## Terwer Creek

Terwer Creek is a fourth order stream that enters the north side of the Klamath River approximately 5.6 river miles upstream of the Pacific Ocean (Figure 35). Terwer Creek supports anadromous populations of chinook and coho salmon, steelhead and coastal cutthroat trout, and Pacific lamprey. East Fork Terwer Creek is the largest tributary and supports populations of coho, steelhead, coastal cutthroat, and Pacific lamprey. Lower Terwer Creek watershed provides habitat for non-natal salmonids migrating through the Klamath River prior to initiating spawning activities or entering the ocean. Cool water inputs emanating from the watershed also provides critically important thermal refugia for adult and juvenile salmonids migrating in the Klamath River during late spring – summer.

Terwer Creek drains 31.8 $mi^2$ with the headwaters originating at an elevation of 1,600 feet. A majority of the watershed is moderately to highly confined by bedrock outcrops, terraces, and steep valley side walls. Terwer Creek and the Klamath River historically formed and maintained an expansive, low gradient, deltaic valley at the confluence of these two systems. The valley has since been greatly altered by land and water management activities and large flood events occurring over the last 150 years. California Highway 169 currently bisects the Terwer Creek valley to provide access the community of Klamath Glen and other private properties (Figure 36). Following the 1964 flood, the U.S. Army Corps of Engineers constructed a large-scale flood control levee along the Klamath River just upstream of the Terwer Creek confluence to protect Klamath Glen residents and private infrastructure from future flooding (Figure 36). Approximately 60 acres of the valley supports small-scale livestock operations and a naturally reproducing herd of feral cattle also inhabits the valley.

The Yurok Tribe has been conducting physical, biological, and hydrological monitoring; stakeholder outreach; and watershed restoration planning and implementation in Terwer Creek since the mid-1990s (Tables 1 – 2). The LKRSB restoration plan (Gale and Randolph 2000) ranked Terwer Creek as a top priority watershed for receiving restoration based on existing habitat quality and quantity; and use of the drainage by anadromous and resident salmonid populations. The primary restoration objective set forth in the sub-basin plan was treatment of potential road-related sediment sources to reduce future sedimentation of the fluvial corridor. Another priority restoration recommendation was reducing impacts to riparian and stream habitats from domestic livestock and feral cattle.

## Terwer Creek Restoration Background

The following is a brief summary of the restorative efforts that YTFP has implemented in Terwer Creek since 2003. YTFP coordinated with Green Diamond Resource Company (GDRC) (private timber company) and Mr. Ken Farley (small-scale rancher) to implement riparian and stream restoration measures in the watershed. Projects were funded through grants obtained from the Bureau of Indian Affairs, CDFG, NOAA, NRCS, and USFWS.

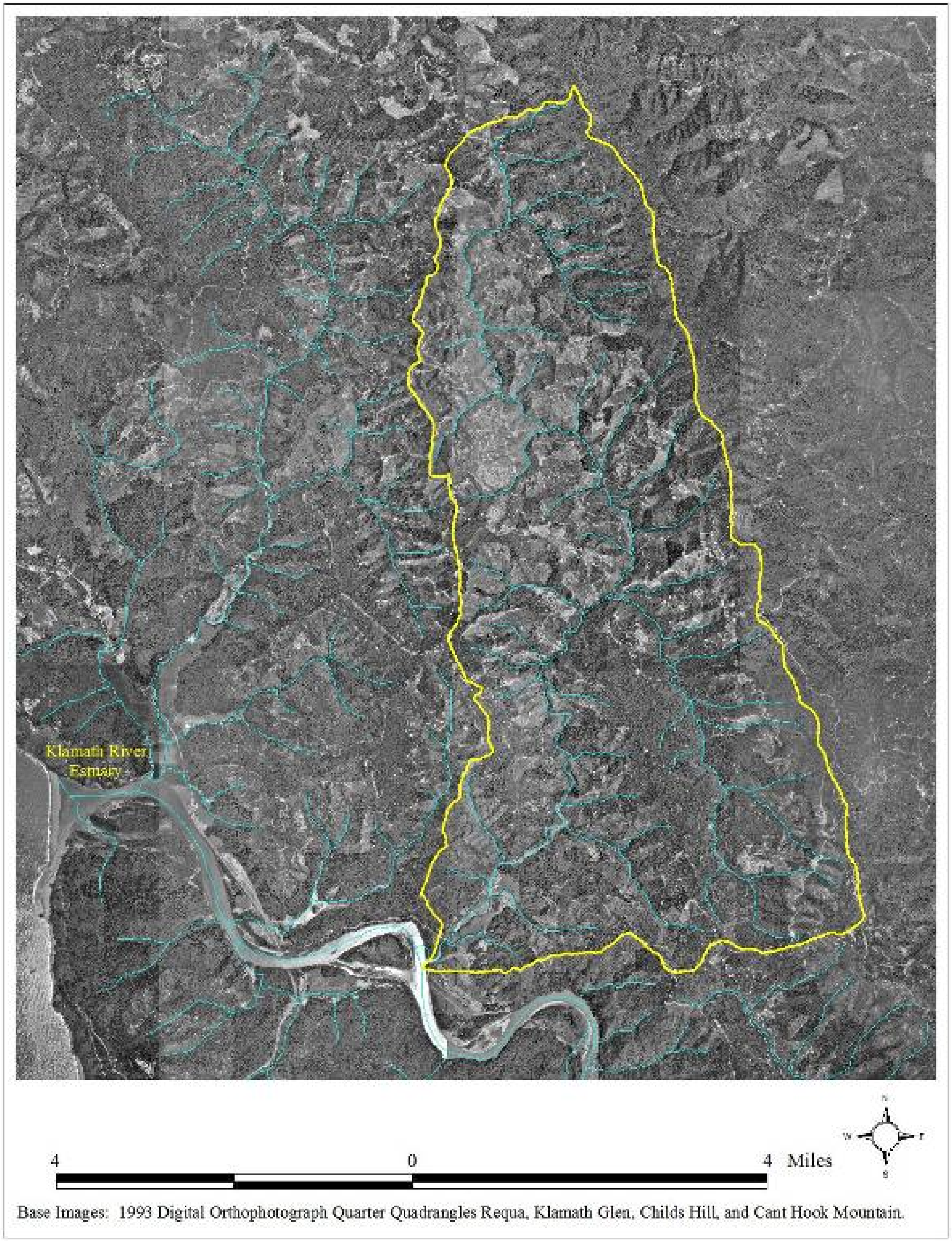


Figure 35. The Terwer Creek watershed, Lower Klamath River Sub-basin, California.


Figure 36. Aerial photographs of lower Terwer Creek, Lower Klamath River Sub-basin, California (2004).

**Lower Terwer Restoration Phase I**

YTFP initiated riparian enhancement in lower Terwer Creek during 2003 to address riparian dysfunction and channel instability in the reach located directly upstream of several small-scale livestock operations (Figure 37) (Gale and Beesley 2006). This area is locally known as Arrow Mills after the timber mill that formerly operated at the site. Specific tasks associated with phase 1 included: 1) removing invasive vegetation from the project area to promote existing and planted riparian vegetation (Figure 38); 2) stabilizing highly erodable

Figure 37.  Map of the Arrow Mills site (outlined in red) in Terwer Creek prior to riparian enhancement activities, Lower Klamath River Sub-basin, California (2004 Air Photo).

