7 GEOMORPHIC, HYDRAULIC, AND BIOTIC BASIS OF ENGINEERING DESIGN

This chapter provides an overview of restoration opportunities for the focal study area and a set of studies evaluating different potential design components. In Section 7.1, key natural processes affecting the site and observed alterations to those processes are summarized. In Section 7.2, options for addressing process alterations are assembled into a matrix keyed to locations on a map of the study area. The remaining sections of Chapter 7 analyze in more detail key potential ecological restoration and site reconstruction components. These include an analysis of the effects of a one-foot deepening of selected swales on dry year aquatic surface area, and of the potential for lowering the sewerline across Tallac Creek. Options for parking lot and access road reconstruction were developed and analyzed, and bike and hiking trails options explored.

7.1 NATURAL PROCESSES AND PROCESS ALTERATIONS

As the analyses in the previous chapters have described, the conditions of the Taylor Tallac wetland complex have been substantially affected by the last century and a half of human use. The construction of roads, parking lots, and beach access trails, and the associated filling of wetlands; the recreational use of the site by thousands of people each year; the construction of a sewer line across the meadow; and over a hundred years of grazing by domestic animals have each had consequences for ecological structure and function. The signs of loss of ecological quality at Taylor Tallac may be more subtle than in some other instances but they are evident nonetheless. Often ecological loss is not immediately obvious because it involves an absence—a loss of species or of ecologically valuable characteristics. Whether it is Forster’s terns, cutthroat trout, or particular species of meadow forbs because the site is still green and vegetated, the loss can be an ecological “out of sight, out of mind.”

7.1.1 KEY PROCESSES: CLIMATIC CYCLES, GRAZING, AND RECREATIONAL USE

Hydrologic processes are the key drivers of wetland function in all wetland systems. Hydrologic conditions strongly shape vegetation, and vegetation in combination with hydrology provides key controlling conditions for wildlife presence or absence, and abundance.

The first key factor to recognize is the central importance of climatic cycles, that is, natural cycles of drought and wetter years, to the hydrologic function of the site. Like much of the rest of the western United States, the Tahoe Basin experiences interdecadal-scale cycles of wetter years and droughts. Recognition of these cycles has been greatly refined in recent years through dendrochronology and other studies, but fluctuating lake levels over the last century, as described and analyzed in Section 2.3.4 and the associated exhibits, provide clear evidence of these cycles. The effects of drought-wet cycles on wetland ecosystems are large. Some of the specific effects on vegetation cycles are described more specifically below, but the key point is that these periodic droughts stress and may kill many species of wetland and riparian plants. Similarly, multiple years of high precipitation create much wetter conditions and favor the development of different suites of species. Complicating these successional processes is the relatively short growing season at Tahoe's elevation.

In addition, the presence of the Tahoe City dam further complicates the hydrology of near shore wetland systems. The current dam elevation has been in effect since the 1920s. Maximum lake elevation today, with the dam, is six feet above its maximum at the natural rim (ca. 6222' NGVD; 6223 Lake Tahoe Datum). Installation of the dam and subsequent adjustment of the barrier beach location and height to the new high lake level have undoubtedly had major effects on the near shore wetlands. Because these adjustments predate any aerial photos, we have little information on their precise consequences. Additional studies, including dating soil cores, could help to understand these historic changes.

The third and fourth key factors are associated with human activities: grazing and recreational use. A century or more of grazing has exacerbated the effects of periodic drought, as has the last forty-plus years of increasingly heavy recreational use. Though grazing has many effects on meadow ecosystems, not all necessarily negative, grazing during drought years when plants are already under stress simply layers one stress on top of another. More plants die; roots are killed; particular species may be removed completely; and other less valuable ones increase. Droughts that extend for several years may have consequences that last for many more years. Recovery when conditions improve depends on the presence of seeds or other propagules in the soil. If these have been eliminated or reduced, recovery is slowed, even under the best conditions.

A similar situation prevails in the sandy beach ridges and wetland swales that parallel the lake shore. Sandy substrates are very easily physically disturbed and plants rooted in such substrates are killed easily by this disturbance. Recovery can be very slow, especially when the disturbance is repeated regularly. Loose sand from the beach ridges erodes and begins to fill in the swales. As the bottom elevation of the swales is raised, they become drier because the surface is further from groundwater in dry years.

7.1.2 NATURAL PROCESS SUMMARY

This section summarizes the key natural processes affecting the site.

GEOLOGIC SETTING

The geomorphic, hydrologic and ecologic properties and dynamics of the Taylor and Tallac Creek watersheds and wetlands are intimately linked to their geological setting.

In the focal study area Taylor and Tallac Creeks form alluvial fans within depositional basins. The basins were created by glacial and fluvial action when the lake levels were lower than present and then filled as the creeks deposited sediment in the form of alluvial fans. These basins were separated by a low but distinct ridge in the center of the site that is believed to be a medial moraine. At a higher lake stand, this medial moraine was cut back to approximately the location of the south side of Swale 4. Even higher lake stands may have done some leveling of the moraine as far back as in the vicinity of the gravel parking lot and entry gate.

SWALES AND LAGOONS

Following glaciation and rises in lake level the creeks deposited sediment in the basins and wave action produced a series of beaches parallel with the current shoreline. Falls in lake level left these behind as raised beach ridges, with swales in between. Alternate explanations for the swale and ridge system include a large landslide and reworking of sediments by subsequent wave action, and tectonic activity. All of these processes may have interacted to produce the observed patterns.

There is evidence that Swale 1 at least occasionally carried water from Tallac Creek to the Taylor Creek side in the recent past. The swales further inland, Swales 2 and 3, do not appear to have been connected across the two wetlands, at least in recent times, if ever. The furthest swale from the beach, Swale 4, was continuous between the two wetlands in the recent past, as shown by Exhibit 2.6-6, but may not have behaved like a typical channel connecting the two wetlands as the swale does not become flooded (due to lake level) until levels rise above 6227 feet (NGVD) (see Exhibit 2.6-14). However, during wet springs water stands on both sides of the access road berm, indicating a former at least occasional and temporary surface water connectivity in the past.

Groundwater levels, and the patterns of fluctuation in groundwater levels, are the predominant drivers of vegetation response in the swales and lagoons adjacent to the lake. In the zone of the wetlands nearest the lake, lake levels and ground water levels are essentially equivalent, at least during summer months when input from snow melt is over and input from Taylor and Tallac creeks is reduced.

The consequences for vegetation of the six-foot or more swings in water levels driven by climatic cycles are significant. In the bottoms of the swales and in the lower elevation portions of the creek's floodplains, open water a foot or more deep may stand for several years during the wet portions of the cycle. Under these conditions, yellow pond lilies, pondweeds, and other aquatic plants become established. Large areas of the bottom are unvegetated.

When water levels drop, these unvegetated areas are exposed as mud flat. As long as soils remain moist, pond lily roots and corms may persist, but if drought continues, even these may be killed. Exposed mudflat areas are colonized by early successional meadow species such as ticklegrass (*Agrostis scabra*). Eventually other grasses, sedges and rushes characteristic of wet meadows establish. Willows sprout extensively in these newly exposed areas. When high lake stands return, the meadow plants and willows are killed.

The open water provided by swales and lagoonal portions of the creek floodplains is important for use by wildlife, particularly for waterfowl, shorebirds, and amphibians. In dry years, when the amount of open water is greatly reduced, these remaining low areas increase in importance. Waterfowl, shorebirds, and amphibians find these persistent wetter areas essential to survival.

Abundant willows lining the edges of the swales, evident in historic aerial photos, were killed or stressed by the drought, and have not recovered since the lake level rose again. The loss of these willows may in part be connected to erosion during the high flows and storms of 1997.

The lagoons and creek mouths associated with Tallac and Taylor Creeks exhibit various features typical of coastal barrier beach systems. The mouths of both creeks periodically close in late summer/early fall when stream flow levels decrease. Well-documented long-term data is lacking to determine the frequency, duration, and consequences of creek mouth closure. However, the mouths of both creeks closed in August 2004. In July 1999 the mouth of Tallac was observed to be closed, while the mouth of Taylor Creek remained open (Jones & Stokes 2000). Creek mouth closure can result in increase water surface elevation in the lagoons behind the barrier beach. On August 6, 2004, the Tallac lagoon surface was approximately eight inches higher than the lake elevation, while the Taylor lagoon was approximately four inches higher. On July 29, 1999, the Tallac lagoon was reported to be approximately one foot higher than the lake surface elevation.

Downcutting by the creeks when lake levels fall has contributed to the development of the deeper water lagoonal areas in the lowest reaches of both Taylor and Tallac creeks. When lake levels rise, and natural littoral processes build up sand ridges at the creek-lake interface, these down cut areas become lagoons.

As mentioned earlier, these lagoonal areas are particularly important in dry years when surrounding areas become much drier. The incremental increase in lagoon elevation through barrier beach closure or near closure contributes to an increase in surface water area, wetted perimeter, and locally increases groundwater in the surrounding areas. Under conditions of drought stress, any improvement in these conditions, even small ones, can be significant. Rainfall associated with late summer thunderstorms can also recharge these areas, resulting in, at least temporarily, increased flooded area.

STREAM CORRIDORS

The riparian zones of Taylor and Tallac creeks, upstream of the areas of direct lake influence, form in a relatively flat alluvial situation, just downstream from a break in slope from the steeper, rockier upper watershed. Taylor Creek upstream of the focal study area appears to be relatively stable and functioning well, with significant high quality aquatic habitat. There is some apparently natural bank erosion on outside bends, which contributes a large amount of sediment to the lower wetland and the lake. There is some impact from trails adjacent to the creek that are eroding and contributing fine sediment to the system. In the focal study area, there is a high flow channel that appears to have been formed during the 1997 rain on snow event.

The upper watershed of Tallac Creek is very steep and is dominated by debris flows and channel erosion and deposition. This ensures that sediment generated in the upper watershed is more likely to be delivered to the beaver dams on the wetland portion of the alluvial fan, whereas sediment generated in upper Taylor Creek watershed is trapped in Fallen Leaf Lake. Debris flows and channel erosion is largely trapped by beaver dams. However, during episodic events we assume large sediment fluxes may pass down to the Tallac Wetland. However, it is unlikely that large amounts of sediment pass more than a few hundred yards past the break in slope near SR89.

Beaver

Beaver dams and activity are key factors affecting wetland and riparian plant communities in this zone. Taylor Creek is impacted by dams, though in contrast to Tallac Creek, it retains a sinuous single thread main channel with a series of anabranching distributaries. The beaver dams trap sediment that would otherwise pass to the mouths of Taylor and Tallac creeks. Backwater effects caused by beaver dams elevate groundwater elevations in the vicinity of the dams. Elevated groundwater levels alter vegetation composition, with an increase in marsh and wet meadow species, and an increase in riparian species, such as willow. Tallac Creek downstream of SR 89 is dominated by a series of beaver dams that trap sediment and produce disjointed drainage through a series of distributary channels.

Beaver also modify vegetation directly through tree cutting. Physical modifications by beaver and vegetation responses may in turn increase small mammal and bird populations. Willow flycatchers were observed in wildlife surveys in the riparian scrub in this zone in summer 2004.

DRIER MEADOW

The drier meadow (Exhibit 3.3-1) shows up as a distinctive feature throughout the historical aerial photo time series. At all times and conditions it appears drier than the floodplain meadows to the west and northwest. This area is slightly higher in elevation than adjacent meadow areas. It is also underlain by a different soil type, a coarser textured, gravelly soil that is presumably better drained. These two factors combine to create a different vegetation pattern. These factors also mean that the site is affected earlier and harder by drought conditions than lower elevation meadows on finer textured soils.

LODGEPOLE

Climatic cycles have also had significant consequences for the site's ecosystems that are not directly connected to human activity. The 1987 to 1994 drought was the most severe in the 20th century. Lake Tahoe reached its lowest recorded elevation in the last 100 years. Drought stress in the lodgepole pines on the beach ridges facilitated their attack by insects and disease. It is also likely that lack of periodic fire in the meadows had previously allowed lodgepole numbers to increase.

UPLAND

The upland portion of the focal study area is found primarily on remnants of a medial moraine in the center of the site. This higher elevation and better drained coarser substrate area supports primarily Jeffrey pine and mixed coniferous forests.

7.1.3 PROCESS ALTERATIONS

The previous section summarized natural processes. This section summarizes how these processes have been affected by anthropogenic changes.

SWALES AND LAGOONS

There is some evidence that Swale 1 has carried water from Tallac Creek to Taylor Creek in the recent past; however, three constructed causeways with undersized culverts currently constrict the swale, restricting the flow of water, sediment and nutrients between the two wetlands. The farthest swale from the beach, Swale 4, was continuous between the two wetlands in the recent past (Exhibit 2.6-6) when there was no access road, but may not have behaved like a typical channel connecting the two wetlands as the swale does not become flooded (due to lake level) until levels rise above 6227 feet (NGVD) (Exhibit 2.6-14). However, during wet springs water stands on both sides of the access road berm, indicating that it acts as a barrier to occasional, temporary hydrologic connectivity, and so restricting the flow of water, sediments, and nutrients between the two wetlands.

