APPENDIX I

Laguna Salada Conceptual Restoration Plan

Sharp Park Conceptual Restoration Alternatives Report

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Sharp Park Conceptual Restoration Plan
Executive Summary

BACKGROUND

Sharp Park is a 417-acre multiple use facility owned and maintained by the City of San Francisco, Recreation and Parks Department (SFRPD), and located in Pacifica, CA. One of the park's most prominent natural features is a wetland complex located at the west end of the park. The wetland complex consists of a lagoon (Laguna Salada), a pond (Horse Stable Pond), and a channel that connects the two bodies of water. The US Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) have identified the wetland complex at Sharp Park as important habitat for the endangered and fully protected San Francisco garter snake (SFGS) *(Thamnophis sirtalis tetrataenia)* and the California red-legged frog (CRLF) *(Rana draytonii)*. Habitat quality for the SFGS and CRLF in the wetland complex has been steadily diminishing for several reasons, including sedimentation, reduced open water habitat, overgrowth of emergent wetland plant communities, and lack of adjacent upland habitat.

PURPOSE

Both the USFWS and CDFG have recommended that SFRPD develop recovery actions to ensure the continued survival of populations of the SFGS and CRLF in Sharp Park. The purpose of preparing this conceptual plan is to develop and evaluate various alternatives for restoring SFGS and CRLF habitat within the wetland complex, the area surrounding the wetland complex, and the entire golf course area. The primary goal of each conceptual alternative was to propose an effective way of increasing upland habitat adjacent to existing or proposed wetland habitat, to restore the quality of existing wetland habitat, and to evaluate and respond to the changes such actions would require of the existing golf course design and operation.

METHODS

Studies were performed to assess the presence or absence of the SFGS and CRLF, and to evaluate the quality of their habitat within the wetland complex. These studies are reported in Appendix C of the conceptual planning report. Hydrologists prepared studies to assess the hydrological features of the wetland complex and to assist in making restoration recommendations (Appendix A). A golf course designer prepared various realignment options for the 18-hole and 9-hole alternatives and worked with the restoration planners to accommodate needed habitat expansion areas. A local engineering firm prepared topographic and bathymetric maps of the wetland complex and surrounding area.

The information in these studies was used to define the problem and develop measures to enhance the quality of habitat for the SFGS and CRLF, to reduce the potential that these species would be harmed by golf course practices or by other park users, and to assess the differences in habitat value between an 18-hole golf course, a 9-hole golf course, and golf course closure.

ALTERNATIVES

The common component of all alternatives is restoration of the wetland complex. Under all alternatives, similar features are proposed to restore wetland habitat and reduce the potential for recurrence of the problems that now occur, which include sedimentation, eutrophication due to dead and decaying vegetation, loss of open water habitat, and flooding of fairways. Implementing the restoration actions below would accomplish the main goal of the project, which is to enhance CRLF and SGFS habitat.

- **Dredging to remove sediment and decaying vegetation**. The areas that are currently open water within the lagoon would be deepened by up to 2 feet, and open water areas within the pond by up to 3 feet.
- **Recontouring the shoreline to create shallow water habitat**. The eastern edge of the lagoon, the edges of the connecting channel, and the north and south edges of the pond would be contoured to create shallow water habitat (1-3' deep) to allow for CRLF breeding habitat.
- **Creation of an upland peninsula.** A peninsula of approximately 2 acres will be created in the middle of the lagoon to create additional upland habitat for the SFGS and shallow water habitat for the CRLF.
- **Construction of upland mounds**. Upland mounds will be created on the east and south sides of the lagoon and in the dispersal corridor between the lagoon and the pond.
- **Pump Operations.** Altering the methods of operating pumps and other measures to control hydrological features is proposed under all alternatives.
- **Upland/Aquatic linkage and habitat segment.** A habitat linkage area between the lagoon and the pond would be constructed with native upland vegetation and mounds designed to allow SFGS movement and resting between the lagoon and the pond.
- **Completion of a Compliance Plan.** SFRPD has completed a compliance plan that is designed to avoid mortality and injury of SFGS and CRLFs resulting from maintenance and operations of the golf course (SFRPD 2009).
- **Closure of Hole 12.** Hole 12 would be closed under all alternatives to allow for creation of an upland habitat corridor between the lagoon and the pond/Mori Point area.
- **Catchment Basins**. To slow the rate of sedimentation from upstream sources, sediment catchment basins would be installed in two locations, one near the mouth of Sanchez Creek and the other on City of Pacifica property just outside the northern boundary of the Sharp Park.
- **Fencing**. All alternatives include installation of a post and rail fence along the seawall to the west of the lagoon, according to the Draft Compliance Plan. The wetland complex would also be fenced to discourage intrusion by humans or domestic animals, although the configuration of the fence may vary according to the alternative.
- **Revegetation**. Uplands, wetland, and shallow aquatic areas would be revegetated with an appropriate mix of native plant species.

DESCRIPTION OF ALTERNATIVES

Alternative A18

This alternative is intended to fulfill the recovery goals for the snake and frog while maintaining as much of the current golf course configuration as possible. In addition to the measures described above, Holes 10 and 13 would be slightly shortened and/or narrowed, and a new hole would be created near the rifle range/ archery course east of Highway 1. The area on the west side of the lagoon would be restored from its degraded condition to native upland habitat. Portions of the fairways in holes 10, 14 and 15 would be raised to 10.0' NAVD 88 from their current elevation of between 6.5' and 9.0', and hole 18 would be raised to allow a 2% slope relative to hole 14. In addition to the restoration of the entire wetland complex, this alternative would result in restoration or creation of 10.7 acres of California red-legged frog breeding / San Francisco garter snake primary foraging habitat and 23.4 acres of San Francisco garter snake upland basking / retreat habitat, all of which would be found either adjacent to the wetland complex or between the pond and the lagoon. Estimated construction costs for this alternative range from $5.9M (all excavated materials reused onsite) to $11.3M (all excavated materials hauled offsite).

Alternative A-9

This alternative is intended as a compromise between golf considerations and expanded upland areas east of the main body of the lagoon, and to increase opportunities for recreational pursuits other than golf. In addition to implementing the measures common to all alternatives, all holes bordering the wetland complex would be closed and restored to coastal scrub/shrub habitat. Three holes (1, 8, and 9) would remain west of Highway 1, along with a driving range and teaching area, and two new holes would be constructed at the rifle range. All existing holes east of Highway 1 would remain in their current location. In addition to the restoration of the entire wetland complex, this alternative would result in restoration or creation of 10.7 acres of California red-legged frog breeding / San Francisco garter snake primary foraging habitat and 44.3 acres of San Francisco garter snake upland basking / retreat habitat, much of which would be constructed at a greater distance from the wetland complex than the upland habitat restored under Alternative A18. Estimated costs for this alternative range from $7.8M (all excavated materials reused onsite) to $15.6M (all excavated materials hauled offsite).

No Golf Alternative (Alternative A-0)

This alternative was developed with the goal of maximizing the amount of available upland habitat for the snake and frog in the absence of golf operations. Because the lack of suitable upland habitat was identified as the limiting factor for the snake, the golf areas would be converted into uplands. Enhancements to wetland areas in lower Sanchez Creek and the wetland complex would be identical to those in Alternatives A18 and A9. Water from Sanchez Creek would be captured in two shallow ponds to provide additional breeding habitat for the CRLF. In addition to the restoration of the entire wetland complex, this alternative would result in restoration or creation of 11.3 acres of California red-legged frog breeding / San Francisco garter snake primary foraging habitat and 97.4 acres of San Francisco garter snake upland basking / retreat habitat, much of which would be constructed at a greater distance from the wetland complex than the upland habitat restored under Alternatives A18 or A9. Estimated costs for this alternative range from $9.0M (all excavated materials reused onsite) to $22.2M (all excavated materials hauled offsite).

FINDINGS AND CONCLUSIONS

Habitat requirements of the SFGS vary throughout the year, and include foraging habitat and nearby upland retreats located in underground burrows and soil crevices, typically located in a grassland-shrub community. Upland habitat for this species at Sharp Park is restricted to a small area south of Horse Stable Pond. The lack of suitable upland habitat is therefore a primary limiting factor in ensuring the persistence of the SFGS at Sharp Park. The SFGS population may have also been affected by wave overwash, collecting, predation, and golf course maintenance practices.

The CRLF usually occurs in or near quiet permanent water of streams, marshes, ponds, and lakes, in habitats characterized by dense, shrubby riparian vegetation. The primary limiting factor for the CRLF in the Sharp Park wetland complex is a vegetation structure that is not conducive to successful breeding and/or recruitment of larval stages into the adult population. The dense emergent vegetation found in the lagoon and pond combined with little remaining open water offers poor habitat for the survival of egg masses or tadpoles.

With no action, the future of SFGS at Sharp Park is, at best, uncertain. Although historically SFGS have existed at Sharp Park while it functioned as a golf course, conditions of the wetland and adjacent uplands are far less favorable than in the past. Though beneficial, increasing CRLF breeding habitat alone will not increase the distribution and carrying capacity of the SFGS, due to the limited availability of upland habitat in Sharp Park. Increasing SFGS use of the area north of Horse Stable Pond, the areas adjacent to Laguna Salada, and the connecting canal will require maintaining undisturbed upland habitat in and between these areas. These enhancements can be accomplished without significant changes to the golf course design or to the movement of golfers on the course.

All three alternatives will achieve the habitat goals. The main differences between the various alternatives are the degree of upland habitat that would be created east of the wetland complex, the costs to implement the respective alternatives, and the tradeoff between the amount of habitat and the degree to which golf opportunities are lost. Implementing Alternative A-18 would be the least costly alternative, would result in the least impact to golf, and would restore the least amount of upland habitat. Implementing Alternative A-9 would cost more and restore more upland habitat than Alternative A-18 but would cost less and restore less upland habitat than the No Golf Alternative. Implementing the No Golf Alternative would have the highest costs, would result in the greatest impact to golf, and would restore the greatest amount of upland habitat of the three alternatives. However, because the best upland habitat for the SFGS is that which is found near water bodies, much of the upland habitat located east of the wetland complex would be of lower value than that located immediately adjacent to the wetland complex. Therefore, from a habitat restoration standpoint, converting uplands immediately adjacent to the wetland areas would result in the greatest net benefit to the SFGS per acre of enhanced habitat. Focusing restoration efforts on these areas also would result in the least amount of lost golf opportunities since more distant habitat would remain available for golf.

Although the value of the habitat gained through the No Golf Alternative would diminish with increasing distance from the wetland complex, the cost of restoring this habitat would not. Considering that there are limited funds available for a myriad of restoration projects in the Bay Area, extra money that would be required to restore habitat further from the wetland complex may be better spent elsewhere. Furthermore, because of the close proximity of Sharp Park to urban features including housing, highways, major roads, and businesses and the intrinsic threats posed by them to the SFGS, more extensive upland restoration carries its own risks. Restoring uplands and locating additional wetland further to the east of the wetland complex would potentially increase the chance of take of this species by drawing the SFGS away from the relatively protected existing wetland complex into areas that would likely be extensively used by hikers, mountain bikers, and dog walkers. Finally, in the event of a seawall breach or overtopping of the seawall by storm surge, it is the connection to upland habitat at Mori Point, rather than restored golf areas east of the lagoon, that will be of critical importance to the SFGS. This fundamental aspect is met by all alternatives.

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1. INTRODUCTION

Sharp Park is a 417-acre multiple use facility owned and maintained by the City of San Francisco, Recreation and Parks Department (SFRPD). Its main use is as an 18-hole golf course, of which 14 holes are on the west side of Highway 1, and 4 holes are east of Highway 1. Sharp Park also offers an archery course, opportunities for bird watching, and walking and cycling on the seawall that is found on the west side of the park. Sharp Park is located in San Mateo County near the City of Pacifica, California (Figure 1).

One of the most significant features of Sharp Park is a wetland complex at the west end of the park. The wetland complex consists of Laguna Salada, Horse Stable Pond, and a channel about 1,000 feet long that connects the two water bodies (Figure 2). Laguna Salada (the lagoon) is a large freshwater lagoon of approximately 27 acres which offers open water and marsh habitat for numerous wildlife species. Horse Stable Pond (the pond) is smaller than the lagoon but still offers viable wildlife habitat. Although the connecting channel is shallower than the lagoon and the pond and is overgrown with emergent vegetation, it still offers a viable aquatic corridor between the pond and lagoon under most conditions.

The US Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) have identified the wetland complex at Sharp Park as important habitat for the endangered and fully protected San Francisco garter snake (SFGS) *(Thamnophis sirtalis tetrataenia)* and the California red-legged frog (CRLF) *(Rana draytonii).* Although historically these species have existed at Sharp Park while it functioned as a golf course, conditions of the wetlands and adjacent uplands are far less favorable in than in the past. Both agencies have recommended that SFRPD enhance habitat conditions in and around the wetland to ensure the viability of the population of the populations of these species that are found there, and take measures to reduce the possibility of harm to these species (referred to as "take").

This conceptual plan was originally conceived to serve as a template to restore the wetland complex and immediate upland area as part of a recovery action recommended by CDFG and USFWS. In response to later events, the scope of this plan was increased to encompass restoration alternatives throughout the park, focusing mainly on the wetland complex and on those areas used for golf. Ultimately, 3 restoration alternatives were developed, including an 18-hole alternative, a 9-hole alternative, and a No Golf Alternative, under which the entire golf course would be closed and restored to native habitat.

The primary goal of each conceptual alternative was to propose an effective way of increasing upland habitat adjacent to existing or future aquatic habitat, to restore the quality of the wetlands, and to evaluate and respond to the consequences of such a change to the existing golf course design and operation. The objectives of this conceptual restoration plan are to describe the existing resources, develop possible restoration alternatives, assess the extent to which each alternative could increase the value and extent of habitat for the SFGS and CRLF, to give an estimate of construction costs for each alternative, and to describe the process that would need to occur to partially or completely restore the wetland complex and golf areas. Changes in mowing, golf operations, and maintenance practices that are intended to reduce the chance of take of listed species were addressed as part of a separate compliance plan completed by SFRPD in 2009.

The wetland restoration components are similar across all alternatives, but the degree of upland restoration varies considerably for each alternative. The primary components of the restoration plan are as follows:

> **Dredging.** Much of the wetland complex would be dredged to remove accumulated sediments and biomass. Dredging various parts of the wetland and open water areas will inhibit the growth of the type of emergent vegetation that now fills in the wetland complex. Dredging plans will be designed to maximize foraging and breeding habitat for the SFGS and CRLF, while minimizing future maintenance requirements, resulting in lower costs to the City as well as reduced habitat disturbance in the future. Dredge spoils will be reused onsite to the degree possible.

Project Location

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 1

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Sharp Park General Features

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 2

TETRA TECH

Habitat Conversion The main limiting factor in terms of habitat for the SFGS is lack of suitable upland habitat immediately adjacent to the lagoon. The SFGS needs basking and resting habitat, with escape cover (vegetation) and burrows for retreat from daily thermal extremes, at or near its main foraging habitat, which is found where frogs congregate. All alternatives call for converting some areas of the golf course and the existing wetlands to upland habitat needed by the SFGS for basking and resting, and allowance for development of rodent burrow complexes in appropriate locations. The main objective would be to establish a habitat linkage for SFGS between the lagoon and the pond and adjacent upland areas at Mori Point, located south of the wetlands complex. Wetlands that are converted to uplands during this process would be replaced onsite.

Public access to sensitive wetland and upland areas would be controlled by installation of a post and rail fence, but would also be enhanced under some alternatives by creation of a walking trail around all or part of the lagoon, a boardwalk over wetlands and uplands between the lagoon and the pond, and interpretive signs or kiosks at various vantage points. Restoring an upland peninsula in the center of the lagoon will increase valuable edge and shallow water habitat over current conditions.

As the public agency charged with providing and maintaining recreational facilities for the City of San Francisco, SFRPD balances resource management with recreational concerns. To help meet this goal, SFRPD created the Significant Natural Resource Areas Program (SNRAP). The SNRAP manages 31 natural areas, 30 of which are within the City of San Francisco and one (the wetland complex at Sharp Park) in Pacifica. The mission of this program is to preserve, restore, and enhance the Natural Areas and promote environmental stewardship of these areas.

Under this program, the wetland complex is being and will be managed and protected for the natural and human values it provides. Therefore, every effort has been made to develop a conceptual plan that would maintain and restore viable, high-value habitat for the SFGS and CRLF while retaining as many recreational features as possible. Management planning for the wetland complex and all other Natural Areas managed under this program is detailed in the Significant Natural Resource Areas Management Plan (SNARMP, SFRPD 2006). The plan is intended to guide natural resource protection, habitat restoration, trail and access improvements, and maintenance activities over the next 20 years.

SFRPD is in the process of preparing an Environmental Impact Report (EIR) in accordance with the California Environmental Quality Act (CEQA) to assess the potential effects of implementing the SNARMP. Assessing the environmental, cultural, recreational, and economic effects of implementing the recommended wetland restoration actions within the natural areas at Sharp Park will be an integral part of the EIR. Consideration of actions proposed outside of the natural areas would occur during separate CEQA documentation.

1.1 Preparation of the Conceptual Plan

This conceptual plan was created as a collaborative effort between SFRPD, Swaim Biological, Nickels Golf, and Tetra Tech, Inc. Public agencies including California Department of Fish and Game and US Fish and Wildlife Service were involved from the earliest phases of the project, and assisted with setting the goals of the project. Staff from the Golden Gate National Recreation Area (GGNRA) and the City of Pacifica added local knowledge and planning assistance during the conceptual planning process.

Tetra Tech is an environmental consulting firm with staff that specialize in preparation of natural resource management plans and wetland restoration plans. For this project, Tetra Tech is assisting SFRPD with project management, restoration design, engineering and cost estimating, assessment of general biological resources, and regulatory compliance and permitting. Tetra Tech's team includes Swaim Biological, who surveyed the wetland complex area for the presence of SFGS and CRLF and their habitat, and assisted in preparing recommendations for restoration of habitat; Kamman Hydrology, who assessed and reported the hydrological features of the park, and provided recommendations for various restoration alternatives; and Nickels Golf Group, who prepared the golf course realignment alternatives. A local engineering firm was hired to prepare a topographical map of the wetland complex.

As part of the preparation of this conceptual plan, studies were completed to document topographic and hydrologic conditions and to determine the extent to which the marsh complex and surrounding areas are used by the snake and the frog during their lifecycle. At the same time, a golf course designer prepared a number of alternative golf course alignments that could be implemented to adjust the amount of available habitat while maintaining an attractive and challenging golf environment. A wetland delineation was conducted to determine the extent to which wetlands or other waters of the US under the jurisdiction of the US Army Corps of Engineers are found in the project area.

The information in these studies was used to develop measures to increase or maintain the amount and quality of habitat for the SFGS and CRLF, to reduce the potential that these species would be harmed by golf course practices or by other park users, and to assess the differences in habitat value between an 18-hole golf course, a 9-hole golf course, and golf course closure. One 18-hole alternative (Alternative A18) and one 9-hole alternative (Alternative A9) were brought forward for assessment. A single alternative (the No Golf Alternative) was also developed to assess closing the golf course and converting the fairways to upland habitat. The alternatives are described in detail in Section 4.

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2. HISTORICAL CONDITIONS

Prior to the development of the Sharp Park Golf Course beginning in the 1920s, the Laguna Salada site was characterized by ranch lands, sand dunes, and a large lagoon (PWA 1992). Although it is likely that some freshwater wetlands existed behind the dunes, the common name of Laguna Salada (Salty Lagoon) suggests that the lagoon was formerly brackish to saline. In one of the early photographs of the region, a small channel that connected the lagoon with the Pacific Ocean can be seen, along with a shoreline of relatively low relief.

A direct hydrologic connection between the lagoon and the ocean was eliminated with the construction of the golf course and the seawall. To avoid flooding the golf course, tidal exchange was eliminated and runoff from the watershed has been pumped into the ocean from a location at the pond since 1941. The elimination of saline water allowed the establishment of saline-intolerant vegetation such as cypress, grasses, and shrubs for bank stabilization and landscaping purposes. However, salts in bottom sediments persist and make the lagoon and the pond slightly saline, a condition which increases as water levels decline throughout the drought period (Kamman 2009). An abandoned gravity flow outlet which was once used to convey overflow from the pond to the ocean is still in place, but the outboard end is covered by several feet of sand. It is possible that small amounts of seawater enter the pond through this pipe during very high tides.

