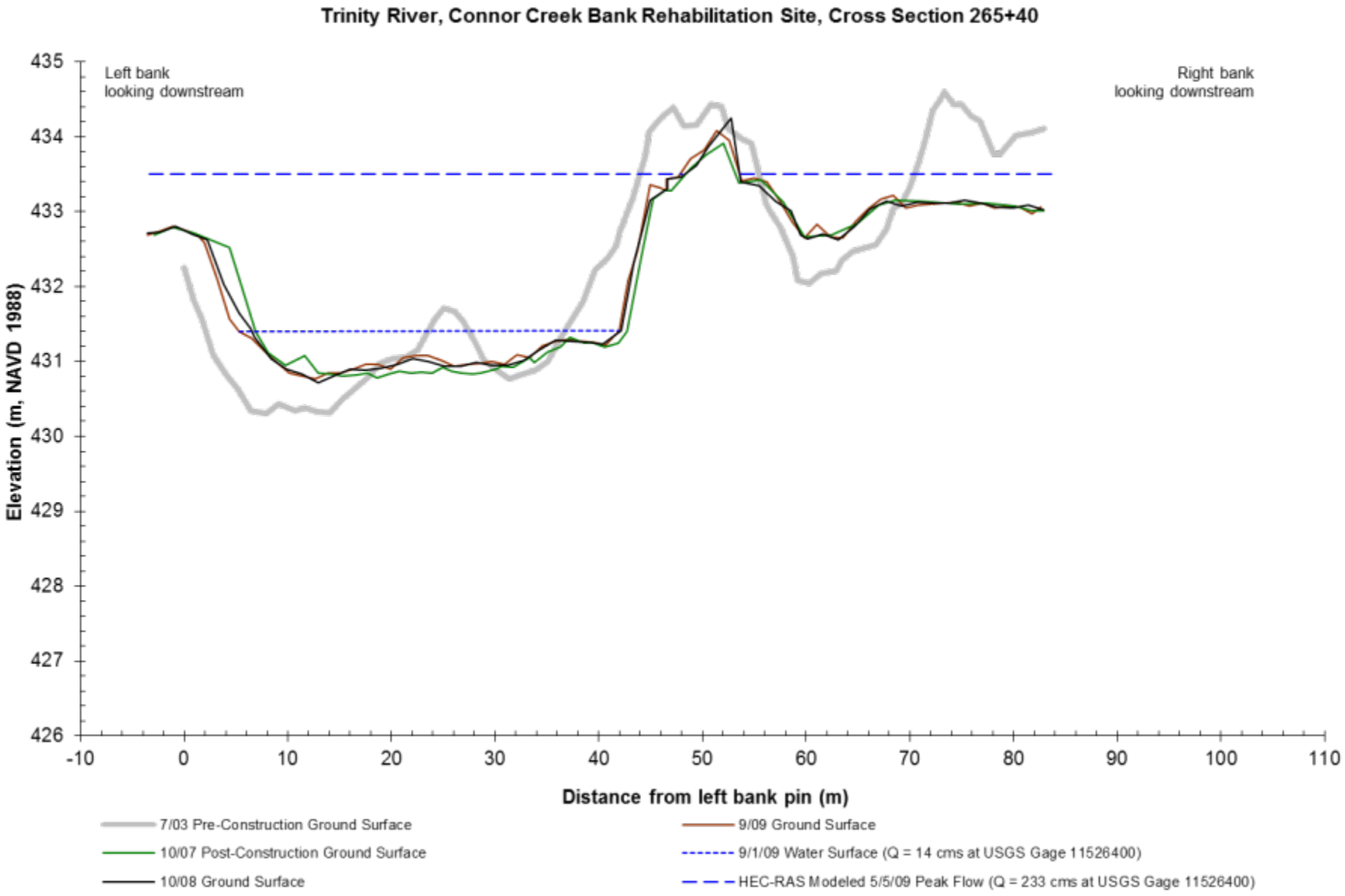

Trinity River, Valdor Gulch, Cross Section 166+75
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
429
428
427
426
425
424
423
422
421
420
419
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
10/05 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
8/12/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

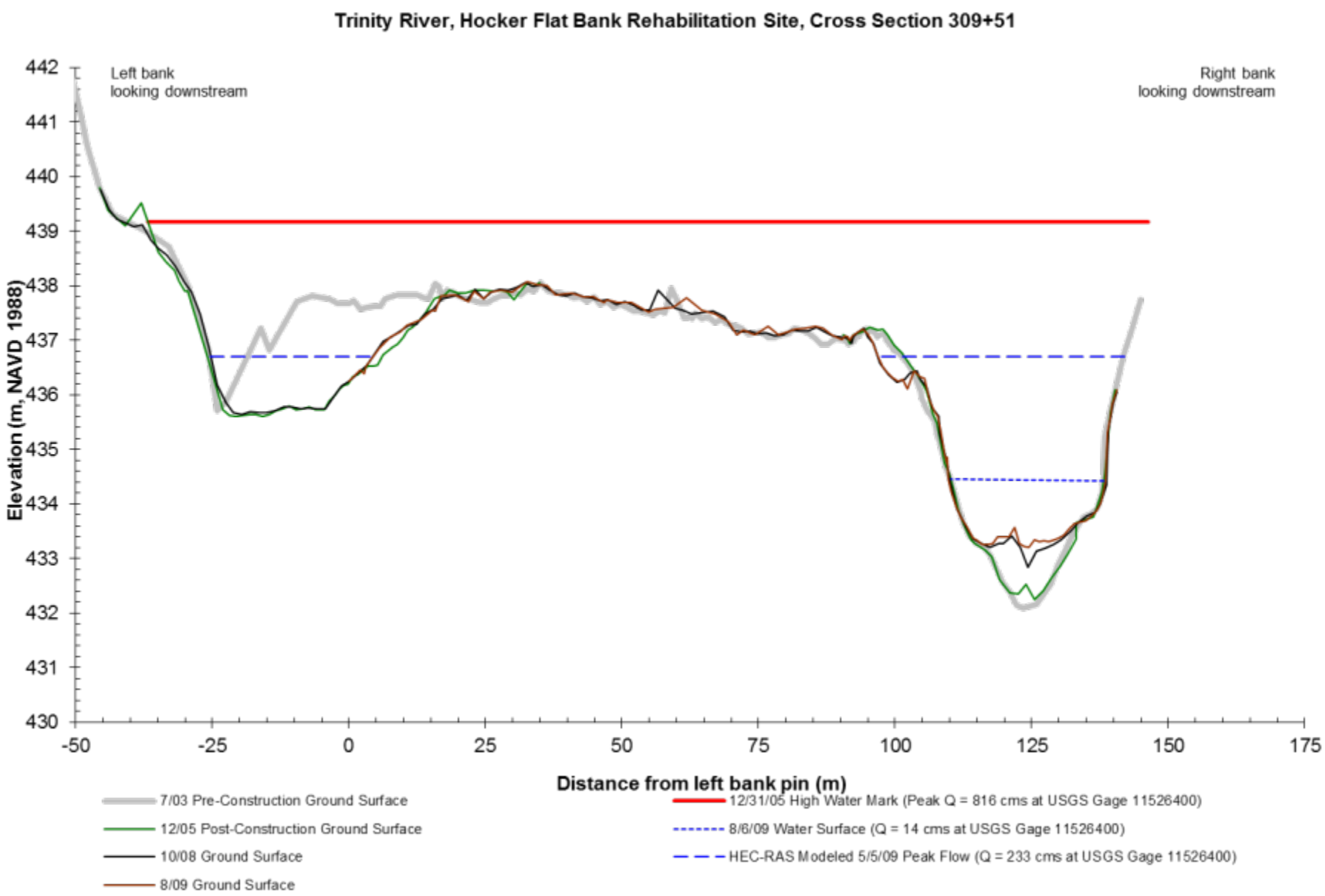

Trinity River, Connor Creek Bank Rehabilitation Site, Cross Section 241+60
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
436
435
434
433
432
431
430
429
428
427
426
-10
0
10
20
30
40
50
60
70
80
90
100
110
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
10/08 Ground Surface
08/09 Ground Surface
8/3/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

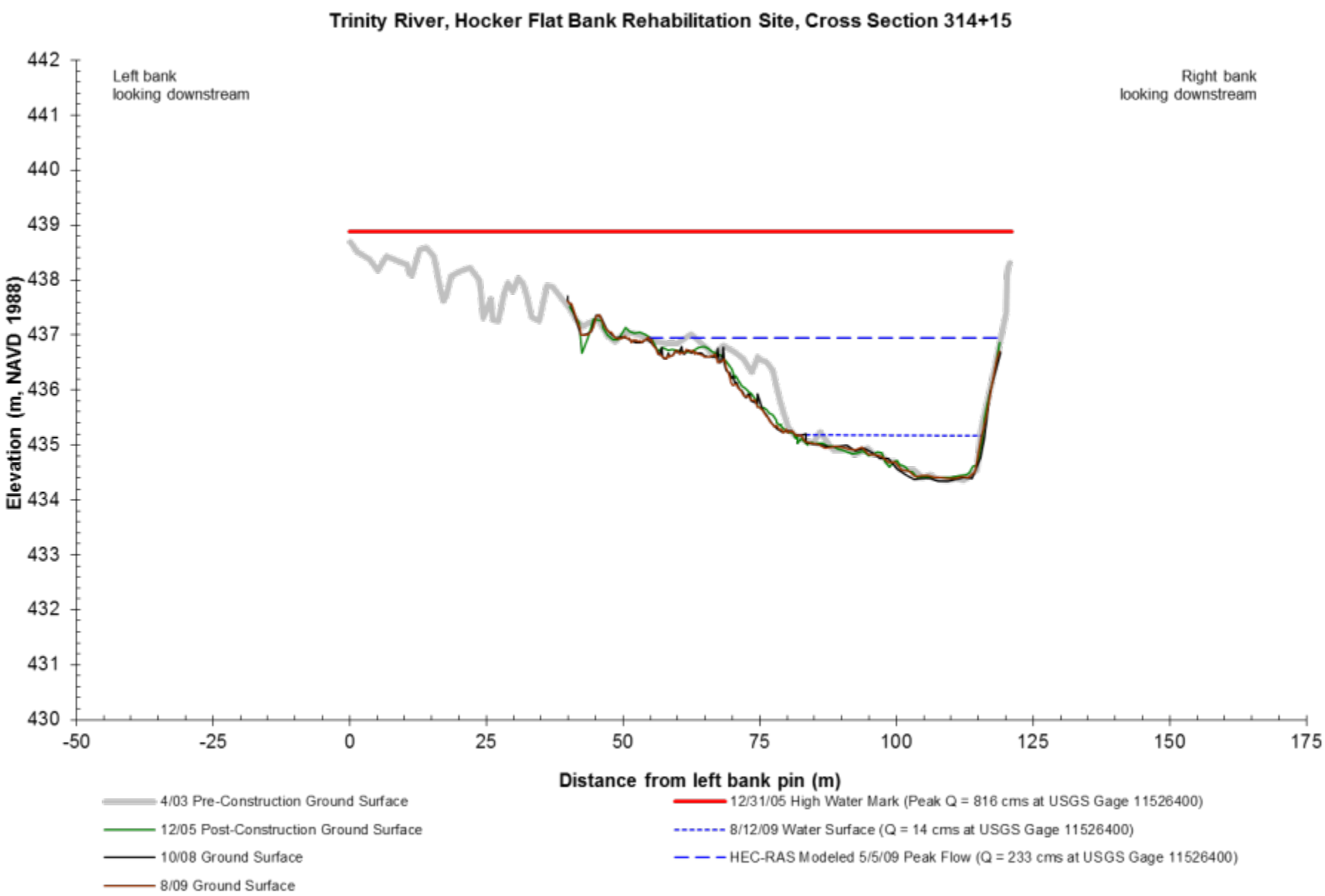

Trinity River, Conner Creek Bank Rehabilitation Site, Cross Section 247+40
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
436
435
434
433
432
431
430
429
428
427
426
-10
0
10
20
30
40
50
60
70
80
90
100
110
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
8/09 Ground Surface
8/3/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

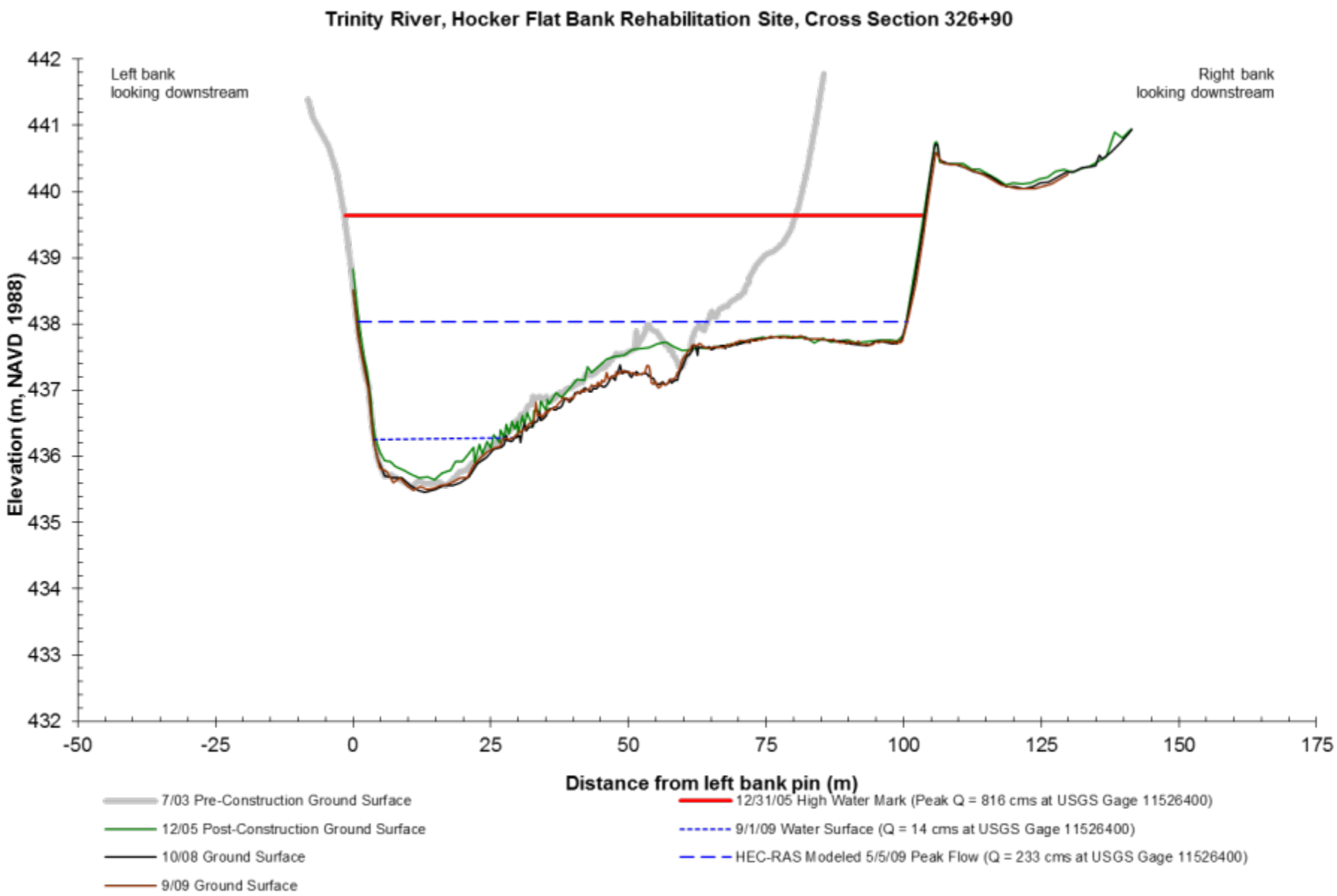

Trinity River, Conner Creek Bank Rehabilitation Site, Cross Section 252+35
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
436
435
434
433
432
431
430
429
428
427
426
-10
0
10
20
30
40
50
60
70
80
90
100
110
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
8/3/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

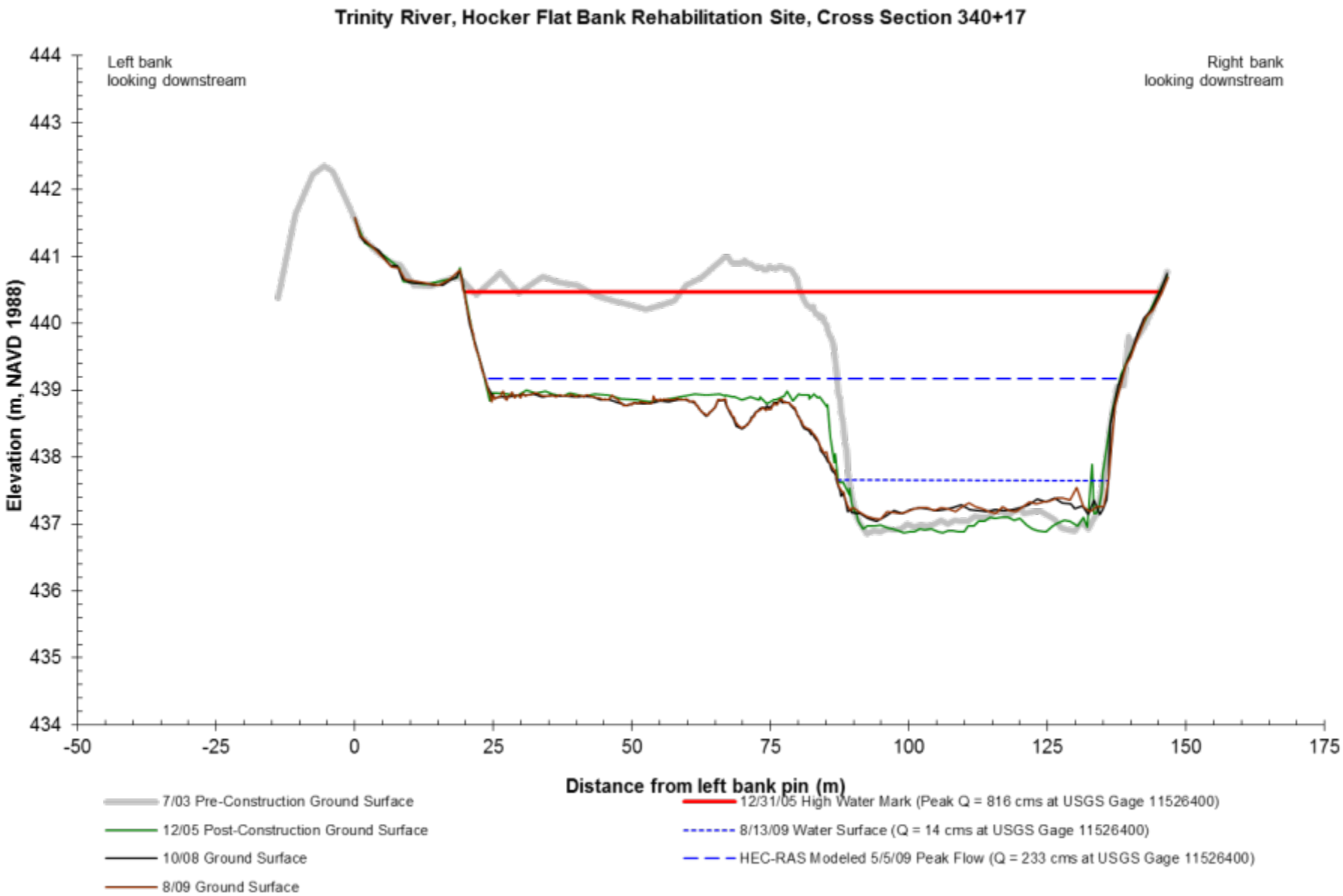

Trinity River, Connor Creek Bank Rehabilitation Site, Cross Section 260+05
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
436
435
434
433
432
431
430
429
428
427
426
-10
0
10
20
30
40
50
60
70
80
90
100
110
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
10/08 Ground Surface
08/09 Ground Surface
8-03-09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

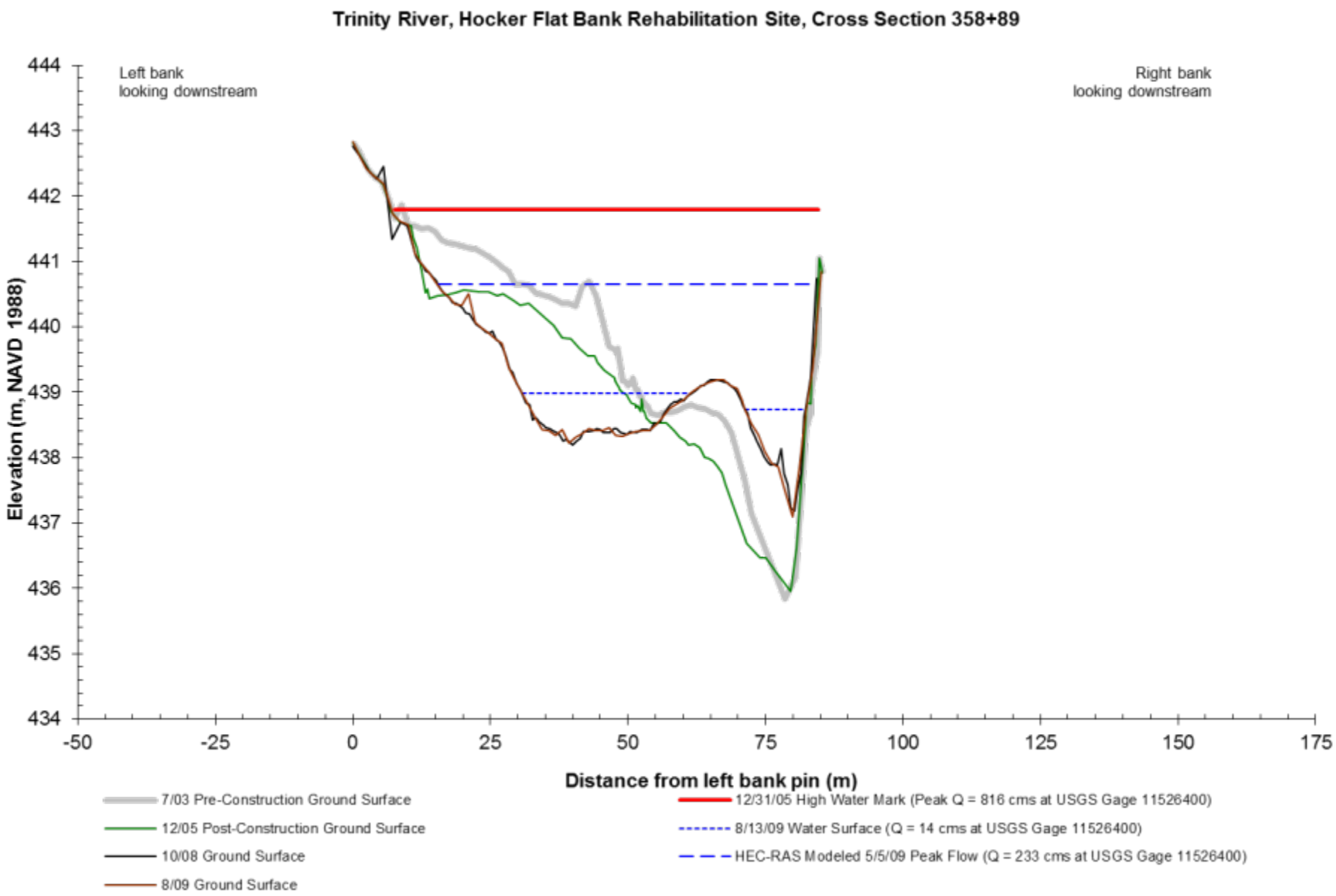

Trinity River, Connor Creek Bank Rehabilitation Site, Cross Section 265+40
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
435
434
433
432
431
430
429
428
427
426
-10
0
10
20
30
40
50
60
70
80
90
100
110
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
10/07 Post-Construction Ground Surface
10/08 Ground Surface
9/09 Ground Surface
9/1/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

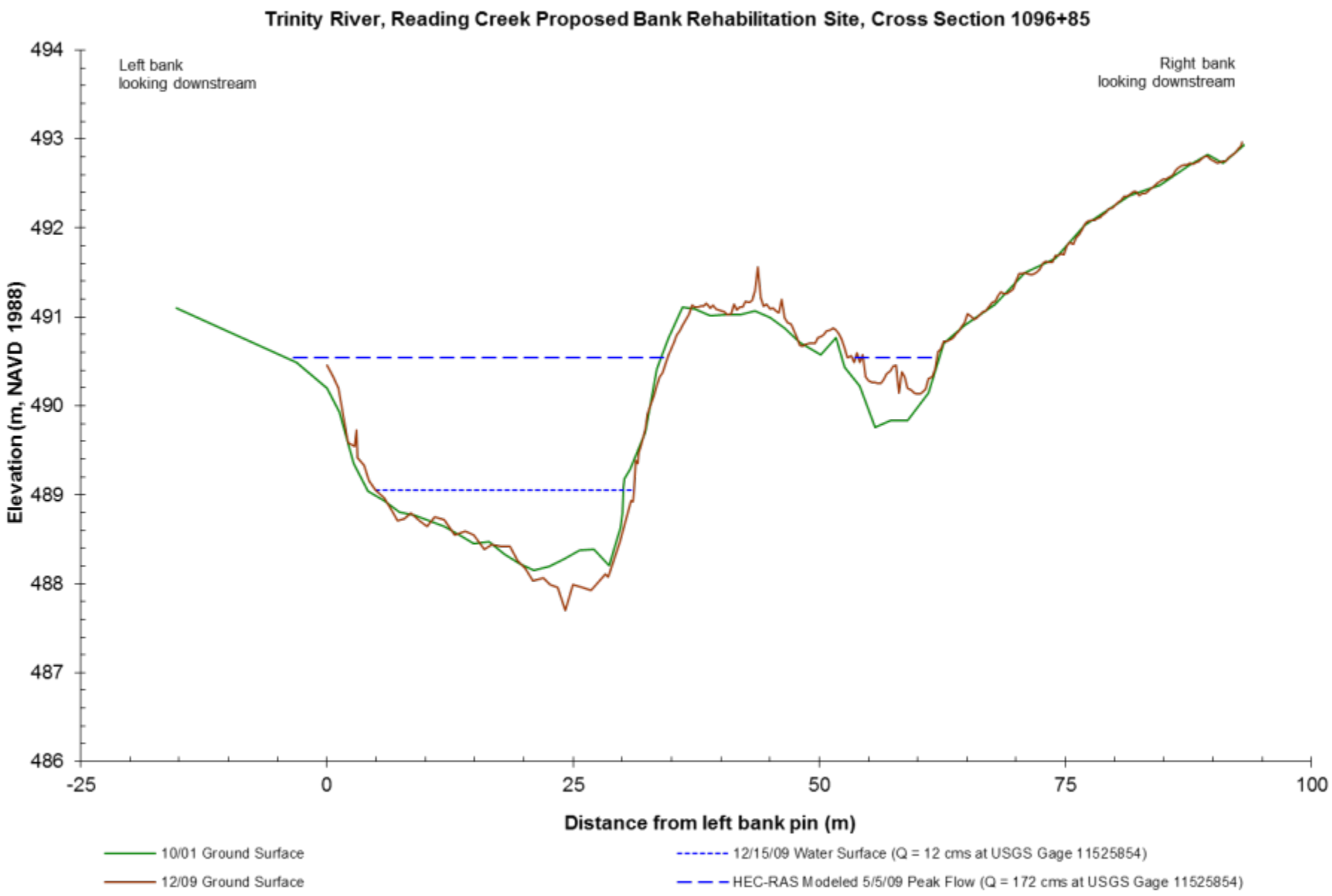

Trinity River, Hocker Flat Bank Rehabilitation Site, Cross Section 309+51
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
442
441
440
439
438
437
436
435
434
433
432
431
430
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
12/05 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
12/31/05 High Water Mark (Peak Q = 816 cms at USGS Gage 11526400)
8/6/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

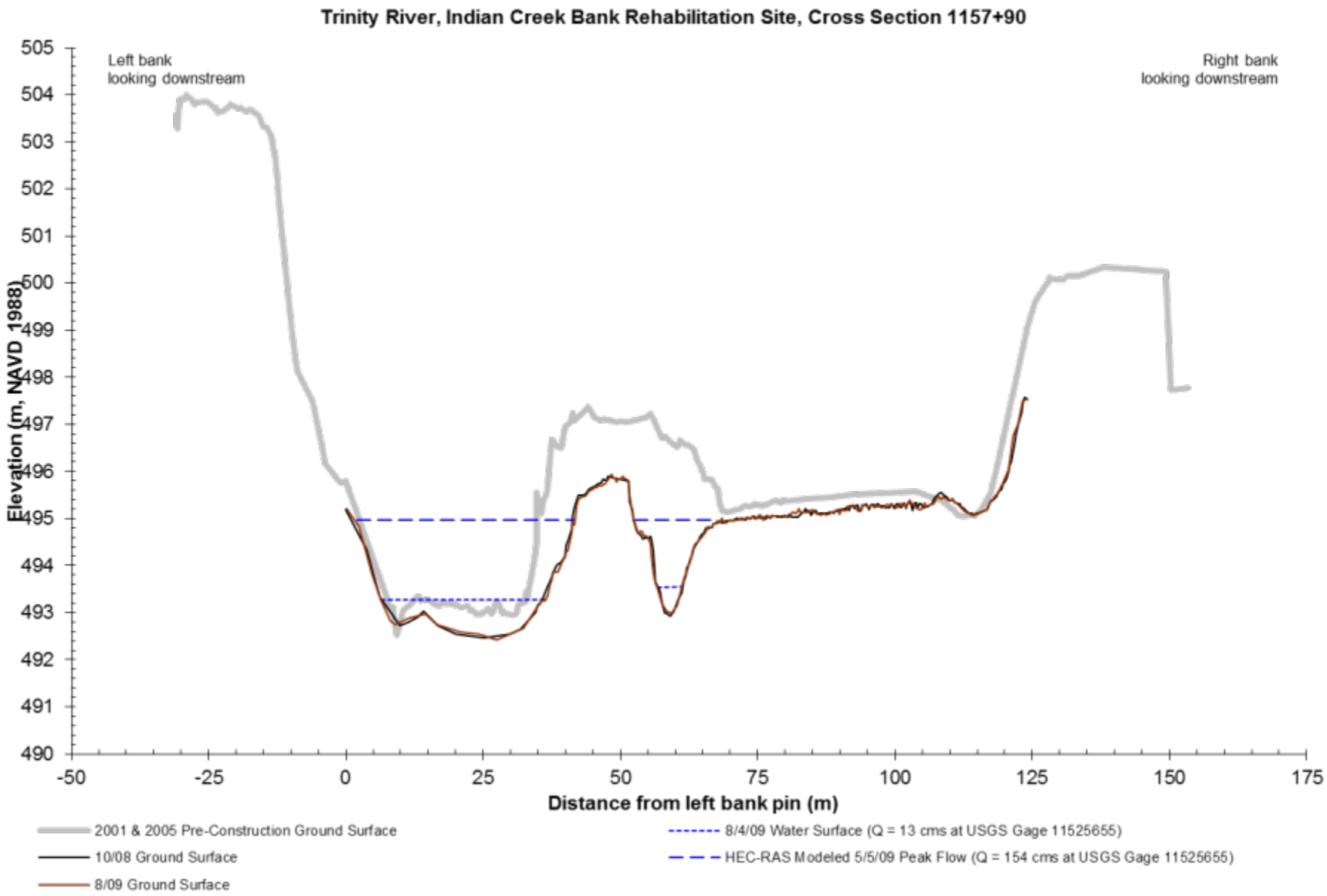

Trinity River, Hocker Flat Bank Rehabilitation Site, Cross Section 314+15
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
442
441
440
439
438
437
436
435
434
433
432
431
430
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
4/03 Pre-Construction Ground Surface
12/05 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
12/31/05 High Water Mark (Peak Q = 816 cms at USGS Gage 11526400)
8/12/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

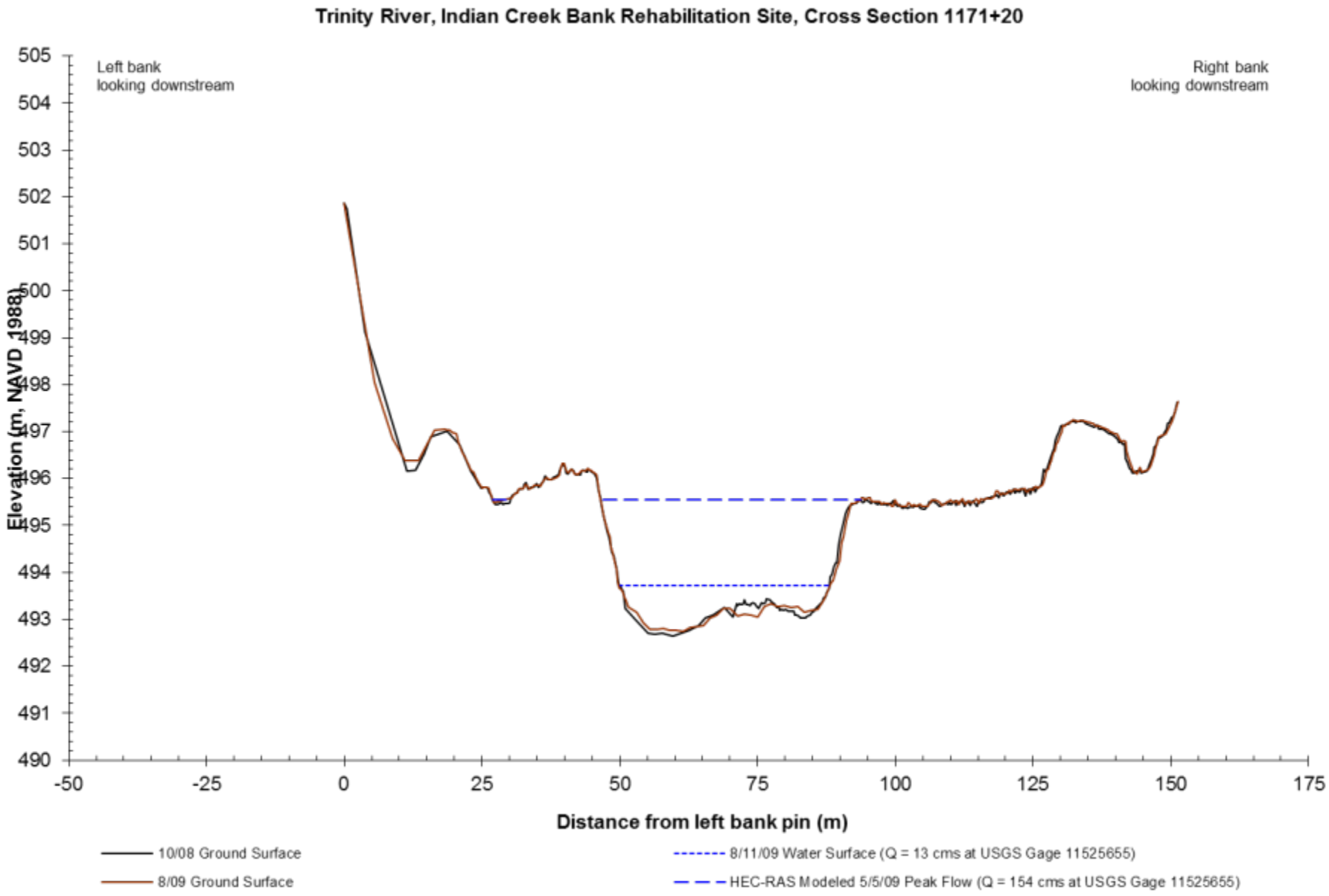

Trinity River, Hocker Flat Bank Rehabilitation Site, Cross Section 326+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
442
441
440
439
438
437
436
435
434
433
432
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
12/05 Post-Construction Ground Surface
10/08 Ground Surface
9/09 Ground Surface
12/31/05 High Water Mark (Peak Q = 816 cms at USGS Gage 11526400)
9/1/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

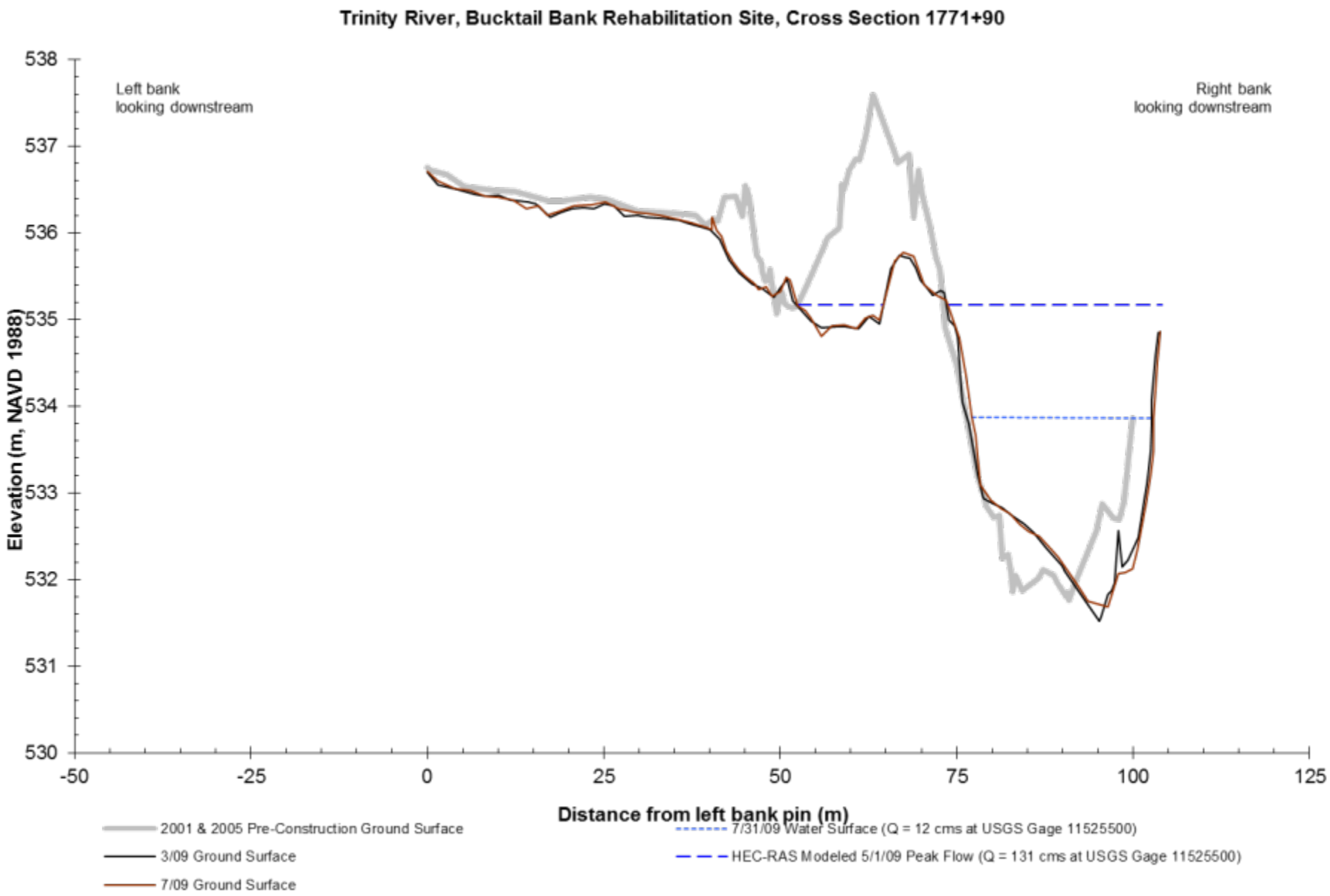

Trinity River, Hocker Flat Bank Rehabilitation Site, Cross Section 340+17
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
444
443
442
441
440
439
438
437
436
435
434
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
12/05 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
12/31/05 High Water Mark (Peak Q = 816 cms at USGS Gage 11526400)
8/13/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

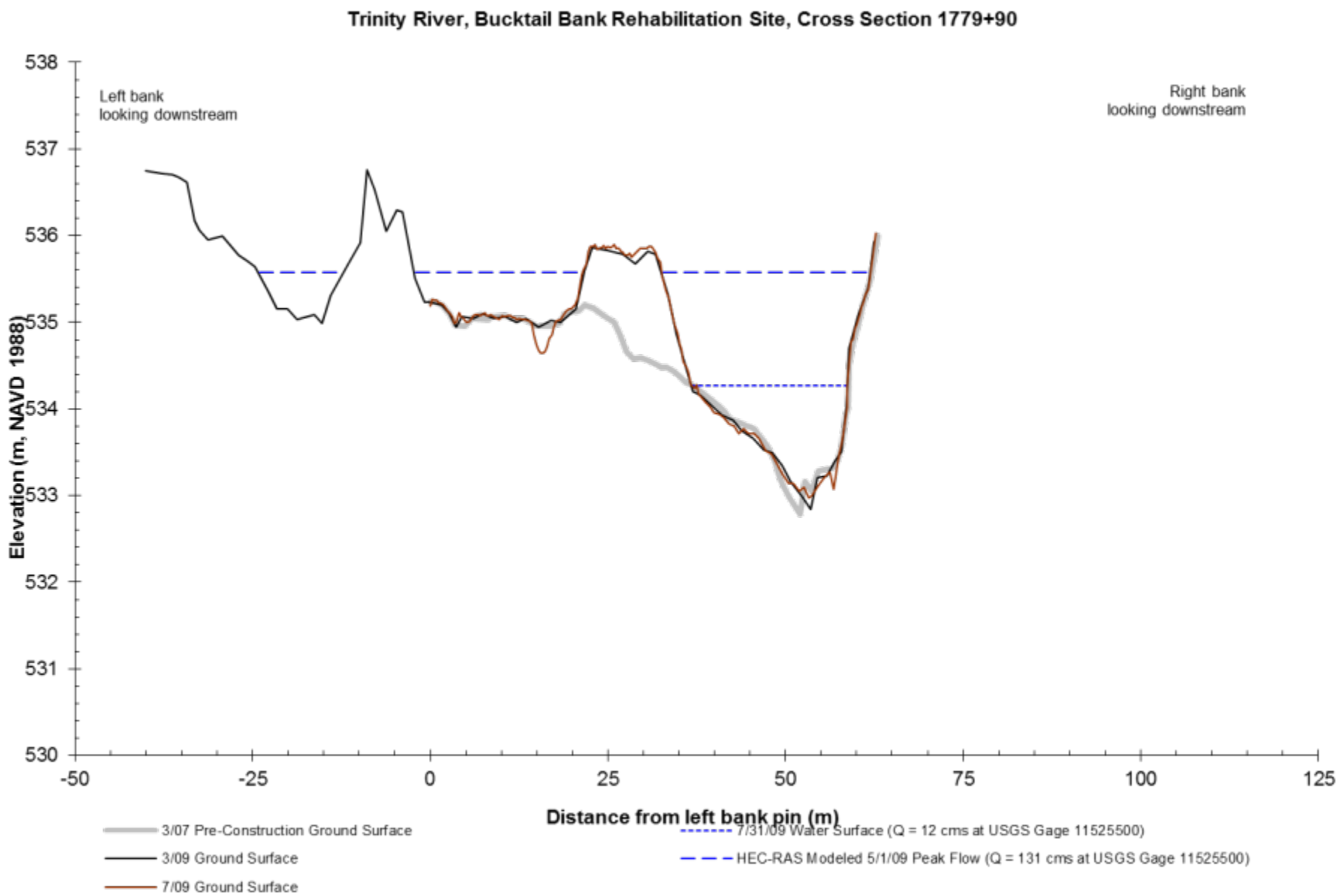

Trinity River, Hocker Flat Bank Rehabilitation Site, Cross Section 358+89
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
444
443
442
441
440
439
438
437
436
435
434
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
12/05 Post-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
12/31/05 High Water Mark (Peak Q = 816 cms at USGS Gage 11526400)
8/13/09 Water Surface (Q = 14 cms at USGS Gage 11526400)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 233 cms at USGS Gage 11526400)

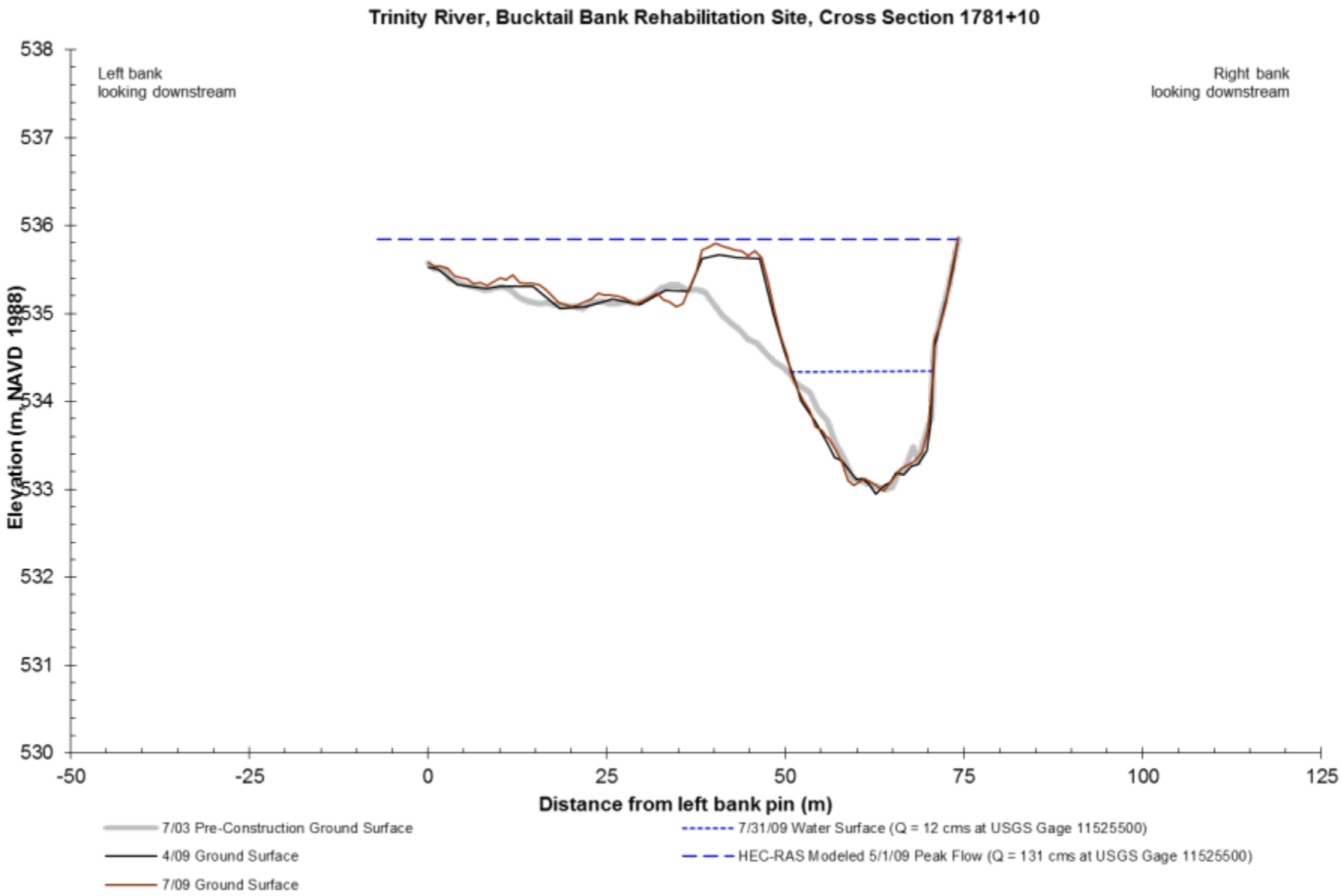

Trinity River, Reading Creek Proposed Bank Rehabilitation Site, Cross Section 1096+85
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
494
493
492
491
490
489
488
487
486
-25
0
25
50
75
100
Distance from left bank pin (m)
10/01 Ground Surface
12/09 Ground Surface
12/15/09 Water Surface (Q = 12 cms at USGS Gage 11525854)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 172 cms at USGS Gage 11525854)