Blockage of swales due to access road crossings and pathways where culverts have not been provided, such as Swale 4, interrupts both surface and sub-surface hydrologic connectivity. The blockage of Swale 4 by the access road crossing has created a surface hydrologic discontinuity resulting in a surface water elevation head differential from the east to the west of the access road. This surface hydrologic discontinuity is further exacerbated by compaction and consolidation of the sub-surface soils during and since construction of the access road, which has resulted in partial sub-surface hydrologic discontinuity.

The blockage and constriction of swales by construction of the access roads and trails to the beach have caused significant increase in the bottom elevations of much of the swale system. This is particularly evident in the western portion where a foot or more of sediment has accumulated since 1956. Infrastructure development has also greatly increased public access to the beach ridges and swales. Decades of trampling by people has lead to the large expanses of bare sandy areas on the beach ridge tops, and increased erosion into the swales, contributing to their filling. This increase in swale bottom elevation means that the swales are significantly drier in dry years than they would have been previously. Therefore their ability to support water-dependent wildlife has been compromised.

The west parking lot appears to have been constructed on fill in the meadow and is therefore creating a surface and sub-surface hydrologic discontinuity due to blockage of swales and ground compaction. The east parking lot is likely constructed on natural, somewhat higher ground and is therefore not likely creating the same sort of hydrologic discontinuities as the west parking lot.

Lower Taylor Creek flows are manipulated by management of releases from Fallen Leaf Lake. In particular, fall flows are regularly increased to facilitate the run of non-native Kokanee salmon. These increased flows may affect the timing, frequency, and length of time of barrier beach closure, though we have no data to determine the extent and consequences of these effects. The closed mouth of Taylor Creek is routinely opened by U.S. Forest Service staff in the fall to facilitate kokanee passage. The manipulations have been occurring for the last 20 years, or more (Michael St. Michel 2004, pers. comm.).

The STPUD sewer pipe that crosses Tallac Creek near the downstream extent of the creek may be modifying surface and groundwater connectivity by constricting flows and artificially elevating groundwater elevations. In addition, this structure acts as a grade control which may be inhibiting migrating head-cuts that support the formation lagoonal lobes as observed on Taylor Creek. However, it is unclear to what extent the lagoonal features have been impacted by this grade control structure in conjunction with other factors such as upland grazing. In addition, while the grade control structure may have limited the formation of lagoonal features, it may have accentuated the formation of wetlands further upstream by raising groundwater elevations.

The impervious areas represented by the access roads and parking lots contribute pollutants in the form of suspended solids, oils and grease, nitrates and phosphates through runoff. Ditches that run parallel to the main access road concentrate runoff and pollutants but these likely infiltrate or are partially conveyed to swale 4 or ponded areas adjacent to swale 4. Access roads servicing the parking lots likely have a greater contribution to the receiving waters of the lake due to their closer proximity. Certainly, runoff from these access roads will pass into the adjacent swales. The most significant contribution of pollutants to the lake likely result from the east and west parking lots, due to their proximity adjacent to Baldwin Beach.

OTHER ROAD EFFECTS

Roads can serve as invasion routes for non-native species, although there is no specific data on this for the focal study area.

The presence of roads can interrupt wildlife movement. While there is no specific evidence for this in the focal study area, the access road bisecting the swales could be inhibiting movement of amphibians and, perhaps, some small mammals.

STREAM CORRIDORS

Tallac Creek is the most obviously dynamic system, with signs of severe erosion and deposition due to natural debris flows in the upper watershed, and erosion from horse and cattle grazing in the wetland area. The instability of the upper watershed of Tallac Creek is also affected by the presence of undersized culverts that encourage channel deposition and avulsion, increasing the chances that a debris flow will take an unexpected course out of a current channel.

Taylor Creek is less disturbed, but naturally generates more sediment due to a combination of its greater watershed area and the 'hungry water' phenomenon from sediment depleted water flowing out of Fallen Leaf Lake. The dominant source of sediment in Taylor Creek is bank erosion between Fallen Leaf Lake and SR 89. Both creeks are affected by base level fluctuations from changing lake levels in Lake Tahoe. Taylor Creek is more affected due to the absence of grade control near its outlet.

BEAVER

Beaver dams can impede fish passage. USFS staff periodically breach beaver dams on Taylor Creek to facilitate kokanee passage.

GRAZING

Unlike Taylor Creek, the Tallac Creek riparian zone is grazed. Horse grazing along the two main channels in Tallac Marsh has broken down stream banks and has caused channel widening. Streambank trampling damages plant root systems, weakening and eventually killing plants. As streamside vegetation is removed, bank erosion increases and sediment trapping may be diminished. Exposed and unconsolidated soils are eroded, and contribute fine sediment to the stream and lake. The general consequences of these impacts in the lower portions of Tallac Creek and in the swales seem to have been sediment aggradation, loss of channel and swale depth, and channel widening.

Lack of creekside riparian vegetation leads to increased water temperatures, increased algae production, and changes in invertebrate composition in the streams. These changes in the food web can affect fish, amphibian, and other aquatic wildlife species. Grazing in the meadow has suppressed willow establishment, downstream of the area of beaver influence.

Repeated trampling of meadow soils by livestock compacts soils, which impedes water and air infiltration into the soil, and inhibits plant root growth. This damage can be particularly apparent in wet soils because they compact more readily. Grazing and trampling in the floodplain and meadow has led to the development of small rills and gullies. These erode during snowmelt, and contribute fine sediments to the creek and lake. Gullies and bare areas also become established along trails the livestock travel.

Grazing during drought years exacerbates the stress on meadow plants, leading over time to a reduction in plant diversity and productivity. Grazing can leads to shifts in plant species composition, with less palatable species increasing and other species increasing. It is likely that grazing has reduced the prevalence of, for example, Nevada rush (*Juncus nevadensis*), while Kentucky bluegrass (*Poa pratensis*) and smooth buttercup (*Ranunculus alismifolius*) have increased.

Fire Suppression

Effects of fire suppression on the meadow systems are difficult to determine because little is known about the details of pre-European settlement fire regimes in meadows and riparian area. However, typical consequences of fires in meadows are thatch removal, facilitating healthy reproduction of meadow plants, and the creation of increased microtopographic diversity, facilitating plant diversity.

Lodgepole density has significantly increased on the beach ridge tops since 1940, likely because of fire suppression. Lodgepole subsequently declined beginning in the 1980s with drought and insect infestation. Lodgepole tends to invade meadows during drier periods. A 1994 fire, coming at the end of seven years of drought, killed many lodgepole in the area where it burned. Since then, no new lodgepole seedlings have established in the wetter, lower elevation portions of the burn area, but lodgepole seedlings are establishing on the higher, drier beach ridge tops.

Upland

The 1940s aerial photo shows what appears to be a disturbed area in the center of this zone. The source of this disturbance is not clear. Since that time there has been a gradual increase in tree cover in this disturbed area. A gravel parking lot and the site access gate currently occupy this area. Twentieth-century fire suppression has led to an overall increased density of trees in this area, including an increase in the presence of white fir.

7.2 Restoration Opportunities Matrix and Map

The restoration opportunities matrix (Table 7.2-1) is a synthesis of the primary process alterations affecting wetland function and wildlife habitat in the focal study area. The matrix identifies the alterations degrading the process and potential actions to restore its function. The alteration elements are keyed to a map that identifies its general location (Exhibit 7.2-1).

7.3 Parking Lot and Access Road Study

A range of options are available to address negative effects associated with the parking lots and access road to Baldwin Beach. The following study evaluated five parking lot and access road configurations and the effects of implementing each of the options on water quality. Estimates of walking distance and time to the beach are also provided for each parking option.

Table 7.2-1
Restoration Opportunities Matrix

Map Location	Process Alteration	Possible Action #1	Possible Action #2	Possible Action #3	Possible Action #4	Possible Action #5
Physical and Ecological Processes in the Wetland						
1	a. Road fill in swale blocks surface water flow b. Paved access road reduces infiltration and introduces urban runoff c. Paved access road facilitates high volume of recreational users to sensitive beach and wetland areas d. Potential impacts to groundwater flow due to compaction beneath e. Segments wetland system, creates an edge f. Potentially impedes wildlife movement for certain species	Remove road & associated fill	Remove fill & install culvert(s)	Remove fill & install bridge	Remove road and add foot path to the beach	No action
2	a. Paved access road reduces infiltration and introduces urban runoff b. Paved access road facilitates high volume of recreational users to sensitive beach and wetland areas c. Segments wetland system, creates an edge	Remove road	Replace road with foot/bike trail	Replace road with bridge	No action	No action
3	a. Eastern parking lot pavement has replaced native vegetation.	Remove parking lot and revegetate	Remove and excavate beneath parking lot and connect with adjacent swale to create additional lagoon habitat	No action	No action	No action
	b. Eastern parking lot facilitates access to beach and is associated with vegetation trampling, erosion, and litter	Remove parking lot	Provide clear, guided, limited access paths to beach	Redesign parking lot and access road system to one central lot, reducing overall number of spaces	No action	No action
	c. Eastern parking lot reduces infiltration and introduces urban runoff	Remove parking lot	Construct vegetated filter/swale/BMPs around parking lot edges	Construct internal drainage areas (micro cells/micro channels) to treat runoff	Replace with porous asphalt/ concrete to increase infiltration	Move parking lot to more capable land
	d. Loss of vegetation equals loss of wildlife habitat	Remove parking lot	No action	No action	No action	No action
	e. Constructed on area designated as low capability land	Remove parking lot	No action	No action	No action	No action
4	Inadequately-sized and un-maintained culvert underneath pedestrian causeway restricting surface water flow in swale	Conduct regular maintenance	Replace with larger and/or double culverts	Remove culverts and replace with bridges	Remove and restore	Remove and replace with bottomless culvert

Table 7.2-1 Restoration Opportunities Matrix						
Map Location	Process Alteration	Possible Action #1	Possible Action #2	Possible Action #3	Possible Action #4	Possible Action #5
6	Inadequately-sized and un-maintained culvert underneath pedestrian causeway restricting surface water flow in swale	Conduct regular maintenance	Replace with larger and/or double culverts	Remove culverts and replace with bridges	Remove and restore	No action
7	a. Paved access road reducing infiltration and introducing runoff	Remove road	Replace with porous asphalt	Construct vegetated filter/BMPs along road margin	No action	No action
	b. Paved access road introducing high volumes of recreational users to sensitive beach and wetland areas	Remove road	Replace road with foot/bike trail	Redesign parking lot and access road system to one central lot, reducing overall number of spaces	No action	No action
	c. Potentially impedes wildlife movement	Remove road	No action	No action	No action	No action
	d. Pavement has replaced native vegetation	Remove road and revegetate	No action	No action	No action	No action
	e. Fill along road edges allows for increased lodgepole pine establishment	Remove road and fill	No action	No action	No action	No action
8	a. North swale--maintenance road disconnecting flow in near shore swales	Remove	Replace with bottomless culverts	Install bridge	Redesign access	No action
	b. South swale--maintenance road disconnecting flow in near shore swales	Remove	Replace with bottomless culverts	Install bridge	Redesign access	No action
9	Swale disconnected by road system	Remove road	Replace with bottomless culverts	Redesign/modify road	Install bridge	No action
10	a. Western parking lot is increasing urban runoff and reducing infiltration	Remove	Relocate	Construct vegetated filter/BMPs around parking lot edges	Replace with porous asphalt/concrete to increase infiltration	Redesign parking lot and access road system to one central lot, reducing overall number of spaces
	b. Use of western parking lot associated with vegetation trampling, erosion, and litter; and potential impacts to Tahoe yellow cress	Remove	Relocate	Provide guided, limited access paths to beach	Provide interpretive signs	No action
	c. Western parking lot has replaced approximately 0.6-acre of meadow vegetation	Remove and revegetate	Relocate	Remove and excavate to increase potential lagoonal area	No action	No action
	d. Western parking lot has reduced potential Tahoe yellow cress habitat	Remove	Develop a Tahoe yellow cress interpretive garden	No action	No action	No action
	e. Loss of vegetation reduces wildlife habitat	Remove and revegetate	Remove and excavate to increase potential lagoonal area	No action	No action	No action
	f. Fill placed in wetland habitat reducing wetland function and processes	Remove fill and revegetate	Remove and excavate to increase potential wetland area	No action	No action	No action
	g. Lodgepole established in fill along parking lot edge	Remove fill	No action	No action	No action	No action
	h. Facilitates high recreational use (boat dragging, mouth crossing)	Remove	Relocate	No action	No action	No action
12	Rip rap bank on dogleg of Tallac Creek prevents natural migration of channel bend	Remove	Use bioengineering methods to stabilize	No action	No action	No action

