

# TOLAY CREEK RIPARIAN ENHANCEMENT PLAN

*November 2009*



**DEVELOPED FOR:  
Sonoma Land Trust**

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## BACKGROUND

The Tolay Creek watershed in Sonoma County is a sub-basin of the Sonoma Creek hydrologic area located in the San Francisco Bay hydrologic region (*Figure 1. Watershed Map*).

Comprised of thirteen tributaries, the watershed drains an approximately 8.3 square mile basin. The main stem of Tolay creek is a tributary to San Pablo Bay — its headwaters are formed by Tolay Lake, with the main stem crossing through rangeland until it becomes part of the tidally influenced salt-marsh ecosystem downstream of the Highway 121 bridge (*Figure 2. Topographic Map*).

Detailed information regarding the physical, biotic and cultural history of the watershed is comprehensively covered in other documents (LSA, 2009; Florsheim, 2008) and is not summarized here.

The Sonoma Land Trust (SLT) purchased the Tolay Creek Ranch in 2007 in order to protect the natural and cultural resources. This property connects the Tolay Lake Regional Park with several thousand acres of protected land including California Department of Fish and Game's Napa-Sonoma Marsh System along Highways 37 and 121, the US Fish and Wildlife Service's San Pablo Bay National Wildlife Refuge, and SLT's Sears Point Restoration Project. Due to its diverse habitats and continuity with other recent acquisitions, this project will also provide scenic protection; public recreational access; and educational/interpretive opportunities for natural, cultural, historical and aesthetic resources. SLT intends to transfer its ownership to the Sonoma County Regional Parks Department in three to five years.

The enhancement strategy for Tolay Creek Ranch is to replicate a natural riparian ecosystem and floodplain riparian oak woodland. When completed, the project will establish a diversity of plant types and species, enhance biological diversity, as well as reduce erosion and sediment contributions to aquatic and wetland systems.

## ENHANCEMENT PLAN OBJECTIVES

The objectives of the Tolay Creek Riparian Enhancement Plan are as follows:

- a. develop a set of conceptual and detailed specifications for increasing biological diversity along the riparian corridor of Tolay Creek and its major tributaries
- b. outline opportunities for community involvement in the implementation of habitat enhancement and monitoring efforts
- c. outline options for scientific research and the involvement of academic institutions in the enhancement efforts and ongoing monitoring thereof
- d. provide potential options for funding the proposed enhancement, research and community involvement recommendations.

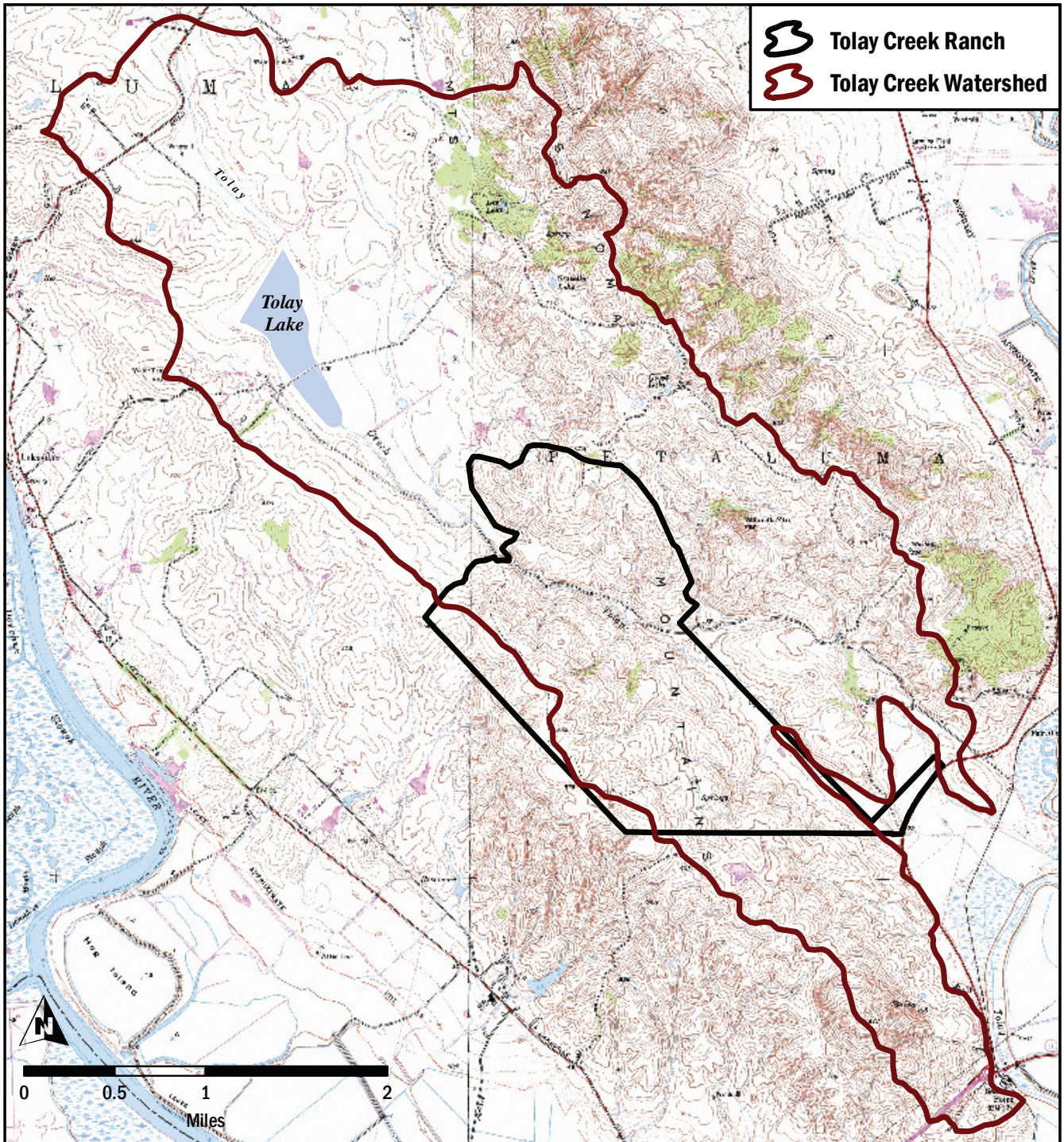
## ENHANCEMENT PLANNING METHODOLOGY

Development of the Tolay Creek Riparian Enhancement Plan was supported by literature and spatial data review, queries of the California Natural Diversity Database, an analysis of historic and current aerial photographs, field surveys, and consultation with Dr. Joan Florsheim, the adjacent land manager and

Figure 1.  
 Watershed Map. Data sources: Sonoma Land Trust & California  
 Interagency Watershed Mapping Committee, Calwater 2.2.



Figure 2.  
Topographic Map. Data sources: Sonoma Land Trust, California Interagency Watershed Mapping Committee & USGS Topographic 7.5 min. Sears Point & Petaluma River Quadrangles.





*Middle Tolay Creek Basin/Upper Tolay Creek Basin transition zone, on Tolay Regional Park property*

Bob Neale of the Sonoma Land Trust. A list of GIS data layers is included as Appendix A.

West Coast Watershed defined the enhancement area as the main stem and major tributaries of Tolay Creek on the Sonoma Land Trust Tolay Creek Ranch (Figure 3. *Property Photograph Location Map*). The *Baseline Geomorphic Assessment of Tolay Creek* (Florsheim, 2008) divides Tolay Creek into three segments, the upper, middle, and lower basins. The upper basin is located northwest of the Sonoma Land Trust property, primarily on Tolay Lake Regional Park property. The middle and lower reaches are located on SLT property. For this plan, the stream corridor was delineated according to Dr. Florsheim's designation of middle basin and lower basin, with further delineation of each reach into revegetation planning zones (Figure 4. *Potential Habitat Enhancement Map*).

Field surveys of Tolay Creek and its major tributaries took place between February and May 2009, and resulted in mapped, written and photographic documentation of the current status of the riparian corridor (eg, corridor extent, plant species composition and abundance, and other habitat features).

Detailed management recommendations were developed from the above data, including geographically explicit information regarding invasive plant control, exclusionary fencing, genetically appropriate native plant revegetation, and minor erosion control. Additional

management recommendations include information on cultural resource enhancement and protection, seasonal cattle access, plant collection and propagation, maintenance, and a long term approach to research and monitoring.

### CURRENT STATUS OF RIPARIAN AREAS

In general, the riparian zones associated with Tolay Creek and its tributaries are highly degraded, characterized by steep, eroding banks and in many places completely devoid of native perennial vegetation. Consultation with long term landowners indicates that the main stem of Tolay Creek experienced rapid loss of riparian vegetation during the early 1990s, and that riparian cover has not re-established since that time (personal communication, Bob Neale, Sonoma Land Trust). Historic aerial photos from 1942, 1961 and 1997 (Appendix B) were not of a high quality resolution, yet do not appear to support this anecdotal evidence.

An initial baseline assessment of Tolay Creek (Florsheim, 2008) indicates that a number of factors may have contributed to changes in the Tolay Creek watershed geomorphology, including land use and natural processes. Hydrologic and geomorphic changes in the upper watershed and Tolay Lake may have influenced the rapid channel incision and bank erosion currently in evidence on the Tolay Creek Ranch. Other potential causes of channel incision and bank erosion are base level lowering and associated headward migration erosion due to marsh subsidence downstream of Highway 121, though the channel is currently aggrading in the area near the Highway 121 bridge.

Current or potential sensitive species and habitats on the property include California red-legged frog (*Rana draytonii*), western pond turtle (*Actinemys marmorata*), Golden Eagle (*Aquila chrysaetos*), fountain death camas (*Zigadenus micranthus* var *fontanus*), Lobb's aquatic buttercup (*Ranunculus lobbii*), Marin dwarf flax (*Hesperolinon congestum*), California golden violet (*Viola pedunculata*), native grasslands, and wetlands (Figure 5. *Sensitive Features Map*).

Cattle currently have access to all of the drainages on the property, leaving little opportunity for natural regeneration of

native species. Cattle graze and trample the vegetation, disturbing the soil, which causes accelerated erosion and provides conditions favorable for invasive non-native plant species and other weeds.

### Mainstem Tolay Creek

Near the upstream property boundary, on the Tolay Lake Regional Park property, Tolay Creek is lined predominantly with young willows, with an occasional mature coast live oak on the upper bank.

Downstream of the property boundary, Tolay Creek in the middle basin is largely denuded of woody vegetation for relatively long reaches, with pockets of mature riparian vegetation interspersed primarily in areas with steeper gradients.

Vegetation in many of the open active channel areas include wetland plants such as common tule (*Scirpus acutus*), marsh baccharis (*Baccharis douglasii*), spikerush (*Eleocharis macrostachya*), sedge (*Carex* spp.) and rush (*Juncus* spp.), as well as a wide assortment of weedy species. Invasive species include Himalayan blackberry (*Rubus armeniacus*), Fuller's teasal (*Dipsacus fullonum*), pennyroyal (*Mentha pulegium*), and black mustard (*Brassica nigra*).

The vegetation in steeper gradient areas consists primarily of red willow (*Salix laevigata*) and arroyo willow (*Salix lasiolepis*) along the low flow channel. Coast live oak (*Quercus agrifolia*), Oregon oak (*Quercus garryana*), and valley oak (*Quercus lobata*) are the dominant riparian tree species on the upper bank, with on occasional California buckeye (*Aesculus californica*), big-leaf maple (*Acer macrophyllum*), and California bay-laurel (*Umbellularia californica*).

Some of the deciduous oaks appear to be valley oak/Oregon oak hybrids and will be referred to as valley oaks in this plan. Valley oak and Oregon oak are in the same subgenus, *Lepidobalanus*. Oaks within the same subgenus can hybridize, especially when two populations overlap, which is often the case in Sonoma County. Hybrid oaks within the same subgenus produce viable acorns. The deciduous oaks in the Tolay Creek watershed often do not have the classic leaf shape of



either valley oak or Oregon oak, leading one to believe they may well be hybrids. The only way to be certain is through genetic testing.

Shrub species include poison oak (*Toxicodendron diversilobum*), snowberry (*Symphoricarpos albus*), and the invasive Himalayan blackberry (*Rubus armeniacus*) as dominants, with an occasional honeysuckle (*Lonicera hispidula*), California wild blackberry (*Rubus ursinus*), California wild rose (*Rosa californica*), and coffeeberry (*Rhamnus californica*).

In the lower portion of middle Tolay Creek basin, as well as the upper portion of lower Tolay Creek basin, vegetation consists primarily of widely scattered thickets of arroyo willow and sandbar willow (*Salix exigua*) along the low flow channel, and mature valley oaks on the upper banks. Channel incision is common, and bank failure is threatening some of the valley oaks (see Photo #16, Figure 7. Habitat Enhancement Map, Tolay Creek Mainstem Zone B).

The section of Tolay Creek in the lower basin below the lower crossing consists of an occasional mature valley oak on the upper banks, with widely scattered arroyo and red willow along the channel (see Photo #5, Figure 6. Habitat Enhancement Map, Tolay Creek Mainstem Zone A). As the valley becomes wider, oaks are absent and woody vegetation consists only of an occasional mature red willow along the channel (see Photo # 1, Figure 6. Habitat Enhancement Map, Tolay Creek

Middle Tolay Creek Basin near northwestern property boundary and upper crossing



Mainstem Zone A). Bank erosion is prevalent along most of the channel (see Photos #3 and #5, Figure 6. *Habitat Enhancement Map, Tolay Creek Mainstem Zone A*), although sediment deposition is occurring in the downstream portion of the zones, near the Highway 121 bridge. Herbaceous vegetation in the open areas is dominated by weedy species and scattered clumps of Himalayan blackberry, with pockets of wetland plants such as common tule (*Scirpus acutus*), spikerush (*Eleocharis macrostachya*), mugwort (*Artemisia douglasii*), sedge (*Carex* spp.) and rush (*Juncus* spp.). Medusahead (*Taeniatherum caput-medusae*) is currently present in the lower Tolay Creek basin and yellow starthistle (*Centaurea solstitialis*) is found throughout the property.

### Tributaries

The Baseline Geomorphic Assessment of Tolay Creek (Florsheim 2008) documents thirteen tributaries within the Tolay Creek watershed. Eight of these tributaries are on the property, four on each side of the Tolay Creek channel. These tributaries appear as blue-line tributaries on USGS topographic maps. In addition to these eight major tributaries, there are numerous seasonal drainages on the property that are beyond the scope of this plan. Erosion is prevalent in most of the tributaries and seasonal drainages on the property. Most of the tributaries are sparsely vegetated with riparian trees and shrubs, with the exception of areas fed by seeps and springs. These areas are typically vegetated with coast live oak as the dominant tree, with an occasional California buckeye, red willow, and California bay-laurel. Dominant shrubs include poison oak, snowberry, and the invasive Himalayan blackberry, with an occasional toyon (*Heteromeles arbutifolia*), honeysuckle, California wild blackberry, California wild rose, coyote bush (*Baccharis pilularis*), and coffeeberry. There are many seeps along the drainages, vegetated with rushes and sedge, along with annual weeds (see Photo #58, Figure 8. *Habitat Enhancement Map, Tolay Creek Tributary Zone T1*). Clumps of Himalayan blackberry are fairly common.

Tributary 1 consists of a relatively large watershed with headwaters including the serpentine area on the property, as well as numerous springs. Soils are erosive and bank erosion is common (see Photos #52-55, Figure 8. *Habitat*

*Enhancement Map, Tolay Creek Tributary Zone T1*). The lower portion is largely denuded, with an occasional valley oak, red willow, and Himalayan blackberry. Portions of the upper riparian zone are well vegetated, particularly the southernmost tributary, which is dominated by oaks and an occasional California buckeye, red willow, and California bay-laurel.

Tributary 2 is primarily denuded of woody species with the exception of several stands of oak and an occasional willow (see Photos #59a & 59b, Figure 9. *Habitat Enhancement Map, Tolay Creek Mainstem Zone C, Tributary Zones T2, T5 & T6*). There are scattered clumps of poison oak and Himalayan blackberry along the mid to lower portions of the channel.

Tributary 3 is well vegetated with mature riparian vegetation dominated by coast live oak, with the exception of the upper reach. The upper reach is primarily denuded of woody vegetation, with the exception of Himalayan blackberry.

Tributary 4 is primarily denuded of woody species with the exception of a stand of coast live oak and an occasional willow. There are scattered clumps of poison oak and Himalayan blackberry along the mid to lower portions of the channel.