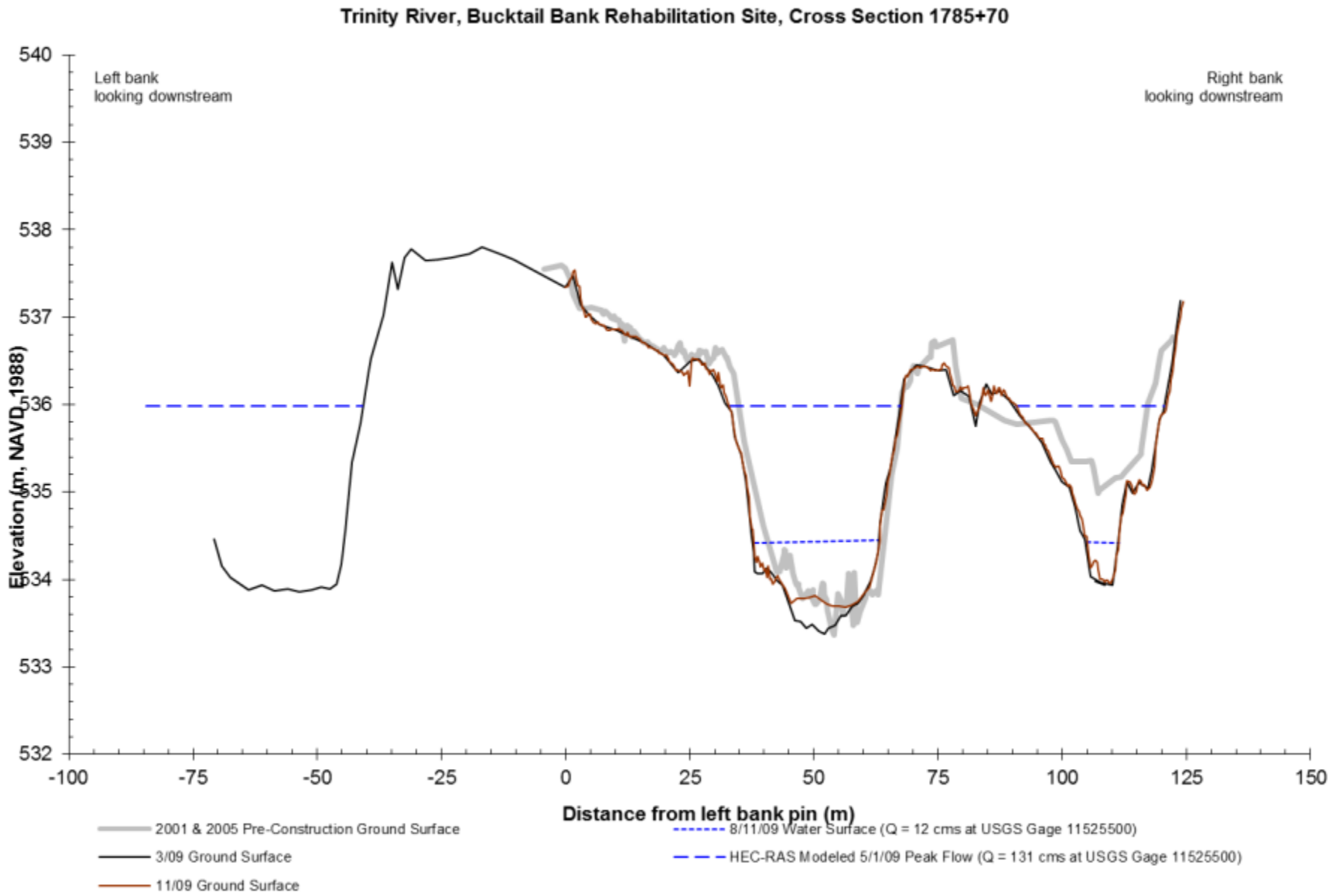

Trinity River, Indian Creek Bank Rehabilitation Site, Cross Section 1157+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
505
504
503
502
501
500
499
498
497
496
495
494
493
492
491
490
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
2001 & 2005 Pre-Construction Ground Surface
10/08 Ground Surface
8/09 Ground Surface
8/4/09 Water Surface (Q = 13 cms at USGS Gage 11525655)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 154 cms at USGS Gage 11525655)

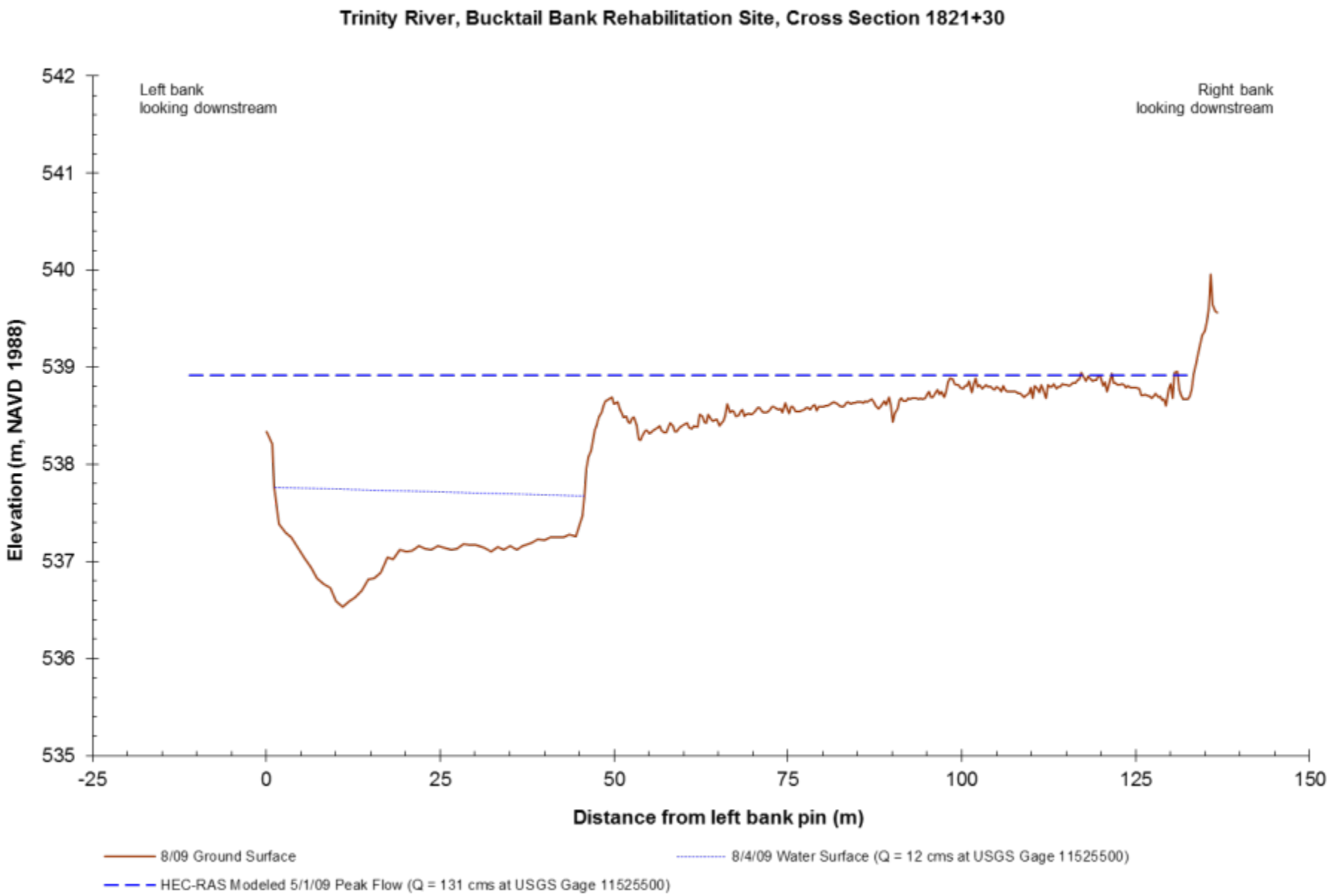

Trinity River, Indian Creek Bank Rehabilitation Site, Cross Section 1171+20
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
505
504
503
502
501
500
499
498
497
496
495
494
493
492
491
490
-50
-25
0
25
50
75
100
125
150
175
Distance from left bank pin (m)
10/08 Ground Surface
8/09 Ground Surface
8/11/09 Water Surface (Q = 13 cms at USGS Gage 11525655)
HEC-RAS Modeled 5/5/09 Peak Flow (Q = 154 cms at USGS Gage 11525655)

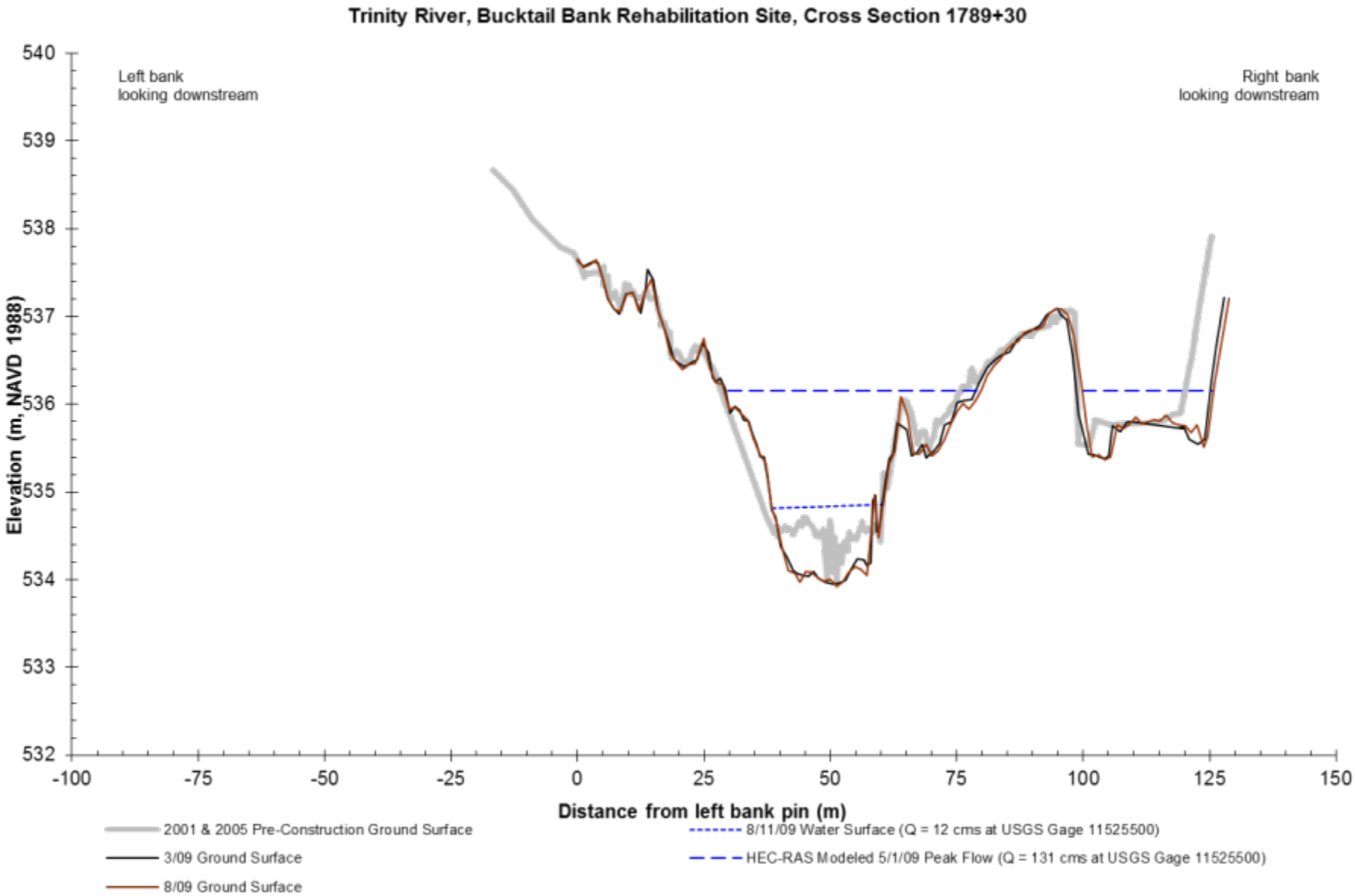

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1771+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
538
537
536
535
534
533
532
531
530
-50
-25
0
25
50
75
100
125
Distance from left bank pin (m)
2001 & 2005 Pre-Construction Ground Surface
3/09 Ground Surface
7/09 Ground Surface
7/31/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

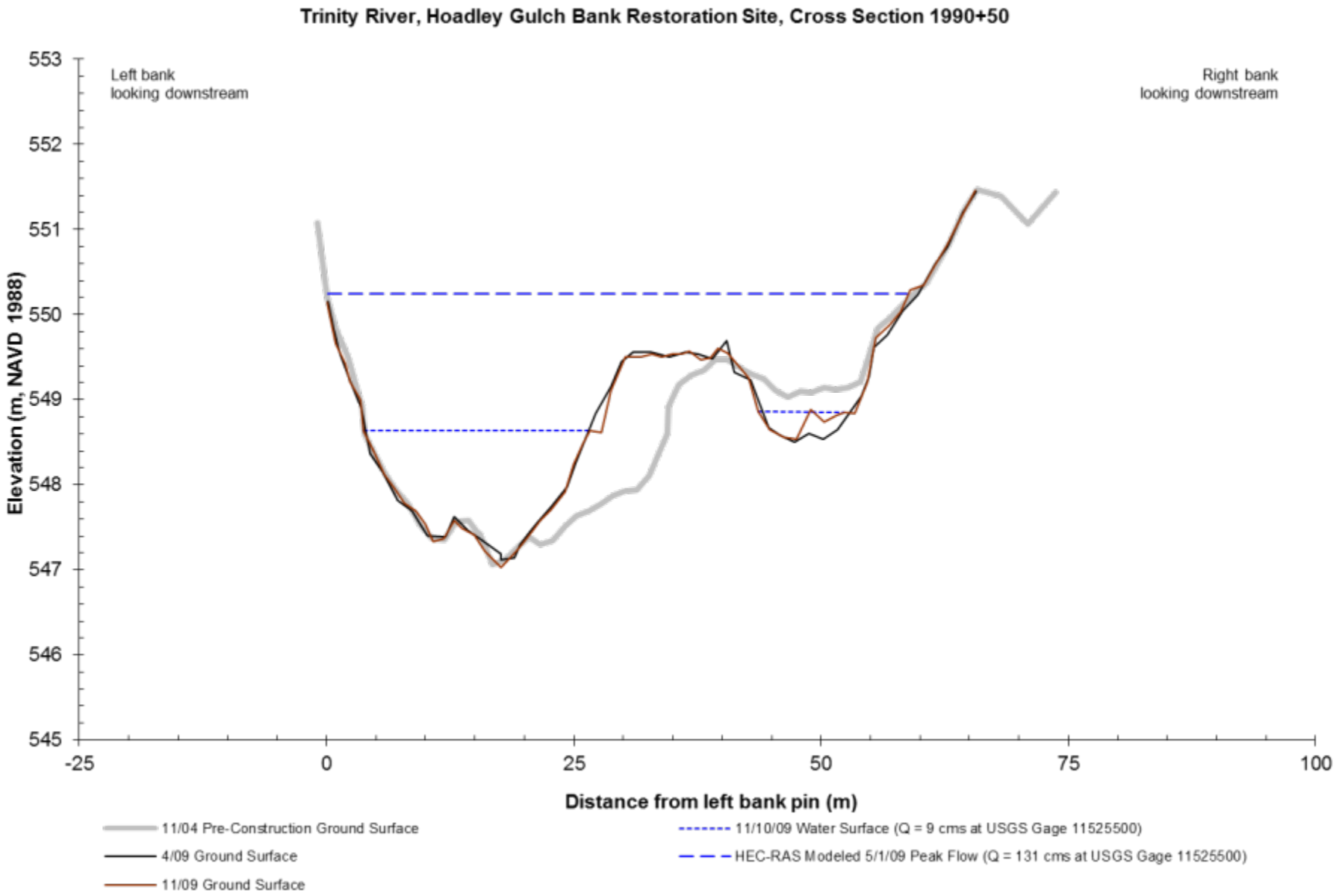

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1779+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
538
537
536
535
534
533
532
531
530
-50
-25
0
25
50
75
100
125
Distance from left bank pin (m)
3/07 Pre-Construction Ground Surface
3/09 Ground Surface
7/09 Ground Surface
7/31/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

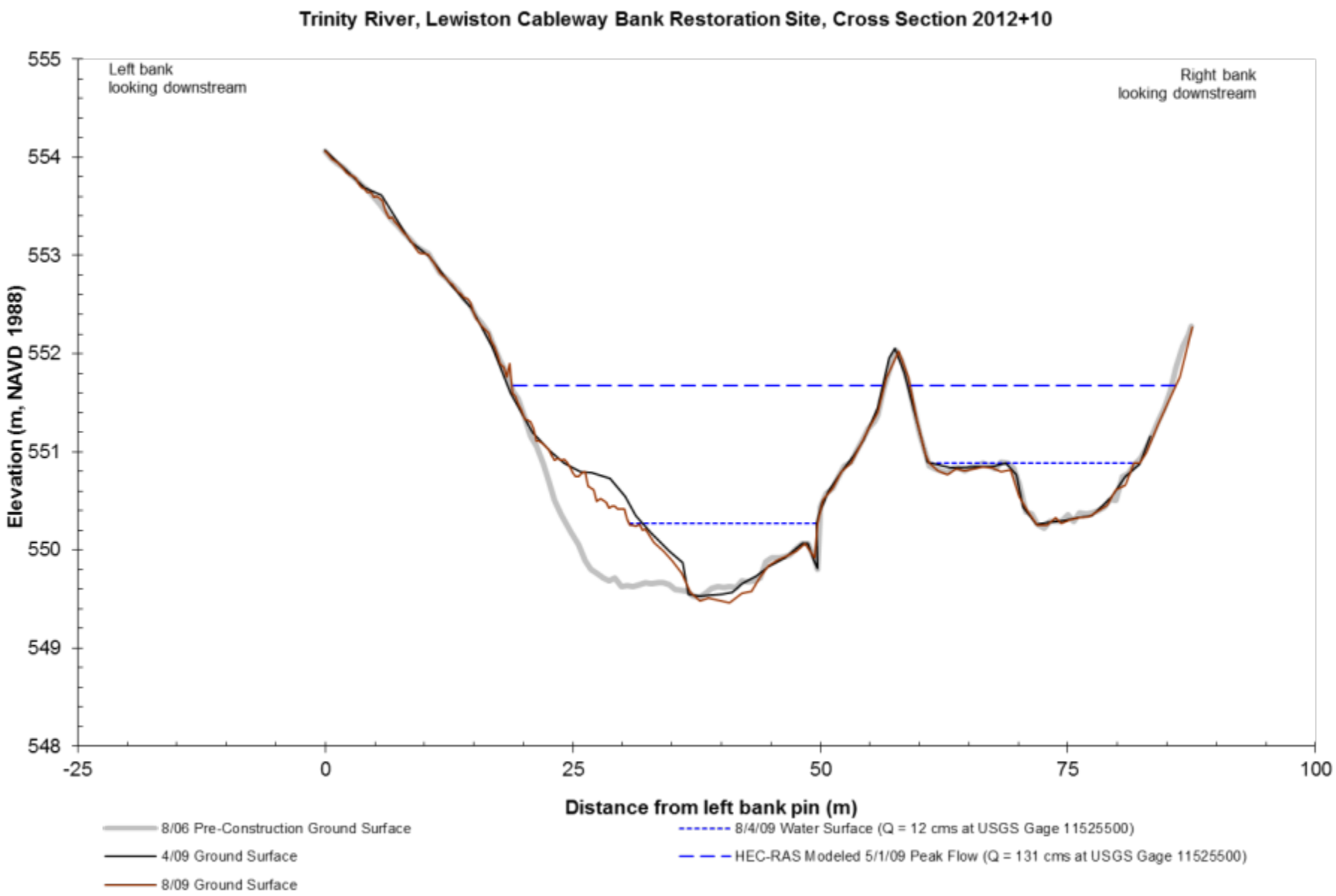

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1781+10
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
538
537
536
535
534
533
532
531
530
-50
-25
0
25
50
75
100
125
Distance from left bank pin (m)
7/03 Pre-Construction Ground Surface
4/09 Ground Surface
7/09 Ground Surface
7/31/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

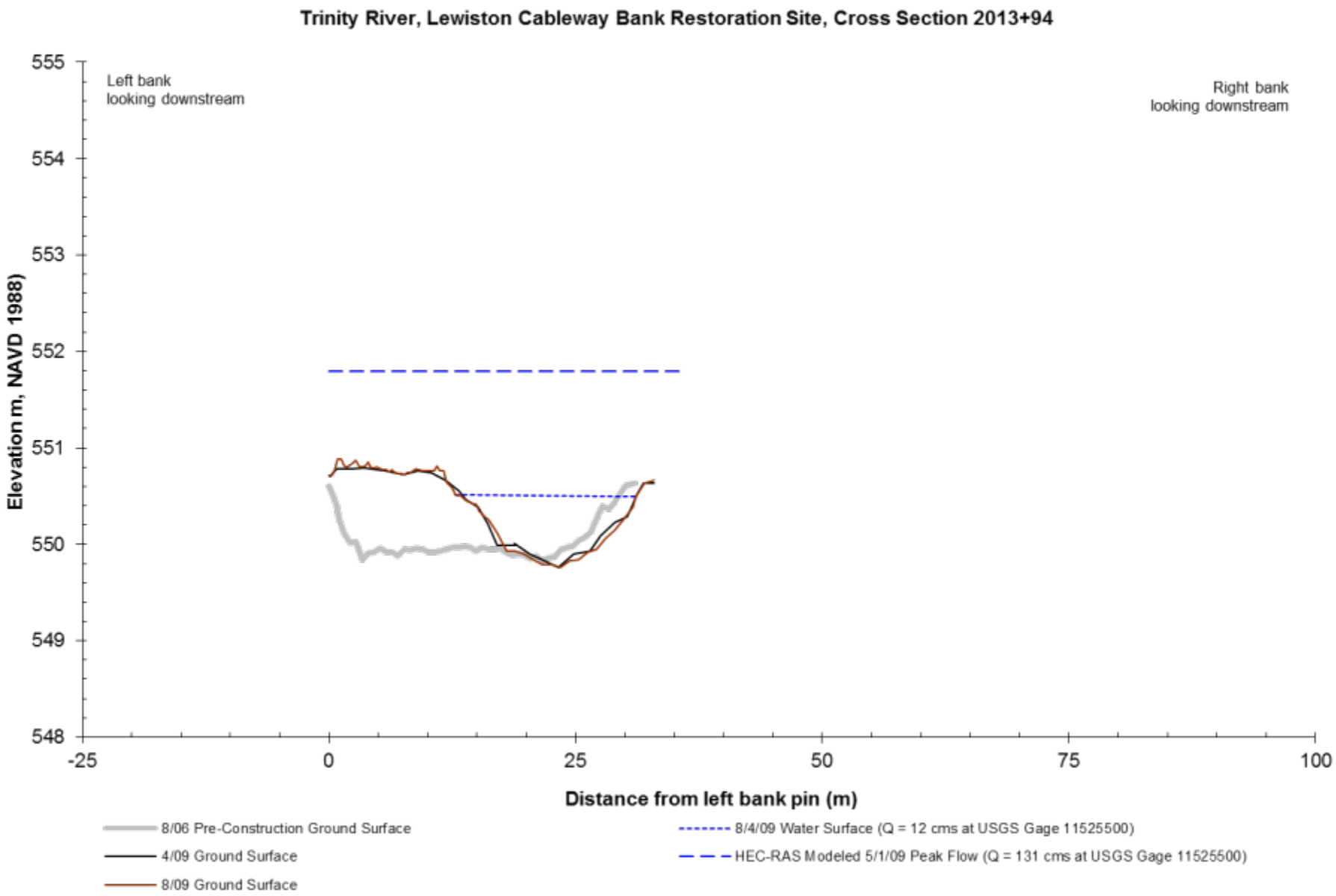

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1785+70
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
540
539
538
537
536
535
534
533
532
-100
-75
-50
-25
0
25
50
75
100
125
150
Distance from left bank pin (m)
2001 & 2005 Pre-Construction Ground Surface
3/09 Ground Surface
11/09 Ground Surface
8/11/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

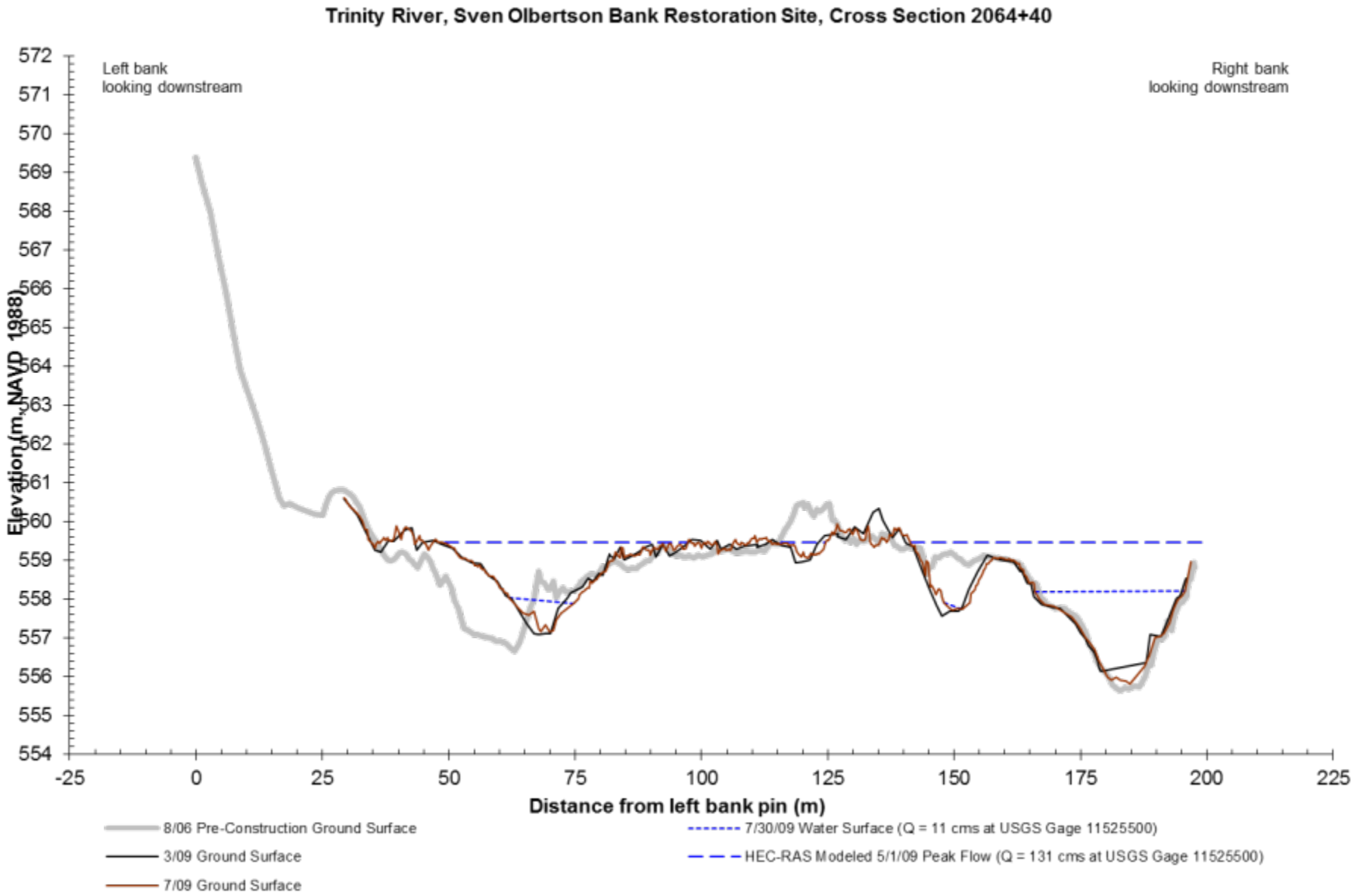

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1821+30
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
542
541
540
539
538
537
536
535
-25
0
25
50
75
100
125
150
Distance from left bank pin (m)
8/09 Ground Surface
8/4/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

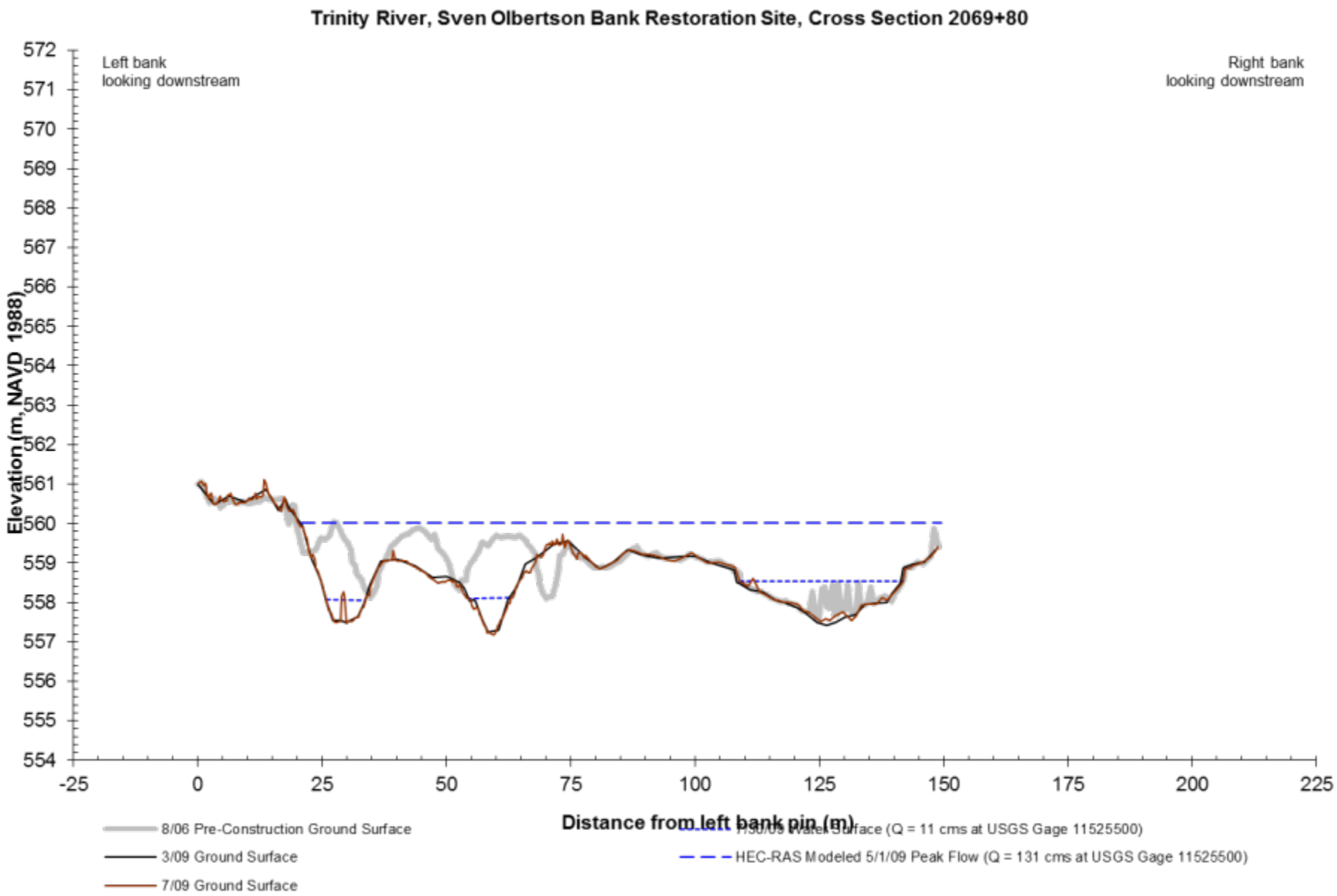

Trinity River, Bucktail Bank Rehabilitation Site, Cross Section 1789+30
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
540
539
538
537
536
535
534
533
532
-100
-75
-50
-25
0
25
50
75
100
125
150
Distance from left bank pin (m)
2001 & 2005 Pre-Construction Ground Surface
3/09 Ground Surface
8/09 Ground Surface
8/11/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)


Trinity River, Hoadley Gulch Bank Restoration Site, Cross Section 1990+50
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
553
552
551
550
549
548
547
546
545
-25
0
25
50
75
100
Distance from left bank pin (m)
11/04 Pre-Construction Ground Surface
4/09 Ground Surface
11/09 Ground Surface
11/10/09 Water Surface (Q = 9 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)


Trinity River, Lewiston Cableway Bank Restoration Site, Cross Section 2012+10
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
555
554
553
552
551
550
549
548
-25
0
25
50
75
100
Distance from left bank pin (m)
8/06 Pre-Construction Ground Surface
4/09 Ground Surface
8/09 Ground Surface
8/4/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)


Trinity River, Lewiston Cableway Bank Restoration Site, Cross Section 2013+94
Left bank
looking downstream
Right bank
looking downstream
Elevation m, NAVD 1988)
555
554
553
552
551
550
549
548
-25
0
25
50
75
100
Distance from left bank pin (m)
8/06 Pre-Construction Ground Surface
4/09 Ground Surface
8/09 Ground Surface
8/4/09 Water Surface (Q = 12 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)


Trinity River, Sven Olbertson Bank Restoration Site, Cross Section 2064+40
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
572
571
570
569
568
567
566
565
564
563
562
561
560
559
558
557
556
555
554
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
8/06 Pre-Construction Ground Surface
3/09 Ground Surface
7/09 Ground Surface
7/30/09 Water Surface (Q = 11 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)


Trinity River, Sven Olbertson Bank Restoration Site, Cross Section 2069+80
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
572
571
570
569
568
567
566
565
564
563
562
561
560
559
558
557
556
555
554
-25
0
25
50
75
100
125
150
175
200
225
Distance from left bank pin (m)
8/06 Pre-Construction Ground Surface
3/09 Ground Surface
7/09 Ground Surface
7/30/09 Water Surface (Q = 11 cms at USGS Gage 11525500)
HEC-RAS Modeled 5/1/09 Peak Flow (Q = 131 cms at USGS Gage 11525500)

APPENDIX C. BED MOBILITY

Monitoring period: 12/2/08 to 4/14/09										
Reach / Site	**Cross section**	**Facies**	**Stationing (from left bank) (m)**	**Number of tracer rocks in set**	**Spacing on cross section (m)**	**Particle size class**	**Particle size (mm)**	**Number of tracer rocks mobilized**	**Percent of tracer rocks mobilized**	**Rocks that moved, by station**
Valdor Gulch	151+80	2	17.7 - 22.3	4	1.2	D_{84}	38	2	50%	103.0, 104.2
				0	0	D_{50}	6	N/A	N/A	N/A
		3	22.3 - 32.0+	9	1.2	D_{84}	117	0	0%	
				9	1.2	D_{50}	65	2	22%	116.4, 117.7
		combined		13	1.2	D_{84}		2	15%	
				9	1.2	D_{50}		2	22%	
	166+75	4	97.8 - 104.0	6	1.2	D_{84}	23	0	0%	
				0	0	D_{50}	7	N/A		
		6	111.2 - 128.0+	8	1.2	D_{84}	126	0	0%	
				8	2.4	D_{50}	58	1	13%	120.1
		combined		14		D_{84}		0	0%	
				8		D_{50}		1	13%	
Hocker Flat	314+15	2	70.4 - 100.9+	18	1.2	D_{84}	128	2	11%	90.2, 91.4
				18		D_{50}	72	2	11%	85.3, 87.8
	326+90	N/A		9	1.2	D_{84}	125	0	0%	
				9		D_{50}	79	1	11%	292.3
	358+89	3	19.5 - 26.8	6	1.2	D_{84}	123	0	0%	
				6		D_{50}	73	0	0%	
		4	26.8 - 38.1+	9	1.2	D_{84}	142	0	0%	
				9		D_{50}	80	1	11%	36.6
		combined		15		D_{84}		0	0%	
				15		D_{50}		1	7%	
Peak discharge within monitoring period:										
3/2/09 Instantaneous Peak: Q = 113 cms (3,990 cfs) at USGS Gage 11526400										

Monitoring period: 4/14/09 to 6/30/09										
Reach / Site	**Cross section**	**Facies**	**Stationing (from left bank) (m)**	**Number of tracer rocks in set**	**Spacing on cross section (m)**	**Particle size class**	**Particle size (mm)**	**Number of tracer rocks mobilized**	**Percent of tracer rocks mobilized**	**Rocks that moved, by station**
Valdor Gulch	151+80	2	17.7 - 22.3	4	1.2	D_{84}	38	3	75%	105.5
				0	0	D_{50}	6	N/A	N/A	
		3	22.3 - 32.0+	9	1.2	D_{84}	117	4	44%	112.8, 114.0, 116.4, 117.6
				7	1.2	D_{50}	65	5	71%	111.6, 112.8, 115.2, 116.4, 117.6
		combined		13	1.2	D_{84}		7	54%	
				7	1.2	D_{50}		5	71%	
	166+75	4	97.8 - 104.0	6	1.2	D_{84}	23	0	0%	
				0	0	D_{50}	7	N/A	n/a	
		6	111.2 - 128.0+	8	1.2	D_{84}	126	2	25%	111.6, 120.1
				7	2.4	D_{50}	58	4	57%	114.0, 115.2 116.4, 120.1
		combined		14		D_{84}		2	14%	
				7		D_{50}		4	57%	
Hocker Flat	314+15	2	70.4 - 100.9+	18	1.2	D_{84}	128	11	61%	83.8, 85.0, 87.5 through 97.5
				18		D_{50}	72	12	67%	83.8 through 97.5
	326+90	N/A		9	1.2	D_{84}	125	6	67%	19.5, 20.7, 21.9, 23.1, 24.4, 26.8
				9		D_{50}	79	9	100%	19.5 through 26.8 (all rocks moved)
	358+89	3	19.5 - 26.8	6	1.2	D_{84}	123	0	0%	
				4		D_{50}	73	0	0%	
		4	26.8 - 38.1+	9	1.2	D_{84}	142	5	56%	30.5, 32.9, 34.1, 35.4, 36.5
				9		D_{50}	80	5	56%	30.5, 32.9, 34.1, 35.4, 36.5
		combined		15		D_{84}		5	33%	
				15		D_{50}		5	33%	
Peak discharge within monitoring period:										
5/5/09 Instantaneous Peak: Q = 233 cms (8,230 cfs) at USGS Gage 11526400										

Monitoring period: 4/22/09 to 6/30/09										
Reach / Site	**Cross section**	**Facies**	**Stationing (from left bank) (m)**	**Number of tracer rocks in set**	**Spacing on cross section (m)**	**Particle size class**	**Particle size (mm)**	**Number of tracer rocks mobilized**	**Percent of tracer rocks mobilized**	**Rocks that moved, by station**
Bucktail	1781+10	N/A	40.2 - 61.0	18	1.2	D_{84}	85	N/A	N/A	Rock set vandalized, results unreliable.
				18	1.2	D_{50}	58	N/A	N/A	
	1779+90	N/A	31.1 - 51.8	18	1.2	D_{84}	85	13	72%	
				18	1.2	D_{50}	58	13	72%	
Hoadley Gulch	1990+50	N/A	19.5 - 35.4	14	1.2	D_{84}	85	N/A	N/A	Rock set vandalized, results unreliable.
				14	1.2	D_{50}	58	N/A	N/A	
Lewiston Cableway	2012+10	N/A	23.8- 46.9	20	1.2	D_{84}	85	9	45%	
				20	1.2	D_{50}	58	9	45%	
	2013+94	N/A	4.3 - 27.4	20	1.2	D_{84}	85	5	25%	11.6, 14.0, 17.7, 18.9, 23.8
				20	1.2	D_{50}	58	8	40%	17.7, 18.9, 20.1, 21.3, 22.6, 23.8, 25.0, 26.2
Peak discharge within monitoring period:										
5/1/09 Instantaneous Peak: Q = 131 cms (4,630 cfs) at USGS Gage 11525500										

APPENDIX D. SCOUR CHAIN MONITORING

Valdor Gulch Scour Chain Installation and Monitoring Summary											
Cross Section	**Station (m)**	**Recovery date**	**Recovery: Bed surface elevation at chain location (m)**	**New length of chain (m)**	**Length of chain as installed (m)**	**Scour depth (m)**	**Surface D_{84} (mm)**	**Relative scour (dsc/D_{84})**	**Bed surface elevation when chain was installed (m)**	**Bed surface elevation difference pre - post (m)**	**Redepositio n thickness (m)**
151+80	106.2	6/30/2009	424.3	0.19	0.15	0.04	116	0.3	424.2	-0.02	0.06
	109.3	6/30/2009	424.1	0.22	0.20	0.02	116	0.2	424.1	-0.01	0.03
	112.1	6/30/2009	423.7	0.34	0.31	0.00	116	0.0	423.6	-0.06	0.00
	115.5	7/1/2009	423.3	0.26	0.26	0.00	116	0.0	423.3	0.01	0.00
166+75	112.1	6/30/2009	424.9	0.28	0.15	0.13	128	1.0	425.0	0.06	0.07
	114.9	6/30/2009	424.3	0.21	0.16	0.05	128	0.4	424.3	0.00	0.05
	118.2	6/30/2009	424.3	0.15	0.15	0.00	128	0.0	424.3	-0.01	0.01

Hocker Flat Scour Chain Installation and Monitoring Summary											
Cross Section	**Station (m)**	**Recovery date**	**Recovery: Bed surface elevation at chain location (m)**	**New length of chain (m)**	**Length of chain as installed (m)**	**Scour depth (m)**	**Surface D_{84} (mm)**	**Relative scour (dsc/D_{84})**	**Bed surface elevation when chain was installed (m)**	**Bed surface elevation difference pre - post (m)**	**Redepositio n thickness (m)**
314+15	76.8	6/30/2009	435.5	0.23	0.19	0.04	128.0	0.31	435.4	-0.05	0.09
	83.2	6/30/2009	435.1	0.24	0.19	0.05	128.0	0.39	435.1	-0.02	0.07
	87.8	6/30/2009	434.9	0.27	0.23	0.04	128.0	0.31	434.9	-0.02	0.06
326+90	23.5	6/30/2009	436.0	0.31	0.20	0.11	125.0	0.88	435.9	-0.06	0.17
	26.5	6/30/2009	436.1	0.25	0.17	0.08	125.0	0.64	436.1	0.02	0.06
	29.0	6/30/2009	436.3	0.22	0.18	0.04	125.0	0.32	436.2	-0.06	0.10
	32.0	6/30/2009	436.4	0.30	0.18	0.12	125.0	0.96	436.4	-0.01	0.13
358+89	25.9	6/30/2009	439.9	0.23	0.20	0.03	123.0	0.24	439.8	-0.02	0.05
	29.6	6/30/2009	439.3	0.24	0.26	0.00	142.0	0.00	439.2	-0.06	0.06
	33.2	6/30/2009	438.6	0.34	0.32	0.02	142.0	0.14	438.6	-0.05	0.07

Site	Feature	Maximum scour (m)	Minimum scour (m)	Maximum depostion (m)	Minimum deposition (m)
Valdor Gulch 151+80	Bar flank	0.04	0.00	0.06	0.00
Valdor Gulch 166+75	Bar flank	0.13	0.00	0.07	0.01
Hocker Flat 314+15	Bar flank	0.05	0.04	0.09	0.06
Hocker Flat 326+90	Bar flank	0.12	0.04	0.17	0.06
Hocker Flat 358+89	Bar flank	0.03	0.00	0.07	0.05

APPENDIX E. ADDITIONAL RIPARIAN MONITORING RESULTS

Pear Tree Riparian Results

2007 Mapping Results

In 2007, one year following construction, the total vegetated area mapped was 2.1 hectares (5.1 acres) and accounted for 44.6% of the mapped area (Figure E-1). Pear Tree was 33.9% open ground in 2007 (Figure 3-1). Revegetation mapped in 2007 was 2.9% of the area and occurred just downstream of where Pear Tree Gulch flows into the site (rehabilitation activity area R5, Figure A-4). Narrowleaf willow regrowth accounted for 2% of total area and was generally encountered along the 13 cms (450 cfs) water edge, especially along the constructed feathered edge. Remnant vegetation accounted for 31.2% of the total mapped area and consisted mostly of individual willow shrubs. The constructed terrace (activity area U1, Figure A-3) was open. Woody plant seedling regeneration accounted for 1.4% of the area and consisted of young-of-year, 2-year old seedlings and 3-year old seedlings. Young-of-year seedlings grew at the head of the point bar and around the backwater alcove. Two-year and 3-year old plants grew in concentric bands behind the young-of-year seedlings at the head of the point bar (Figure E-1).2008 Mapping Results

In 2008, the total vegetated area mapped was 3.0 hectares (7.5 acres) and accounted for 65% of the mapped area (Figure E-2). The area of open ground mapped in 2008 was reduced to 13.9% of the site (Figure 3-1). Most of the mapped open areas in 2007 were replaced by sweetclover in 2008. Herbaceous plants covered 25.1% of site. The largest patches of mapped woody plants in 2008 were either planted or those left remaining after construction (i.e., remnant). The area of willow regrowth nearly doubled to 3.7% of the mapped area. The area of regeneration slightly increased to 2.0%. Similar to 2007, areas of regrowth occurred primarily along the low water edge (13 cms (450 cfs)) at the feathered edge site (rehabilitation activity area R6, Figure A-3). A combination of root sprouts and young-of-year seedlings dominated small areas between remnant shrubs in rehabilitation activity area R4 and between resprouting shrubs in rehabilitation activity area R-5 (Figure A-3). The upland area (U1, Figure A-3) which was unvegetated in 2007 was dominated by sweetclover in 2008.

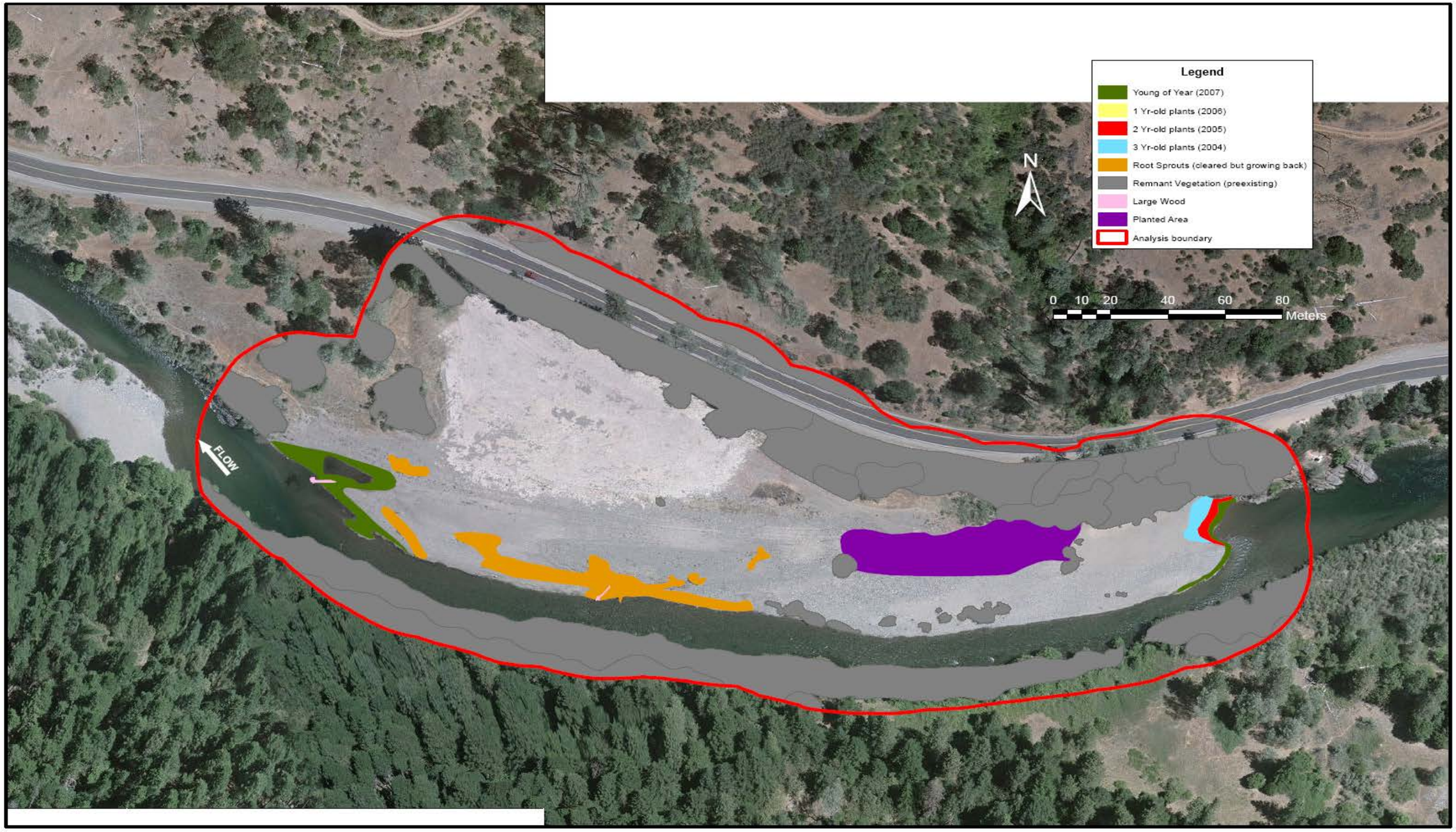


Figure E-1. Pear Tree 2007 rehabilitation site map, one year after construction.