Considerable shoreline erosion has occurred along the Laguna Salada shoreline since completion of the Sharp Park Golf Course in 1932. This unarmored earthen seawall was constructed between 1941 and 1952 to prevent waves from overtopping the shoreline and damaging the golf course (PWA 1992). This embankment was repeatedly breached by storm waves, allowing the former natural process of wave overwash to occur and damage fairway landscaping.

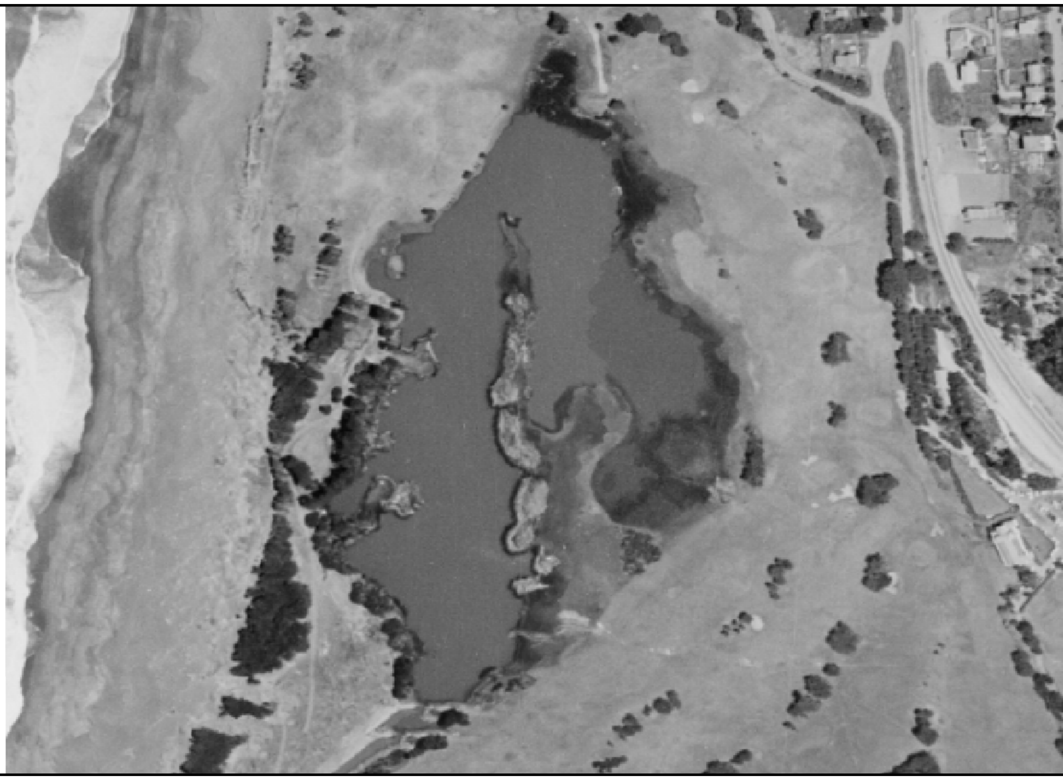
The most severe erosion occurred in 1983 when most of the embankment was eroded and wave overwash carried sand onto the golf course fairways and into the lagoon. It was estimated that nearly half of the 200-300 feet of shoreline lost between 1931 and 1984 occurred between 1978 and 1984, and largely due to the 1983 event (PWA 1992). The seawall was rebuilt after this event, and is being assessed by geotechnical experts under separate contract with SFRPD.

Flooding of the golf course has been a recurrent problem since the 1940s. In 1958, most of the golf course was submerged by a combination of wave overwash and storm inflows. In addition to damaging the golf course, increased salinity due to overwash may have been lethal to the CRLF and may have resulted in a near lack of SFGS prey during periods when the lagoon was too saline. A pump system was installed in 1941 to control the water level in the lagoon by pumping runoff to the ocean. Since the 1940s, the pump system has been augmented to pump up to 11,500 gallons per minute (GPM). Simulated storm models (Appendix A) show that this capacity is exceeded by rainfall events at or greater than 2-year recurrence intervals.

A defunct gravity flow drain is located at the pond, but currently does not function to remove stormwater. Reconstructing this drain would involve placing a new pipe through the seawall, over or through the beach on concrete footings placed on bedrock, and extending far enough into the surf to ensure that the outlet would not become buried in sand. Estimated costs for rebuilding this feature are between $400-800k. Rebuilding this structure would help to alleviate some of the flooding problems that are attributed to pump limitations.

The presence of the SFGS at Laguna Salada was documented as early as 1946 (Fox 1951). Although the CRLF was not considered rare at the time, their presence was also documented in 1946 as one was present in the stomach contents of an SFGS at the lagoon (Wade Fox, unpublished field notes). Comparing recent survey reports (Swaim, 2004 and 2008) to earlier reports (Fox 1951) indicates that the population of SFGS at Laguna Salada and likely at Horse Stable Pond has declined since early records of the presence and abundance of this species were recorded in 1946. This may be due to many factors including the sedimentation of the lagoon, the conversion of upland habitat surrounding the exterior of the lagoon to golf fairways and greens, and illegal collecting of the species until listing in 1973. Barry (1978) suggested illegal collecting was one of the main factors in the decline of SFGS there, based on his interviews with reptile dealers. Field notes maintained by Wade Fox and obtained from the Museum of Vertebrate Zoology indicated that as early as 1946, the lack of upland habitat for SFGS was apparent. However, conditions were still such that Fox collected 44 specimens of SFGS at the lagoon over 1946 and 1947, over 15 years after the golf course was built and operating. In 1979, 37 SFGS were located in the wetland area adjacent to Horse Stable Pond and 46 in the Mori Point "bowl area" (Barry 1979). This indicates that at that time, the wetland complex, primarily Horse Stable Pond, was still supporting a relatively abundant population of SFGS. It was not until after the 1983 storms that a precipitous decline in SFGS in the Horse Stable Pond and Mori Point area was documented (McGinnis 1986; 1988, 1991, 1997).

Ongoing sedimentation of the lagoon has increased as sediment from the watershed is no longer flushed into the ocean during tidal surges or large storms. Sediment sources include erosion of dirt roads and parking areas, as well as natural input from erosion of Sanchez Creek and lightly vegetated hillsides. This has resulted in a higher bottom elevation of the wetland complex over time, allowing shallow emergent vegetation to spread at the expense of open water. Aerial photographs of the lagoon in 1956 and 2007 show the extent to which the open water part of the lagoon has converted to vegetated wetland (Figure 3).



1956

2005

Aerial Photos From 1956 And 2005

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 3

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3. Existing Conditions

Assessment of historic aerial photographs of the Laguna Salada area indicates that prior to development of the Sharp Park Golf Course and the seawall located west of the wetland complex, environmental conditions at the project site were representative of a coastal lagoon system. Environmental changes during subsequent decades have modified the hydrologic characteristics of the system by isolating the lagoon and adjacent wetlands from the ocean.

The wetland complex at Sharp Park provides extensive habitat for the SFGS and the CRLF. SFGS habitat quality in the marsh complex is enhanced by its proximity to upland areas at Mori Point, located to the south of the lagoon and pond (Figure 2). The SFGS has been identified at Laguna Salada since at least 1940 (Fox 1951), but the importance of the population that occupies the area has gained more attention in recent years since the successful restoration of SFGS habitat at Mori Point and as other important habitat areas have been reduced in size or value.

Sharp Park's location near several open space areas makes it an important part of the overall distribution of SFGS and CRLF on the San Francisco Peninsula. The Golden Gate National Recreation Area (GGNRA) borders Sharp Park on the southwest and supports SFGS and CRLF. Habitat enhancement projects in 2004, 2005, and 2007 increased the amount of breeding habitat for CRLF and foraging habitat for SFGS at Mori Point. Trapping studies conducted in 2004, 2006, and 2008 have shown that the new ponds are being used by resident SFGS populations (Swaim Biological, Inc. 2008). Additional CRLF habitat is found at Sweeney Ridge, which lies to the east and southeast and provides habitat for the CRLF. SFGS were recently reconfirmed at the north end of San Andreas Reservoir, just east of Sweeney Ridge (SBI 2008 [unpublished]). To the north of Sharp Park, Milagra Ridge in the GGNRA supports CRLF and contains habitat suitable to support SFGS. To the south, beyond Mori Point, the Calera Creek watershed supports a large population of CRLF and also includes potential habitat for the SFGS. Individual SFGS and CRLFs probably move between some or all of these sites, and Sharp Park provides suitable habitat for dispersal and foraging for both species, as well as being a source population for CRLF.

3.1 Watershed Characteristics

The natural watershed of Sanchez Creek includes 844 acres (1.3 square miles) (PWA 1992). The watershed consists of moderate to steep slopes in the upper watershed (Sweeney-Minchizo soil series) and flatter floodplain terraces (Tunites or Lockwood soil series) near the coast (PWA 1992). Most of the flatter terraces have been developed for residential, road, or golf course use, while most of the upper watershed remains undeveloped. The watershed is drained by Sanchez Creek, which extends approximately 1.7 miles between Horse Stable Pond and the watershed divide. Annual precipitation in the area ranges from about 29.5 inches annually at the coast to 30.5 inches annually at the watershed divide.

3.2 Topography

Topographic information was reproduced on AutoCAD drawings that reflect the locations of thousands of vertical points taken by a roving, survey-grade GPS. Points were tied to five control points which were checked with a Total Station unit. Points in aquatic areas were taken by surveyors in a boat using a rod and level. In aquatic areas, bathymetry lines were produced at 0.5 foot contour intervals, and topographic lines outside of aquatic areas were produced at 1.0 foot contour intervals (Figure 4). Because the project originally only included the marsh complex and its immediate surroundings, topographic and bathymetric information at these contour intervals is not available beyond these areas. USGS topographic contour maps at 5 foot contours have been used for other aspects of the conceptual plan, including development of alternative fairway alignments east of Highway 1.

The bathymetric survey determined the range of depths for all the aquatic features at the project site. The aquatic features including Laguna Salada and surrounding wetlands range from 0 to 7.5 feet (NAVD 88). The aquatic features including Horse Stable Pond and surrounding wetlands range from 3 to 9.5 feet (NAVD 88). The open water portion of the connecting channel ranges from 3 to 7 feet (NAVD 88). Cross sections and profile locations are shown in Figure 5, and topography/bathymetry at each cross section and along the profile is depicted in Figures 6-11.

3.3 HYDROLOGY

In combination with topography, the hydrology of the wetland complex creates the physical habitat which supports the vegetation and wildlife resources in this area. Water levels in the wetland complex, which is found in the lowest part of the park, are maintained primarily by groundwater, but are augmented in the rainy season by storm flows. The main components of the hydrologic system are described below.

Laguna Salada

Laguna Salada, the main component of the wetland complex, consists of an open water pond and adjacent emergent wetland occupying about 27 acres. The lagoon has a bottom elevation of between 0 and 2.5 feet, and is up to 7.5 feet deep under normal circumstances.

Horse Stable Pond

Horse Stable Pond, located at the south end of the wetland complex, consists of an open water pond and a freshwater wetland, which extends between the shoreline levee on the west and about 500 feet east to the housing subdivision. The pond is considerably smaller and shallower than the lagoon, with bottom elevations between 3 and 5 feet and typical water depths ranging from 1 to 3 ft.

Horse Stable Pond is fed by Sanchez Creek, which enters from the east, and Laguna Salada, which enters from the north via a connecting channel. Some surface water likely also enters from Mori Point, located to the south.

Connecting Channel

A meandering channel approximately 1,000 ft. long connects the lagoon with the pond and allows for bidirectional flow under all but the lowest water levels. Although the true bottom of this channel is at approximately 3' (NAVD 88), dead and decaying vegetation has raised the functional floor and provides a platform from which rooted emergent grows across most of the channel.

Sanchez Creek

Sanchez Creek is about 1.5 miles long and drains the 844 acre (1.3 sq. mile) watershed. The creek flows under Highway 1 just south of the Fairway Drive exit and is alternately culverted and daylighted across the golf course. Under original conditions, Sanchez Creek was approximately 5-7 feet wide and had a narrow riparian zone on either side.

Topography And Bathymetry

Topography displayed at 1.0' intervals
Bathymetry displayed at 0.5' intervals

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Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 4

Legend

Contours

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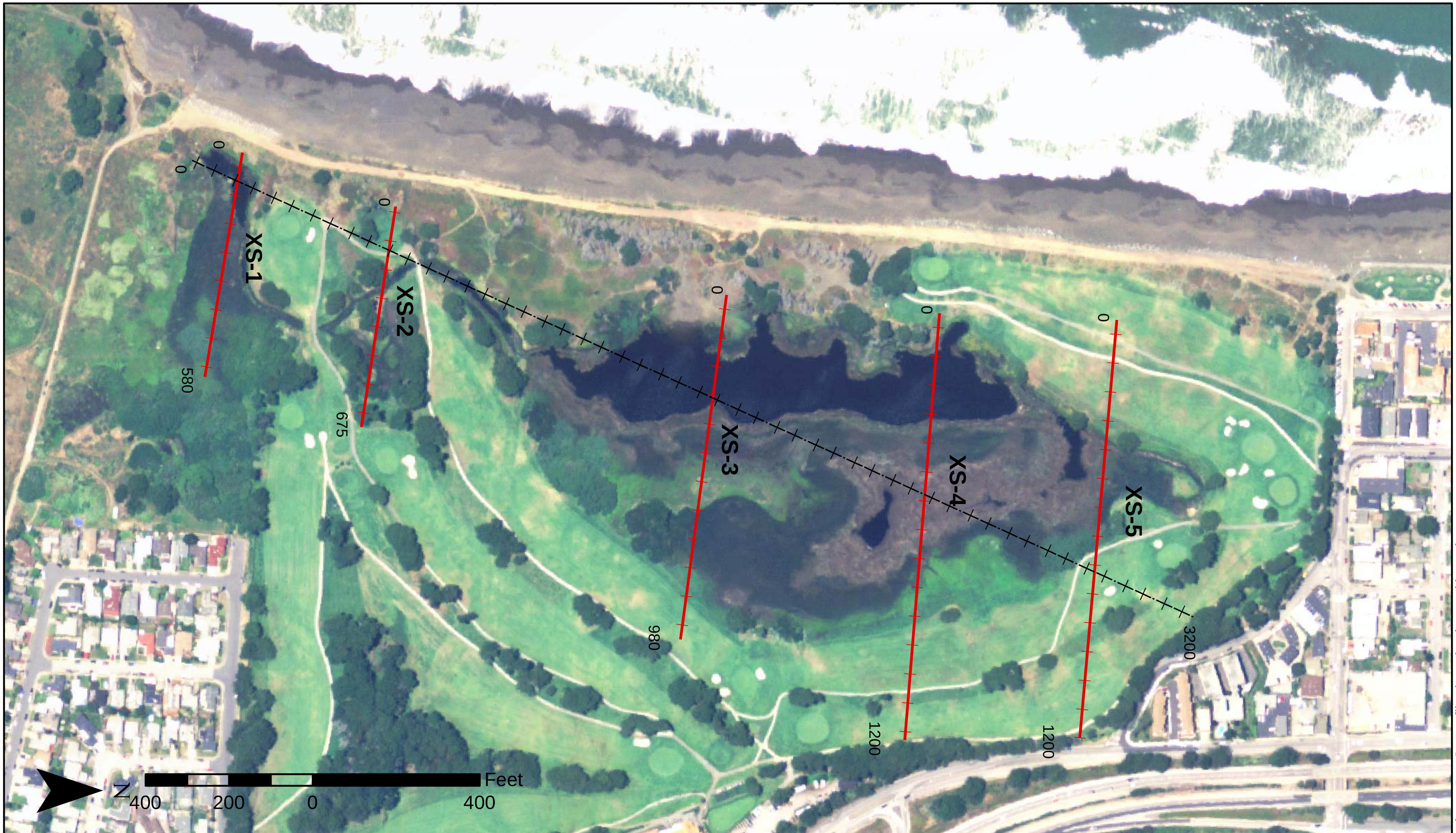

Cross Section And Profile Locations

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Pacifica, CA

Figure 5

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Profile
Cross Section

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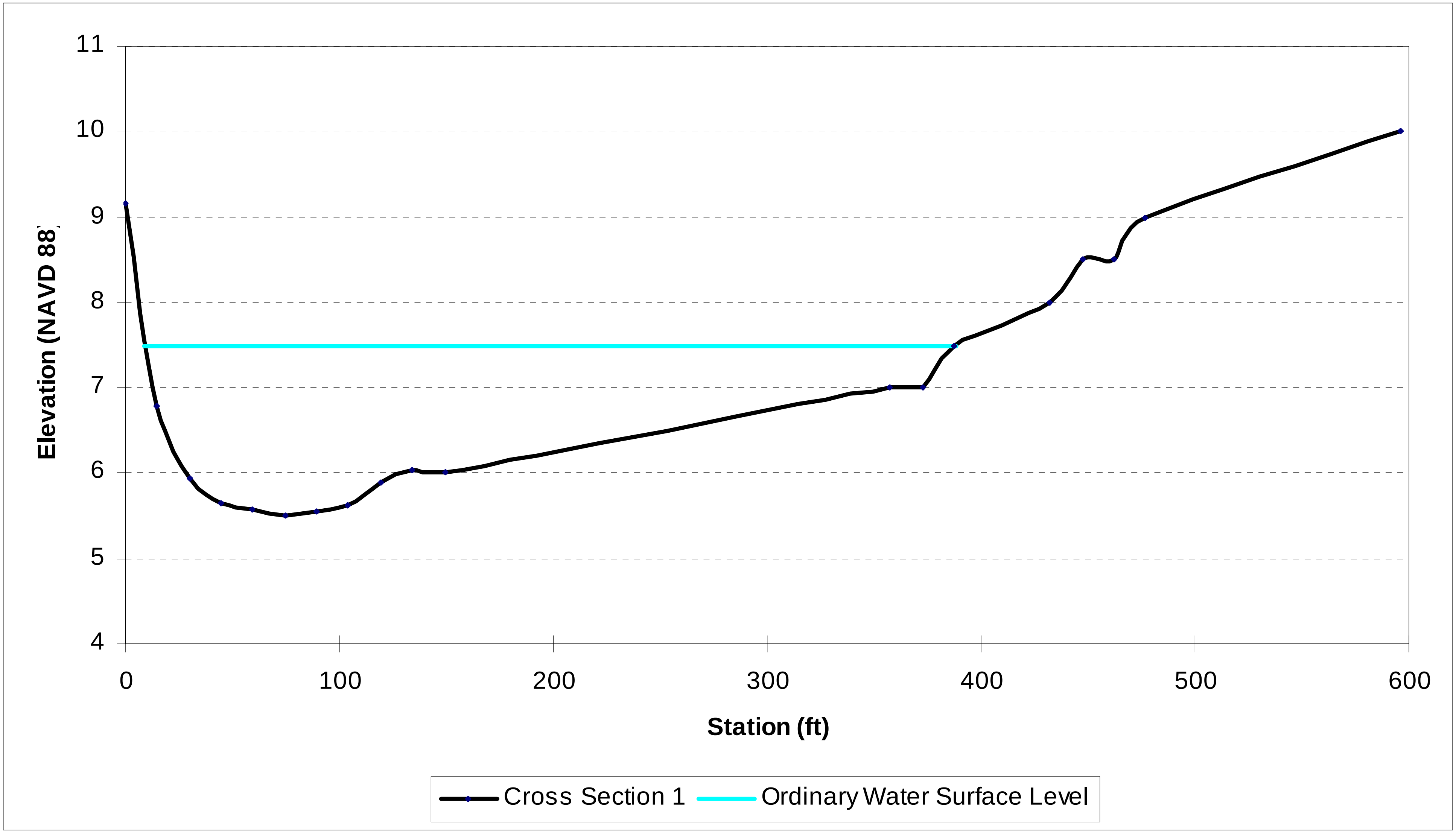

Cross Section 1
(Refer to Figure 5 for cross section locations)