Table 7.2-1 Restoration Opportunities Matrix						
Map Location	Process Alteration	Possible Action #1	Possible Action #2	Possible Action #3	Possible Action #4	Possible Action #5
13	Sewer line acts as grade control and may lagoonal development by halting channel headcutting processes	Remove	Leave in place	Re-align	No action	No action
14	Tallac lagoon at low lake stands—Tallac wetland presently dries out at low lake stands	Excavate to lower swales	Remove grazing	No action	No action	No action
15	Manipulation of the mouth of Taylor Creek interferes with barrier beach/lagoon function	Stop manipulating mouth	Stop flushing flows in fall--design an analog flow regime	Monitor results	Develop new interpretive program based on cutthroat	No action
16	a. Swales dry under prolonged drought conditions	Deepen swales to increase percent of time inundated/ saturated	No action	No action	No action	No action
20	Ditch in Taylor Marsh draining meadow	Fill in ditch	Install periodic obstructions to flow along its length	No action	No action	No action
22	SR 89 culvert for Tallac Creek not adequate for high flood flows	Describe plan for better solution in event of a future high flow event	Replace with bottomless culvert	Increase culvert size	Coordinate with Caltrans to construct a bridge	No action
Recreation & Education						
5	Human foot traffic is accelerating filling of near shore swales	Redesign trails to discourage off-trail use	Provide boardwalks to beach	Provide appropriate access to specific locations for education/ interpretation	Provide interpretive signs	No action
11	People crossing the mouth of Tallac to access beach and causing bank degradation	Build an access bridge	Restrict people from this section of beach	Interpretive signs	Move ski beach location	No action
21	Need for improved Washoe facilities and participation (no direct process alteration)	Develop selected, distributed, opportunities throughout the site for Washoe traditional tending & gathering	No action	No action	No action	No action
24	Need for improved bike access	Redesign/add to bike path system for better flow, new access opportunities	No action	No action	No action	No action
Land Use						
17	Private in-holding (no direct process alteration)	Purchase in-holding	Lease in-holding	No action	No action	No action
18	Grazing and associated erosion and water quality problems degrading aquatic habitat and may result in changing fish and aquatic invertebrate communities	Remove horses	Reduce numbers	Produce monitoring plan	Fence horses off from stream channels	No action
Upland Forest						
19	Diseased, dead, & dying lodgepole	Thin selectively to remove dead trees	Continue prescribed burns	Thin seedlings to reduce density	Use Washoe/FS to manage annually	Excavate areas and manage area native riparian vegetation
23	Conifer encroachment in aspen stands (multiple areas throughout focal study area)	Monitor and remove conifers when necessary	Implement schedule for prescribed burning in stands	Manage to expand aspen stand	No action	No action
25	Diseased aspen along interpretive trails in Taylor Marsh	Thinning	Prescribed burn	No action	No action	No action

7.3.1 DESIGN OPTIONS

The five parking lot and access road options summarized below were digitized using Geographic Information System (GIS) software (Exhibits 7.3-1 to 7.3-5). In addition, a diagram was produced to illustrate the conceptual parking lot design that incorporates infiltration planters (Exhibit 7.3-6).

- Parking Lot Option 1 represents existing conditions, retaining both east and west parking lots and the access roads that connect them to SR 89 to the south.
- Parking Lot Option 2 includes removing the west car park and its access road, and relocating this west parking lot onto higher capability land closer to SR 89. An interpretative boardwalk is incorporated, connecting the east parking lot to the lake shoreline, and directing pedestrian access.
- Parking Lot Option 3 includes removing both east and west existing parking lots, and developing two replacement lots: one at the end of the access road and the other on higher capability land. An interpretative boardwalk provides public access from the parking lot to the beach.
- Parking Lot Option 4 includes removal of both existing parking lots, replacing them with one large lot on higher ground, and a drop-off area near the beach.
- Parking Lot Option 5 includes a similar parking lot configuration to Alternative 4, but the access road to the lake is now decommissioned with pedestrian access only, and an interpretive boardwalk connecting the access road to the beach.

Table 7.3-1 provides the square footage, number of parking spaces, distance to beach (in feet), and estimated walking time (in minutes) associated with each of the five options.

7.3.2 HYDROLOGIC AND WATER QUALITY EFFECTS

The effects to hydrologic conditions and water quality associated with implementing each of the proposed options were assessed using GIS techniques in combination with water quality modeling guidelines provided by the Storm Water Quality Improvement Committee (SWQIC) (NHC 2003). It was assumed that for each of the proposed option, best management practices (BMPs) would be implemented as part of the design to maximize filtration and infiltration of the runoff and pollutants from the impervious surfaces (parking lots, access roads, and building infrastructure such as restrooms). For example, BMPs could range from vegetated buffers or infiltration trenches along the perimeter of impervious surfaces to retention ponds centrally located in the middle of parking lots.

The total impervious area for each option was calculated in GIS and implemented in the SWQIC guidelines as Indirectly Connected Impervious Area (ICIR). For simplicity, a vegetated buffer around all impervious surfaces was assumed to represent the area available for treatment of runoff and pollutants. Results generated using spreadsheet techniques provided by the SWQIC guidelines are shown in Table 7.3-2.

Table 7.3-1
Parking Lot Option Study

Parking Lot Option No.	Parking Lot Description	Parking Lot Size (square feet)	Lot Status	Parking Spaces	Distance from Lot to Beach (linear feet)	Estimated Average Walking Time: Lot to Beach* (minutes)
1	No Proposed Changes	n/a	n/a	n/a	n/a	n/a
	Existing (west)	26,400	Retain	57	20	1
	Existing (east)	37,050	Retain	108	220	1
2	Proposed Lot	25,200	Add	60	2,250	9
	Existing (west)	26,400	Remove	57	20	1
	Existing (east)	37,050	Retain	108	220	1
3	Proposed Lot (near beach)	33,600	Add	80	300	2
	Proposed Lot (near entrance)	25,200	Add	60	2,250	9
	Existing (west)	26,400	Remove	57	20	1
	Existing (east)	37,050	Remove	108	220	1
4	Proposed Lot	70,000	Add	160	2,000	8
	Proposed Drop-off Area	n/a	Add	n/a	220	1
	Existing (west)	26,400	Remove	57	20	1
	Existing (east)	37,050	Remove	108	220	1
5	Proposed Lot	70,000	Add	160	2,000	8
	Existing (west)	26,400	Remove	57	20	1
	Existing (east)	37,050	Remove	108	220	1

Note: Arrival at the beach is measured at the western edge of the beach, near contour elevation 6,225 feet (approximate). Estimated average walking time is rounded-up to the nearest minute

Table 7.3-2
Average Annual Load from Runoff (in Tons)

Option	Impervious Area (acres)	NO_3	TKN	SRP	TP	TSS
Existing Conditions	3.743	0.000391	0.001727	0.000235	0.001010	0.3456
Option 1	3.743	0.000391	0.001727	0.000235	0.001010	0.3456
Option 2	3.133	0.000400	0.001770	0.000241	0.001036	0.3542
Option 3	2.783	0.000262	0.001393	0.000172	0.000853	0.2465
Option 4	3.556	0.000407	0.001798	0.000245	0.001052	0.3596
Option 5	2.602	0.000275	0.001484	0.000182	0.000911	0.2603

The values shown in Table 7.3-2 are presented here for comparative purposes between existing and proposed conditions. The water quality constituents listed above have been identified as priority pollutants in the Lake Tahoe Basin in Section 303(d) of the 1972 Clean Water Act implemented by Lahontan Regional Water Quality Control Board (LRWQCB). In addition, recent research by experts such as Heyvaert, Reuter, and Goldman at the Tahoe Research Group has suggested that available research indicates that phosphorous, nitrogen and fine suspended sediment particles contribute the most toward clarity loss in the lake (USDA 2000). The values shown under existing conditions are relatively small in comparison to typical values obtained from heavily urbanized areas around the basin. The pollutant loads shown in these tables are a function of impervious area and therefore proposals to reduce impervious area from the existing condition will generally result in lower pollutant loads.

It can be observed that Alternative 1 does not reduce pollutant loadings from existing conditions. Option 2 and 4 actually slightly increase pollutant loadings from existing conditions, whereas Option 3 and 5 reduce pollutant loadings, primarily due to the reduction in impervious area that these options represent.

7.4 TRAILS AND PUBLIC ACCESS OPTIONS STUDY

The trails and public access options study identifies several option to expand recreational use and interpretive opportunities in the focal study area while minimizing their effects to the wetlands and Tallac Creek. The trail systems would incorporate overlooks and sections of raised boardwalks through wetland areas. There are ten different segment options for bicycle trails, boardwalks, and hiking/pedestrian trails to circulate recreational users through the focal study area (Exhibit 7.4-1). These options present a range of opportunities and could be used together or individual elements could be selected. Table 7.4-1 identifies the different trail options and the types of surfaces for each. The table also provides the approximate lengths (in miles and feet) of each trail segment and the approximate traveling time in minutes.

7.5 SWALE RESTORATION STUDY

The topographic model of existing conditions at the site, generated as described in Chapter 2, was modified for proposed swale restoration by excavation of up to one foot of sediment in Swale 1. The resulting topography was modeled to quantify the resulting change in area of wetland.

7.5.1 DESIGN OPTIONS

A topographic model of the site for existing conditions was generated using 2004 aerial photogrammetry data supplemented by ground survey data collected in October 2004. The ground survey consisted of thalweg elevations along Swale 1. The existing conditions model was then modified hypothetically assuming 1 foot of excavation throughout Swale 1 for ground levels below 6227 feet NGVD 29. In addition, in areas where existing pedestrian trails or vehicular access roads crossing swales are proposed for removal, the model was modified to represent the removal of fill material from the swale.

Table 7.4-1
Trails and Public Access Options

Option	Trail Name	Location	Surface Treatment	Approximate Distance (miles)	Approximate Distance (linear feet)	Estimated Average Traveling Time** (minutes)
Bicycle Trails						
A	Upper Parking Area Trail	From Highway 89 to proposed upper parking area (separate from existing road to remain)	A.C. Paving	0.27	1,442	2
B	Western Perimeter Trail	Western perimeter trail from near end of existing bike trail to proposed overlook	A.C. Paving	0.80	4,228	7
C	Taylor to Tallac Trail	Inland connection from existing bike trail near Taylor Creek to existing bike trail near Tallac Creek	A.C. Paving	1.31	6,932	11
D	Tahoe Loop Trail Stub	Bicycle trail stub off of western perimeter trail for future trail extension around Lake Tahoe	A.C. Paving	0.05	244	1
Boardwalks						
E	Baldwin Beach Boardwalk	From existing eastern parking lot to Baldwin Beach*	Treated Wood	0.03	175	1
F	Tallac Creek Boardwalk	From trail leading from existing eastern parking lot/boardwalk to western perimeter trail	Treated Wood	0.30	1,565	6
Hiking / Pedestrian Trails						
C	Taylor to Tallac Trail	Inland connection from existing bike trail near Taylor Creek to existing bike trail near Tallac Creek	Decomposed Granite	1.31	6,932	11
G	Central Trail	From existing eastern parking lot/boardwalk to proposed western boardwalk	Decomposed Granite	0.31	1,624	7
H	Ski Beach Trail	From western boardwalk to Ski Beach*	Decomposed Granite	0.16	843	4
I	Overlook Trail	From western boardwalk to proposed overlook	Decomposed Granite	0.28	1,481	6

*Note:*Arrival at the beach is measured at the western edge of the beach, near contour elevation 6,225' (approximate).*
*** Estimated traveling time is rounded-up to the nearest minute.*

7.5.2 HYDROLOGIC EFFECTS

The theoretical inundation area of the wetlands was calculated for existing conditions and the modified conditions, which assume 1 foot of excavation in Swale 1. The theoretical inundation area for a range of lake elevations is shown in Exhibits 7.5-1 and 7.5-2 and tabulated in Table 7.5-1. Table 7.5-1 shows that the hypothetical excavation of Swale 1 generates the greatest relative increase in wetland area when the lake level is relatively low, at approximately 6224 feet NGVD 29.

Table 7.5-1
Theoretical Wetland Area: Pre- and Post- Surface Modification (Swale Excavation)

Lake Level (ft NGVD 29)	Existing Inundation Area (acres)	Modified Inundation Area (acres)	Percent Increase
6,223	2.2	3.4	52.7
6,224	4.4	7.1	62.4
6,225	9.7	12.2	25.1
6,226	20.6	23.2	12.9
6,227	39.3	39.4	0.4
6,228	93.43	93.45	0

7.6 SEWER LINE STUDY AND BATHROOM OPTIONS

Three option are considered for relocation of the South Lake Tahoe Public Utilities District (STPUD) sewer pipe currently acting as a grade control structure where is crosses Tallac Creek.

7.6.1 SEWER LINE DESIGN OPTIONS

Presently, the STPUD sewer line crosses Tallac Creek parallel to the shore of Lake Tahoe, servicing upland sewerage from properties to the west of the site and the bathroom facilities at the west and east parking lots. As identified in Chapter 2, this sewer line crossing is encased in concrete and likely acts as a grade control structure on Tallac Creek. The presence of this structure may have restricted the formation of lagoonal features through headcutting or may act to elevate the wetland water table in the spring and summer months. Therefore, three options are proposed here to lower or relocate this sewer line:

- Alternative 1 – Lower sewer pipe under Tallac Creek to create a siphon. Two options are proposed: 1A and 1B. 1A and 1B differ in respect to the positioning of new manholes to accommodate the proposed siphon.

- Alternative 2 – Modify sewer pipe gradient and manhole invert elevation to increase the depth of the pipe under Tallac Creek.