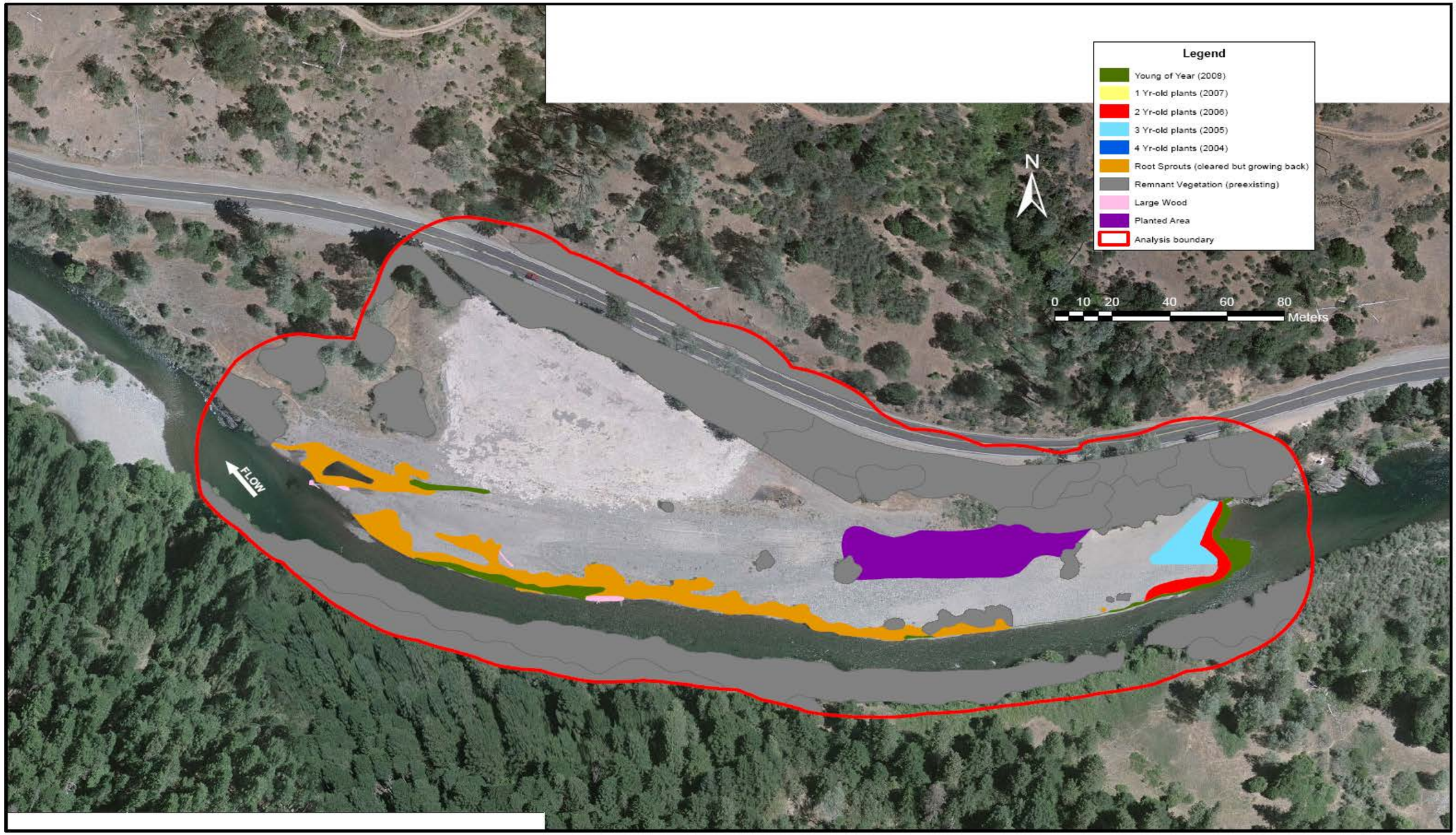


Figure E-2. Pear Tree 2008 rehabilitation site map, two years after construction.

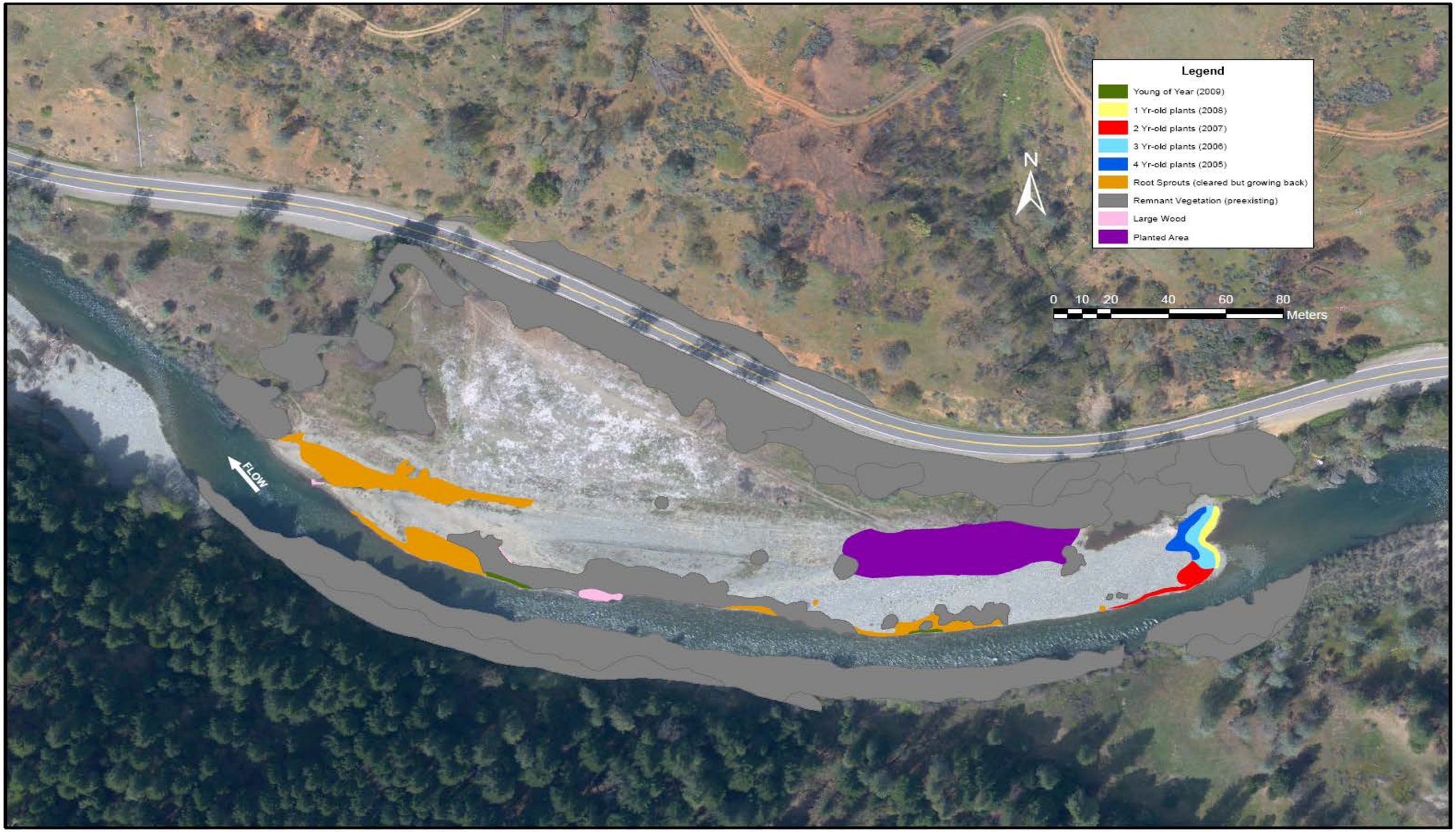


Figure E-3. Pear Tree 2009 rehabilitation site map, three years after construction.

Valdor Gulch Riparian Results

2007 Mapping Results

In 2007, the total mapped vegetated area was 9.5 hectares (23.4 acres) and accounted for 63.8% of the mapped area (Figure 3-2). One year after construction, revegetation accounted for 0% of the area, open ground was 6.5% of the area, seedling regeneration accounted for 0.6% of the mapped area, and the regrowth of willows removed during construction accounted for 7.2% of the mapped area (Figure 3-2). Remnant vegetation was 26.4% of the mapped area. In 2007, young-of-year seedlings dominated many of the regeneration patch types; however, young-of-year seedlings were often mapped together with root sprouts. Pure stands of young-of-year seedlings without root sprouts were observed on a medial bar at the mouth of the constructed side channel and along the low water edge of the re-constructed point bar. Mapped regrowth in 2007 occurred predominantly at upper Valdor Gulch on the medial bar, at lower Valdor Gulch along the feathered edges (i.e., activity areas R3 and R9, Figure A-6) and the constructed floodplains (i.e., activity areas R4, R5, and R8, Figure A-6). The majority of resprouting plants were narrowleaf and dusky willows.2008 Mapping Results.

In 2008, the total mapped vegetated area was 9.0 hectares (22.3 acres) and accounted for 60.7% of the mapped area (Figure 3-2). The area of open ground covered 9.6% of the area in 2008, an increase since 2007. The area of revegetation mapped increased slightly to 0.4% of total mapped area (Figure 3-2). Remnant vegetation covered a similar area as in 2007 and was 26.4% of the mapped area. Regrowth accounted for 10% of the vegetated area and was an increase from 2007. Regrowing willows expanded mostly on the medial bar in upper Valdor Gulch and covered formerly open areas such as constructed floodplains and feathered edges in lower Valdor Gulch.

Seedlings accounted for only 1.4% of the mapped area, an increase in area compared to 2007 mapping. Most mapped patches of seedlings were composed of young-of-year seedlings, although areas where 1-year, 3-year, and 4-year seedlings were dominant were also mapped. Most seedling-dominated stands were mapped in the upper Valdor Gulch area along the margins of the medial bar, main-channel and side channel. Seedlings typically grew on sites of fine sediment deposition, such as at the head of the medial bar, downstream of large wood, along the tail end of the medial bar, and on a bar in the side channel. Downstream at lower Valdor Gulch, seedling-dominated stands occurred at feathered edges (i.e., activity area R3, Figure A-6) and on the upstream side of the point bar (i.e., activity area R5, Figure A-6).

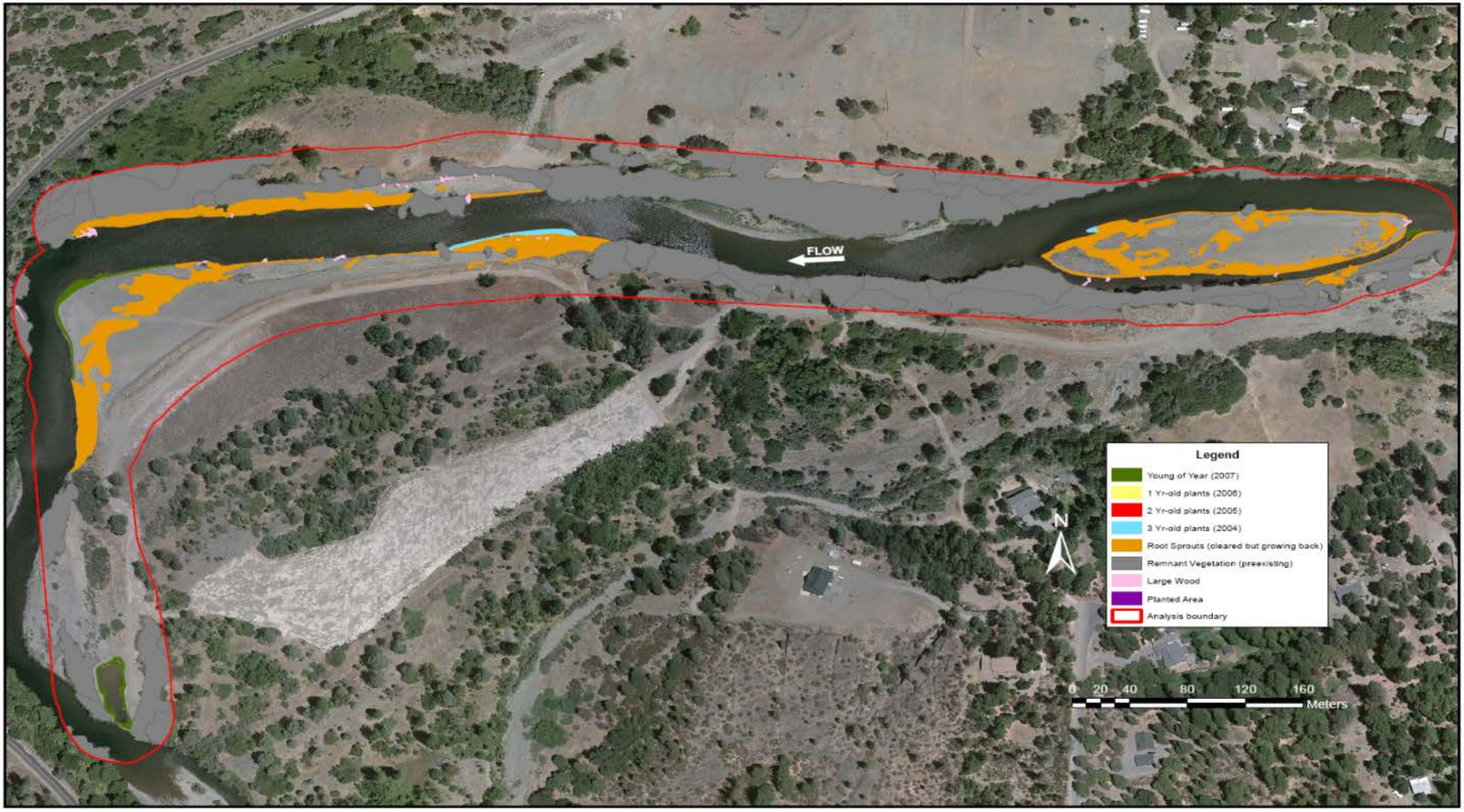


Figure E-4. Valdor Gulch rehabilitation site 2007 map, one year after construction.

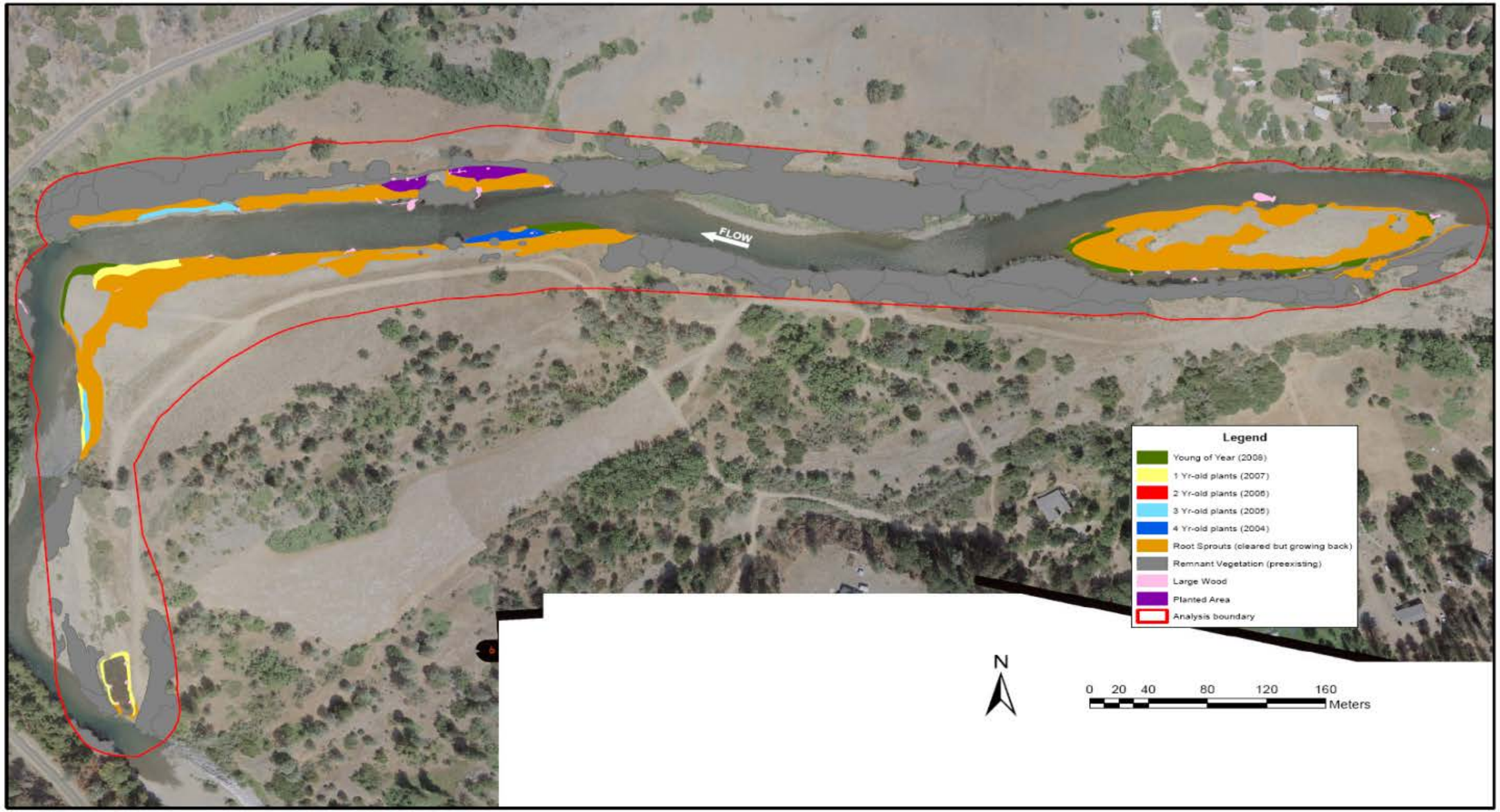


Figure E-5. Valdor Gulch rehabilitation site 2008 map, two years after construction.

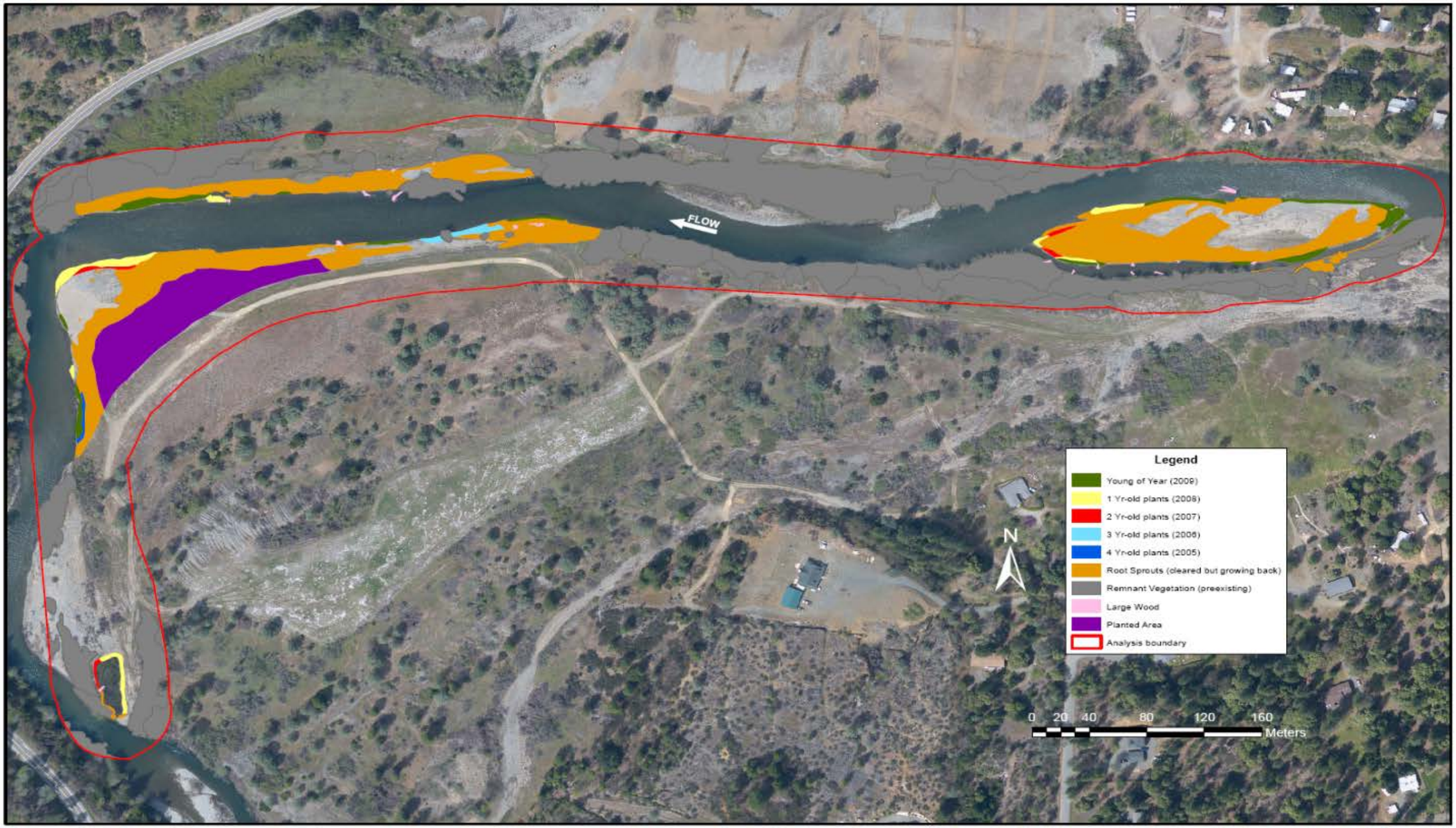


Figure E-6. Valdor Gulch rehabilitation site 2009 map, three years after construction. Band Transect 141+20 Results

Band transect 141+20 was the most downstream band transect monitored at Valdor Gulch and was collocated with cross section 141+20 (Figure A-4). Band transect 141+20 intersects a constructed point bar and the 170 cms (6,000 cfs) floodplain at the downstream end of the site (e.g., activity area R5, Figure A-6). Band transect 141+20 has been monitored in fall 2005 (pre-construction), fall 2006 (as-built), fall 2008 (two years after construction), and fall 2009 (Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank was not monitored. The band transect begins below the 13 cms (450 cfs) water surface and extends across the constructed floodplain and terminates on a terrace. Band transect 141+20 occurs in a location where vehicle and foot traffic are high, which could influence the changes in seedling density; therefore, human disturbance cannot be discounted when identifying the mechanisms responsible for seedling mortality along band transect 141+20.Post-Construction Changes in Cover Type Boundaries.

Immediately following rehabilitation in fall 2006, there was an increase in open ground due to vegetation clearing and floodplain construction. By fall 2009, the constructed floodplain substrate became more heterogeneous, with areas of sand deposition interspersed with mostly clean, large gravels and cobbles. Since rehabilitation, the point bar/feathered edge has remained mostly open with a narrow band of seedlings and root sprouts near the low water edge (Figure E-7).

On the constructed floodplain, there has been no real change in the area covered by narrowleaf willow since rehabilitation. Before construction, a mature narrowleaf willow thicket grew on what was to become post-rehabilitation floodplain. Rehabilitation in fall 2006 cleared the mature narrowleaf willow patch but was unable to remove all of the roots. During the spring and summer of 2007, the remnant roots re-sprouted; by fall 2009, three years after construction, the highest density of narrowleaf willow along the band transect occurred on the constructed floodplain (Figure E-7).

The upland portion of the cross section intersects grassland, which was uniformly labeled as non-native grassland in 2006 and 2008, but was later differentiated into non-native grassland, yellow star-thistle grassland, and silver lupine in 2009. Currently, the non-native grassland patches occur on terrace surfaces that were undisturbed by construction. However, there was an overall decrease in terrace grasslands from 2006 to 2009 due to construction of the 170 cms (6,600 cfs) floodplain and subsequent revegetation with cottonwoods. The increase in open/cottonwood patches along the band transect between 2006 and 2009 corresponds with the decrease in grassland patches and is a result of revegetation following construction.

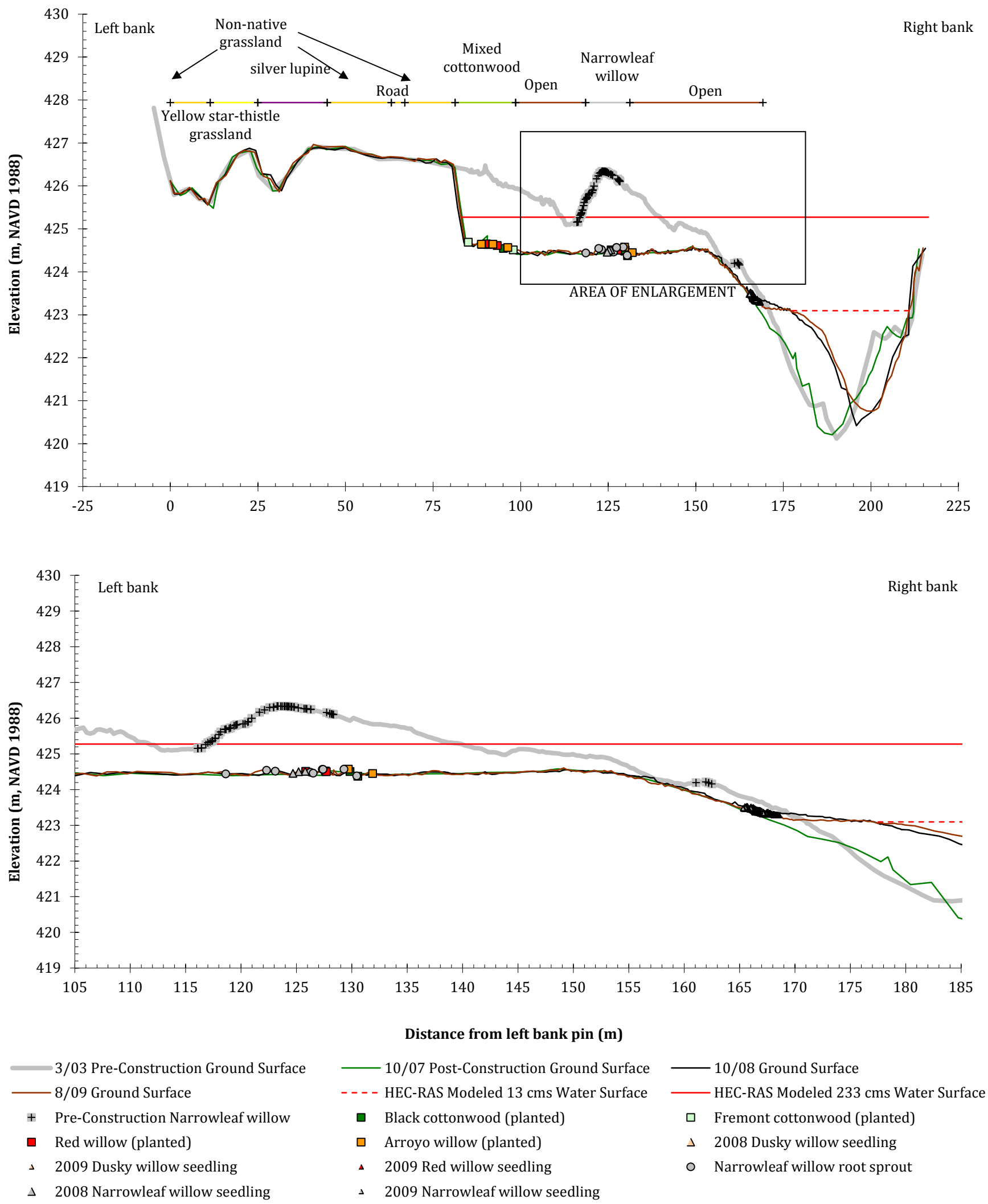


Figure E-7. a) Cross section 141+20, and b) Enlarged cross section 140+20.

Post-Construction Initiation and Establishment Trends

The site was monitored in fall 2006, immediately following construction, to document as-built conditions. Seedlings were not observed; however, regions of root sprouts were documented where the riparian vegetation and sediment berm were removed (McBain & Trush and HVT 2007a). Band transect monitoring was not conducted in fall 2007, one growing season after construction.

In fall 2008, two years following construction, 488 young-of-year seedlings were measured on the cross section. No other seedling Cohorts were documented (Figure E-7). Over 99% of the seedlings were narrowleaf or dusky willow. Six white alder seedlings, one black cottonwood and one arroyo willow seedling were also documented. All seedlings sampled in fall 2008 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. No root sprouts were observed between the 13 to 57 cms (450 to 2,000 cfs) water surface in 2008.

In fall 2009, three years after construction, 228 young-of-year seedlings and 33 1-year seedlings were measured on the band transect. All naturally regenerating hardwoods sampled in fall 2009 (including young-of-year and 1-year old seedlings) occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. The 2009 young-of-year seedlings occurred in the same relative location along the band transect as the 2008 young-of-year seedlings (Figure E-7). Survivors from the 2008 Cohort were intermixed with the 2009 seedlings; however, only 8% of the 2008 Cohort survived to fall 2009 (Figure E 8). In 2009, a total of 11 root sprouts were measured at the low water edge. Although the overall number of root sprouts is small, the abundance and size has increased. As of fall 2009, seedlings along the low water edge do not appear to be inducing deposition or effecting any morphological changes.Channelbed Mobility/Scour Induced Demographic Changes

The peak 2009 flow scoured the channel margin to a depth of 7.6 cm and removed 92% of the 2008 Cohort seedlings (Figure E-7). Channelbed mobility results on cross section 151+80 upstream. Similar bank location and substrate composition to where seedlings occur on band transect 141+20, show that 75% of the D84 size class (i.e., 36 mm) was mobilized along the channel margin (see Valdor Gulch Bed Mobility Monitoring Results). The 7.6 cm scour depth measured along the band transect was about twice the depth of the D84 measured on 151+80 and was sufficient to inhibit establishing hardwood seedlings from the 2008 Cohort. A scour depth that was twice the size of the D_{84} should be able to remove seedlings less than 2 years old and was clearly able to scour away 1-year-old seedlings.

The point bar intersected by band transect 141+20 intersects is building (it extends ~13 m from the low water edge under 0.3 m or less of water); however, a veneer of sand is depositing on the constructed floodplain in the pre-construction berm location. Within this sand deposition zone, there are 18 plants: 11 narrowleaf willows (six remnant large shrubs,

one 2007 shrub, and two 2008 root sprouts) and seven planted hardwoods (two red willows, three black cottonwoods, and two arroyo willows). There is a strong possibility that the riparian berm—or at least a band of narrowleaf willows with a sand deposit—will re-form in the same location as the pre-construction riparian berm as a result of regrowing plants.

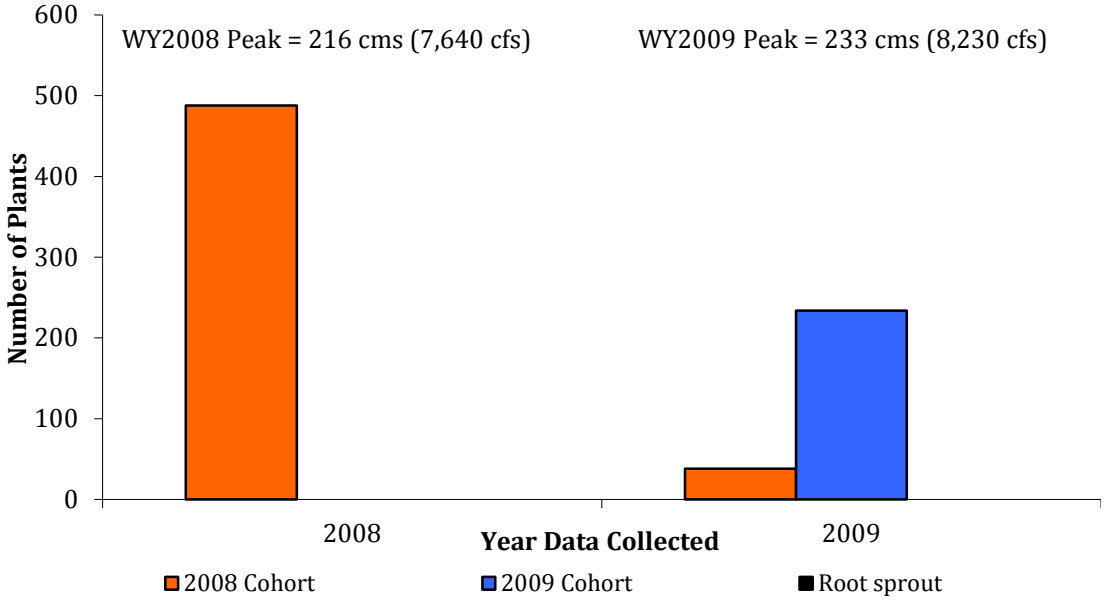


Figure E-8. Cross section 141+20 WY 2008-2009 seedling demographics within 13–57 cms (450-2000 cfs) ROD discharge inundation zone.

Red-Yellow-Green Analysis

Seedling-caused detrimental riparian encroachment along the low water edge has been inhibited. Presently, there is a low encroachment risk along band transect 141+20. Currently, there are only young-of-year seedlings from the 2009 Cohort growing along the low water edge, which gives initiating seedlings one more year without removal before the site moves to a yellow, cautionary status with a moderate risk of encroachment (Figure E 9).Band Transect 151+80 Results

Band transect 151+80 was the middle band transect sampled at Valdor Gulch and was collocated with cross section 151+80 (Figure A-4). Band transect 151+80 intersects a constructed feathered edge (e.g., activity area R3, Figure A-6) that grades downstream into the constructed point bar and 187 cms (6,600 cfs) floodplain at cross section 141+20 (e.g., activity area R5, Figure A-6). Band transect 151+80 was installed because of high vehicle and foot traffic at band transect 141+20; it was placed in a low foot traffic area upstream and should reflect similar results as band transect 141+20. Band transect 151+80 was monitored in fall 2008 (two years after construction), and fall 2009 (Table 3-4). Band transect 151+80 was only sampled along the rehabilitated left bank portion of the cross

section. The rehabilitated right bank was not monitored (e.g., activity area R8, Figure A-6). Band transect 151+80 begins below the 13cms (450 cfs) water surface on the left bank and extends across the feathered edge terminating on a terrace next to the access road.

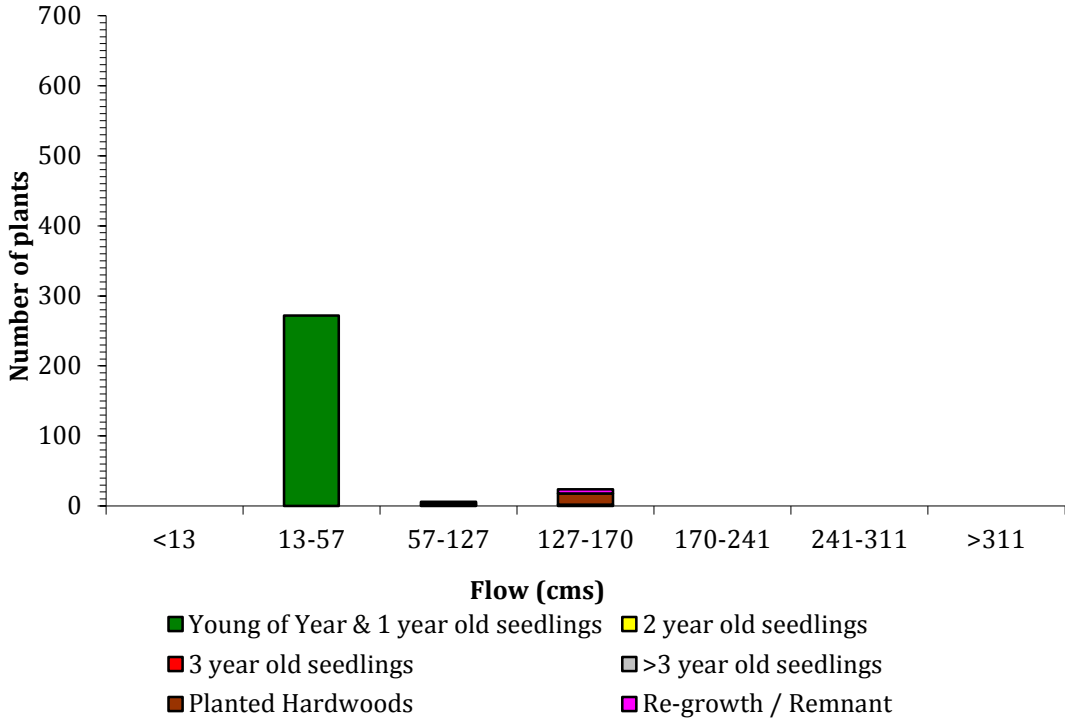


Figure E-9. Red - Yellow - Green analysis cross section 141+20.

Post-Construction Changes in Cover Type Boundaries

Immediately following rehabilitation in fall 2006, there was an increase in open ground due to vegetation clearing and floodplain construction. Since rehabilitation, the lower portions of the feathered edge closest to the water have remained mostly open, with root sprouts and seedlings trying to establish near the low water edge.

The upland portion of the cross section was non-native grassland in 2008; however, yellow star-thistle dominated several areas of the non-native grassland in 2009. Approximately half of the non-native grassland that band transect 151+80 intersects transitioned into yellow star-thistle grassland in 2009. The non-native grassland patches grow on terraces adjacent to the feathered edge. Considering both patch types together, there was no net change in area of these non-native cover types growing on the terrace from 2008 to 2009. Post-Construction Initiation and Establishment Trends

Band transect 151+80 was not monitored in fall 2006, immediately following construction, and band transect monitoring was not conducted in fall 2007, one growing season after

construction. In fall 2008, two years following construction, 106 young-of-year seedlings (e.g., 2008 Cohort), 17 1 year-old seedlings (e.g., 2007 Cohort), and two 2 year-old seedlings (e.g., 2006 Cohort) were documented on band transect 151+80 (Figure E-10). More than 85% of the hardwoods sampled in 2008 occurred between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces (Figure E-10). Over 97% of all seedlings counted in fall 2008 occurred between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces. Thirty eight root sprouts, or 20% of the total stems sampled, were observed between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces in 2008. The majority of hardwoods growing above 57 cms (2,000 cfs) in 2008 were root sprouts and accounted for 13% of the total stems counted along the band transect. All of the seedlings and root sprouts documented in 2008 along 151+80 were narrowleaf or dusky willow.

In fall 2009, three years after construction, 94 young-of-year seedlings (e.g., 2009 Cohort), 64 1-year old seedlings (e.g., 2008 Cohort), and five 2-year-old seedlings (e.g., 2007 Cohort) were measured on the band transect between the 13 and 311 cms (450 and 11,000 cfs) HEC water surfaces. More than 96% of naturally regenerating hardwoods sampled in fall 2009 (including young-of-year and 1-year old seedlings) occurred between the 13 and 57 cms (450 to 2,000 cfs) HEC water surfaces. Two hundred young-of-year seedlings occurred in the same relative location along the band transect as the 2008 young-of-year seedlings (Figure E 10). Survivors from the 2008 and 2007 Cohort also occurred in a similar location and were intermixed with the 2009 seedlings; however, only 60% of the 2008 Cohort and 30% of the 2007 Cohort survived to fall 2009 (Figure E-11). In 2009, at total of 24 root sprouts were measured at the low water edge, a modest decrease from 2008. Although the overall number of root sprouts decreased since 2008, the root sprout size has increased. All of the seedlings and root sprouts documented in 2009 along 151+80 were narrowleaf or dusky willow. As of fall 2009, seedlings along the low water edge do not appear to be influencing fine sediment deposition or effecting any morphological changes along the low water edge; however, root sprouts farther up the bank are causing fine sediment deposition.Channelbed Mobility/Scour Induced Demographic Changes

The peak 2009 flow scoured the channel margin, removing 40% of the 2008 Cohort, 70% of the 2007 Cohort, and 100% of the 2006 Cohort seedlings (Figure E-11). Channelbed mobility results measured at band transect 151+80 indicate that 75% of the D_{84} size class (i.e., 36 mm) was mobilized along the channel margin (see Valdor Gulch Bed Mobility Monitoring Results) and that measured scour depths exceeded the size of one D_{84} (Appendix B). Scour depth and channelbed mobility results suggest that channelbed mobility and scour were greatest along the 13 cms (450 cfs) margin and are the likely mechanisms for scouring away seedlings. The mixture of root sprouts and seedlings along the low water edge is probably inhibiting full bed mobility and the effectiveness of floods to remove seedlings.

The largest riparian hardwoods growing on band transect 151+80 occur above the 57 cms (2,000 cfs) HEC water surface and are narrowleaf and dusky willows (Figure E-10). Mature willows are growing on the upper half of the feathered edge and are the product of regrowth from willows that were cleared during construction. The regrowing willows are reproductively mature shrubs and do not appear to have been scoured or mechanically damaged by flood flows. The ground surface where the mature root sprouts occur is slightly higher in elevation than in 2008 due to the increased density of root sprouts and fine sediment deposition.

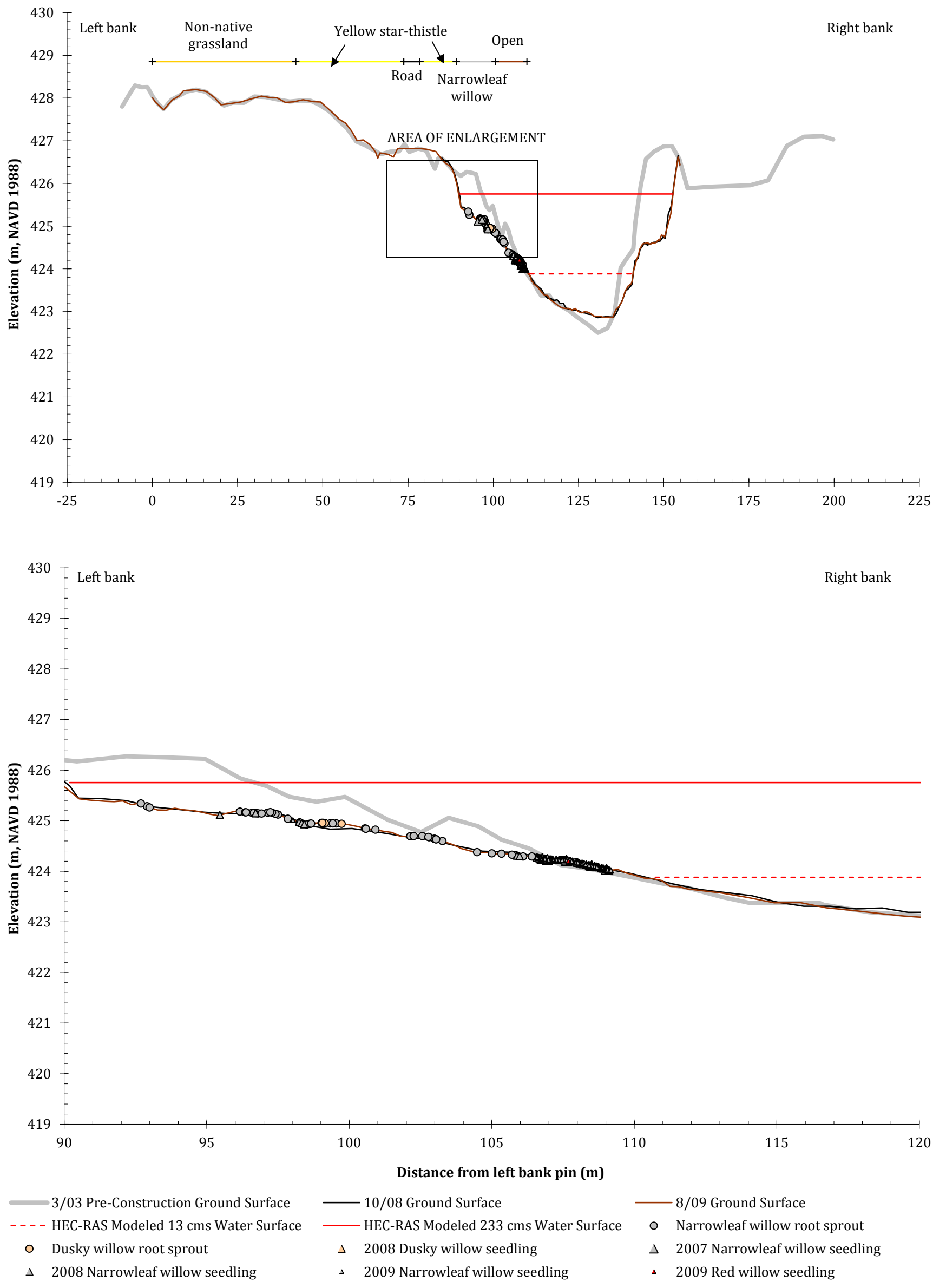


Figure E-10. a) Cross section 151+80, and b) Enlarged cross section 151+80.

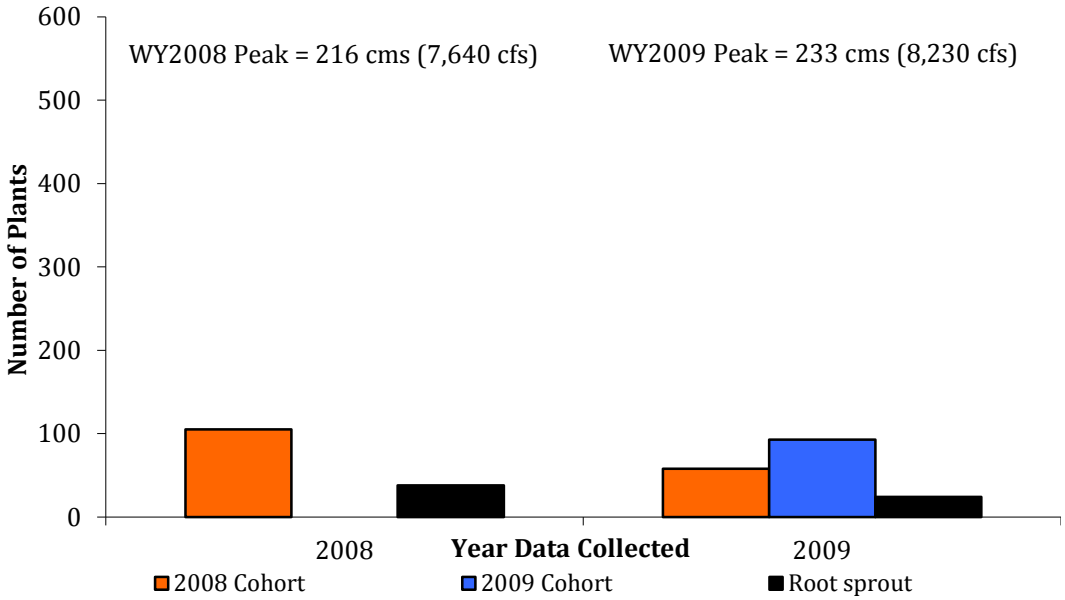


Figure E-11. Cross section 151+80 WY 2008-2009 seedling demographics within 13-57 cms (450-2000 cfs) ROD discharge inundation zone.

Red-Yellow-Green Analysis

Seedling-caused detrimental riparian encroachment along the low water edge has been inhibited. Presently, there is a low to moderate encroachment risk along band transect 151+80. Currently, there are young-of-year (e.g., 2009 Cohort), 1-year (e.g., 2008 Cohort), and 2-year (e.g., 2007 Cohort) seedlings growing along the low water edge. The presence of 2-year old seedlings along the low water edge is an indication that the site is at moderate risk of detrimental encroachment at this location (Figure E 12).

Root sprout-induced detrimental riparian encroachment has not been inhibited between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces (Figure E-12). Root sprout size has increased between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces since 2008. It is unlikely that the root sprouts will ever be scoured from the low water edge and they may ultimately exert more of a geomorphic influence than seedlings in the re-formation of the riparian berm. Additionally, the root sprouts near the middle to top of the feathered edge are already encouraging sand deposition. Therefore, the presence of root sprouts along the low water margin may be more problematic because root sprouts are unlikely to be removed by flood flows and have the same ability to trap fine sediments and form berms as younger, more easily removed seedlings of similar stem ages.

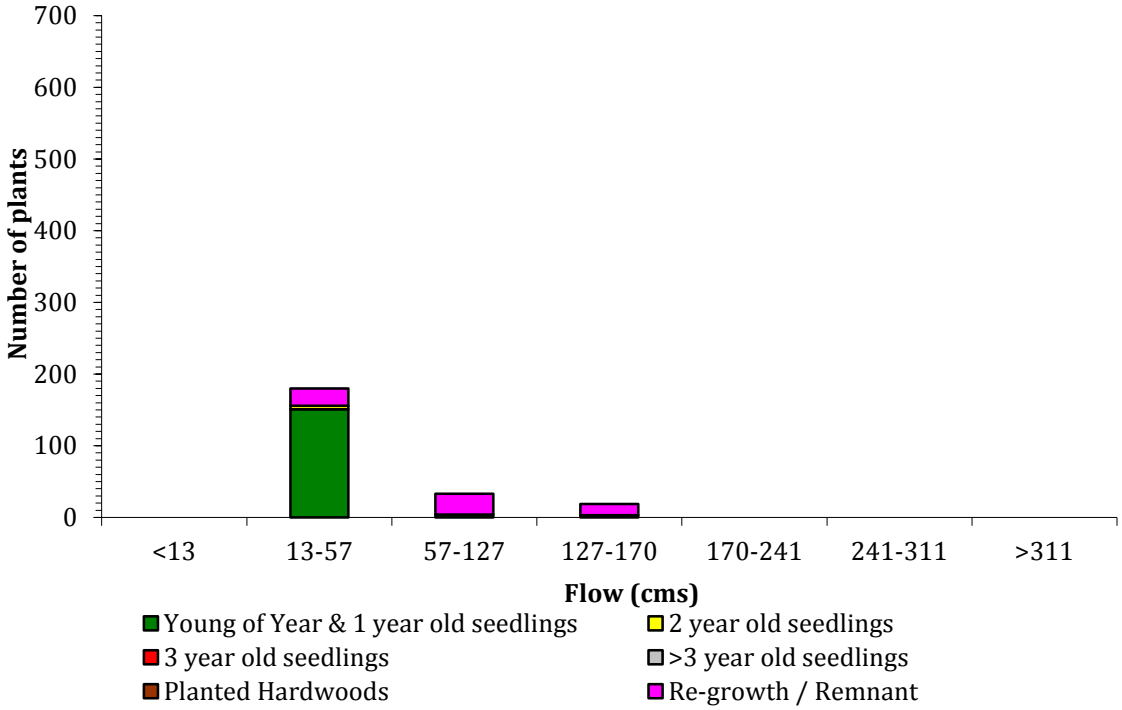


Figure E-12. Red – Yellow - Green analysis cross section 151+80.