Figure 6

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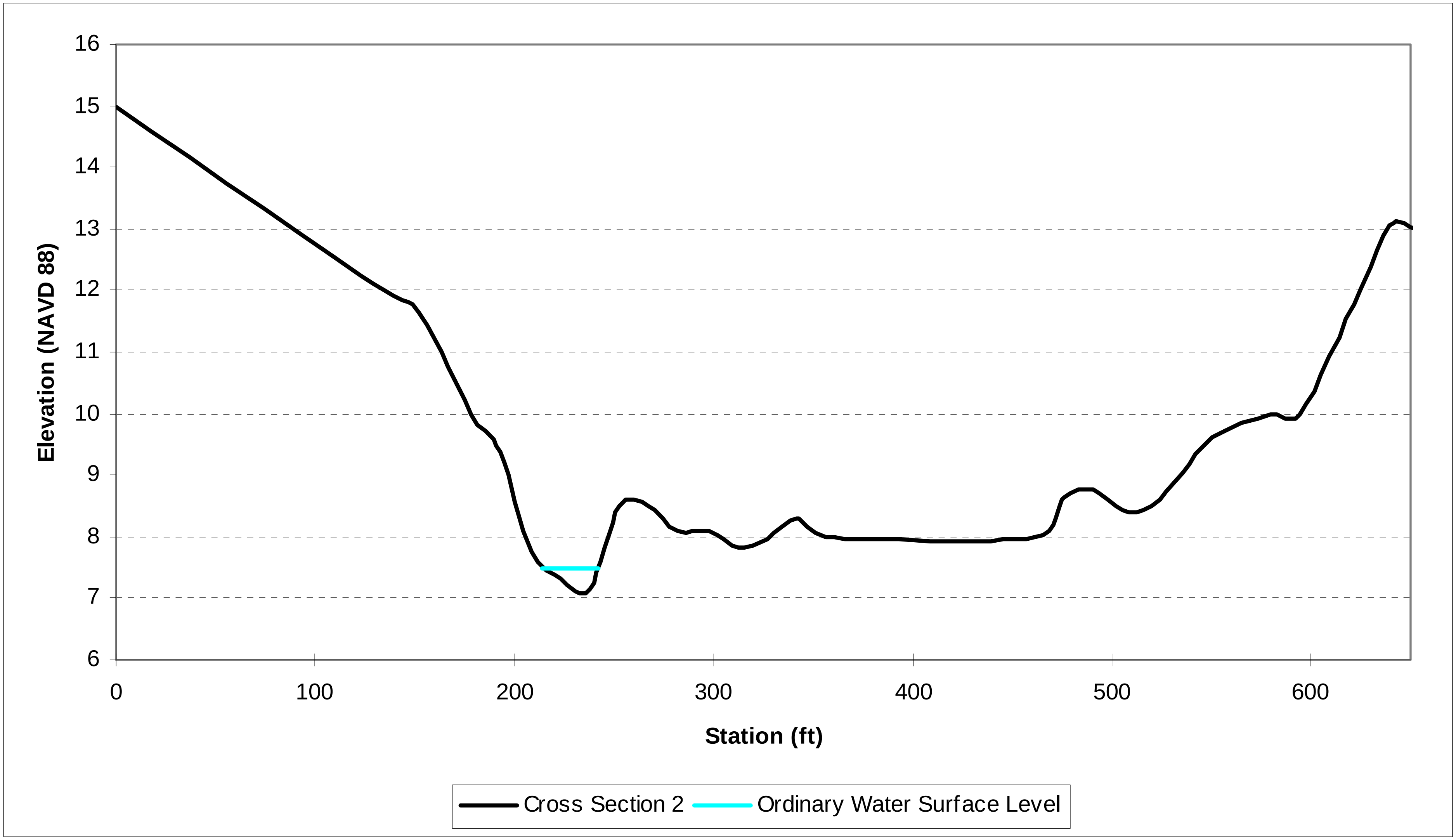

Cross Section 2
(Refer to Figure 5 for cross section locations)

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Figure 7

Sharp Park Conceptual Restoration Plan

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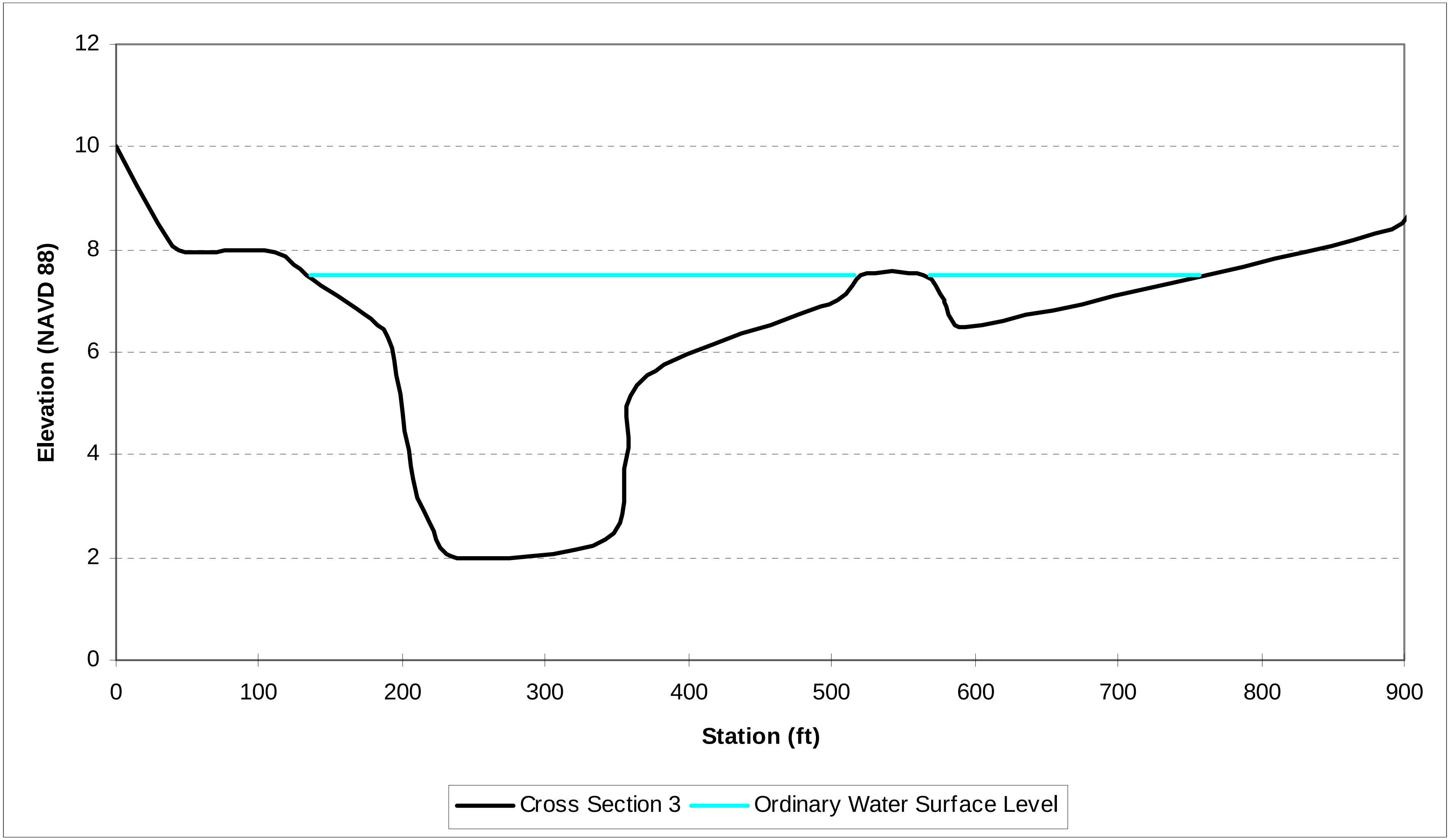

Cross Section 3
(Refer to Figure 5 for cross section locations)

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Figure 8

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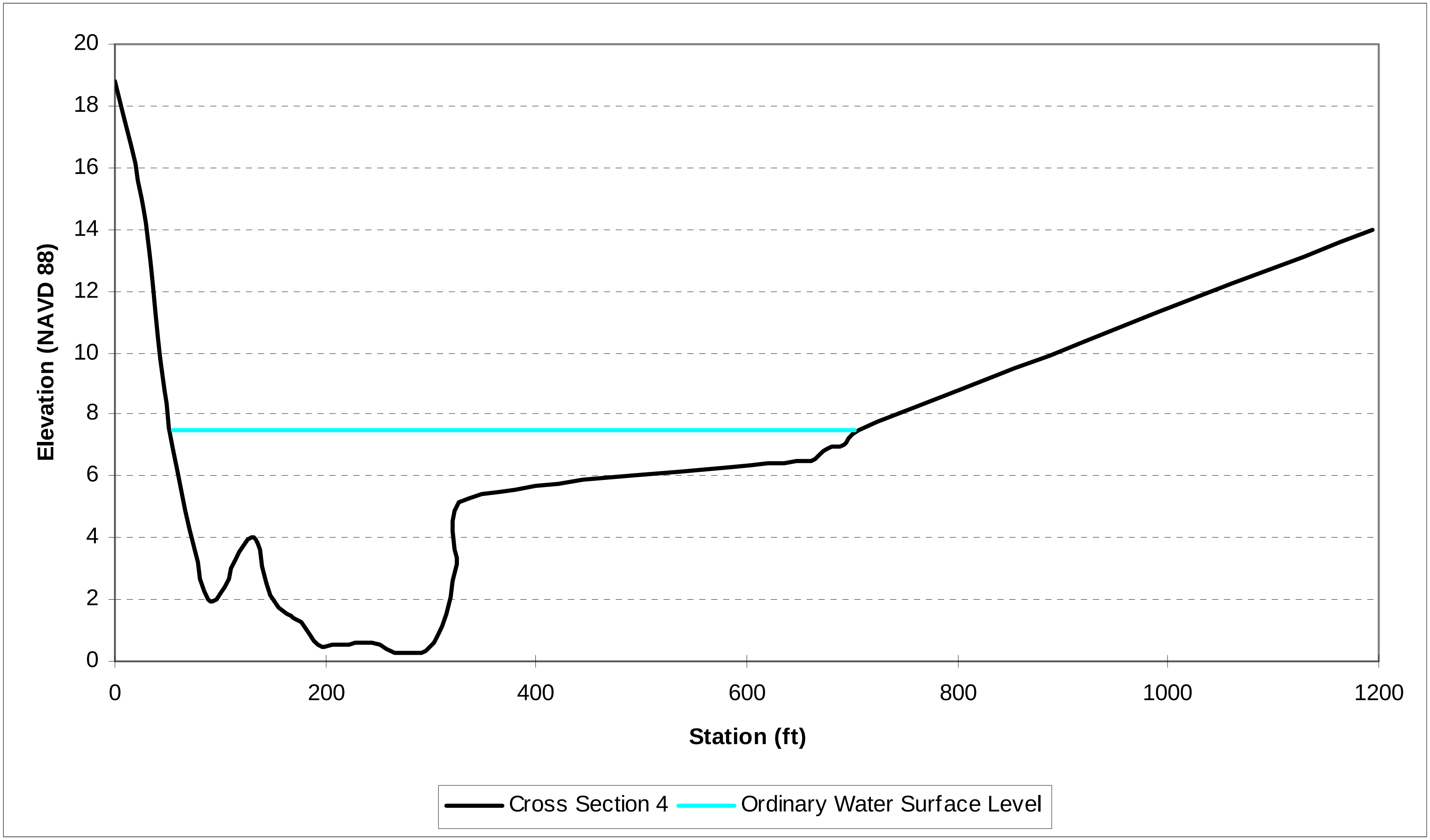

Cross Section 4
(Refer to Figure 5 for cross section locations)

Figure 9

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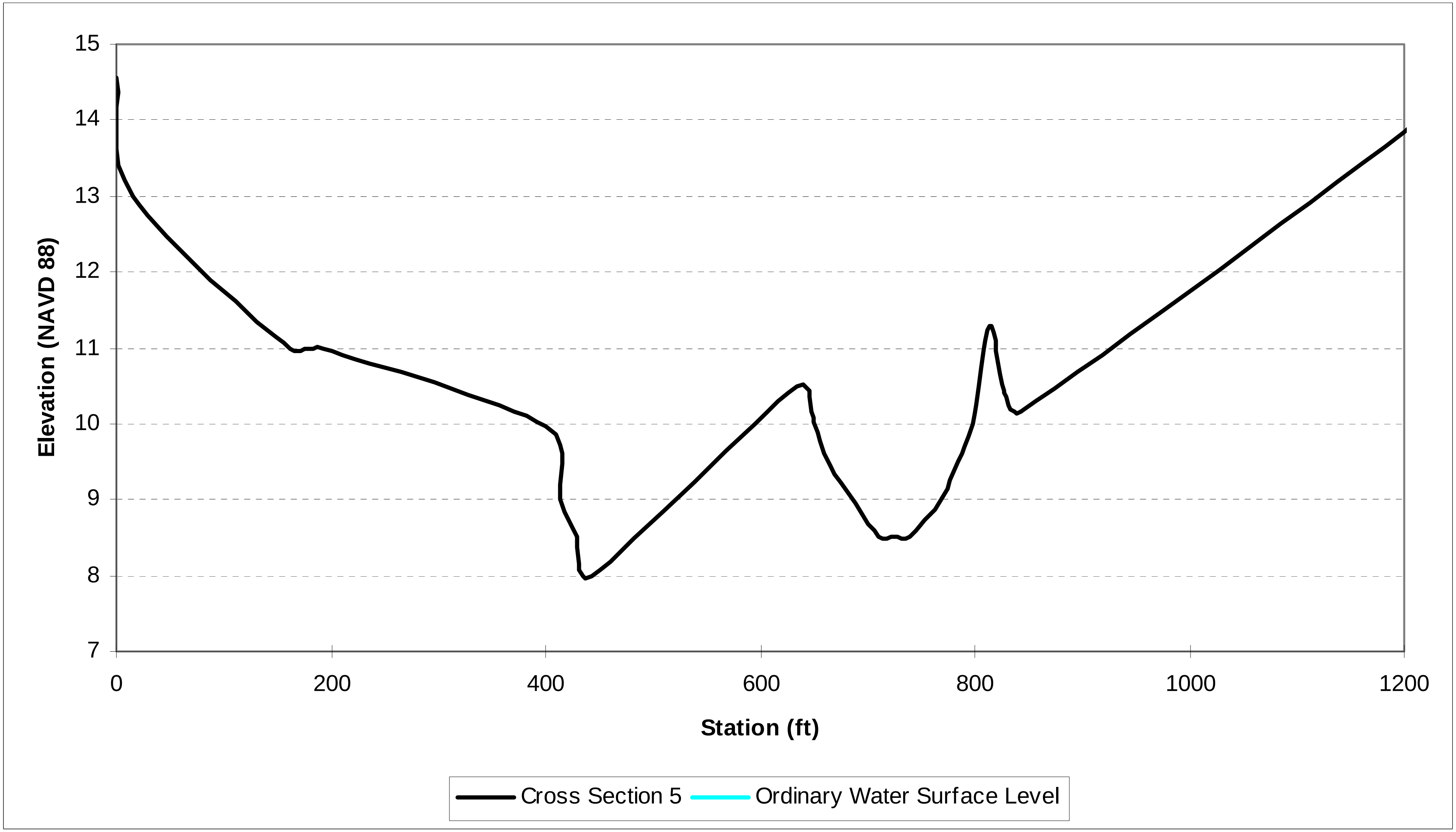

Cross Section 5
(Refer to Figure 5 for cross section locations)

Figure 10

Sharp Park Conceptual Restoration Plan
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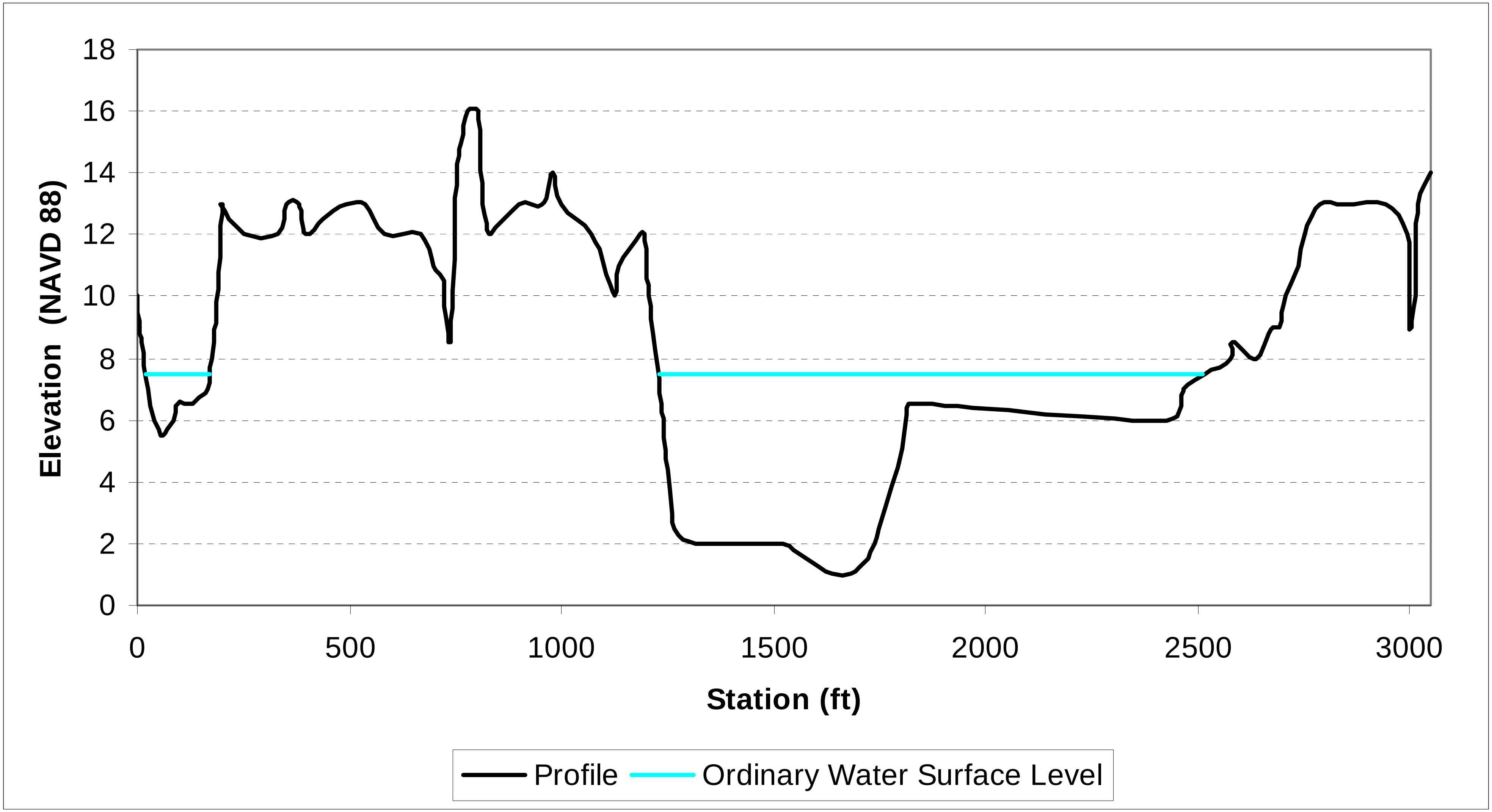

Profile of Wetlands Complex
(Refer to Figure 5 for cross section locations)

Figure 11

Sharp Park Conceptual Restoration Plan
Pacifica, CA

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Pacific Ocean/Seawall

Coastal sediment processes, including littoral sand transport, ocean wave transport (on- and off-shore), and wind blown sand create the beach and dunes along the west side of Laguna Salada (PWA 1992). A compacted earthen seawall was significantly reconstructed by the City of San Francisco in 1989 to reduce the damage from wave overtopping. The seawall performs its role of preventing tidal inundation and flooding of the study area under most conditions, but has been overtopped during very high storm surges, including events in 1956 and 1983.

For the purposes of this restoration plan, it is assumed that the seawall is stable and will continue to provide the wetland complex with a high level of protection from tidal inundation. The integrity of the seawall is being assessed by a geotechnical team under separate contract with SFRPD.

Water Quality

With the exception of salinity concentrations, water quality has not been identified as a limiting factor in the habitat value of the wetlands complex. Salinity concentrations were modeled under a variety of conditions, and were found to be below the threshold at which they would harm amphibians or other wildlife (Kamman 2009). Although water quality may be affected by nutrients carried by runoff from the golf course or by petroleum-based pollutants and heavy metals carried by runoff from Highway 1, water quality is being assessed under a separate contract and complete information is not yet available.

Sea Level Rise

Sea levels are projected to rise by up to 1.4 meters by 2100 (CA Natural Resources Agency 2009). Mean Higher High Water (MHHW) elevations under current conditions as well as those projected for the years 2030, 2040, and 2100 are illustrated in Figure 12. Although floods occurring under predicted sea levels at 2100 would not cover a significantly larger area of Sharp Park than would a flood occurring under current conditions, the seawall would be put under more stress and would likely be overtopped more frequently, placing wildlife in the wetlands complex at greater risk of harm due to greatly increased salinity levels.