- Alternative 3 – Relocate the sewer pipe alignment to either divert flows to the south of the lake shoreline (3A), or divert flows directly to the sewer pipe at SR 89 (3B); rendering the current sewer pipe between Tallac Creek and the wet well obsolete.

The conceptual alignment of these three options is shown in planform by Exhibit 7.6-1.

7.6.2 HYDROLOGIC EFFECTS OF SEWER LINE REDESIGN

A longitudinal profile of the sewer line invert elevation was developed based on information provided by STPUD design plans dating from 1970. The planform design plans of the sewer line were roughly georeferenced in GIS to develop a longitudinal profile of the existing ground surface along the sewer line. Exhibit 7.6-2 shows the longitudinal profiles of the sewer line invert and ground surface elevations along with recently surveyed manhole invert and rim elevations. For the two manhole rims that were located, it was only possible to remove one of the manhole covers in order to measure the sewer pipe invert elevation. The invert and rim elevations surveyed in the field are very similar to the elevations shown on the STPUD design drawings.

Superimposed on to Exhibit 7.6-2 are conceptual longitudinal profiles for two options for a siphon (Option 1A and 1B) and an overall modification of the sewer pipe invert and gradient between Tallac Creek and the wet well (Alternative 2). Under these option, the horizontal alignment of the sewer pipe would be not be altered. These option provide the potential for geomorphic processes to develop in Tallac Creek unrestricted by the presence of the sewer pipe.

Two additional options are presented (Option 3A and 3B) which involve lateral movement of the pipe. Alternative 3A maintains the pipe at the current elevation but moves it upstream, away from the shoreline of the lake, to a location where the sewer pipe would have greater cover due to higher ground elevations. This option relocates the pipe acting as a grade control and therefore partially eliminates the restriction on geomorphic processes in Tallac Creek. However, relocation along this alignment provides only limited development of these processes, but more importantly, may enable lagoonal features to develop through connection to Swale 1. Alternative 3B involves abandoning the current section of pipe between Tallac Creek and the wet well, by diverting the sewer pipe along an alignment directly to the existing sewer pipe along SR 89.

Clearly, cost may be a limiting factor associated with selection of a sewer pipe alternative here. Cost estimates were not within the scope of this study.

7.6.3 BATHROOM OPTIONS

If it is determined feasible to completely remove the sewer line within the focal study area, the existing bathrooms can be replaced by ecologically-friendly, freestanding bathrooms. A viable option would be to install composting toilets that do not require water, sewer lines, or chemical treatments. Some maintenance would be required to empty the composted material, but this material can sometimes (depending on local health authority regulations) be incorporated as mulch for horticultural plantings.

Another option to support freestanding bathrooms is a system called a Living Machine™. These systems are ecologically engineered wastewater treatment reclamation systems that incorporate the treatment of wastewater by wetland plants and animals held with aquarium-like tanks. Living Machines™ have been successfully used in a number of interpretive centers, including Audubon's Corkscrew Swamp Sanctuary in the Everglades (Dharma Living Systems 2004). The effluent does need to be disinfected by a chlorination-dechlorination unit, but following this process the water can be recycled back to the toilets. Only approximately 10% of the water needs to be discharged to an absorption mound. This type of system can be a low-cost option that handles large fluctuations in flows from holiday crowds.

7.7 MANAGEMENT ISSUES

Preparing and implementing a comprehensive long-term management plan for the focal study area would be a natural complement to the potential physical restoration actions described in this chapter and in Chapter 8. Current management actions are undertaken piecemeal by different groups within the Forest Service. Several potential management issues were identified during the assessment of plant communities and aquatic ecosystems in Chapter 3 that can best be addressed by incorporating them into an overall management plan for the site. While a few of the following issues are identified as a components of the overall conceptual restoration design (e.g., lodgepole pine management), others need to be addressed more fully as part of a long-term program and require additional studies prior to implementing (e.g., prescribed burning).

CONIFER STANDS

Fire suppression in combination with historic logging has produced conifer stands that are overstocked with an increasing dominance of white fir. These overstocked and even-aged stands generally lack structural diversity because the dense shade created by the overstory prevents the establishment of understory vegetation. These crowded stands are more susceptible to disease outbreaks during periods of extended drought when the trees become water stressed and are a greater fire hazard. In the focal study area this includes the areas mapped as Jeffrey pine, Sierran mixed conifer, and lodgepole pine. The Jeffrey pine community is open in certain areas (e.g., along the access road), but denser areas that have a large component of white fir may need to be treated. The Sierran mixed conifer communities appear to be generally dense with a large component of white fir and little understory. Treatments for these areas may include a program of thinning in combination with prescribed burning. In general, the areas mapped as lodgepole pine along the upland edge of the meadow in focal study area appear to have structural diversity. However, the large diseased and dying stand of lodgepole pine on the remnant beach ridges need some type of treatment to return it to more historic conditions. An annual mortality flight conducted in 1996 by LTBMU mapped the lodgepole stand on the remnant beach ridges as having 6-10% mortality, but did not identify the cause. In reviewing the 1995 aerial photo of the focal study area, it appears that there was much greater mortality at that time (Exhibit 4.2-6). This lodgepole pine stand likely became stressed over the drought in the late 1980's and early 1990's and was unable to defend themselves against bark beetles, or some other pathogen. The diseased stand has been periodically burned, and the dead, dying, and charred trees reduce the aesthetic of the surrounding marsh. Management may include a program of significant thinning in combination with prescribed burning to restore the historic structure of these stands. It would be beneficial to identify and retain tall snags and some downed trees as wildlife habitat.

ASPEN STANDS

Some areas within the aspen stands in the focal study area were observed to lack structural diversity and exhibit signs of disease. While conifer encroachment did not appear to be significant in any of the stands observed during reconnaissance surveys, this may be an issue in the future as well. The aspen stands within the Baldwin allotment have several denuded trails that accelerate the draining of surface and groundwater and add sediment to Tallac Creek. In addition, browse of young saplings by the horses can deter aspen regeneration. Detailed surveys would need to be conducted to assess the structural diversity and health of these stands and to develop a management protocol. These assessments could be done as part of the Aspen Delineation Project sponsored by Region 5 of the Forest Service. The goal of this project, which is directed by a volunteer David Burton (peregrines@prodigy.net), is to inventory and assess aspen stands within Region 5 and gather information on the types and results of aspen stand restoration projects. The project identifies a protocol and provides a data collection form to help coordinate and unify information-gathering efforts throughout the region. As part of the project, a General Technical Report, Aspen on Rangelands: Monitoring and Analysis Project, is being prepared to provide a summary of research on the effects of browse on aspen regeneration, a protocol to identify if browse is affecting aspen regeneration, and an effectiveness monitoring protocol to establish and evaluate management objectives dealing with aspen stands on rangelands. This report was scheduled for review in the winter of 2004, but is not yet available to the public. It is recommended that these resources be utilized prior to implementing any management actions such as prescribed burning or thinning projects. It is also recommended that the system of denuded trails in the aspen stands within Baldwin allotment be restored by decompacting and recontouring to pre-existing conditions and planting native vegetation.

LODGEPOLE PINE INVASION OF MONTANE MEADOW

While extensive lodgepole pine invasion within the meadow was not observed during reconnaissance surveys or detected during the aerial time series analyses, extended droughts and heavy grazing is often correlated with the establishment of lodgepole pine within montane meadows. If it is determined that lodgepole pines are establishing in significant numbers, it may be beneficial to implement a prescribed burning program for the montane meadow to reduce these invasions.

SPRINGS AND SEEPS

Very little information on the springs and seeps within the focal study area was available for the assessment. It is recommended that surveys be conducted to map the locations of these features and investigate their water source and function in watershed as part of the overall management of the site.

LAGOON

The annual manipulation of Taylor Creek mouth to allow kokanee passage adversely affects stream water-based lagoon formation in years with low lake levels. In addition, the managed flows in the fall to facilitate kokanee passage are higher than seasonally appropriate and may also negatively affect the ability of stream water to form lagoon in low lake level years. These lagoonal areas are important waterfowl habitat and allow greater residence time for aquatic vegetation to remove nutrients from the water column.

Lagoons can also provide important rearing and intermittent habitat for several native fish species including Lahontan redside, Lahontan speckled dace, and Tahoe sucker as well as non-native warm-water species. Allowing for variations in lagoon habitat associated with naturally occurring processes will generally benefit native species as they are adapted to these changing conditions. Conversely, artificially stable aquatic environments will generally benefit non-native species that are not adapted to the changing environments.

BEAVER

Modifications made by beaver in the focal study area have diversified wetland, riparian, and stream habitats and provide habitat for various wildlife including fish, waterfowl and other birds, and amphibians. The effects of beaver on the environment are discussed in detail in Section 3.3.10. To maintain a balance in the Taylor Tallac marsh ecosystem, it may be beneficial to establish a threshold for the number of beavers this area can sufficiently support, or identify some other management tool, and monitor these numbers as part of the marsh's overall management.

GRAZING

As discussed in Chapter 4, grazing in the Baldwin allotment has resulted in the degradation of montane meadow and aspen plant communities. If feasible, it is recommended that the grazing be eliminated, especially in wetland habitats, or managed more rigorously to reduce associated impacts.

SPECIAL-STATUS PLANTS

Two special-status plant species are known to occur within the focal study area, Tahoe yellow cress and marsh skullcap (Chapter 3). Management should include periodic plant surveys to document the location, extent, and numbers of populations occurring in the focal study area. The distribution of Tahoe yellow cress is highly dynamic since available habitat varies with lake level. Available habitat increases with dry periods as additional sand is exposed and decreases during wetter periods (TRPA 2002). The occupied areas should be monitored on an annual basis and fencing expanded as plants establish outside of the protected area.

INVASIVE NONNATIVE PLANTS

While extensive infestations of invasive nonnative plants were not observed during reconnaissance surveys, assessments should be part of the overall management of the site. While common dandelion and nonnative grasses have become naturalized in the montane meadow, other more invasive species, such as bull thistle (Cirsium vulgare) and perennial pepperweed (Lepidium latifolium), are common wetland meadow invaders and eventually outcompete and replace native vegetation. The other invasive plant noted during the assessment is Eurasian watermilfoil. As mentioned in Chapter 3, infestations of this plant have been observed at the mouth of Taylor Creek (LRWQCB 2002; Walter 2000). This invasive pest plant, which is on California Exotic Pest Plant Council (CalEPPC) List A-1: widespread aggressive invader, can develop large populations, replacing native species and adversely affecting aquatic ecology. The species prefers the calm water conditions typical of the lagoonal areas. Eurasian is known to choke out waterways, shade out native aquatic species, reduce wildlife habitat values, and increase water temperatures. In addition, it has been reported to increase phosphorus and nitrogen levels in waters when it is decomposing and it can raise the pH and decrease available oxygen (Bossard et al. 2000). Control methods for this species include physical treatments such as hand-pulling and screening with an opaque fabric to block UV light, and chemical treatments (Bossard et al. 2000). Foliar applications include the use of 2,4-D, diquat, complexed copper, endothall dipotassium salt, and edothall. Successes have also been reported using fluridone (SONAR), with concentrations of 10-15 ppb (must be maintained in water column for 10 to 12 weeks). Follow up treatments can be conducted using divers to hand pull regrowth. Triclopyr may prove useful if it is approved for aquatic use. It requires a relatively short contact period (18 to 48 hours) and selectively controls Eurasian watermilfoil (WA Water Quality Program 2002).

The Monsanto Corporation suggests that the use of Rodeo on emergent leaves (application of a 1.75% solution) during fall with lowered water levels can provide 95% control (Bossard et al. 2000). This species is difficult to control and treatment methods are generally not very effective. In addition, this species has established throughout marina's in the lake, therefore, new propagules may re-introduce this plant after it has been treated.

LAHONTAN CUTTHROAT TROUT REINTRODUCTION AND RESTORATION

Reintroduction and the probability for successful restoration of Lahontan cutthroat trout in the study area watershed would be challenging given the existing conditions. One of the primary causes of cutthroat decline are interactions with alien trout (Moyle 2002). With few exceptions, populations decline and disappear following the introduction of rainbow, brown, and brook trout, often with all three in the same stream similar to the study area watershed. The effect of introduced trout can vary, in part, depending upon their spawning season. Brown and brook trout are fall spawners as opposed to spring spawning cutthroat (Moyle 2002). This effect results from brown and brook trout juveniles already occupying habitat when cutthroat fry are still emerging and thus being subject to aggressive displacement and predation by the slightly older and larger nonnatives. Rainbows, a spring spawning trout, can hybridize with cutthroats, producing a theoretically sterile "cut-bow" hybrid offspring. Hybridization between rainbow and cutthroat trout effectively disrupts genetic integrity and reproduction capability. These factors combined with more general predation and competition interactions create extremely difficult conditions for sustainable cutthroat coexistence with alien trout species.

While numerous restoration efforts are under way for stream and small lake Lahontan cutthroat trout populations, these projects often involve efforts to eradicate nonnative trout above natural or human made barriers prior to reintroduction. The eradication of nonnative trout species and prevention of their return through barriers would be important management considerations if restoration of Lahontan cutthroat trout is pursued. Changing the managed flow releases from Fallen Leaf Lake into Taylor Creek is another management consideration that would have to be taken into account.