Band Transect 166+75 Results

Band transect 166+75 was the most upstream band transect monitored at Valdor Gulch and was collocated with cross section 166+75 (Figure A-5). Band transect 166+75 intersects a constructed floodplain on a rehabilitated medial bar (e.g., activity area R1, Figure A-6) and rehabilitated side channel (e.g., activity area R2, Figure A-6). Band transect 166+75 has been monitored in fall 2005 (pre-construction), fall 2006 (as-built), fall 2008 (two years after construction), and fall 2009 (Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank was not monitored. Band transect 166+75 begins below the 13 cms (450 cfs) water surface on the left bank of the mainstem and extends across the constructed floodplain on the medial bar, crossing the constructed side channel and terminating on the left bank terrace.Post-Construction Changes in Cover Type Boundaries

In 2005, narrowleaf willow, mixed willow, and arroyo willow patches dominated the medial bar margins from the right bank of the seasonal side channel, across the top of the existing sediment berm and along left bank of the main-channel. The central portion of the medial bar was non-native grassland (McBain & Trush 2006). Only flows greater than 57 cms (2,000 cfs) inundated the side channel in 2005 and the side channel bottom was a narrowleaf willow thicket (McBain & Trush 2006). Floodplain

construction on the medial bar and side channel rehabilitation in fall 2006 cleared all vegetation from the medial bar surface and side channel. Significant portions of the cleared narrowleaf and mixed willow patches have regrown since 2006 on the medial bar surface. A patch of white alder-Oregon ash-shiny willow grew along the left bank of the constructed side channel, was relatively undisturbed during construction, and did not change between 2006 and 2009 (Figure E-13).

In fall 2006, an existing side channel inundated by flows greater than 57 cms (2,000 cfs) was excavated so that the side channel would have continuous streamflows at all discharges. As a result, the length of open water increased in fall 2006 along the band transect in the location where the existing side channel was rehabilitated.

The upland portion of the band transect, beyond the riparian vegetation on the left bank of the side channel, intersected non-native grasslands. The species composition of the non-native grasslands has changed since 2005. Before construction, the non-native grassland had an abundance of Parry's rabbitbrush. Since 2006, after construction, Parry's rabbitbrush abundance has dropped; in 2009, yellow star-thistle was abundant in the grassland. Post-Construction Initiation and Establishment Trends

Band transect 166+75 was monitored in fall 2006, immediately following construction, to document as-built conditions. Seedlings were not observed; however, regions of root sprouts were documented from the side channel across the left edge of the constructed floodplain on the medial bar (McBain & Trush and HVT 2007a). Band transect monitoring was not conducted in fall 2007, one growing season after construction.

In fall 2008, two years following construction, 58 young-of-year seedlings (e.g., 2008 Cohort) and 818 1 year-old seedlings (e.g., 2007 Cohort) were documented on band transect 166+75 (Figure E 14). More than 95% of the hardwoods sampled in 2008 occurred below the 57 cms (2,000 cfs) HEC water surface (Figure E-14). Over 99% of all seedlings occurred below the 57 cms (2,000 cfs) HEC water surface in fall 2008. One hundred and four root sprouts, or 10% of the total stems sampled, were observed below the 57 cms (2,000 cfs) HEC water surface in 2008. Over 70% of hardwoods growing above 57 cms (2,000 cfs) in 2008 were root sprouts and accounted for 3% of the total stems counted along the band transect. Nine planted hardwoods occurred above 57 cms (2,000 cfs). Five hardwood species were sampled in 2008 (white alder, Oregon ash, narrowleaf willow, red willow, and dusky willow), though narrowleaf and dusky willow made up 99% of the seedlings sampled.

Three years after construction, 549 young-of-year seedlings (e.g., 2009 Cohort), 103 1-year old seedlings (e.g., 2008 Cohort), ten 2-year-old seedlings (e.g., 2007 Cohort), and four 3 year-old seedlings (e.g., 2006 Cohort) were measured on the band transect between the 13 and 311 cms (450 and 11,000 cfs) HEC water surfaces.

Several Cohort misidentifications were apparent along band transect 166+75. The four 2006 Cohort seedlings were likely misidentified root spouts. The increase in 2008 Cohort seedlings sampled in 2009 (i.e., 1 –year old seedlings) from those sampled in 2008 (i.e., young-of-year seedlings) is a sampling error. It is likely that many seedlings identified as the 2008 Cohort were actually in the 2009 Cohort. Only 4% of the stems sampled were misidentified into the wrong Cohort for the overall sample. Unfortunately, the misidentification represented a 44% increase in seedlings between 2008 monitoring and 2009.

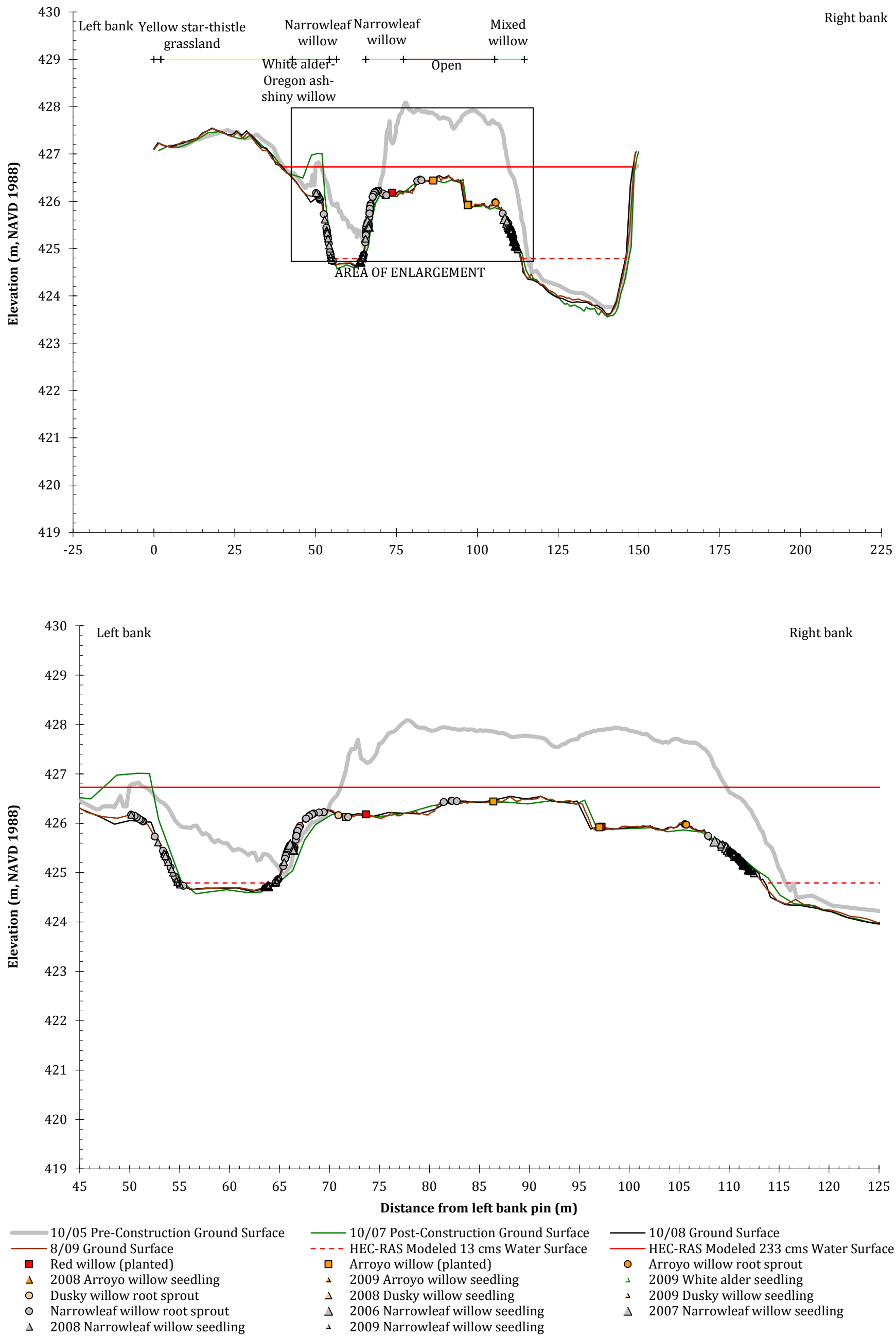


Figure E-13. a) Cross section 166+75, and b) Enlarged cross section 166+75.

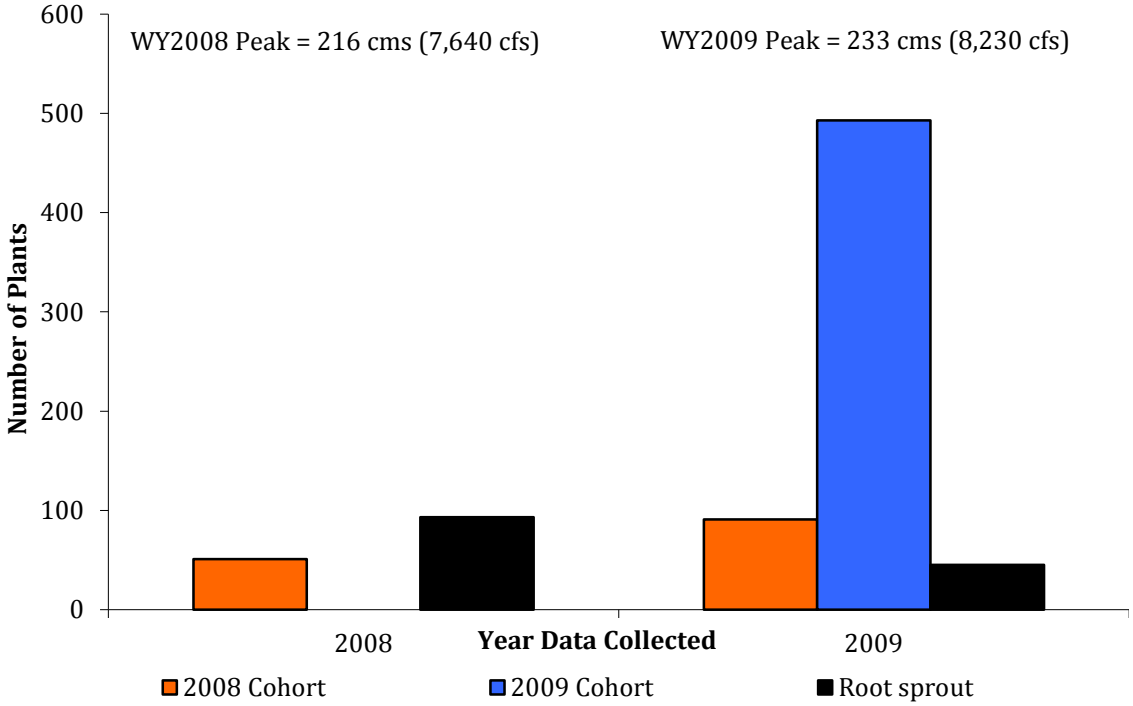


Figure E-14. Cross section 166+75 WY 2008-2009 seedling demographics within 13-57 cms (450-2000 cfs) ROD discharge inundation zone.

In fall 2009, 99% of naturally regenerating hardwoods sampled (including young-of-year and 1-year old seedlings) occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Four hardwood species were sampled (white alder, arroyo willow, narrowleaf willow, and dusky willow), although narrowleaf willow was the dominant species along 166+75. The young-of-year seedlings grew in two locations on the cross section: along the left bank of the main-channel and along the wet right bank edges of the side channel. The 2009 young-of-year Cohort seedlings occurred in the same relative location along the band transect as the 2008 young-of-year seedlings (Figure E-13). Survivors from the 2008 and 2007 Cohort also occurred in a similar location and were intermixed with the 2009 seedlings. There was an 88% decrease overall in the 2007 and 2008 Cohorts combined (Figure E-11). In 2009, at total of 47 root sprouts were measured at the low water edge, a 46% decrease from 2008. Channelbed Mobility/Scour Induced Demographic Changes

The scour chains and marked rocks suggest that channelbed mobility and scour is sufficient to cause mortality of 1-year old seedlings in close proximity to the 13 cms (450 cfs) water edge. While seedlings were scoured along the 13 cms (450 cfs) channel edge, the effectiveness of scour diminished with distance from the low water edge. Marked rock

mobility decreased markedly much beyond the edge of the 13 cms (450 cfs) water surface. The greatest amount of scour and mobility was documented on the wetted channel side of the establishing seedlings, which suggests that seedlings are already beginning to modify local hydraulics, slow velocities to a point where deposition occurs on the seedlings, and force greater shear stress to be focused along the streamward edge of the seedlings. Sand deposition was documented over the remaining seedlings. By 2009, a sediment berm has begun to form and the low water channel has begun to simplify.

The largest riparian hardwoods growing on band transect 166+75 occur above the 57 cms (2,000 cfs) water surface and are narrowleaf and dusky willows (Figure E-13). Mature willows are growing along the side channel and the main-channel and are the product of regrowth from willows that were cleared/removed during construction. The regrowing willows are reproductively mature shrubs and do not appear to have been scoured or mechanically damaged by flood flows.

Sand deposition is occurring along the mainstem on the medial bar near several large arroyo willow root sprouts. Extensive deposition is occurring along the right bank of the side channel among the resprouting narrowleaf willow, which is extensive along the side channel with high stem density. These conditions, combined with slower water velocities in the side channel, encourage deposition of fine sediment.Red-Yellow-Green Analysis

Seedling-caused detrimental riparian encroachment near the 13 cms (450 cfs) water edge is a limited but growing threat. Detrimental encroachment is presently a moderate risk along band transect 166+75 because of seedlings and the apparent instigation of the detrimental encroachment process. Currently, there are young-of-year (e.g., 2009 Cohort), 1-year (e.g., 2008 Cohort), and 2-year (e.g., 2007 Cohort) seedlings growing along the low water edge. The presence of 2-year old seedlings along the low water edge is a further indication that the site is at moderate risk of detrimental encroachment at this location (Figure E-15).

Root sprout-induced detrimental riparian encroachment has not been inhibited between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces (Figure E-15). Root sprout size has increased between the 13 and 57 cms (450 and 2,000 cfs) HEC water surface since 2008. It is unlikely that the root sprouts will ever be scoured from the low water edge, and they may ultimately exert more of a geomorphic influence than seedlings in the re-formation of the riparian berm. Additionally, the root sprouts near the middle to top of the feathered edge are already encouraging sand deposition. Therefore, the presence of root sprouts along the low water margin may be more problematic because root sprouts are unlikely to be removed by flood flows and have the same ability to trap fine sediments and form berms as younger, more easily removed seedlings of similar stem ages.

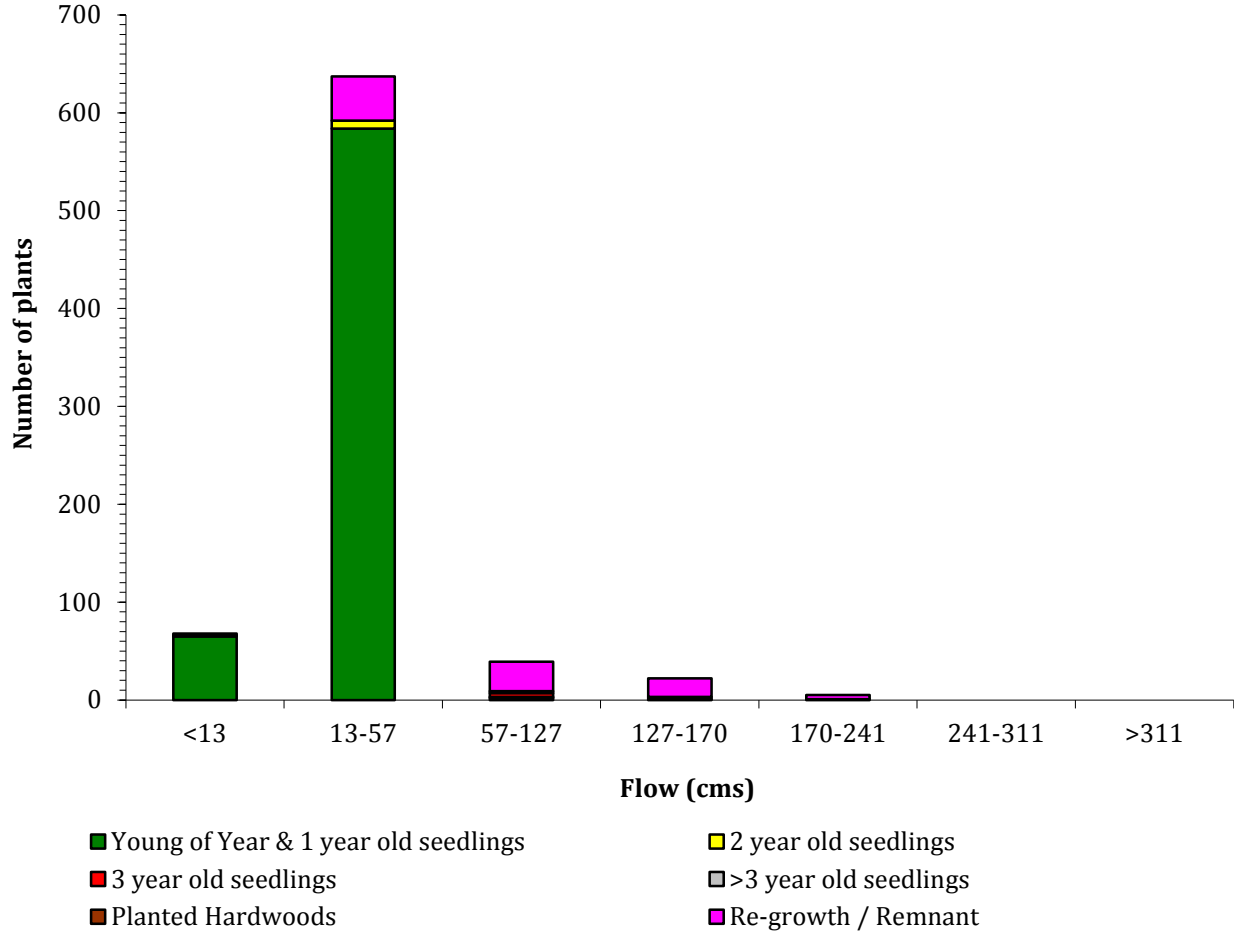


Figure E-15. Red - Yellow - Green analysis cross section 166+75.

Connor Creek

Riparian Mapping

2007 Mapping Results

In 2007, the total vegetated area mapped was 4.9 hectares (12.0 acres) and accounted for 52.8% of the mapped area (Figure E-16). One year after construction, revegetation accounted for less than 1% of the area, open ground was 20.5% of the area, remnant vegetation was 42.1% of the area, seedling regeneration accounted for 4.4% of the area, and the regrowth of willows removed during construction accounted for 3.3% of the area (Figure 3-5). In 2007, patches of young-of-year seedlings were more extensive than root sprouts. Stands of young-of-year seedlings without root sprouts intermixed were observed on lower elevation benches and along the 13cms (450 cfs) water edge (i.e., activity areas R2 and R5, Figure A-8). With the exception of a dense strip along the downstream feathered edge of the site (i.e., activity area R5, Figure A-8), mapped regrowth in 2007 was limited to the constructed 170 cms (6,000 cfs) floodplain and small localized clumps of regrowth on the high-flow scour channel surface (i.e., activity areas R3 and R5, Figure A-8). The majority of resprouting plants were narrowleaf and dusky willows.2008 Mapping Results

In 2008, the total mapped vegetated area was 5.9 hectares (14.6 acres) and accounted for 64.3% of the mapped area (Figure E-17). Remnant vegetation was 28.3% of the mapped area and represented a small reduction in area since 2007. The reduction in remnant vegetation is likely a difference in mapping boundaries and not a real difference. The area of open ground was reduced to 12.6% in 2008 because sweetclover covered much of the area mapped as open ground in 2007. The area of revegetation remained approximately the same between 2007 and 2008, accounting for less than 1% of the total mapped area (Figure 3-5). Regrowth accounted for 5.4% of the vegetated area, an increase in coverage from 2007. In 2008 willow regrowth continued to expand on 170 cms (6,000 cfs) constructed floodplains (Figure E-17).

Seedlings accounted for only 3.4% of the mapped area in 2008, a small reduction in area compared to 2007 mapping. The decrease in mapped seedlings is likely due to the increase in the area and abundance of regrowth. Most mapped patches of seedlings were composed of young-of-year seedlings, although areas where 1-yr, 3-yr, and 4-yr seedlings were dominant were also mapped. Large areas of regeneration mapped in 2007 were not observed again in 2008. Instead, smaller patches of young-of-year seedlings were mapped along the main-channel margin on open bar features (i.e., activity area R2) and on the 170 cms (6,000 cfs) floodplain (i.e., activity area R5, Figure A-8). The most frequently encountered regenerating patches were composed of 2-yr old seedlings and young-of-year seedlings, followed by those patches composed of 1-yr old seedlings and young-of-year seedlings.

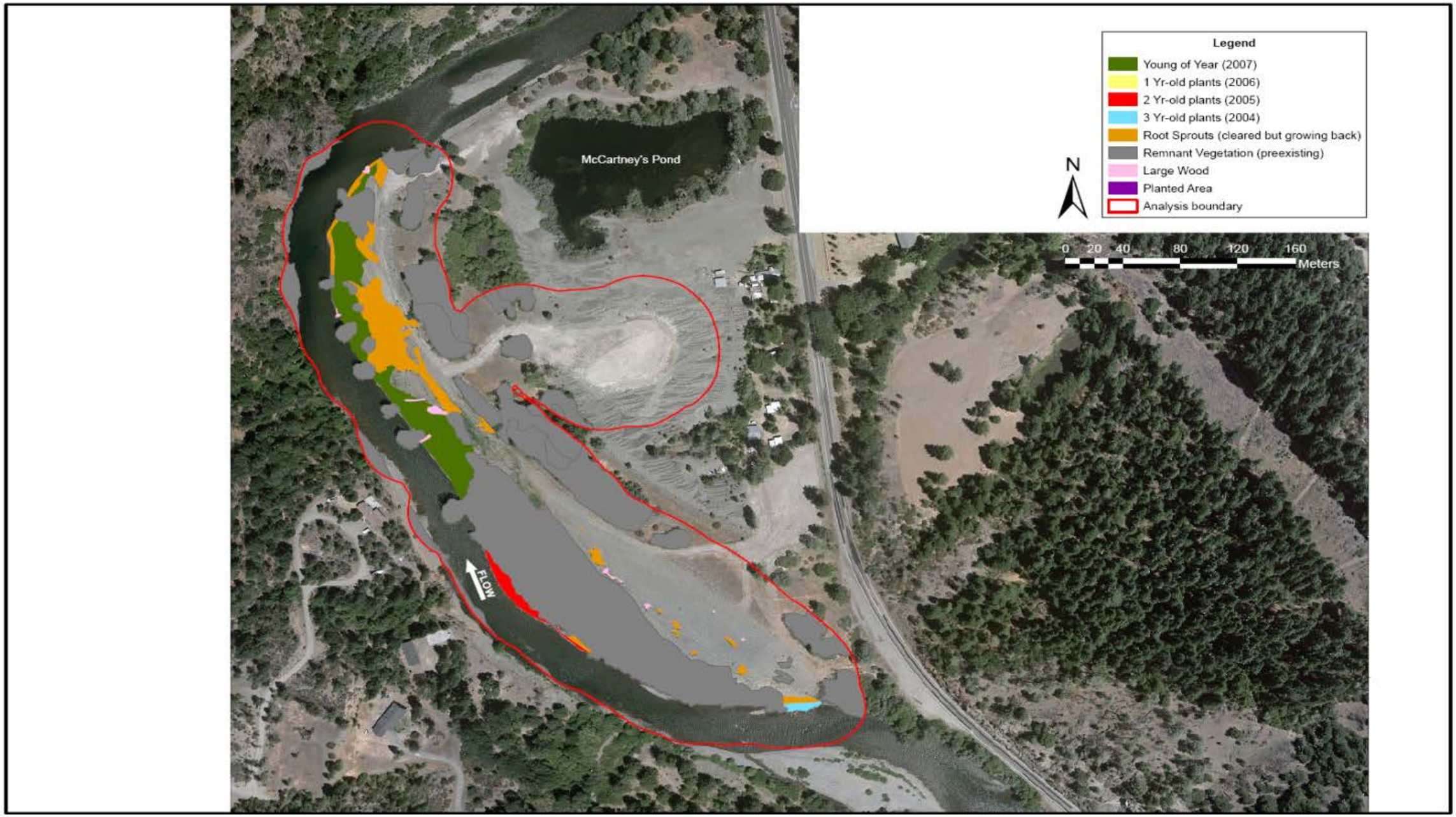


Figure E-16. Connor Creek 2007 rehabilitation site map, one year after construction.

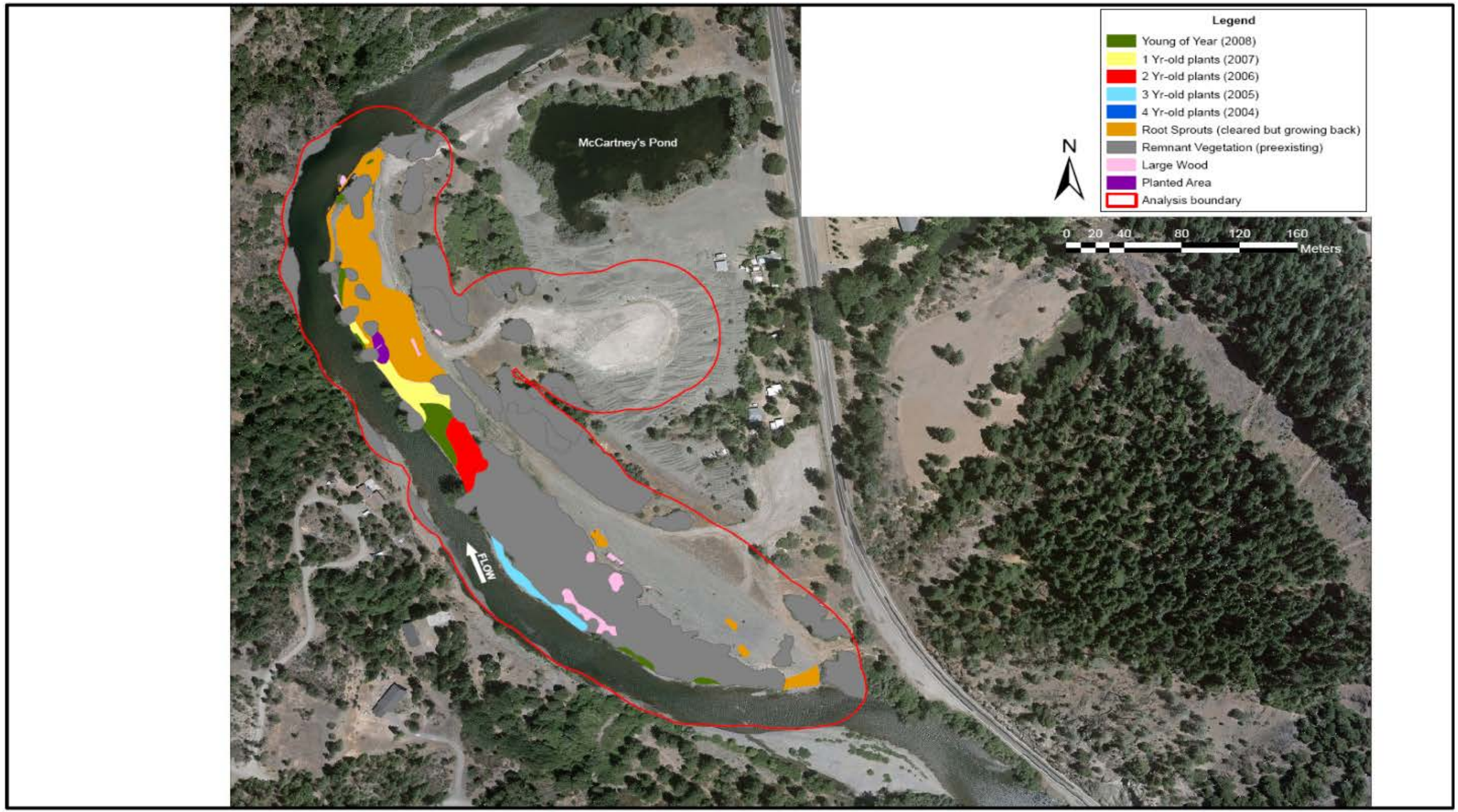


Figure E-17. Connor Creek 2008 rehabilitation site map, two years after construction.

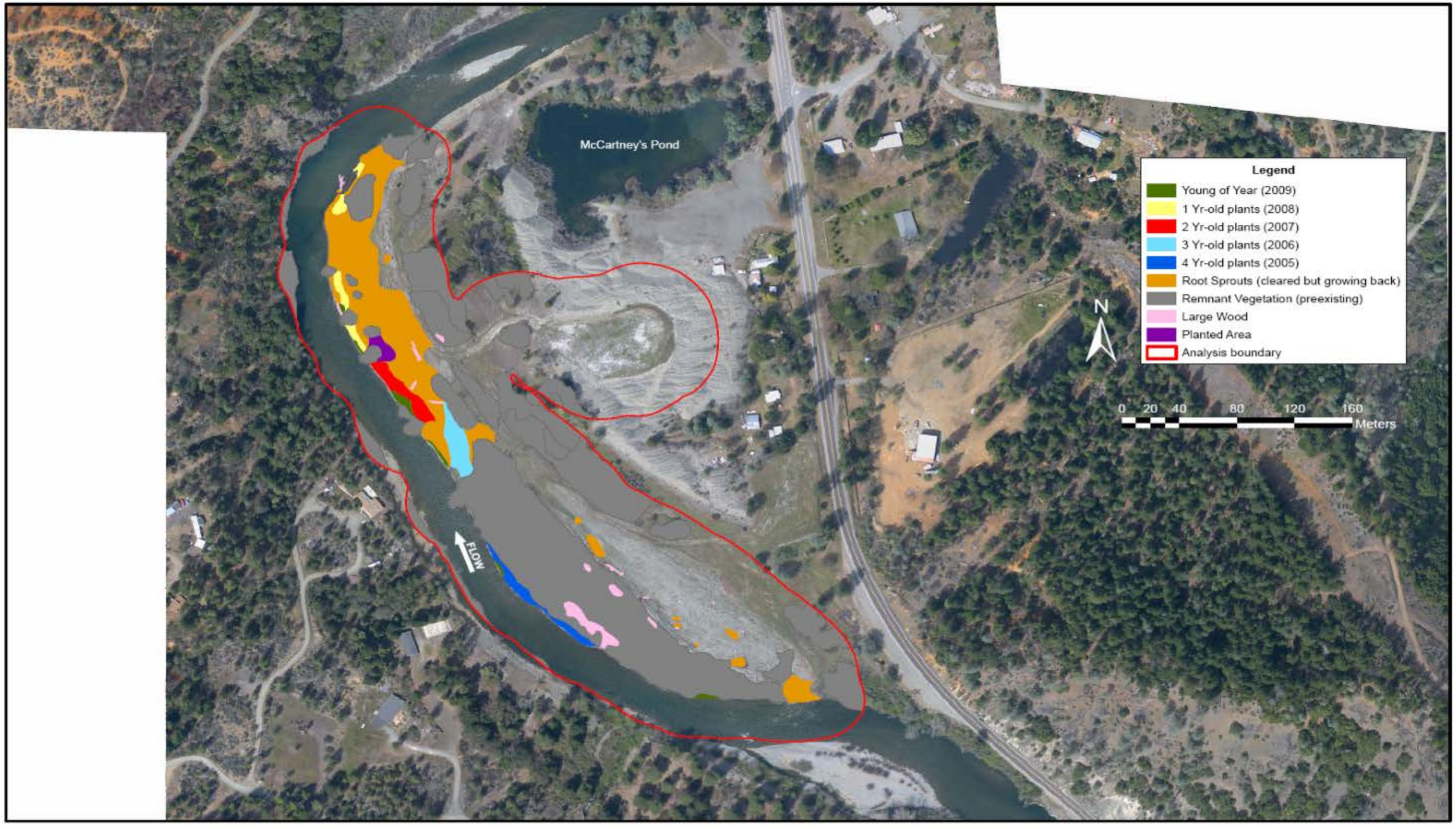


Figure E-18. Connor Creek 2009 rehabilitation site map, three years after construction.

Hocker Flat

Riparian Mapping

2007 Mapping Results

In 2007, the total vegetated area mapped was 6.7 hectares (16.5 acres) and accounted for 33.4% of the mapped area (Figure E-19 - Figure E-20). Two years after construction, revegetation accounted for less than 1% of the area, open ground was 43.1% of the area, remnant vegetation was 20.6% of the area, seedling regeneration accounted for 1.7% of the mapped area, and the regrowth of willows removed during construction accounted for 4.0% of the mapped area (Figure 3-6). In 2007, the mapped patches of regenerating woody plants were predominantly composed of 1- and 2-year old seedlings (Figure E-19 - Figure E-20). All mapped patches of seedlings occurred along the main-channel margin. Most of the mapped remnant vegetation was located at upper Hocker Flat, where a portion of the riparian berm was left (activity area R3 and R4, Figure A-12). In 2007, regrowth was greatest at lower Hocker Flat. The middle portion of Hocker Flat on the right bank showed moderate regrowth. Much of the mapped regrowth occurred along the main-channel. The majority of resprouting plants were narrowleaf and dusky willows.2008 Mapping Results

In 2008, the total mapped vegetated area was 10.9 hectares (27.0 acres) and accounted for 54.5% of the mapped area (Figure 3-6). Remnant vegetation was 21.8% of the mapped area and represented a small increase in area since 2007. The area of open ground was reduced to 22.9% in 2008, a reduction of almost half the area since 2007. Herbaceous patches covered 23.2% of the mapped area in 2008, nearly a four-fold increase in area since 2007. Parry's rabbitbrush and sweetclover were the most abundant herbaceous patch types at Hocker Flat in 2008, although some non-native grassland and reed canary grass patches were mapped. The area of revegetation between 2007 and 2008 increased to 2.4% (Figure 3-6). In 2008, willow regrowth continued to expand along the main-channel and accounted for 5.0% of the vegetated area (Figure E-19 - Figure E-22). Regrowth consisted mostly of narrowleaf willow, was highest at the downstream half of the site (at lower Hocker Flat and the right bank of middle Hocker Flat, a.k.a. Jim Smith pilot rehabilitation site), and gradually decreased toward the upstream end of the site. Seedlings accounted for 2.2% of the mapped area in 2008, a small increase in area compared to 2007 mapping. In 2008, 3-year old and young-of-year seedlings were the most abundant.

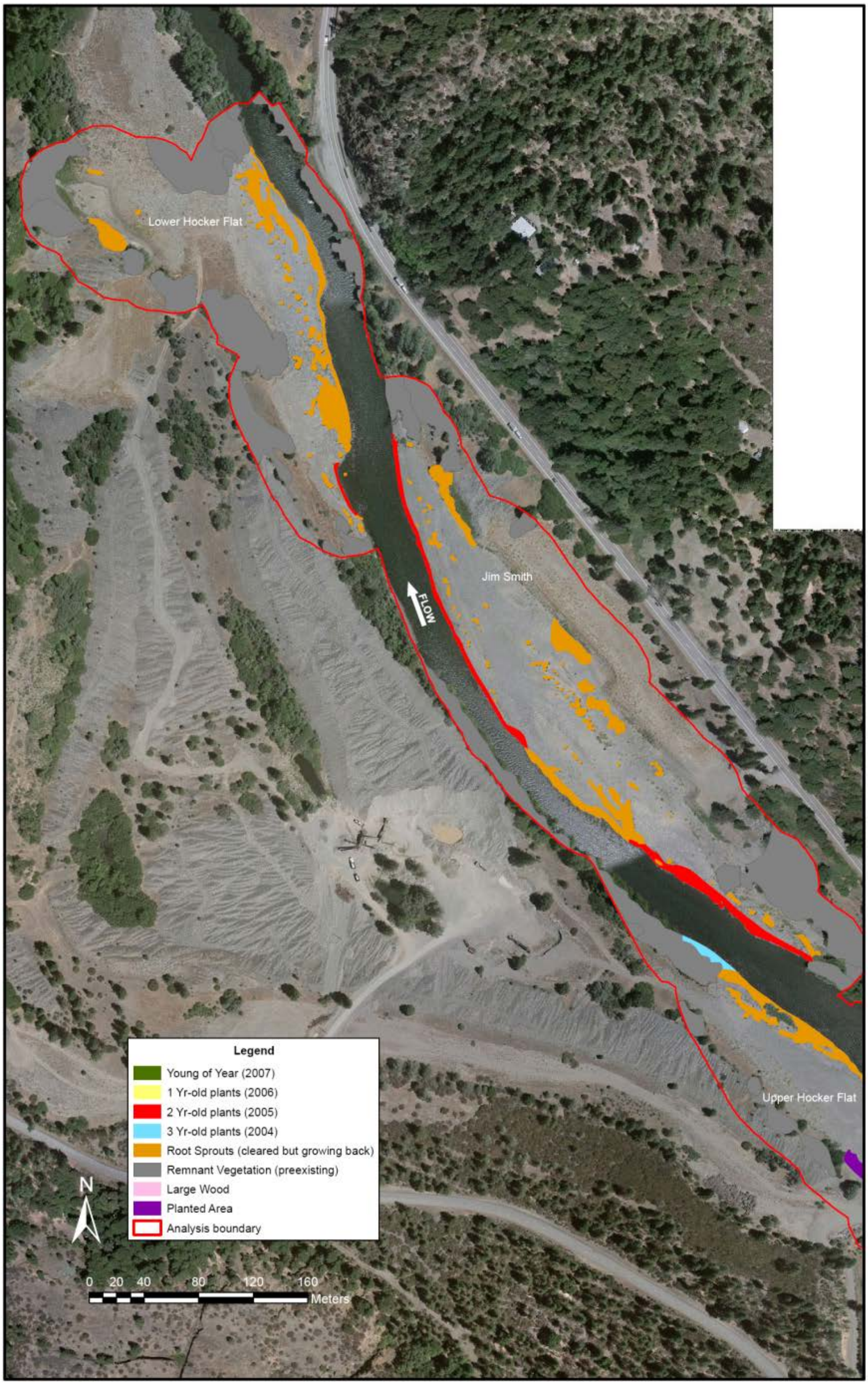


Figure E-19. Lower Hocker Flat rehabilitation site 2007 map, two years after construction.

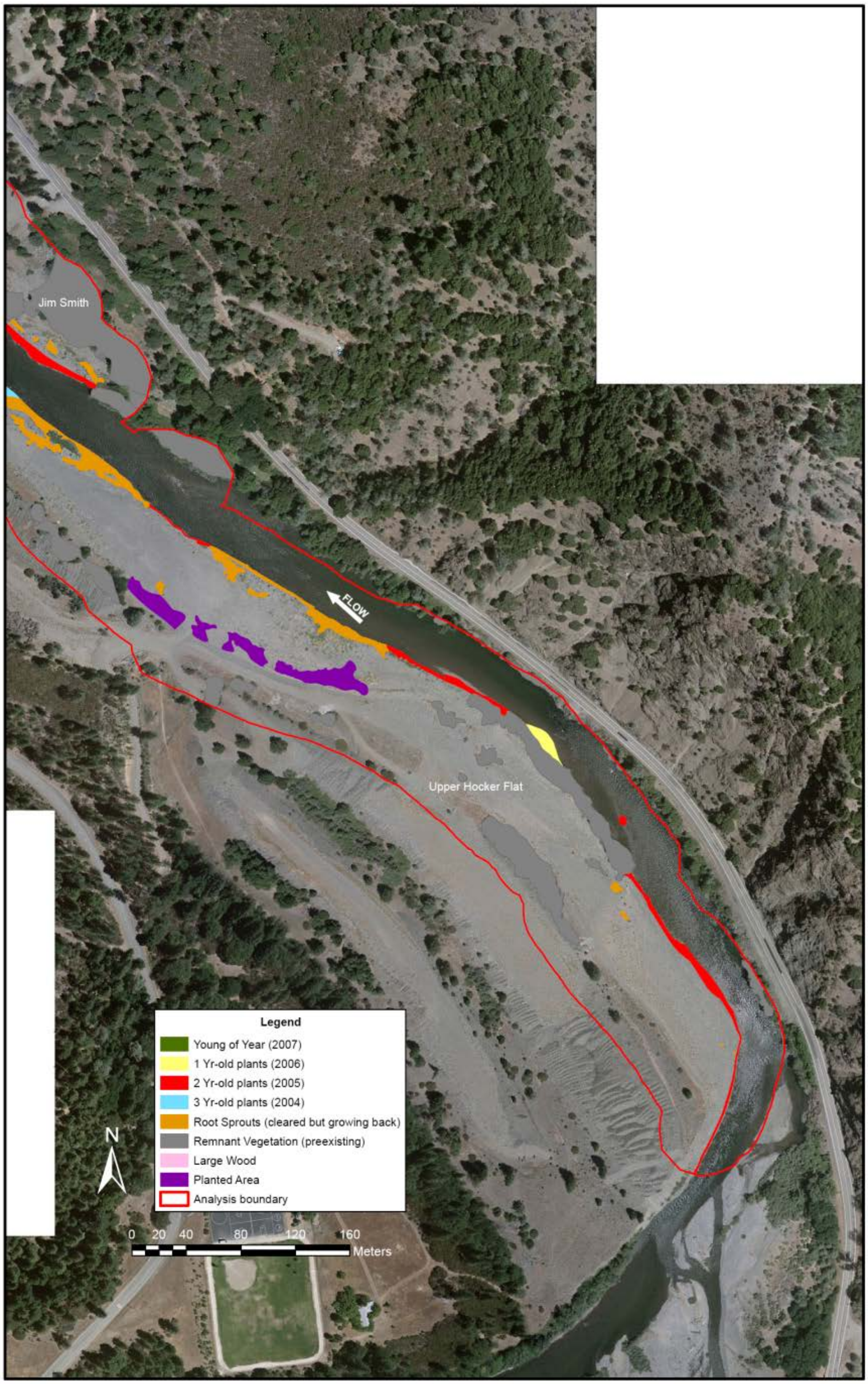


Figure E-20. Upper Hocker Flat rehabilitation site 2007 map, two years after construction.

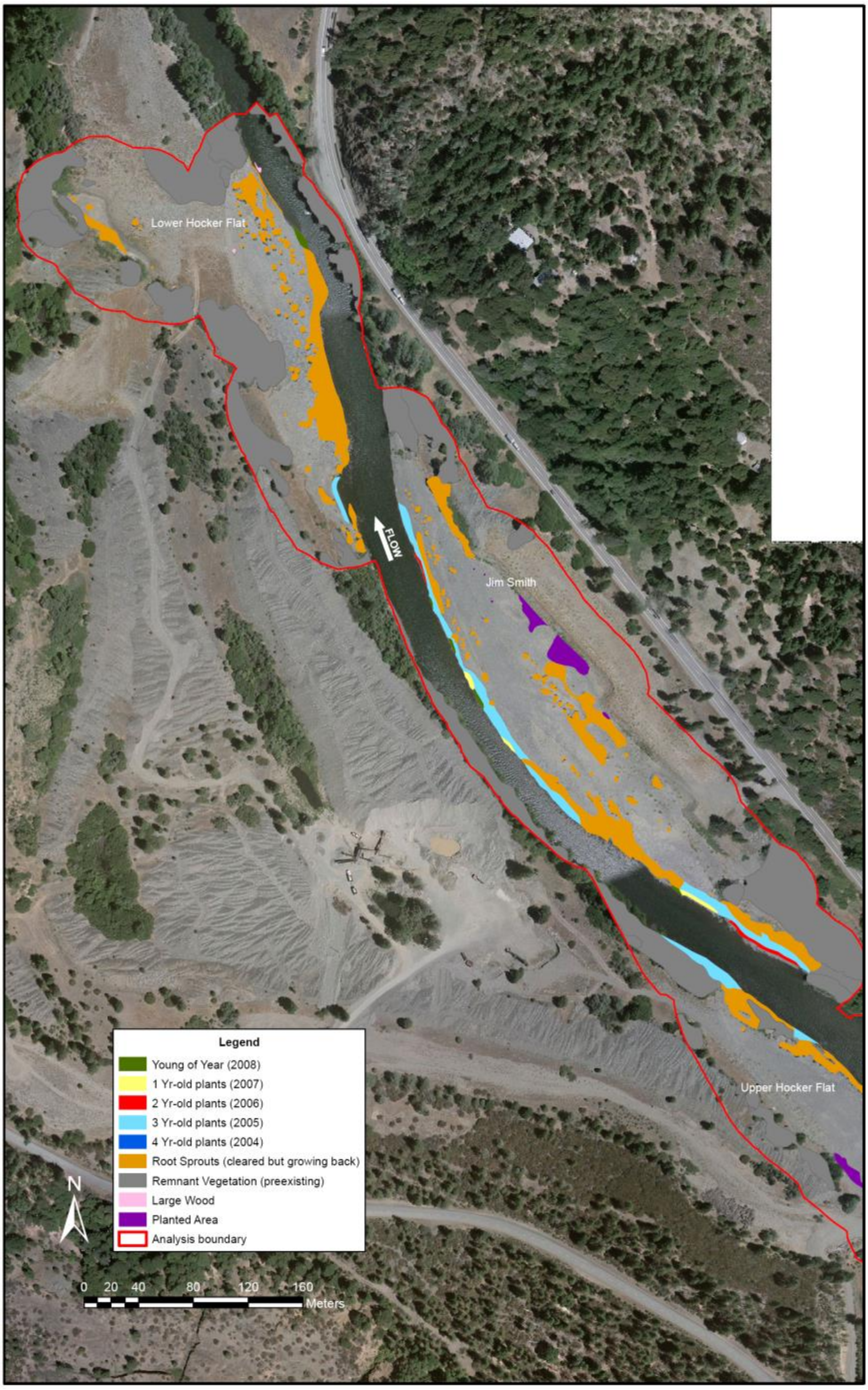


Figure E-21. Lower Hocker Flat rehabilitation site 2008 map, three years after construction.

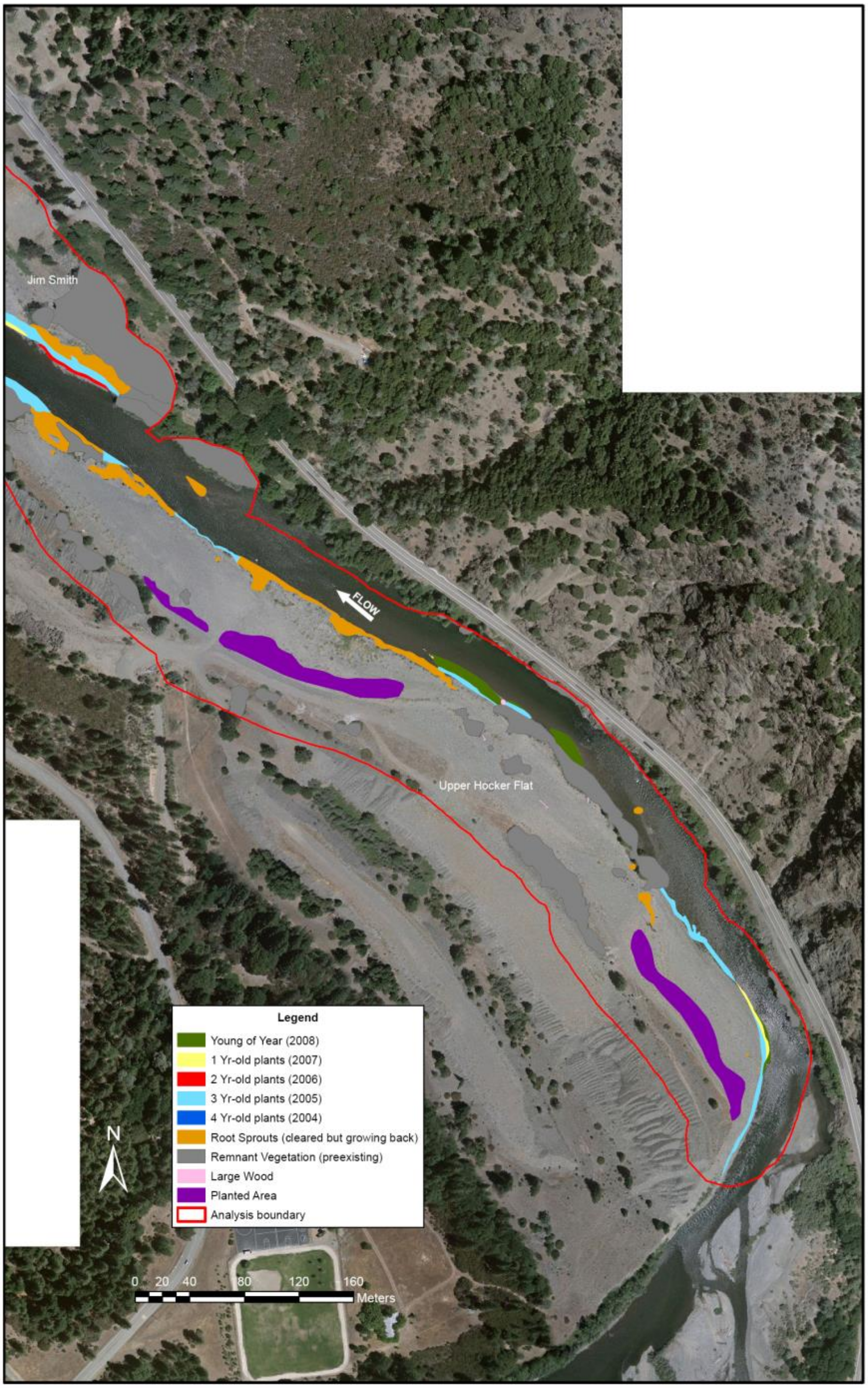


Figure E-22. Upper Hocker Flat rehabilitation site 2008 map, three years after construction.