Figure 38. Photographs of a himalayan blackberry stand (top left photograph 2004); and Yurok Tribal Fisheries Program staff preparing to burn recently pulled blackberries (top right photograph 2004) and then removing blackberry crowns and planting native trees in lower Terwer Creek, Lower Klamath River Sub-basin, California (bottom photograph 2005).

banks using willow revetment techniques (i.e. siltation baffles and sprigs) (Figure 39) and large wood structures (Figure 40); and 3) planting floodprone surfaces and terraces with native willow, maple, cottonwood, and conifers (Figure 41).

Figure 39. Construction of a willow siltation baffles in lower Terwer Creek, Lower Klamath River Sub-basin, California (2004) (Note the large wood placed at the base of the baffle).

Figure 40. Large wood and willow structures following construction (top photograph 2005) and during a moderate flow event (bottom photograph 2005), lower Terwer Creek, Lower Klamath River Sub-basin, California.

Figure 41. Riparian area in lower Terwer Creek following planting efforts by Yurok Tribal Fisheries Program staff, Lower Klamath River Sub-basin, California (2007).

The primary restoration goal for lower Terwer Creek was to re-establish complex, native riparian forests to facilitate the following objectives:

- ensure recruitment of large wood to stream, floodprone, and terrace habitats;
- provide flow resistance to reduce near-bank shear stress and thus reduce soil loss;
- increase stream habitat complexity and channel stability;
- store fine grain materials on floodprone surfaces to promote root growth and increased shear resistance of bank materials; and
- reduce sediment delivery to critical salmonid habitats located downstream of the site.

Crews constructed a total of 32 willow siltation baffles on a floodprone surface located on the east side of Terwer Creek (Figure 42). The baffles were constructed perpendicular to the dominant flow path and were 20-25 feet in length. Baffles were comprised of live willow posts and brush and the bases were buried up to 5-6 feet with parent soil and gravels. The aerial portion of the willows varied in height from 5-15 feet. Five large wood-boulder structures were constructed along the bank of a high flow channel located at the site (Figure 40). Live willow was incorporated in these structures to enhance riparian conditions and promote long-term channel stability (Figure 40). A primary task of this first phase was reducing invasive vegetation including Canadian thistle, bull thistle, pampas grass, and Himalayan blackberry. Crews then planted the area with ~1,000 live willow sprigs, 120 big-

Figure 42. Photographs taken from a permanent photographic monitoring point in Terwer Creek, Lower Klamath River Sub-basin, California. The top photograph depicts pre-project conditions (2004), while the bottom photograph depicts newly constructed willow siltation baffles on the floodplain (2005).

leaf maple, 160 black cottonwood, 41 red alder, and 200 bare-root Douglas fir (Figure 41). The deciduous trees were started from seed (maples and alders) or cuttings (cottonwood) and were grown out for over a year at the YTFP native tree nursery.

Other priority objectives for YTFP included providing quality employment opportunities for Yurok Tribe members and staff through hands-on experience planning, implementing, and monitoring watershed restoration in the LKRSB. Long-term topographic, vegetation, and photographic monitoring protocols were established and implemented in the project area to assess channel and riparian response to restoration. The project area was inundated in early December 2004 by a high flow event (Figure 43). Post-flow evaluations revealed the baffles and structures withstood the event and were effective at accumulating fine grain materials by reducing local stream velocities (Figure 43).

**Farley Property Emergency Project**

In February 2005, YTFP conducted an emergency repair of a rapidly eroding bank located on the west side of Terwer Creek across from Arrow Mills (Figure 44) (Gale 2006a). Channel instability related to excessive sedimentation of fluvial habitats, large-scale riparian dysfunction, and a severe lack of instream wood accumulations resulted in over ten feet of lateral bank erosion during winter 2004-2005 and threatened valuable infrastructure such as private roads, pastures, and a domestic water supply well. YTFP used 200 tons of quarry boulders to stabilize ~100 feet of eroding bank with the intention of removing the material when alternative measures could be employed to ensure local channel stability and long-term infrastructure protection. Boulders were placed along the eroding bank up to the level of the adjoining road to minimize any additional erosion or lateral channel migration. The treatment resulted in the prevention of an estimated 600 cubic yards of sediment delivered to the stream had the erosion continued. An additional 275 tons of quarry rock was stockpiled at the site for rapid treatment of additional erosion problems should they arise. The surplus quarry rock was used to treat other priority sites in lower Terwer Creek during summer 2006.

**Farley Property Restoration Project**

YTFP continued working with GDRC and Mr. Farley to implement stream and riparian enhancement on the west bank of Terwer Creek just upstream of the emergency repair site (Figure 44). Activities conducted in this area were similar to those implemented at the Arrow Mills site located directly across the creek (Figure 37) (Gale 2006b). The main objective was to address 1,250 feet of highly erodable banks and reduce impacts to infrastructure and pastures located downstream. In the past, heavy equipment was used to excavate channels through lower Terwer Creek with the intent of controlling the channel to reduce the loss of infrastructure during flood events. Channel materials were often excavated and stockpiled along the existing bank as makeshift levees. Therefore, a majority of the active surfaces located in lower Terwer Creek consist of loosely consolidated gravels and repeated disturbance of the area has greatly impacted native plant recruitment and survival.

A relatively high flow event during December 2004 resulted in substantial erosion at the site and prompted YTFP and Mr. Farley to develop a strategy to reduce bank erosion and protect

Figure 43. Willow siltation baffles during a high flow event (top photograph 2004) and during summer (bottom photograph 2005), lower Terwer Creek, Lower Klamath River Sub-basin, California.

Figure 44.  Map of the Lower Terwer Creek Emergency Bank Protection Project (outlined in red), and the Farley Restoration Project (outlined in gold), Lower Klamath River Sub-basin, California (2004 Air Photo).

his property.  A primary concern for Mr. Farley was protecting a well that provides water to his property and several other landowners in the valley.  Implementation at this site occurred from August 2005 – February 2006.  Pampas grass (plants and sprouts) and Himalayan blackberry patches were removed from the project area prior to implementation.  A drip irrigation system was constructed and used as well as additional water that was transported to the site to ensure willow survival through the first few dry seasons following construction.

YTFP constructed 14 willow siltation baffles along the bank using a combination of heavy equipment and hand-crews (Figure 45). The baffles were comprised of willow brush and the bases were lined with ¼ ton quarry rock in an effort to reduce localized scour (Figure 46). Fifteen willow mattresses were constructed parallel with the channel along the bank between the baffles. Mattress bases were lined with small and large wood to improve growing conditions (Figure 47). YTFP crews also constructed a series of large wood-boulder structures upstream of Mr. Farley's well to deflect stream flows away from his property and reduce near-bank shear stress (Figure ). Live willow was incorporated in all of the structures and willow mattresses were constructed between the structures to promote long-term bank stability (Figure 48). Crews also constructed 41 willow brush and post baffles on the adjacent floodprone surface; and planted 500 willow sprigs, 30 big-leaf maple, 65 black cottonwood, 41 red alder, and 350 bareroot Douglas fir trees. The deciduous trees were started from seed (maples and alders) or cuttings (cottonwood) and grown out for over a year at the YTFP native tree nursery. These measures were implemented to immediately enhance existing riparian habitats; reduce stream velocities on floodprone surfaces; and promote conditions that maintain complex, native riparian forests and large wood recruitment to Terwer Creek.