Hydrologic Evaluation

Kamman Hydrology and Engineering, Inc. (KHE) performed a hydrological evaluation of the marsh complex and watershed during an entire hydrological cycle in 2008 and 2009. The purpose of the hydrological assessment was to improve understanding of the hydrologic processes which affect the distribution of ecological habitats in the wetland system and flooding of the adjacent golf course. Two of the main objectives behind the formulation of the hydrological study were to determine how to regulate water levels to avoid flooding parts of Holes 10, 12, 14, and 15 and to avoid stranding CRLF egg masses.

Much of what is currently known about the hydrology of the wetland complex was presented by Phil Williams and Associates et al. (PWA) in an earlier resource enhancement plan (PWA 1992). The PWA report includes a description of historical conditions at the site as well as results from a hydrologic monitoring study during the period 1990-1991. The KHE study aimed to expand on the findings of the earlier research to reflect current conditions at the site and to extend those findings into a suite of analytical models to be used in the planning and design for restoration alternatives.

Sea Level Rise Projections Over 100 Years

This figure shows the portions of Sharp Park that would be inundated if the seawall were breached or were not present. Inundated areas are estimated based on projected sea level rise scenarios.

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Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 12

MHHW_2000	MHHW_2040
MHHW_2030	MHHW_2100

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KHE maintained a hydrologic monitoring network at the site during the period April 2008 to April 2009. Field data collection focused on understanding the variability of water level and salinity in the wetland complex. Monitoring data were utilized to characterize current site conditions and to calibrate analytical models for additional investigation. Three specific analytical modeling tools were developed:

- A water budget model to investigate the seasonal variations of water supply and demand at the site.
- A salinity mass balance model to investigate the sources and relative impact on water quality.
- A hydraulic model to simulate the water level response in the wetland system to winter storm runoff.

Key findings of the report, in terms of relevance to SFGS and CRLF habitat and restoration design are as follows:

- The marsh system is not water limited, and water surface levels are maintained by groundwater even in very dry years. Increases in precipitation and runoff to the system only increase the amount of water that must be pumped out of the system. This is important in that it indicates that increasing the system's storage capacity through extensive dredging will not result in diminished water levels or compromised water quality.
- Although dense vegetation in the eastern part of the lagoon may slightly reduce the rate of drainage to the greater lagoon area and thus to the pumps in Horse Stable Pond, dense vegetation does not significantly contribute to water levels that encroach onto the golf fairways. Water surface elevations that result in standing water on the fairways result from inadequate pumping rates during periods of storm flows. Flooded fairways occur during dry months as well, possibly from poor drainage of golf course irrigation runoff or from input of runoff from the adjacent community, which would enter through a culvert at the north end of the lagoon. Poor drainage may be resulting from buildup of sediment in the main channel that separates the eastern half of the lagoon from the open water portion (west side) of the lagoon.
- Salinity varies according to the volume of water in the marsh complex at any given time. Salinity results from salts in the soils and water of the lagoon that are residual from the time that the lagoon was tidally inundated, and from salts deposited during subsequent overtopping of the seawall.
- Elevated salinity was found at a seep at the base of the seawall on the western edge of the pond (Wayne 2008). This saline water may have seeped through the seawall during sustained high tides, or may enter the pond through an abandoned culvert that once conveyed overflow from the pond to the ocean. Salinity from this seep is localized and is not of sufficient quantity to increase salinity levels in the rest of the pond (Kamman 2009). No other evidence of salt water intrusion through the seawall was found.

The complete hydrological report is found in Appendix A.

3.4 Sediment

The wetland complex is at the hydrologic terminus of an 844-acre coastal watershed. The watershed includes one primary drainage, Sanchez Creek, and a smaller subbasin to the north that enters the main lagoon via a small, roadside swale and culvert. Neither of these waterways are gauged. Sanchez Creek drains to the pond, and the small swale drains to the main lagoon. Construction of the seawall has prevented sediment loads from exiting the watershed as they normally might have during storm events (high flows, tidal flushing, etc.).

As part of the engineering design for this project, a sediment yield analysis is being prepared. The primary objective of the sediment yield analysis is to better understand the rate at which sediment is transported to the wetland complex from the watershed. Annual sediment delivery rates, i.e., sediment yields, are estimated in order to support design of sediment detention and removal facilities. The location and capacity of sedimentation basins will be designed to consider removal effectiveness and facility maintenance.

The approach to the sediment yield analysis includes a first-cut level of analysis based on the Revised Universal Soil Loss (RUSLE) methodology to estimate the long-term average annual soil loss from the tributary area. To the extent possible, existing information and studies and knowledge of the site will be used to guide estimation of parameters. Additionally, the Modified Universal Soil Loss Equation (MUSLE) is being used to predict soil erosion from the 2-, 5-, 10-, 25-, 50-, and 100-year storm events. Results from RUSLE and MUSLE will be compared to local or regional sediment yield data to evaluate the level of certainty in the yield estimates for the wetland complex. Uncertainties in sediment yield estimates will be taken into consideration during design through factors of safety and use of other conservative design parameters.

Data sources include existing reports, hydrologic analysis of the watershed, field reconnaissance, vegetation maps, land use maps, soil maps, and precipitation records. Total suspended sediment estimates will use, in part, the results of water samples pulled at Sanchez Creek and the sub-basin channel during a storm in winter of 2008.

3.5 VEGETATION

The majority of the Sharp Park study area is planted with golf course grasses including Kentucky bluegrass *(Poa pratensis)*, ryegrass *(Lolium* sp.), and kikuyu *(Pennisetum clandestinum)*, separated by occasional stands of Monterey cypress *(Cupressus macrocarpa)*. Although none of these grasses are native to the study areas, kikuyu in particular is considered a highly invasive weed and is very difficult to manage (Randall 2002). Areas used for golf are constantly disturbed by visitors and maintenance staff, and also have very minimal vegetative diversity. Therefore, they generally provide low value habitat and are only used by generalist species such as robins and starlings, which are adapted to these conditions. Primary habitat areas are found at the lagoon, the pond, the connecting canal, Sanchez Creek, and the uplands on GGNRA property found south of the pond. These areas provide habitat for six special status species as recognized by the State of California and US Fish and Wildlife Service: San Francisco forktail damselfly *(Ischnura gemina)*, California red-legged frog, western pond turtle *(Clemmys marmorata)*, San Francisco garter snake, salt marsh common yellowthroat *(Geothlypus tricha)s* and dusky-footed woodrat *(Neotoma fuscipes)*.

The construction of the Sharp Park Golf Course replaced native coastal scrub and grasslands, as well as artichoke farms (Sweeney 2008). Sanchez Creek, which runs through the golf course, has been culverted west of Highway 1. The stream remains daylighted east of Highway 1 except in the rifle range area, where it is also culverted. Some riparian scrub vegetation is found along the edges of Sanchez Creek east of the highway, and the stream is largely shaded in this area by large Monterey cypress trees. Freshwater marsh is found at the edges of the pond, the lagoon, and in the canal. Coastal scrub, dead Monterey cypress, and weedy, non-native plant species including iceplant are found to the west of the lagoon and wet meadow to the south and east. Most of the golf course is east of the lagoon; however, two holes are present in the area located northwest of the lagoon.

South of the pond are formerly grazed uplands which now consist of ruderal vegetation such as invasive weeds. To the west of the lagoon is a sparsely vegetated ~8 meter (~25 foot) high levee. Sand dunes interspersed with sections of golf course and marsh plants lie along the base of the levee on the landward side (PWA 1992).

In September 2008, a wetland delineation was performed to identify the wetland resources and other "Waters of the United States" that would fall under the jurisdiction of the U.S. Army Corps of Engineers (USACE) at the wetland complex. Wetlands in the study area were identified using NWI maps, soil survey information, and site observations. Potential wetlands were delineated in the field using the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Environmental Laboratory 2008). Tetra Tech staff also prepared informal field maps of vegetation community types during several reconnaissance level field surveys.

Plant Community Descriptions

Several types of wetland plant communities were identified in the marsh complex, and upland and ruderal communities were identified around the marsh complex. Wetland habitat types include freshwater marsh, willow scrub, and wet meadow. Other habitat types include foredune, ruderal, and riparian. These habitat types are described below. Other plant communities including mixed conifer forest, Monterey cypress forest, eucalyptus forest, and coastal scrub/grassland were identified at the far eastern part of the project area and at nearby Mori Point. All habitat types are displayed at the community level in Figure 13.

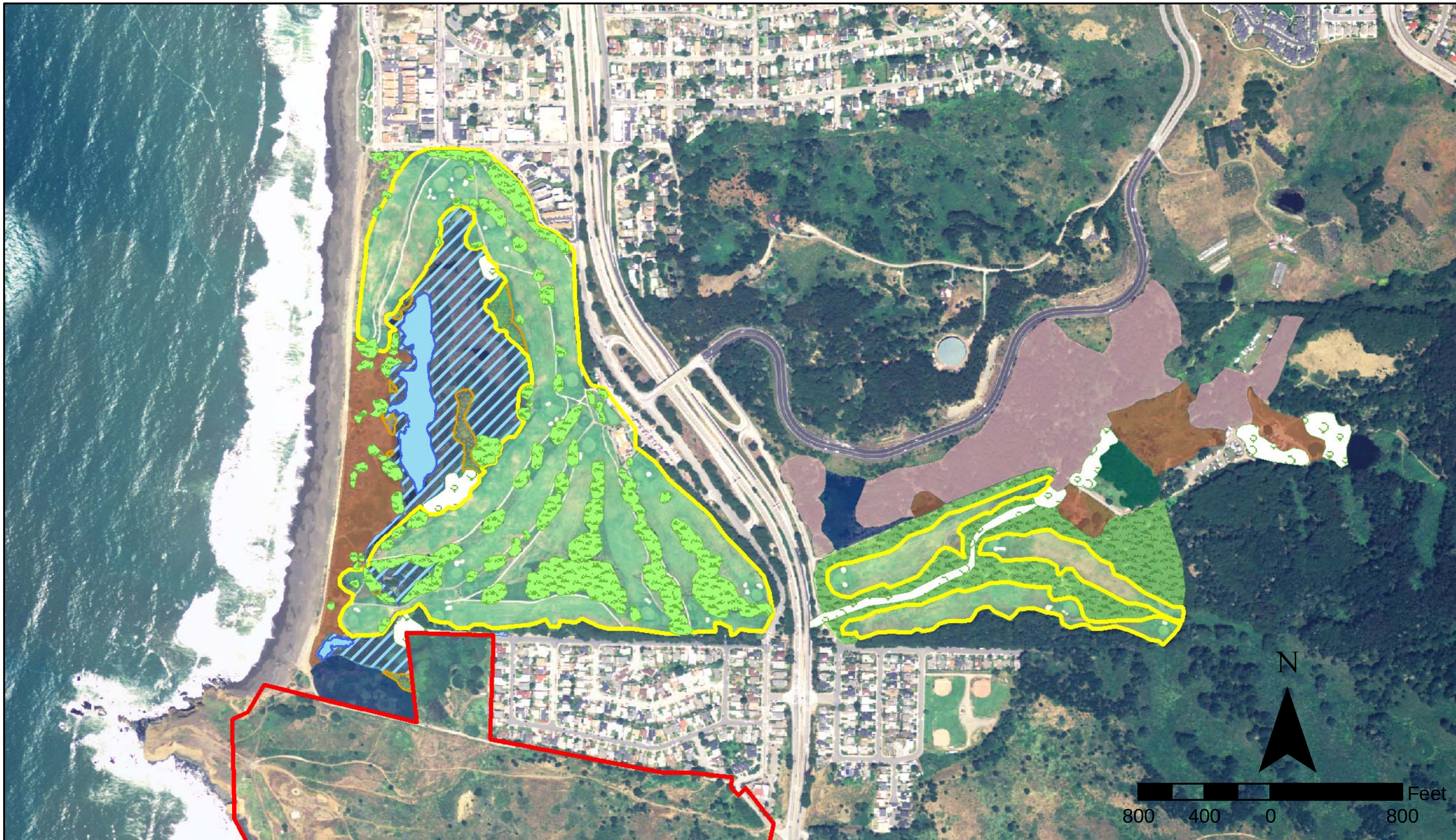
Freshwater Marsh

Freshwater marsh within the study area includes vegetated areas within and adjacent to Laguna Salada and Horse Stable Pond and the connecting channel (Tetra Tech 2008). Dominant vegetation within the freshwater marsh areas include bulrush *(Scirpus s*p.), cattail *(Typha angustifolia),* and coastal cinquefoil *(Potentilla anserina),* all of which are obligate wetland species. Cattails and bulrush have steadily encroached on much of what was formerly open water habitat in the eastern portion of Laguna Salada and in the connecting channel between the lagoon and the pond (Tetra Tech 2008). A small pond containing emergent vegetation was observed within the willow scrub area south of the golf course on GGNRA lands. GGNRA staff enhanced this pond by deepening an existing wetland to provide suitable breeding habitat for California red-legged frogs (Tetra Tech 2008).

Regular golf course maintenance appears to be controlling the growth of wetland habitat in some areas adjacent to the lagoon, as remnants of some hydrophytic plant communities were observed in lower elevation mowed areas (Tetra Tech 2008). Wetland vegetation has been encroaching onto the golf areas as poor drainage on the north and northwest parts of the lagoon has allowed for a larger flooded area.

Willow Scrub

Willow scrub within the study area was located south of the Sharp Park golf course, to the east of Horse Stable Pond, and near the archery range (Tetra Tech 2008). Small areas of this habitat type are also found on the northeast and southeast sides of Laguna Salada and along Sanchez Creek, east of Highway 1. The willow scrub communities are characterized by a dense overstory of arroyo willow *(Salix lasiolepis)* and sitka willow *(S. sitchensis),* which are both facultative wetland species, with an understory composed of obligate hydrophytes, such as panicled bulrush *(Scirpus microcarpus)* and coastal cinquefoil *(Potentilla anserina)* (Tetra Tech 2008).



General Habitat Types

Sharp Park Conceptual Restoration Plan
Pacifica, CA

Figure 13

- Willow Scrub
- Wet Meadow
- Freshwater Marsh
- Unvegetated Pond/Open Water
- Coastal Scrub/Grassland
- Eucalyptus Forest
- Mixed Conifer/Laurel
- Monterey Cypress
- Ruderal
- GGNRA
- Golf Area

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Wet Meadow

Wet meadow occurs on the east side of Laguna Salada where the fairways flatten out at the edges of Holes 14 and 15, and also where a swale forms a meadow directly east of and adjacent to Horse Stable Pond. Dominant plants in this area include Baltic rush *(Juncus balticus)*, spreading rush *(J. patens),* bulrush *(Scirpus americanus)*, curly dock *(Rumex crispus)*, and coastal cinquefoil. Coyote bush *(Baccharis pilularis)* occurs on the hummocks amid the wetlands, which may be evidence that uplands were once present near the lagoon. Wet meadow vegetation grades to riparian willows (*Salix* spp.) and cattails (*Typha* spp.) near Sanchez Creek.

Wet meadow also occurs along the east side of the lagoon as well as on a peninsula of higher ground in the middle of the lagoon. Salt concentrations in the soils in these areas, residual to the time when the lagoon was open to tidal action, are probably responsible for the occurrence of some salt marsh plants including saltgrass *(Distichlis spicata)*, fleshy jaumea *(Jaumea carnosa)*, and Virginia pickleweed *(Salicornia virginica)*. Salt tolerant plant species are also found at the edge of the pond.

Ruderal Vegetation

Ruderal vegetation is found in the areas around the parking lot, in the upland habitat south of the pond and west of the lagoon, at the site of the closed rifle range, and at the archery range (Tetra Tech 2008). The vegetation in these areas includes primarily invasive forbs such as wild radish *(Raphanus sativus),* curly dock *(Rumex crispus),* and wild oats *(Avena barbosa)* (Tetra Tech 2008).

The hills on Mori Point are covered with non-native annual grasses mixed with invasive forbs including wild radish, bristly ox tongue *(Picris echioides)*, and sweet fennel *(Foeniculum vulgare)* with a few Monterey cypress (PWA 1992, Tetra Tech 2008).

In addition to maintained tees, greens, fairways, and sand traps, the golf course roughs include many non-native plants. Where the fairways border the lagoon, wet meadow and marsh plants function as hazards for the golf course. Between the holes (in the rough) are various non-native grasses.

Foredune

The western portion of the lagoon has undergone considerable disturbance, both from periodic high tides and storms and from development of the golf holes that were once there. The 25-foot high seawall supports only sparse ruderal vegetation. At its base, sands support foredune species and, closer to the lagoon, salt marsh species. Areas of bare sand are interspersed with patches of foredune plants. Residual soil salts are probably responsible for the occurrence of these species, since the lagoon itself supports freshwater marsh species. Species observed include coastal sand verbena *(Abronia latifolia)*, silver bur ragweed *(Ambrosia chamissonis),* ice plant (*Mesembryanthemum* sp.), and New Zealand spinach *(Tetragonia expansa)*.

Riparian

West of Highway 1, Sanchez Creek has been channelized and runs through a corridor southeast of the lagoon, parallel to Fairway Drive. In open areas the banks are partially vegetated with plantain (*Plantago* sp.), panicled bulrush *(Scirpus microcarpus)*, knotweed *(Polygonum* sp.), and broom (*Cytisus* sp.) (PWA 1992). A dense overstory of Monterey pine *(Pinus radiata)* and Monterey cypress cover much of its course in this area and as a result, there is little riparian vegetation. Near the end of Fairway Drive, the creek is culverted under the golf course. When it emerges from the culvert it flows under a thicket of willows. The stream then flows west through a dense stand of cattails and enters the pond (PWA 1992).

Wetlands

Wetlands in the study area were identified using National Wetland Inventory (NWI) maps, soil survey information, and site observations. Potential wetlands were delineated in the field using the routine on-site method (level 2), as outlined in Section D of the Wetlands Delineation Manual (Environmental Laboratory 1987). This method is referred to as the three-parameter approach because it uses three criteria—presence of hydrophytic (water adapted) vegetation, hydric soils, and wetland hydrology. The three-parameter approach determines whether an area is a jurisdictional wetland under normal conditions. Jurisdictional wetlands are regulated by the USACE under Section 404 of the Clean Water Act (CWA) and by the Regional Water Quality Control Board under Section 401 of the CWA.

A total of 27.42 of acres of Waters of the US were delineated within the study area (Appendix B, Figure 3). Jurisdictional areas were classified into four habitat types: freshwater marsh, willow scrub, wet meadow, and unvegetated pond (open water). The amount of each jurisdictional habitat type within the study area is shown in Table 1, below.

Table 1. Wetlands and Other Waters in the Wetlands Complex

Habitat Type	Jurisdictional Determination	Area (Acres)
Freshwater marsh	Wetlands	19.56
Willow scrub	Wetlands	0.93
Wet meadow	Wetlands	2.44
Unvegetated pond	Other Waters of the US	4.49
Total wetlands/waters		27.42

3.6 Sensitive Wildlife Resources

Swaim Biological conducted surveys for the SFGS and CRLF at or near the wetland complex as part of this project in 2008, and in 2004, 2006, and 2008 as part of another project. Visual survey locations included the following aquatic habitats and associated uplands: Horse Stable Pond, Laguna Salada, the canal connecting Horse Stable Pond and Laguna Salada, Sanchez Creek west of Highway 1, and Arrowhead Lake east of Highway 1 and the archery range. Aside from determining the presence or absence of these species, one of the main objectives of the surveys was to identify limiting factors for the SFGS and CRLF and their prey species. The complete survey report is found in Appendix C.

California Red-legged Frog

Habitat Requirements

This species usually occurs in or near quiet permanent water of streams, marshes, ponds, and lakes (Stebbins 2003, NatureServe 2009) typically ~0.7 meter (2.3 foot) deep, in habitats characterized by dense, shrubby riparian vegetation (Hayes and Jennings 1988). During the dry summer months, California red-legged frogs estivate in small mammal burrows, leaf litter, or in other moist sites in or near riparian areas (~30 meters; 100 feet) (USFWS 1996). Individuals may range far from water along riparian corridors and in damp thickets and forests. The California red-legged frog is generally found near water but often disperses to upland habitat after rains (Stebbins 2003). Although frogs at most locations remain at the breeding site year-round, long-distance movements of up to 2.2 miles to and from non-breeding sites have been observed (Bulger et al. 2003). Lack of a dispersal corridor leading to other viable habitat means that frogs found in the wetland complex at Sharp Park are unlikely to migrate.