The majority of Tributary 5 is along the vineyard on the adjacent property retained by the Roche family. The confluence of Tributary 5 with Tolay Creek, extending upstream for several hundred feet is located on the SLT property. This portion of the drainage is lined with rotting stumps of formerly planted eucalyptus or Monterey pine (see Photo #33b, Figure 9. *Habitat Enhancement Map, Tolay Creek Mainstem Zone C, Tributary Zones T2, T5 & T6*). The entire reach of Tributary 5 is primarily denuded of woody vegetation. A culvert and ranch road crossing is located near the confluence (see Photo #33a, Figure 9. *Habitat Enhancement Map, Tolay Creek Mainstem Zone C, Tributary Zones T2, T5 & T6*).

Tributary 6 is predominately on adjacent properties, with the exception of the confluence with Tolay Creek, extending upstream for several hundred feet. The upper portion of the drainage appears to be well vegetated with riparian vegetation. A

large stand of mature blue gum eucalyptus is located along the channel to the east of the SLT property. There is another stand of blue gum eucalyptus at the confluence of Tributary 6 and Tolay Creek on the property (see Photo #34 and #35, Figure 9. *Habitat Enhancement Map, Tolay Creek Mainstem Zone C, Tributary Zones T2, T5 & T6*).

Tributary 7 is largely denuded of trees near the confluence with Tolay Creek, as well as the eroded upper reaches. The mid-portion of the drainage, extending approximately 1,000 feet, is vegetated with mature riparian vegetation consisting primarily of coast live oak, Oregon oak, California bay-laurel, and willow. A small infestation of the invasive black mustard is currently within the riparian zone.

Tributary 8 is largely denuded of trees near the confluence with Tolay Creek, as well as the upper reaches (see Photo #42, Figure 10. *Habitat Enhancement Map, Tolay Creek Mainstem Zone D, E & F, Tributary Zones T7 & T8*). There is a relatively small stand of trees consisting primarily of coast live oak and red willow below a seep in the middle section. Yellow starthistle and black mustard are currently within the riparian zone.

**RIPARIAN ENHANCEMENT AND MANAGEMENT RECOMMENDATIONS**

Given the highly degraded state of the riparian habitat along the main stem and tributaries of Tolay Creek, there are many enhancement opportunities on the property which can be accomplished via exclusionary fencing, invasive plant removal, native plant revegetation, and minor erosion control. Potential enhancement areas have been prioritized and can be implemented over time, using a phased approach. At a minimum, the Tolay Creek riparian corridor should be fenced in the conceptual configuration shown in Figure 4, Potential Habitat Enhancement Map. This configuration can be modified in the field by SLT staff and collaborators, and it is recommended that the proposed fencing layout be flagged first, followed by a field review with a variety of partners — including Regional Parks, SCAPOSD, NRCS, CDFG, USFWS, the grazing leasee, tribal representatives, fluvial geomorphologists and restoration ecologists. Fenced areas can be

assessed after fence installation to determine the degree of natural regeneration of native habitat and the need for native plant revegetation. Active native plant revegetation is expected to substantially accelerate the enhancement of the riparian zone and the associated increase in biological diversity.

Priority areas for habitat enhancement (Figure 4. *Potential Habitat Enhancement Map*) include the entire reach of Tolay Creek on the property as well as portions of several of the tributaries. If the budget does not allow for revegetation of the entire recommended areas depicted on the Potential Habitat Enhancement Map, the following areas should be given the highest priority: lower Tolay Creek basin (Zones A-1/A-2), the uppermost portion of middle Tolay Creek basin (Zones F-1/F-2), and Tributary 1 (Zones T1 A-D). Zones A-1 and A-2 are almost completely denuded of woody vegetation with the exception of a few isolated mature red willows, and the invasive Himalayan blackberry. Zones F-1 and F-2 contain potential habitat for the red-legged frog and western pond turtle (LSA 2009). These zones should be fenced and revegetated, in an effort to create cover around potential breeding habitat. Tributary 1 is a priority, as erosion is pervasive along most of the watercourse, the watershed contains sensitive species, and most of the channel banks are denuded. Following is a table that summarizes the habitat enhancement recommendations and project prioritization.

<b>ZONE</b>	<b>ENHANCEMENT ACTIVITY</b>	<b>PRIORITY</b>	<b>PRIORITY OBJECTIVE / (CONSTRAINTS)</b>
A-1/A-2	Riparian revegetation, invasive plant removal	high	To provide bank protection and channel structure along primarily denuded stream reach.
B-1/B-2	Riparian revegetation, invasive plant removal	high	To provide bank protection, channel structure and habitat enhancement.
C-1/C-2	Riparian revegetation	medium	To provide bank protection, channel structure and habitat enhancement.
D-1/D-2	Riparian revegetation, invasive plant removal	medium	To provide bank protection, channel structure and habitat enhancement.
E-1/E-2	Riparian revegetation	high	To provide bank protection, channel structure and habitat enhancement.

**TABLE 1. HABITAT ENHANCEMENT RECOMMENDATIONS AND PROJECT PRIORITIZATION**

F-1/F-2	Riparian revegetation	high	To provide habitat enhancement for sensitive species.
T1 (A-D)	Upland habitat & oak revegetation	high	To provide bank protection along primarily denuded tributary and habitat enhancement for sensitive species.
T2-A/T2-B	Habitat protection	low	Habitat protection (limited access to water sources)
T5-A/T5-B	Habitat protection	low	Habitat protection (limited access to water sources)
T6-A/T6-B	Habitat protection	low	Habitat protection (limited access to water sources)
T7-A/T7-B	Upland habitat & oak revegetation, invasive plant removal	medium	Habitat enhancement
T8-A/T8-B	Upland habitat & oak revegetation, invasive plant removal	medium	Habitat enhancement

**Habitat Enhancement Approach & Conceptual Schedule**

The enhancement strategy for Tolay Creek is to replicate a natural riparian ecosystem and floodplain riparian oak woodland. A successful native habitat enhancement project will establish a diversity of plant types and species, enhance biological diversity, as well as reduce erosion and sediment contributions to aquatic and wetland systems. Once established - generally after three to five years - the project should require a minimal amount of management.

Exclusionary fencing and invasive plant removal are two critical management activities that are recommended to ensure the success of the native plant habitat enhancement efforts. Fencing is recommended as the first phase of the enhancement effort, with invasive plant control taking place immediately thereafter, followed by native plant revegetation. Although native plant revegetation is recommended to take place after the implementation of fencing and initial invasives control, native plant seed collection and the propagation of container plants can start as early as the summer of the first year. Following is a conceptual schedule for phased implementation for each zone:

**TABLE 2. CONCEPTUAL SCHEDULE FOR PHASED IMPLEMENTATION**

TIMEFRAME	ACTIVITY
Summer/Fall	secure required permits
	install exclusionary fencing
	remove blackberry (if using herbicide)
	collect native seeds from watershed
	baseline documentation/data collection for ongoing research
Winter	install container plants, willow sprigs, direct seeds and emergent transplants (note: genetically appropriate container plants require up to 18 months from collection to installation)
	hand removal of invasive plants
Spring	monitoring

**Riparian Exclusionary Fencing**

The intent of riparian fencing on the property is to mostly exclude cattle from the riparian zone until natural regeneration and/or active revegetation become established enough to withstand grazing pressure. Ten years is often adequate for fast growing riparian species. Oaks grow more slowly and may require additional time beyond ten years to allow the saplings to become mature enough to withstand impacts from cattle. Excluding cattle from the riparian zone will minimize the bank erosion caused by cattle and allow for natural regeneration, as well as protect native plants installed during revegetation efforts. Limited-duration seasonal access into the exclusionary fencing zones is recommended in June and August. Optimum timing of limited riparian grazing will depend on seasonal weather patterns and should be monitored closely to limit impacts to the creek and channel banks. Water troughs should be provided for the cattle within the fenced zone to discourage the need for the animals to access the creek.

The highest priority areas recommended for riparian fencing are shown in Figure 4. Potential Habitat Enhancement Map, with fencing locations being approximate. To limit costs, existing fences near the riparian zones have been incorporated into the proposed riparian fence system. The existing fence

along Mangel Ranch Road is currently functional, but in fair to poor condition.

When designing the fence, the topography should be considered to avoid dips and minimize corners, which increase the cost. The cattle operator on the property should be consulted with during the design phase to ensure concerns regarding cattle movement and water provision are addressed. The design should incorporate gates to allow for access to crews to perform planting, plant maintenance, and invasive plant control and other resource stewardship activities. Fencing across the channel is challenging, requiring regular maintenance during the rainy season, as debris during high flows often gets caught in the crossing. Cross channel fencing can be temporary and removed during periods of high flow. The fence should be maintained on a regular basis to ensure its effectiveness in restricting access by cattle, as well as for the well being of any cows that may become trapped inside. As budget allows, and as information becomes available from ongoing research and monitoring, fencing around additional drainages should be considered to address cattle-related erosion.

### Invasive Plant Species

Invasive plants, sometimes referred to as “transformer” species, displace native species, change plant community structure, and reduce the value of habitat for wildlife (Bossard et al, 2000). Invasive plants may also disrupt physical ecosystem processes such as fire regimes, erosion and sedimentation, nutrient cycling, and light availability. Early detection and rapid response are the most effective and cost efficient responses to invasive species, after prevention. The ultimate objective of controlling invasive species within the riparian zone on the property is to preserve or restore a functioning riparian ecosystem. It is therefore important to adequately control invasive plant species to a degree that will allow for the establishment of native species. Eradication of the invasive species prior to revegetation is preferable, but not always practical, and ongoing monitoring and suppression of the invaders is usually required.

Species rated High by the California Invasive Plant Council (Cal-IPC) within the riparian

zones on the property include Himalayan blackberry (*Rubus armeniacus*), medusahead (*Taeniatherum caput-medusae*), and yellow starthistle (*Centaurea solstitialis*). These species generally have “severe ecological impacts on physical processes, plant and animal communities, and vegetation structure” (California Invasive Plant Council 2006). Himalayan blackberry is widely scattered along the channel banks of Tolay Creek and most of the tributaries. It is currently being kept in check by cattle grazing and possibly, deer browse. This species is likely to become much more widespread after cattle are excluded by fencing the riparian zones, requiring an immediate and comprehensive response. Medusahead and yellow starthistle are located primarily in the upland areas out of the riparian zones. These species are aggressive invaders and should be monitored, and a detailed plan developed for their control.

Species rated Moderate by Cal-IPC within the riparian zones on the property include purple star thistle (*Centaurea calcitrapa*), Italian thistle (*Carduus pycnocephalus*), bull thistle (*Cirsium vulgare*), Fuller’s teasal (*Dipsacus fullonum*), black mustard (*Brassica nigra*), pennyroyal (*Mentha pulegium*), and blue gum eucalyptus (*Eucalyptus globulus*). Moderate rated species “have substantial and apparent, but generally not severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and their attributes are conducive to moderate rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread” (California Invasive Plant Council 2006). These species should be monitored on a regular basis and treated proactively if threatening the riparian zones.

Methods recommended by Cal-IPC, The Nature Conservancy, and CDFG to control many invasive species can be found on the following websites:

[www.cal-ipc.org/ip/management/plant\\_profiles/index.php](http://www.cal-ipc.org/ip/management/plant_profiles/index.php)

<http://tncinvasives.ucdavis.edu/esadocs.html>

[www.cdfa.ca.gov/phpps/ipc/weedinfo](http://www.cdfa.ca.gov/phpps/ipc/weedinfo)

Whatever control method is used, a qualified ecologist should carefully manage its implementation so that impacts to sensitive areas and special status species are avoided. If using herbicides, weed whackers, or mowers, the applicator or operator should be well trained and adept at identifying and distinguishing between native and non-native species. When using herbicides, the directions on the label should always be followed, and the licensed applicator must know and follow all state and local regulations. The Sonoma County Agricultural Commissioner's office is responsible for enforcing the regulations set by the California Department of Pesticide Regulation, and is available for consultation.

The landowner is always responsible for informing all agencies of planned work within a riparian zone. The California Department of Fish and Game is the lead agency for riparian vegetation management projects. Such projects come under Fish and Game Code 1603, and may require a Streambed Alteration Agreement. Small amounts of vegetation removal and replanting may not require a Streambed Alteration Agreement, but it is still necessary to notify the Department of Fish and Game to determine if an Agreement is necessary.

In addition, the Regional Water Quality Control Board may need notification if the vegetation removal would result in soil erosion, and/or runoff of pesticides into the stream (due to removal of a vegetative buffer). Typically in an agricultural setting, the use of heavy machinery within the riparian zone to change the grade, bank slope or to remove vegetation requires a water quality permit. On the other hand, the use of work crews to prune and cut plants typically does not require a permit from the Regional Board. Exceptions may occur when the waterway is known to support one or more endangered species.

### **Invasive Wildlife Species**

The American bullfrog (*Rana catesbeiana*) has been documented on the property in the seasonal pond at the headwaters of Tributary 1 (see *Figure 4: Potential Habitat Enhancement Map*). The American bullfrog was first introduced to California in 1895 for its meaty legs and to augment the declining

native red-legged frog, whose populations were already suffered from over-harvesting. Today, this invasive species can be found in many of the ponds, lakes, and slow-moving streams in California, including Tolay Lake. In California, the American bullfrog preys on spadefoot toads, red-legged and yellow-legged frogs, young western pond turtles as well as native fish and waterfowl chicks.

## **Native Plant Revegetation**

### **Revegetation Zones**

The entire riparian corridor of Tolay Creek and its major tributaries on the Tolay Creek Ranch, consisting of twelve revegetation zones, should be considered for native plant revegetation (*Figure 4. Potential Habitat Enhancement Map, and Figures 6-10, Habitat Enhancement Maps by zone*).

Zones A-1, A-2, B-1, and B-2 are located in the lower Tolay Creek basin. Zones C-1, C-2, D-1, D-2, E-1, E-2, F-1, and F-2 are located in the middle Tolay Creek basin. Delineation of the zones was derived from differences in channel gradient and vegetation. Zones including the number 1 are on the right side of the channel if facing upstream, and zones that include the number 2 are located on the left side of the channel.

Tributary 1 includes four revegetation zones (1-A through 1-D). A gap in the proposed riparian fence to allow cattle to pass separates Zones 1-A/1-B and 1-C/1-D. Revegetation zones on Tributaries 2, 5, 6, 7, and 8 are located in the lower reaches of the drainages, where the riparian areas are largely denuded of woody vegetation and soil moisture is retained further into the dry season than most of the upper reaches. Zones that include the letter A or C are on the right side of the drainage if facing upstream. Zones that include the letter B or D are on the left side of the drainage.

### **Revegetation Approach**

Appendix C — Tolay Creek Native Plant Revegetation Details and Plant Lists describes the number of plants recommended per zone by species, with detailed information regarding spacing, installation method and container (propagation method). A total of 3,913 plants are specified for Tolay Creek and 945 plants

for the tributaries. Appendix D provides a cost estimate for the Tolay Creek revegetation.

The native plant revegetation approach is intended to closely replicate the natural system, by planting primarily oaks on the upper portions of the riparian zone with associated tree species including California buckeye and an occasional big-leaf maple. The density of the tree species should be higher in proximity to the channel to mimic natural conditions. The open areas further from the channel will be planted with clusters of oaks, leaving open areas between clusters. Shrub placement should be in ecologically appropriate locations along the channel that are devoid of native vegetation. Detailed specifications for plant placement will be developed in the field just prior to installation, with color-coded flags depicting the installation location for individual plants. Flagging layout will reflect the most appropriate location for individual plants, based on the specie's life history and physiological requirements. Plant location flagging should be performed by a professional qualified in ecological restoration, with knowledge of local habitats and ecosystems.

Although California bay-laurel is located on the property, it should not be considered in the revegetation effort as it can support substantial *Phytophthora ramorum* sporulation on its leaves, the fungus that causes Sudden Oak Death (SOD). Contaminated bay-laurel may contribute greatly to the spread of the pathogen onto more susceptible plants, including coast live oak (California Forest Pest Council 2008). Several mature coast live oaks symptomatic of SOD were noted on the west side of Tolay Creek during the fieldwork for this plan.

Shrub candidates include California wild rose, California blackberry, coffeeberry, snowberry, and coyote bush. Although no blue elderberry (*Sambucus mexicana*) or hawthorn (*Crataegus douglasii*) were noted on the property, they are included in the recommended plant list as they occur within the Tolay Creek watershed at Tolay Lake Regional Park, and are considered valuable to wildlife.