**Lower Terwer Restoration Phase II**

YTFP continued addressing riparian dysfunction and channel instability on both the west and east banks of Terwer Creek in the vicinity of Mr. Farley's property from July – November 2006 (Figure 49) (Gale 2007a). Project objectives were similar to those of Phase I with a focus on stabilizing erosive banks and planting riparian habitats with native trees. Crews constructed 11 willow siltation baffles and 10 willow mattresses along the west bank of the channel upstream of Mr. Farley's well (Figure 50). The baffles were comprised of willow brush and the bases were lined with ¼ ton quarry rock in an effort to reduce localized scour. Mattress bases were lined with small and large wood to improve growing conditions. Crews also removed the quarry rock that was placed in February 2005 as an emergency treatment of an eroding bank. Five large wood-boulder structures with live willow incorporated were constructed at this location to ensure long-term bank stability.

Crews constructed six willow siltation baffles and 12 willow mattresses along the east bank of Terwer Creek (Figures 51 – 52). As on the west bank, the baffle bases were lined with ¼ ton quarry rock and the mattress bases were lined with wood. All baffles and mattresses were watered during project implementation to ensure survival. Four large wood-boulder structures with live willow incorporated were constructed along at this location (Figure 53). Invasive pampas grass plants and sprouts, and Himalayan blackberry patches were removed from the project site prior to any riparian planting. A total of 59 big-leaf maple, 210 black cottonwood, and 51 red alder, 186 Douglas fir, three coastal redwood, and 37 bareroot western red cedar trees were planted in the project area. The deciduous trees were started from seed (maples and alders) or cuttings (cottonwood) and grown out for over a year at the YTFP native tree nursery. The fir and redwood trees were bareroot trees that YTFP grew out in 5-gallon containers for 1-2 years in our nursery before planting. In addition, 79 live willow sprigs were planted in the vicinity of the large wood-boulder structures.

Figure 45. Photographs of an eroding bank in lower Terwer Creek (top photograph 2005) and newly constructed willow siltation baffles and mattresses at the same location (bottom photograph 2005), Lower Klamath River Sub-basin, California.

Figure 46. Placement of ¼ ton quarry rock at the base of a willow siltation baffle constructed in lower Terwer Creek, Lower Klamath River Sub-basin, California (2005).

Figure 47. Placement of large wood at the base of a willow mattress constructed in lower Terwer Creek, Lower Klamath River Sub-basin, California (2005).


Figure 48. Construction of large wood-boulder structures in lower Terwer Creek, Lower Klamath River Sub-basin, California (2005).

Figure 49.  Map of the Lower Terwer Creek Restoration Phases I and II Project Area (outlined in red), Lower Klamath River Sub-basin, California (2004 Air Photo).

Figure 50. Willow siltation baffles and mattresses constructed along the west bank of lower Terwer Creek, Lower Klamath River Sub-basin, California (YTFP 2006).

Figure 51. Photographs of an eroding bank in lower Terwer Creek, Lower Klamath River Sub-basin, California (2006).

Figure 52. Newly constructed willow siltation baffles and mattresses along the east bank of lower Terwer Creek Lower Klamath River Sub-basin, California (2006).

Figure 53. Large wood-boulder structure constructed along the east bank of lower Terwer Creek, Lower Klamath River Sub-basin, California (2008).

**Lower Terwer Restoration Phase III**

The most recent restoration program activities were implemented in lower Terwer Creek from July 2007 – spring 2008 (Figure 54) (Gale 2007b). The objectives were to supplement previous restorative efforts by increasing the number of willow siltation baffles and large wood-boulder structures to increase bank stability; and planting more native conifers and deciduous trees within riparian habitats. Other project objectives included monitoring the survival of previously constructed willow baffles and planted trees as well as continual removal of invasive, non-native plants in the project area. As in Phase II, crews addressed both banks of Terwer Creek at Arrow Mills and Mr. Farley's property. Crews constructed 28 willow baffles on Mr. Farley's property adjacent to his well to ensure long-term protection of his infrastructure and pastures (Figure 55). These "terrace" baffles were planted without quarry rock just behind the large wood-boulder structures and willow mattresses that were constructed along this bank in 2005. Another 17 willow siltation baffles were also constructed ~ 400 feet downstream of Mr. Farley's well. These baffles were constructed with ¼ ton quarry rock at the bases in an effort to reduce localized scour.

Twenty-three willow siltation baffles with ¼ ton quarry rock were constructed along the west bank of Terwer Creek just downstream of the large wood-boulder structures that were placed in Phase I (Figure 56). Crews also planted 12 willow mattresses between these baffles to increase flow resistance to reduce near-bank shear stress along the entire eroding bank. Crews also constructed 12 willow siltation baffles and four willow mattresses along the east bank of Terwer Creek ~ 1,500 feet downstream of the Arrow Mills Site (Figures 57 – 58). These baffles were comprised of willow brush and the bases were lined with ¼ ton quarry rock in an effort to reduce localized scour. Mattress bases were lined with small and large wood to improve growing conditions. Sixteen willow terrace baffles (no quarry rock) were constructed directly behind the siltation baffles to increase storage of fine grain materials on this floodplain to promote root growth and increased shear resistance of bank materials.

Crews removed Himalayan blackberry patches from all of the baffle construction sites as well as from areas previously treated and planted to promote native tree survival in lower Terwer Creek. A total of 21 big-leaf maple, seven red alder, 456 Douglas fir, 200 Sitka spruce, 36 western red cedar, and one coastal redwood were planted throughout the project area. The deciduous trees were all stock grown at the YTFP native tree nursery. The conifers were bareroot trees that YTFP crews grew out in 5-gallon containers for 1-2 years in the nursery before planting. During late winter – early spring 2008, YTFP crews built a fairly large cattle exclusion fence at the Arrow Mills site to protect this riparian area from feral and domestic cattle that inhabit lower Terwer Creek. Crews also coordinated with Redwood National Park for use of their elk fence panels. Mr. Farley has used the panels to build a containment pen that he baits to capture his loose cattle as well as the feral cattle. Mr. Farley has been working with the proper authorities to sell any feral cattle at public auctions.

**<u>Restoration Effectiveness Monitoring in Terwer Creek</u>**

YTFP began monitoring physical and biological parameters in Lower Klamath River tributaries in 1997 (Gale and Randolph 2000). YTFP has documented fish distribution in the

Figure 54. Map of the Lower Terwer Creek Restoration Phases I and II Project Area (outlined in red) and Phase III Project Area (outlined in gold), Lower Klamath River Sub-basin, California (2004 Air Photo).

Figure 55. Willow terrace baffles constructed to protect private infrastructures and pastures in lower Terwer Creek, Lower Klamath River Sub-basin, California (2008).

Figure 56. Willow siltation baffles constructed along the east bank of Terwer Creek, Lower Klamath River Sub-basin, California (top photograph 2006 and bottom photograph 2008).

Figure 57.  Photographs of an eroding bank in lower Terwer Creek, Lower Klamath River Sub-basin, California (top photograph 2005, bottom photograph 2006).