PROTECTION OF SHOREZONE HABITAT IN LAKE TAHOE

The shorezone of Lake Tahoe provides important spawning and rearing habitat for many fish species, especially native minnows. It is recommended that the shorezone of Lake Tahoe is managed to minimize disturbances to potential habitat for fish species.

7.8 REFERENCES

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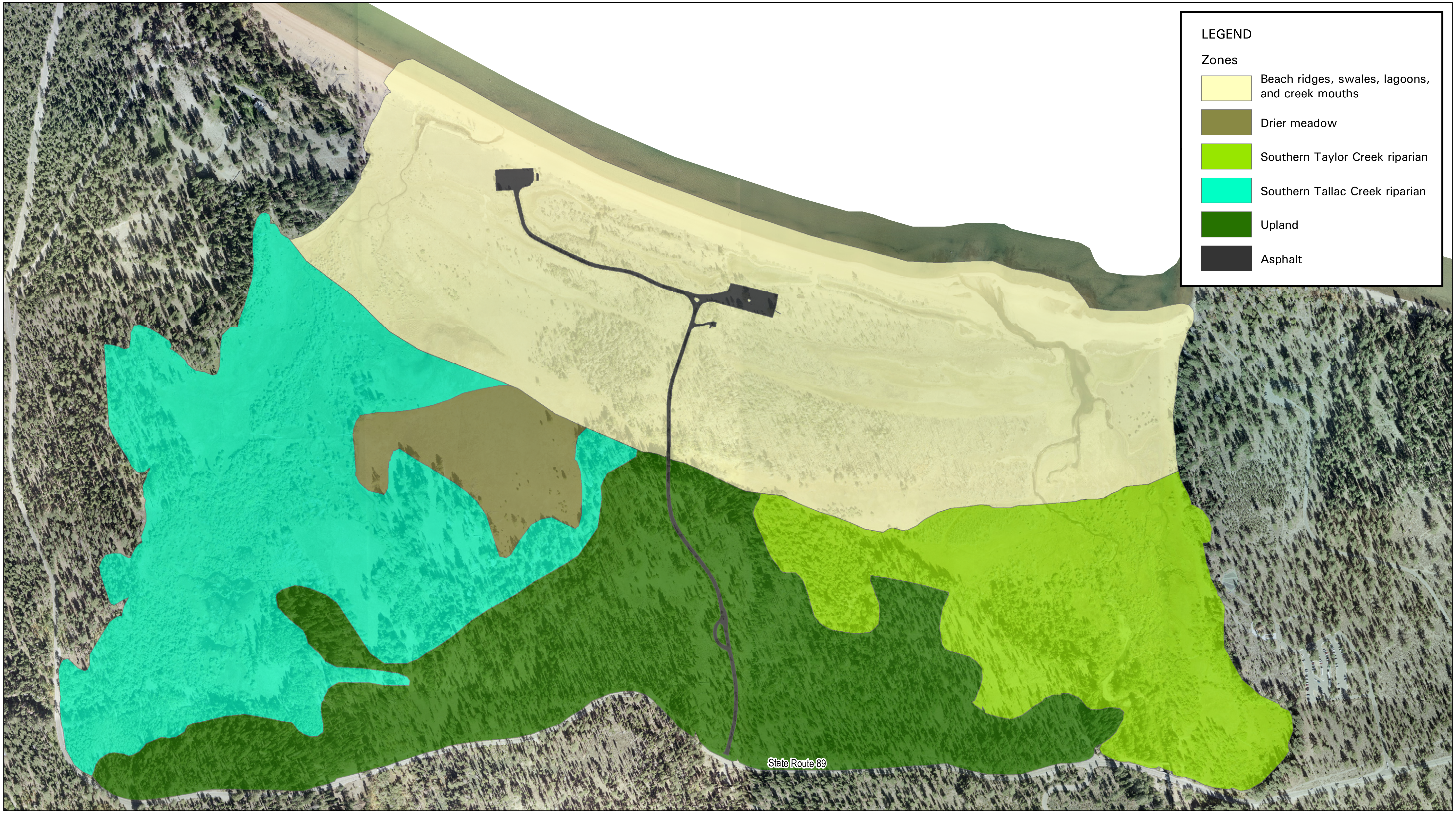

Sources: North American Mapping Company 10/9/03, EDAW 2004

Plant Communities and Aquatic Ecosystems with Lagoon from 2000

EXHIBIT 7.1-1

Taylor, Tallac and Spring Creek Watershed EAR

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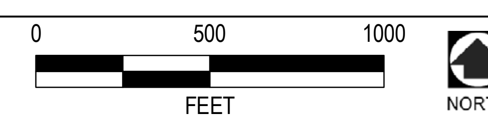

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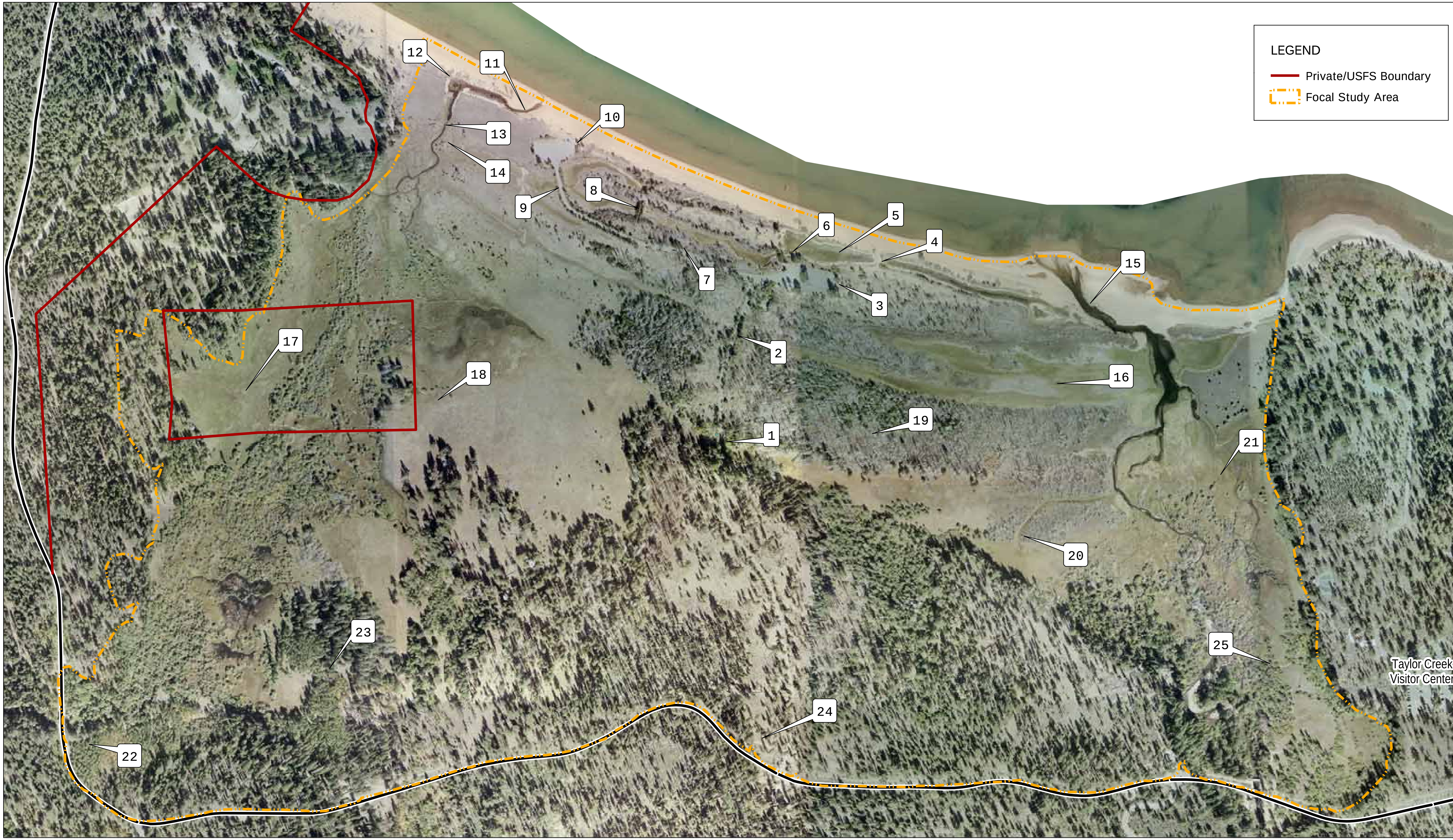

Source: North American Mapping Company 10/9/03

Restoration Opportunities

EXHIBIT 7.2-1

Taylor, Tallac, and Spring Creek Watershed EAR

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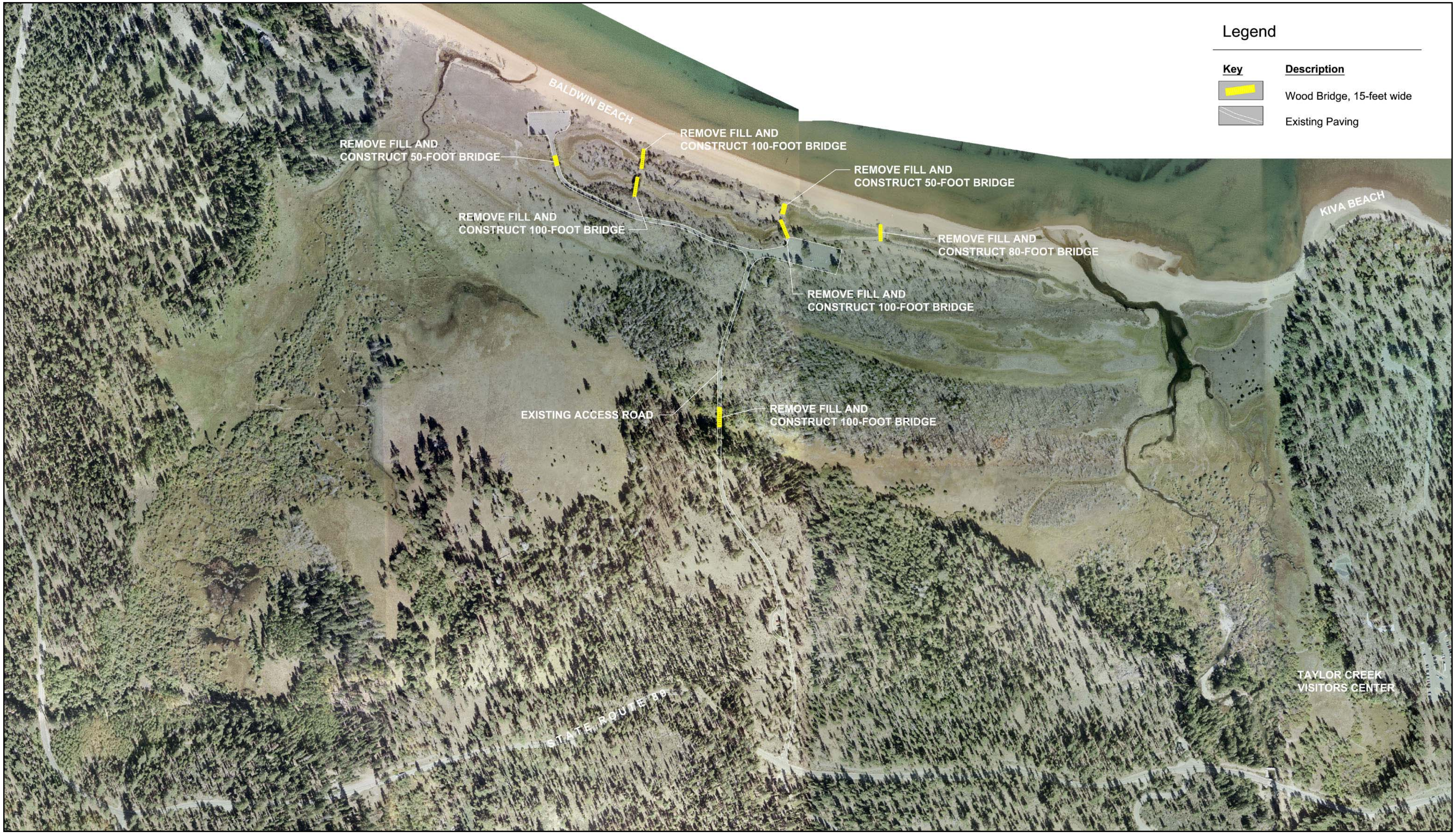