This revegetation plan does not address the area around the lower crossing. After an engineered design has been completed, a

revegetation plan associated with the construction of the crossing may be developed.

### Revegetation Techniques

Recommended revegetation techniques for the property include direct seeding, installation of dormant willow cuttings or sprigs, transplanting emergent wetland plants, and installing container plants. These techniques are described below and shown graphically in Appendix C — Tolay Creek Native Plant Revegetation Details and Plant Lists. By using several techniques, genetically appropriate native plant revegetation can be implemented in phases over several years. Container plants and plants installed with the direct seed method will need to be irrigated regularly during the dry season, typically from late April through October, until the plants become established.

### Direct Seed Method

Oak species and California buckeye can be planted by the direct seed method. This method entails collecting ripe seed within the watershed in the fall, and planting the seed when soil conditions are favorable during the same season. The advantage of this method is it eliminates nursery costs. The disadvantage is the seeds are subject to rot, drying up, and predation. The direct seed method depends on an adequate seed crop and may have to be performed several years in succession if seed is not available in the desired year.

### Willow Sprigging

Revegetation using willow species can be performed by taking dormant 2.5 – 4 foot cuttings from parent plants within the watershed, keeping them cool and moist, and installing them along the channel banks within a day or two after collection. Willows should be collected when dormant – usually December-January. The placement should be in pockets of sediment above the low flow channel (see Photo #2, Figure 6. Habitat Enhancement Map, Tolay Creek Mainstem Zone A). Because of the possibility of sprigs being washed out during high flows, sprigs should be placed at least two feet into the soil, with only a small portion of the sprig protruding above the soil. Another alternative (which may reduce the likelihood of washout and ensure the safety of personnel) is to propa-

gate willows as container plants and install them at the end of the rainy season during February and March. Willows should generally be installed in clusters of 4-6 sprigs per cluster, alternating between red willow and arroyo willow. Areas with emergent plants already established should be avoided.

Willow material should be collected within the watershed. It may be necessary to request permission from Sonoma County Regional Parks to collect material at Tolay Lake Regional Park if adequate material is not available on the Tolay Creek Ranch property. To ensure the willow sprig is installed deep enough, it is important that the collected material is as straight as possible.

#### **Emergent Transplant Installation**

Wetland species, such as those in the *Carex*, *Eleocharis*, *Scirpus* and *Juncus* genera can be collected from abundant, thriving, local populations, taking only a portion of the plant, including the root system, and transplanted in ecologically appropriate locations. Transplanting of emergents should be performed during the winter or early spring when soil conditions are moist or saturated. If herbaceous areas along the channel do not naturally regenerate after excluding cattle, transplanting emergent vegetation is a cost-effective means of revegetation.

#### **Container Plant Installation**

This method generally requires a one to two year timeframe as it depends on collecting seed or cuttings, propagating the seed or cuttings in a specialized native plant nursery, potting up the propagules into containers, and outplanting the seedlings the following wet season.

If planted above the area that typically floods, plant protection and weed mats are recommended. Weed mats should be at least 3 foot by 3 foot, and made of a material that does not breakdown for at least three years. The fiber of the material should not unravel, as reptiles can get trapped in the fabric of some materials used for weed mats. Consultation with the California Department of Fish and Game is recommended regarding an acceptable weed mat material. Container plants protected by hardware are extremely susceptible to damage caused by cattle.

Restricting cattle from these areas is critical until the plants become well established and tree species are tall and sturdy enough to withstand grazing and rubbing by cattle.

#### **Seed Collecting and Plant Propagation**

Seeds and cuttings should be collected from the Tolay Creek watershed, as close to the project site as possible to ensure the genetic integrity of the plant material, as well as adaptations to local soil and climate conditions. Seed can be collected for most species only during the fall, so planning ahead is important. Seed should be delivered for propagation to a nursery specializing in native plants and grown in containers designed for restoration, or collected via contract with a native plants nursery. Plants are typically ready for outplanting the following fall/winter.

#### **Maintenance**

A proactive maintenance program is key to the success of a revegetation project, particularly in an environment such as Tolay Creek, where there are numerous weed species that thrive due to soil disturbance by cattle, along with the increased levels of nitrogen from cattle manure. Lack of sufficient maintenance is often the underlying reason for a revegetation project failure. The budget for a project should always include funding and sufficient time allowance for monitoring and maintenance. Maintenance costs are often at least as much as the initial implementation costs.

The riparian zone is currently dominated by annual weed species that are likely to grow prolifically after the areas are fenced and grazing pressure is reduced. Tall weeds within planting zones should be mowed prior to plant installation and should be controlled immediately around the weed mats until the plants become established, typically in two to three years. Hand weeding around individual plants is recommended several times a year, typically twice during the spring months and once during the summer.

Container plants and direct seed plantings should be irrigated regularly during the dry season, typically from late April through October, until the plants become established. This is generally done approximately every seven to ten days, depending on weather

conditions. Irrigation amount should be the minimum amount necessary to keep the plants healthy, typically  $\frac{1}{4}$  to  $\frac{1}{2}$  gallon per plant if hand watering, and up to one gallon per plant if using a temporary drip system.

Installing a temporary drip system will require a dependable water source during the dry season. Springs on the property could be developed as water sources, and there may be a possibility of hooking up a temporary system to the system supplying irrigation to the vineyard. Any above ground drip line is highly susceptible to damage by cattle, and possibly rodents, and must be monitored on a regular basis.

Many deer were observed on the property during the fieldwork for this plan. If deer browse on targeted native saplings is extensive, deer browse can be temporarily controlled by applying animal repellents to the foliage of seedlings. Deer repellents should be applied just before bud break and at several month intervals during the active growing period as needed.

It is critical to the success of revegetation efforts that cattle be restricted from the revegetation zones after plants are installed — if cattle are provided with seasonal access to the exclusionary zones, their behavior and impacts to the project should be carefully monitored, and evaluated.

## CLIMATE CHANGE

Enhancement efforts at Tolay Creek offer an opportunity to evaluate climate mitigation and adaptation activities. In terms of mitigation, SLT could evaluate the carbon sequestration value of the project using the criteria established by the Climate Action Reserve in its Forest Protocols, while accounting for the many co-benefits related to biological diversity enhancement. SLT could also consider participating in regional research projects related to adaptation — including species movement and resiliency in response to climate change.

## RESEARCH, MONITORING AND ADAPTIVE MANAGEMENT

### Research

There are numerous opportunities for research associated with the habitat enhancement program on the Tolay Creek Ranch, including documentation of change resulting from the management practices implemented along the riparian corridor. This plan includes a proposed conceptual experiment to evaluate the biodiversity benefits associated with cattle exclusion, invasive plant removal, and active native plant revegetation, as well as the timing of these benefits. Additional consultation with local scientists may result in revision/refinement of the proposed experiment.

It is hoped that experimental data will inform decisions about investments in active management choices - such as fencing and native plant revegetation - versus more passive approaches such as natural regeneration. It is also hoped that the experiment will inform decisions about the combination of approaches that may be most appropriate at this and similar sites.

The experimental design proposes the following treatments to evaluate the above management strategies:

Treatment A: exclusionary fencing with no revegetation (natural regeneration)

Treatment B: exclusionary fencing, native plant revegetation

Treatment C: no exclusionary fencing, native plant revegetation

Treatment D: CONTROL - no exclusionary fencing, no revegetation (natural regeneration)

Plots will be arrayed in 200 foot sections along Zone A, will be of the same size and cross-sectional orientation along the stream channel, and will receive invasive plant suppression treatments prior to implementation of the experiment. Those plots receiving the native plant revegetation treatment will have equal numbers of the same species installed at similar elevations and distances from the low flow channel. There are four proposed replicates of each plot.



Baseline data should be gathered prior to experimental implementation, including plant cover and plant species composition and abundance for each plot, as well as cross-sectional data to determine the elevation and distance of each plot from the low flow channel. Additional data should include the date of plot establishment and the location of all plots longitudinally along Tolay Creek. The experiment should be monitored for at least five years, with data evaluated using appropriate statistical methods.

Other data to be gathered during the baseline and subsequent monitoring of the experimental plots and the other habitat enhancement areas may include the following:

- fluvial-geomorphic parameters recommended by Dr. Joan Florsheim
- vertebrates species composition and abundance
- invertebrates (aquatic and terrestrial) species composition and abundance
- bird species composition and abundance
- mammal species composition and abundance

**Monitoring**

Development of a detailed monitoring plan is recommended, and should include a photo-monitoring component that follows the approach outlined in Appendix E — photo-monitoring protocol. Monitoring of the non-experimental elements of the habitat enhancement program should be adequate to determine whether specific objectives are being met. In the case of native plant revegetation zones, the objective is to replicate riparian habitat typical of un-degraded landscapes in this region. In the absence of high quality reference sites along Tolay Creek, the target for the riparian corridor of Tolay Creek might be a corridor characterized by a specified number of species, reproducing on site, representing a variety of successional stages and habitat types.

Monitoring parameters for the native plant revegetation zones should include percent survival by species, and ocular estimates by planting zone of relative cover of native and invasive plant species. Both planted and naturally regenerating species should

be documented. Additional monitoring parameters might include reproductive status of plants in each zone (e.g., are they producing seeds or propagules, and are these seeds/propagules establishing new plants?), and photo-documentation of each zone.

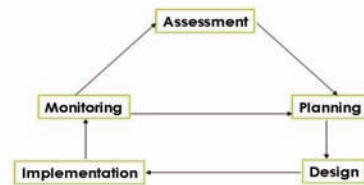
General monitoring should be performed during each maintenance visit. Plant vigor should be evaluated, paying particular attention to signs of drought stress, over watering, disease, and browse. Invasive species within the revegetation zones should be documented and treated proactively. If mortality is high, replacement planting may be recommended.

After several years of monitoring following implementation, untreated drainages should be assessed for habitat enhancement opportunities. Natural regeneration may reduce the need for revegetation of some species.

**Adaptive Management**

Adaptive management — the ongoing refinement of the management approach based on data collection — is especially appropriate for habitat enhancement programs of this magnitude. Given the limited funding available for ecological restoration, applied experimentation and ongoing data collection can help to guide the investment of staff time and funding and enhance the project’s likelihood of success. The Tolay Creek Riparian Enhancement program is a prime candidate for an adaptive management approach, given the importance of the watershed, the connection of this property with other conserved lands, the incredibly degraded nature of the riparian corridor, and the capacity of Sonoma Land Trust and its partners to garner funding to implement a long-term, scientifically rigorous approach to ecological restoration.

Comprehensive Process for Ecological Restoration: the Adaptive Management Model



**WATERSHED-WIDE MANAGEMENT AND POTENTIAL PARTNERSHIPS**

There are numerous opportunities for partnering both within and beyond the boundaries of the Tolay Creek Ranch in order to enhance the biological diversity of the Tolay Creek watershed and the region.

Volunteers can be utilized for native plant revegetation, maintenance, and general monitoring. Training, or preferably direct supervision by a professional with restoration experience is recommended. Substantial cost saving measures can only be made with dedicated commitment by a volunteer force. Otherwise, the cost of training and supervision will likely offset any productive work. Tasks suitable for adult volunteers include, revegetation, hand-weeding around plants, protective hardware maintenance, monitoring the condition of the riparian fence, and general monitoring of the revegetation planting. Detailed record keeping is an important communication tool.

Environmental education opportunities for high school students include being involved in a limited amount of revegetation, plant maintenance, and monitoring. Children below high school age can perform direct seed and container plant installation, as well as hand watering, with one-on-one supervision by trained high school students or adults.

Because the Tolay Creek Ranch is contiguous with several other publicly owned or protected lands that are in the process of being evaluated for enhancement, it is critical that enhancement efforts on Tolay Creek Ranch are considered in this larger regional context. The impact of the enhancement activities on the property are likely to be much more profound if planned and implemented in concert with stewardship actions on the roughly 21,000 acres that are currently conserved or protected in the area.

The following table outlines potential partners and resources that may be relevant to Tolay Creek riparian enhancement efforts.

**TABLE 3. POTENTIAL PARTNERS AND RESOURCES**

ENTITY	DATA	TECHNICAL ASSISTANCE	FUNDING	VOLUNTEERS
US Fish and Wildlife Service (USFWS)	x	x	x	
Sonoma County Regional Parks (SCRPD)	x	x		x
Sonoma County Ag Preservation & Open Space (SCAPOS)	x	x	x	
Natural Resources Conservation Service (NRCS)				
California Department of Fish & Game (CDFG)				
Federated Indians of the Graton Rancheria (FIGR)	x	x		x
Southern Sonoma RCD	x	x		x
Community Foundation Sonoma County			x	
Sonoma State University	x	x		x
UC Berkeley/UC Davis	x	x		x
Santa Rosa Junior College	x			x
Miscellaneous NGOs	x	x		x

In the interest of gaining economies of scope and scale, as well as the effective sharing of information and resources, SLT might consider the formation of a Tolay Creek watershed advisory committee that evaluates data and enhancement opportunities in the watershed and the larger region. This committee — comprised potentially of the above listed groups — could meet regularly to share information and cooperatively plan for enhancement in the watershed and region, taking into account data and priorities from a variety of sources and perspectives. This collaborative approach to planning would by its nature integrate multiple objectives (e.g., physical, biotic, cultural, socio-economic) with the outputs from this integrated planning approach having a higher likelihood of being successful and of attracting funding.

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Agricultural Preservation and Open Space District. A.R.S Project 01-025. 17 pp.

Bossard, Carla C. et al. 2000. *Invasive Plants of California's Wildlands*. University of California Press.

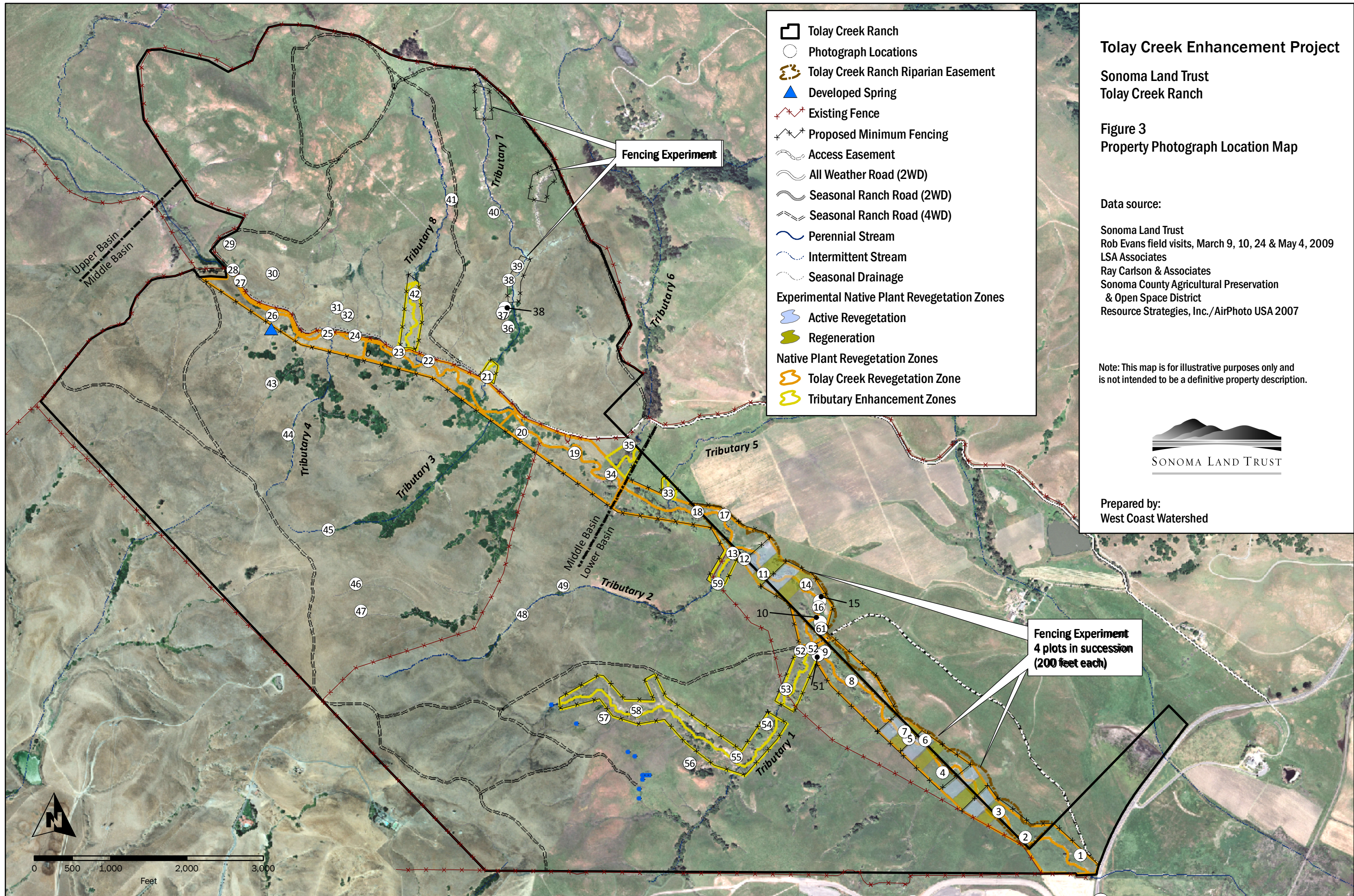
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LSA Associates (LSA). 2009. A Cultural Resources Study of the Tolay Creek Ranch near Petaluma, Sonoma County, CA.