Figure 58.  Recently constructed willow siltation baffles during a high flow event in 2006 (top photograph), and then with additional willow terrace baffles in 2008 (bottom photograph), lower Terwer Creek, Lower Klamath River Sub-basin, California.

watershed; and mapped stream habitats and conducted large wood surveys in the anadromous portion of Terwer Creek (Tables 1 – 2).  YTFP monitored juvenile salmonid outmigration in Terwer Creek from 2001 – 2004 and conducted juvenile coho abundance surveys during 2002 – 2004.  YTEP currently operates two stream gages in the watershed to document long-term hydrologic patterns and statistics.  Terwer Creek stream gage data can be accessed along with other Tribal operated water quantity and quality stations in the LKRSB at: http://exchange.yuroktribe.nsn.us/lrgsclient/stations/stations.html.

In 2003, YTFP began collecting baseline physical and biological information in association with our restoration program in lower Terwer Creek. A series of permanent, georeferenced vegetation transects were established in the project area according to CDFG methods (Figure 59). Baseline transect surveys were conducted in August 2004 to document pre-project riparian conditions. Long-term photographic monitoring stations were also established at key locations along vegetation transects and pre-project images were obtained. Vegetation transects were resurveyed and post-project images were obtained in August 2005 to document conditions following restoration implementation and winter high flows. These data indicated that restorative measures resulted in increases in willow abundance in treated sites (Gale and Beesley 2006; Gale 2007c). Since 2003, YTFP has conducted regular inspections of willow revetment areas and planted trees to document site conditions and vegetation survival. The knowledge gained from this monitoring has guided our riparian restoration program in Tewer Creek and other LKRSB tributaries and has resulted in improved native plant survival and natural recruitment.

YTFP also established several permanent topographic survey benchmarks and cross sections in lower Terwer Creek to document long-term changes in channel and floodplain topography (Figure 60) (Gale and Beesley 2006; Gale 2008). Three-dimensional topographic surveys were first conducted at the Arrow Mills site during spring 2005 using a Nikon Optical Total Station. In 2006 and 2007, YTFP repeated and expanded the initial survey to include new restoration sites and document conditions from Arrow Mills to the confluence with the Klamath River (Figure 61). YTFP continues to pursue the funds required to maintain and expand our topographic survey efforts in Terwer Creek. Topographic reference reaches should be established upstream of Arrow mills to characterize the entire anadromous portion of the watershed. Long-term channel survey data is critical when developing geomorphically sound restoration strategies and monitoring the effectiveness of implemented plans.

A critical factor inhibiting salmonid productivity and native plant survival in lower Terwer Creek is the depth to the water table from late spring through fall. Lower Terwer Creek consistently experiences subsurface flows from May – October (Figure 62). Subsurface tributary flows interrupt juvenile outmigration in the spring and adult immigration in the fall; limit the quality and quantity of salmonid rearing habitat; reduce available cool water refuge; increase competition and predation; thereby reducing overall survival from spawning to emigration. As part of a larger assessment of LKRSB tributaries, YTFP documented the timing and aerial extent of subsurface flows (2004-2005); and monitored water table elevations at several wells (2005 – 2008) (Figure 63) in lower Terwer Creek (Beesley and Fiori 2007b). The main objective of that study was to examine the interaction of rainfall and Klamath River flow levels with local tributary water tables and surface flows. The data indicated that without sufficient precipitation, water tables and surface flows receded rapidly due to the coarse alluvium comprising the fluvial corridor of lower Terwer Creek.

Groundwater monitoring and topographic survey data collected at the Arrow Mills site indicated that the water table during late summer – fall was 25 – 30 feet below the active channel and floodplain surfaces (Figure 64). The summer water table was closer to channel and floodplain surfaces at monitoring stations located ~ 4,000 feet downstream of the Arrow Mills site (Figure 65). Water tables located near the mouth of Terwer Creek appeared to be

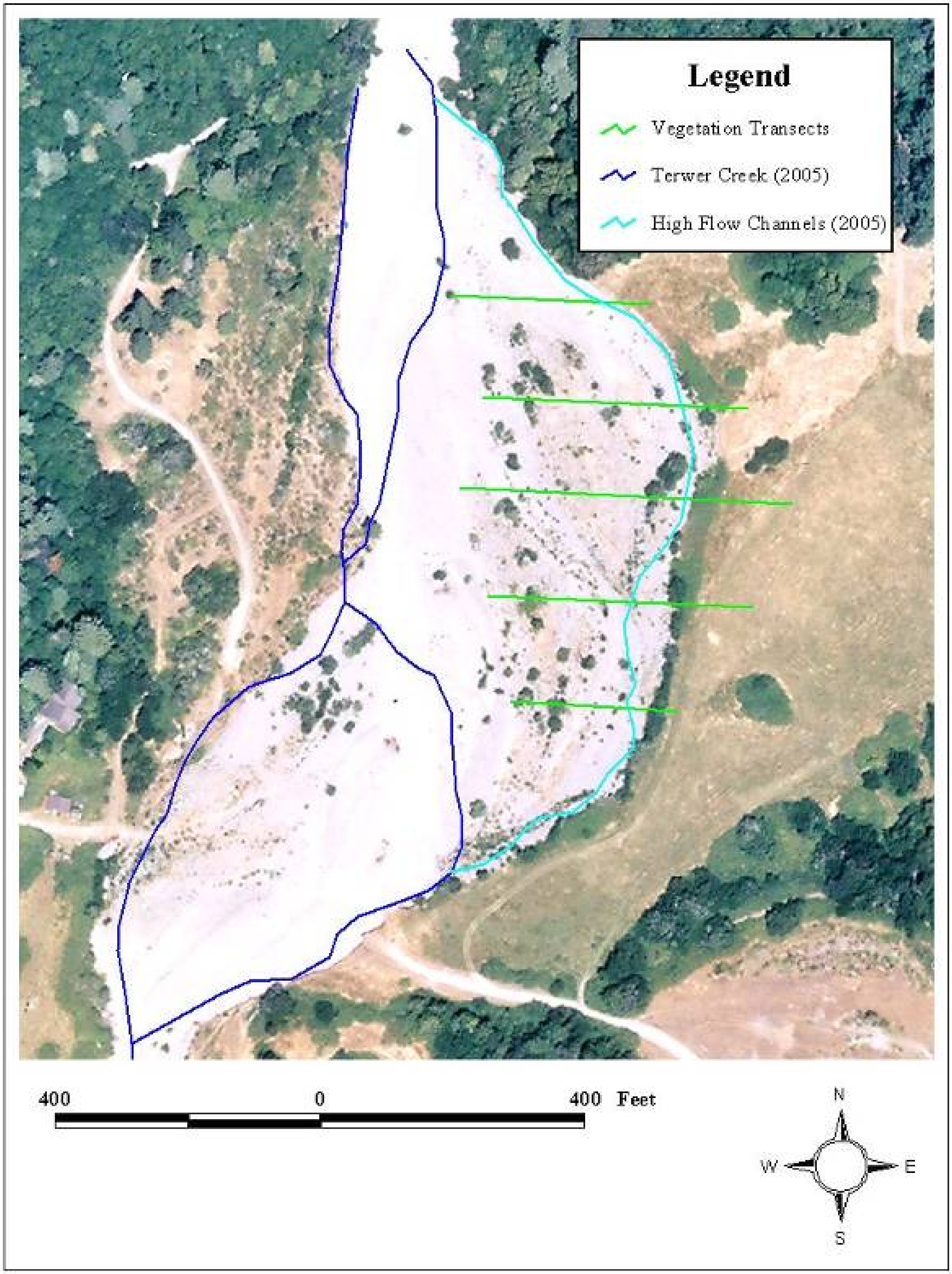


Figure 59. Permanent vegetation monitoring transects located in lower Terwer Creek, Lower Klamath River Sub-basin, California (2004 Air Photo).