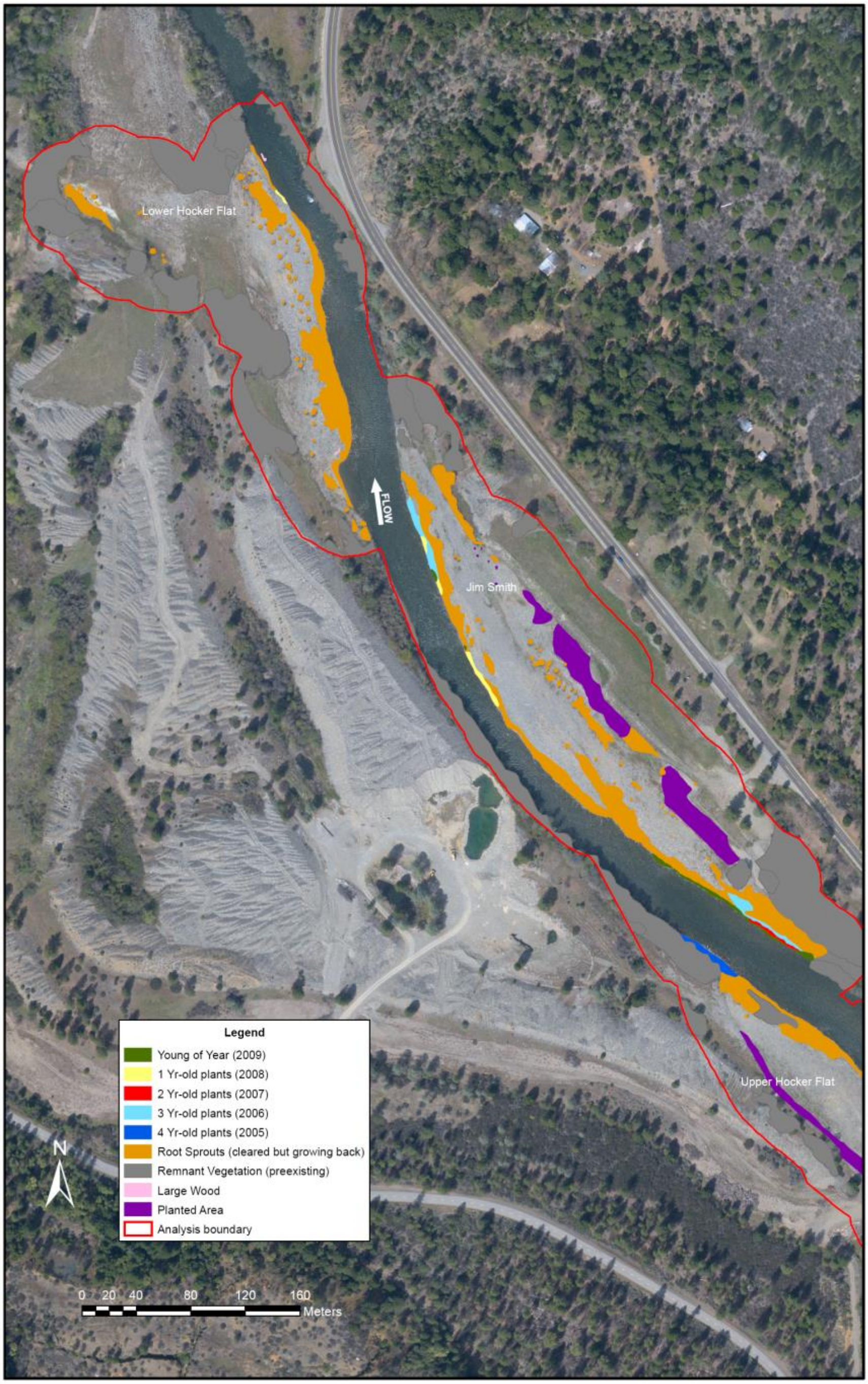


Figure E-23. Lower Hocker Flat rehabilitation site 2009 map, four years after construction.

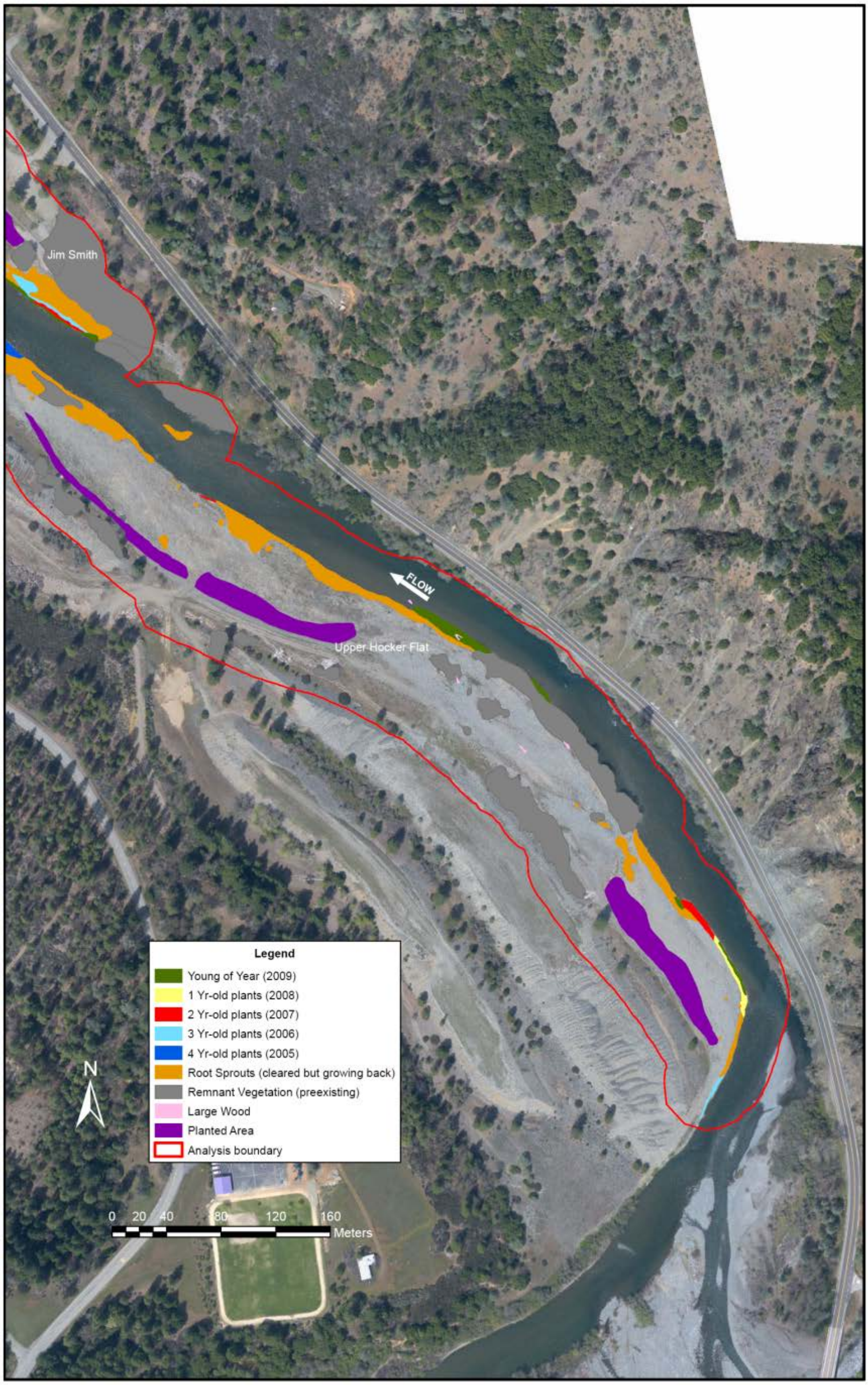


Figure E-24. Upper Hocker Flat rehabilitation site 2009 map, four years after construction.

Band Transect 314+15 Results

Band transect 314+15 was the most downstream band transect monitored at Hocker Flat in WY 2009 and was collocated with cross section 314+15 (Figure A-11). Band transect 314+15 intersects a 170 cms (6,000 cfs) constructed floodplain on the left bank at the downstream end of the site (e.g., activity area R6, Figure A-12). Band transect 314+15 was monitored in the fall 2003 (pre-construction), spring and fall 2006 (as-built), fall 2008 (two years after construction), and fall 2009 (Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The un-rehabilitated right bank was not monitored. The band transect begins below the 13 cms (450 cfs) water surface and extends across the constructed floodplain, terminating at the base of a dredger tailing pile.Post-Construction Changes in Cover Type Boundaries

Vegetation removal began on the river side of a large narrowleaf-dusky willow patch in the fall 2005. A feathered edge was constructed where vegetation had been cleared along the 13 cms (450 cfs) water edge and a floodplain surface was constructed farther away and at a higher elevation (e.g., activity area R6, Figure A-12). Before construction in 2005, the upland area where the floodplain surface would be built was partially covered in non-native grassland. The feathered edge and constructed floodplain were open ground after construction was completed in fall 2005. By 2009, much of the open ground where non-native grasslands had originally occurred had developed a sparse cover of rabbitbrush. The areas along the main-channel and where the floodplain was constructed were covered with narrowleaf and dusky willow before construction, but were converted to open ground after construction in the fall 2005. Rehabilitation in the fall 2005 cleared mature narrowleaf willows but was unable to remove all of the roots. The cover of the narrowleaf-dusky willow patch along the 13 cms (450 cfs) water edge increased slightly between 2005 and 2008 as the willow patch regrew following construction. After construction, remnant and resprouting narrowleaf and dusky willows continued to thrive on the constructed floodplain and along the 13 cms (450 cfs) water edge. By fall 2009, the vegetation cover on the constructed floodplain surface and feathered edge appears to be very similar in cover, stem density and location to the pre-construction condition. Currently, willow regrowth covers approximately half of the band transect, converting what was open ground after construction to open/narrowleaf-dusky willow in 2009 (Figure E-25). Post-Construction Initiation and Establishment Trends.

The Hocker Flat site was monitored in fall 2005 immediately following construction to document as-built conditions, and no seedlings were observed. The site was monitored again in spring and fall 2006, and regions of root sprouts were

documented where the riparian vegetation and sediment berm were removed (McBain & Trush and HVT 2007a). In fall 2006, one year following construction, 51 young-of-year seedlings were measured on the band transect; other seedling cohorts were not documented (Figure E-26; McBain & Trush and HVT 2007a). Over 99% of the seedlings were narrowleaf or dusky willow. One red willow seedling was also documented. All seedlings sampled in the fall 2006 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. In 2006, a total of 33 root sprouts were measured between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Although the overall number of root sprouts was small, the abundance and size has since increased. Band transect 314+15 was not monitored during WY 2007.

In fall 2008, three years following construction, 188 young-of-year seedlings, 40 1-year seedlings, ten 2-year seedlings and one 3-year seedling were measured on the band transect (Figure E-26). Over 99% of the seedlings were narrowleaf or dusky willow. One white alder was also documented. All seedlings sampled in the fall 2008 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. In 2008, at total of 60 root sprouts were measured between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Six other occurrences of root regrowth were documented above 57 cms (2,000 cfs).

In fall 2009, four years after construction, 261 young-of-year seedlings, 186 1-year seedlings, and 19 2-year seedlings were measured on the band transect (Figure E-26). Over 99% of the seedlings were narrowleaf or dusky willow, although five white alders and one Oregon ash were also documented. All naturally regenerating hardwoods sampled in the fall 2009 (including young-of-year and 1-year old seedlings) occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Young-of-year 2009 seedlings occurred in the same relative location along the band transect as the young-of-year 2008 seedlings (Figure E-25). The Oregon ash was growing at the highest elevation of any of the seedlings measured. Survivors from the 2008 Cohort also occurred in the same location as the 2009 seedlings; however, 99% of the 2008 Cohort, and 48% of the 2007 Cohort, survived to fall 2009 (Figure E-26). In 2009, a total of 13 root sprouts were measured below the 27 cms (2,000 cfs) HEC water surface and represent a 78% decrease in measured root sprouts. Although the overall number of root sprouts decreased, the size has increased. As of fall 2009, seedlings and regrowth along the 13 cms (450 cfs) water edge do not appear to be inducing deposition or any morphological change.WY 2009 Channelbed Mobility/Scour Induced Demographic Changes.

The maximum streamflow at Hocker Flat since the WY2006 flood was 233 cms (8,230 cfs) and occurred on May 5, 2009. The WY 2009 annual maximum peak of

233 cms (8,230 cfs) scoured the 13 cms (450 cfs) channel margin to a maximum depth of 5.1 cm and removed 2% of the 2008 Cohort seedlings (Figure E-26). Channelbed mobility results on cross section 314+15 show that 11% of the D84 size class (i.e., 130 mm) was mobilized along the channel margin (see Hocker Flat Bed Mobility Results). The 5.1 cm scour depth measured along the band transect was less than half the depth of the D84 measured and suggests that the channelbed surface scour needed to remove 1 year old seedlings was not achieved in WY 2009. It is conceivable that willow regrowth along 314+15 is sufficient to reduce the scouring effects of floods greater than 227 cms (8,000 cfs), facilitating the further establishment of woody riparian vegetation along the 13cms (450 cfs) water edge.

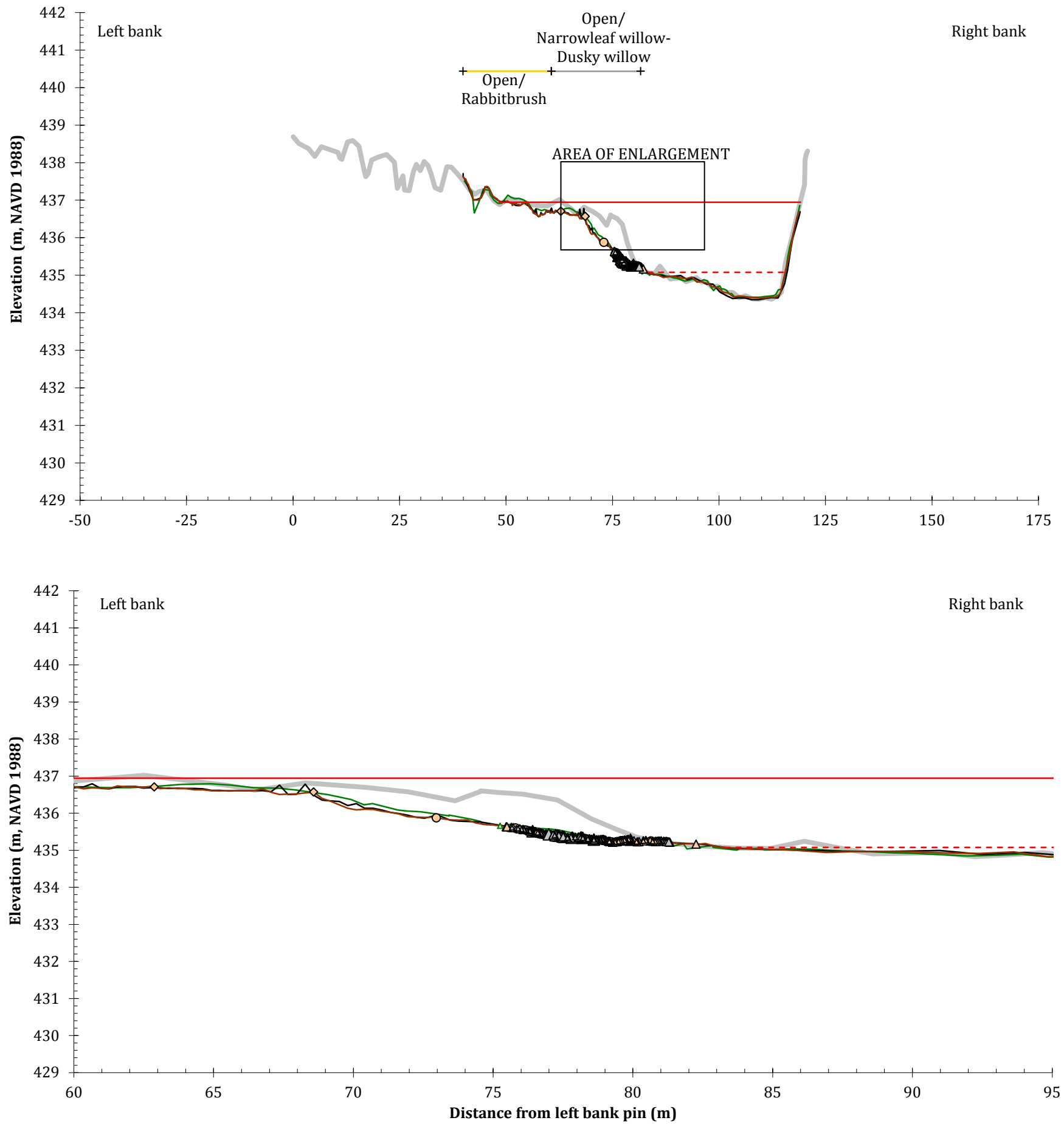


Figure E-25. a) Cross section 314+15, and b) Enlarged cross section 314+15.

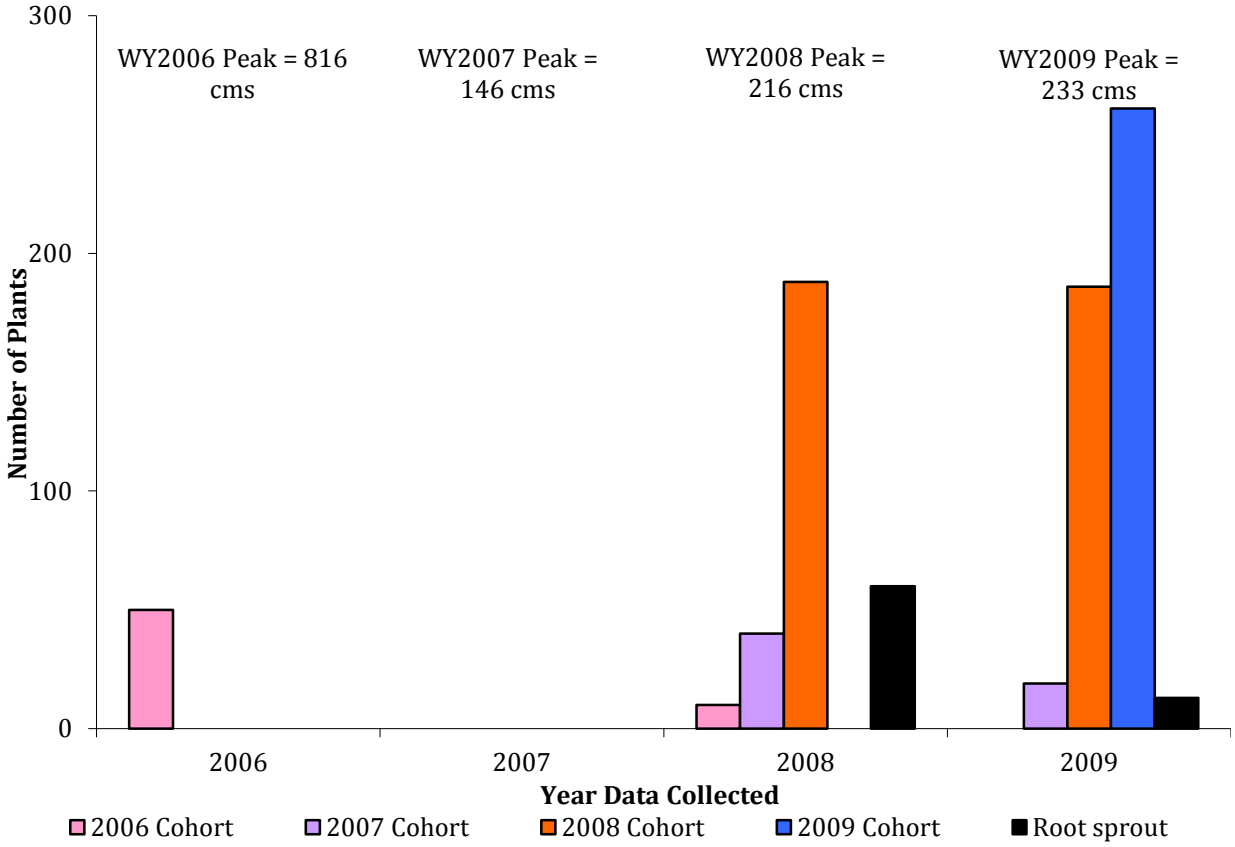


Figure E-26. Cross section 314+15 WY 2008-2009 seedling demographics within 13 to 57 cms (450-2000 cfs) ROD discharge inundation zone.

The band transect intersects three dusky willow clumps that are regrowing from remnant roots on the left bank constructed floodplain. Each regrowing willow is a large shrub with a root collar greater than 50 cm and more than 20 branches/stems. One willow is regrowing at the 57 cms (2,000 cfs) water surface elevation; the other two are above 184 cms (6,500 cfs; Figure E 25). It is unlikely that streamflows will be able to remove the regrowing willow along the 57 cms (2,000 cfs) water edge; however, for now, there has been no deposition in the area around the willow, though deposition may occur sometime in the future. One effect that the large regrowing willow may have is slowing water velocities along the water edge to inhibit channelbed scour and seedling mortality. On an otherwise barren floodplain surface, the two regrowing willow shrubs are not likely to induce detrimental channel encroachment and may provide valuable aquatic habitat at flows higher than 127 cms (4,500 cfs).

Red-Yellow-Green Analysis

Detrimental riparian encroachment caused by seedlings or regrowing willows has not been inhibited along the 13 cms (450 cfs) water edge. There is a high

encroachment risk along band transect 314+15 (Figure E-27). Root sprouts are already well established along the low water edge. While flows are able to shear off some of the stems, many are becoming larger shrubs. Although there has not yet been a large amount of deposition along the channel margin, the presence of larger and larger shrubs is likely to influence fine sediment deposition in the future. Even if a typical berm does not form, the channel edge will likely soon be armored with mature regrowth (i.e., most of the plants currently at this site are re-sprouts from remnant root-wads rather than new recruits to the site). Therefore, current establishment trends indicate that this location is at a high risk of encroachment (Figure E-27).Band Transect 326+90 Results

Band transect 326+90 was the middle band transect monitored at Hocker Flat in WY 2009 and was collocated with cross section 326+90 (Figure A-10). Band transect 326+90 was originally located at the Jim Smith pilot rehabilitation site (a.k.a. cross section 12+00) which was included within the overall Hocker Flat channel rehabilitation. The Jim Smith site has been monitored since 1996. Band transect 326+90 intersects a 170 cms (6,000 cfs) floodplain on the right bank (e.g., activity area R5, Figure A-10). Band transect 326+90 was monitored in the fall 2003 (pre-construction), spring and fall 2006 (as-built), fall 2008 (two years after construction), and fall 2009 (Table 3-4). The band transect was sampled along the rehabilitated right bank portion of the cross section. The un-rehabilitated left bank was not monitored. The band transect begins below the 13 cms (450 cfs) water surface and extends across the constructed floodplain, up to a constructed terrace, and terminates at the base of a large Ponderosa pine.

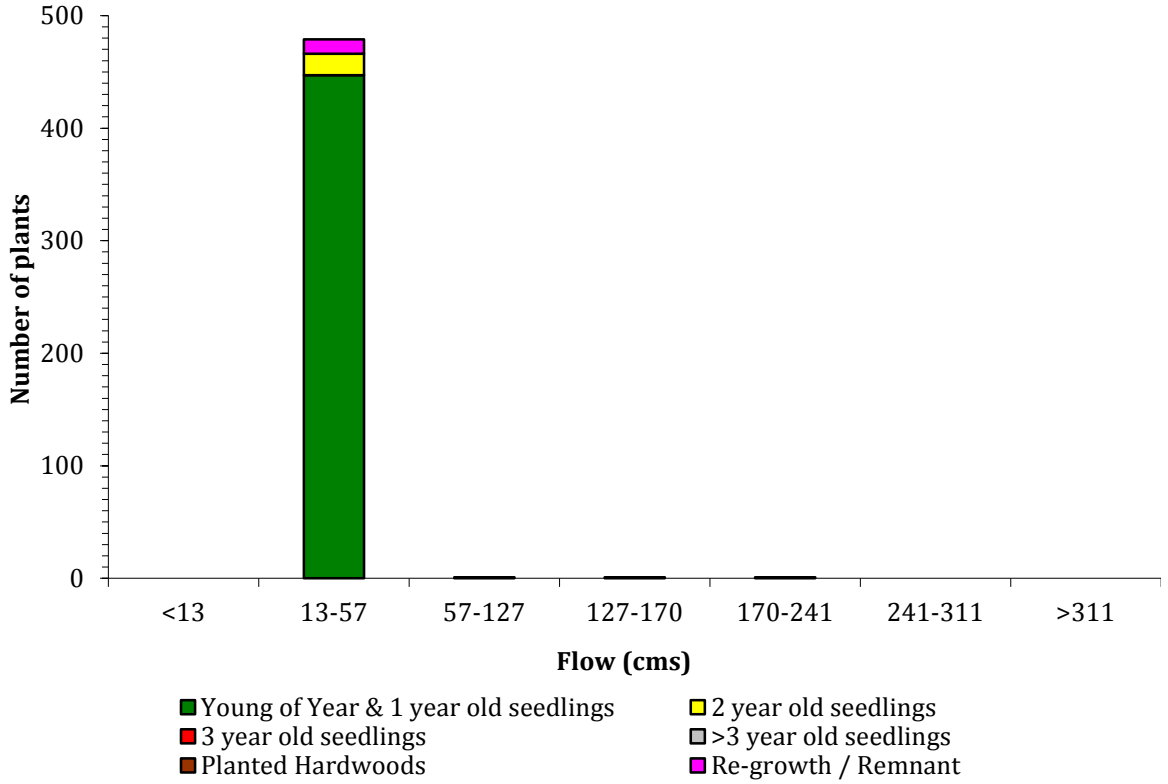


Figure E-27. Red – Yellow - Green analysis cross section 314+15.

Post-Construction Changes in Cover Type Boundaries

Along the right bank 13 cms (450 cfs) water edge, a large narrowleaf — dusky willow patch was removed during construction, a floodplain surface constructed at the pilot rehabilitation site and a terrace constructed in the reclaimed gravel mine (e.g., activity area R5 and U4, Figure A-12). After construction in the winter 2005, the entire cross section was open ground. The constructed terrace rapidly converted from open ground into a non-native grassland by 2008. In 2009, the non-native grassland on the constructed terrace had turned into yellow star-thistle grassland. In 2009 the constructed floodplain had locations where revegetated plants (i.e., black cottonwood, red willow, arroyo willow, etc), regrowing narrowleaf willow, and open ground occurred. Black cottonwood was planted in 2005 and has increased in height and area since. A large patch of narrowleaf – dusky willow was regrowing between the river and the black cottonwood patch (Figure E-28). Open ground lies between the narrowleaf – dusky willow patches along the 13 cms (450 cfs) water edge and the constructed floodplain (Figure E-28). Open ground has been decreasing in area since 2008 as regrowing willow patches have increased in size and area. Narrowleaf–dusky willow cover increased between 2005 and 2008 as the willow patch along the 13 cms (450 cfs) water edge

re-grew. Currently, willow regrowth covers generally the same area as before construction, and open ground following construction in 2005 has become narrowleaf – dusky willow in 2009. Narrowleaf – dusky willow regrowth has been forming monotypic bands along the mainstem water edge and has the potential to detrimentally encroach the channel.Post-Construction Initiation and Establishment Trends.

Initiation results for band transect 326+90, monitored in the fall 2005 and fall 2006, were the same as those for band transect 314+15 (see Post-Construction Initiation and Establishment Trends, on page 34). In fall 2006, one year following construction, 20 young-of-year seedlings were measured on the band transect (Figure E-29). In the fall 2006, 80% of the seedlings were narrowleaf or dusky willow; however, one red willow, two black cottonwoods and one Fremont cottonwood were also documented. All seedlings sampled in fall 2006 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface (McBain & Trush and HVT 2007a). In 2006, a total of 37 root sprouts were measured between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Although the overall number of root sprouts was small, the abundance and size has continued to increase. Band transect 326+90 was not monitored during WY 2007.

In fall 2008, 42 young-of-year seedlings, 59 1-year seedlings, and one 2-year seedling were measured on the band transect. All the seedlings were narrowleaf or dusky willow in WY 2008. Over 99% of the seedlings sampled in fall 2008 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. In 2008, a total of 74 root sprouts were measured between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Twenty four other occurrences of root regrowth were documented between the 57 cms (2,000 cfs) and 241 cms (8,500 cfs) HEC water surface. One Fremont cottonwood regrowing from root spouts was documented between the 170 cms (6,000 cfs) and 241 cms (8,500 cfs) HEC water surface. In fall 2008, four black cottonwoods and two red willows that were planted in January 2006 were documented between the 127 cms (4,500 cfs) and 170 cms (6,000 cfs) HEC water surface.

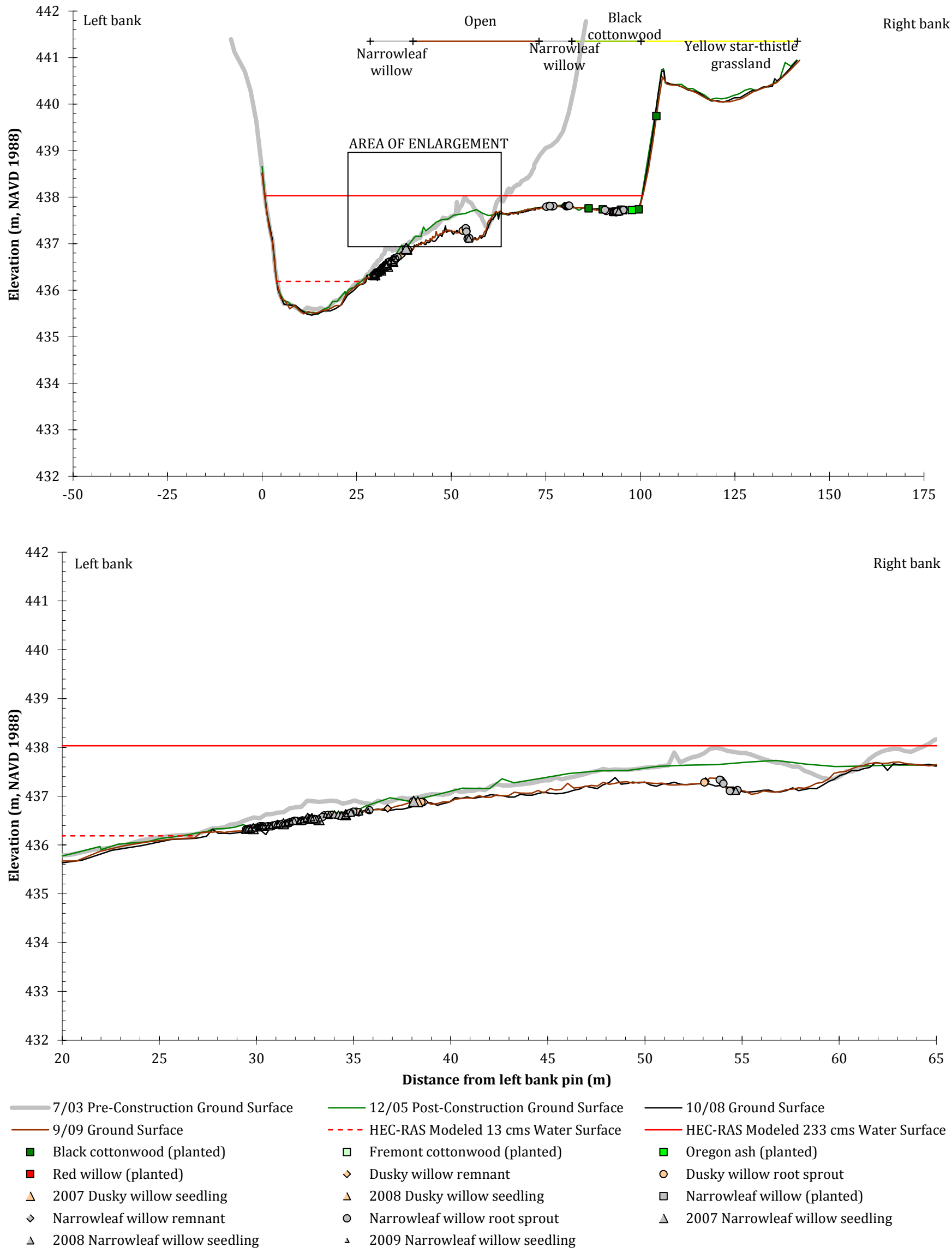


Figure E-28. a) Cross section 326+90, and b) Enlarged cross section 326+90.

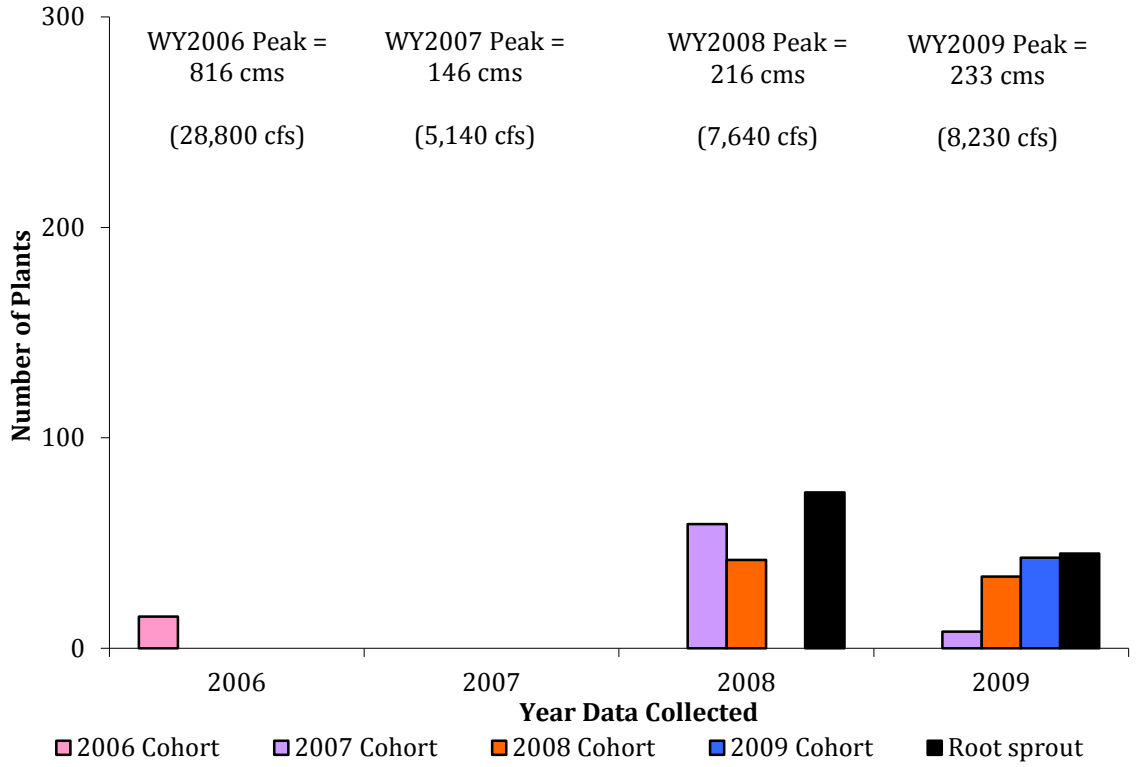


Figure E-29. Cross section 326+90 WY 2008-2009 seedling demographics within 13 to 57 cms (450-2000 cfs) ROD discharge inundation zone.

In fall 2009, four years after construction, 43 young-of-year seedlings, 37 1-year seedlings, and eight 2-year seedlings were measured on the band transect (Figure E-25). All of the seedlings were narrowleaf or dusky willow in WY 2009 and mostly occurred below the 57 cms (2,000 cfs) HEC water surface. One narrowleaf willow seedling occurred between the 127 cms (4,500 cfs) and 170 cms (6,000 cfs) HEC water surface. Young-of-year-2009 seedlings and root sprouts occurred in the same relative location along the band transect as the 2008 young-of-year seedlings and root sprouts (Figure E-28). Eighty eight percent of the 2008 Cohort, and 28% of the 2007 Cohort, survived to fall 2009 (Figure E 29) and were growing intermixed with the 2009 seedlings (Figure E-28). In 2009, at total of 45 root sprouts were measured below 57 cms (2,000 cfs), representing a 39% decrease in measured root sprouts in this bank zone. Although the overall number of root sprouts decreased in 2009, plant size overall continues to increase; and while regrowth along the 13 cms (450 cfs) water edge does not appear to be inducing deposition or morphological change, there is high potential for detrimental encroachment trends to begin.

WY 2009 Channelbed Mobility/Scour Induced Demographic Changes

Since WY2006, the maximum streamflow at Hocker Flat was 233 cms (8,230 cfs) and occurred on May 5, 2009. The WY 2009 annual maximum peak of 233 cms (8,230 cfs) scoured the 13 cms (450 cfs) channel margin to a maximum depth of 11.9 cm in locations without seedlings or root resprouts and 4.1 cm in locations where seedlings and root sprouts were located. Limited channelbed scour, in locations where there were seedlings, removed 12% of the 2008 and 86% of 2007 Cohort seedlings. Channelbed mobility results on cross section 326+90 show that none of the D_{84} size class (i.e., 125 mm) was mobilized along the channel margin (see Hocker Flat Bed Mobility Results). The 4.1 cm scour depth measured along the band transect where seedlings were located was less than half the depth of the D84 measured and suggests that the channelbed surface scour needed to remove 1-year old seedlings was not achieved in WY 2009. The channelbed scoured to a depth of approximately 11 cm on either side of the band of establishing seedlings and willow resprouts, which may have been sufficient to cause scour mortality to 1- and 2-year old seedlings establishing along the outside patch edge. Willow regrowth and seedling establishment along 326+90 is sufficient to reduce the scouring effects of floods greater than 227 cms (8,000 cfs), thus facilitating the further establishment of woody riparian vegetation along the 13 cms (450 cfs) water edge.

Willow regrowth from remnant roots on the right bank is inducing fine sediment deposition, although the implications differ depending on bank location of the regrowth. Regrowing willows are slowing water velocities along the water edge and inhibiting channelbed scour and seedling mortality. The patch of narrowleaf - dusky willow regrowth farthest from the channel has more deposition than the patch growing along the 13 cms (450 cfs) water edge. Higher and farther away from the 13 cms (450 cfs) water edge, regrowing willow shrubs are not likely to induce detrimental channel encroachment and may provide valuable aquatic habitat at flows higher than 127 cms (4,500 cfs).Red-Yellow-Green Analysis

Detrimental riparian encroachment caused by seedlings or regrowing willows has not been inhibited along the 13 cms (450 cfs) water edge. There is a high encroachment risk along band transect 326+90. Root sprouts are already well established along the low water edge, and while higher flows are able to shear off some of the stems, many are becoming larger shrubs. There has been limited deposition along the channel margin, but the presence of larger and larger shrubs is likely to influence fine sediment deposition in the future. It is likely that a typical berm will form, the channel edge will be armored with mature regrowth, and channel morphology will simplify. Current establishment trends indicate that this

location is at a high risk of encroachment (Figure E 30).

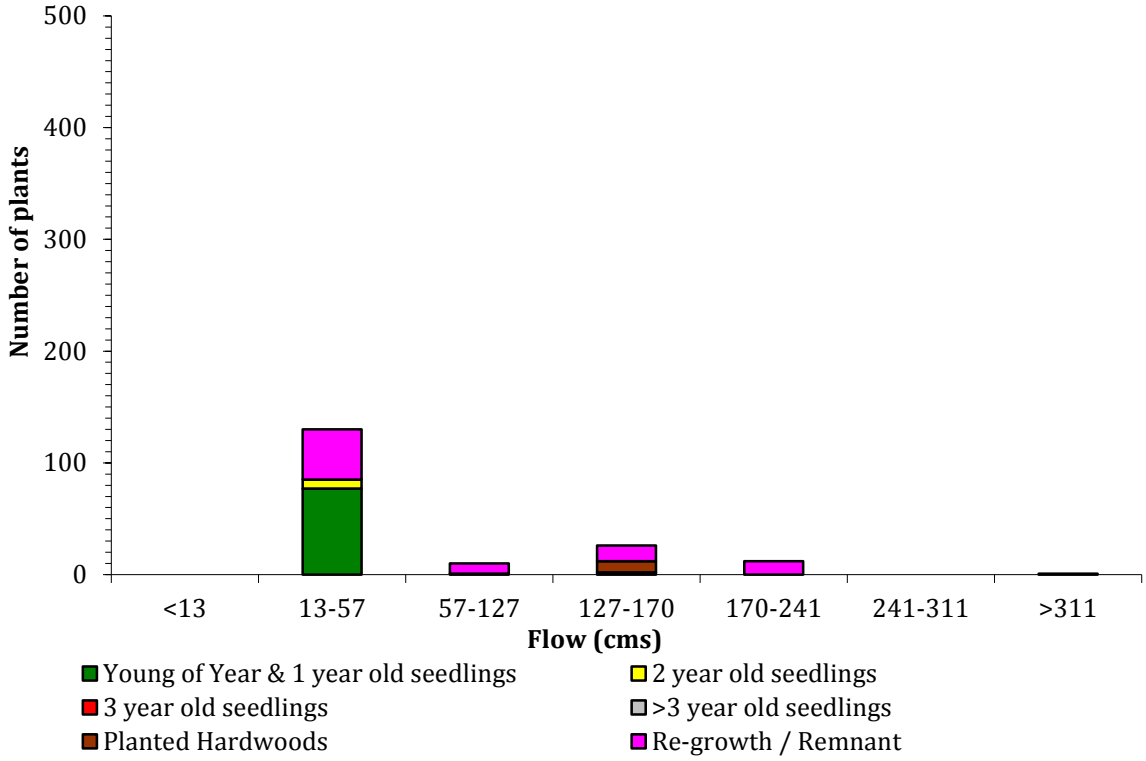


Figure E-30. Red – Yellow - Green analysis cross section 326+90.

Band Transect 340+17 Results

Band transect 340+17 was the most upstream band transect monitored at Hocker Flat in WY 2009 and was collocated with cross section 340+17 (Figure A-10). Band transect 340+17 crosses a feathered edge and intersects a 170 cms (6,000 cfs) floodplain (e.g., activity area R4, Figure A-12). Band transect 340+17 was monitored in the fall 2003 (pre-construction), spring and fall 2006 (as-built), fall 2008 (two years after construction), and fall 2009 (Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank was not monitored. The band transect begins below the 13cms (450 cfs) water surface, extends across the constructed floodplain surface and terminates at the base of a dredger tailing pile. Overall, band transect 340+17 has had a high species richness along the channel edge and has always had more species growing on it than other Hocker Flat band transects.Post Construction Changes in Cover Type Boundaries.

Vegetation removal during construction cleared a narrowleaf – dusky willow and white alder patch in the fall 2005 (McBain & Trush and HVT 2007a). A feathered edge was constructed where vegetation had been cleared along the 13 cms (450 cfs)

water edge and a floodplain surface was constructed farther away and at a higher elevation (e.g., activity area R4, Figure A-12). The feathered edge and constructed floodplain were open ground following construction in fall 2005. Rehabilitation cleared mature willows but was unable to remove all of the roots. The cover of the narrowleaf – dusky willow patch along the 13 cms (450 cfs) water edge increased between 2005 and 2008 as the willow patch re-grew following construction. Post-construction, seedlings and resprouting narrowleaf and dusky willows thrive along the 13 cms (450 cfs) water edge, influencing fine sediment deposition patterns; however, the majority of the transect on the constructed floodplain surface remains open ground (Figure E-31). High-flows have scoured and deposited sand on the constructed floodplain surface, but no significant vegetation cover has established since 2005. Post-Construction Initiation and Establishment Trends

Initiation results for band transect 340+17, monitored in the fall 2005 and fall 2006, were the same as those for band transect 314+15 and 326+90 (see Post-Construction Initiation and Establishment Trends, on page 34). In fall 2006, one year following construction, 75 young-of-year seedlings were measured on the band transect (Figure E-32). In fall 2006, 84% of the seedlings were narrowleaf or dusky willow; however, red willow and white alder seedlings were also documented. All seedlings sampled in fall 2006 occurred between the 13 to 170 cms (450 to 6,000 cfs) HEC water surface (McBain & Trush and HVT 2007a). No root sprouts were documented on band transect 340+17 in fall 2006. Band transect 340+17 was not monitored during WY 2007.

In fall 2008, three years following construction, 29 young-of-year seedlings and 16 1-year seedlings were measured on the band transect (Figure E-32). In fall 2008, 89% of the seedlings were narrowleaf or dusky willow; however, one Oregon ash, two red willow and two white alder seedlings were also documented. All seedlings sampled in fall 2008 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface. Seedlings that had previously initiated on the constructed floodplain surface in 2006 were dead. In 2008, at total of 15 root sprouts were measured between the 13 to 57 cms (450 to 2,000 cfs) HEC water surface, with the highest density of root sprouts occurring between the 8.5 and 13 cms (300 and 450 cfs, respectively) HEC water surface.

In fall 2009, four years after construction, 27 young-of-year seedlings, 13 1-year seedlings, and one 2-year seedling were measured on the band transect (Figure E-32). In fall 2009, 93% of the seedlings were narrowleaf or dusky willow; however, one red willow and two arroyo willows were also documented. All seedlings sampled in fall 2009 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water

surface. Young-of-year-2009 seedlings occurred in the same relative location along the band transect as the young-of-year-2008 seedlings (Figure E-32). Survivors from the 2008 Cohort were intermixed with the 2009 seedlings, with 52% of the 2008 Cohort and 7% of the 2007 Cohort surviving to fall 2009 (Figure E 32). In 2009, at total of five root sprouts were measured below 57 cms (2,000 cfs), representing a 66% decrease in measured root sprouts. Although the overall number of root sprouts decreased, the size of regrowing willows has increased. As of fall 2009, seedlings and regrowth along the 13 cms (450 cfs) water edge do not appear to be inducing any morphological change.

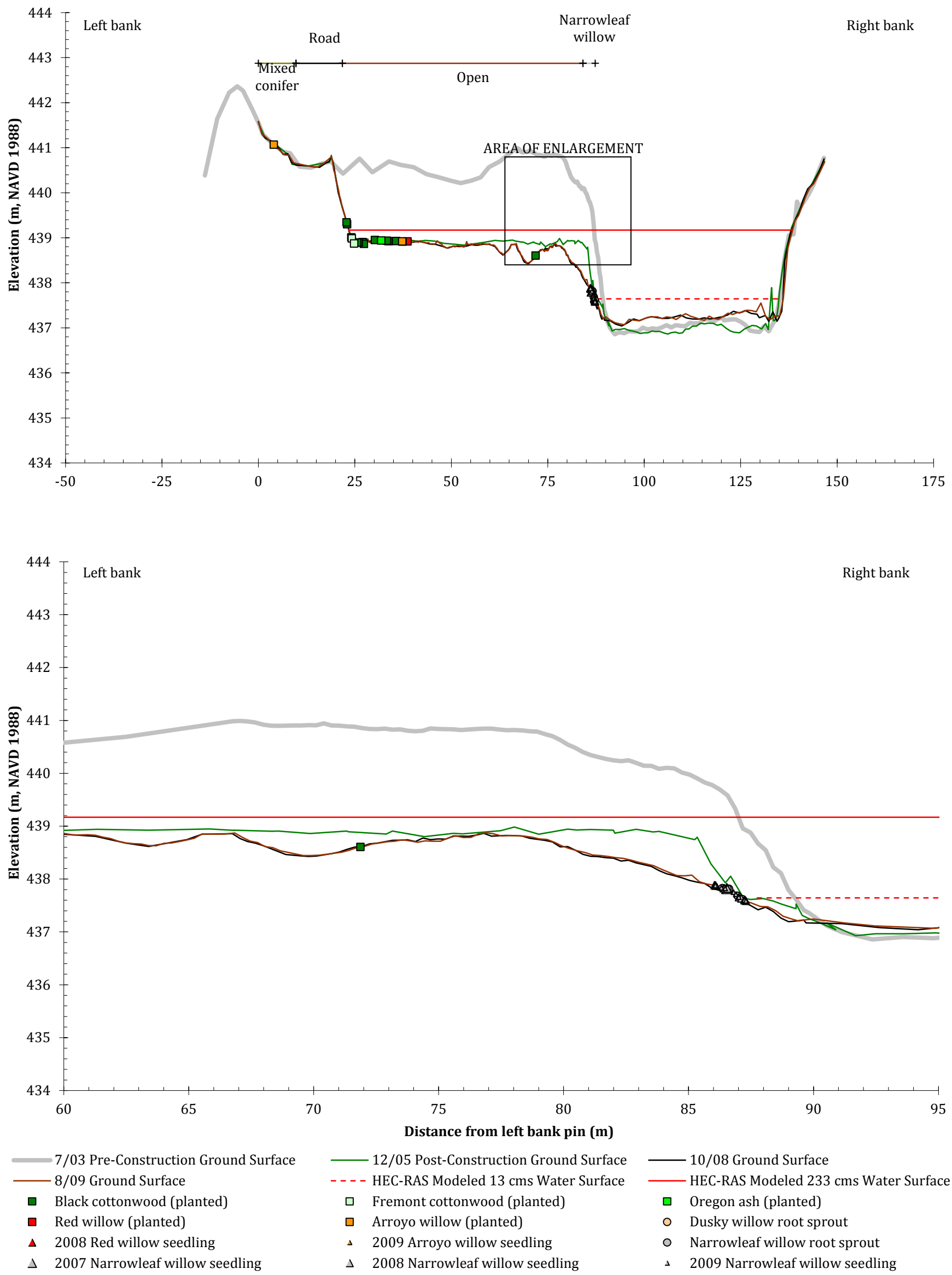


Figure E-31. a) Cross section 340+17, and b) Enlarged cross section 340+17.