Aerial Photograph: October 9, 2003

Option 1

EXHIBIT 7.3-1

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

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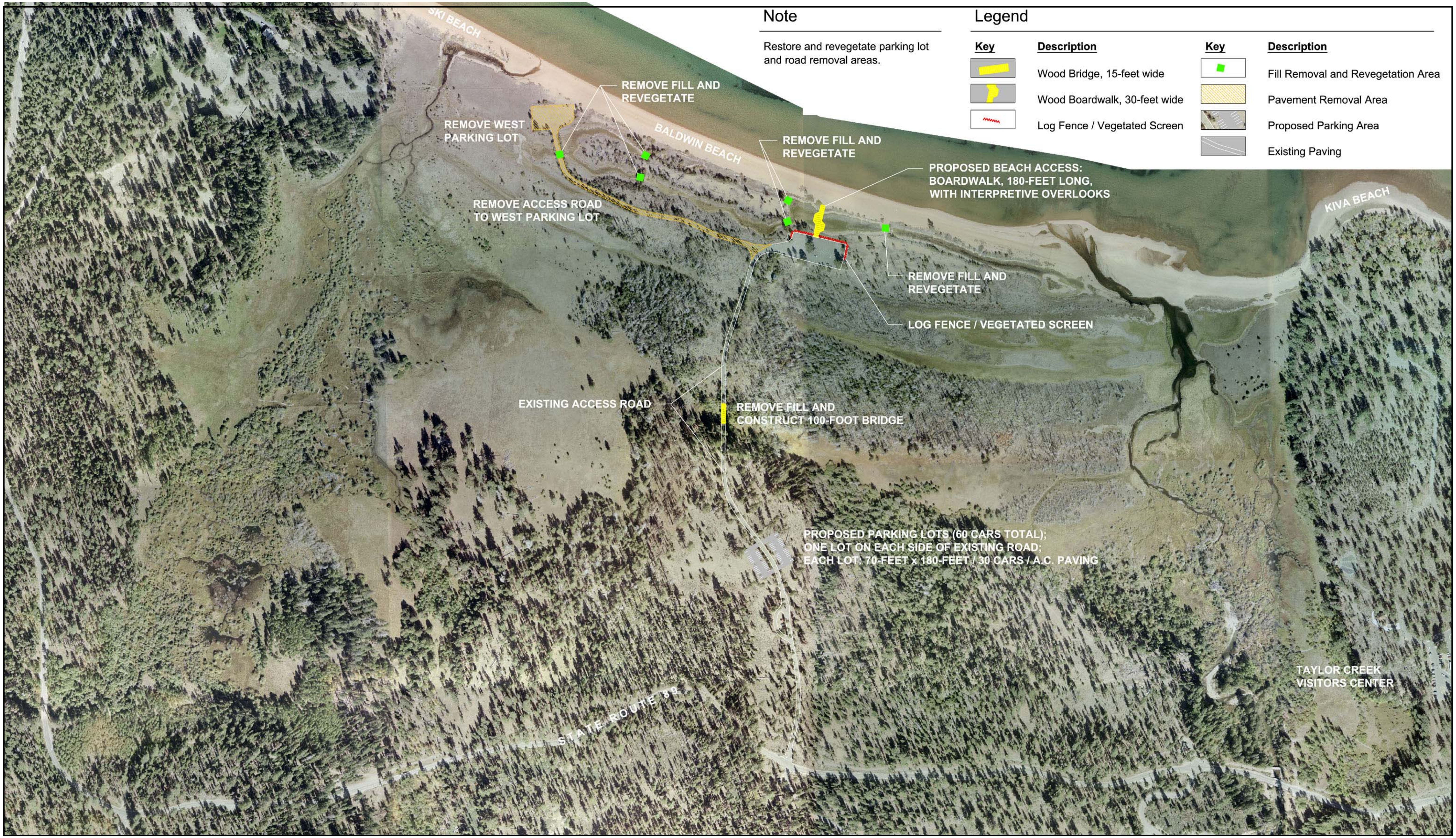
FEET
NORTH
EDAW



Note

Restore and revegetate parking lot and road removal areas.

Legend

Key	Description	Key	Description
	Wood Bridge, 15-feet wide		Fill Removal and Revegetation Area
	Wood Boardwalk, 30-feet wide		Pavement Removal Area
	Log Fence / Vegetated Screen		Proposed Parking Area
			Existing Paving