LSA Associates, Inc. 2009. *Biological Resources Study, Tolay Creek Ranch, Sonoma County, California*. 56 pp.



# Tolay Creek Enhancement Project

Sonoma Land Trust  
Tolay Creek Ranch

Figure 4  
Potential Habitat Enhancement Map

Data source:

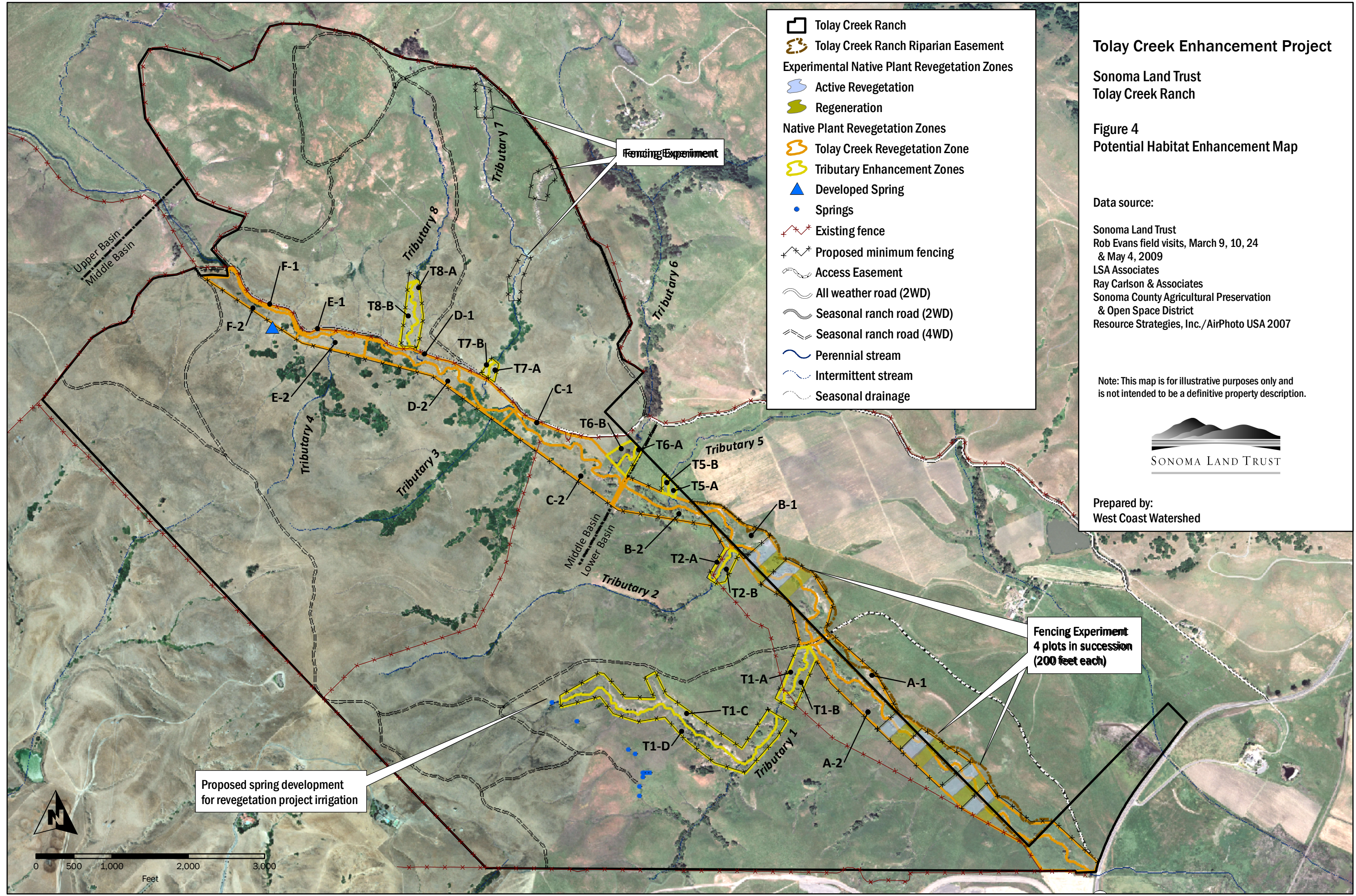
Sonoma Land Trust  
Rob Evans field visits, March 9, 10, 24  
& May 4, 2009  
LSA Associates  
Ray Carlson & Associates  
Sonoma County Agricultural Preservation  
& Open Space District  
Resource Strategies, Inc./AirPhoto USA 2007

Note: This map is for illustrative purposes only and  
is not intended to be a definitive property description.



Prepared by:  
West Coast Watershed

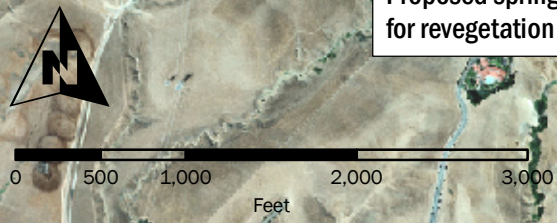
- Tolay Creek Ranch
- Tolay Creek Ranch Riparian Easement
- Experimental Native Plant Revegetation Zones**
- Active Revegetation
- Regeneration
- Native Plant Revegetation Zones**
- Tolay Creek Revegetation Zone
- Tributary Enhancement Zones
- Developed Spring
- Springs
- Existing fence
- Proposed minimum fencing
- Access Easement
- All weather road (2WD)
- Seasonal ranch road (2WD)
- Seasonal ranch road (4WD)
- Perennial stream
- Intermittent stream
- Seasonal drainage

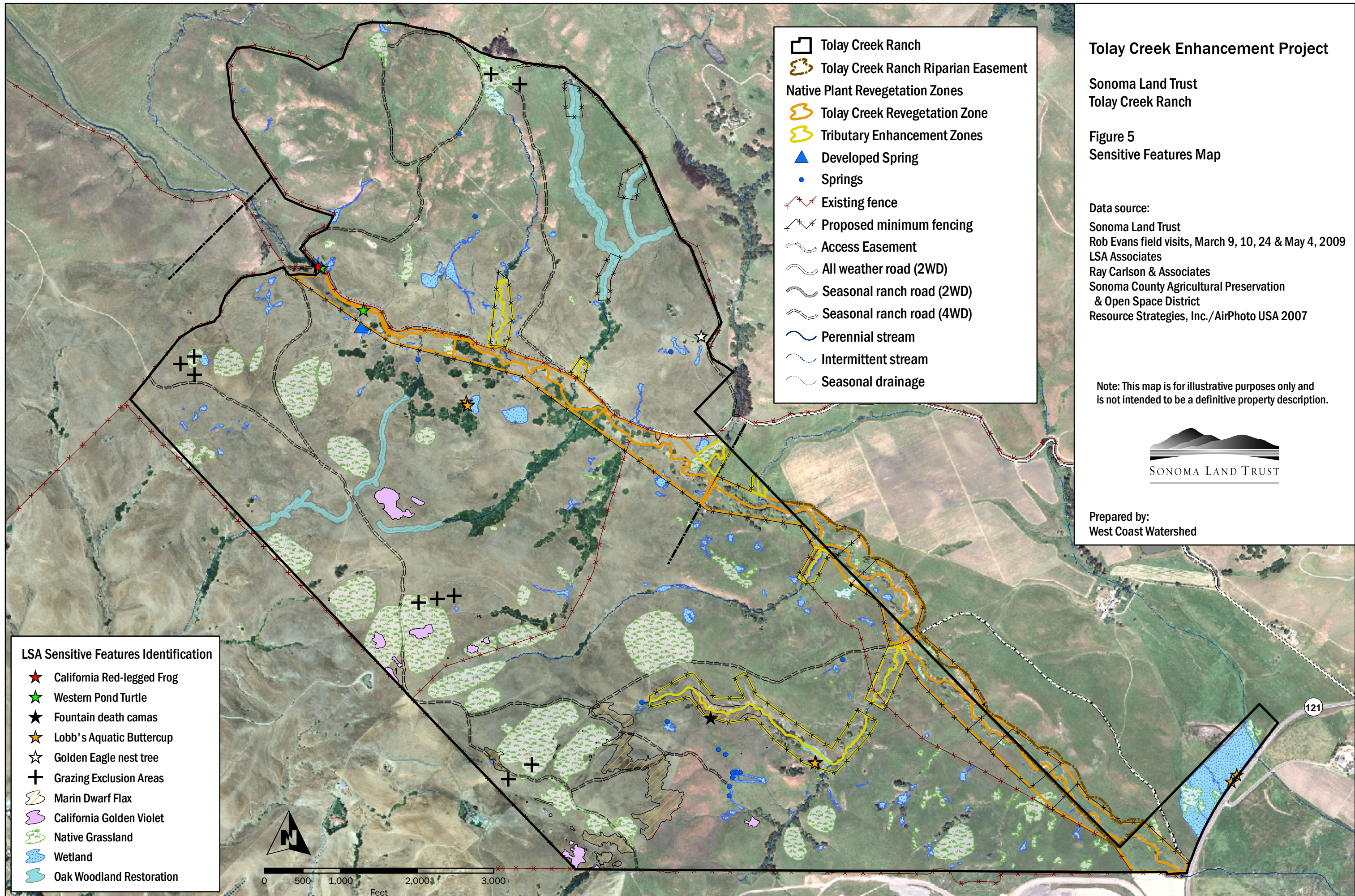


Fencing Experiment

Fencing Experiment  
4 plots in succession  
(200 feet each)

Proposed spring development  
for revegetation project irrigation





- Tolay Creek Ranch
- Tolay Creek Ranch Riparian Easement
- Native Plant Revegetation Zones**
- Tolay Creek Revegetation Zone
- Tributary Enhancement Zones
- Developed Spring
- Springs
- Existing fence
- Proposed minimum fencing
- Access Easement
- All weather road (2WD)
- Seasonal ranch road (2WD)
- Seasonal ranch road (4WD)
- Perennial stream
- Intermittent stream
- Seasonal drainage

**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Figure 5  
Sensitive Features Map

Data source:  
Sonoma Land Trust  
Rob Evans field visits, March 9, 10, 24 & May 4, 2009  
LSA Associates  
Ray Carlson & Associates  
Sonoma County Agricultural Preservation  
& Open Space District  
Resource Strategies, Inc./AirPhoto USA 2007

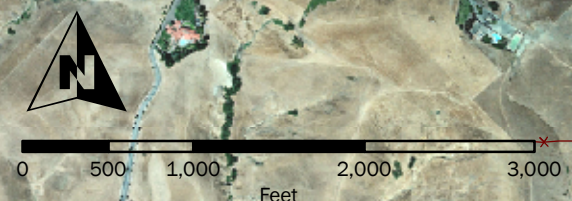
Note: This map is for illustrative purposes only and is not intended to be a definitive property description.



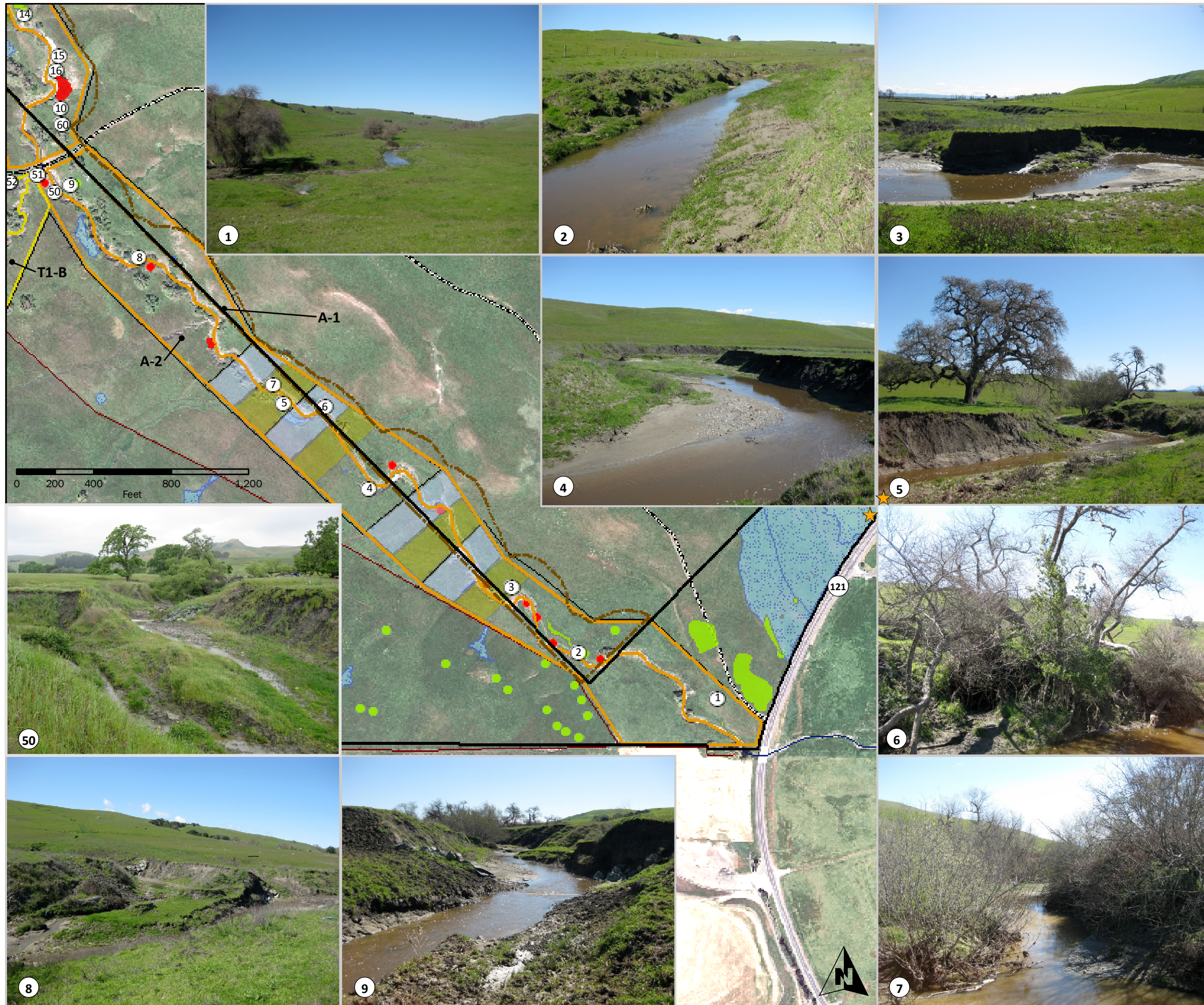
Prepared by:  
West Coast Watershed

**LSA Sensitive Features Identification**

- California Red-legged Frog
- Western Pond Turtle
- Fountain death camas
- Lobb's Aquatic Buttercup
- Golden Eagle nest tree
- Grazing Exclusion Areas
- Marin Dwarf Flax
- California Golden Violet
- Native Grassland
- Wetland
- Oak Woodland Restoration



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# Tolay Creek Enhancement Project