Breeding occurs in permanent or seasonal water of ponds, marshes, or quiet stream pools, and sometimes in lakes (Fellers, in Jones et al. 2005). Eggs are often attached to emergent vegetation where they float at the surface (Hayes and Miyamoto 1984). CRLF typically breeds during or shortly after large rainfall events in late winter or early spring (Hayes and Miyamoto 1984, USFWS 1996). The breeding period lasts about 1 to 2 weeks and eggs hatch in 6 to 14 days. Larvae metamorphose in 3.5 to 7 months after hatching but occasionally overwinter (Fellers et al. 2001). Larval mortality tends to be very high within this species. Sexual maturity is reached in 3 to 4 years and individuals may live 8 to 10 years.

Diet for the California red-legged frog includes various terrestrial and aquatic invertebrates, mainly invertebrates of shoreline or water surface. Diet of large adults also includes small vertebrates. Larvae eat algae, organic debris, plant tissue, and other minute organisms (NatureServe 2009).

Local Occurrence

A total of 85 CRLF egg masses were located in or near the study area (SBI 2008). The highest concentration was in Horse Stable Pond, with 57 masses being located. Twenty egg masses were found in portions of Laguna Salada and four were found in the canal. East of Highway 1, four egg masses were found in Arrowhead Lake (SBI 2008). No egg masses were found in Sanchez Creek or in areas of extremely dense emergent vegetation that lacked open water (SBI 2008).

Areas that are suitable for foraging and basking but where no sign of breeding was observed include Sanchez Creek and portions of Laguna Salada, notably the north end. Juvenile and adult CRLFs were concentrated in and around the pond, the canal, and lower Sanchez Creek (SBI 2008). In these areas, CRLFs have been observed basking or sitting under vegetation next to the water. However, they were not observed in extremely dense cattails or bulrushes (SBI 2008).

The primary limiting factor for the CRLF in the wetlands complex is a vegetation structure that is inappropriate and not optimal for successful breeding and/or recruitment of larval stages into the adult population. The dense emergent vegetation combined with little remaining open water offers poor habitat for the survival of egg masses or tadpoles. Tadpoles hatched from eggs deposited on flooded areas of the golf course have been stranded in these areas due to their inability to penetrate the dense vegetation at the edge of the lagoon (Wayne 2008).

Locally, high salinity in the study area would lead to severely compromised habitat. One-hundred percent of CRLF egg masses die at salinity levels of 4.5 parts per thousand (ppt) (Jennings and Hayes 1990), and larvae cannot survive in concentrations higher than 7.0 ppt (USFWS 2002). The presence of egg masses in Laguna Salada, the canal, and Horse Stable Pond suggest salinity levels of less than 4.5 ppt are present during the breeding season. Although loss of CRLFs or their eggs due to salinity increases has not been documented at Laguna Salada in the past, the potential for this occurrence has led to the recommendation that any frog ponds created at Sharp Park be situated above the 100-year storm surge elevation that is predicted under current conditions and under projected conditions 30, 40, and 100 years in the future.

San Francisco Garter Snake

Habitat Requirements

The habitat requirements of the SFGS vary throughout the year, and multiple habitat types are used on a seasonal and often daily basis. From spring through early fall SFGS are found in wetland areas where they forage for frogs, tadpoles, and small fish. During these months they makes daily movements between foraging habitat and nearby upland retreats located in underground burrows and soil crevices, typically located in a grassland-shrub community. Grassy hillsides, floating algae, and rush mats also are used at this time for basking and mating. Beginning in mid- to late fall they may move to more distant uplands and winter underground retreats. Here they remain relatively inactive during the winter months versus the rest of the year. SFGS have been seen in all months of the year during warm weather, including individuals foraging in ponds during February. In some populations where uplands immediately adjacent to the aquatic habitat are suitable for winter retreats, SFGS will take advantage of these closer burrows (Larsen 1994).

Local Occurrence

Under current conditions, high quality upland habitat for the SFGS at Sharp Park is restricted to a small area south of Horse Stable Pond. Laguna Salada and the connecting channel contain functionally little or no adjacent SFGS upland habitat that is secure from daily human disturbance and exposure to predators (SBI 2009). This lack of suitable upland habitat with disturbance by golf activity during the day minimizes the connectivity between the aquatic habitats in Horse Stable Pond and Laguna Salada and deters occupancy by the snake in all but the southernmost portion of the park. The edges of Laguna Salada currently are the most likely routes for SFGS to follow, and movement through these areas could expose snakes to mortality from predation, mowing, and being crushed by golf carts and people. The lack of suitable upland habitat that would be used on a regular basis is therefore a limiting factor in ensuring the persistence of the SFGS at Sharp Park. Upland habitat that would be suitable for winter retreats is also limited as any that exists immediately adjacent to the lagoon would be subject to the flooding that occurs each winter.

For SFGS that travel to the lagoon from uplands near the pond or Mori Point, the extremely dense structure of the aquatic vegetation combined with little open water/emergent vegetation edge habitat at the lagoon provides extremely poor foraging habitat (SBI 2009). The deterioration of breeding habitat due to inappropriately dense vegetation also limits CRLF productivity at Laguna Salada.

Arrowhead Lake supports a breeding population of California red-legged frogs and Pacific chorus frogs, and is bounded by dense riparian vegetation, providing suitable foraging habitat for the San Francisco garter snake. Although no San Francisco garter snakes were observed there during these surveys, Arrowhead Lake and the surrounding uplands may be used as habitat. There is a historical record of SFGS on the parcel north of and adjacent to Sharp Park with no barriers between. San Francisco garter snakes are also known to occupy the SFPUC watershed land to the east around San Andreas Reservoir below Sweeney Ridge.

Survey Results

SBI conducted visual surveys in 2008 specifically for SFGS in March, April, and May of 2008. No SFGS were observed during visual surveys, which included the areas around lower Sanchez Creek, the lagoon, the canal, and the pond. However, the abundance of prey items in these areas, their proximity to recent observations of the snake at Mori Point and the pond (SBI 2006), and historical occurrence suggest that they are likely to be used by SFGS for foraging and movement. Five SFGS were trapped at a nearby wetlands at Mori Point in 2008 (SBI unpubl. data) and in wetland habitats south of the golf course and east of Horse Stable Pond. On July 9th, 2008, Golden Gate National Recreation Area biologists reported seeing a SFGS in the 'north pond', a few hundred feet east of Horse Stable Pond (S. Bennett in litt 2008).

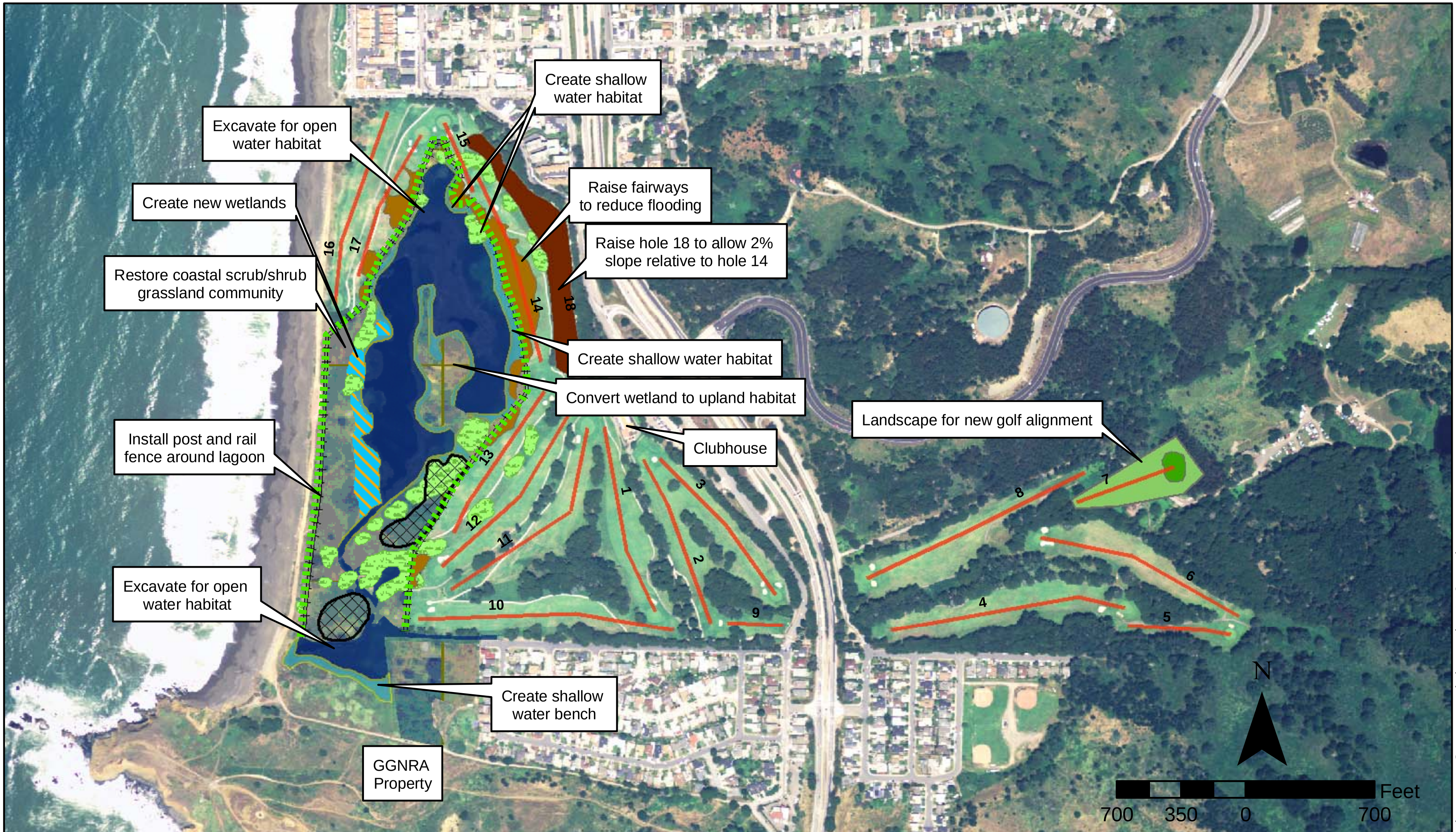
4. CONCEPTUAL PLANNING

During planning for the recovery effort, several broad goals were identified by SFRPD and through agency input. Those are as follows:

- Maintain and restore habitat for listed species, particularly the SFGS and CRLF;
- Meet the recommendations of the SFGS Recovery Plan (USFWS 1985);
- Restore functional wetland and upland habitat that is high-value and low maintenance;
- Comply with the requirements of state and federal regulations, including ESAs and the Clean Water Act; and,
- Preserve and enhance recreational opportunities that correspond to the listed species goals.

A series of conceptual alternatives have been created to detail proposed conditions that are predicted to occur under various alternatives and to assess whether each alternative would meet the recovery goals (Figures 14-16). A habitat assessment model was completed for existing conditions and for conditions that are projected to develop under each conceptual plan. Figure 17 shows habitat quality under existing conditions, and Figures 18-20 show projected habitat quality for the SFGS and CRLF under Alternatives A18, A9, and No Golf, respectively. Table 3 compares the amount of habitat for each species under the various alternatives compared to the projected costs. A detailed cost estimate is provided in Appendix D, and the process of determining costs is explained in Section 4.9.

Each alternative differs in the extent of upland habitat that would be restored as well as the alignment and location of golf holes. A gradient of measures is proposed under various alternatives, ranging from an alternative that would restore the wetlands and minimal surrounding upland habitat to a more comprehensive alternative that would also restore the wetlands but would also include a much greater amount of upland restoration as well as excavation of frog ponds and daylighting of Sanchez Creek. Alternatives include maintaining an 18-hole golf course, closing 9 holes and creating a 9-hole course with a driving range, and closing the park to golf while still allowing other recreational opportunities on the site. All alternatives share the same goal, which is to enhance habitat for the SFGS and CRLF, and share the same restoration features in and around the wetlands complex: creation of upland basking and retreat habitat adjacent to the wetlands, excavation of excess sediment and decaying vegetation from the wetlands complex, creation of an upland corridor between the pond and the lagoon, and recontouring the shoreline to create shallow water habitat.



Conceptual Alternative A18

Sharp Park Conceptual Restoration Plan
Pacifica, CA

Figure 14

TETRA TECH

	Fairways		Raise to 10' Contour		Coastal Shrub/Grassland		Open Water
	Fence		Upland Mounds for SFGS Habitat		New Wetlands		Convert to Golf Holes
	Habitat Boundary		Remove Non-Native Trees		Shallow Water Habitat		

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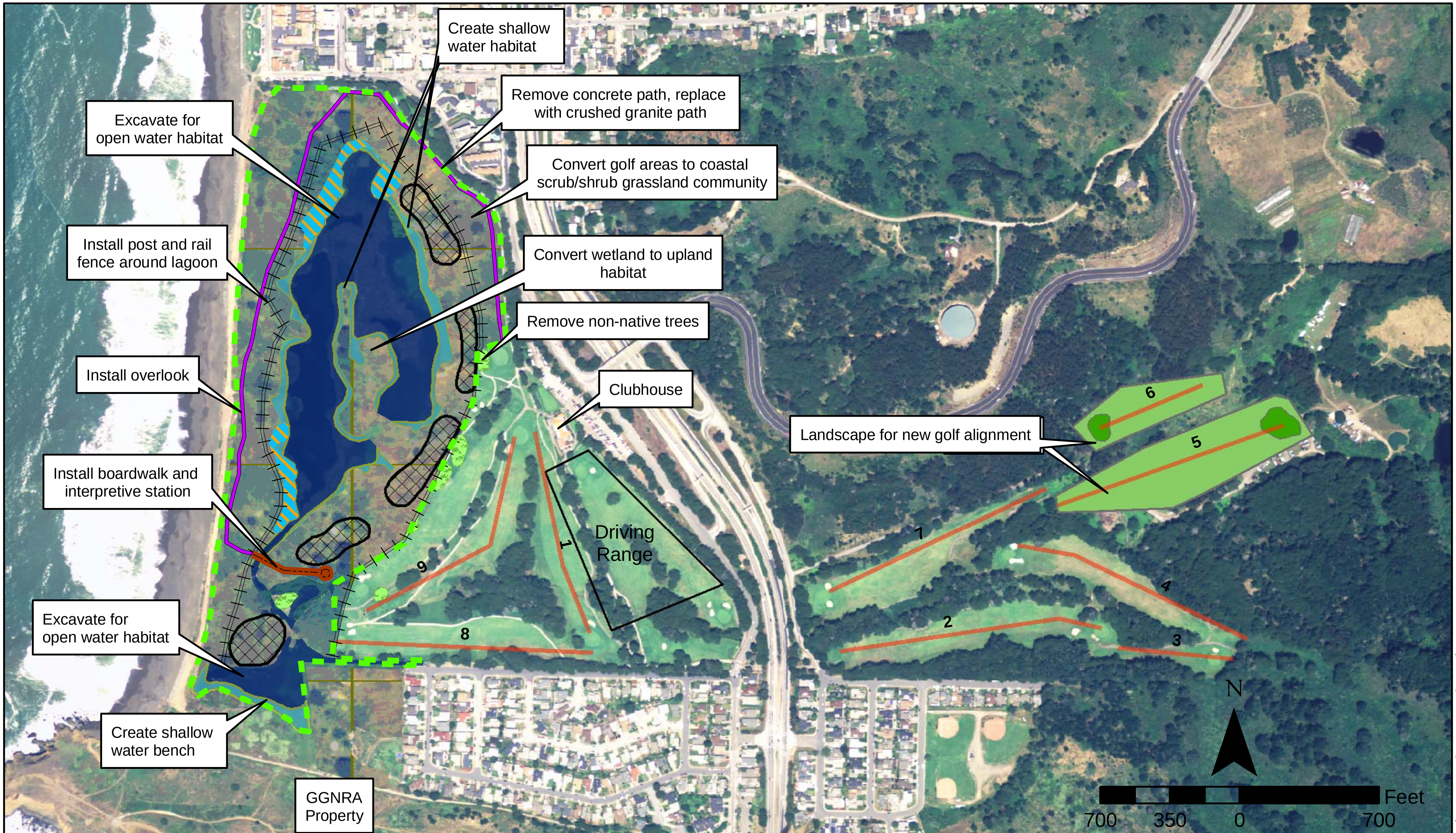

Conceptual Alternative A9

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 15

TETRA TECH

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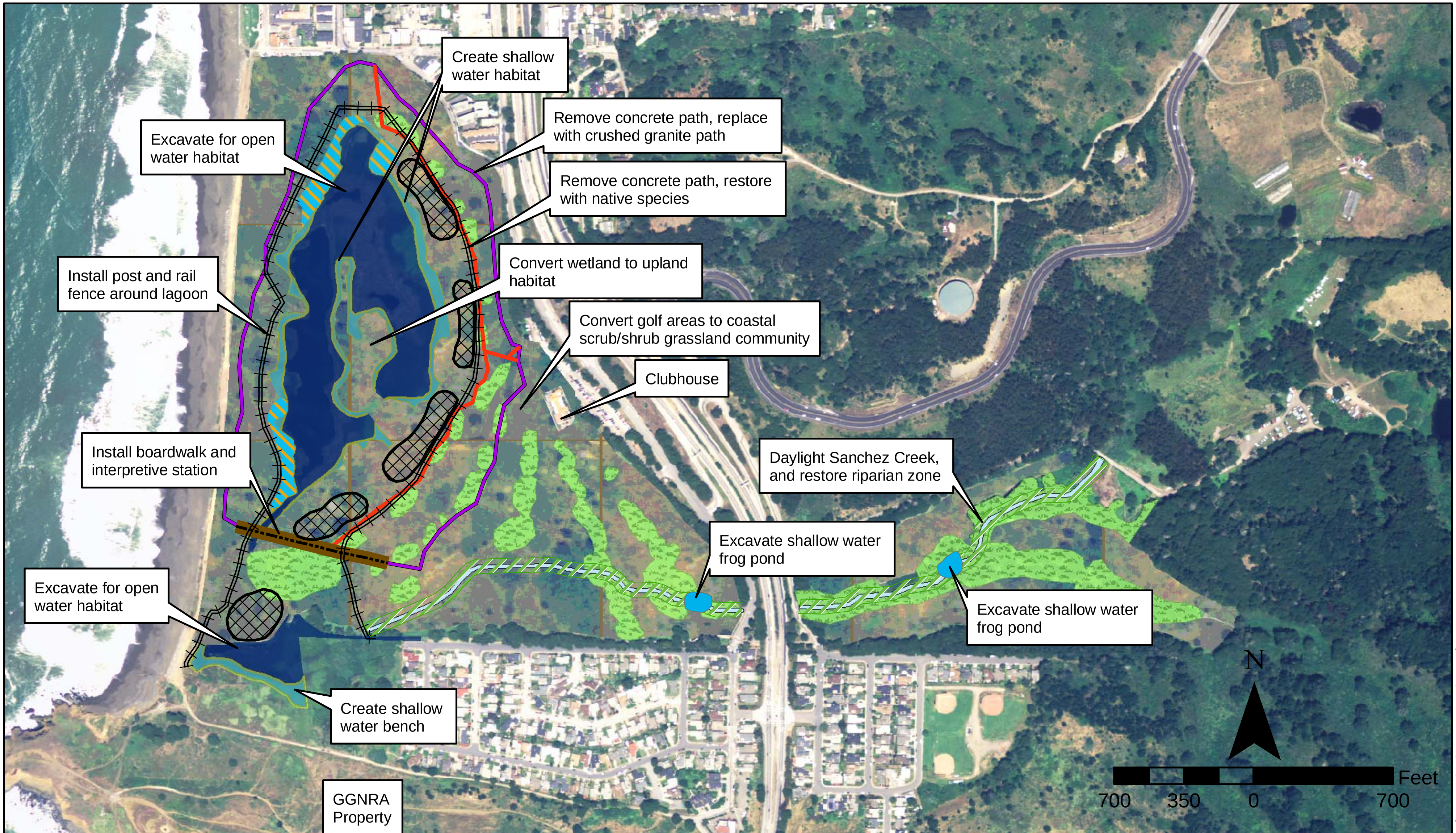

No Golf Alternative

Figure 16

Sharp Park Conceptual Restoration Plan
Pacifica, CA

	Boardwalk	Riparian Habitat	Remove Non-Native Trees	Open water
	Daylight Sanchez Creek	Upland Mounds for SFGS Habitat	Coastal Shrub/Grassland	
Fence	Frog pond	New Wetlands	Shallow Water Habitat	