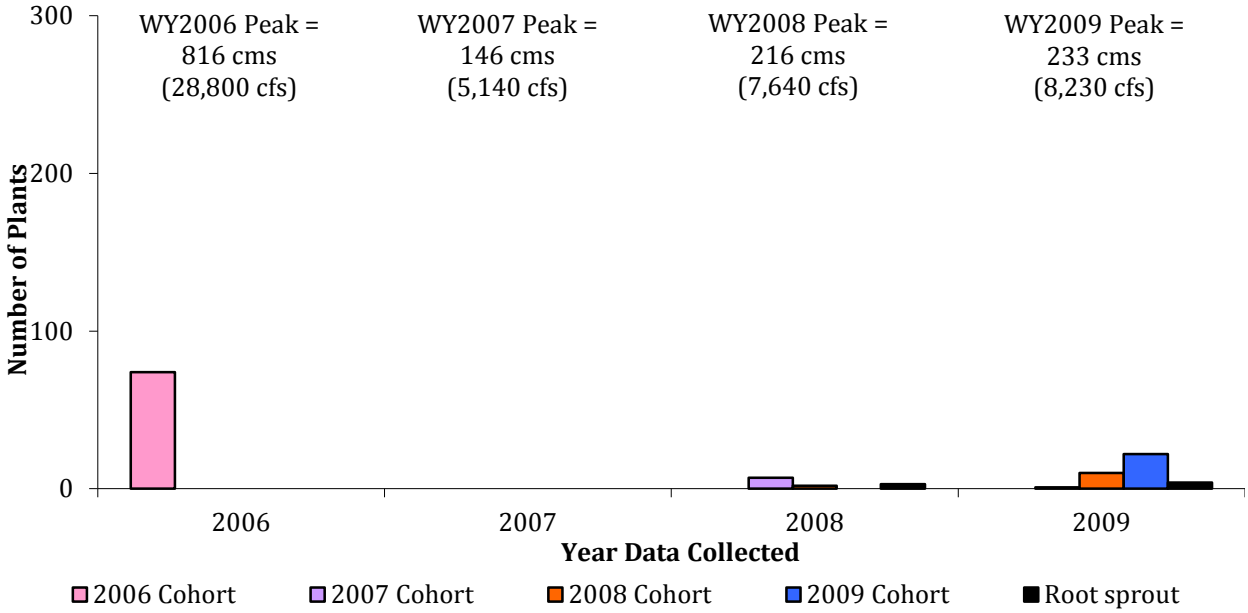


Figure E-32. Cross section 340+17 WY 2008-2009 seedling demographics within 13 to 57 cms (450-2000 cfs) ROD discharge inundation zone.

WY 2009 Channelbed Mobility/Scour Induced Demographic Changes

The maximum streamflow at Hocker Flat since WY2006 was 233 cms (8,230 cfs) and occurred on May 5, 2009. Geomorphic monitoring was not conducted at band transect 340+17; however, based on the results from other cross sections where channelbed mobility and scour were measured, the WY 2009 annual maximum peak scoured the 13 cms (450 cfs) channel margin, likely removing 48% of the 2008 Cohort seedlings (Figure E-32). At Hocker Flat cross sections where mobility and scour were measured, the scour was less than the depth of the D_{84}, which suggests that channelbed surface scour needed to remove 1-year old seedlings was not achieved in WY 2009.Red-Yellow-Green Analysis.

Detrimental riparian encroachment caused by seedlings or regrowing willows has been inhibited along the 13 cms (450 cfs) water edge. There is a low encroachment risk along band transect 340+17 (Figure E-33). The mainstem channel is migrating into the constructed left bank and a mid channel bar is forming. In planform, riparian vegetation was re-establishing along the 13 cms (450 cfs) water edge; however, growth was not dense. It is possible that adjustments to cross section area due to the formation of a mid channel bar equates to higher scour along the feathered edge, which in turn removes root sprouts and establishing seedlings. Therefore, the current establishment trends indicate that this location is at a low risk of detrimental riparian vegetation encroachment (Figure E-27).

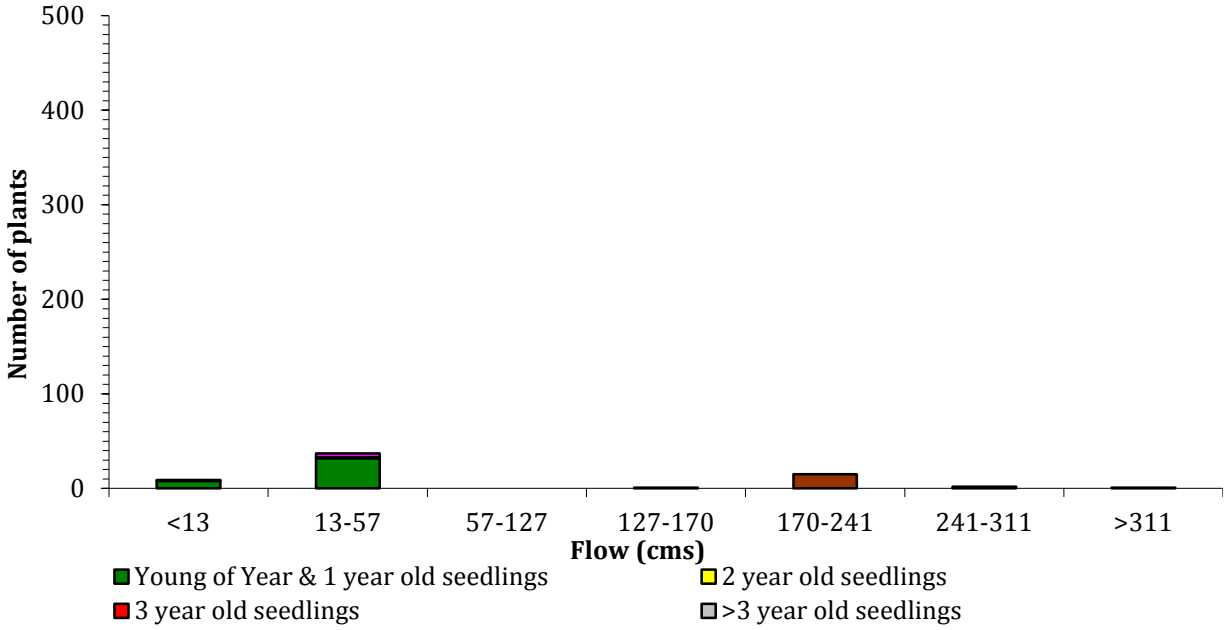


Figure E-33. Red - Yellow - Green analysis cross section 340+17.

Lower and Middle Indian Creek

Vegetation Mapping

2008 Mapping Results

In 2008, the total mapped vegetated area for Lower Indian Creek was 11.3 hectares (27.9 acres) and accounted for 63.4 % of the mapped area (Figure 3-10). In 2008 the area of open ground was 14.1 % of the mapped area, an increase since pre-construction. Remnant vegetation was 44.8% of the mapped area and represented a 32.5% decrease since before construction. The site was revegetated in WY 2008, one year after construction. Seedling regeneration accounted for 4.0% of the mapped area and was the largest percent of the mapped area of any rehabilitation site monitored. Many of the naturally regenerating seedlings were black cottonwoods. Willow regrowth accounted for 4.3% of the mapped area (Figure 3-10). Mapped regrowth was primarily narrowleaf and dusky willows.

The 2008 total mapped vegetated area for the Middle Indian Creek was 3.9 hectares (9.6 acres) and accounted for 55% of the mapped area (Figure E-36). The area of open ground was 9.7% of the mapped area and was the same as before construction (Figure 3-11). Remnant vegetation was 50.6% of the mapped area and represented a 10% reduction in pre-construction area. In 2008, the cleared understory was resprouting in most locations where it was removed. Revegetation did not occur at the Middle Indian Creek site. Regrowth accounted for 4.4% of the vegetated area. Seedling regeneration was not documented.

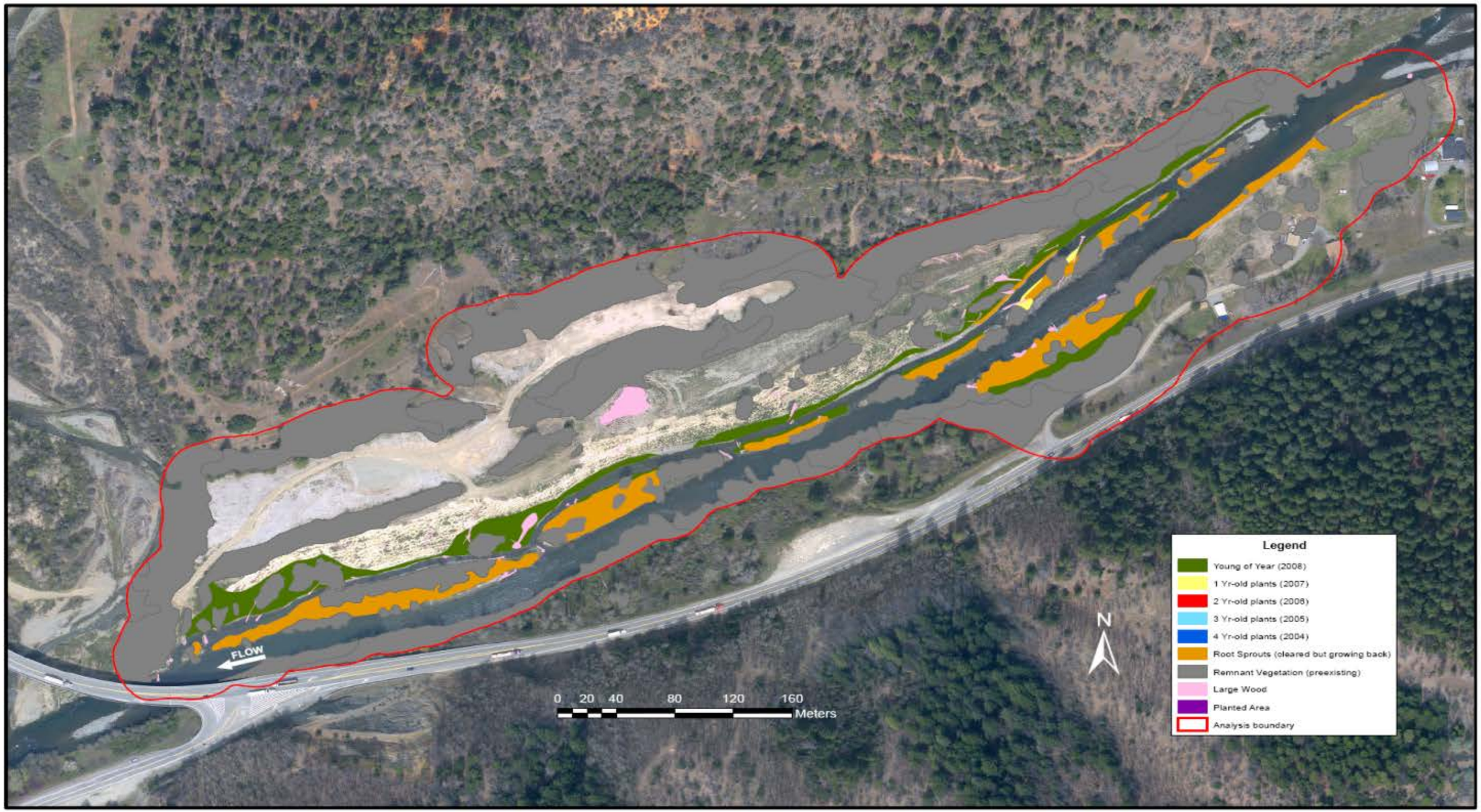


Figure E-34. Lower Indian Creek rehabilitation site 2008 map, one year after construction.

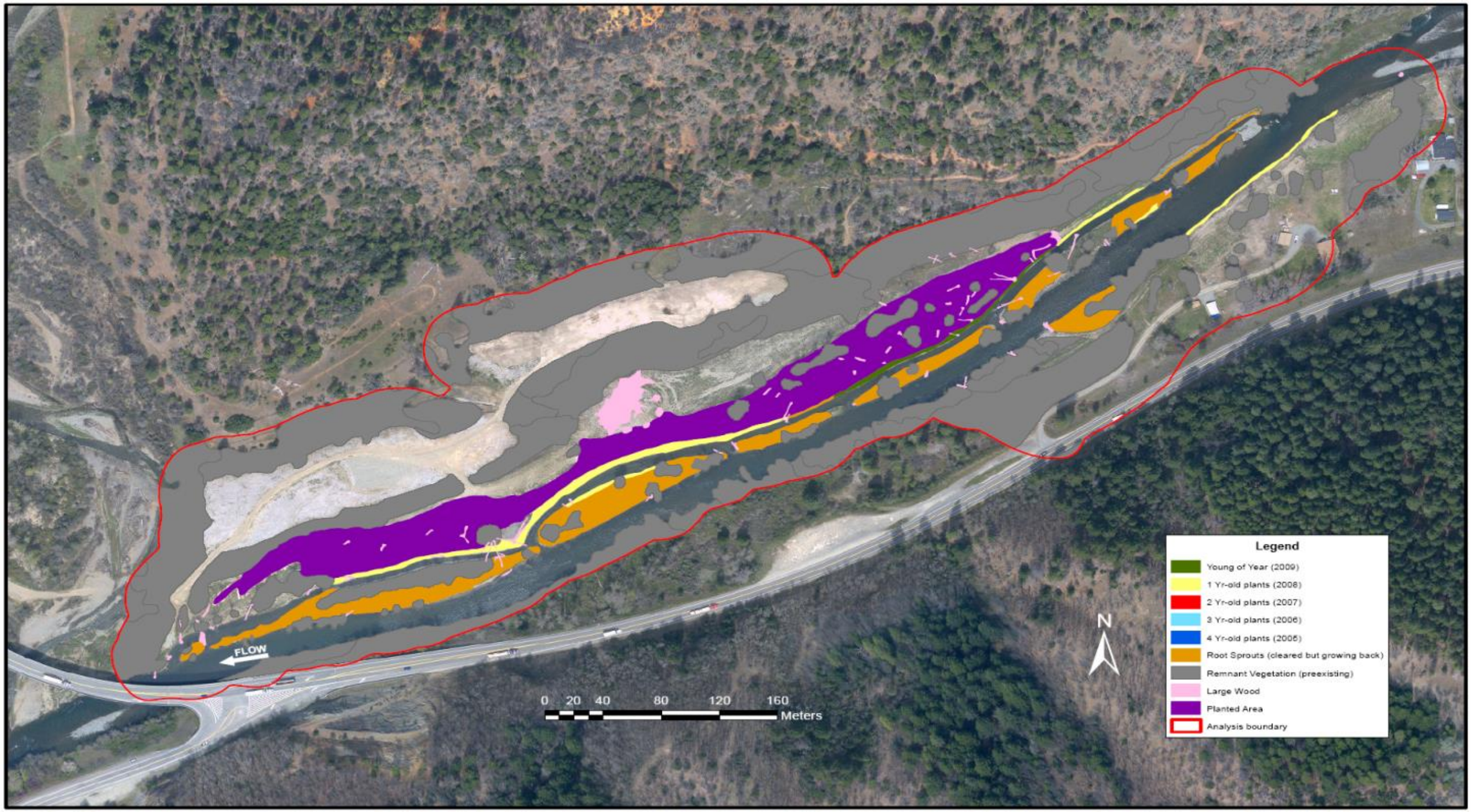


Figure E-35. Lower Indian Creek rehabilitation site 2009 map, two years after construction.

Figure E-36. Middle Indian Creek 2008 rehabilitation site map, one year after construction.

Figure E-37. Middle Indian Creek 2009 rehabilitation site map, two years after construction.

Band Transect 1157+90 Results

Band transect 1157+90 was the downstream transect monitored at the Lower Indian Creek rehabilitation site and was collocated with cross section 1157+90 (Figure A-16). Band transect 1157+90 extends from toe of the valley wall on the left bank across the mainstem, to the right bank side channel and floodplain surface (e.g., activity area R8, Figure A-18) and continues past the construction area into the remnant black cottonwood stand along the left bank of the mainstem channel. The band transect was not sampled along the unrehabilitated left bank portion of the band transect. Post-Construction Changes in Cover Type Boundaries.

Following rehabilitation, along band transect 1157+90 there has been an increase in open water and in open ground due to side channel and floodplain construction (Figure E-38). Between 2008 and 2009 the area of red willow and white alder decreased along the transect. A patch red willow trees near the mainstem channel fell during the winter of WY 2009 and the patch converted to mixed willow. Post-construction the area of sweet clover has increased in disturbed areas along the band transect. A large portion of the transect near the side channel was composed of black cottonwood seedlings in WY 2008 and WY 2009 (Figure E-38).Post-Construction Initiation and Establishment Trends

In fall 2008, one year after construction, 1,038 young-of-year seedlings, five 1-yr seedlings, and two > 3-yr old woody plants were measured on the band transect. Sixty five percent of the seedlings documented were dead red willow or black cottonwood seedlings and occurred between the 57 and 127 cms (2,000 and 4,500 cfs) HEC water surfaces. Dead red willow and black cottonwood seedlings had desiccated. Seedlings and woody plant regrowth was documented along the mainstem, but no seedlings were documented below the 57 cms (2,000 cfs) HEC water surface (Figure E-38). Unlike other rehabilitation sites, only one narrow leaf willow seedling was documented along the transect. Sixty percent of the young-of-year seedlings were black cottonwood. The other 39.9% of regenerating seedlings documented were red willows. All woody plant seedlings were documented between the 57 and 241 cms (2,000 and 8,500 cfs) HEC water surfaces. In 2008, a total of 34 root sprouts were measured above the 57 cms (2,000 cfs) HEC water surface. Black cottonwood, red willow and narrowleaf willow were regrowing from remnant roots and should not induce detrimental riparian encroachment.

In fall 2009, two years after construction 19 young-of-year seedlings, 54 1-yr seedlings, two 3-year old, four 3-yr old, and 5 > 3-yr old woody plants were measured on the band transect. Seedlings and woody plant regrowth continued to increase in size was documented along the mainstem, but the number of individual

stems measured went down. Twenty five seedlings were documented below the 57 cms (2,000 cfs) HEC water surface, with less than a third of them being narrowleaf willow. (Figure E-39). WY 2009 was the first time that woody plant seedling were documented below the 57 cms (2,000 cfs) HEC water surface since WY2006 (Figure E-39). Two alders, one black cottonwood, and 14 red willows and were also documented between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Over 68% of the seedlings occurred above the 57 cms (2,000 cfs) HEC water surface, of which 44% were red

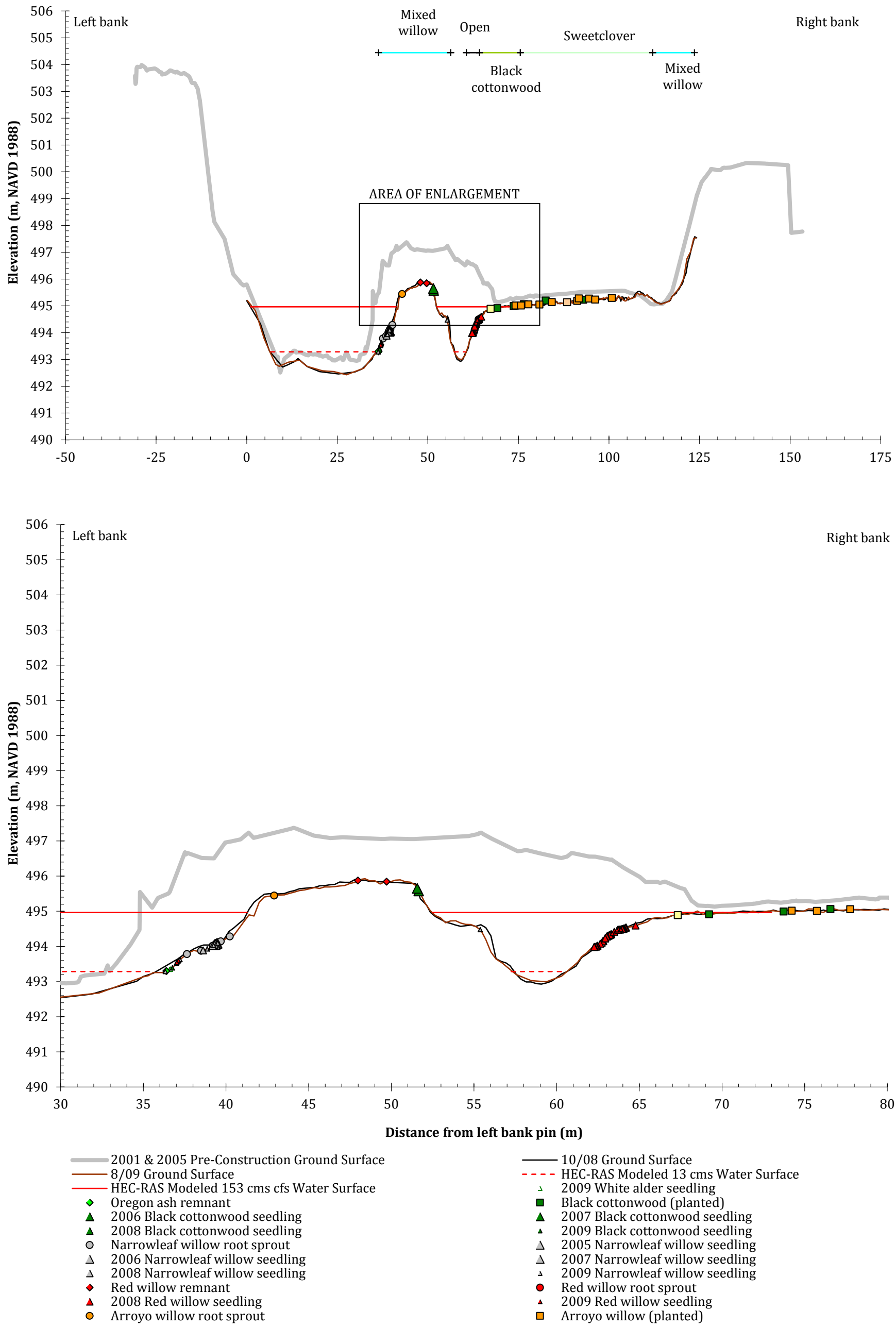


Figure E-38. a) Cross section 1157+90, and b) Enlarged cross section 1157+90.

willow. However 12 narrowleaf willow, and five black cottonwood seedlings were also documented between the 57 and 127 cms (2,000 and 4,500 cfs) HEC water surfaces (Figure E-39). All naturally regenerating hardwoods sampled in the fall 2009 (including young-of-year and 1-yr old seedlings) occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. The colonization and more vigorous and rapid growth of sweet clover was the primary reason for the reduction in seedlings between WY 2008 and WY 2009. In 2009, a total of 19 root sprouts were measured along the band transect (Figure E 39). In 2009, a total of four root sprouts were measured below the 57 cms (2,000 cfs) HEC water surface which represents a slight increase in root sprouts below the 57 cms (2,000 cfs) HEC water surface since WY 2008 (Figure E-39). Eighteen woody plants that were planted during revegetation are located above the 127 cms (4,500 cfs) HEC water surface along the band transect on the constructed floodplain (Figure E-39). Survivors from the 2008 Cohort also occurred in same the location as in 2008 and were intermixed with the 2009 seedlings; however only 5% of the 2008 Cohort, and 40% of the 2007 Cohort survived to the fall 2009 (Figure E-39).Channelbed Mobility/Scour Induced Demographic Changes.

Streamflow recession killed more seedlings at band transect 1157+90 than channel bed scour. Over half the seedlings documented in WY 2008 died from desiccation. It was possible that in WY 2008 the recession rates from the 127 cms (4,500 cfs) peak to the 57 cms (2,000 cfs) bench, or the prolonged 57 cms (2,000 cfs) bench to 13 cms (450 cfs) bench were too fast and that young roots could not keep up with the rapidly drying soils associated with river stage recession. The maximum streamflow at Lower Indian Creek between in WY 2009 was 153 cms (5,420 cfs) on May 1, 2009. Geomorphic experiments were not conducted at this band transect, and riparian monitoring began one year following construction in the fall 2008. The only topographic changes in WY 2009 were limited to small area of scour along the right of the mainstem and the left bank of the constructed side channel. Channelbed scour occurred in locations where not many seedlings had been documented, and did not affect seedling demographics along this band transect as much as inter-specific competition between establishing seedlings and sweet clover. The changes in seedling demographics along band transect 1157+90 were not due to channelbed mobility or scour.Red-Yellow-Green Analysis.

Two years after construction the majority of seedlings documented along the band transect occurred between the 127 and 170 cms (4,500 and 6,000 cfs) HEC water surfaces (Figure E-40). Woody vegetation was documented along the mainstem channel low water edge. Currently there are very few woody plant seedlings from the 2009 Cohort growing along the mainstem low water edge. In the side channel along the 13 cms (450 cfs) water edge, hundreds of seedlings regenerated in 2009 (Figure E-40). Revegetation, seedling recruitment, and willow regrowth along the side channel are likely to create heavily

vegetated side channel banks within the next 10 years providing shade and habitat structure for many aquatic and terrestrial animals.

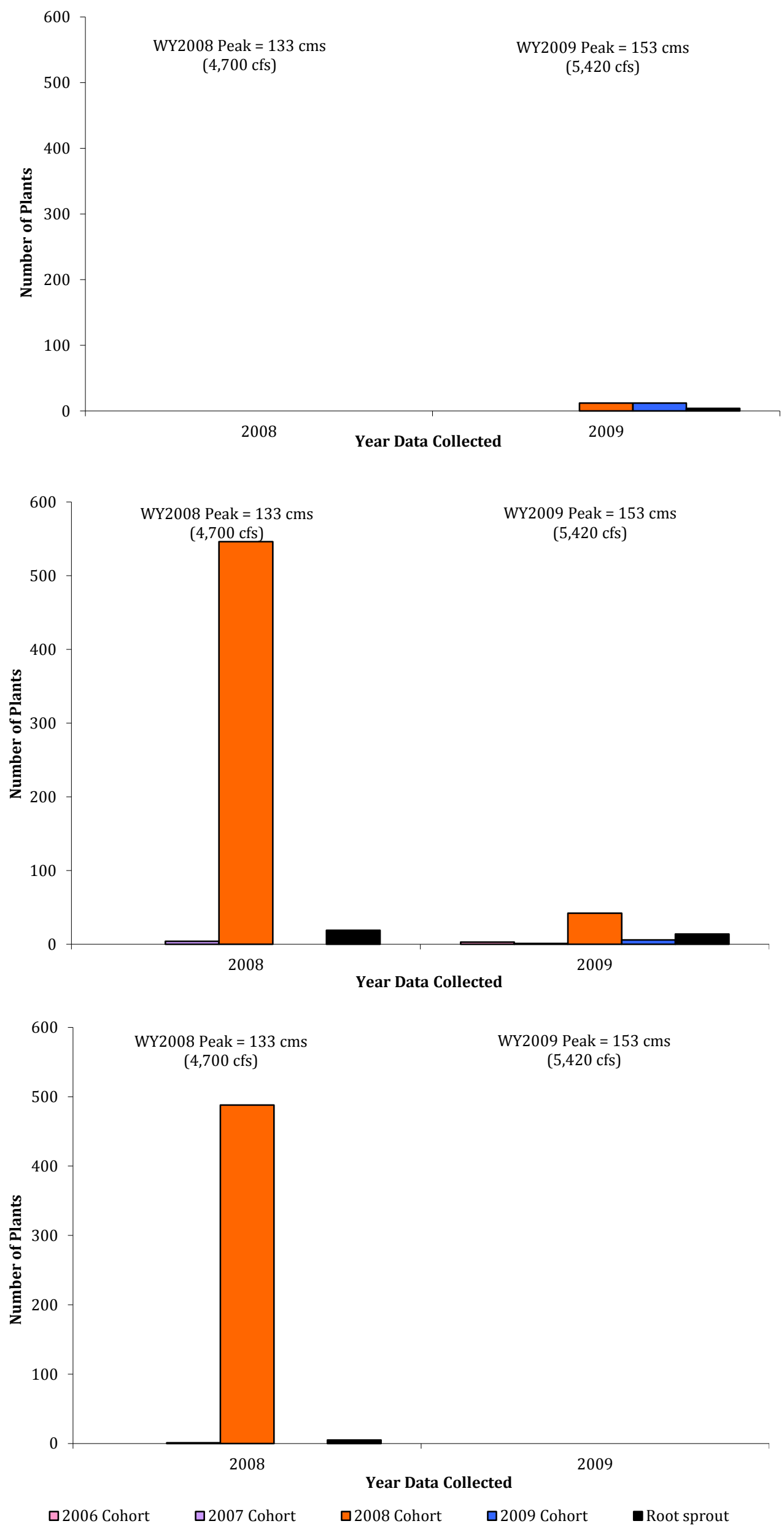


Figure E-39. a) Cross section 1157+90 WY 2008-2009 seedling demographics within 13 - 57 cms (450 - 2000 cfs) ROD discharge inundation zone, b) Cross section 1157+90 WY 2008-2009 seedling demographics within 2000-4500 cfs ROD discharge inundation zone, and c) Cross section 1157+90 2008-2009 seedling demographics within 4500-6000 cfs ROD discharge inundation zone. WY 2008 peak discharge was 133 cms (4,700 cfs), and WY 2009 peak discharge was 153 cms (5,420 cfs).

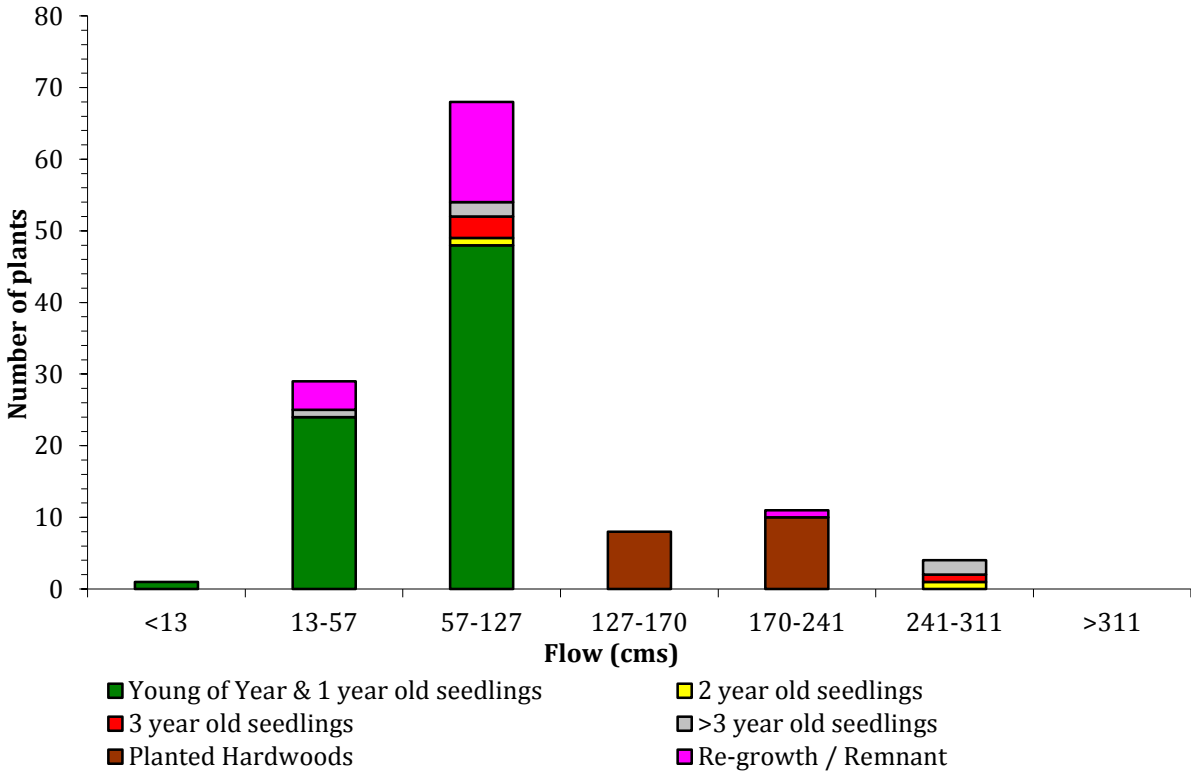


Figure E-40. Red – Yellow - Green analysis cross section 1157+90.

Band Transect 1171+20 Results

Band transect 1171+20was the most upstream band transect monitored at the Lower Indian Creek site and was collocated with cross section 1171+20 (Figure 1-18). Band transect 1171+20extends from toe of the valley wall on the left bank across the constructed high-flow channels, across the mainstem channel and the right bank constructed floodplain surface (e.g., activity area R7, Figure A-18). The band transect was sampled along both the rehabilitated left and right bank portions of the band transect. Post-Construction Changes in Cover Type Boundaries.

Along band transect 1171+20 following rehabilitation there was a short term increase in open ground due to floodplain construction, but by WY 2009 much of the open ground was covered in sweet clover (Figure E-41). Along the transect the area of white alder and mixed willow has decreased compared to pre-construction. Post-construction the area of sweet clover has increased on the right bank constructed floodplain surface. The ponderosa pine and mixed conifer patches along the valley walls were undisturbed during rehabilitation and presumably cover the same area along the band transect.

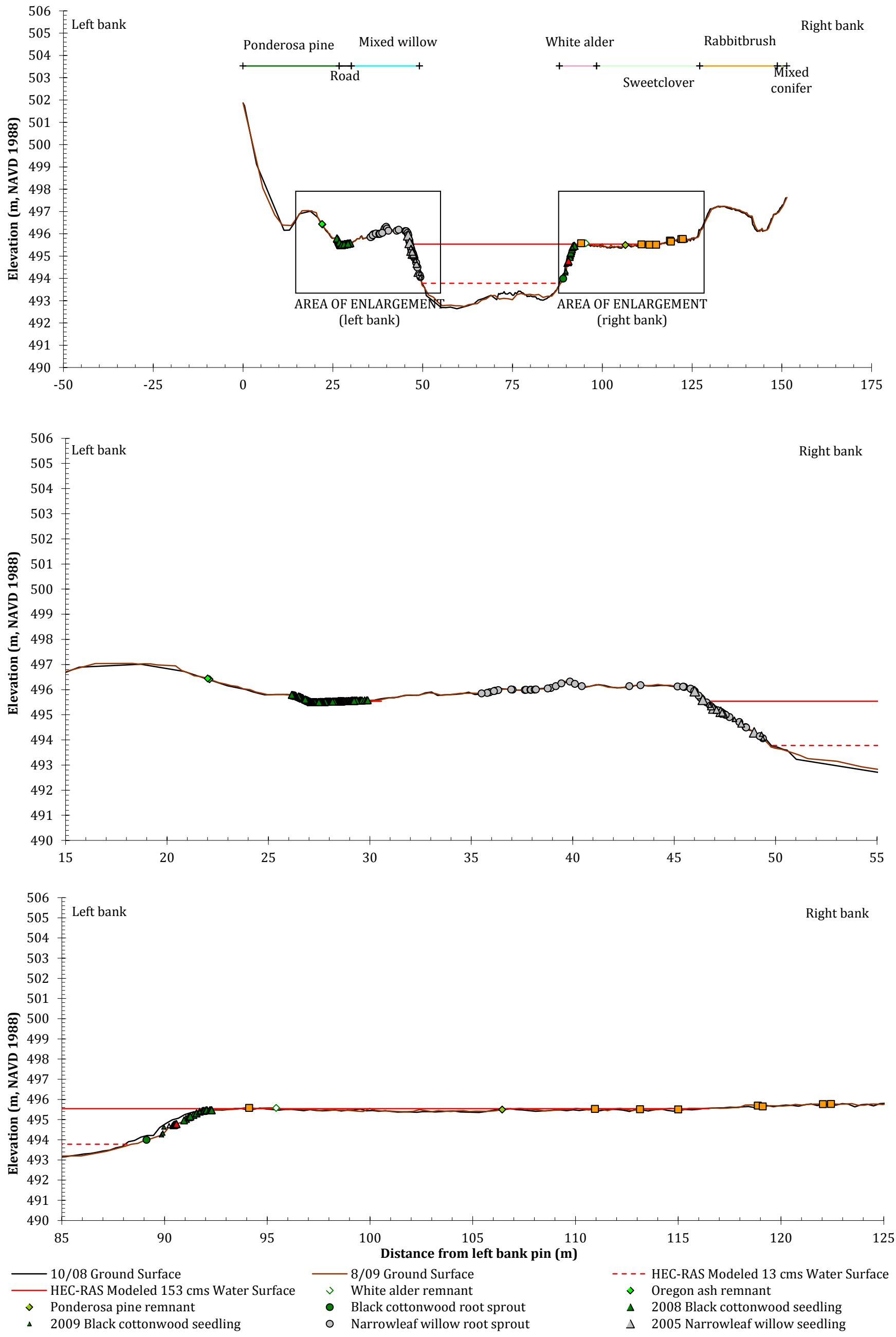


Figure E-41. a) Cross section 1171+20, b) Enlarged left bank cross section 1171+20, and c) Enlarged right bank cross section 1171+20.

Post-Construction Initiation and Establishment Trends

In fall 2008, one year after construction, a total of 9,058 young-of-year seedlings, seven 1-yr seedlings, and two woody plants greater than 3-year old were measured on band transect. Forty-one percent of the seedlings documented were black cottonwood seedlings that had desiccated and occurred between the 127 and 170 cms (4,500 and 6,000 cfs) HEC water surfaces. Two seedlings were documented below the 57 cms (2,000 cfs) HEC water surface. Woody plant regrowth was documented along the mainstem, below the 57 cms (2,000 cfs) HEC water surface (Figure E-41). Ninety nine percent of the young-of-year seedlings were black cottonwood. The other regenerating seedlings documented were one red willow, one white alder, and two narrowleaf willows. Two 1-year old plants on the left bank and 140 seedlings on the right bank occurred below 57 cms (2,000 cfs) HEC water surface. In 2008, a total of 35 root sprouts were measured below the 57 cms (2,000 cfs) HEC water surface. Black cottonwood, red willow and narrowleaf willow were regrowing from remnant roots; but at least half of the regrowth was located above the 57 cms (2,000 cfs) HEC water surface and should not induce detrimental riparian encroachment.

In fall 2009, two years after construction, 14 young-of-year seedlings, 845 1-yr seedlings, four 3-year old, and two woody plants great than 3-yr old were measured on the band transect. Woody plant regrowth continued to increase in size and was documented along the mainstem. Eight seedlings were documented below the 57 cms (2,000 cfs) HEC water surface, the majority of them being narrowleaf willow (Figure E-42). Three black cottonwoods were also documented between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces. Over 99% of the seedlings occurred above the 57 cms (2,000 cfs) HEC water surface and 95% were black cottonwoods. However 15 narrowleaf and 11 red willows were also documented between the 57 and 241 cms (2,000 and 8,500 cfs) HEC water surfaces (Figure E-42). Ninety five percent of the seedlings (including young-of-year and 1-yr old seedlings) sampled in WY 2009 occurred between the 170 and 241 cms (6,000 and 8,500 cfs) HEC water surfaces. The colonization and vigorous and rapid growth of sweet clover was the primary reason for the reduction in seedlings between WY 2008 and WY 2009. In 2009, a total of three root sprouts were measured below the 57 cms (2,000 cfs) HEC water surface (Figure E-42). Eight woody plants that were planted during revegetation were located in WY 2009 above the 127 cms (4,500 cfs) HEC water surface along the band transect on the constructed floodplain (Figure E-42). Survivors from the 2008 Cohort occurred in the same location as in 2008 and were intermixed with the 2009 seedlings; but

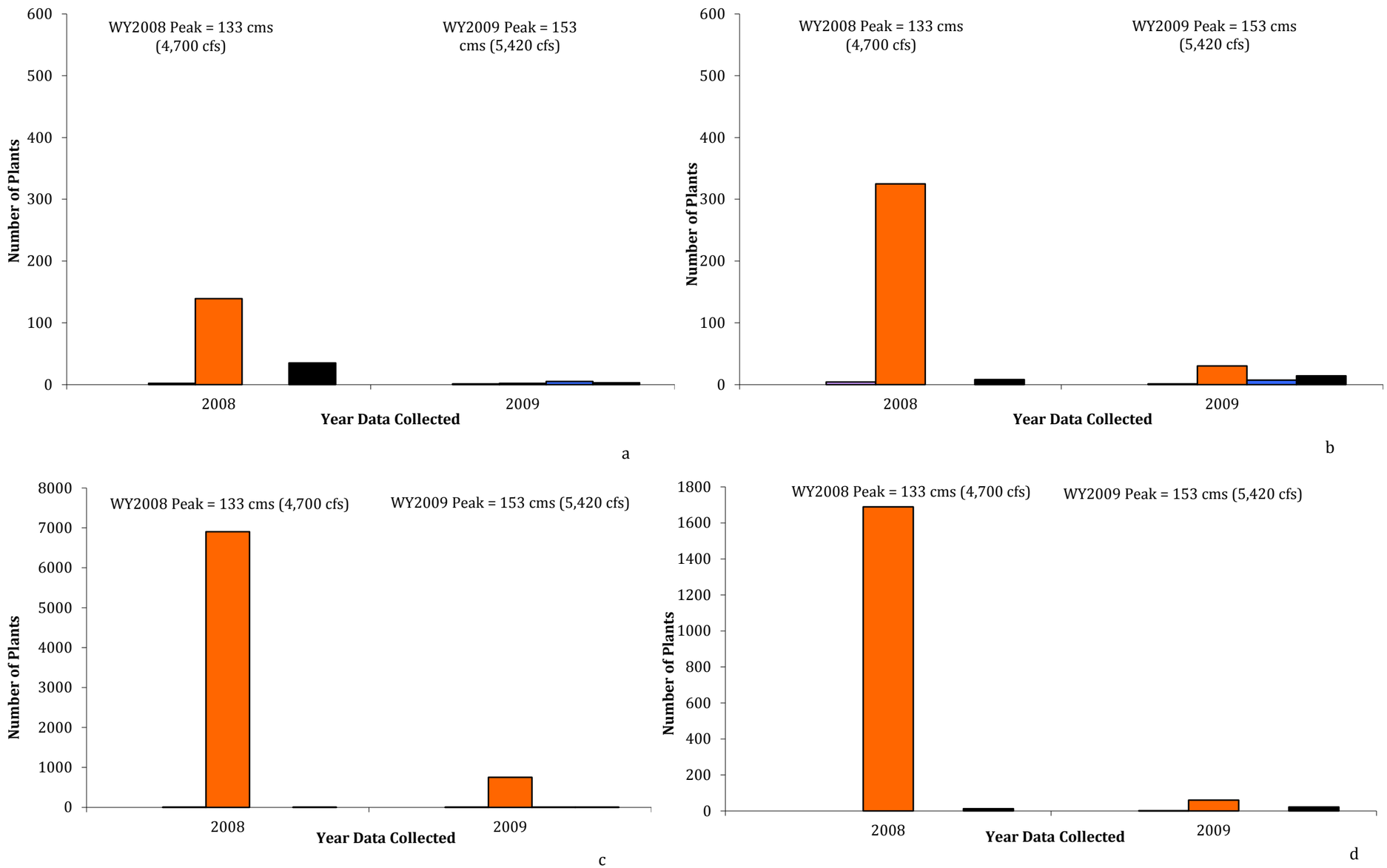


Figure E-42. a) Cross section 1171+20 WY 2008-2009 seedling demographics within 13 – 57 cms (450 - 2000 cfs) ROD discharge inundation zone, b) Cross section 1171+20 WY 2008-2009 seedling demographics within 57 – 127 cms (2000 - 4500 cfs) ROD discharge inundation zone, c) Cross section 1171+20 WY 2008-2009 seedling demographics within 127 -170 cms(4500 - 6000 cfs) ROD discharge inundation zone, and d) Cross section 1171+20 WY 2008-2009 seedling demographics within 170-241 cms (6000-8500 cfs) ROD discharge inundation zone. WY 2008 peak discharge was 133 cms (4,700 cfs), and WY 2009 peak discharge was 153 cms (5,420 cfs).

only 9% of the 2008 Cohort and 57% of the 2007 Cohort survived to the fall 2009 (Figure E-42).

Channelbed Mobility/Scour Induced Demographic Changes

Streamflow recession killed more seedlings at band transect 1171+20 than channel bed scour. Forty one percent of the seedlings documented in WY 2008 died from desiccation. It was possible that in WY 2008 the recession rates from the 127 cms (4,500 cfs) peak to the 57 cms (2,000 cfs) bench, or the prolonged 57 cms (2,000 cfs) bench to 13 cms (450 cfs) bench were too fast and that young roots could not keep up with the rapidly drying soils associated with river stage recession. The maximum streamflow at Lower Indian Creek between in WY 2009 was 153 cms (5,420 cfs) on May 1, 2009. Geomorphic experiments were not conducted at this band transect, and riparian monitoring began one year following construction in the fall 2008. Scour related mortality was not expected given the size of the WY 2009 peak flood event. The only topographic changes in WY 2009 were limited to a small area of scour along the right bank of the mainstem. Channelbed scour occurred in locations many seedlings had been documented, but did not affect seedling demographics along this band transect as much as inter-specific competition between establishing seedlings and sweet clover. Red-Yellow-Green Analysis.

Two years after construction the majority of seedlings documented along the band transect occurred between the 127 and 170 cms (4,500 and 6,000 cfs) HEC water surfaces (Figure E-43). Currently there are very few woody plant seedlings from the 2009 Cohort growing along the mainstem low water edge. On the constructed floodplain and high-flow channels hundreds of seedlings regenerated in 2008 and 2009, above the 127 cms (4,500 cfs) HEC water surface (Figure E-43). Revegetation, seedling recruitment, and willow regrowth on the constructed floodplain and high-flow channels are likely to create heavily vegetated multi storied vegetation within the next ten years providing shade and habitat structure for many aquatic and terrestrial animals.

Vitzhum Gulch

Vegetation Mapping

2008 Mapping Results

In 2008, the total mapped vegetated area was 8.0 hectares (19.7 acres) and accounted for 71.5% of the mapped area (Figure 3-15). In 2006, the area of open ground covered less than 1% of the mapped area, and in 2008 the area of open ground increased to 5.9% of the mapped area due to the notch construction. Remnant vegetation was 65.2% of the mapped area and represented a 16.5% reduction in pre-construction area. Unlike other sites, sweetclover was not documented on constructed surfaces at Vitzthum Gulch. Regrowth

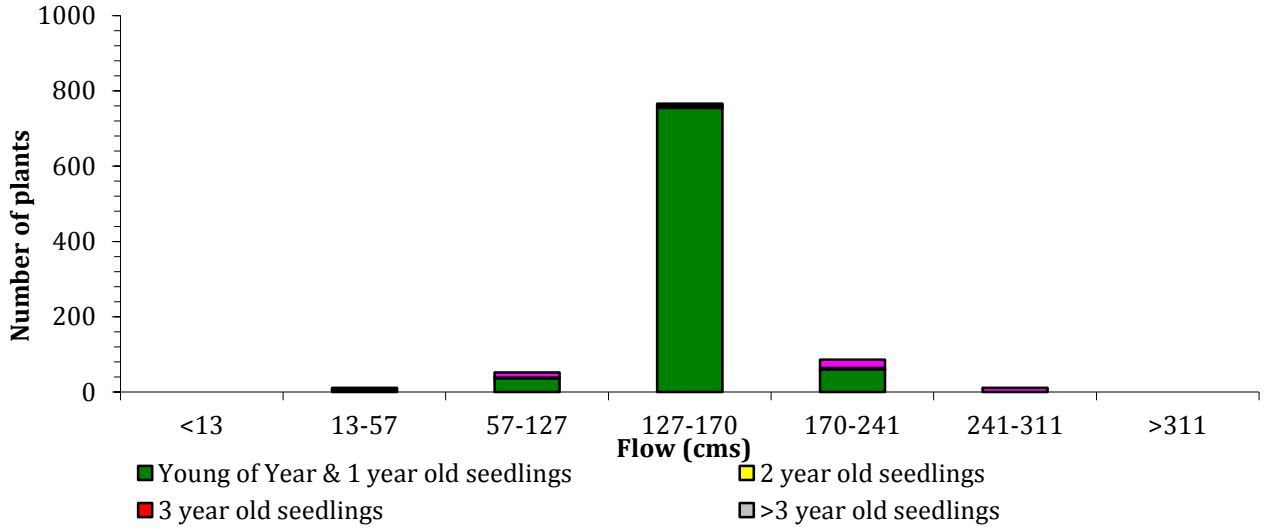


Figure E-43. Red - Yellow - Green analysis cross section 1171+20.

accounted for 4.7% of the vegetated area and occurred primarily in the berm notches (Figure E-44). The areas where regrowth was documented were larger than areas where seedling initiation was observed. Seedlings accounted for 1.7% of the mapped area in 2008; no seedlings were observed at Vitzthum Gulch before construction. Stands of young-of-year seedlings with root sprouts intermixed were abundant at Vitzthum Gulch around the wetted edges of the berm notches.