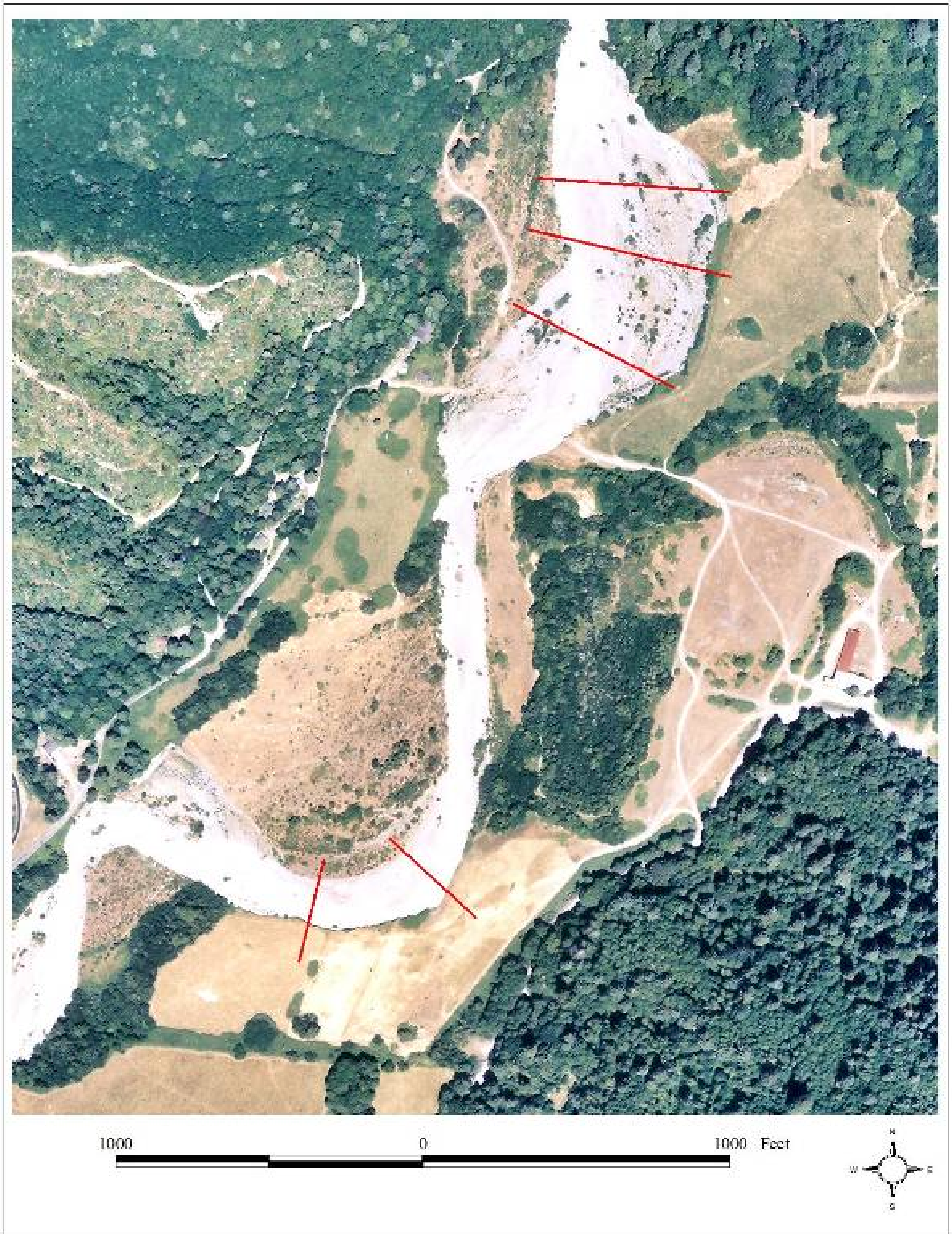


Figure 60. Permanent monitoring cross sections located in lower Terwer Creek, Lower Klamath River Sub-basin, California (2004 Air Photo).

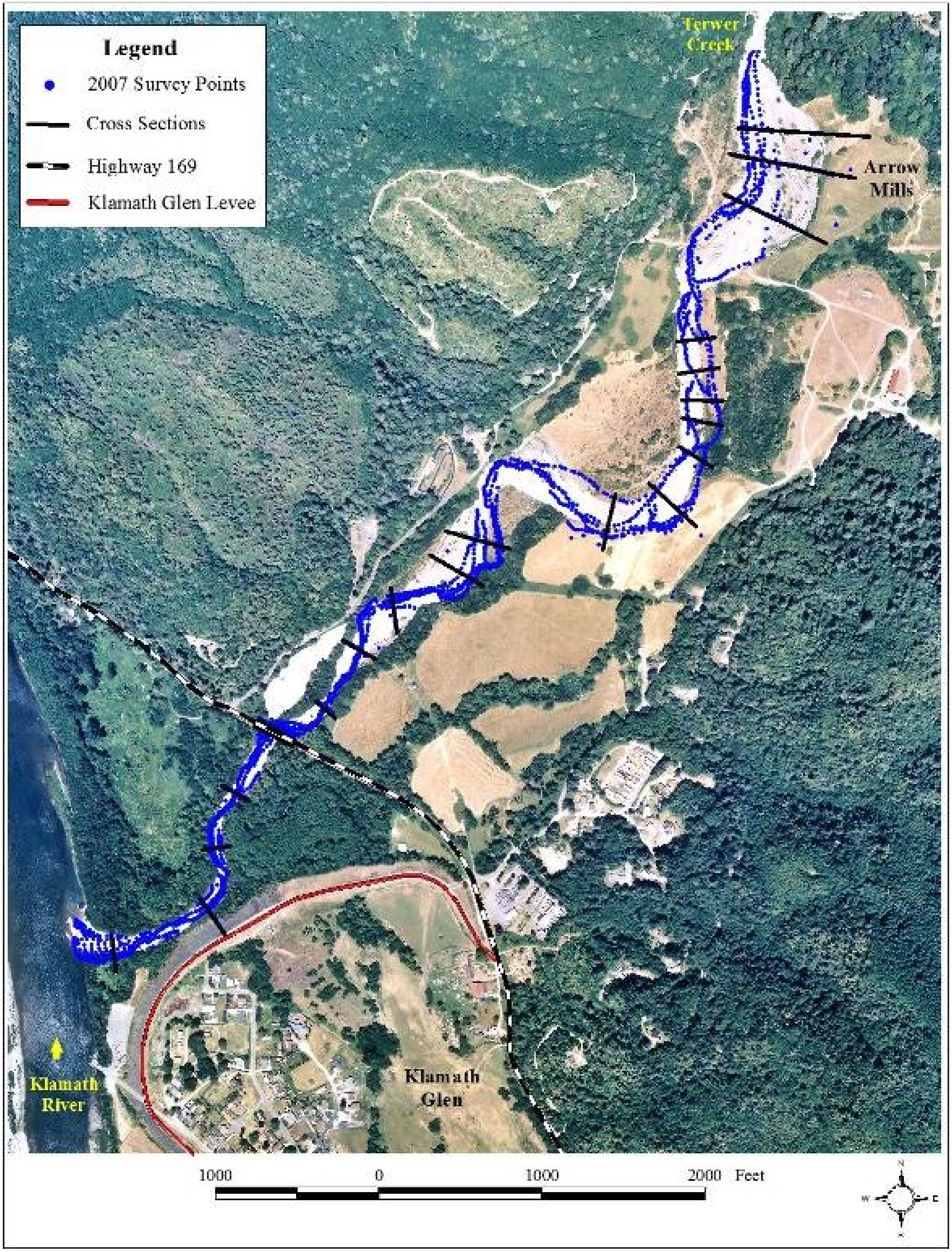


Figure 61. Map depicting the 2007 topographic survey of lower Terwer Creek, Lower Klamath River Sub-basin, California (2004 Air Photo).