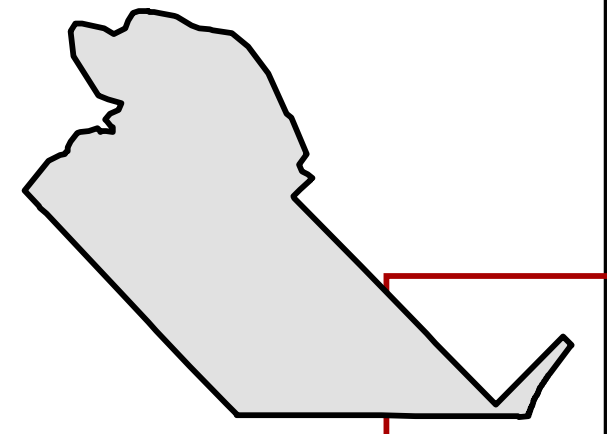
Sonoma Land Trust  
 Tolay Creek Ranch  
 Figure 6  
 Habitat Enhancement Map  
 Tolay Creek Mainstem Zone A

- Tolay Creek Ranch
- Tolay Creek Ranch Riparian Easement
- Photograph Locations
- Native Plant Revegetation Zones**
- Tolay Creek Revegetation Zone
- Tributary Enhancement Zones
- Experimental Native Plant Revegetation Zones**
- Active Revegetation
- Regeneration
- Existing fence
- Proposed minimum fencing
- Wetland
- Springs
- Himalayan Blackberry
- Medusahead

Data source:  
 Sonoma Land Trust  
 Rob Evans field visits, March 9, 10, 24  
 & May 4, 2009  
 LSA Associates  
 Ray Carlson & Associates  
 Sonoma County Agricultural Preservation  
 & Open Space District  
 Resource Strategies, Inc./AirPhoto USA 2007

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

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# Tolay Creek Enhancement Project

Sonoma Land Trust

Tolay Creek Ranch

Figure 7

Habitat Enhancement Map

Tolay Creek Mainstem Zone B

-  Tolay Creek Ranch
-  Tolay Creek Ranch Riparian Easement
-  Photograph Locations
-  Existing Fence
-  Proposed Minimum Fencing
-  Wetland
- Native Plant Revegetation Zones**
-  Tolay Creek Revegetation Zone
-  Tributary Enhancement Zones
- Experimental Native Plant Revegetation Zones**
-  Active Revegetation
-  Regeneration
- Non-native Plant Locations**
-  Himalayan Blackberry
-  Medusahead
-  Blue Gum
-  Monterey Cypress

Data source:

Sonoma Land Trust

Rob Evans field visits March 9, 10, 24 & May 4, 2009

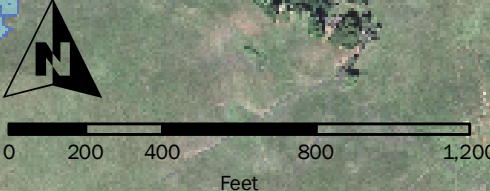
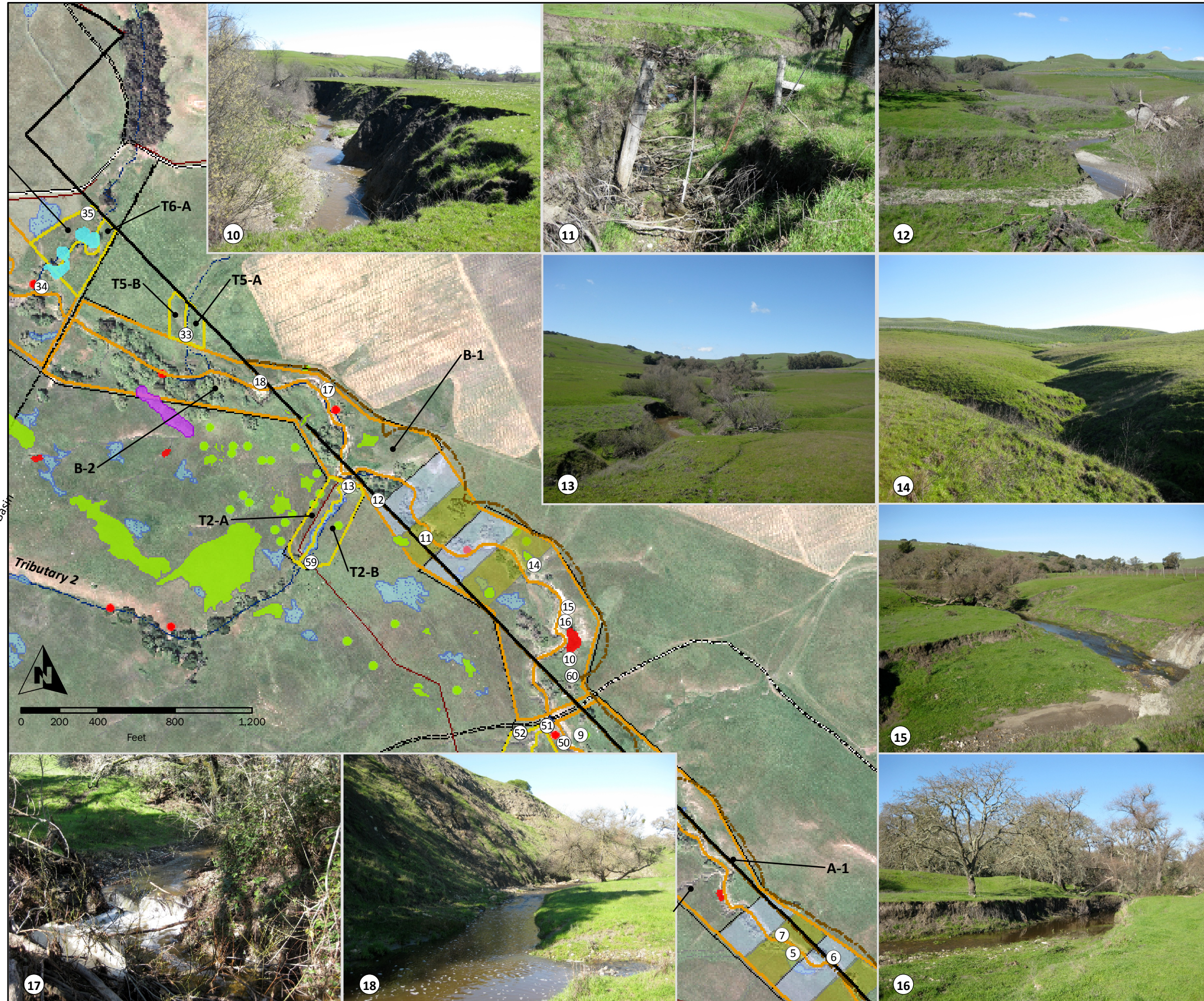
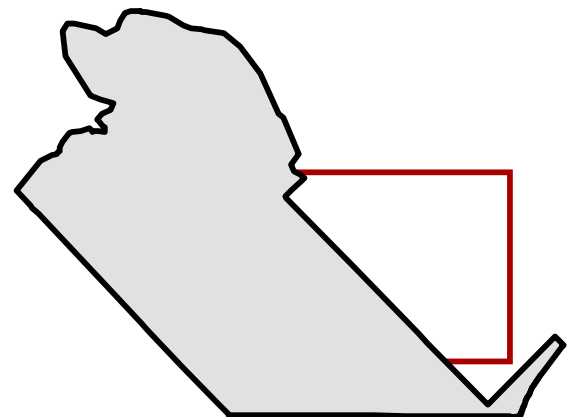
LSA Associates

Ray Carlson & Associates

Resource Strategies, Inc./Digital Globe 2007

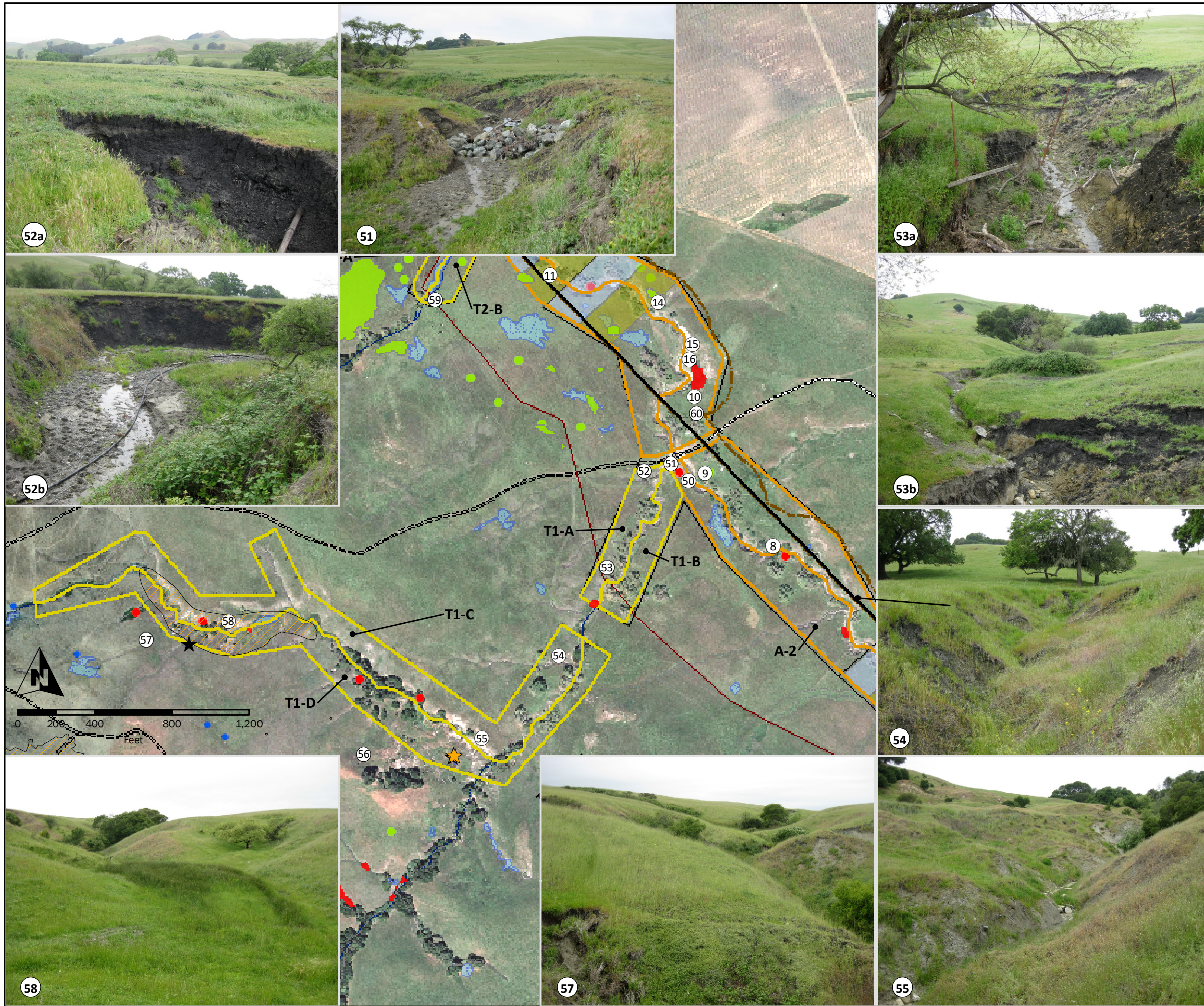
Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

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**Tolay Creek Enhancement Project**  
**Sonoma Land Trust**  
**Tolay Creek Ranch**  
**Figure 8**  
**Habitat Enhancement Map**  
**Tolay Creek Tributary Zones T1**

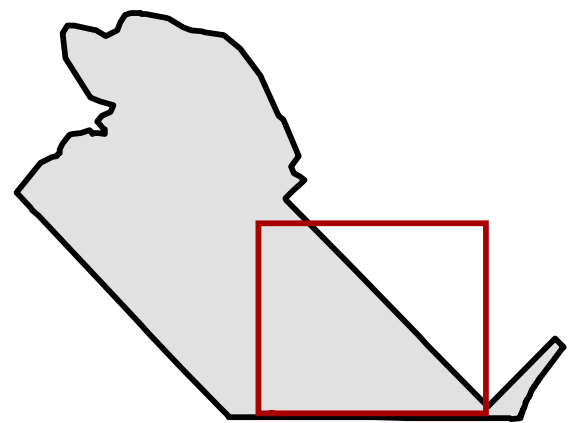


- Tolay Creek Ranch
- Tolay Creek Ranch Riparian Easement
- Photograph Locations
- Existing Fence
- Proposed Minimum Fencing
- Wetland
- Springs
- Native Plant Revegetation Zones**
- Tolay Creek Revegetation Zone
- Tributary Enhancement Zones
- Experimental Native Plant Revegetation Zones**
- Active Revegetation
- Regeneration
- Non-native Plant Locations**
- Himalayan Blackberry
- Medusahead
- Sensitive Features**
- Lobb's Aquatic Buttercup
- Fountain Death Camas

Data source:  
 Sonoma Land Trust  
 Rob Evans field visits March 9, 10, 24 & May 4, 2009  
 LSA Associates  
 Ray Carlson & Associates  
 Resource Strategies, Inc./Digital Globe 2007

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

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# Tolay Creek Enhancement Project

Sonoma Land Trust  
Tolay Creek Ranch

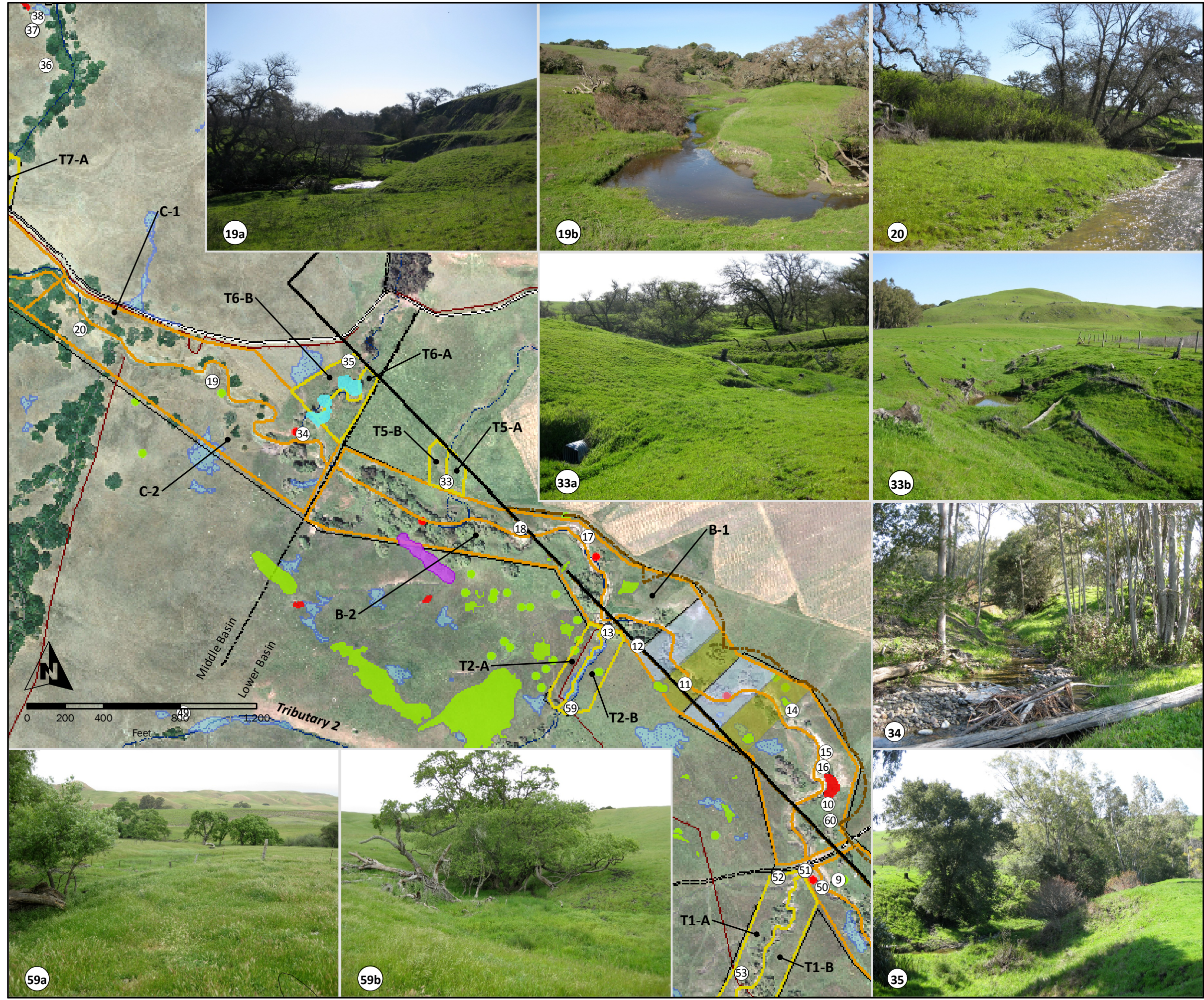
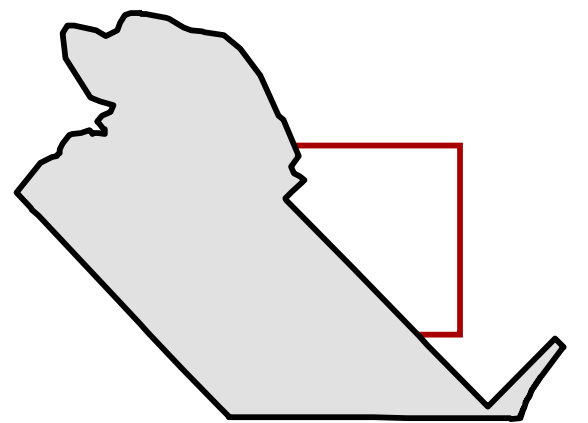
Figure 9  
Habitat Enhancement Map  
Tolay Creek Mainstem Zone C  
Tributary Zones T2, T5 & T6