Aerial Photograph: October 9, 2003

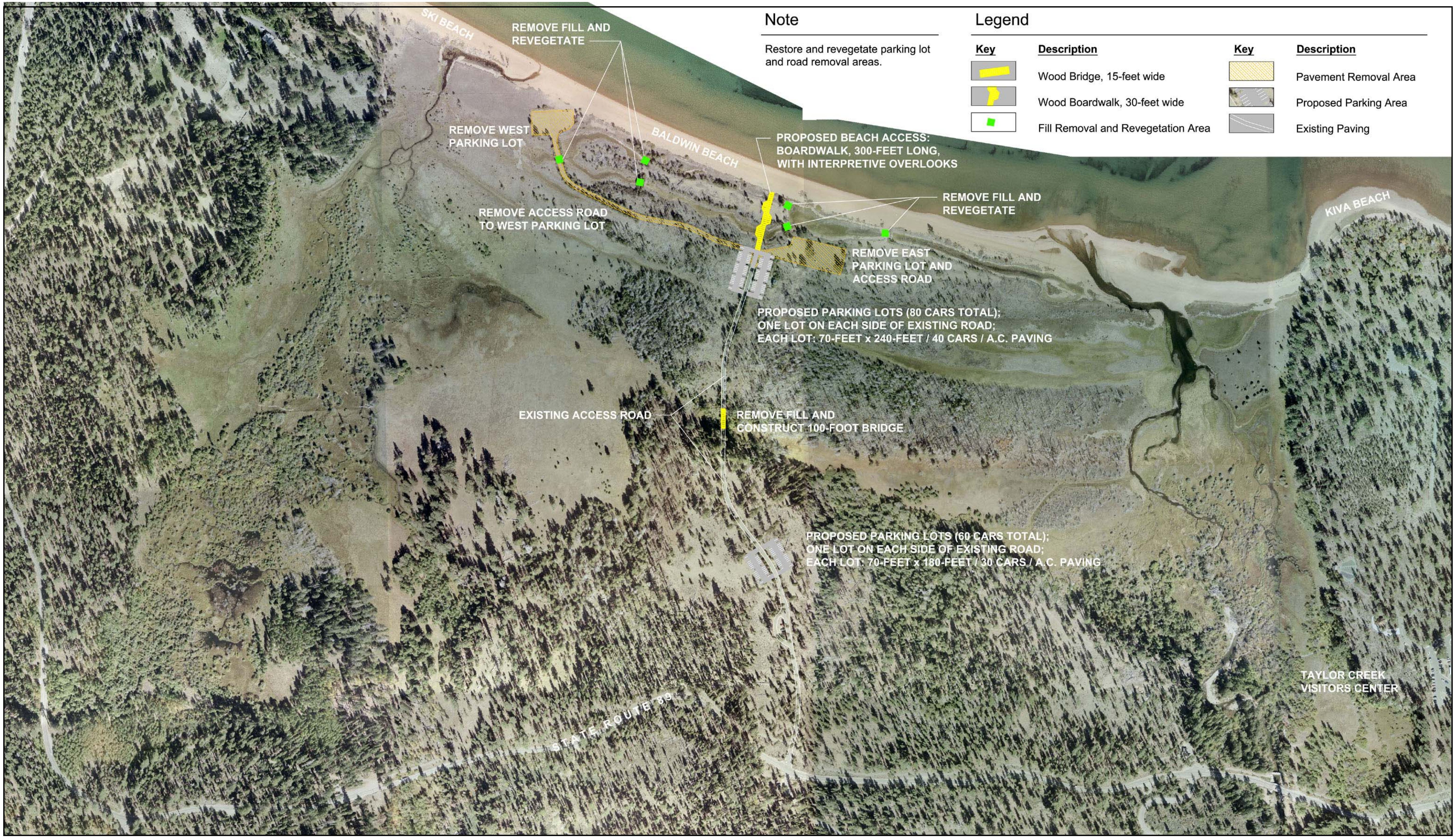
0 485 990
FEET
NORTH

Option 2

EXHIBIT 7.3-2

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

EDAW



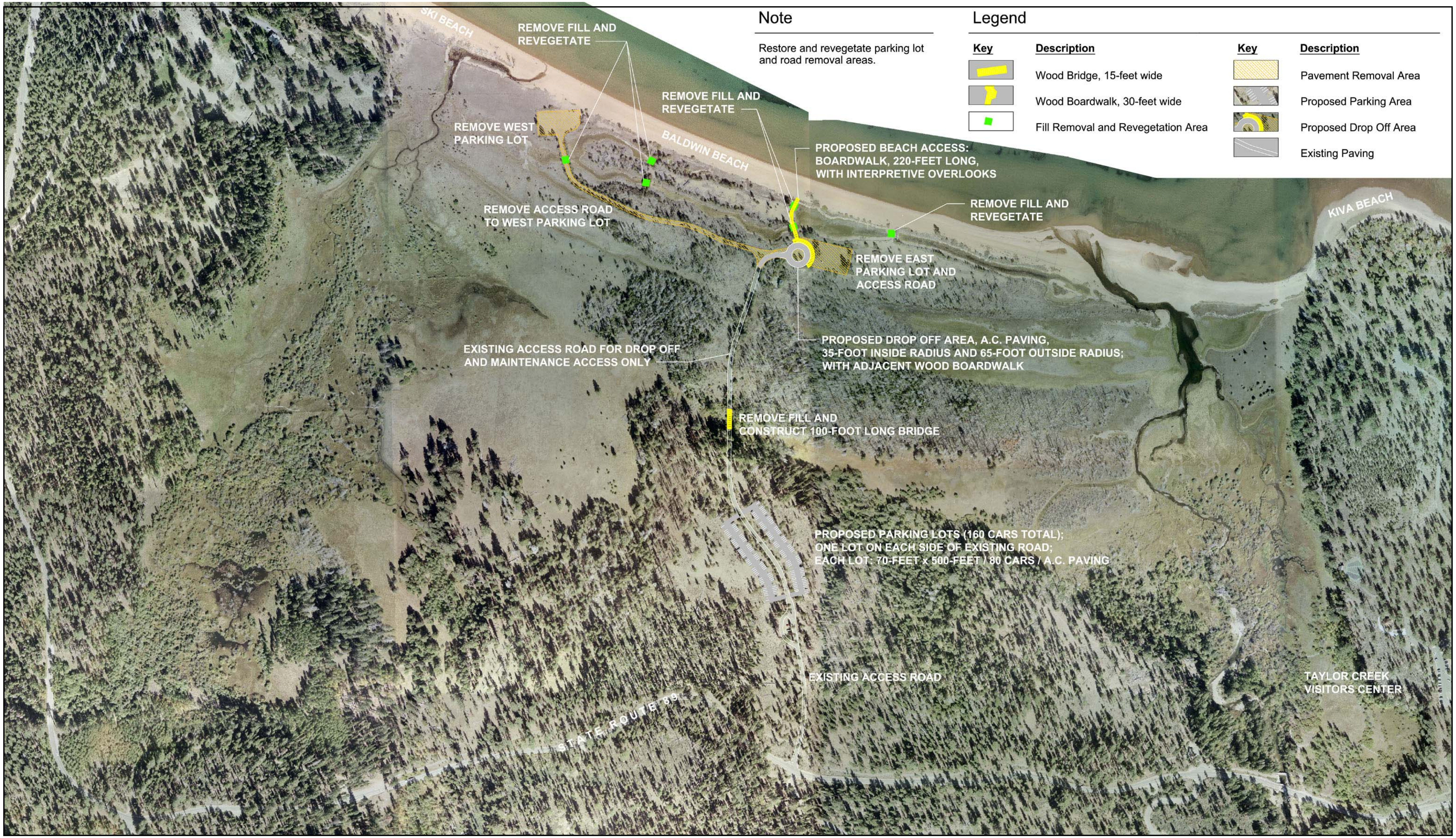
Aerial Photograph: October 9, 2003

Option 3

EXHIBIT 7.3-3

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

EDAW



Aerial Photograph: October 9, 2003

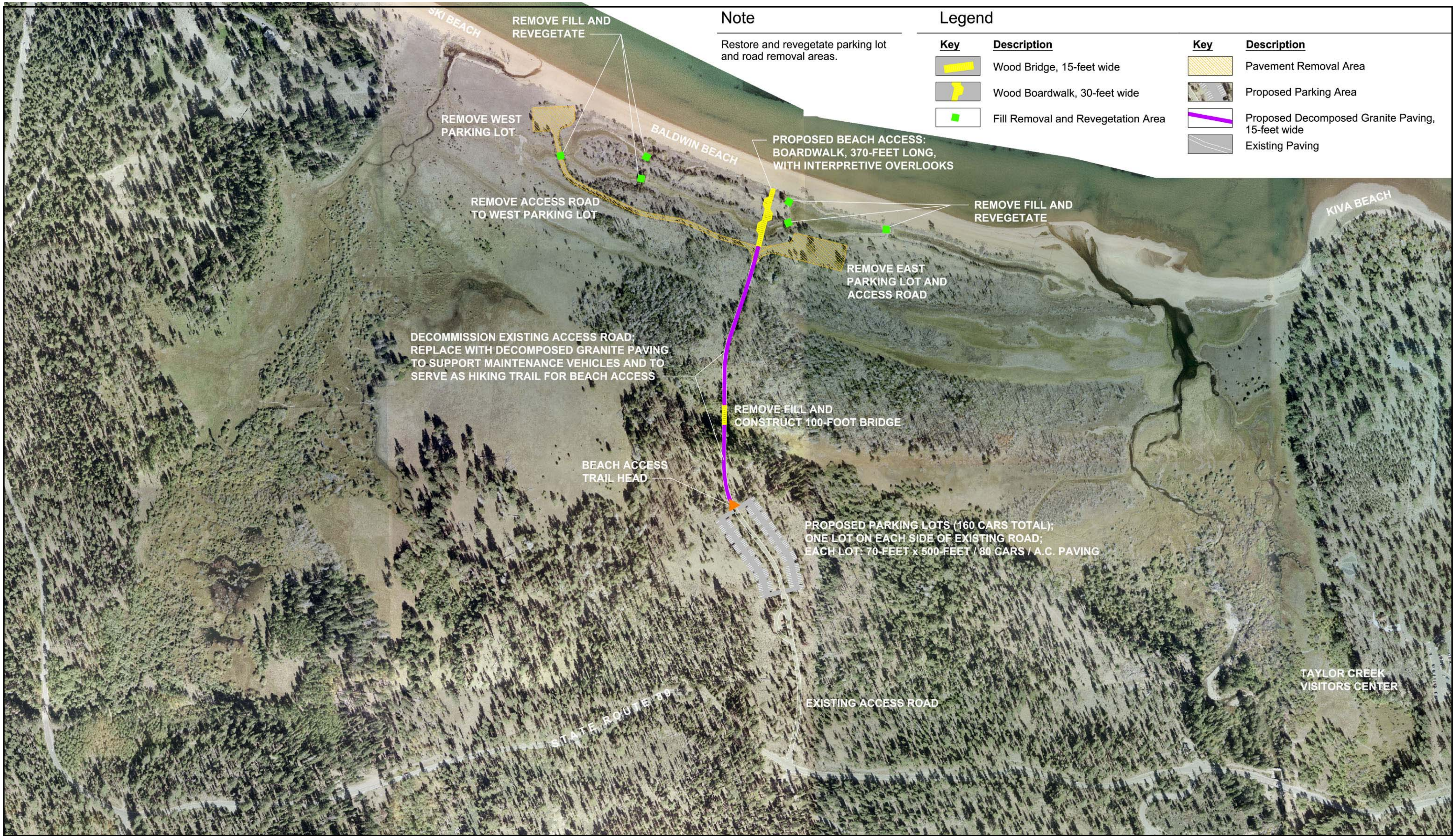
Option 4

EXHIBIT 7.3-4

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

0 485 990
FEET
NORTH

EDAW



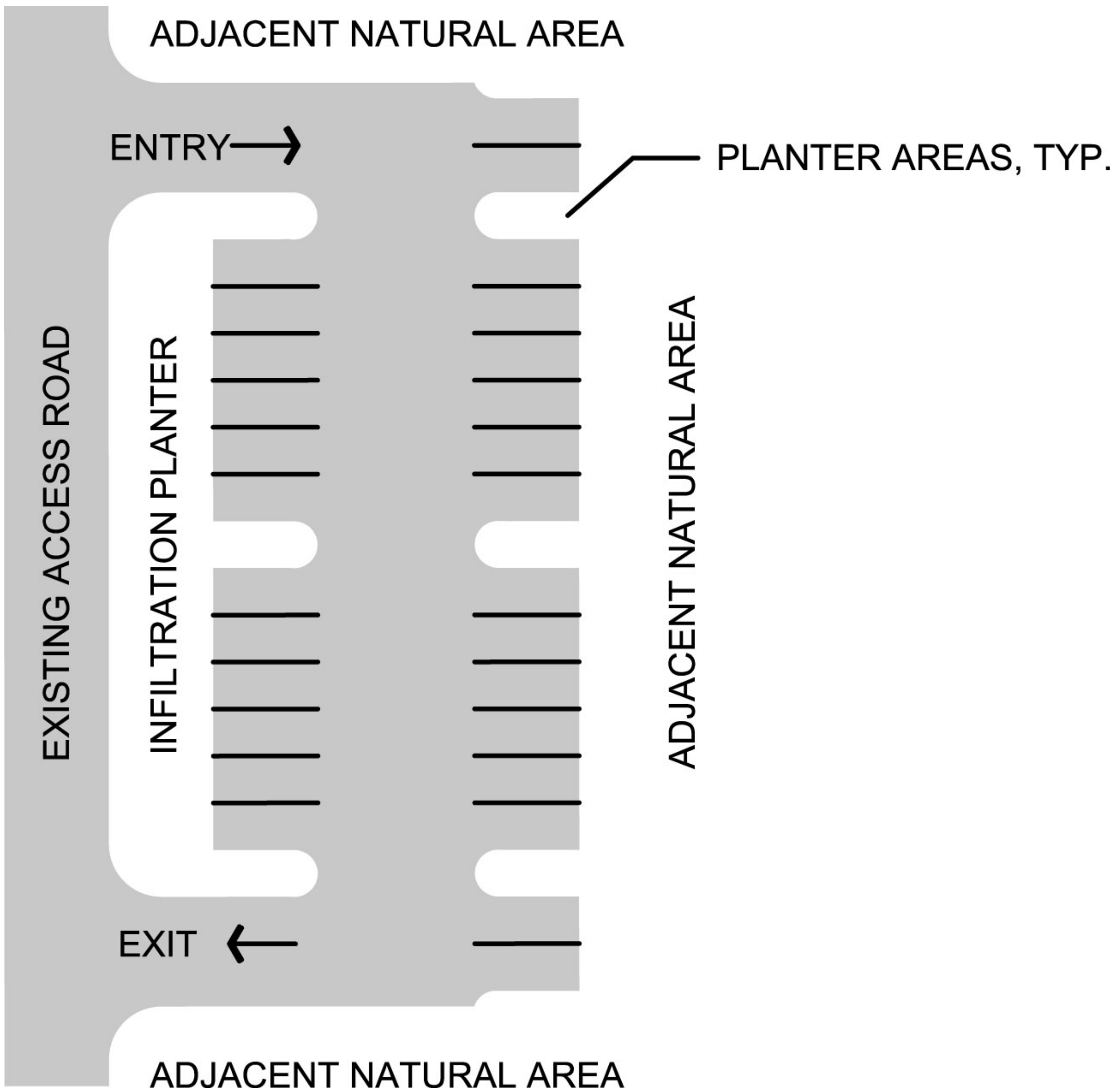
Aerial Photograph: October 9, 2003

Option 5

EXHIBIT 7.3-5

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

EDAW

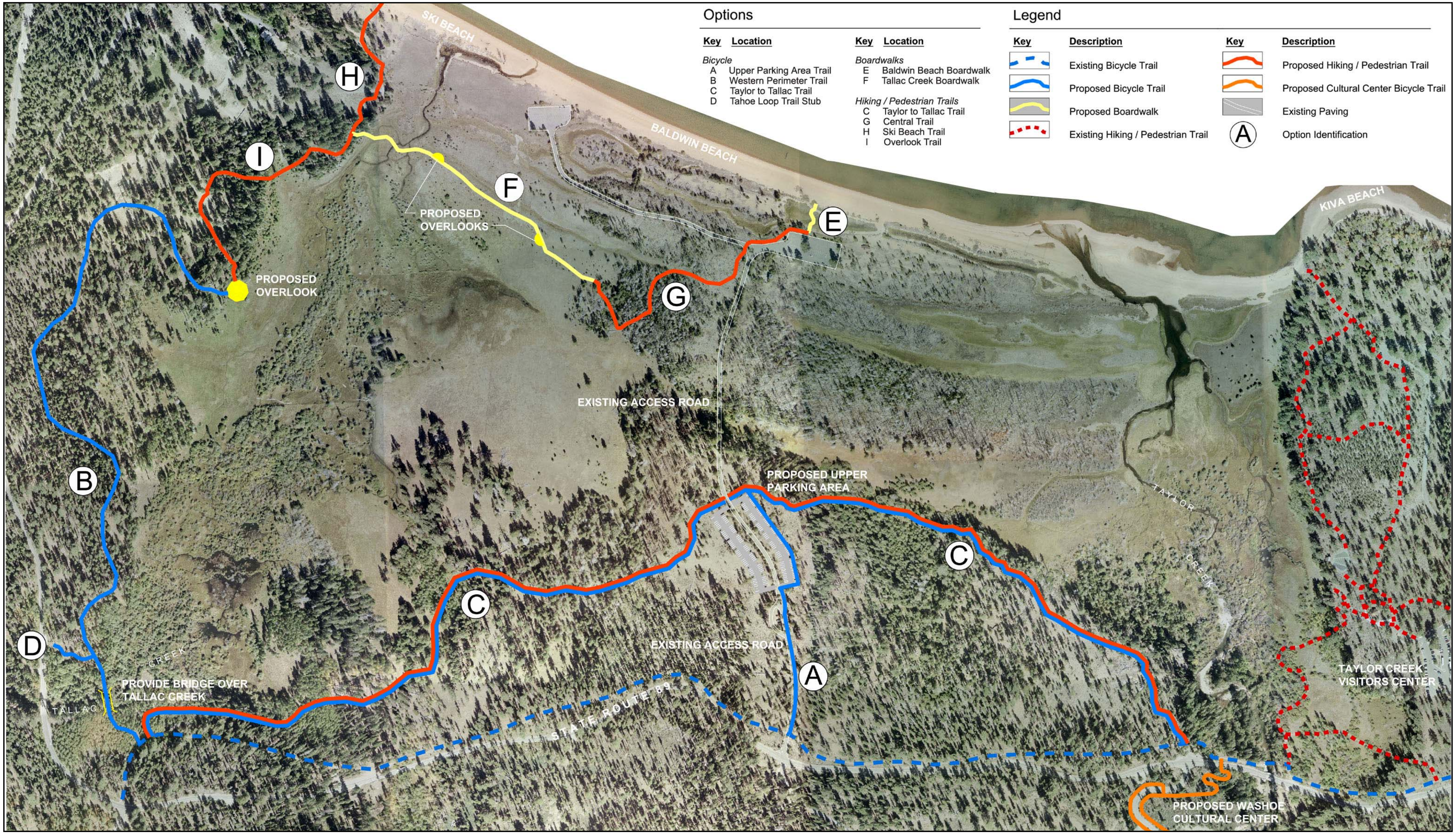


Typical Parking Lot Layout

EXHIBIT 7.3-6

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05

EDAW



Aerial Photograph: October 9, 2003

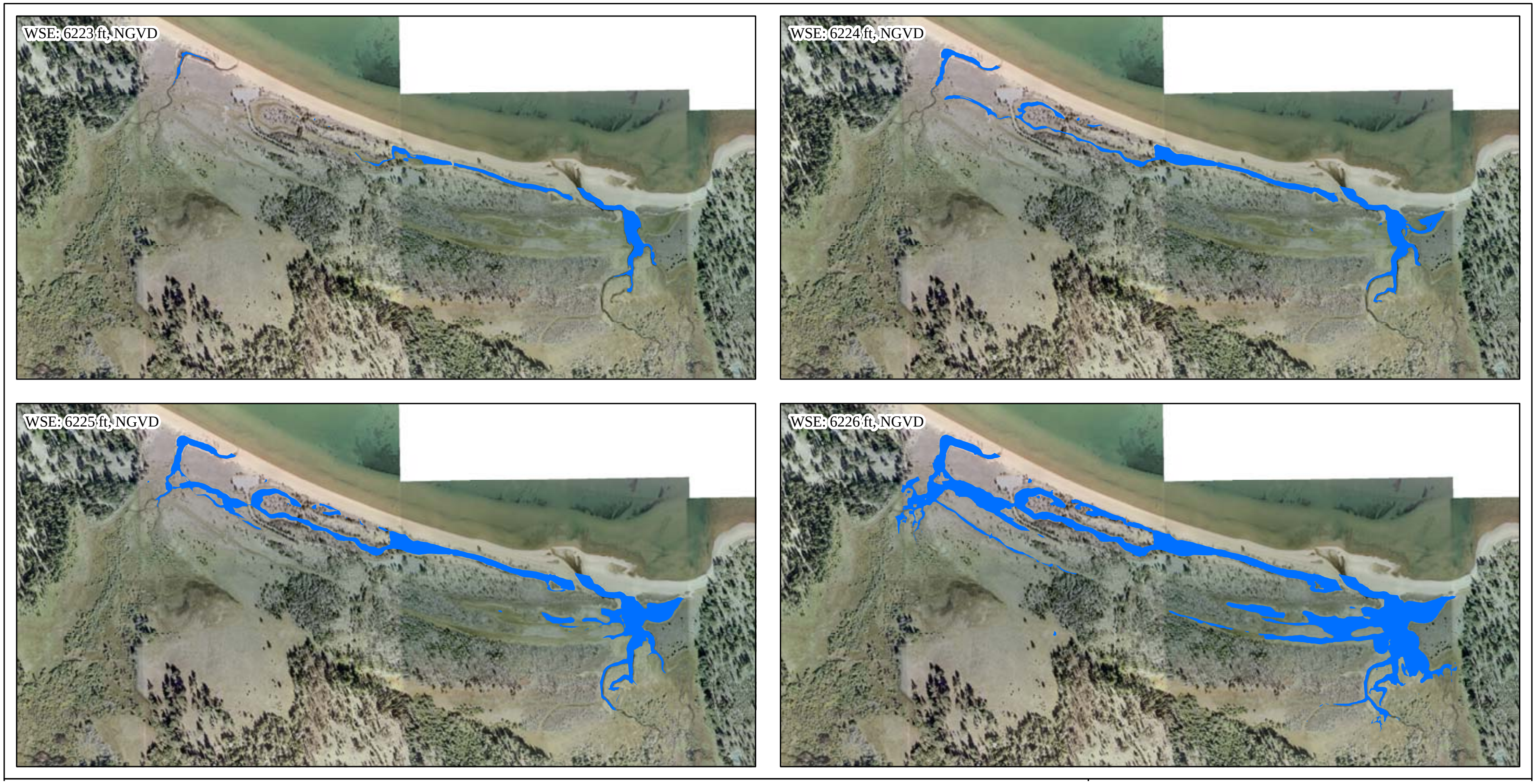