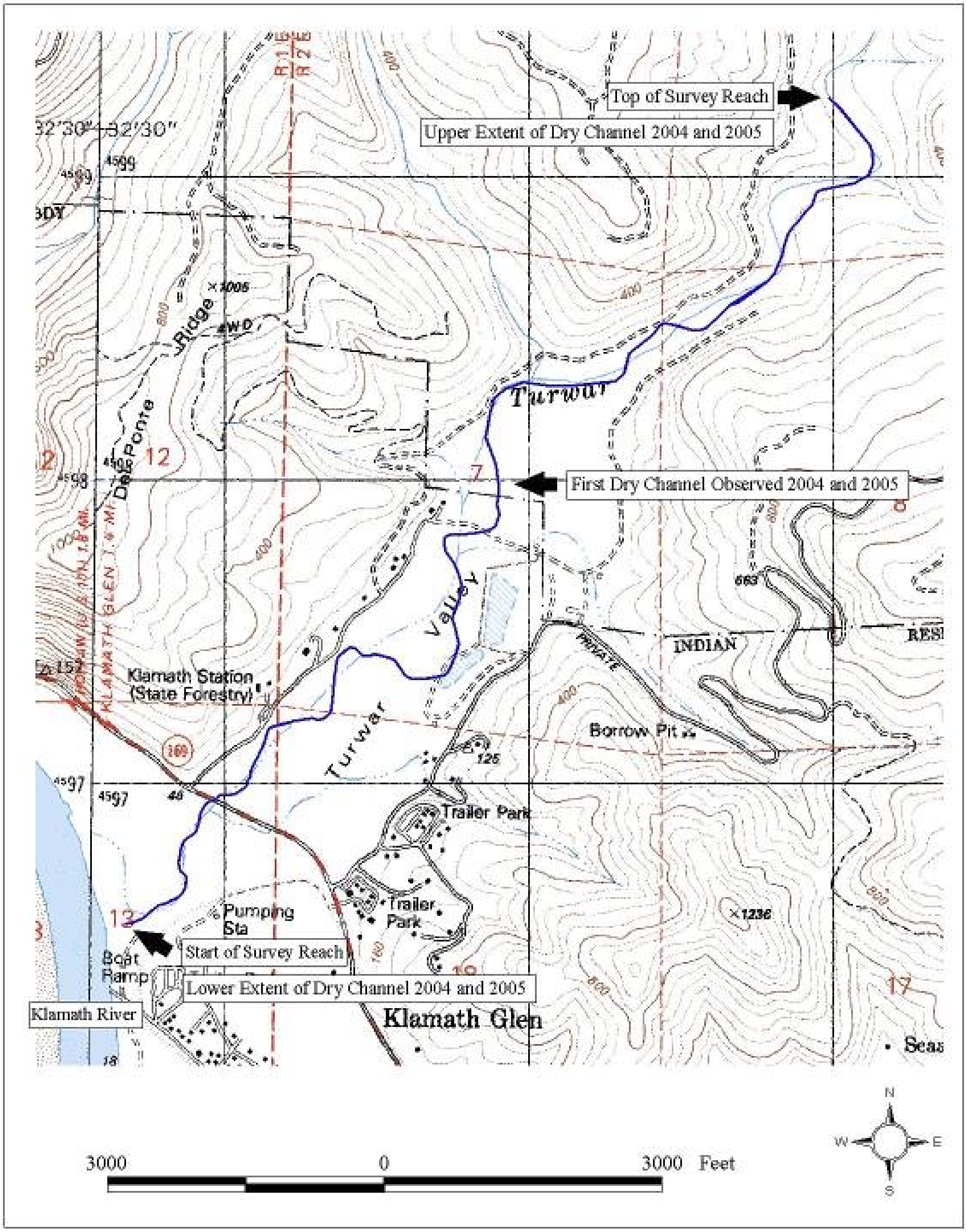


Figure 62. Map depicting the Terwer Creek channel and the reach surveyed for subsurface flow for the period 1 April 2004 – 31 December 2005, Lower Klamath River Sub-basin, California.