-  Tolay Creek Ranch
-  Tolay Creek Ranch Riparian Easement
-  Photograph Locations
-  Existing Fence
-  Proposed Minimum Fencing
-  Wetland
- Native Plant Revegetation Zones**
-  Tolay Creek Revegetation Zone
-  Tributary Enhancement Zones
- Experimental Native Plant Revegetation Zones**
-  Active Revegetation
-  Regeneration
- Non-native Plant Locations**
-  Himalayan Blackberry
-  Medusahead
-  Blue Gum
-  Monterey Cypress

Data source:  
Sonoma Land Trust  
Rob Evans field visits March 9, 10, 24 & May 4, 2009  
LSA Associates  
Ray Carlson & Associates  
Resource Strategies, Inc./Digital Globe 2007

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

Prepared by: West Coast Watershed



**Tolay Creek Enhancement Project**

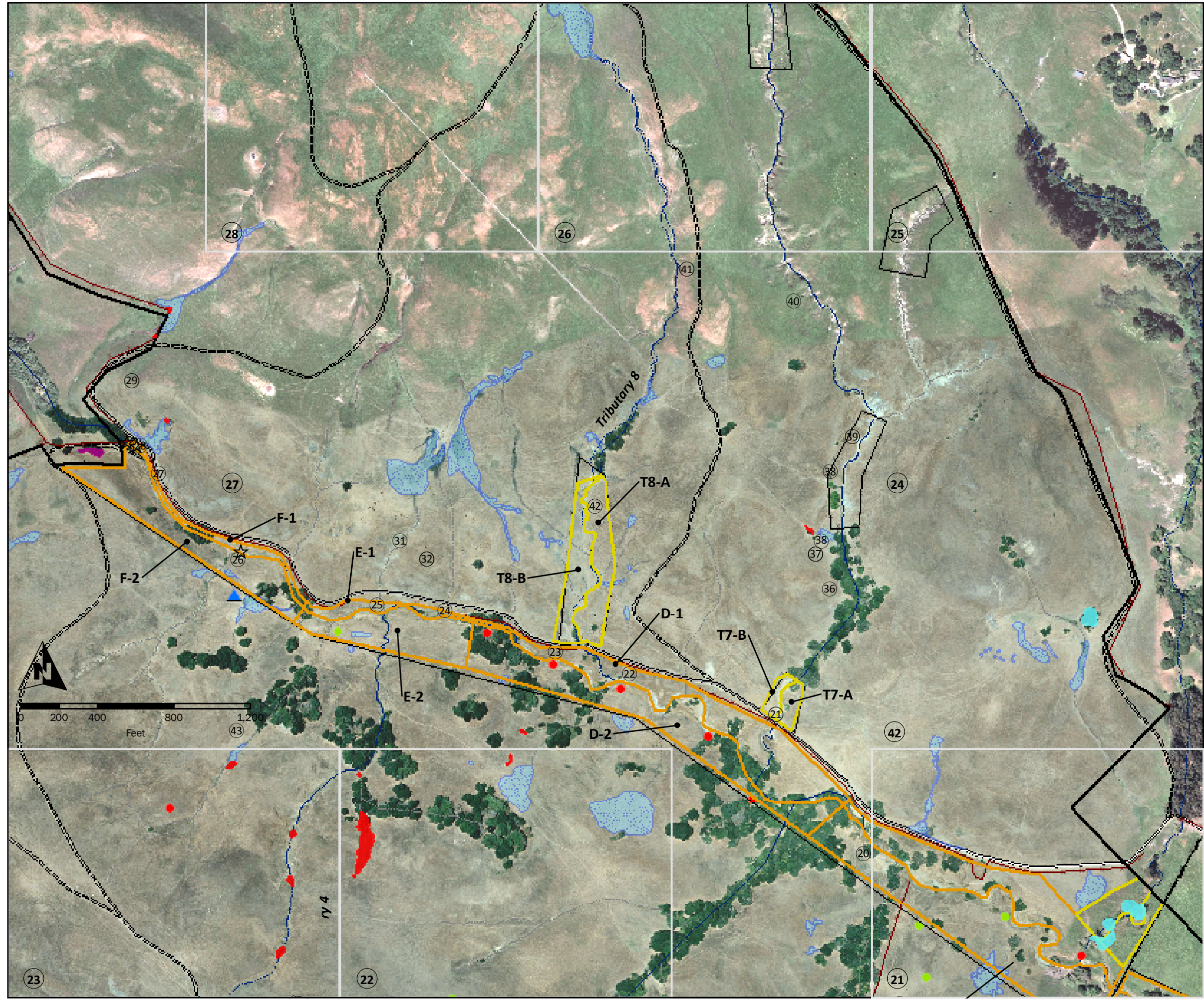
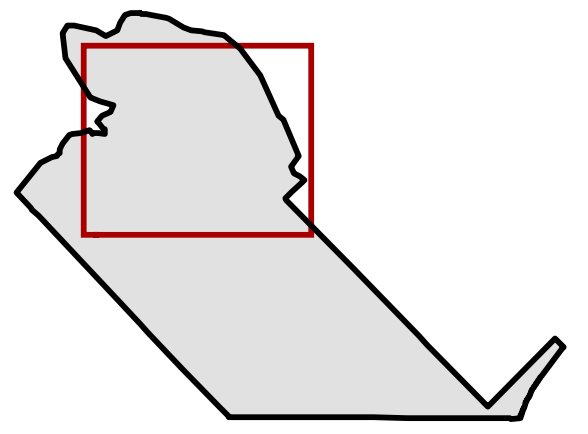
Sonoma Land Trust  
 Tolay Creek Ranch  
 Figure 10  
 Habitat Enhancement Map  
 Tolay Creek Mainstem Zones D, E & F  
 Tributary Zones T7 & T8

- Tolay Creek Ranch
- Photograph Locations
- ✂ Existing Fence
- ✂ Proposed Minimum Fencing
- ▲ Developed Spring
- ☁ Wetland
- Native Plant Revegetation Zones**
- 🟡 Tolay Creek Revegetation Zone
- 🟡 Tributary Enhancement Zones
- Non-native Plant Locations**
- 🔴 Himalayan Blackberry
- 🟢 Medusahead
- 🟣 Black Acacia
- Non-native Plant Locations**
- ★ California Red-legged Frog
- 🌿 Western Pond Turtle

Data source:  
 Sonoma Land Trust  
 Rob Evans field visits March 9, 10, 24 & May 4, 2009  
 LSA Associates  
 Ray Carlson & Associates  
 Resource Strategies, Inc./Digital Globe 2007

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

Prepared by: West Coast Watershed



**APPENDICES**

Appendix A. GIS Data Layers

## Appendix A

### Tolay Creek Enhancement Plan GIS Data Layers

Name	File Folder	File Name
Photograph Locations	\Tolay\Data\WCW	Roche_photo_point
Developed Spring	\Tolay\Data\WCW	Roche_features
Existing Fence	\Tolay\Data\WCW	Tolay_fence
Experimental Native Plant Revegetation Zones	\Tolay\Data\WCW	Roche_experimental_reveg
Tolay Creek Basins	\Tolay\Data\WCW	Tolay_basins
Native Plant Revegetation Zones	\Tolay\Data\WCW	Roche_reveg_zones
Drainage	\Tolay\Data\WCW	Drainage_export
Sonoma Land Trust Roche Ranch	\Tolay\Data\SLT\Roche	Roche_perim_07
Springs	\Tolay\Data\SLT\Roche	Roche_springs
Roche Easements	\Tolay\Data\SLT\Roche	Roche_easements_draft
SLT - Roche Riparian Easement	\Tolay\Data\SLT\Roche\R_Carlson_Data_12_07	RiparianEasemnt_Carlson
Farm Roads	\Tolay\Data\SLT\Roche\SCAPOSD_CE_Baseline_Report_Data	Roche_access_roads_CRP
Stream	\Tolay\Data\SLT\Roche\SCAPOSD_CE_Baseline_Report_Data	streams_clip_photo_edit
Aerial Imagery - PETALUMA RIVER-NE	\Tolay\Data\imagery\	PETALUMA RIVER-NE.sid
Aerial Imagery - PETALUMA RIVER-SE	\Tolay\Data\imagery\	PETALUMA RIVER-SE.sid
Aerial Imagery - SEARS POINT-NW	\Tolay\Data\imagery\	SEARS POINT-NW.sid
Aerial Imagery - SEARS POINT-SW	\Tolay\Data\imagery\	SEARS POINT-SW.sid

**APPENDICES**

Appendix B. Historic Maps: 1942, 1961 and 1997



## Tolay Creek Enhancement Project

Sonoma Land Trust  
Tolay Creek Ranch

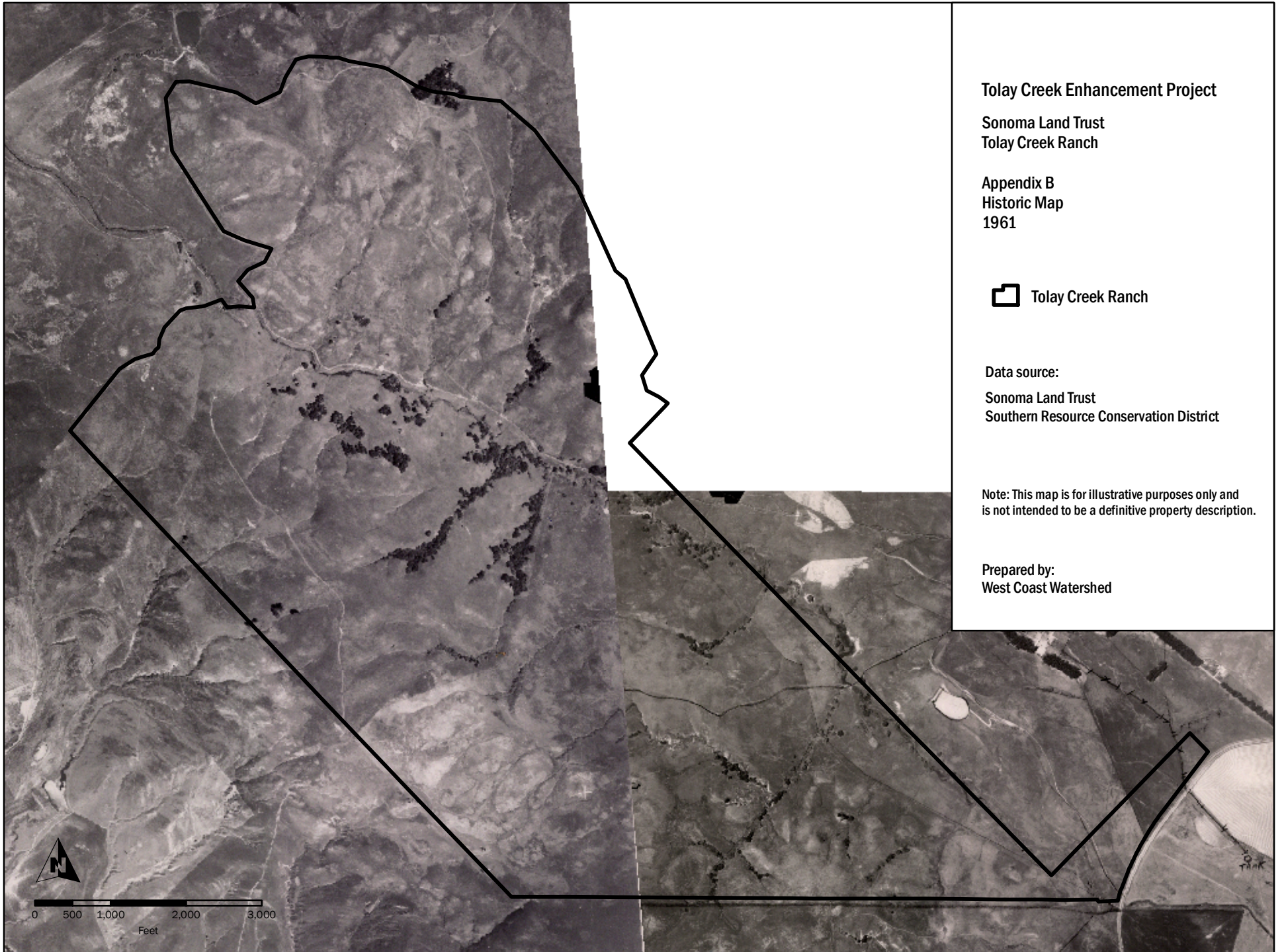
Appendix B  
Historic Map  
1942



Data source:  
Sonoma Land Trust  
Southern Resource Conservation District

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

Prepared by:  
West Coast Watershed



**Tolay Creek Enhancement Project**

**Sonoma Land Trust  
Tolay Creek Ranch**

**Appendix B  
Historic Map  
1961**

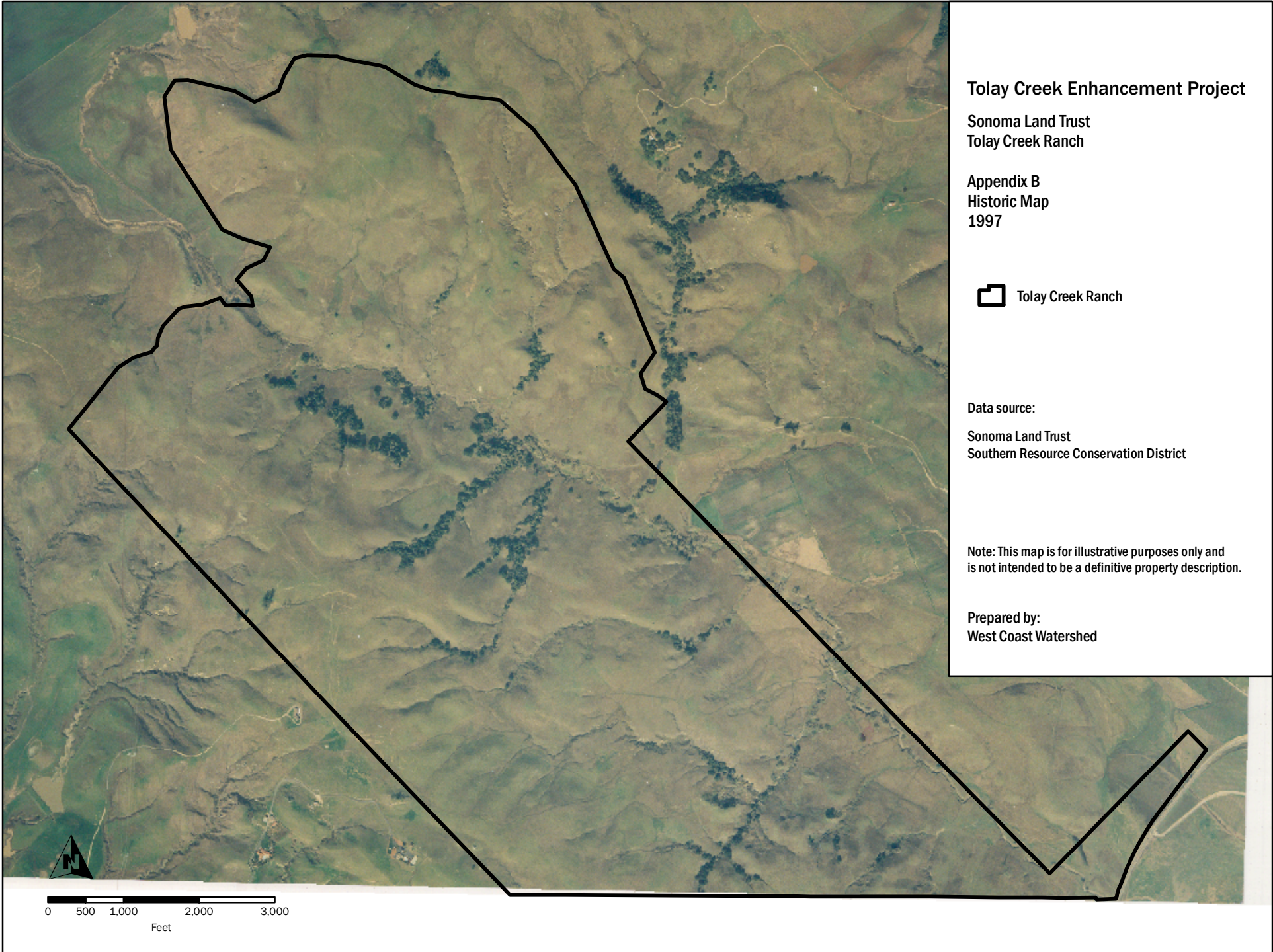
 **Tolay Creek Ranch**

**Data source:  
Sonoma Land Trust  
Southern Resource Conservation District**

**Note: This map is for illustrative purposes only and  
is not intended to be a definitive property description.**

**Prepared by:  
West Coast Watershed**






**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Appendix B  
Historic Map  
1997

 Tolay Creek Ranch

Data source:  
Sonoma Land Trust  
Southern Resource Conservation District

Note: This map is for illustrative purposes only and is not intended to be a definitive property description.