Figure E-44. Vitzhum Gulch vegetation map, 2008.

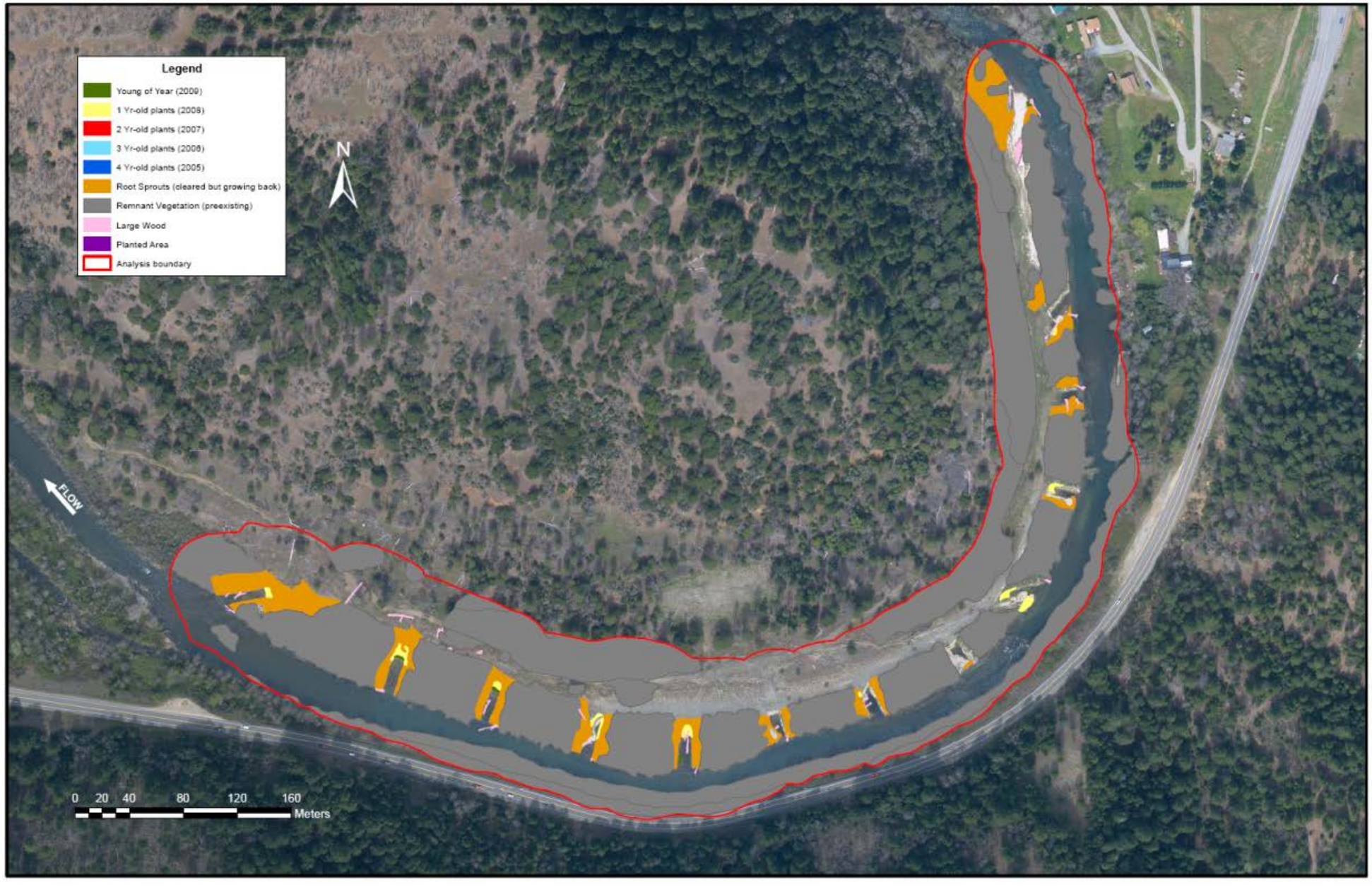


Figure E-45. Vitzhum Gulch vegetation map, 2009.

Bucktail-Dark Gulch

Vegetation Mapping

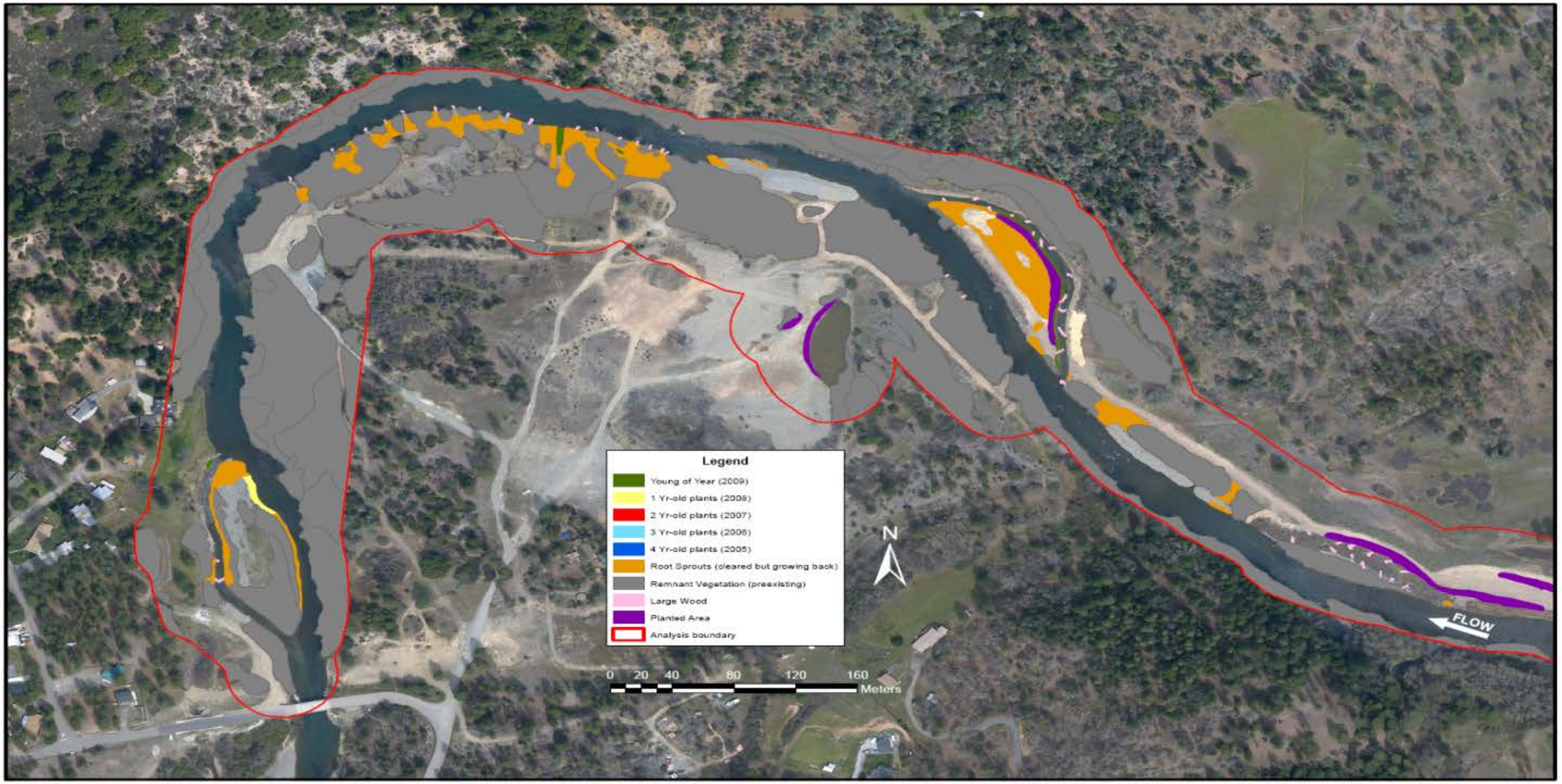


Figure E-46. Bucktail rehabilitation site 2009 map, one year after construction.

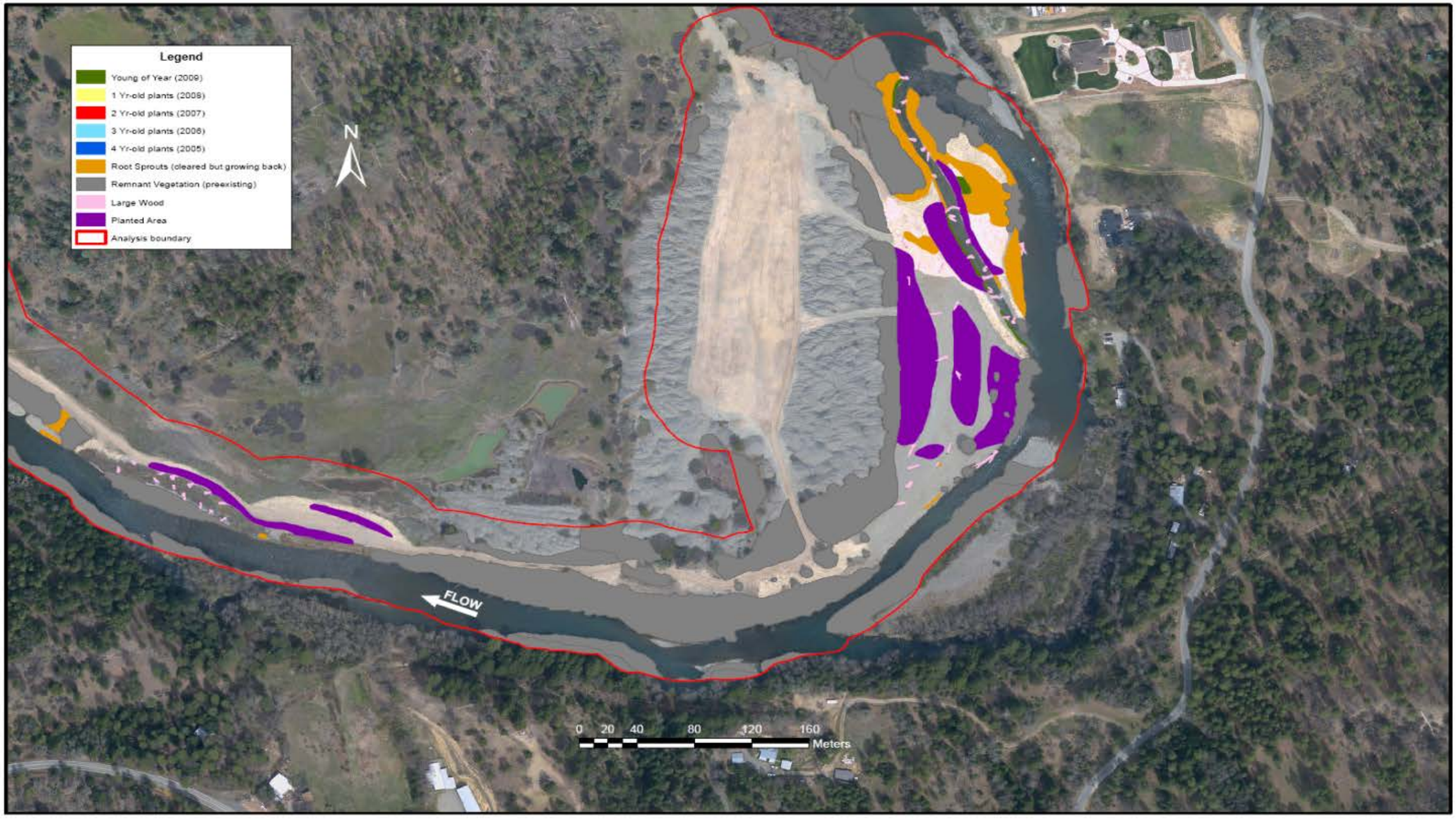


Figure E-47. Dark Gulch rehabilitation site 2009 map, one year after construction.

Band Transect 1779+90 Results

Band transect 1779+90 was the most downstream band transect monitored at the Bucktail-Dark Gulch and was collocated with cross section 1779+90 (Figure A-22, Figure E-48). Band transect 1779+90 was originally located at the Bucktail pilot rehabilitation site (a.k.a. cross section 12+00) and has been included within the overall Bucktail-Dark Gulch channel rehabilitation. The Bucktail site has been monitored since 1994, before the Bucktail-Dark Gulch channel rehabilitation was constructed. Band transect 1779+90 intersects the middle part of a naturally formed bar where additional coarse sediment was placed during rehabilitation (e.g., activity area IC7, Figure A-23). Band transect 1779+90 was monitored in fall 2009, one year after construction as well as in WY2006 prior to construction (Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank was not monitored. The band transect begins below the 13 cms (450 cfs) water surface and extends across the bar with augmented coarse sediment and terminates at the base of a dredger tailing pile.

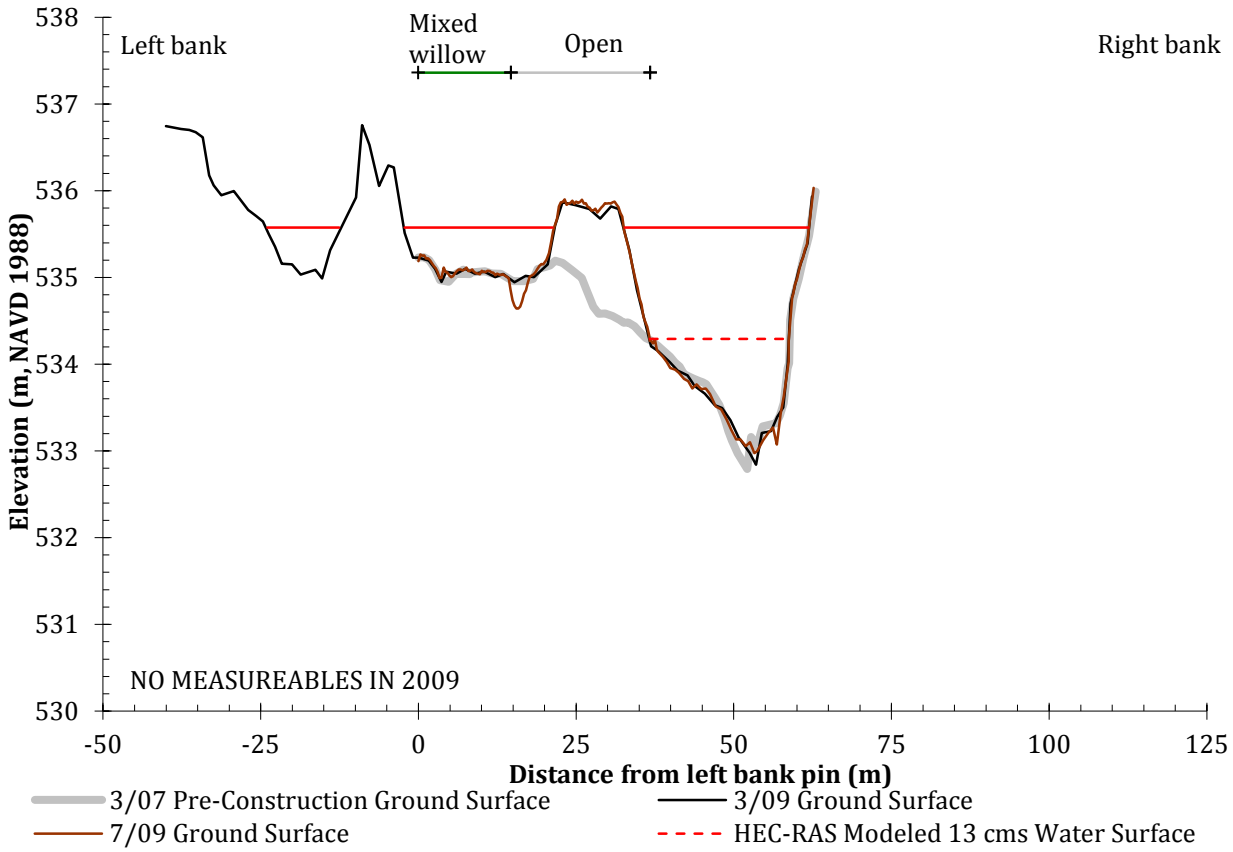


Figure E-48. Cross section 1779+90.

Post-Construction Evaluation

Following rehabilitation, there has been little change in the area along the band transect that was open ground. In fall 2009, the constructed gravel bar substrate was homogenous with mostly clean large gravels and cobbles. The location of mixed willow patches along the band transect also have not changed since before construction. Remnant plants, regrowing willows, or woody plant seedlings were not documented along the band transect (Figure E-49).Channelbed Mobility/Scour Induced Demographic Changes.

Annual maximum peak induced scour was undetectable along the channel margin (Figure E-49) and would have been insufficient to inhibit establishing hardwood seedlings along the 13 cms (450 cfs) water edge. However, the bar where gravel augmentation was conducted in 2008 has remained free of detrimentally encroaching vegetation since it originally deposited in WY1995. There is a low encroachment risk along band transect 1779+90. Currently, there are no woody plant seedlings from the 2009 Cohort growing along the low water edge.Band transect 1785+70 results.

Band transect 1785+70 was collocated with cross section 1785+70 (Figure A-22, Figure E-49). Band transect 1785+70 extends from the left bank, across the riparian berm and main-channel, up the cleared edge and across the constructed floodplain surface and the constructed low-flow side channel to the valley wall (e.g., activity area IC7 and R4, Figure A-23). Band transect 1785+70 was monitored in WY2006 before construction and again in fall 2009 (Table 3-1).The band transect was sampled along the unrehabilitated left bank portion and the rehabilitated right bank of the cross section. The left bank wetland enhancement was not monitored. Post-Construction Evaluation.

Following rehabilitation, there was an increase in open water and a decrease in open ground due to side channel and floodplain construction. The locations of mixed willow, white alder and narrowleaf willow along the band transect have not changed since before construction (Figure E-49). The left bank upland portion of the band transect consists of human disturbance created during construction and a yellow star-thistle grassland. Channel rehabilitation did not disturb the narrow riparian berm on the left bank, which is dominated by senescing, or dead white alders. A remnant patch of white alders occurs on the right bank. The canopy cover of the white alder patch is now quite sparse – few alder trees were left and much of the willow understory was removed during construction (Figure E-49). Himalaya blackberry has become the dominant plant in what was a white alder patch before construction and has likely responded favorably to the removal of the white alder canopy. Narrowleaf willow thickets were cleared during the construction of the right bank floodplain surface; however, many of the roots remained after construction and the thicket is rapidly

regrowing. An open patch along the left bank of the constructed low-flow side channel was revegetated following construction and provides suitable growing conditions for seedlings and willow regrowth (Figure E-49). A patch of revegetated rushes on the right bank of the constructed low-flow side channel transitions to mixed willow at the upland end of the cross section (Figure E-49).

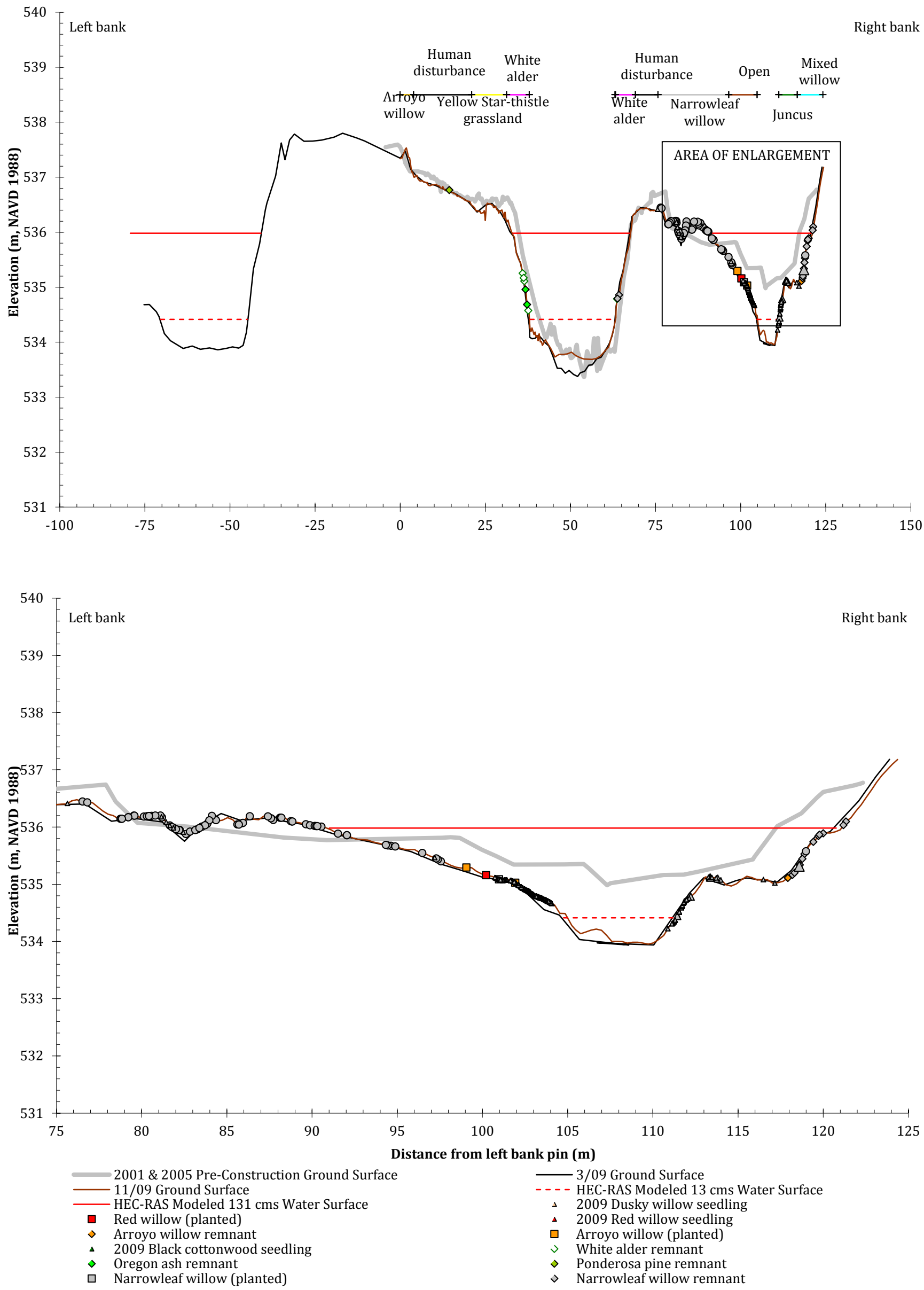


Figure E-49. a) Cross section 1785+70, and b) Enlarged cross section 1785+70.

In fall 2009, 241 young-of-year seedlings, 5 1-year seedlings, and 12 greater than 3-year old woody plants were measured on the band transect. Over 88% of the young-of-year seedlings were narrowleaf and dusky willow. However, 13 red willows and one black cottonwood were also documented between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces. Over 91% of naturally regenerating hardwoods sampled in fall 2009 (including young-of-year and 1-year old seedlings) occurred between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces. One narrowleaf willow seedling was documented on the constructed floodplain surface, above 170 cms (6,000 cfs). Four revegetated woody plants were measured along the band transect on the constructed floodplain. In 2009, no willow regrowth was documented below 57 cms (2,000 cfs), with the majority of willow regrowth occurring between the 57 and 170 cms (2,000 and 6,000 cfs) HEC water surfaces (Figure E-49). Channelbed Mobility/Scour Induced Demographic Changes.

Geomorphic experiments were not conducted at this cross section. However, in WY 2009, no detectable topographic changes occurred as a result of initiating and establishing vegetation. The descending limb of spring TRFE releases caused fine sediments to deposit in the side channel. Subsequently, seedlings germinated on the freshly deposited fine sediments. The deposition on the left bank of the side channel was more likely a result of side channel slope and entrance conditions rather than establishing vegetation. Thus the side channel created topographic changes, which in turn caused seedling initiation, rather than initiation causing topographic changes. Seedling results along the side channel suggest that regeneration on freshly deposited fine sediments in side channels may be a viable way to promote natural seedling regeneration in locations farther away from and higher in elevation than the mainstem channel margin.Red-Yellow-Green Analysis.

One year after construction, only mature woody vegetation was documented along the mainstem channel low water edge. Currently, there are not woody plant seedlings from the 2009 Cohort growing along the mainstem low water edge. In the side channel along the 13 cms (450 cfs) water edge, numerous seedlings regenerated in 2009 (Figure E-50). Revegetation, seedling recruitment, and extensive willow regrowth along the left bank of the side channel are likely to create a heavily vegetated side channel bank within the next five to ten years. While dense vegetation will provide shade and habitat structure for many aquatic and terrestrial animals, it may significantly reduce conveyance in the side channel and cause it to close off (not detrimental encroachment per se, but perhaps a detrimental effect of establishing vegetation). To maintain side channel conveyance, it may be desirable to release streamflows that induce scour and clean out fine sediments that have accumulated in the side channel. There is moderate risk that establishing vegetation could induce enough

deposition in the side channel to cut off flow from the mainstem into the side channel.

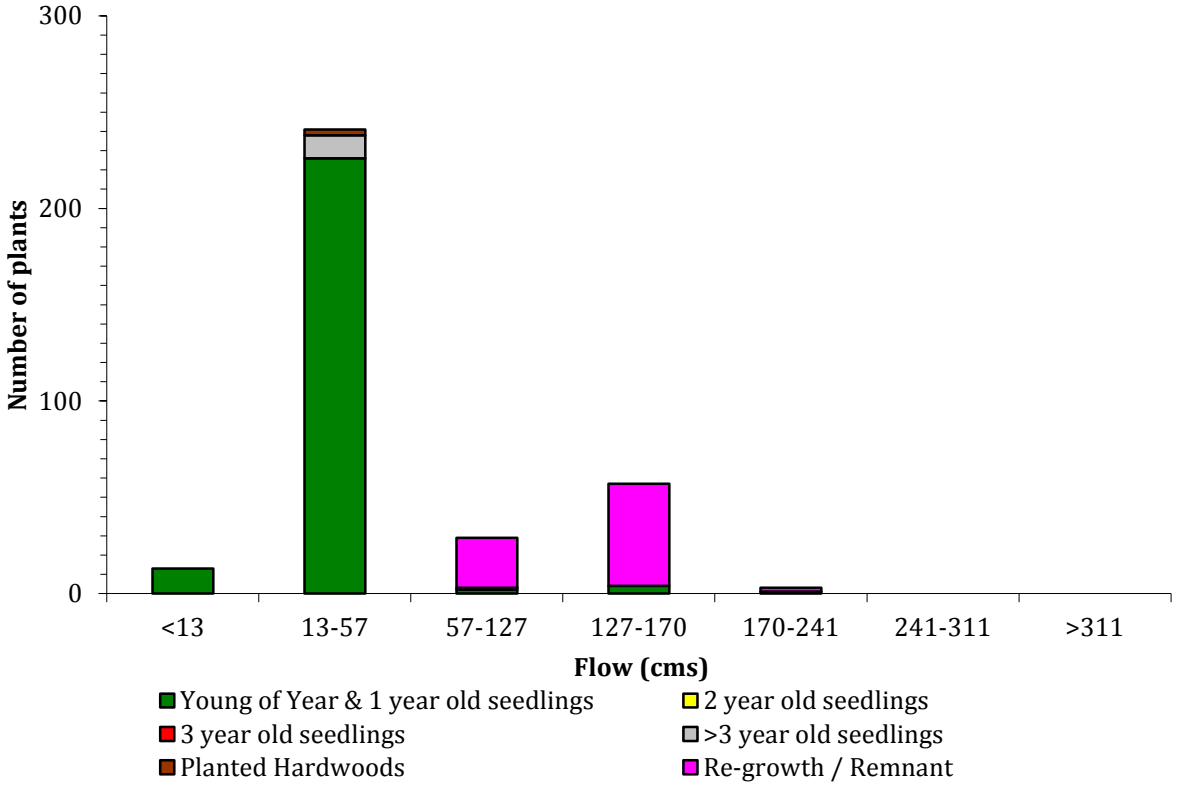


Figure E-50. Red - Yellow - Green analysis cross section 1785+70.

Band Transect 1821+30 Results

Band transect 1821+30 was the most upstream band transect monitored at the Bucktail-Dark Gulch rehabilitation site and was collocated with cross section 1821+30 (Figure A-21). Band transect 1821+30 begins below the right bank 13 cms (450 cfs) water surface, goes up a point bar apex, crosses the constructed 170 cms (6,000 cfs) floodplain and terminates at the toe of excavated dredger tailings (e.g., activity area R1, Figure A-23). Band transect 1821+30 was monitored along the rehabilitated right bank in WY 2009, one year after construction, but not prior to construction (Table 3-1). The band transect was not sampled along the unrehabilitated left bank. Post-Construction Evaluation.

Following rehabilitation, there was an increase in open area due to floodplain construction. The locations of white alder along the band transect presumably have not changed since before construction (Figure E-51). Along the mainstem, a remnant white alder patch was avoided during side channel construction. The remnant white alder patch was primarily composed of senescent white alders and is likely to convert to mixed willow in the future. In addition, canopy cover of the white alder patch is now quite sparse – most of the remnant white alder were senescent and unhealthy (Figure E-51). A majority of the band transect

extends across the constructed floodplain surface, which was mostly open ground (Figure E-51). Some remnant woody plants and willow regrowth (especially dusky and narrowleaf willow) were measured along the band transect. Remnant woody plants and willow regrowth generally occurred approximately 18 m (60 ft) behind the riparian berm and had vigorous growth.

Seedlings were not documented (Figure E-51). Forty willows and black cottonwoods planted during revegetation were documented along the band transect. Willow regrowth was not documented between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces. Willow regrowth was documented above the 57 cms (2,000 cfs) HEC water surface on the constructed floodplain.Channelbed Mobility/Scour Induced Demographic Changes.

Geomorphic experiments were not conducted at this cross section and no previous topographic surveys exist to conduct a comparison between years. However, from the survey that was conducted in WY 2009, there was no detectable topographic change as a result of initiating and establishing vegetation (Figure E-51). In the future, topographic changes are expected to occur in the area where willow regrowth and remnant willow shrubs occur (i.e., approximately 18 m [60 ft] behind the remnant riparian vegetation along the mainstem channel). Remnant plants are already large shrubs and may influence fine sediment deposition during floodplain inundation at 170 cms (6,000 cfs). Red-Yellow-Green Analysis.

Currently, there are not riparian hardwood seedlings growing along the band transect. (Figure E-52). Revegetation, remnant vegetation and willow regrowth are likely to cover the constructed floodplain surface above the 57 cms (2,000 cfs) HEC water surface over the next ten years. There is no risk that establishing vegetation could induce enough deposition to cause detrimental vegetation encroachment.

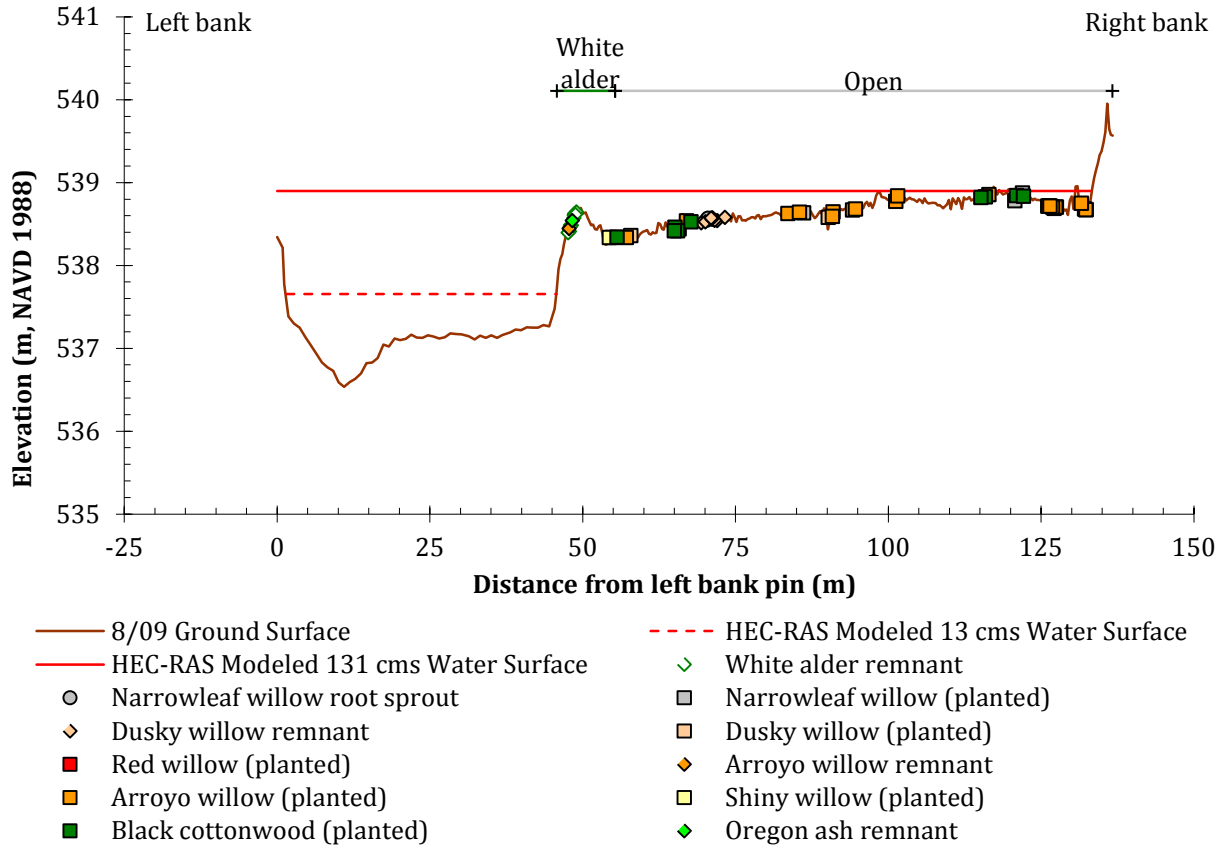


Figure E-51. Cross section 1821+30.

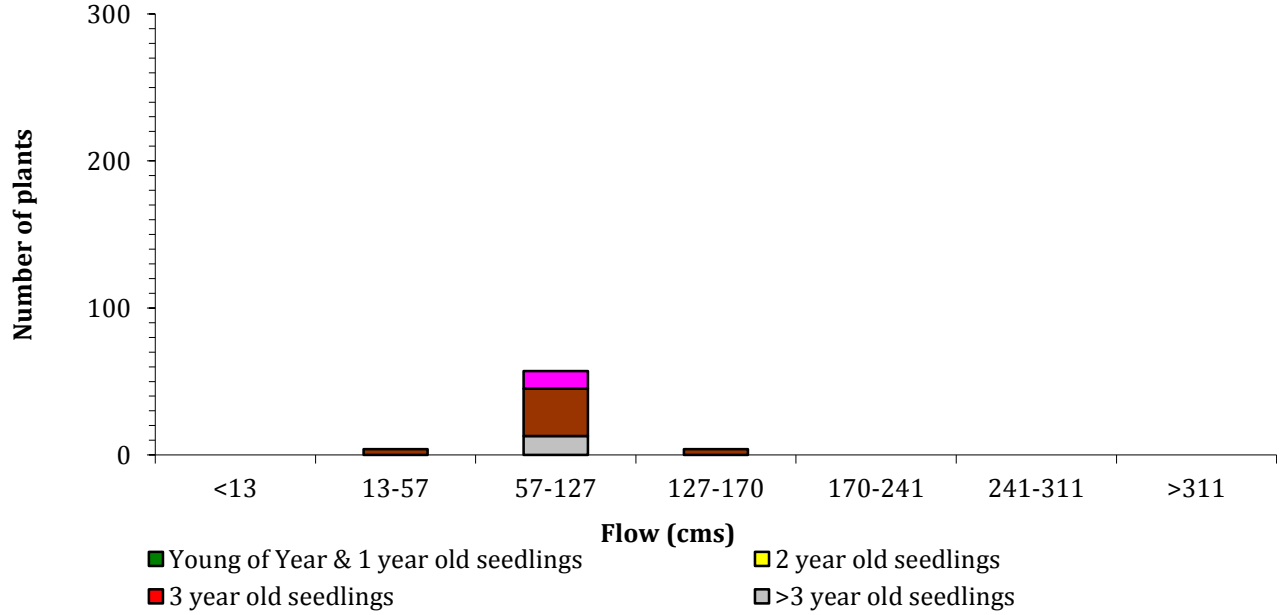


Figure E-52. Red - Yellow - Green analysis cross section 1821+30.

Hoadley Gulch

Vegetation Mapping

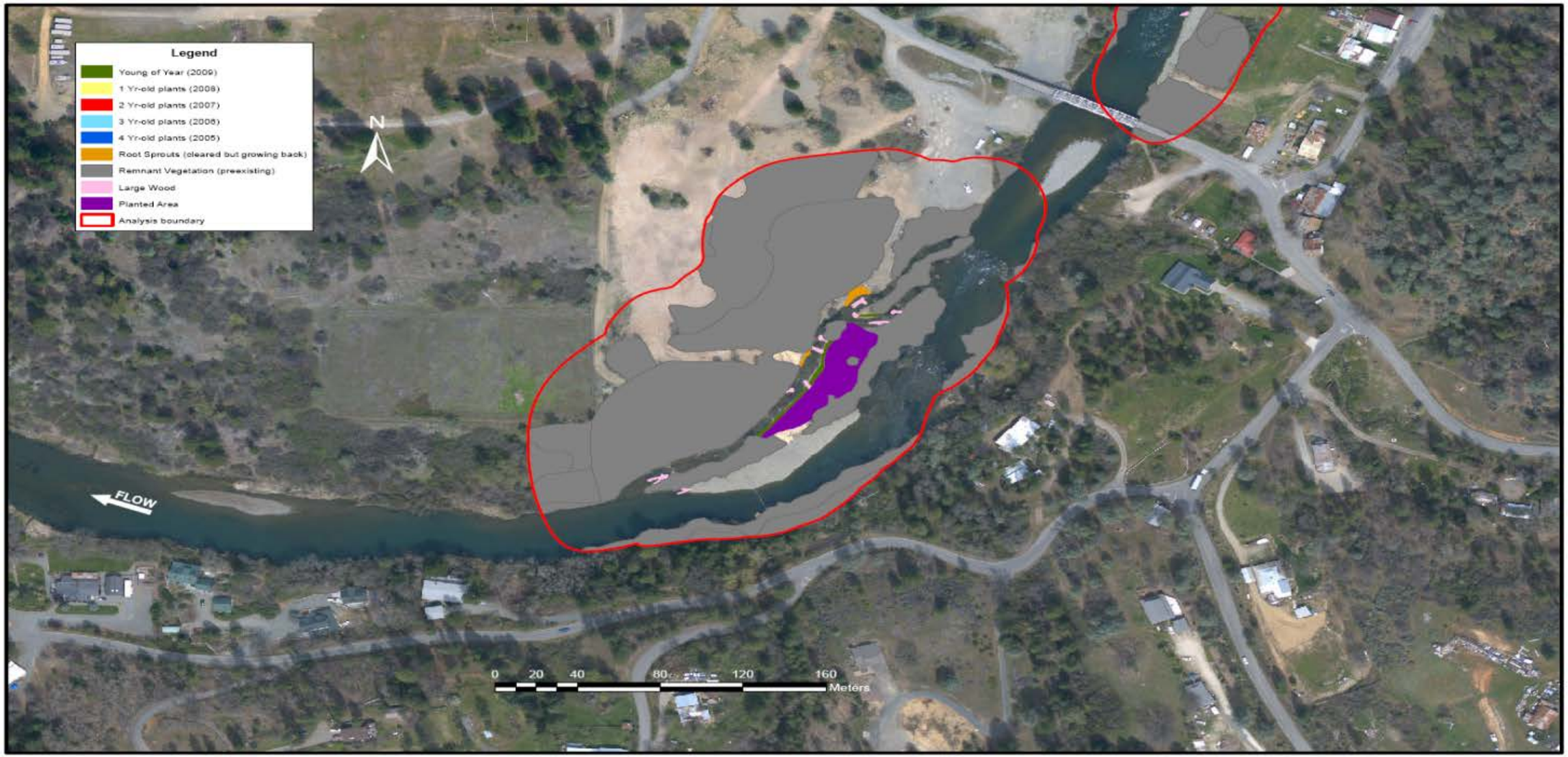


Figure E-53. Hoadley Gulch 2009 rehabilitation site map, one year after construction.

Lewiston Cableway

Vegetation Mapping

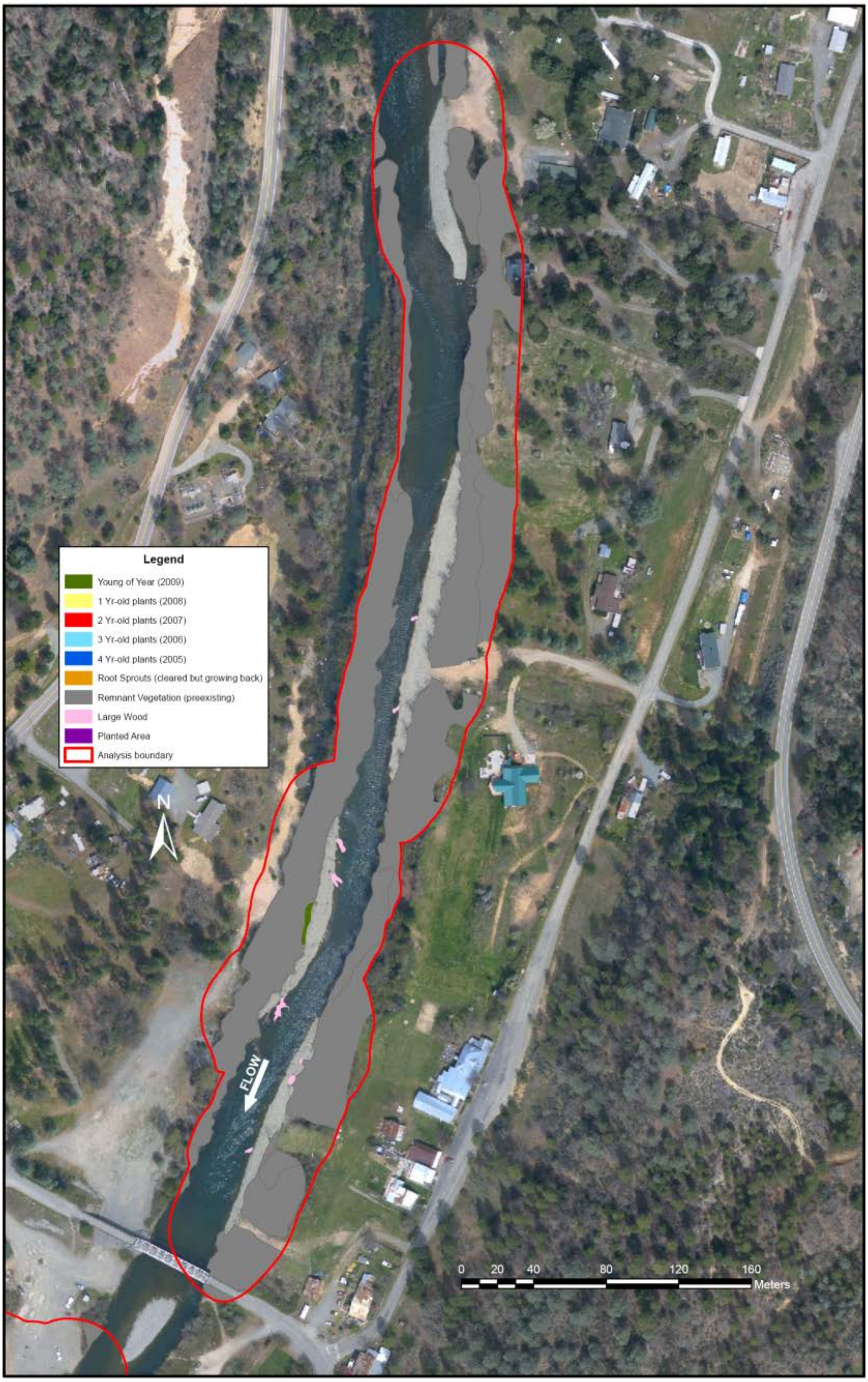


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Figure E-54. Lower Lewiston Cableway rehabilitation site 2009 map, one year after construction.

Band Transect 2012+10 Results

Band transect 2012+10 was the most downstream band transect monitored at the Lewiston Cableway and was collocated with cross section 2012+10 (Figure A-26). Band transect 2012+10 intersects the downstream end of a constructed point bar in the middle portion of the rehabilitation site (e.g., activity area IC8, Figure A-25). Band transect 2012+10 was monitored in fall 2009, one year after construction, but was not monitored prior to construction (Table 3-4, Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank and side channel were not monitored. The band transect begins below the 13 cms (450 cfs) HEC water surface and extends across the constructed bar and terminates on a terrace. Band transect 2012+10 occurs in a location where vehicle and foot traffic are high, which could influence the changes in seedling density. Therefore human disturbance cannot be discounted when identifying the mechanisms responsible for seedling mortality along band transect 2012+10.

Post-Construction Evaluation.

Following rehabilitation, there was an increase in open ground and a decrease in open water due to gravel bar construction. In fall 2009, the constructed gravel bar substrate was homogenous with mostly clean large gravels and cobbles. Since construction, a portion of the constructed bar has been scoured away (Figure E-55). The locations of mixed willow and yellow star-thistle grasslands along the band transect presumably have not changed since before construction. Currently, the yellow star- thistle grassland patches occur on terrace surfaces that were undisturbed by construction.

Seedlings were not documented. One remnant arroyo willow older than three years is growing between the 57 and 127 cms (2,000 and 4,500 cfs) HEC water surfaces and poses no immediate threat to cause detrimental riparian encroachment (Figure E-55). Willow regrowth was not documented between the 13 and 57 cms (450 and 2,000 cfs) HEC water surfaces.Channelbed Mobility/Scour Induced Demographic Changes.

The maximum streamflow at Lewiston Cableway in WY 2009 was 131 cms (4,630 cfs) on May 1, 2009. The annual maximum peak scoured the channel margin to a depth of 24 cm (0.79 ft) (Figure E-55). Channelbed mobility results show that only 45% of the D84 size class (i.e., 85 mm) was mobilized along the channel margin (see Hoadley Gulch Bed Mobility Results). The 24 cm (0.79 ft) scour depth measured along the band transect was more than twice the depth of the D_{84} and would have been sufficient to inhibit establishing hardwood seedlings less than two years old.

Seedling-caused detrimental riparian encroachment along the low water edge has been inhibited. There is a low encroachment risk along band transect 2012+10. Currently, there are not woody plant seedlings from the 2009 Cohort growing along the low water edge.

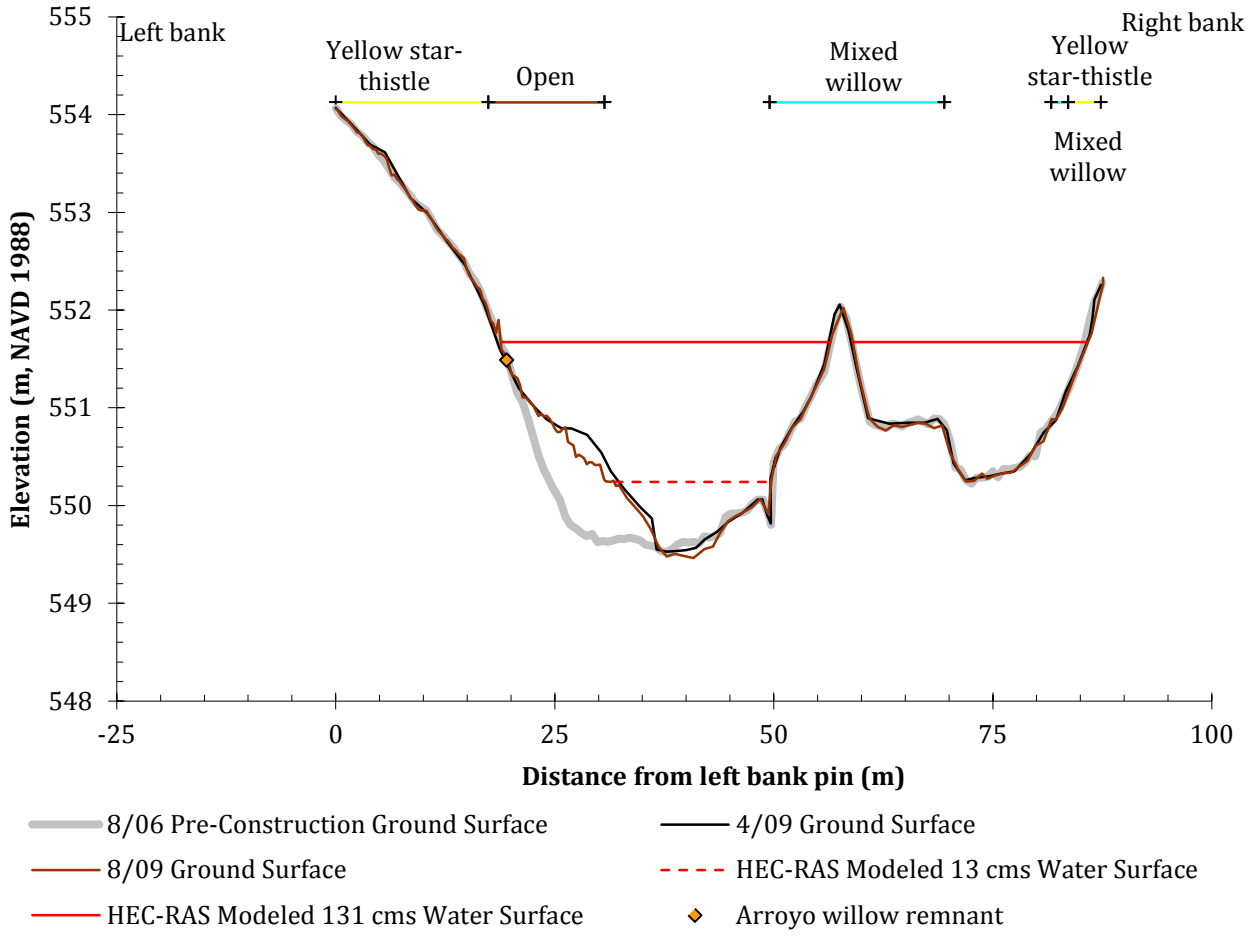


Figure E-55. Cross section 2012+10.