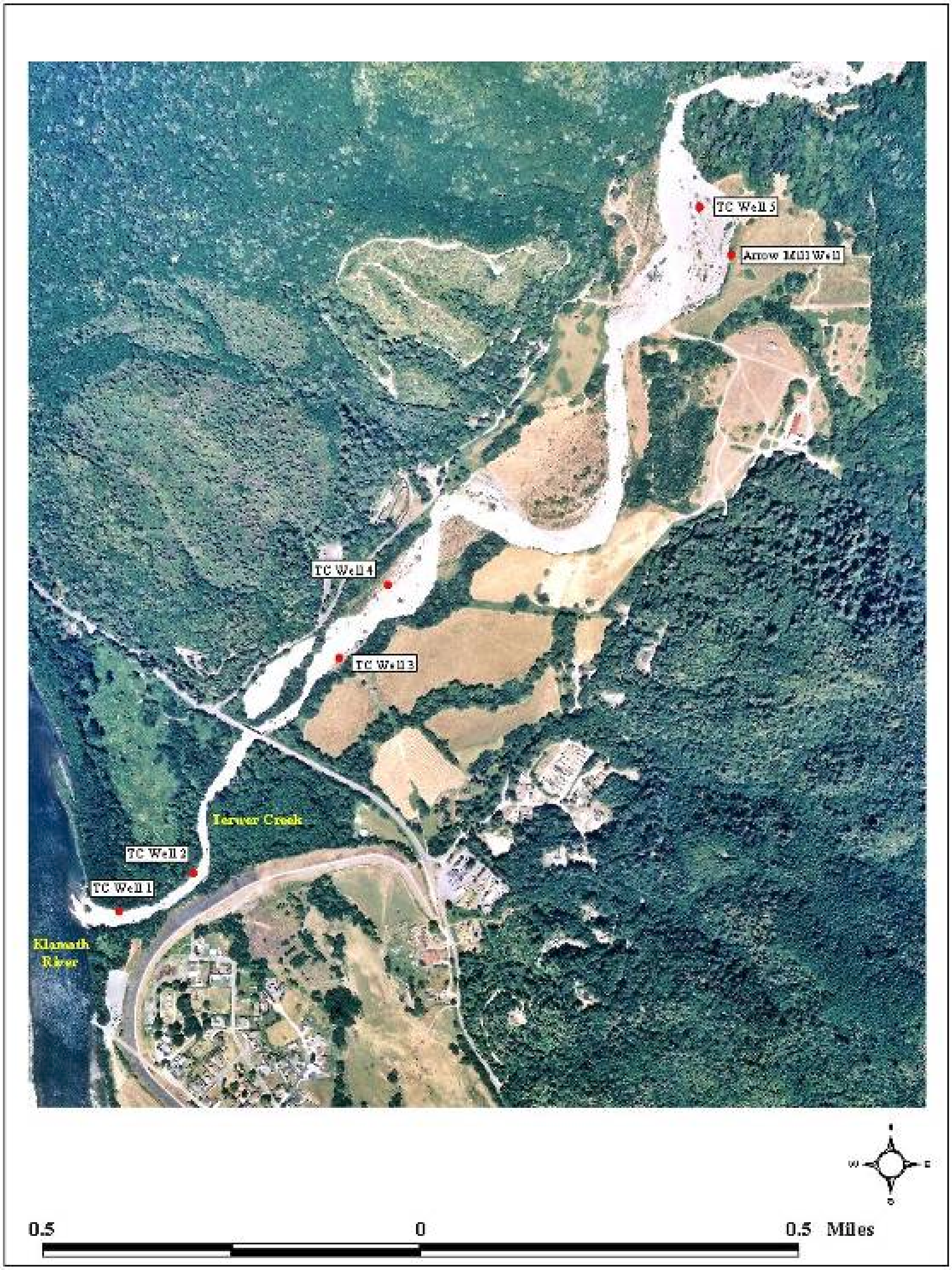


Figure 63.  Location of groundwater monitoring wells in Terwer Creek, Lower Klamath River Sub-basin, California (2004 Air Photo).

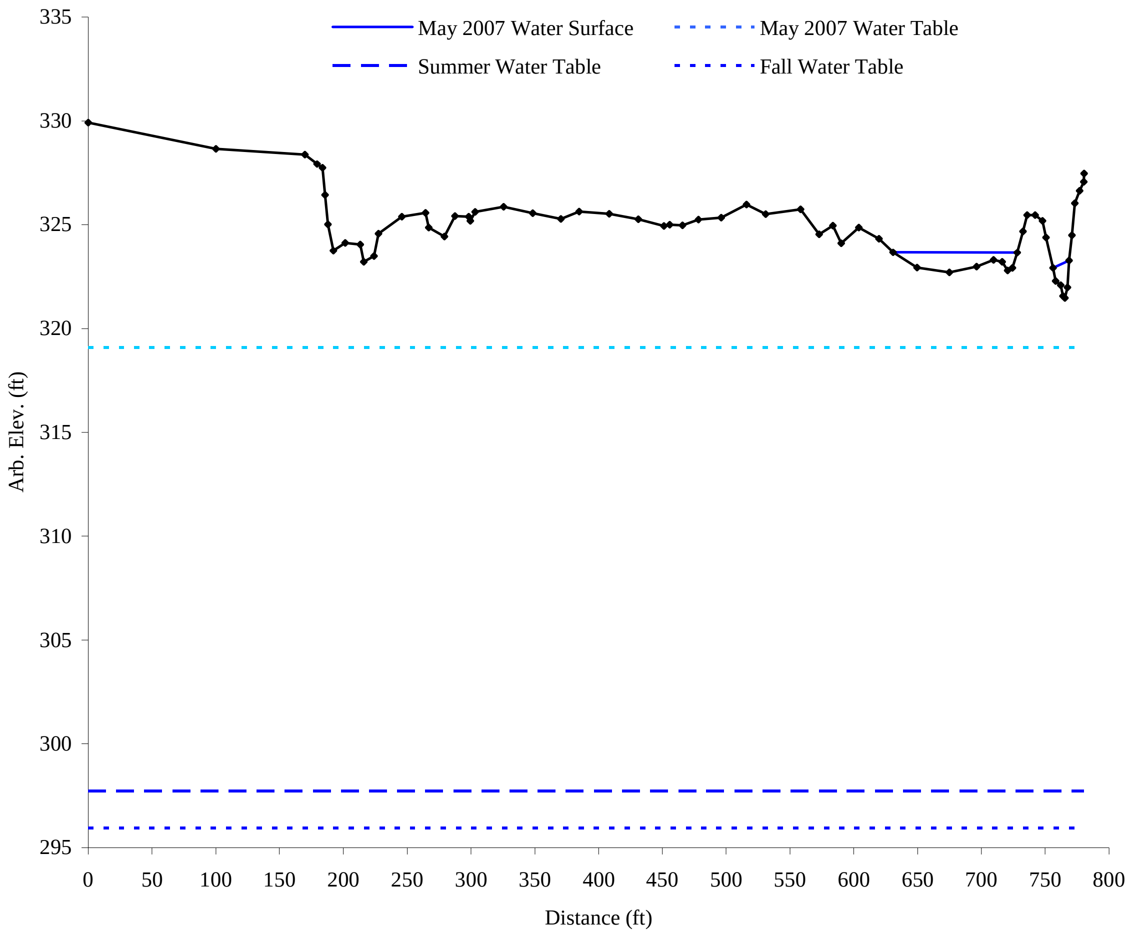


Figure 64. Cross section plot depicting elevations of channel and floodprone surfaces relative to base flow and water table elevations in the vicinity of Arrow Mills, Terwer Creek, Lower Klamath River Sub-basin, California (2007).