TETRA TECH

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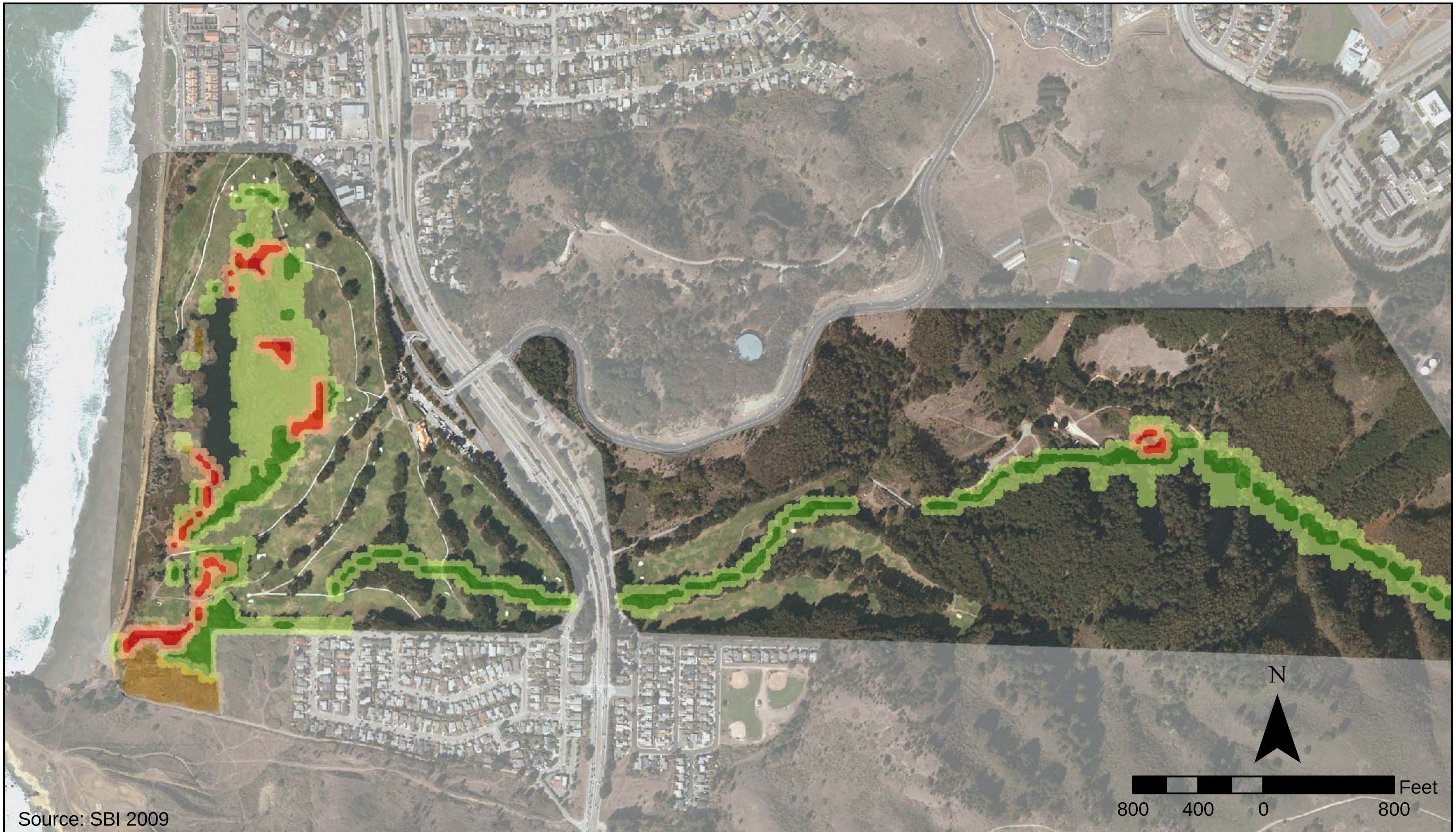

Habitat Quality Under Existing Conditions

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Habitat Quality for the California Red-legged Frog and the San Francisco Garter Snake at Sharp Park

Figure 17

TETRA TECH

CRLF breeding / SFGS primary foraging habitat
- Highly Suitable
- Moderately Suitable

CRLF non-breeding / SFGS movement and secondary foraging habitat
- Highly Suitable
- Moderately Suitable

SFGS upland (retreat and basking) habitat
- Highly Suitable
- Moderately Suitable

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Habitat Quality Projection, Alternative A18

Sharp Park Conceptual Restoration Plan
Pacifica, CA

Habitat Quality Projection for the California Red-legged Frog and the San Francisco Garter Snake at Sharp Park

Figure 18

CRLF breeding / SFGS primary foraging habitat
- Highly Suitable
- Moderately Suitable

SFGS upland (retreat and basking) habitat
- Highly Suitable
- Moderately Suitable

CRLF non-breeding / SFGS movement and secondary foraging habitat
- Highly Suitable
- Moderately Suitable

TETRA TECH

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Habitat Quality Projection, Alternative A9

Habitat Quality Projection for the California Red-legged Frog and the San Francisco Garter Snake at Sharp Park

TETRA TECH

Figure 19

Sharp Park Conceptual Restoration Plan

Pacifica, CA

CRLF breeding / SFGS primary foraging habitat
- Highly Suitable
- Moderately Suitable

CRLF non-breeding / SFGS secondary foraging habitat
- Highly Suitable
- Moderately Suitable

SFGS upland (basking and retreat) habitat
- Highly Suitable
- Moderately Suitable

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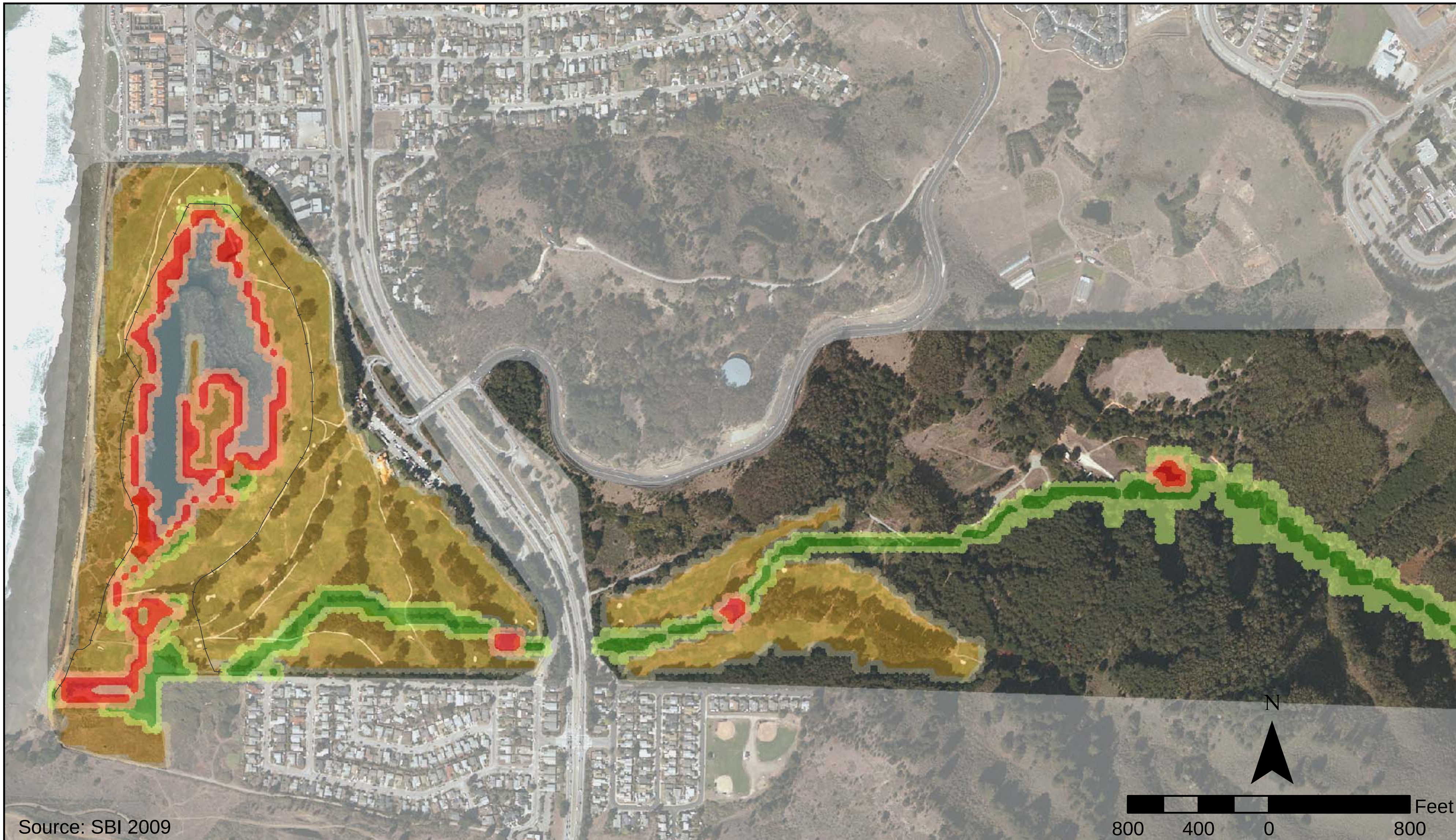

Habitat Quality Projection, No Golf Alternative

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Habitat Quality Projection for the California Red-legged Frog
and the San Francisco Garter Snake at Sharp Park

Figure 20

TETRA TECH

CRLF breeding / SFGS primary foraging habitat
- Highly Suitable
- Moderately Suitable

SFGS upland (basking and retreat) habitat
- Highly Suitable
- Moderately Suitable

CRLF non-breeding / SFGS secondary foraging habitat
- Highly Suitable
- Moderately Suitable

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4.1 Project Constraints

A number of physical, recreational, and biological factors influenced the design of this conceptual plan and in some cases limited or defined the extent of the proposed restoration. These included, but were not limited to, the following:

- *CRLF breeding habitat requirements* SFRPD closely monitors and regulates pumping from Horse Stable Pond into the ocean to avoid stranding CRLF egg masses at that breeding site. This occurs during the entire breeding period for the CRLF (generally December through March). This practice, in part, has resulted in water backing up onto the course flooding large portions of Holes 10, 14, and 15, and cutting off Hole 12 with a large pool of water around the culverted section of the connecting channel. The results of this are three-fold: 1) It eliminates all or portions of these holes from play, sometimes for extended periods 2) CRLFs sometimes lay their eggs during wet periods in the shallow pools that form in the flooded fairways. When the water levels drop, these egg masses can be stranded on dry ground and desiccate. Even if water persists long enough for eggs to hatch in these areas, most tadpoles would have limited mobility in the dense vegetation in the marsh area and may be stranded well before metamorphosis, and 3) Any potential SFGS upland available in areas not in play on the course is also flooded.

- *Presence of the seawall* A seawall separates the western edge of Sharp Park from the ocean and beach. Although members of the public suggested that a restoration option may include breaching the seawall to allow Sanchez Creek to run freely into the ocean, this option was considered infeasible for several reasons. The seawall plays a significant role in maintaining public safety by alleviating flooding during storm surges, and also keeps seawater out of the marsh complex, where saline water could harm resident reptiles and amphibians.

- *Sharp Park Clubhouse* The clubhouse is a historic feature, and its removal as a restoration feature was not considered as an option. Therefore, restoration plans were created assuming that the clubhouse and associated parking area would remain in place.

- *Archery Range* An archery range is located east of Highway 1 near the defunct rifle range. All plans were created to limit effects to the archery range or its access points.

- *Re-use of dredge spoils* It is assumed that some of the spoils removed during dredging of parts of the marsh complex would be used to restore fairways to upland habitat or to serve as the substrate for creation of new golf holes under some of the alternatives. However, spoils with greater than 50% organic material are deemed unsuitable for golf course substrate due to the potential for uneven settling, therefore organic sediments would only be spread where upland habitat is proposed.

- *Highway 1* Highway 1 provides a barrier to migration of the SFGS from the upper part of the park to the marsh complex and vice versa. Although a tunnel under the highway allows travel between the eastern and western parts of the park, the tunnel is not considered to be a viable corridor for migration of the snake. CRLF may have a low but significant flow of genetic exchange through culverts under Highway 1 and potentially overland.

- *Golf course history and alignment requirements* The golf course is a well known example of the design of Alistair McKenzie, a well known golf course architect who designed courses in the 1920s and 1930s. Although the prevailing goal in creating these conceptual plans was to enhance habitat value and diminish potential for harm to snakes and CRLF s, every effort was made to preserve the vision of Dr. MacKenzie and to minimize the need to substantially reconfigure the golf alignment. Furthermore, golf courses are generally constructed to follow a standard sequence of difficulty (par) from hole to hole, a factor that was considered in the various designs.

- *Mitigation for impacts to wetlands* Under all alternatives, an upland pensinsula will be created in the middle of the lagoon. Because this will result in fill of up to 2 acres of wetlands, 2 acres of wetlands must be created from the upland edges of the lagoon, which in some cases may encroach on existing fairways. By mitigating for impacts to wetlands and complying with other permit conditions required by the US Army Corps of Engineers (USACE) and the Regional Water Quality Control Board (RWQCB), SFRPD maintains compliance with Sections 404 and 401 of the Clean Water Act.

4.2 HABITAT CONSIDERATIONS

Historically, SFGS habitat at Sharp Park was concentrated in and around Laguna Salada and Horse Stable Pond. Habitat in these areas has become degraded over time as a result of sedimentation and excessive plant growth, flooding by seawater, and a variety of human impacts.

Both the SFGS and CRLF would benefit from the restoration of productive breeding and foraging habitat in each of these aquatic features. This could be accomplished by creating open water habitats adjacent to emergent vegetation in Laguna Salada, the canal, lower Sanchez Creek, and Horse Stable Pond. Because of their historic occupancy and the presence of features that currently support the SFGS, the conceptual plans were developed with the primary goal of restoring and enhancing habitat in these areas. Although CRLF are known to breed in Arrowhead Lake east of Highway 1, enhancements to the eastern portion of the park were not prioritized because there is no current evidence of occupation by the SFGS at Arrowhead Lake, nor is there a connection to the SFGS population at Mori Point. Each conceptual plan includes enhancements to wetland areas of the pond, the canal, and the lagoon in order to increase CRLF breeding and SFGS foraging habitat.

In order to address the shortage of suitable upland habitat for the SFGS, however, changes to the use of land adjacent to the wetland complex are required. The primary goal of each conceptual alternative was to propose an effective way of increasing upland habitat adjacent to existing or future aquatic habitat, and to evaluate the consequences of such a change to the existing golf course design and operation.

Restoration Options

Under all alternatives, creating new uplands west of Highway 1 would require the conversion of Hole 12 to wildlife habitat that includes both enhanced wetland and upland features. The two former golf holes west of Laguna Salada taken out of play after saltwater flooding in the 1980s currently contain non-native plants and bare, sandy ground that provide little habitat value for the snake and frog. These areas could be converted into upland habitat for the SFGS if CRLF breeding habitat that is free from predatory fish and which contains shallow water and emergent vegetation is also created in adjacent parts of Laguna Salada. Upland habitat created in these areas however would be susceptible to pedestrian trespassing, off-leash dog activity, potential saltwater spray, and may be prone to future flooding. Locating newly-created upland habitat on Laguna Salada's southeast and northeast sides instead would reduce some of the risks of impact by pedestrians, pets and ocean water, but would require one or more golf holes to be modified or relocated, and could increase impacts by golf course maintenance activities such as mowing. Creating SFGS upland habitat on the east side of the lagoon rather than the west side would allow for creation of new wetlands on the west side of the lagoon to mitigate for wetlands that are filled during planned restoration activities.

Creating upland habitat on the east side of Highway 1 would not benefit snakes and frogs in the areas where they primarily occur. Success criteria would be expected to require that SFGS either colonize the area by crossing the highway, an event that probably occurs rarely and presents substantial hazards to snakes that attempt it or by moving into the area from the Crystal Springs watershed. Connectivity to the Crystal Springs watershed to the east is limited by the unsuitable nature of the dense stands of eucalyptus and mixed evergreen forest and lack of distinct hydrologic connection with optimal foraging opportunities for promoting longer movements of SFGS. The exception to this could benefit CRLF and would occur under the No Golf Alternative, in which frog ponds would be created along Sanchez Creek, one of which would be constructed east of Highway 1. Sufficient CRLF populations in the immediate area are present and would be very likely to colonize new ponds on Sanchez Creek.

4.3 Golf Course Planning Considerations

Developing viable design solutions for a reconfigured Sharp Park Golf Course involves tying together golf course playability, endangered species habitat requirements, the original vision of Dr. Alister MacKenzie, and the unique physical and natural components of site.

Redesigning the layout and design of the golf course included understanding the evolution of the original layout dating back to 1931. Since the course was constructed it has changed due to storms off the Pacific Ocean and construction of roads. The result is that four of the oceanfront holes were relocated to the east side of the park and a sea wall protects the golf course from the ocean.

Presently there are 11 holes that are in the original location plus a shortened par three with an original green complex. Over most of the past 80 years the typical MacKenzie characteristics have almost disappeared but can still be seen.

Alternative A18 keeps almost all of the original holes and would accomplish the goal of creating viable upland SFGS adjacent to the wetlands. To maintain an 18-hole regulation course on this property, it is important to keep the existing 18th hole in place because the course needs to return to the clubhouse. A scorecard showing the final lengths and pars of each hole under Alternative A18 is shown as Appendix E.

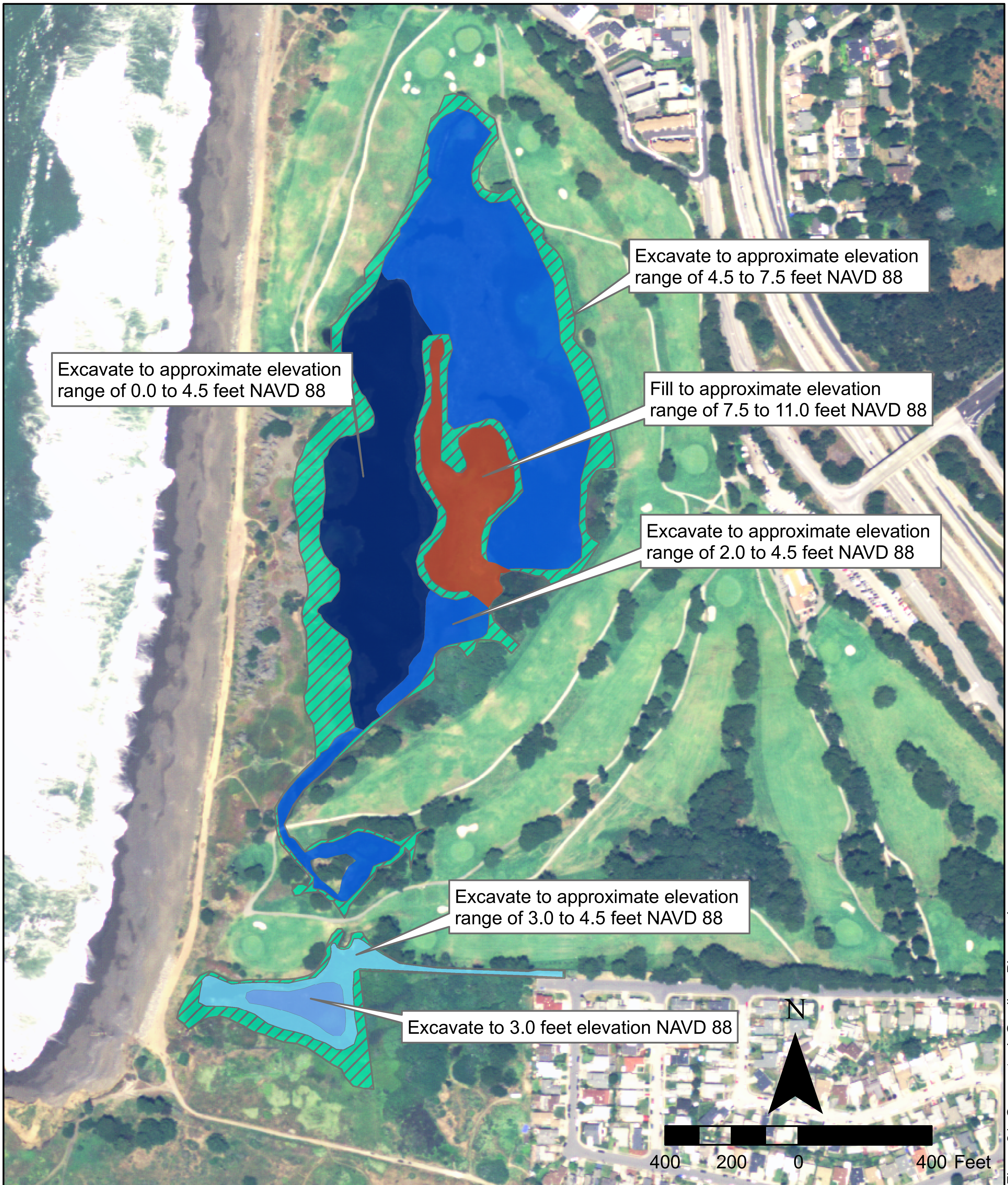
The proposed 9-hole alternative would eliminate golf around the lagoon by eliminating two golf holes and replacing the two holes at the rifle range. The 9-hole alternative would also add a driving range and practice hole.