Band Transect 2013+94 Results

Band transect 2013+94 was the most upstream band transect monitored at the Lewiston Cableway and was collocated with cross section 2013+94 (Figure A-26). Band transect 2013+94 intersects the upstream end of a constructed point bar in the middle portion of the rehabilitation site (e.g., activity area IC8, Figure A-25). Band transect 2013+94 was monitored in fall 2009, one year after construction, but was not monitored prior to construction (Table 3-4, Table 3-1). The band transect was sampled along the rehabilitated left bank portion of the cross section. The unrehabilitated right bank and side channel were not monitored. The band transect begins below the 13 cms (450 cfs) water surface, extends across the constructed bar, and terminates on a terrace. Band transect 2013+94 occurs in a

location where vehicle and foot traffic are high, which could influence the changes in seedling density. Therefore, human disturbance cannot be discounted when identifying the mechanisms responsible for seedling mortality along band transect 2013+94.

Post-Construction Evaluation

Following rehabilitation, there was an increase in open ground and a decrease in open water due to gravel bar construction. In fall 2009, the constructed gravel bar substrate was homogenous with mostly clean large gravels and cobbles. Since construction, the upstream portion of the constructed bar has not changed much (Figure E-56). The locations of mixed willow along the band transect presumably have not changed since before construction. Remnant plants, regrowing willows, or woody plant seedlings were not documented along the band transect (Figure E-56). Channelbed Mobility/Scour Induced Demographic Changes.

Channelbed mobility results show that only 25% of the D_{84} size class (i.e., 85 mm) was mobilized along the channel margin (see Hoadley Gulch Bed Mobility Results). The 4 cm (0.13 ft) scour depth measured along the band transect was less than the depth of one D_{84} and would have been insufficient to inhibit establishing hardwood seedlings greater than one year old (Figure E-56). Seedling-caused detrimental riparian encroachment along the low water edge has been inhibited. There is a low encroachment risk along band transect 2013+94. Currently, there are not woody plant seedlings from the 2009 Cohort growing along the low water edge.

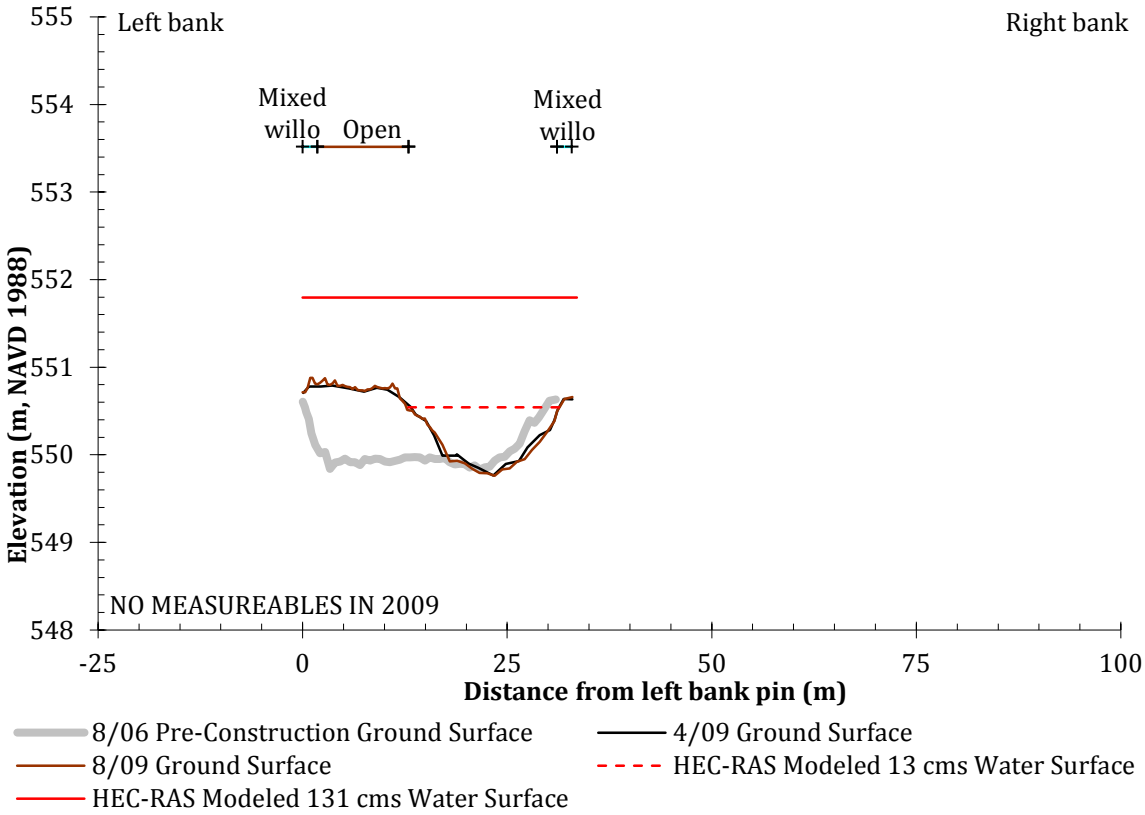


Figure E-56. Cross section 2013+94.

Deadwood Creek

Vegetation Mapping

Figure E-57. Deadwood Creek 2009 rehabilitation site map, one year after construction.

Sven Olbertson

Vegetation Mapping

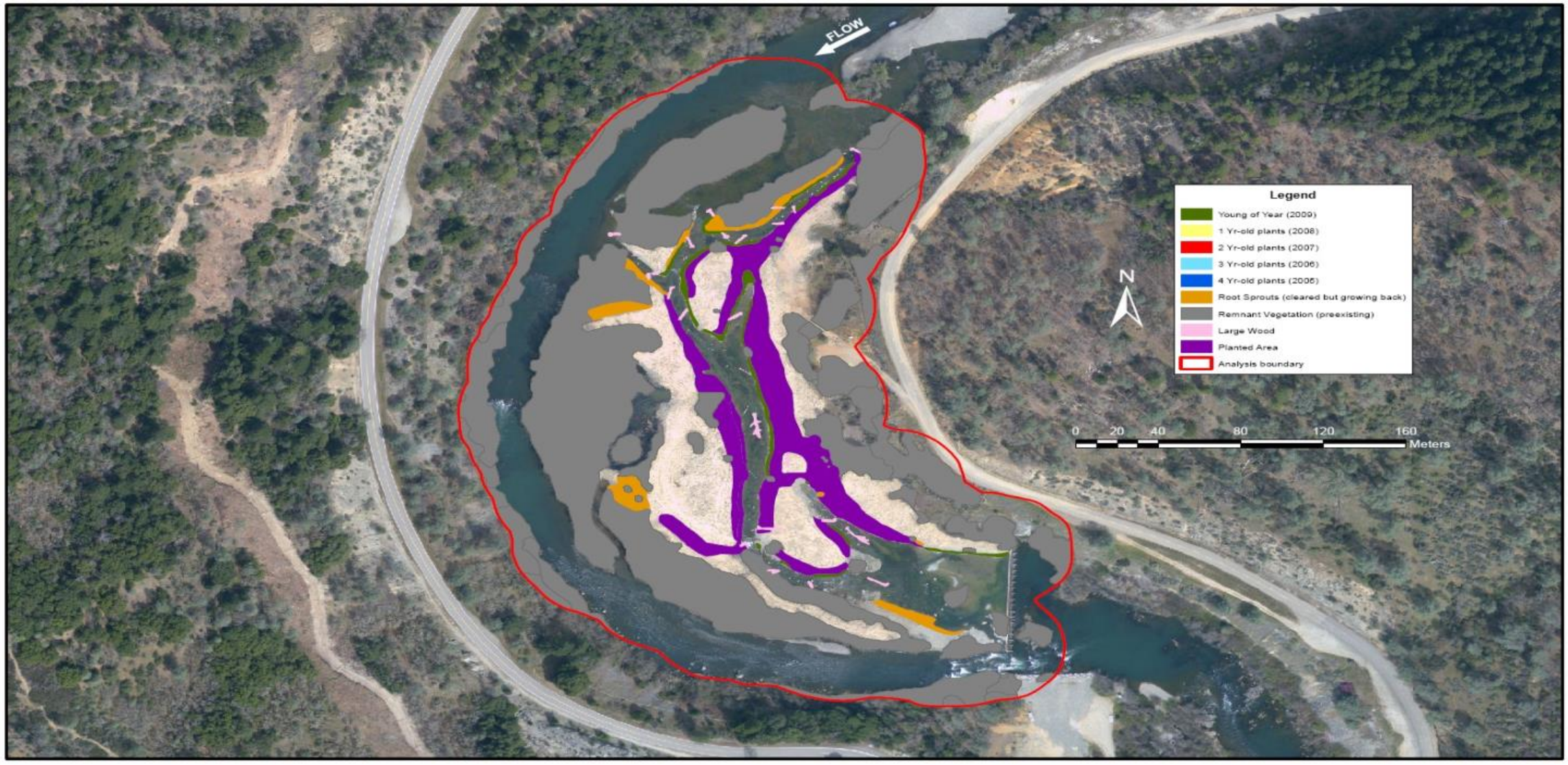


Figure E-58. Sven Olbertson rehabilitation site 2009 map, one year after construction. Band Transect 2064+40 Results

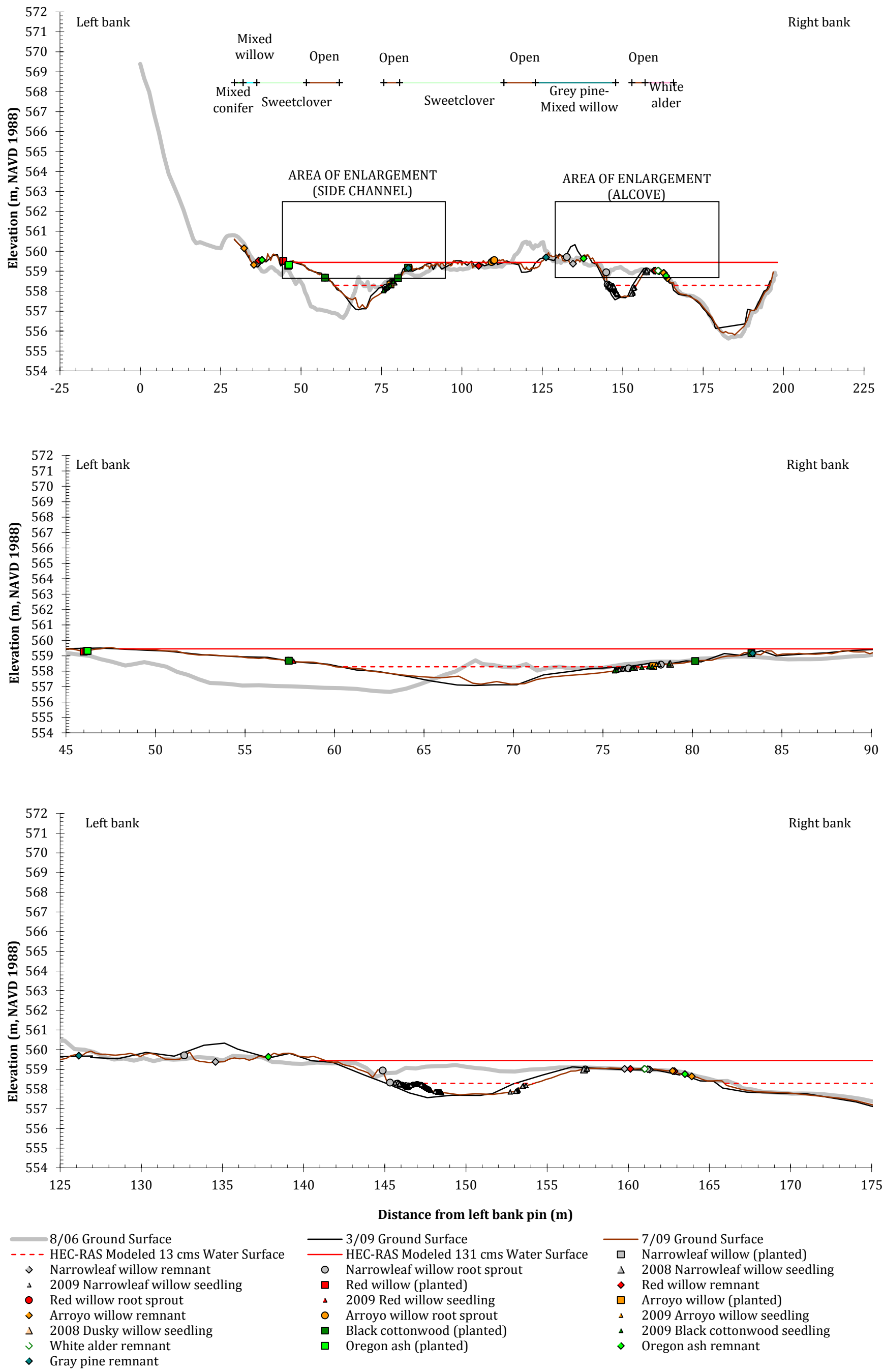


Figure E-59. a) Cross section 2064+40, b) Enlarged cross section side channel 2064+40, and c) Enlarged cross section alcove 2064+40.

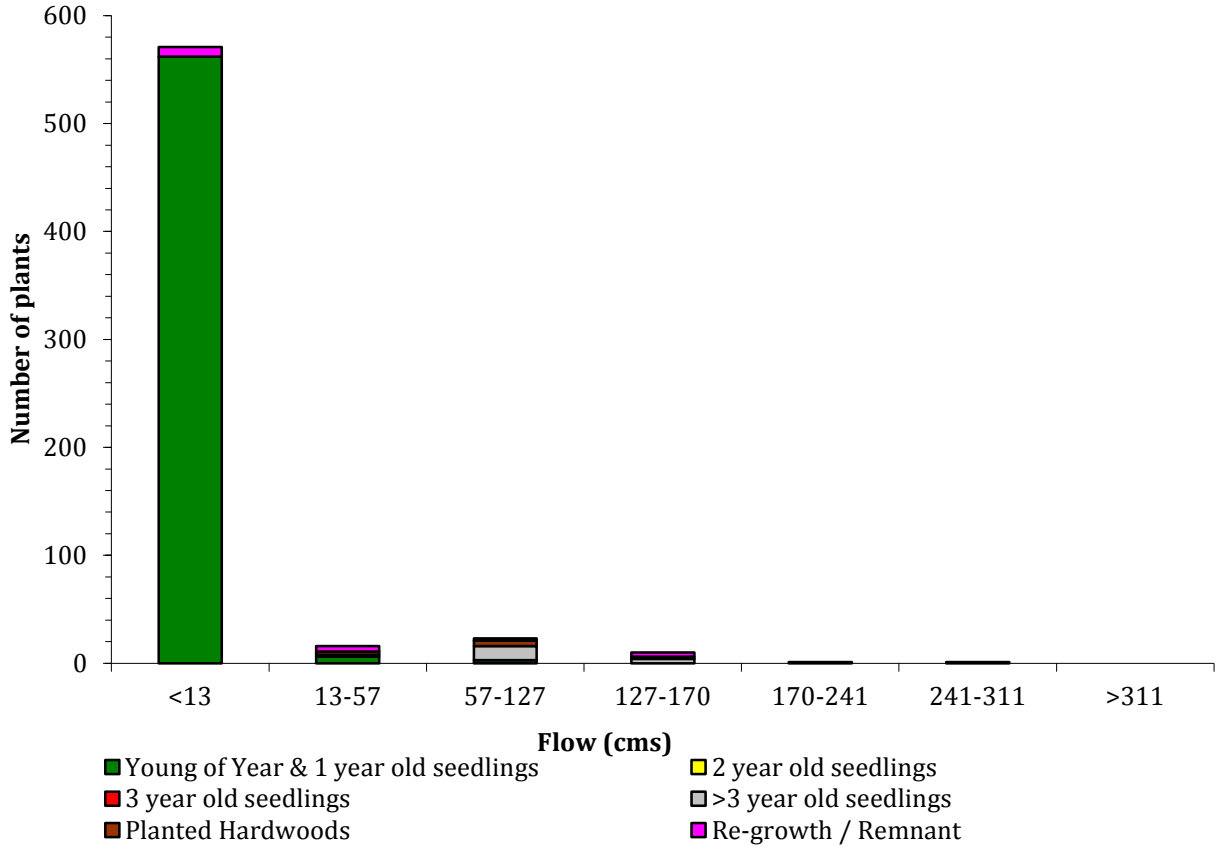


Figure E-60. Red - Yellow - Green analysis cross section 2064+40.

Band transect 2064+40 was the downstream transect monitored at the Sven Olbertson side channel site and was collocated with cross section 2064+40 (Figure A-28). Band transect 2064+40 extends from the toe of the valley wall on the left bank, across the constructed alcove, side channel and floodplain surface (e.g., activity area R1, Figure A-25) and continues past the construction area into the remnant black cottonwood stand along the left bank of the mainstem channel. The band transect was not sampled along the unrehabilitated right bank. Post-Construction Evaluation.

Along band transect 2064+40, there has been an increase in open water and in open ground due to side channel and floodplain construction following construction. The area of mixed willow and white alder has decreased compared to pre-construction conditions. An arroyo willow patch that occurred along the band transect in WY2006 was removed during construction. Post-construction, the area of sweetclover has increased in disturbed areas along the band transect. The black cottonwood patch was undisturbed during rehabilitation and presumably covers the same area along the band transect as it did prior to construction.

In fall 2009, 568 young-of-year seedlings, three 1-year seedlings, and 20 > 3-year old

woody plants were measured on the band transect. No seedlings or regrowth were documented along the mainstem. Over 99% of the young-of-year seedlings were narrowleaf willow. However, one red willow, one arroyo willow and three black cottonwoods were also documented between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Over 99% of naturally regenerating hardwoods sampled in fall 2009 (including young-of-year and 1-year old seedlings) occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Three narrowleaf willow seedling were documented above the 57 cms (2,000 cfs) HEC water surface. Ten revegetated woody plants were measured along the band transect. In 2009, a total of 14 root sprouts were measured below the 57 cms (2,000 cfs) HEC water surface. The overall number of root sprouts is low and the regrowth along the side channel's 13 cms (450 cfs) water edge does not appear to be inducing deposition or any morphological change.

Band Transect 2069+80 Results

Band transect 2069+80 was the most upstream band transect monitored at the Sven Olbertson site and was collocated with cross section 2069+80 (Figure A-28). Band transect 2069+80 extends from the toe of the valley wall on the left bank, across the constructed side channels and floodplain surface (e.g., activity area R1, Figure A-25 and continues past the construction area into the remnant black cottonwood stand along the left bank of the mainstem channel. The band transect was not sampled along the unrehabilitated right bank portion. Post-Construction Changes in Cover Type Boundaries.

Along band transect 2069+80, there has been an increase in open water and in open ground due to side channel and floodplain construction following rehabilitation (Figure E-61). The area of mixed willow has decreased compared to pre-construction conditions. The yellow star-thistle and wild rye grasslands and white alder that occurred along the band transect in WY2006 were removed during construction. Following construction, the area of sweetclover has increased in disturbed areas along the band transect. The black cottonwood patch was undisturbed during rehabilitation and covers the same area along the band transect.

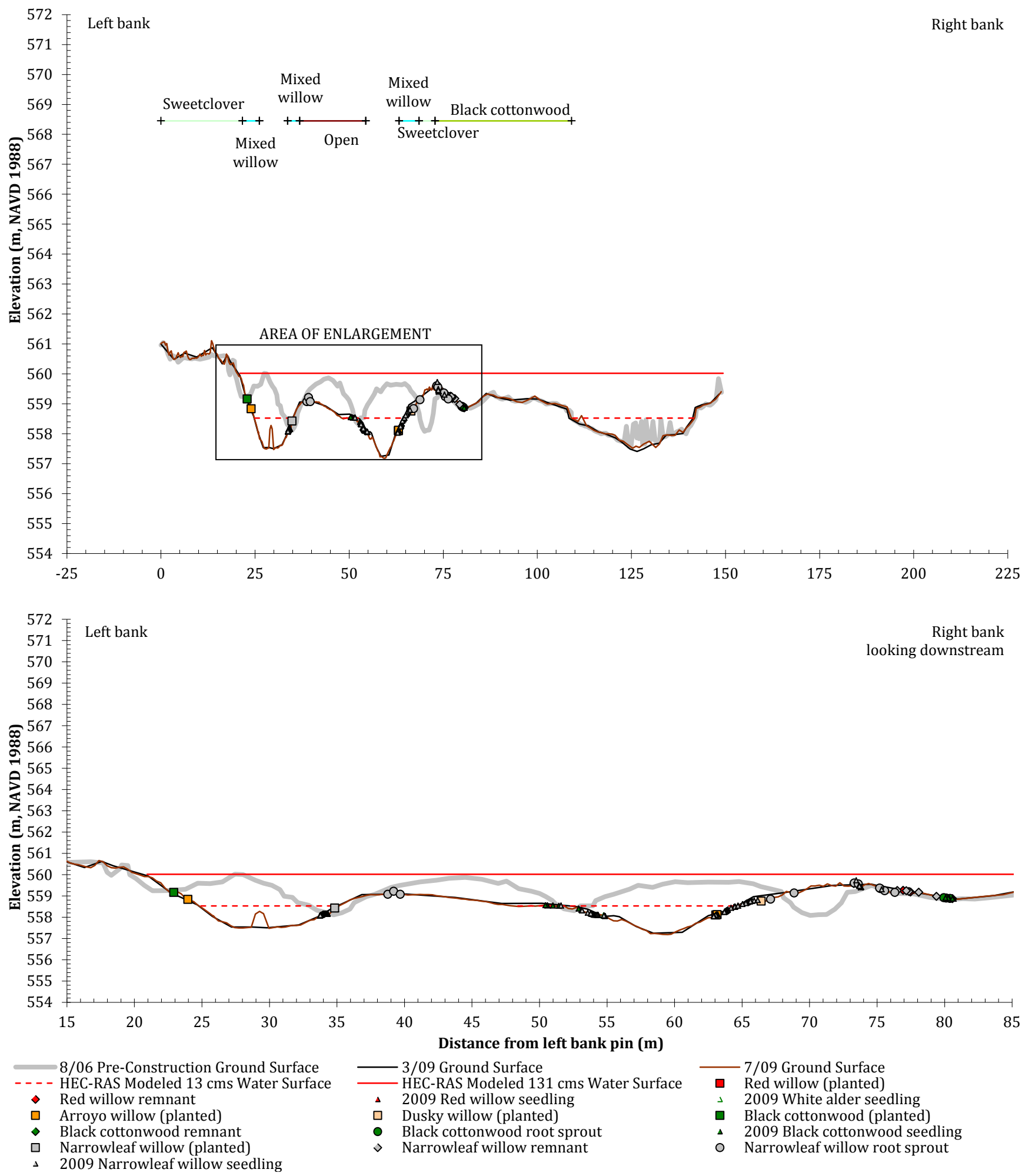


Figure E-61. a) Cross section 2069+80, and b) Enlarged cross section 2069+80.

Post-Construction Initiation and Establishment Trends

In fall 2009, one year after construction, 219 young-of-year seedlings and three >3-year old woody plants were measured on the band transect. Seedlings or regrowth were not observed along the mainstem (Figure E-61). Over 83% of the young-of-year seedlings were narrowleaf willow. However, two red willow, one white alder and 34 black cottonwood seedlings were also documented between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Over 97% of naturally regenerating hardwoods sampled in fall 2009 occurred between the 13 to 57 cms (450 to 2,000 cfs) HEC water surfaces. Six narrowleaf willow seedlings were documented above the 57 cms (2,000 cfs) HEC water surface. Five revegetated woody plants were measured along the band transect. In 2009, a total of 14 root sprouts were measured below the 57 cms (2,000 cfs) HEC water surface. The overall number of root sprouts is low and the regrowth along the side channel's 13 cms (450 cfs) water edge does not appear to be inducing deposition or any morphological change.Channelbed Mobility/Scour Induced Demographic Changes.

For both band transects, geomorphic experiments were not conducted at this band transect, and riparian monitoring occurred one year following construction. The only topographic changes in WY 2009 were limited to small areas of scour along the side channel and alcove margins. Channelbed scour occurred before seedlings could begin growing and did not affect seedling demographics along this band transect (Figure E-61).Red-Yellow-Green Analysis.

One year after construction, only mature woody vegetation was documented along the mainstem channel low water edge. Currently, there are no woody plant seedlings from the 2009 Cohort growing along the mainstem low water edge. In the side channel along the 13 cms (450 cfs) water edge, hundreds of seedlings regenerated in 2009 (Figure E-62). Revegetation, seedling recruitment, and willow regrowth along the side channels and alcoves are likely to create heavily vegetated side channel banks within the next 10 years. While dense vegetation will provide shade and habitat structure for many aquatic and terrestrial animals, it may reduce conveyance in the side channel and cause fine sediment deposition. However, because the fine sediment supply is very limited this close to Lewiston Dam, there is little risk that establishing vegetation could induce enough deposition in the side channel to cut off flow from the mainstem.

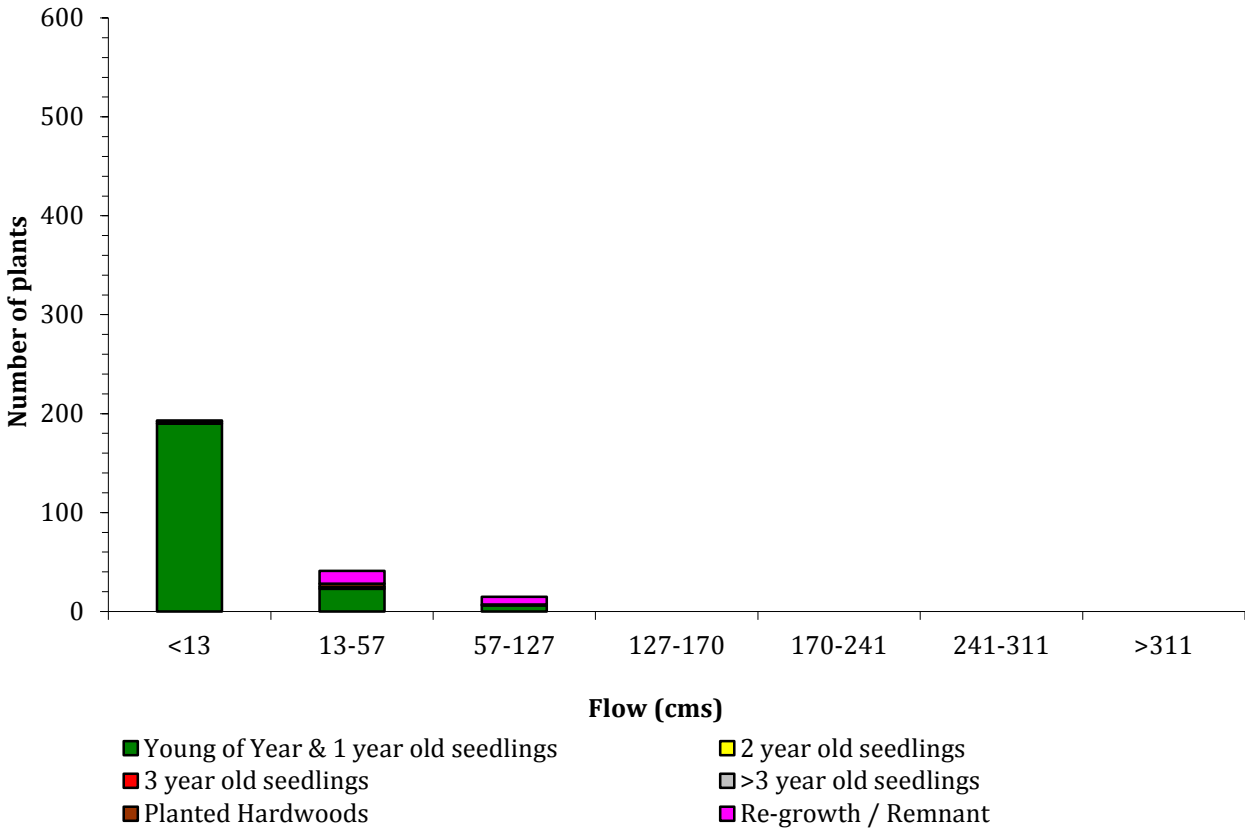
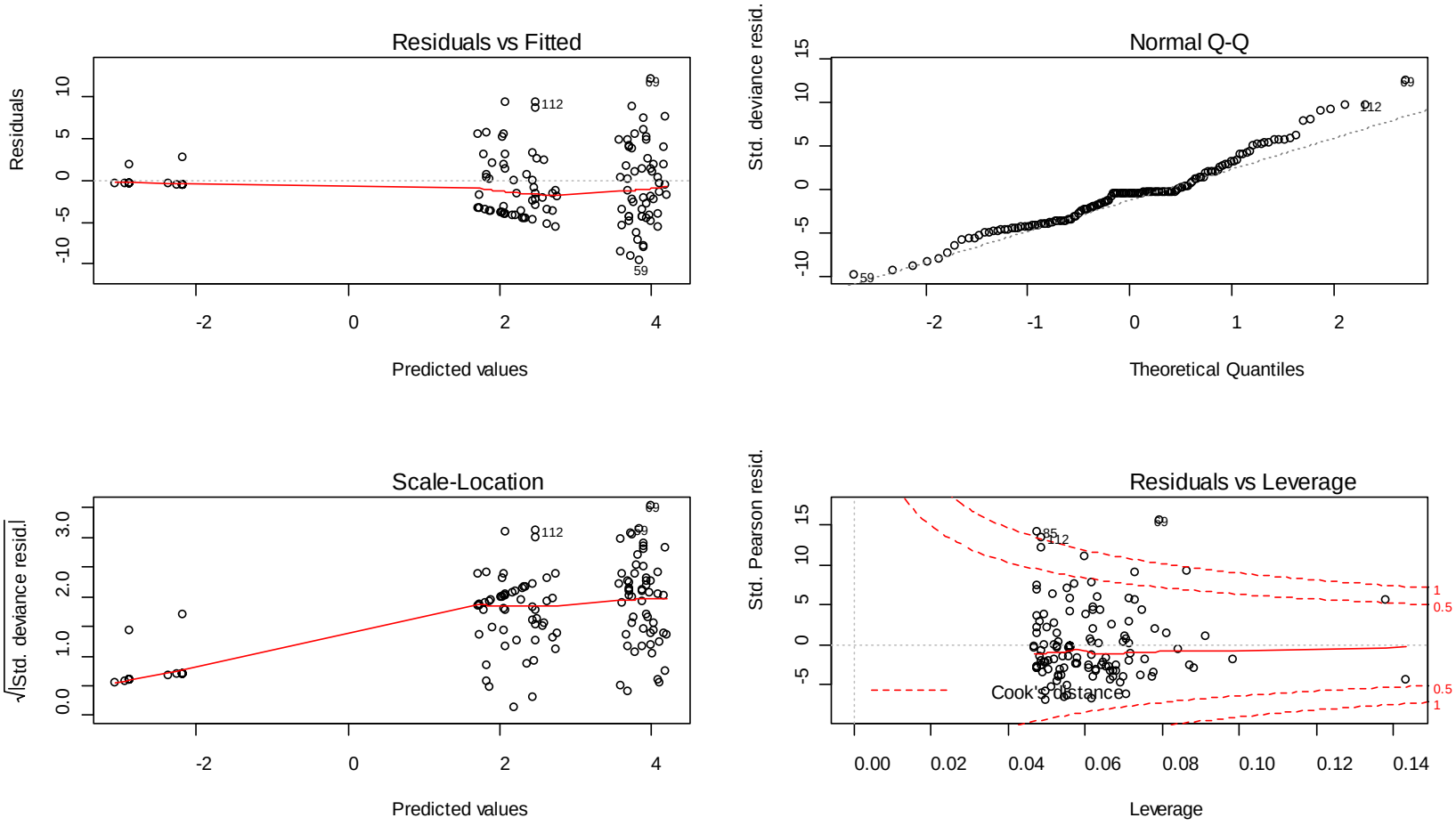


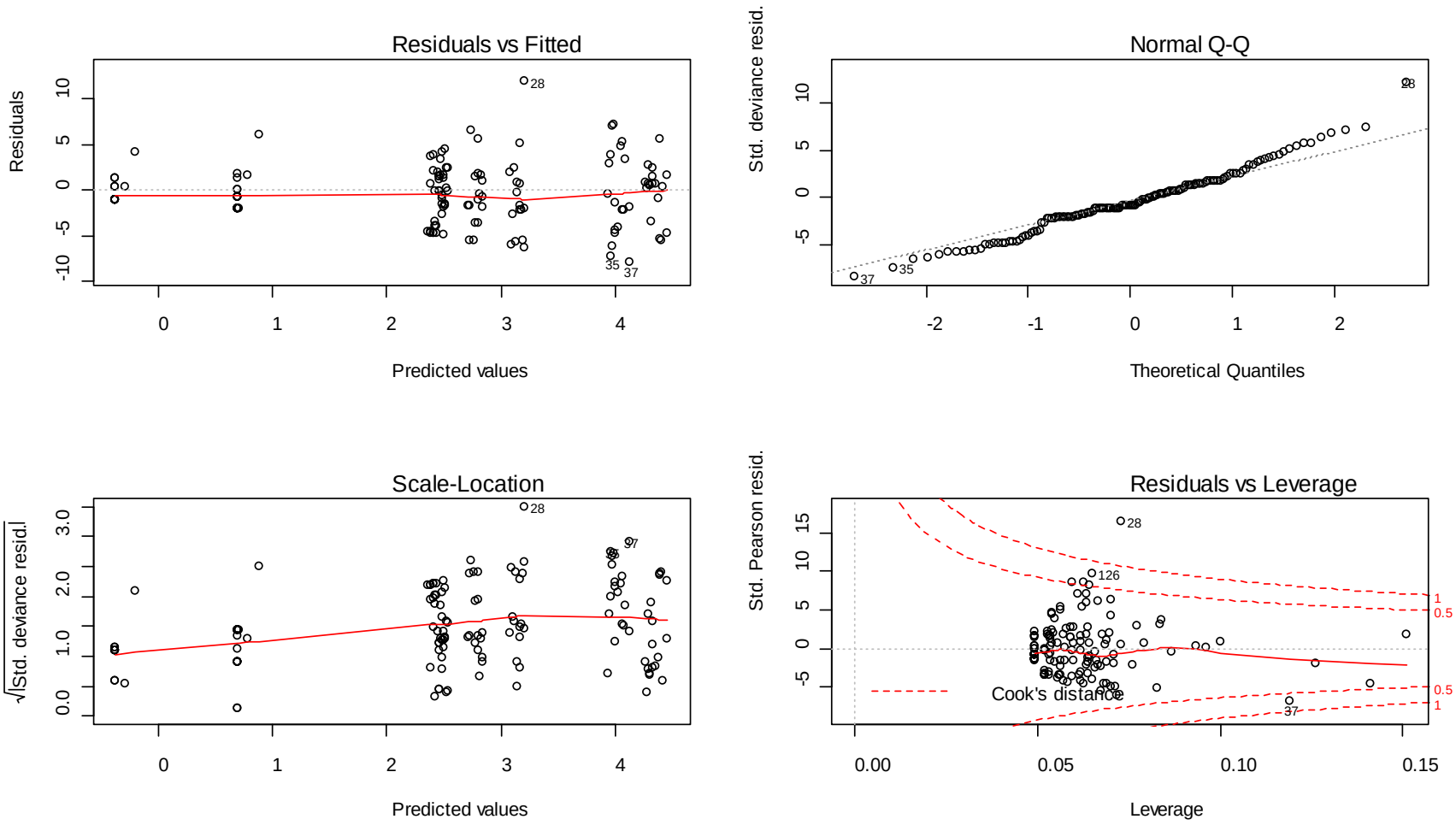
Figure E-62. Red-yellow-green analysis cross section 2069+80.

APPENDIX F. REARING HABITAT EVALUATION

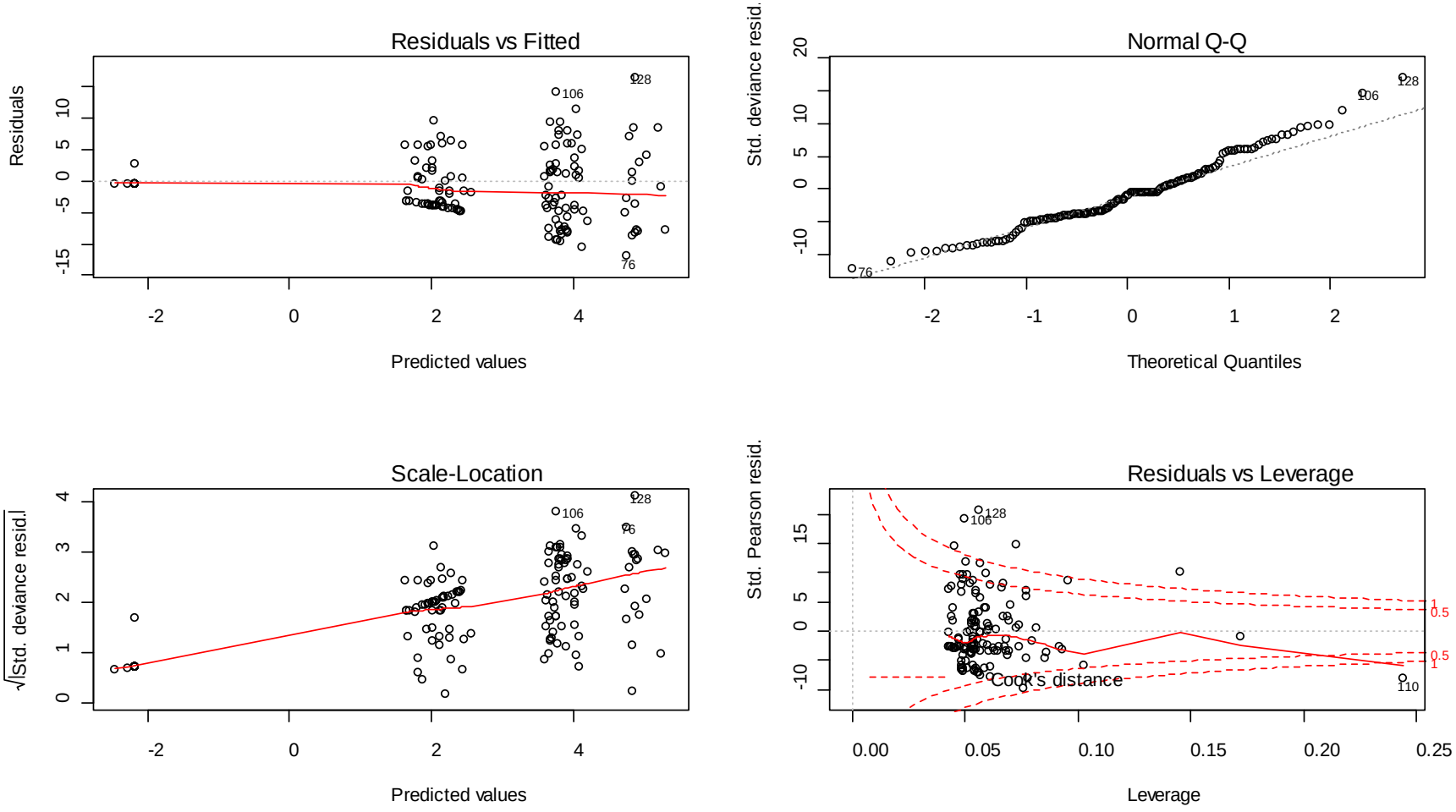
Appendix F-1. Diagnostic plots of the GzLM from the 2009 validation study at Lowden Meadows evaluating diel and habitat category effects on predictions of Chinook Salmon fry. Plots include residuals versus predicted values (residual versus fitted), standardized deviance residuals versus theoretical quantiles (normal Q-Q), square root of standardized deviance residuals versus predicted values (scale-location) and standardized Pearson residuals versus leverage (residuals versus leverage).



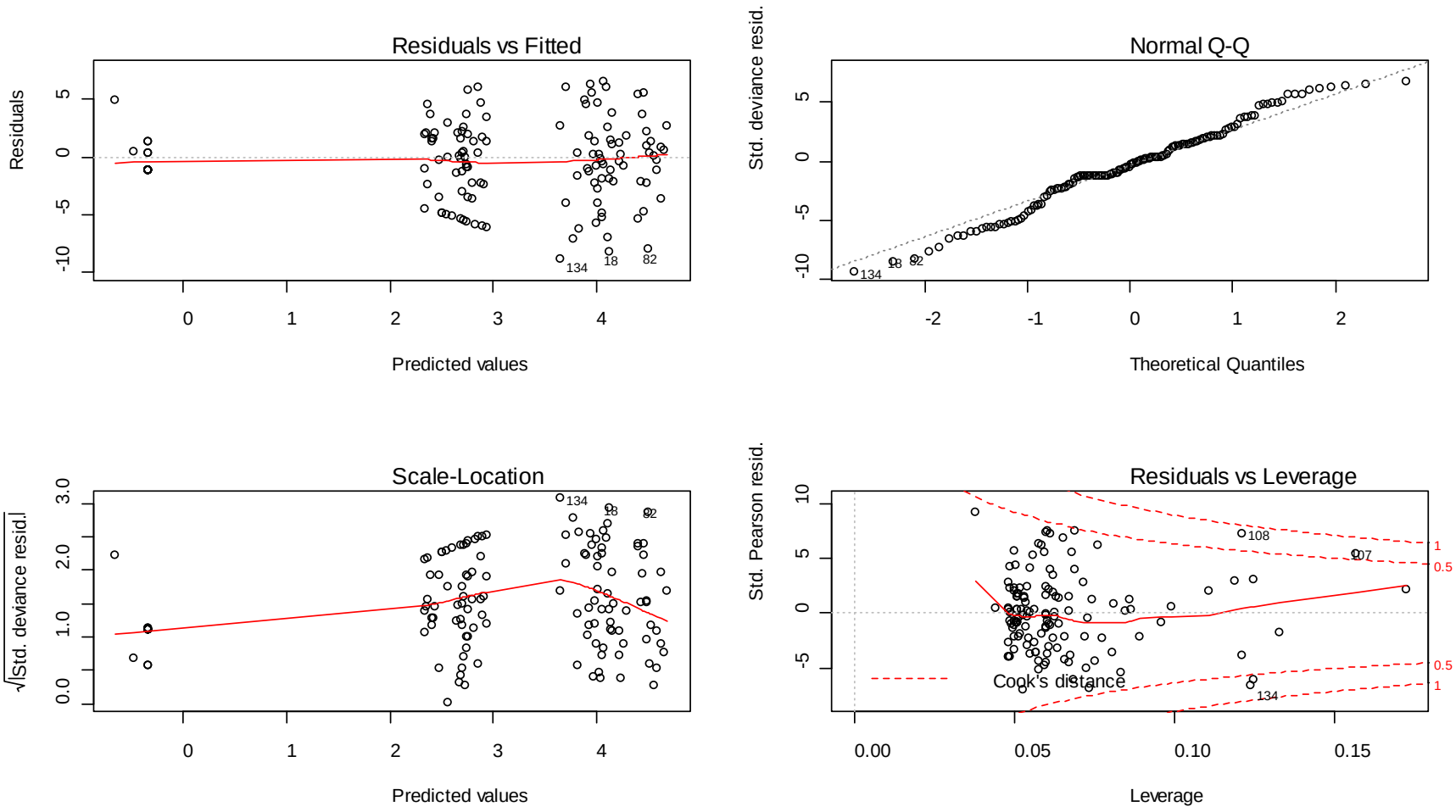
Appendix F-2. Diagnostic plots of the GzLM from the 2009 validation study at Lowden Meadows evaluating diel and habitat category effects on predictions of Chinook Salmon presmolt counts. Plots include residuals versus predicted values (residual versus fitted), standardized deviance residuals versus theoretical quantiles (normal Q-Q), square root of standardized deviance residuals versus predicted values (scale-location) and standardized Pearson residuals versus leverage (residuals versus leverage).

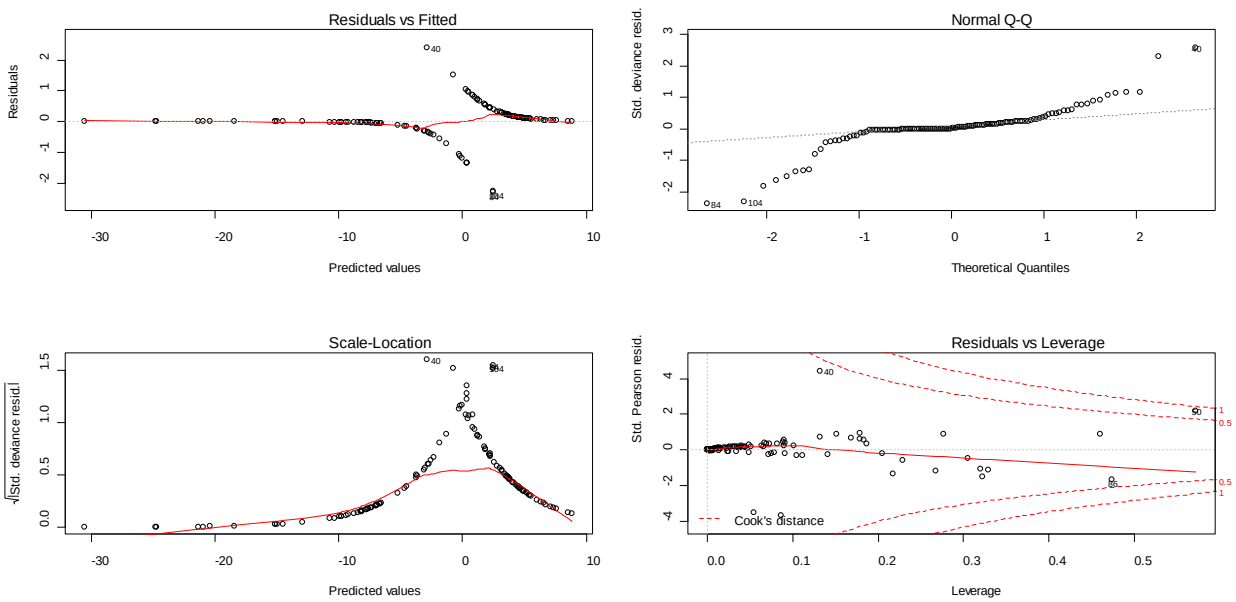


Appendix F-3. Diagnostic plots of the GzLM from the 2008 and 2009 validation studies evaluating Chinook Salmon fry counts in rearing habitat categories. We sampled Lewiston Cableway and Hoadley Gulch sites in 2008 and Lowden Meadows in 2009. This analysis was limited to daytime observations. Plots include residuals versus predicted values (residual versus fitted), standardized deviance residuals versus theoretical quantiles (normal Q-Q), square root of standardized deviance residuals versus predicted values (scale-location) and standardized Pearson residuals versus leverage (residuals versus leverage).



Appendix F-4. Diagnostic plots of the GzLM from the 2008 and 2009 validation studies evaluating Chinook Salmon presmolt counts in rearing habitat categories. We sampled Lewiston Cableway and Hoadley Gulch sites in 2008 and Lowden Meadows in 2009. This analysis was limited to daytime observations. Plots include residuals versus predicted values (residual versus fitted), standardized deviance residuals versus theoretical quantiles (normal Q-Q), square root of standardized deviance residuals versus predicted values (scale-location) and standardized Pearson residuals versus leverage (residuals versus leverage).



APPENDIX G. REDD VALIDATION

Appendix G-1. Diagnostic plots of the best approximating GzLM for Chinook Salmon spawning habitat. The model covariates include mean column velocity, water depth, proportion of the substrate that was medium gravel to small cobble or 11-90 mm (0.43 to 3.54 in), cover within 3 m and proximity to other redds. Plots include residuals versus predicted values (residual versus fitted), standardized deviance residuals versus theoretical quantiles (normal Q-Q), square root of standardized deviance residuals versus predicted values (scale-location) and standardized Pearson residuals versus leverage (residuals versus leverage).