Prepared by:  
West Coast Watershed

**APPENDICES**

Appendix C. Tolay Creek Native Plant Revegetation Details and Plant Lists

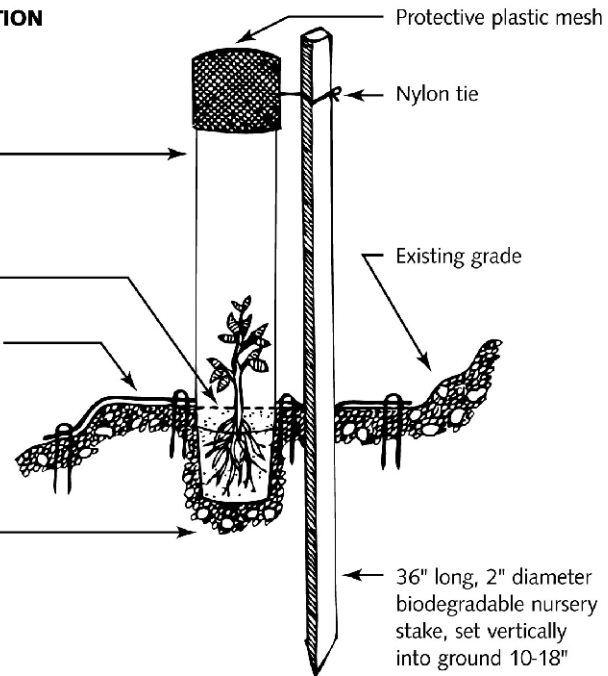
**PLANT PROTECTION TUBE INSTALLATION**  
(not to scale)

Plastic tube, 4.5" diameter by 24" high, set below grade to a 1-4" depth. Secure tube with stake and nylon tie

Liner plant crown at existing grade

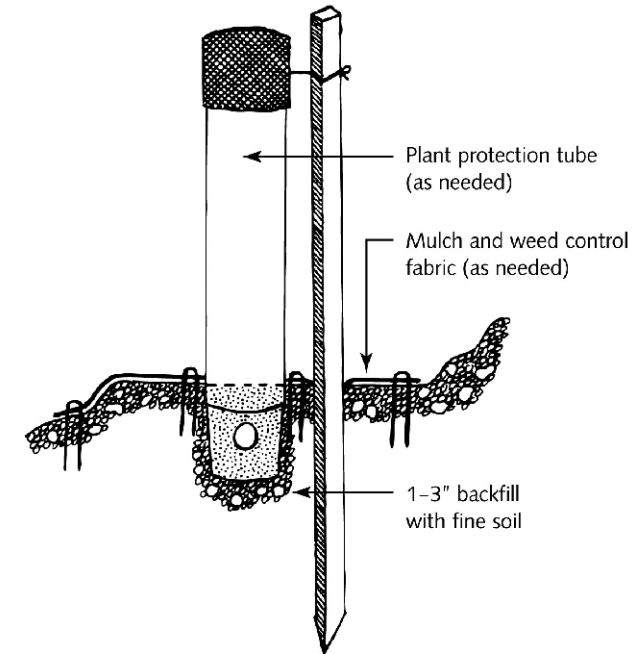
Woven black polypropylene weed control fabric or other weed control fabric

Backfill with fine on-site soil and 0.3 ounce (one teaspoon) osmocote 14-14-14 slow release fertilizer placed at the bottom of the planting hole



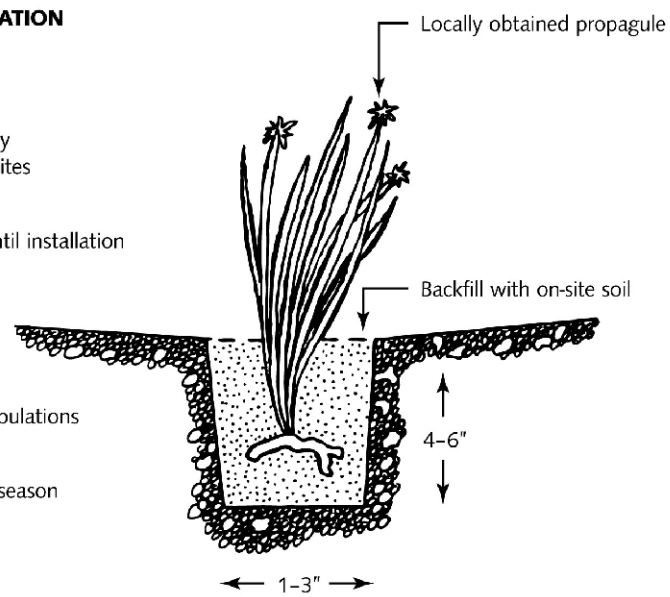
**DIRECT SEED PLANTING DETAIL**  
(not to scale)

- Install native seeds from oaks, buckeye, bay or walnut from November-February
- Install when soil is moist to 10"
- Seed depth at installation = 1-3", depending on species
- Protect plant as needed with plant protection tube and/or fabric mulch (see *Plant Protection Shelter Detail*)



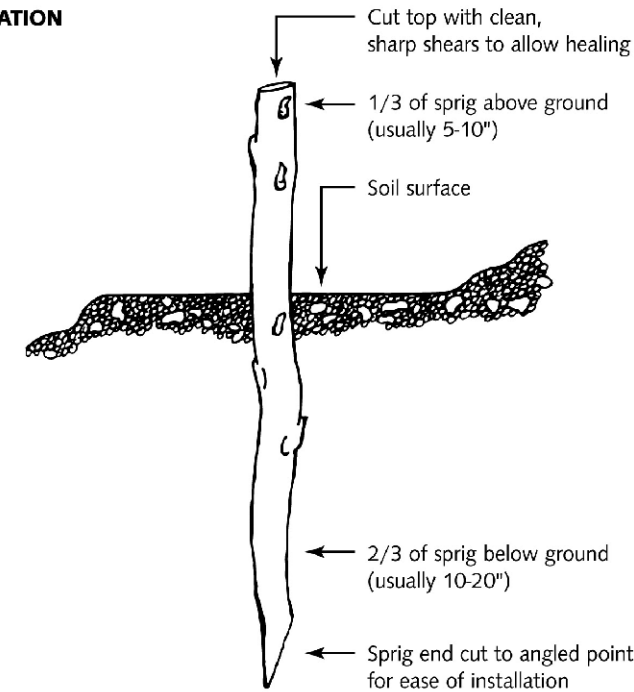
**EMERGENT VEGETATION INSTALLATION**  
(not to scale)

- Excavate planting area
- Collect emergent plants from healthy populations on adjacent or nearby sites
- Keep emergent plants moist and protected from time of collection until installation
- Install emergent plants on same day as collected
- Collect emergent plants in discontinuous small areas to avoid excessive disturbance to existing populations
- Planting shall occur November-April during the dormant/quasi-dormant season



**DORMANT WILLOW SPRIG INSTALLATION**  
(not to scale)

- Install in areas with a year round source of moisture
- Install only during full dormancy (normally December-January)
- Remove branches prior to installation
- Insert with buds pointing upward



**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

**Revegetation Details**



Prepared by:  
West Coast Watershed

**REVEGETATION PLANT LIST - ZONE A**

Scientific Name	Common Name	Flag Color	Number of Plant Locations			Installation Method *	Container Size	Spacing (feet on center)
			A-1	A-2	TOTAL			
<b>SHRUBS</b>								
<i>Baccharis pilularis</i>	coyote bush		35	35	70	plant protection tube	supercell	4-6'
<i>Crataegus douglasii</i>	hawthorn		20	20	40	plant protection tube	supercell	4-6'
<i>Rhamnus californica</i>	coffeeberry		0	0	0	plant protection tube	supercell	4-6'
<i>Rosa californica</i>	California wild rose		50	50	100	plant protection tube	tree band	4-6'
<i>Rubus ursinus</i>	California blackberry		50	50	100	plant protection tube	treeband	4-6'
<i>Sambucus mexicana</i>	blue elderberry		0	0	0	plant protection tube	deepot	4-6'
<i>Symphoricarpos albus</i>	snowberry		0	0	0	plant protection tube	treeband	4-6'
<b>TREES</b>								
<i>Acer macrophyllum</i>	big-leaf maple		0	0	0	plant protection tube / direct seed	supercell	10-15'
<i>Aesculus californica</i>	California buckeye		20	25	45	plant protection tube / direct seed	treepot / direct seed	10-30'
<i>Quercus agrifolia</i>	coast live oak		0	0	0	plant protection tube / direct seed	supercell / direct seed	10-30'
<i>Quercus lobata</i>	valley oak		150	200	350	plant protection tube / direct seed	supercell / direct seed	10-30'
<b>DORMANT CUTTINGS</b>								
<i>Salix laevigata</i>	red willow		200	200	400	dormant cutting		4-6'
<i>Sakix lasiolepis</i>	arroyo willow		250	250	500	dormant cutting		4-6'
<b>EMERGENTS</b>								
<i>Carex</i> sp.	sedge				tbd	transplant		2-4'
<i>Eleocharis</i> sp.	spikerush				tbd	transplant		2-4'
<i>Juncus</i> sp.	rush				tbd	transplant		2-4'
<i>Scirpus</i> sp.	tule				tbd	transplant		2-4'
<b>TOTAL:</b>			<b>775</b>	<b>830</b>	<b>1605</b>			

\* See Revegetation Details

**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Tolay Creek Mainstem Zone A  
Revegetation Plant List

Data source:  
Rob Evans field visits, March 9, 10, 24  
& May 4, 2009



Prepared by:  
West Coast Watershed

REVEGETATION PLANT LIST - ZONE B								
Scientific Name	Common Name	Flag Color	Number of Plant Locations			Installation Method *	Container Size	Spacing (feet on center)
			B-1	B-2	TOTAL			
<b>SHRUBS</b>								
<i>Baccharis pilularis</i>	coyote bush		20	20	40	plant protection tube	supercell	4-6'
<i>Crataegus douglasii</i>	hawthorn		10	10	20	plant protection tube	supercell	4-6'
<i>Rhamnus californica</i>	coffeeberry		20	20	40	plant protection tube	supercell	4-6'
<i>Rosa californica</i>	California wild rose		30	30	60	plant protection tube	tree band	4-6'
<i>Rubus ursinus</i>	California blackberry		30	30	60	plant protection tube	treeband	4-6'
<i>Sambucus mexicana</i>	blue elderberry		10	10	20	plant protection tube	deepot	4-6'
<i>Symphoricarpos albus</i>	snowberry		15	20	35	plant protection tube	treeband	4-6'
<b>TREES</b>								
<i>Acer macrophyllum</i>	big-leaf maple		0	0	0	plant protection tube / direct seed	supercell	10-15'
<i>Aesculus californica</i>	California buckeye		20	20	40	plant protection tube / direct seed	treepot / direct seed	10-30'
<i>Quercus agrifolia</i>	coast live oak		0	0	0	plant protection tube / direct seed	supercell / direct seed	10-30'
<i>Quercus lobata</i>	valley oak		50	60	110	plant protection tube / direct seed	supercell / direct seed	10-30'
<b>DORMANT CUTTINGS</b>								
<i>Salix laevigata</i>	red willow		100	100	200	dormant cutting		4-6'
<i>Saxix lasiolepis</i>	arroyo willow		150	150	300	dormant cutting		4-6'
<b>EMERGENTS</b>								
<i>Carex</i> sp.	sedge				tbd	transplant		2-4'
<i>Eleocharis</i> sp.	spikerush				tbd	transplant		2-4'
<i>Juncus</i> sp.	rush				tbd	transplant		2-4'
<i>Scirpus</i> sp.	tule				tbd	transplant		2-4'
<b>TOTAL:</b>			<b>455</b>	<b>470</b>	<b>925</b>			

\* See Revegetation Details

## Tolay Creek Enhancement Project

Sonoma Land Trust  
Tolay Creek Ranch

Tolay Creek Mainstem Zone B  
Revegetation Plant List

Data source:

Rob Evans field visits, March 9, 10, 24  
& May 4, 2009



Prepared by:  
West Coast Watershed

**REVEGETATION PLANT LIST - ZONES C, T2, T5 & T6**

Scientific Name	Common Name	Flag Color	Number of Plant Locations									Installation Method *	Container Size	Spacing (feet on center)
			C-1	C-2	T2-A	T2-B	T5-A	T5-B	T6-A	T6-B	TOTAL			
<b>SHRUBS</b>														
<i>Baccharis pilularis</i>	coyote bush		10	0	0	0	5	10	5	7	37	plant protection tube	supercell	4-6'
<i>Crataegus douglasii</i>	hawthorn		0	0	0	0	0	0	0	0	0	plant protection tube	supercell	4-6'
<i>Rhamnus californica</i>	coffeeberry		10	15	0	0	5	7	5	5	47	plant protection tube	supercell	4-6'
<i>Rosa californica</i>	California wild rose		60	55	15	10	10	15	10	20	195	plant protection tube	tree band	4-6'
<i>Rubus ursinus</i>	California blackberry		40	25	0	0	0	0	0	0	65	plant protection tube	treeband	4-6'
<i>Sambucus mexicana</i>	blue elderberry		15	10	0	0	0	0	0	0	25	plant protection tube	deepot	4-6'
<i>Symphoricarpos albus</i>	snowberry		0	20	0	0	0	0	10	15	45	plant protection tube	treeband	4-6'
<b>TREES</b>														
<i>Acer macrophyllum</i>	big-leaf maple		0	0	0	0	0	0	0	0	0	plant protection tube / direct seed	supercell	10-15'
<i>Aesculus californica</i>	California buckeye		29	20	0	0	2	4	5	5	65	plant protection tube / direct seed	treepot / direct seed	10-30'
<i>Quercus agrifolia</i>	coast live oak		48	35	0	5	5	7	12	13	125	plant protection tube / direct seed	supercell / direct seed	10-30'
<i>Quercus lobata</i>	valley oak		104	10	10	25	3	4	12	13	181	plant protection tube / direct seed	supercell / direct seed	10-30'
<b>DORMANT CUTTINGS</b>														
<i>Salix laevigata</i>	red willow		10	10	10	10	0	0	10	10	60	dormant cutting		4-6'
<i>Sakix lasiolepis</i>	arroyo willow		0	0	0	0	0	10	10	10	30	dormant cutting		4-6'
<b>EMERGENTS</b>														
<i>Carex sp.</i>	sedge										tbd	transplant		2-4'
<i>Eleocharis sp.</i>	spikerush										tbd	transplant		2-4'
<i>Juncus sp.</i>	rush										tbd	transplant		2-4'
<i>Scirpus sp.</i>	tule										tbd	transplant		2-4'
<b>TOTAL:</b>			<b>326</b>	<b>200</b>	<b>35</b>	<b>50</b>	<b>30</b>	<b>57</b>	<b>79</b>	<b>98</b>	<b>875</b>			