4.4 Features Common to All Alternatives

The common component of all alternatives is restoration of the wetlands complex. Under all alternatives, the same features are proposed to restore wetland habitat and reduce the potential for recurrence of the problems that now occur, which include sedimentation, eutrophication due to dead and decaying vegetation, loss of open water habitat, and flooding of fairways. Implementing the restoration actions below would accomplish the main goal of the project, which is to enhance CRLF and SGFS habitat. The main components of the wetland restoration are as follows:

- **Dredging to remove sediment and decaying vegetation**. The areas that are currently open water within the lagoon would be deepened by up to 2 feet, and open water areas within the pond by up to 3 feet (Figure 21). Dredging to this extent would bring bottom elevations in the lagoon to 0' NAVD 88 at the deepest part of the lagoon, and down to +2' NAVD 88 in the pond. The eastern portions of the lagoon and pond as well as the connecting channel would be excavated up to 6 feet in the centers to restore open water habitat and to ensure that ample edge habitat consisting of open water/emergent vegetation interface and wetland/upland interface would persist for the foreseeable future. Deepening these areas will ensure persistence of open water habitat by discouraging the growth of dense stands of bulrush and cattails that are overgrowing the wetlands and diminishing habitat quality for the SFGS and CRLF.

- **Recontouring the shoreline to create shallow water habitat**. The eastern edge of the lagoon, the edges of the connecting channel, and the north and south edges of the pond would be contoured to create shallow water habitat (1-3' deep) to allow for CRLF breeding habitat. Shallower water (<1') will allow for growth of vegetation upon which frogs can attach egg masses, while deeper water (1-3') will allow for areas of open water or areas floating emergent vegetation.



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Wetland Grading Plan

Sharp Park Conceptual Restoration Plan

Pacifica, CA

Figure 21

TETRA TECH

- **Creation of an upland peninsula.** A peninsula of approximately 2 acres will be created in the middle of the lagoon and shallow water habitat for the CRLF. The peninsula is intended to address the shortage of upland SFGS habitat, and offer additional shallow water habitat at its edges for CRLF breeding. The peninsula will be constructed to be high enough above ordinary high water and the water table that it will develop an upland plant community and allow squirrels and other rodents to establish burrows which would later be used by the SFGS.

- **Construction of upland mounds**. Upland mounds will be created on the east and south sides of the lagoon and in the dispersal corridor between the lagoon and the pond.

- **Pump Operations.** Altering the methods of operating pumps and other measures to control hydrological features is proposed under all alternatives. The main purpose of altering pump operations is to be able to better control water levels without stranding CRLF egg masses, and thereby reduce the extent of golf course flooding. The main feature of this action is to cycle the pumps more frequently so that they turn on when the water is at a lower level than they currently do. The main disadvantage of cycling the pumps more frequently is that they will likely wear out more quickly than they would under current conditions. The need to operate the pumps more frequently could be reduced by raising the level of fairways that flood, as proposed under Alternative A18.

- **Upland/Aquatic linkage and habitat segment.** A habitat linkage area between the lagoon and the pond would be constructed with native upland vegetation and mounds designed to attract the SFGS. Construction of this corridor will require closing Hole 12 and revegetating the area with native upland species. The corridor would be bisected by the connecting channel, which will provide CRLF breeding habitat and SFGS foraging habitat. The habitat linkage will allow the SFGS population to inhabit a contiguous habitat segment area with features that will provide suitable habitat for SFSG on a year round basis between the lagoon and Mori Point without disturbance from humans or mowing equipment.

- **Completion of a Compliance Plan.** SFRPD has completed a compliance plan that is designed to avoid mortality and injury of SFGS and CRLFs resulting from maintenance and operations of the golf course (SFRPD 2009). Features of the compliance plan include increase monitoring to determine the earliest incidence of CRLF egg deposition, restrictions on mowing, gopher trapping, or repairs in sensitive areas, restrictions on use of particular types of herbicides, and increased stewardship training. Compliance planning is occurring under a separate process than the restoration planning described in this report.

- **Closure of Hole 12.** Due to its position directly between the lagoon and the pond, Hole 12 would be closed under all alternatives. Closing this hole would allow for creation of an uninterrupted habitat corridor between the lagoon and the pond and would also reduce the amount of human intrusion into areas that might be transited by SFGS. Hole 12 would be replaced under each alternative, although the exact alignments vary.

- **Catchment Basins**. To slow the rate of sedimentation from upstream sources, sediment catchment basins would be installed in two locations, one near the mouth of Sanchez Creek and the other on City of Pacifica property just outside the northern boundary of the Sharp Park.

- **Fencing**. A post and rail fence would also be installed to discourage human and pet intrusion into the restored habitat area, although the alignment of the fence in areas away from the seawall may vary according to the different alternatives. All alternatives include fencing along the seawall to the west of the lagoon, according to the Draft Compliance Plan.

- **Revegetation**. Uplands, wetlands, and shallow aquatic areas would be revegetated. The proposed plant palette includes aquatic, wetland, transitional and upland plant species known to occur in areas adjacent to Laguna Salada or similar habitat types. These plants occupy different strata to maximize habitat for a variety of species, particularly the SFGS and the CRLF, for cover, basking, and foraging. More specifically, emergent and floating-leaved species were selected to minimize the growth of non-native *Typha angustifolia* that currently provides poor CRLF habitat. Increased emergent and floating-leaved vegetation should also provide increased habitat for the San Francisco forktail damselfly. Sources of information include the recovery plans for the SFGS (USFWS 1985) and the CRLF (USFWS 2002). Table 2 lists plant species that are recommended for revegetation of all areas.

Table 2. Native Plant Species Recommended for Revegetation

Type	Scientific Name	Common Name
Transitional	*Juncus patens*	Spreading Rush
Transitional	*Rubus ursinus*	CA Blackberry
Transitional	*Scrophularia californica*	Beeplant
Transitional/Wetland	*Rumex salicifolius*	Willow Dock
Transitional/Wetland	*Salix lasiolepis*	Arroyo Willow
Transitional/Wetland	*S. sitchensis*	Sitka willow
Upland	*Achillea millefolium*	Yarrow
Upland	*Anaphalis margaritacea*	Pearly everlasting
Upland	*Argentina anserina*	Silverweed cinquefoil
Upland	*Artemisia californica*	CA Sagebrush
Upland	*Baccharis pilularis*	Coyote Bush
Upland	*Bromus carinatus var. maritimus*	CA Brome
Upland	*Castilleja wightii*	Indian Paintbrush
Upland	*Clarkia rubicunda*	Farewell to Spring
Upland	*Danthonia californica*	Oatgrass
Upland	*Diplacus aurantiacus*	Orange Bush Monkeyflower
Upland	*Dudleya farinosa*	Liveforever
Upland	*Festuca rubra*	Red Fescue
Upland	*Leymus triticoides*	Creeping Rye/Beardless Rye
Upland	*Mimulus aurantiacus*	Sticky Monkey Flower
Upland	*Nassella pulchra*	Purple Needle Grass
Upland	*Rhamnus californica*	Coffeeberry
Upland	*Sidalcea malviflora*	Checkerbloom
Wetland	*Eleocharis macrostachya*	Common Spikerush
Wetland	*J. effusus*	Rush
Wetland	*Sagittaria latifolia*	Broad-leaved Arrowhead
Wetland	*Scirpus microcarpus*	Small-fruited Bullrush
Wetland/Aquatic	*Potamogeton diversifolius*	Waterthread Pondweed
Wetland/Aquatic	*Potamogeton nodosus*	Long-leaved Pondweed
Wetland/Aquatic	*Sparganium angustifolium*	Narrowleaf Burreed
Wetland/Aquatic	*S. eurycarpum*	Broad-fruit Burreed
Wetland/Aquatic	*Typha latifolia*	Cattail
Wetland/Aquatic	*Zizania palustris*	Wildrice

Habitat features in restored upland areas would be the same under all alternatives, with the main difference being the extent of restored area. Ruderal areas and areas currently used for golf would all be restored as native coastal scrub/grasslands, although some of the uplands would be restored specifically for SFGS basking habitat.

- **Maintenance and Monitoring**. Assuming that the alternatives are designed and implemented correctly, success of any of the restoration alternatives will depend on the degree of maintenance and monitoring that occurs. Monitoring is recommended on a yearly basis, and maintenance needs will be determined by the results of the monitoring efforts. Monitoring for the following should occur on a yearly basis:

    - **Use by Listed Species** Since this is a recovery action for the SFGS, monitoring for use of restored areas by SFGS and the CRLF should be the major monitoring priority. As wetland and upland communities develop after restoration, habitats for SFGS and CRLF are anticipated to gradually develop as well. Surveys should begin prior to construction, and should continue after construction to document the extent of viable habitat and the population health of these species. Surveys should be coordinated with USFWS and CDFG to ensure compliance with endangered species laws and regulations.

    - **Invasive Plant Species** Since most of the habitat surrounding Sharp Park has been altered by the presence of non-native species, some of which are noxious invasive species, it is likely that restored areas will also be colonized by these species. Due to the relatively large area of restoration and the high labor needs associated with controlling invasive species, it is recommended that resources be applied to controlling the most noxious invasive species, including perennial pepperweed *(Lepidium latifolium),* gorse *(Ulex europaeus)*, reed canary grass *(Phalaris arundinaceae)*, and various types of thistle.

    - **Vegetation Cover** Percent vegetation cover in restored upland areas should be monitored at 6 month intervals for the first three years, and on a yearly basis thereafter. Wetland areas should be monitored to ensure that the target plant communities are developing and to ensure that areas do not become overgrown. Native species should be replanted yearly or as needed to provide a competitive edge over non-native species.

    - **Non-native Wildlife and Feral Species** Habitat restoration can be successful only if predation from non-native or feral species such as cats, bullfrogs, red foxes, and predatory fish can be minimized. Although predatory fish will be eliminated when the wetland complex is drained for construction, it is possible that new specimens will be deposited there later. Red foxes and feral cats have been seen at the site, and should be trapped and removed if they are identified as being threats to the SFGS or CRLF. Bullfrogs, which prey on CRLFs and juvenile SFGS in other areas, have not been identified in significant numbers at Sharp Park, but should be monitored for.

    - **Impacts from Human Use** Changing the use of lands immediately adjacent to the wetlands complex from primarily golf to other forms of recreation will affect the patterns of human use. Human incursion into restored uplands may affect SFGS in these areas, particularly by people on mountain bikes or those who allow dogs into the area, and should be monitored closely.

    - **Sediment** Although some sediment input into the wetlands system is desirable, controlling excessive sedimentation is one of the keys to ensuring that the current problem of overgrowth of emergent species in wetland areas does not occur in the foreseeable future. Sediment basins proposed for the north end of the park and on Sanchez Creek should be monitored for effectiveness on a yearly basis, and will likely need to be cleaned out at least once every five years. Cross sections of the aquatic areas should be taken at established locations every five years to measure sediment accretion.

- **Water Quality** Water quality parameters to be monitored should include salinity, presence of heavy metals, dissolved oxygen, and input of fertilizers or herbicides from runoff or use of recycled water. Measurements should be taken at primary input locations and in the connecting channel. If water quality deficiencies are persistent and affect habitat quality for the SFGS and CRLF, remedial actions will be implemented as needed.
- **Construction Monitoring** A qualified biologist would be onsite during construction to monitor for sensitive species that may enter the construction area. The construction area should be surveyed for listed species prior to construction, and any specimens found in the construction footprint should be trapped and relocated. The biological monitor must be given authority to shut down construction in the event that listed species are found in the construction area.

4.5 ALTERNATIVES

The following alternatives have been considered in this report:

18-Hole Alternative (Alternative A18)

Alternative A18 is the conceptual plan that was under design for recovery of the SFGS and the CRLF prior to consideration of restoring greater Sharp Park (Figure 14). This alternative is intended to fulfill the recovery goals for the snake and frog while maintaining as much of the current golf course configuration as possible.

Under this alternative, Hole 12 would be closed and restored as coastal scrub/grassland habitat. Holes 10 and 13 would be shortened, and a new hole would be created near the rifle range/ archery course east of Highway 1. No new holes would be restored on the west side of the lagoon; instead, this area would be restored from its degraded condition to native upland habitat. Portions of the fairways in holes 10, 14, and 15 would be raised to 10.0' NAVD 88 from their current elevation of between 6.5' and 9.0' to prevent flooding on the fairways and also to discourage frogs from depositing egg masses in locations where the resulting tadpoles may end up being stranded. The fairway, green and tee areas of hole 18 would be raised to allow a consistent 2% slope from the east side of hole 18 to the west side of hole 14. No boardwalk would be created under this alternative, as there would be no need to cross the restored habitat area between the lagoon and pond. Several Monterey cypress trees would be removed from fairways east and north of the lagoon, as well as from the ruderal habitat west of the lagoon.

SFRPD would develop a new 165 yard, par three hole (Hole 7) after the existing 6th hole and in the location of the current organic waste site and rifle range. This hole would replace the existing 12th hole which would be removed to allow habitat creation between the lagoon and the pond. The new hole will be 165 yards from the back tee and play slightly uphill. The bunkering and sculptured contouring would be characteristic of design strategy and aesthesis of Dr. Alister MacKenzie.

The length of the hole is approximate and would become the second longest par three on the course. This length helps provide a variety of distances of par threes which is desirable for a regulation golf course.

9-Hole Alternative (Alternative A9)

This alternative is intended as a compromise between golf considerations and expanded upland areas east of the main body of the lagoon, and to increase opportunities for recreational pursuits other than golf. Under this alternative, all holes bordering the wetland complex would be closed and restored to coastal scrub/shrub habitat (Figure 15). Three holes (1, 8, and 9) would remain west of Highway 1, along with a driving range and teaching area, and two new holes would be constructed at the rifle range. All existing holes east of Highway 1 would remain in their current location. Excess spoils from excavation of the lagoon would be deposited on the rifle range after remediation. Numerous Monterey cypress trees would be removed under this alternative. A concrete golf cart path would be removed and replaced with a crushed granite path that would start near the clubhouse, proceed around the north end of the lagoon, and end at an observation point and interpretive center located on a boardwalk that would extend into the marsh.

This alternative creates a driving range where existing holes #2 and #3 are located. To accommodate this range, and remove all golf around the lagoon, two new holes would be built at the east end of the golf course. The new holes would start after the existing 6th hole and be built on the site of the organic waste dump and the defunct rifle range.

> Hole 4 – Par 4, 400 yards. This would be an uphill hole playing longer than the 400 yards and has the potential to be a challenging par 4.
>
> Hole 5 – Par 3, 175 yards. This mid to long length par three would play slightly downhill. The setting would be very appealing with a natural area on the left and hills on the right.

No Golf Alternative

A single no golf alternative was developed (Figure 16). This alternative was developed with the goal of maximizing the amount of available upland habitat for the snake and frog in the absence of golf operations. Because the lack of suitable upland habitat was identified as the limiting factor for the snake, the golf areas would be converted into uplands. Enhancements to wetland areas in lower Sanchez Creek, Horse Stable Pond, and Laguna Salada would be identical to those outlined in the other concept plans. Water from Sanchez Creek would be captured in two shallow ponds to provide additional breeding habitat for the CRLF.

Under this alternative, all golf holes would be closed and the fairways would be restored to native coastal scrub/shrub habitat. Sanchez Creek would be daylighted as far east as the defunct rifle range and riparian habitat would be restored along the stream. Two shallow ponds would be constructed on Sanchez Creek to enhance CRLF habitat away from the marsh complex. These ponds would be constructed above the 100-year flood elevation that would occur under projected sea-level rise scenarios. A crushed granite walking path would replace concrete golf cart paths and would be extended to encompass the entire lagoon. No bicycles would be allowed on these paths. Visitors would cross the marsh and upland dispersal zone on a boardwalk that would span the entire habitat zone between the lagoon and the pond.

Maintenance of the restored area would still need to occur, and the pumps would need to be operated in the same manner that they currently operate during the winter.

4.6 Potential Impacts of Restoration

If implemented, these plans could cause a number of temporary and permanent effects to natural resources and recreational opportunities at the park. The full range of potential effects will be assessed during preparation of CEQA documentation and will be addressed directly during the permitting phase of the project. The following have been identified as potentially occurring:

- *Take of listed species.* Although this project is considered a recovery action for listed species, accomplishing this goal will require a great deal of earthmoving and alteration of existing resources. Extensive human presence during construction, use of heavy excavating and earth-moving equipment, and noise can all harm wildlife species by interrupting their foraging or breeding habits or by resulting in direct harm to individuals.

- One of the first tasks that would occur during construction would be to drain the lagoon and the pond, which would discourage SFGS and CRLFs from remaining in the project area, reducing the potential for harmful effects to these species. However, although every effort would be made to capture and relocate sensitive wildlife resources prior to construction, the possibility of harm to listed species remains. Impacts to listed species would be addressed extensively during the Section 7 consultation process with USFWS and during similar consultation with CDFG, and standard and specific practices to minimize the potential for take will be developed at that time. Furthermore, impacts to listed species during construction will be offset in the long term by increasing the quantity and quality of their habitat in the marsh complex area.

- Under the 9-hole alternative, a walking path would encircle most of the lagoon area, enhancing opportunities for exercise and wildlife viewing. Under the No Golf alternative, the walking path would encircle the entire lagoon. The absence of golf operations would remove potential threats to wildlife posed by mowing and potential harm and harassment by players, but management for other threats would be required. Under both alternatives, the walking path would be located in the restored upland area, giving humans and dogs relatively unrestricted access to the area that is being restored for SFGS upland habitat. Although signs would be installed asking visitors to remain on the path, incursions into habitat areas would likely occur. Increased casual use of this area could increase disturbance of the SFGS, particularly by dogs and feral cats, which would be unlikely to use this area if it remained a golf course. Mountain biking would pose a threat to snakes basking on or attempting to cross trails.

- *Impacts on Recreation.* Although some recreational pursuits, such as bird watching, would likely be enhanced by the proposed restoration, other recreational aspects of the marsh area could be temporarily or permanently diminished. Dog walking would continue to be an unauthorized activity, and due to the greater presence of sensitive resources and higher potential for damage to egg masses after restoration, enforcement of this restriction, including issuance of tickets, will be increased.

- The most extensive impacts upon recreational resources would occur as a result of converting the golf course to a 9-hole course or by closing the golf course completely. A 9-hole course would be much less attractive to golfers than an 18-hole course, and a No Golf alternative would force golfers to find another course altogether.

- *Impacts to Visual Resources.* Extensive excavation and regrading of the marsh complex would occur and may have short term negative effects on local scenery. However, the marsh complex would be allowed to fill with water immediately upon completion of construction, and the visual impacts would subside at that time. Long-term effects from restoration of the wetlands complex would likely be positive as there would be a larger expanse of visually appealing open water. Some impacts to the viewshed would likely occur with the installation of a driving range, which would require construction of a chain link fence barrier at the south end of the course to keep golf balls from entering the residential area located south of the park.

- *Impacts to Wetlands.* Impacts to wetlands would occur during construction and as a result of creating an upland island in the middle of the lagoon. It is estimated that up to 1.5 acres will be filled during construction, an amount that would subsequently be recreated on the west and south sides of the marsh complex. Ultimately, there would be no net loss in amount or function of wetlands, and the end result would be restored wetland that provides better functions in terms of water quality benefits and wildlife habitat. Impacts to wetlands will be addressed during the Section 404 and 401 permitting processes and during preparation of a Lake and Streambed Alteration Agreement.

4.7 RESTORATION BENEFIT ASSESSMENT

To aid in evaluating the relative benefits of each alternative, SBI developed a habitat scoring system combined with a GIS model to determine the extent and quality of habitat that would be available to the SFGS and CRLF under each alternative. The scoring system was developed to characterize optimal habitat based on habitat correlates of the CRLF and SFGS from published literature, recorded observations of the species at the site during past surveys, and experience with these species at other sites in the region.