Trails and Public Access Options

EXHIBIT 7.4-1

0 485 990
FEET
NORTH

EDAW

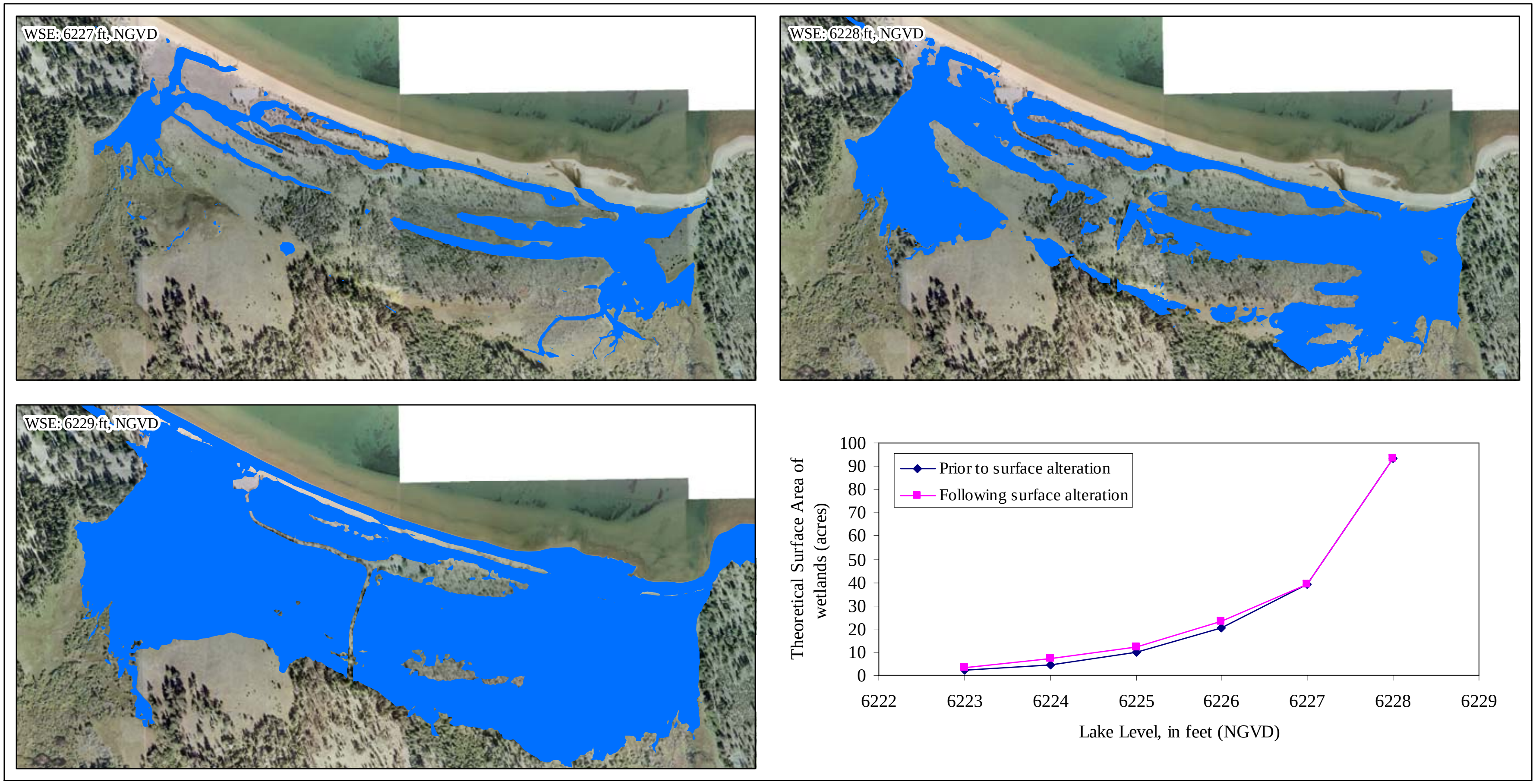
Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
P 3T058.01 01/05



Source: PWA (2005)

Theoretical Inundation due to Lake Level with Swale 1 Excavated

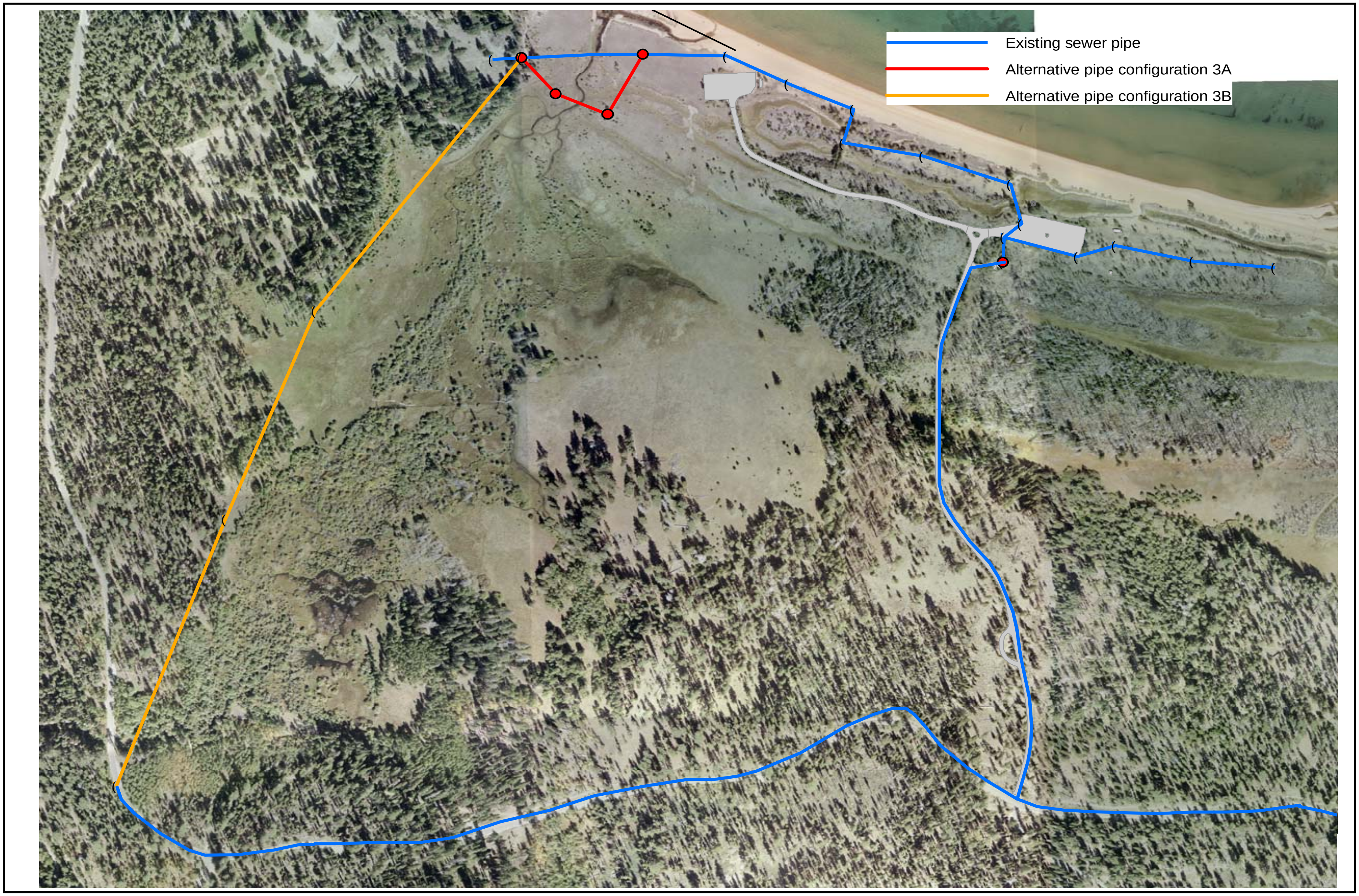
EXHIBIT 7.5-1



Source: PWA (2005)

Theoretical Inundation due to Lake Level with Swale 1 Excavated

EXHIBIT 7.5-2



Source: PWA 2005

Sewer Pipe Realignment Alternatives

EXHIBIT 7.6-1

Taylor, Tallac, and Spring Creek Watershed EAR
U.S. Forest Service
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PWA
Philip Williams & Associates
Consultants in Hydrology

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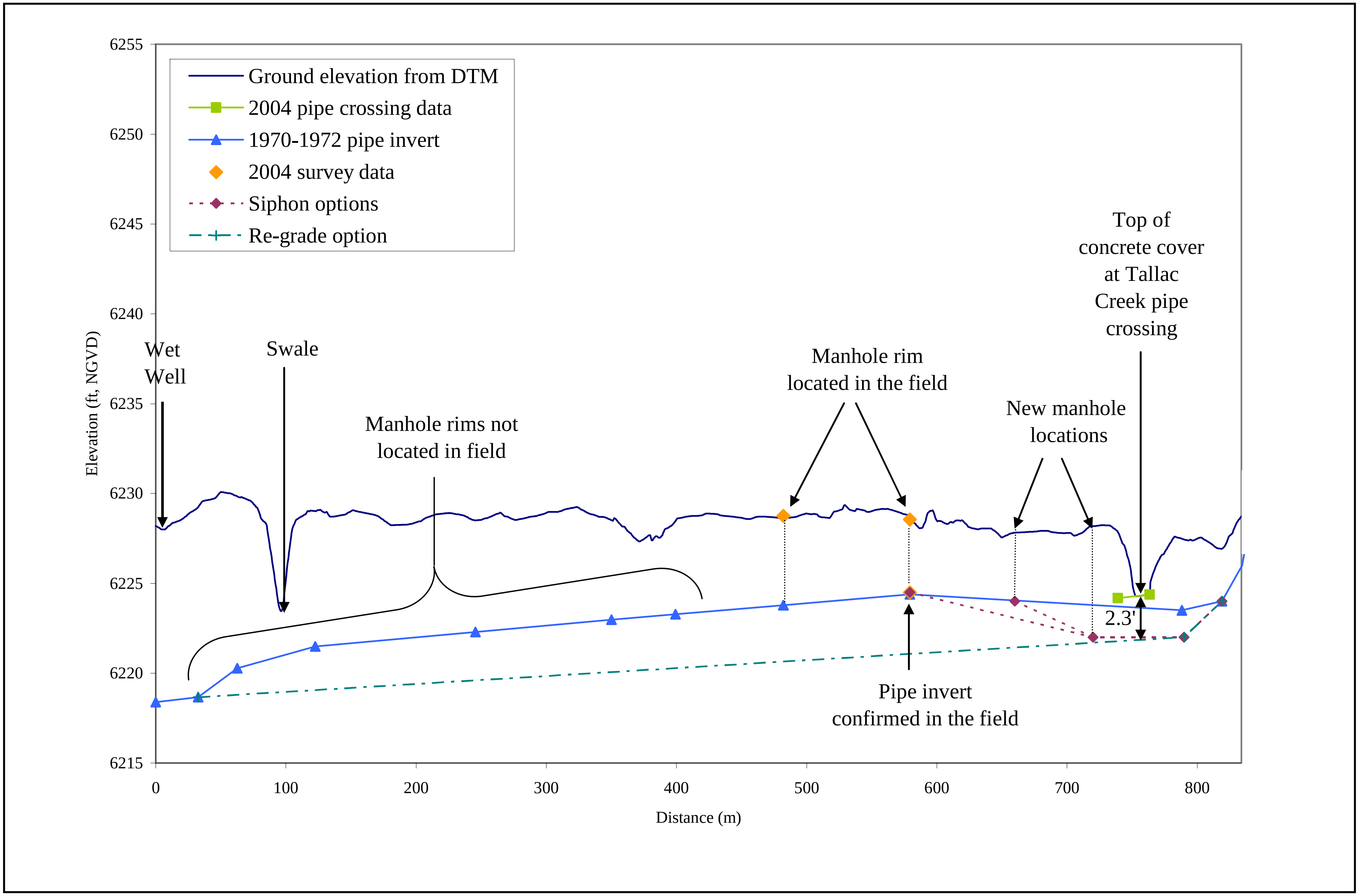

Sewer Pipe Longitudinal Section

EXHIBIT 7.6-2

PWA PHILIP WILLIAMS & ASSOCIATES CONSULTANTS IN HYDROLOGY

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