\* See Revegetation Details

**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Tolay Creek Mainstem Zone C  
Tributary Zones T2, T5 & T6  
Revegetation Plant List

Data source:  
Rob Evans field visits, March 9, 10, 24  
& May 4, 2009



Prepared by:  
West Coast Watershed

**REVEGETATION PLANT LIST - ZONES D, E, F, T7 & T8**

Scientific Name	Common Name	Flag Color	Number of Plant Locations											Installation Method *	Container Size	
			D-1	D-2	E-1	E-2	F-1	F-2	T7-A	T7-B	T8-A	T8-B	TOTAL			
<b>SHRUBS</b>																
<i>Baccharis pilularis</i>	coyote bush		0	0	0	0	0	0	0	0	0	0	0	0	plant protection tube	supercell
<i>Crataegus douglasii</i>	hawthorn		0	0	0	0	0	0	0	0	0	0	0	0	plant protection tube	supercell
<i>Rhamnus californica</i>	coffeeberry		0	0	10	15	0	8	5	5	10	10	63	plant protection tube	supercell	
<i>Rosa californica</i>	California wild rose		20	20	30	30	20	25	0	0	0	0	145	plant protection tube	tree band	
<i>Rubus ursinus</i>	California blackberry		10	10	0	30	20	15	5	5	5	0	100	plant protection tube	treeband	
<i>Sambucus mexicana</i>	blue elderberry		20	20	5	0	10	5	0	5	0	0	65	plant protection tube	deepot	
<i>Symphoricarpos albus</i>	snowberry		0	0	0	0	0	0	0	0	0	0	0	plant protection tube	treeband	
<b>TREES</b>																
<i>Acer macrophyllum</i>	big-leaf maple		15	10	0	0	5	8	0	0	0	0	38	plant protection tube / direct seed	supercell	
<i>Aesculus californica</i>	California buckeye		15	10	10	10	8	13	2	2	3	3	76	plant protection tube / direct seed	treepot / direct seed	
<i>Quercus agrifolia</i>	coast live oak		20	20	15	40	28	34	3	3	12	13	188	plant protection tube / direct seed	supercell / direct seed	
<i>Quercus lobata</i>	valley oak		90	50	10	15	5	5	4	6	13	12	210	plant protection tube / direct seed	supercell / direct seed	
<b>DORMANT CUTTINGS</b>																
<i>Salix laevigata</i>	red willow		20	10	0	0	10	13	5	5	8	7	78	dormant cutting		
<i>Saxifraga lasiolepis</i>	arroyo willow		10	20	0	0	5	10	0	0	0	0	45	dormant cutting		
<b>EMERGENTS</b>																
<i>Carex</i> sp.	sedge												tbd	transplant		
<i>Eleocharis</i> sp.	spikerush												tbd	transplant		
<i>Juncus</i> sp.	rush												tbd	transplant		
<i>Scirpus</i> sp.	tule												tbd	transplant		
<b>TOTAL:</b>			<b>220</b>	<b>170</b>	<b>80</b>	<b>140</b>	<b>111</b>	<b>136</b>	<b>24</b>	<b>31</b>	<b>51</b>	<b>45</b>	<b>1008</b>			

\* See Revegetation Details

**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Tolay Creek Mainstem Zones D, E, F  
Tributary Zones T7 & T8  
Revegetation Plant List

Data source:  
Rob Evans field visits, March 9, 10, 24  
& May 4, 2009



Prepared by:  
West Coast Watershed

REVEGETATION PLANT LIST - ZONE T1										
Scientific Name	Common Name	Flag Color	Number of Plant Locations					Installation Method *	Container Size	Spacing (feet on center)
			T1-A	T1-B	T1-C	T1-D	TOTAL			
<b>SHRUBS</b>										
<i>Baccharis pilularis</i>	coyote bush		0	0	0	0	0	plant protection tube	supercell	4-6'
<i>Crataegus douglasii</i>	hawthorn		0	0	0	0	0	plant protection tube	supercell	4-6'
<i>Rhamnus californica</i>	coffeeberry		5	5	25	20	55	plant protection tube	supercell	4-6'
<i>Rosa californica</i>	California wild rose		10	10	10	10	40	plant protection tube	tree band	4-6'
<i>Rubus ursinus</i>	California blackberry		15	10	0	0	25	plant protection tube	treeband	4-6'
<i>Sambucus mexicana</i>	blue elderberry		0	0	0	0	0	plant protection tube	deepot	4-6'
<i>Symphoricarpos albus</i>	snowberry		15	10	0	0	25	plant protection tube	treeband	4-6'
<b>TREES</b>										
<i>Acer macrophyllum</i>	big-leaf maple		0	0	0	0	0	plant protection tube / direct seed	supercell	10-15'
<i>Aesculus californica</i>	California buckeye		5	5	15	15	40	plant protection tube / direct seed	treepot / direct seed	10-30'
<i>Quercus agrifolia</i>	coast live oak		10	10	50	55	125	plant protection tube / direct seed	supercell / direct seed	10-30'
<i>Quercus lobata</i>	valley oak		25	20	0	0	45	plant protection tube / direct seed	supercell / direct seed	10-30'
<b>DORMANT CUTTINGS</b>										
<i>Salix laevigata</i>	red willow		20	20	20	15	75	dormant cutting		4-6'
<i>Sakix lasiolepis</i>	arroyo willow		10	5	0	0	15	dormant cutting		4-6'
<b>EMERGENTS</b>										
<i>Carex</i> sp.	sedge						tbd	transplant		2-4'
<i>Eleocharis</i> sp.	spikerush						tbd	transplant		2-4'
<i>Juncus</i> sp.	rush						tbd	transplant		2-4'
<i>Scirpus</i> sp.	tule						tbd	transplant		2-4'
<b>TOTAL:</b>			<b>115</b>	<b>95</b>	<b>120</b>	<b>115</b>	<b>445</b>			

\* See Revegetation Details

**Tolay Creek Enhancement Project**

Sonoma Land Trust  
Tolay Creek Ranch

Tolay Creek Tributary Zone T1  
Revegetation Plant List

Data source:  
Rob Evans field visits, March 9, 10, 24  
& May 4, 2009



Prepared by:  
West Coast Watershed



**APPENDICES**

Appendix D. Tolay Creek Enhancement Cost Estimate

## Appendix D

### Tolay Creek Enhancement Plan

#### Cost Estimate

Revegetation Zone	Installation Cost*
A	\$30,535
B	\$18,295
C	\$22,735
D-1	\$5,635
D-2	\$4,300
E-1	\$1,855
E-2	\$3,790
F-1	\$2,900
F-2	\$3,470
T1	\$10,905
T7-A	\$584
T7-B	\$804
T8-A	\$715
T8-B	\$1,090
	<b>Total: \$107,613</b>
<i>* Costs include labor, plant material, protective hardware, and weed mats (where necessary)</i>	

#### Plant Maintenance:

Irrigation System Installation: \$40,000 (Does not include developing water source)

Irrigation System Maintenance: \$3,000 per visit x 9 visits per year = \$27,000/year  
(recommend operating irrigation system for 3 years)

Weed Control (around plants): \$9,000 per visit x 3 visits per year = \$27,000/year  
(recommend weeding around plants for 2-3 years)

#### Project Monitoring:

\$5,000 per annual report

Note: These costs are based on prevailing wage, utilizing supervised volunteers can provide cost savings.

**APPENDICES**

Appendix E. Photo Documentation Protocol



## UNIVERSITY OF CALIFORNIA

Division of Agriculture  
and Natural Resources

<http://anrcatalog.ucdavis.edu>



## California Rangelands Research and Information Center

[http://agronomy.ucdavis.edu/  
calrng/range1.htm](http://agronomy.ucdavis.edu/calrng/range1.htm)

# Photo-Monitoring for Better Land Use Planning and Assessment

**NEIL MCDUGALD** is UC Cooperative Extension Livestock, Range, and Natural Resources Advisor, Fresno and Madera Counties; **BILL FROST** is UCCE Range and Natural Resources Advisor, El Dorado and Amador Counties; and **DENNIS DUDLEY** is Range Conservationist, USDA Natural Resources Conservation Service, Madera, California.

**T**he verb *to monitor* means to watch or to check, often for the purpose of detecting change. There are many ways to monitor change on the landscape, but none is simpler than photo-monitoring and recording observations. This publication will help landowners develop a photo-monitoring program for their property. Other aspects of monitoring are covered in other publications (see Additional Reading). Photo monitoring is a valuable tool for documenting your management as well as conditions or events that affect your management. Photo points are easily established. You may already have old family pictures that illustrate how the property, a stream, or facilities looked in the past. New photographs of the scenes in these old photos provide one good way to get started with your photo monitoring program. If you have no old ranch photos, now is a good time to start developing a photographic record for your own benefit and for the benefit of those who follow you as ranch managers or owners.

While photographs cannot tell the entire story about a situation, project, or practice, much information can be gathered by comparing photographs taken of the same scene over a number of years. When you establish a photographic collection to monitor landscape conditions, you do not generate the large amounts of data often associated with agency monitoring projects. Still, photo-monitoring may surpass other forms of monitoring because it is simple, inexpensive, and rapid, and it can portray landscape changes on a large scale to audiences of varying backgrounds.

## WHY MONITOR?

Before you begin a photo-monitoring program, you should consider why you are monitoring. Here are some common purposes:

- to describe or document current (normal) conditions (*baseline monitoring*)
- to describe or document abnormal or catastrophic events
- to detect and document change (*trend monitoring*)
- to confirm agency assessments
- to investigate perceived problems
- to document the application or implementation of management practices (*implementation monitoring*)
- to document the effectiveness of management practices (*effectiveness monitoring*)

## MEASURABLE OBJECTIVES

A land manager's reasons for monitoring can in many cases be translated into measurable management objectives. Your statement of measurable objectives should tell you what to monitor and where to monitor. For example, suppose your management objective is to increase stream bank shrub cover by reducing livestock grazing along stream channels. You can document the measurable objective of increasing shrub cover with a series of photographs of the stream bank taken over time. Another measurable objective is to maintain adequate residual dry matter on your rangeland. While you cannot take photographs of everything, the installation of photo points at several locations can help you document residual dry matter from year to year (Figure 1). Non-specific management objectives such as enhancing riparian habitat are more difficult to monitor: they lack a clear statement of which habitat characteristics the manager is trying to change. A statement of measurable objectives is crucial to good monitoring.

## WHAT TO MONITOR

There are several kinds of photographs that you can take to document conditions in a watershed or on a farm or ranch, including

- landscape photos
- plot or close-up photos
- photos of riparian, stream, wetland, or other special habitats
- event photos
- practice photos

### Representative Area

A representative area is an area or site that serves as a valid representation of a greater area, and so helps you to meet your monitoring objectives. It is not the best area or the worst area within your site, though you may choose to photograph these as well.

### Frequency of Monitoring

If the objective of photo monitoring is to document change, you need to schedule photo sessions so that you take photos as frequently as monitored conditions change. With seasonal photos, you can document vegetation changes through the year. Annual photos can document changes in gullies or stream banks. A series of baseline photos that document existing conditions can be used to document change due to an abnormal or catastrophic event. Before-and-after photos can document the effectiveness of specific land-management practices.

*Landscape photos* should give a representative view of the area and feature a distinctive landmark in the background (e.g., a peak, rock outcrop, or ridgeline) to aid in taking follow-up photos in the future (Figure 1). Be sure to include enough horizon in the picture to allow a future photographer to find the same photo point again. You can record large areas of bare soil, erosion, weed and shrub invasions, and burns using landscape photos. *Plot or close-up photos* can be used to document ground cover, residual dry matter, erosion, endangered species, and weeds (Figure 2). *Riparian, stream, or wetland photos* provide a representative view of the stream channel, bank stability, ground cover, and overstory vegetation (Figure 3).



**Figure 1.** Annual landscape photos taken in early March (no photo is available for 1998).



**Figure 2.** Close-ups of 1-square-foot plots.



**Figure 3.** Riparian area photographed before and after installation of a fence.

*Event photos* can be used to document unplanned or unusual events such as fires, floods, erosion, wildlife damage, and vandalism (Figure 4), and *practice photos* can be used to document management practices (Figure 5). You can use “before and after” photos to document the implementation and effectiveness of practices, the effects of fire and post-fire recovery, the invasion and control of weeds and shrubs, and other long-term changes.



**Figure 4.** Photos taken to document events (gully formation and rooting by feral pigs).





**Figure 5.** "Before and after" photographs to show the effect of a practice.



## SUPPLIES AND EQUIPMENT

A good quality, pocket-sized, single-lens 35 mm camera is adequate for photo-monitoring. To maintain consistency in the photos over time, you should use only one lens of a fixed focal length. A multi-lens camera is unnecessary. For more information on lens sizes, refer to *Measuring and Monitoring Plant Populations* under Additional Reading. We generally recommend the use of color slide film because its dyes are more stable so the photos retain true colors longer. You can make quality prints from slides. Prints are useful because you can use them in later photo-monitoring sessions to ensure that repeat photos depict the same scene, especially if different people do the photo-monitoring. Any camera with appropriate film, used carefully, will produce useful photos. Digital cameras provide the opportunity to maintain photo records on a personal computer and to delete photographs in the field until just the right scene is captured.

Other supply and equipment needs include note cards or a notebook, a steel post, and a compass. In the notebook you will describe each photo point. Good records that describe the location, time of year, time of day, management activities, and comments on vegetation and other conditions make it easier to re-photograph photo points and to evaluate change. A map showing photo point locations should be included with the notes. You can also use a global positioning system (GPS) receiver to document the photo point location. Good record keeping is crucial to successful photo monitoring. [Figure 6](#) is a sample form that you can copy onto 3 × 5 cards and use to document each photo point.

<b>Photo point name or number</b>	<b>Date photo point established</b>
<b>Location description</b>	<b>Compass bearing</b>
<b>Photograph date and time</b>	<b>Name of photographer</b>
<b>Notes</b>	

**Figure 6.** Sample record card for photo point descriptions (copy onto 3 × 5 cards).

It is crucial that you mark the photo points well so that you will be able to locate them for future photographs. You can use a steel post to mark each photo point, but any other permanent feature, such as a pile of rocks, will do just as well. Trees do not make good photo point markers because they grow and change their shape over time. Take a compass bearing from the photo point to the center of focus for all photos. By establishing permanent photo points with compass bearings, you ensure that monitoring photos will be taken consistently from the same point and in the same direction over time. Time-of-day and time-of-year of photo monitoring should also be consistent over time. If you are monitoring vegetation it is important that you are consistent in the stage of plant growth or maturity that you photograph. Plot photos or close-ups should be taken some distance from marking posts, since the posts may attract livestock whose feeding and traffic will be uncharacteristically heavy in those areas.

Take as many photos as necessary to adequately document landscape conditions. For example, you may need to take upstream, downstream, and across-stream photos in order to thoroughly document riparian conditions along a stretch of a stream. Within each picture, include a photo ID card to record the date and photo point number. Be sure the writing is large and legible. An 8.5 × 11 inch sheet of paper with large, thick writing from a felt-tip pen should be adequate. Some cameras are equipped with a date stamp, which simplifies record keeping. To provide scale in photographs, especially close-ups, you may want to include a profile board (Figure 7) or other object of a known size in the picture. Any object with delineated measurements that will be visible in a photograph is adequate. If you place another permanent marker such as a steel post or a length of rebar where the profile board appears, it will be easier for you to put the profile board in the same position the next time you take pictures. Alternatively, you could place the profile board a known distance in a known direction from the photo point.



**Figure 7.** You can use a profile board to indicate scale in a photograph.

Once you have taken the photos and assembled a complete set of notes, you should store them in a safe, dry place. An envelope provides adequate protection for photos and notes, but transparent photo sleeves available in most office product or photography stores are convenient for storing photographs in a three-ringed binder. Identify each photo either on the back of the print or on the slide mount. You can judge the success of your storage method by observing how easily you can retrieve the records.

### **ADDITIONAL READING**

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United States Environmental Protection Agency. 1993. Monitoring protocols to evaluate water quality effects of grazing management on western rangeland streams. EPA 910/R-93-017.

## FOR MORE INFORMATION

You'll find detailed information on many aspects of water and land use in these titles and in other publications, slide sets, videos, and CD-ROMs from UC ANR:

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