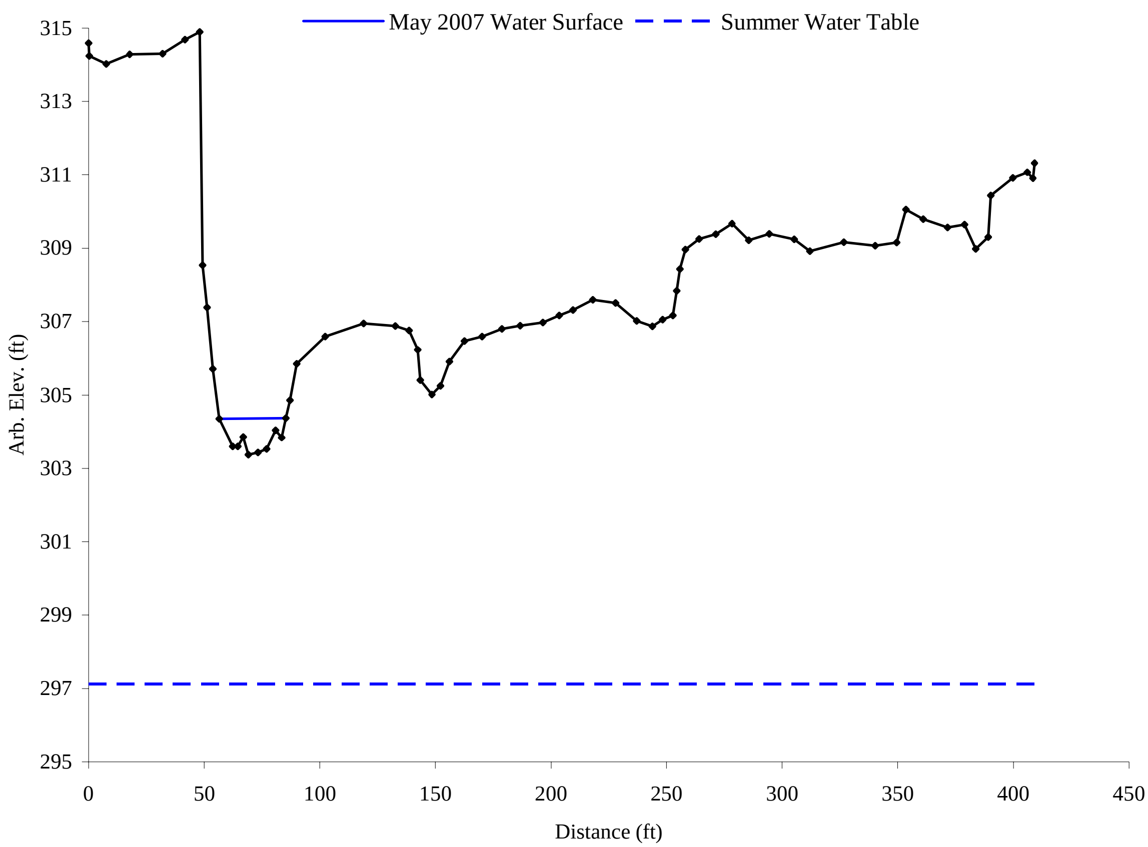


Figure 65. Cross section plot depicting elevations of channel and floodprone surfaces relative to base flow and water table elevations located downstream of Arrow Mills, Terwer Creek, Lower Klamath River Sub-basin, California (2007).

more influenced by Klamath River surface flow and groundwater levels compared to sites monitored further upstream (Beesley and Fiori 2007b). Monitoring groundwater elevations in lower Terwer Creek and other priority LKRSB tributaries has provided critical information regarding seasonal water table recession and recharge rates. This knowledge is extremely helpful when developing comprehensive riparian restoration strategies for the LKRSB.

## Terwer Creek Recommendations

### Upslope Enhancement

Priority restoration objectives for the Terwer Creek watershed include reducing sediment delivery rates throughout the watershed; and reestablishing healthy, native conifer and hardwood riparian forests in the lower valley (Gale and Randolph 2000). The watershed has been impacted by historic timber harvest practices and salvage logging following a fairly intense wildfire in the 1980s. Therefore there is a critical need to address upslope concerns before they fail and deliver more sediment to the fluvial corridor of Terwer Creek. YTWRP has conducted limited upslope restoration in the Terwer Creek watershed. All high and medium priority roads identified in past and future upslope assessments should be addressed in the next five to ten years. A sediment budget should also be constructed to quantify the dominant hillslope sediment sources in the watershed to improve on-going restoration planning, implementation, and monitoring efforts. Sediment budget assessment efforts should also address channel stored sediment in the anadromous portion of Terwer Creek.

**Stream and Floodplain Stored Wood**

Another priority restoration recommendation is to increase the amount of instream large wood in Terwer Creek to meter sediment transfer through the watershed; improve tributary flood capacity to mobilize channel stored sediments; and enhance riparian function through the accumulation of fine sediments and localized increases in water storage capacity. As was recommended for Hunter Creek, increasing the amount of channel and floodplain stored wood should be considered a long-term effort until natural recruitment rates increase as a result of watershed protection and improved timber harvest practices. This summer, YTFP will work with a helicopter company to place large wood in the fluvial corridor of Tectah Creek to alter sediment storage and delivery dynamics and improve instream and riparian conditions. Based on the effectiveness of this effort, YTFP will begin planning a similar effort for Terwer Creek. The helicopter allows YTFP to place wood sources in remote or hard to access locations such as Tectah Creek and a majority of Terwer Creek.

YTFP continues to pursue the funding necessary to locate and stage the wood sources required for these types of efforts. Terwer Creek would require pieces that were 28 inches or greater in diameter at breast height and at least 40 feet in length. A majority of the pieces should have rootwads intact to reduce mobility of these pieces during flood events; and increase the potential to trap mobile wood sources. Accumulations of small wood should be incorporated into engineered wood structures to replicate a natural jam, improve structural integrity, and increase habitat complexity. The processes facilitated by instream and floodplain wood accumulations are critical to channel stability; floodplain formation and maintenance; and riparian health in LKRSB tributaries.

**Riparian Enhancement**

Reestablishing complex, self-maintaining riparian forests in the Terwer Creek watershed is another priority restoration measure. Eradicating the feral cattle populations in Terwer Creek and adjacent watersheds would dramatically increase YTFP's ability to address riparian dysfunction in the LKRSB. Until the feral cattle issue is addressed in Terwer Creek, YTFP will continue building cattle exclusion fences to ensure survival of trees planted in critically important riparian areas. Fences can always be removed once the trees mature or the cattle have been eradicated or heavily managed.

The Yurok native plant nursery has been a vital addition to our riparian restoration efforts in LKRSB tributaries. Crews collect seeds and cuttings from native deciduous trees throughout the year to cultivate at the nursery. Bareroot conifers donated or purchased are often grown out for a few years in five gallon pots to increase tree survival. There is a critical need to expand the nursery to include native wetland species for future projects addressing wetland and slough habitats. Therefore, a priority objective is to obtain long-term funding to maintain a fully operational native plant nursery to serve restorative needs in the LKRSB.

**High Priority Tasks for Terwer Creek**

Highway 169 and the associated bridge as well as the Klamath Glen levee significantly constrict Terwer Creek and concentrates flow through an area that would naturally allow overbank flows to spread onto adjacent floodplains (Figure 61). Unfortunately the bridge was recently upgraded and channel constriction issues were not addressed. Reducing channel constriction at this site would be difficult and expensive given the current bridge configuration, the Klamath Glen levee, and existing private property and infrastructure (Figure 61). However an innovative design that resulted in improved hydrologic function, increased flood storage capacity, and improved conditions for natural resources and the local residents would likely be worth the expense.

The other priority activity is to protect the fine grained soils that comprise the lower valley terraces. Field investigations conducted throughout the LKRSB indicate that a majority of the larger LKRSB tributaries formerly contained extensive floodplains and terraces comprised of fine-grained materials; likely the result of backwater conditions occurring in these areas over long periods of time. Land and water management and possibly climate changes has resulted in substantial erosion and conversion of these surfaces; especially in the last 150 years. These terraces are extremely productive and allow for robust riparian forests capable of increasing bank stability and providing significant fluvial wood recruitment. Small-scale agricultural operations in Terwer Creek and other LKRSB tributaries also depend on these surfaces for raising cattle.

Lower Terwer Creek still contains fairly extensive backwater formed terraces in the vicinity of Arrow Mills (Figure 61). Excessive sedimentation of channel and floodplain habitats is the primary cause of terrace erosion and conversion of floodprone surfaces from those dominated by fine-grained materials to surfaces dominated by gravel and cobble (Figure 57). Major channel reconstruction may be a potential strategy for reducing bank erosion rates and increasing channel stability. However, a comprehensive sediment budget for the watershed and more detailed channel surveys will need to be conducted to determine if channel manipulation would result in long-term benefits including improved sediment routing capacity and increased channel stability. In the meantime, YTFP is planting these surfaces with native conifers and deciduous trees and protecting them from cattle to begin restoring riparian function in the lower valley. These forests will require several decades to mature and will be dependent on our ability to increase channel stability in lower Terwer Creek.