An aerial photograph of the site was divided into equal-sized cells, each 15 X 15 meters or about 1/20th acre, and a standardized scoring system was applied to each cell. Each cell was ranked least suitable (0), moderately suitable (1), or highly suitable (2) based on the presence of the 11 habitat characteristics included in the scoring system. Next, a raster surface consisting of cells, each with a habitat type and score associated with it was created over the photograph. Cells that were scored as containing high-quality habitat were summed in order to calculate the number of total acres of each habitat type in the photograph, and accuracy was verified with field visits to the site. This process was repeated using a concept drawing for each alternative to estimate the amount of habitat that would be created or lost under each alternative. Habitat quality under existing conditions is shown in Figure 17. Habitat quality projections for proposed alternatives are shown in Figures 18 through 20. Table 3 summarizes the results of the habitat quality assessment.

The following categories of habitat types were used in the analysis:

CRLF breeding and SFGS primary foraging habitat. Optimal habitat of this type contains water that persists long enough to facilitate CRLF tadpole development. It also would contain a mix of open water and emergent plant growth, as well as areas of shallow water extending at least one meter from shore. Wetlands in Horse Stable Pond and the connecting channel are examples of this habitat type.

SFGS upland retreat and basking habitat. Optimal upland habitat would consist of grassland or similar vegetation contacting CRLF breeding / SFGS foraging habitat with bushes providing some cover. Rodent burrows or large soil crevices would be present in soil that remains unsaturated throughout winter to provide upland retreats. Under existing conditions, this type of habitat is limited to an area south of Horse Stable Pond.

CRLF non-breeding and SFGS movement and secondary foraging habitat. Habitat containing year-round water or moisture but that is unsuitable for CRLF breeding was considered optimal non-breeding habitat so long as it also contained sufficient cover from predators, and was not separated from breeding habitat by a significant barrier or distance. Examples of this habitat type include dense shrubs located a short distance from water and riparian corridors. SFGS use this habitat type for movement and may forage here, though less frequently than in wetlands where CRLF breeding takes place.

Table 3. Habitat Quality Assessment and Projection Summary

Alternative	Available High-Quality Habitat (Acres) /(Increase over existing conditions)			Advantages for Habitat Quality	Disadvantages for Habitat Quality
	B/F	Up	N/F		
Existing conditions	3.9 (*)	3.8 (*)	13.9 (*)		Virtually no suitable SFGS upland habitat Little upland connectivity between HSP and LS
All Restoration Alternatives				Significant increase in uplands over existing conditions within LS and adjacent areas Increased CRLF breeding / SFGS foraging habitat in LS Adequate connectivity between HSP and LS Elimination of predatory fish Reduction of impacts of park visitors through fencing, signs	Golf operations would pose an ongoing potential threat to individual snakes, except under the No Golf Alternative
A18	10.7 (+6.8)	23.4 (+19.6)	10.0 (-3.9)	See above	SFGS foraging habitat on west and north sides of LS are adjacent to golf course
A9	10.7 (+6.8)	44.3 (+40.5)	10.1 (-3.8)	See above	Footpath through upland areas could result in pedestrian / pet impacts in habitat areas
No Golf	11.3 (+7.4)	97.4 (+93.6)	12.9 (-1.0)	See above, and Increased CRLF breeding / SFGS foraging habitat in LS, additional breeding ponds to mitigate potential future sea level rise Increased SFGS habitat east of Highway 1 Increased habitat by daylighting portions of Sanchez Creek	Footpath through upland areas could result in pedestrian / pet impacts in habitat areas
B/F = California red-legged frog breeding / San Francisco garter snake primary foraging habitat Up = San Francisco garter snake upland basking / retreat habitat N/F = California red-legged frog non-breeding / San Francisco garter snake secondary foraging habitat					

Of the three habitat types mentioned above, CRLF non-breeding and SFGS movement and secondary foraging habitat is considered the least valuable in this location. This is because the moisture and cover that characterize high quality non-breeding habitat also would be available year-round at Laguna Salada, Horse Stable Pond, and the canal. For this and many other frog populations the shallow water and emergent vegetation which characterize high quality breeding habitat effectively function as non-breeding habitat outside of the breeding season. Furthermore, while some frogs at the site are likely to move relatively long distances from their breeding habitat, most probably stay or make only short movements from the water bodies. At one breeding site in Santa Cruz County as many as 80-90% of CRLF were found to remain there year-round (Bulger et al. 2003) although this number is probably very site-specific. While maintaining non-breeding and movement habitat also is important to ensure the survival of local CRLF populations by protecting individuals prone to long distance dispersal (Fellers and Kleeman 2007) addressing the lack of core breeding habitat should be the first priority for CRLF habitat enhancement at Sharp Park. Therefore habitat creation at this site emphasizes providing breeding habitat where moisture and cover persist year-round, and replacing non-breeding habitat with habitat of this type is considered to be a positive tradeoff.

Likewise, while the SFGS may occasionally use typical CRLF non-breeding habitats including riparian forest (SBI 2008), its primary upland habitat consists of grassland or similar areas with some shrubs and underground retreats. Therefore, replacement of CRLF non-breeding and SFGS movement and secondary foraging habitat with upland basking and retreat habitat is considered to be a positive tradeoff for the SFGS as well.

It is also important to note that while the No Golf Alternative offers by far the greatest amount of SFGS upland basking and retreat habitat, much of the newly created upland habitat is located relatively far from the marsh complex. These areas are unlikely to be used as frequently as similar upland areas closer to water, and evidence from another site suggests that extensive upland areas would not be required to maintain a stable population of SFGS. As an example of this, the West-of-Bayshore parcel located in Millbrae, California supports a large population of SFGS despite upland habitat at that site being limited to a relatively narrow area directly adjacent to the canals and marshes. The average total width of the 180-acre parcel is only about 750 feet, and a significant proportion of the area (more than 44%) is covered by wetlands. Consequently, few upland areas at the site extend farther than 350 feet from the wetlands, and most upland areas are considerably closer. Despite the relatively small amount of available upland habitat at that site (about 100 acres of upland vs. 80 acres of wetlands), the SFGS population was estimated to consist of several hundred individuals, and appears to be similar to when it was first estimated in 1994 (SBI 2009).

Under the No-Golf Alternative upland habitats would be created up to 800 feet from the main wetland complex. Upland habitat restored under the No-Golf Alternative east of Highway 1 would be located even farther from the existing wetlands in an area where there have been several studies with a negative finding for SFGS, and barriers to dispersal mean that colonization by SFGS is not guaranteed. While SFGS may eventually use these areas, distant uplands are less likely to be used extensively by the SFGS when suitable habitat exists nearby highly productive wetlands. Therefore, alternatives that concentrate upland basking and retreat habitat near the marsh complex may offer a comparable amount of highly utilized upland habitat in critical areas as does the No Golf Alternative.

Each alternative, including those that retain golf at the park, would provide a several-fold increase in high quality upland habitat over the 3.8 acres currently available, and each would be sufficient to allow the SFGS to persist at the site (Table 3). Alternative A18 would result in 23.4-acres of upland habitat located mainly south and west of the lagoon. Under Alternative A9, 44.3 acres of upland habitat would be distributed mainly around the perimeter of the lagoon. Each of these also would provide uninterrupted areas for SFGS to make seasonal movements to and from high quality winter uplands that will be created between Horse Stable Pond and the lagoon and to the slopes at Mori Point to the south.

4.8 Construction Sequence and Timeline for Implementation

A phased approach to construction was assessed. Under a phased approach, the most pressing tasks would be completed first, with other tasks to follow as funding allowed. The most pressing tasks in this plan are to dredge or excavate to improve water flow and to complete the restoration of the wetland complex and uplands on the east side of the lagoon and between the lagoon and the pond. Restoration of upland areas beyond the areas immediately adjacent to the lagoon or in the dispersal corridor south of the lagoon are considered to be of less importance, and could be constructed at a later time.

A phased approach would likely present a significant increase in the overall budget for the project. There are at least three reasons for this. The first is that the cost of mobilizing and demobilizing equipment, construction crews, traffic control staff, and other staff and equipment is a significant part of the estimated project cost. This cost would only be incurred a single time if the entire project were constructed at once, whereas it would be incurred multiple times under a phased approach. Furthermore, the least cost construction scenario would include re-use of much of the excavated material, which would be of such quantity that it would be impossible to stockpile it for later use. Therefore, it would need to be reused at the same time that it was excavated. A phased approach would make this impossible, necessitating offsite disposal of all excavated materials. Finally, the estimated construction costs for the various alternatives are based on 2009 prices and prevailing wages, which will increase each year after 2009. Therefore, the estimated cost for the same project will be higher in 2010 than the price estimated for 2009.

Under a single phase approach, the wetland complex would be restored first. Numerous steps need to occur before this can happen. Once a preferred alternative has been selected from the conceptual plan, the alternative will go through 30%, 60%, 90% and final design. Each of these levels of design can take several months. Permit applications will likely be prepared at the 30% design level and submitted shortly thereafter. The process of acquiring Section 7, Section 404, and Section 401 permits can take up to a year. Once designs are completed and permits have been secured, a bid package will be sent to prospective contractors, who will submit bids, and the winning contractor will contract with SFRPD and any other project sponsors to construct the project. It is recommended that the project be constructed during the dry period and after the CRLF and SFGS breeding seasons are over. Assuming that the project is designed during the winter and spring of 2010 and permit applications are being reviewed during the spring and summer of 2010, it is likely that the earliest possible opportunity to construct the project would be in summer of 2011.

4.9 Cost Considerations and Estimated Project Budget

Restoration Cost Considerations

Preliminary cost estimates were developed for each Sharp Park restoration alternative using a unit cost-based approach. The unit cost values were based on recent cost quotations, standards for restoration projects, and recent, and/or location-specific bid sheets or unit cost analysis information. Unit cost values represent equipment, labor, materials, and contractor overhead and profit. These cost estimates are at a preliminary level (approximately a 10 percent design) and are intended to allow comparisons between alternatives. The costs do not account for phased construction (multiple mobilizations), and costs are in 2009 dollars. Summary cost estimates for each alternative appear in Tables 4 and 5.

Quantities were estimated from areas shown on the GIS figures, topographic/bathymetric data generated in and around the wetlands complex, and assumed averaged dimensions (e.g., depths of excavation or fill). Site preparation is represented as a percentage of direct constructions costs. It includes mobilization and demobilization, dewatering and/or diversion, erosion control and BMPs, traffic control, utilities, and general demolition of minor obstructions not accounted for in the major cost item costs. The total site preparation percentage was 17%, as shown on the unit cost breakdown table.

General markups are estimated as a percentage of direct construction cost plus site preparation costs. General markups include a contingency to account for uncertainties in design, topography and other site conditions. Markups also include costs of the design phase of the project and construction management. These markups total 50% as shown in the unit cost table. Real estate acquisition costs are assumed to be zero since all restoration activities occur on existing golf course property.

Operation and maintenance costs are represented as a net present value (NPV) over a 50-year assumed project life. These costs include maintenance of vegetation during the first five years, invasive species maintenance every year for the first five years and as needed after five years, pump maintenance at the Horse Stable Pond pumphouse every other year, wetlands maintenance at years 25 and 50, sedimentation basin maintenance every five years, and culvert maintenance at years 25 and 50. These costs are detailed in the operations and maintenance summary table.

An important cost component of each alternative is the cost to dispose of excess excavation or fill that cannot be reused onsite. For this estimate it was assumed that excavation for haul-away would be disposed in Half Moon Bay, California, at the Ox Mountain Landfill Facility. There is a transfer station located in Pacifica; however, the unit cost to dispose at this location is much higher because it requires rehandling before final disposal at a landfill. The total unit cost of $35 per cubic yard for this line item assumes the following:

- nominal cost of $4 per cubic yard for excavation and loading into 26 cubic yard semi end-dumps,
- semi end-dump haul rate of $130 per hour,
- total one-way distance of 20 miles (combined highway and surface street) between Sharp Park Golf Course and Ox Mountain Landfill,
- disposal fee of $23 per cubic yard including escalation and contractor mark-up per July 2009 quotation from Ox Mountain (operated by Republic Services, Inc.).

In general, alternative project costs are driven by earthwork line items such as excavation and grading. Removing, on average, the top 1.5 feet of sod and topsoil off the fairways to ensure that kikuyu is eradicated is one of the most expensive features of this plan, and dredging/placing organic and mineral sediments from the wetland complex is the other most expensive feature. With variations depending on the type and location of excavation, generally the costs are based on the amount of surface area moved. Because the No Golf Alternative proposes to have the greatest area of fairway excavated, it would have the greatest volume excavated (approximately 303,000 cy) whereas Alternative A18 has the least amount of fairway excavated and therefore the least volume of excavated materials (approximately 126,000 cy).

Materials deemed suitable for reuse as golf course substrate are those with low organic content and high sand/silt content. It was assumed that approximately 50% of excavated material was suitable for reuse as golf course substrate onsite. Under the off-site disposal scenario, the remaining fill requires haul-away and landfill disposal. Under this assumption the cost of hauling and disposing off-site of unsuitable fill is ~$10.0M for the No Golf Alternative and between ~$3.8M and $5.5M for Alternatives A18 and A9. If all excavated fill is reused onsite the cost of this task is reduced for each alternative by up to 56%. Further design stages should verify assumptions made in estimating cut and fill quantities and lagoon water surface elevations, as well as the estimated excavation and grading unit costs.

Another element that differentiates the alternatives is the amount of planned riparian and coastal scrub/shrub restoration. The No Golf Alternative requires the greatest amount of riparian and coastal scrub/shrub restoration due to the removal of the golf greens, totaling 94 acres, which is over double the amount of the other three alternatives. Additionally, the No Golf Alternative requires importing nearly three times as much topsoil fill than the other alternatives.

Revegetation costs include mulch/topsoil as needed. Earthwork costs assume no contaminated material. If contaminated materials are encountered, additional costs will be incurred for treatment and/or transport to an appropriate disposal facility.

A final element that differs among alternative designs is the demolition and reconstruction of the golf cart path. Under the No Golf Alternative the entire cart path would be demolished and reconstructed for recreational use. Under Alternative A9, only 20% of the cart path would be demolished and reconstructed. Alternative A18 does not require any work on the cart path and therefore does not incur a cost for this action.

Under all action alternatives, some of the construction, revegetation, monitoring, and maintenance tasks could be performed by SFRPD staff, volunteers, interns, and students. SFRPD staff operate medium-duty equipment such as backhoes and dump trucks, and could perform tasks such as daylighting Sanchez Creek, excavating and maintaining sediment basins, and maintaining the connecting channel. SFRPD also has biological and natural resources management staff that can prepare and implement revegetation and invasive species control plans, monitor egg masses, CRLF populations, and vegetative conditions, and organize interns or volunteers to control invasive species or perform revegetation or other maintenance tasks. The Natural Areas Program also maintains close ties with area colleges, and can likely enlist the assistance of graduate students who could perform thesis work by monitoring vegetative succession, wildlife populations, sedimentation, or other aspects of the post-restoration process that need to be observed, recorded, and assessed in order to determine the success of the project and apply adaptive management as needed.

GOLF COURSE REALIGNMENT COST CONSIDERATIONS

Preliminary cost estimates were developed for each of the Sharp Park Golf Course Alternatives. For a majority of the estimates a unit cost-based approach was used. The unit cost values were based on recent cost quotations, and recent local actual costs analysis information. Unit cost values represent equipment, labor, materials, and contractor overhead and profit. The costs assume all work for each phase will occur at the same time and not result in multiple mobilizations.

These estimates include work that is necessary for the proposed conceptual changes addressed in each alternative. Other course improvements such as bunkers, irrigation, drainage etc. that may need to be implemented are not included in the concepts or cost estimate.

The work addressed and quantities were estimated based on the layout of each alternative. The size of greens, tees, bunkers, irrigation, grading, drainage, grassing, cart path and landscaping are based on the conceptual layout and accepted parameters for golf holes. The work includes greens constructed to USGA recommendations, sand based tees and bunkers built to minimize maintenance. Soil amendment and additional drainage is proposed in newly constructed areas to assist in turf quality and playability.

The alternative project costs were driven by the size of the area being newly constructed or reconstructed and the size and number of golf course features. The construction areas would utilize suitable fill material generated by the habitat restoration process. The cost of moving the material is included in the restoration estimates. The cost to grade the soil into golf course features is included in the golf course estimate.

Both alternatives suggest creating new golf on the east side of the existing golf course and include removal of existing mature vegetation, mostly eucalyptus trees. The costs include hauling away the trees. One alternative provides for the realignment of the archery club access road to allow the construction of a new green.

The inclusion of netting for a driving range is a major component of the nine hole project cost. The costs were based on a generalized netting layout to protect the parking lot and the adjacent golf hole.

ESTIMATED COSTS

Estimated costs reported here include site preparation, construction, and general markups but do not include long-term operations and maintenance. An estimated cost schedule, including maintenance costs, is given in Appendix D.

Table 4. Construction Costs – Offsite Disposal

	NO GOLF	A18	A9
Site Preparation	$2,789,875	$1,056,040	$1,549,454
Restoration Construction	$12,753,248	$4,872,183	$7,114,973
Golf Hole Construction	n/a	$1,612,755	$1,711,750
General Markups	$7,771,561	$3,770,489	$5,188,089
Total	**$ 23,314,684**	**$ 11,311,467**	**$15,564,266**

Table 5. Construction Costs – Excavated Materials Reused Onsite

	NO GOLF	A18	A9
Site Preparation	$858,361	$330,772	$498,867
Restoration Construction	$5,121,184	$2,017,719	$3,006,509
Golf Hole Construction	n/a	$1,612,755	$1,711,750
General Markups	$2,989,773	$1,980,623	$2,608,563
Total	**$ 8,969,318**	**$ 5,941,869**	**$ 7,825,689**

4.10 Regulatory Process

Many of the resources found in the wetlands complex and surrounding areas are protected under one or more state or federal regulations. These regulations are enforced by agencies including the USFWS, US Army Corps of Engineers (USACE), CDFG, and the Regional Water Quality Control Board (RWQCB). Table 6 describes the permits that may be needed for this project and the conditions under which they would be required. Permit applications are generally prepared after the 30% designs for the project have been completed.

This project will require significant consultation with the USACE and RWQCB. As the federal agency charged with enforcement of Section 404 of the Clean Water Act, USACE may permit this project under a Nationwide Permit (NWP) that allows fill of wetlands for restoration projects that result in greater amounts of restored wetlands, or under an Individual Permit. Under this or separate permit, USACE may also comment on the proposed reuse of dredged materials for restoration, as proposed under all alternatives. A Section 401 Water Quality Certification will be requested from RWQCB for impacts to wetlands, habitat, and water quality. Likely concerns during this process involve water quality effects that may arise during draining of the wetlands complex prior to construction, as well as the fate of decant water resulting from placement of dredge spoils in upland locations.

In addition to wetlands regulation, the main regulatory programs guiding this plan are the Federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA), as well as the California provisions for fully-protected species. Although the City of San Francisco is carrying out the restoration of the wetland complex on a voluntary basis, as the owner of Sharp Park, the City must still comply with these regulatory programs in carrying out the alternatives set forth in this plan. Under the ESA, implementation of the plan may require consultation or permitting from the USFWS. Under CESA, implementation of the plan may require consultation or permitting from the CDFG

Table 6. State and Federal Permits That May Be Required for Plan Implementation

Agency	Permit/Approval	Required for
Federal Agencies		
USFWS/NMFS	Incidental Take Permit, Biological Opinion	Federal projects that may affect species listed as endangered, threatened, or proposed under the federal Endangered Species Act (16 USC 1531-1544)
USACE/EPA	Individual /Nationwide Section 404 Permit	Discharge of Dredge/fill into Waters of the U.S., including wetlands
	Section 10 Permit	Construction in navigable waters (may not apply to this project)
State Agencies		
California Coastal Commission	Coastal Zone Consistency Determination	Land development within the coastal zone including grading, removing, placement, and extraction of any earth material; and harvesting of major vegetation
CDFG	Section 2080 Permit (Endangered Species Management)	Activity where a species listed as candidate, threatened, or endangered under the California Endangered Species Act may be present in the project area and state agency is acting as lead agency for CEQA compliance
	Section 2081 Incidental Take Permit	Needed if it is determined through the Section 2080 Permit process that the proposed project may result in take of a state-listed species
	Lake/Streambed Alteration Agreement (California Fish and Game Code 1602)	Change in natural state of a river, stream, lake (includes road or land construction across a natural streambed)
State Water Resources Control Board	Construction Activities Storm Water General Permit	Stormwater discharges associated with construction
Regional Water Quality Control Board	Waste Discharge Requirements (Water Code 13000 et seq.)	Discharge of waste that might affect groundwater or surface water (nonpoint source) quality
	401 Certification (Clean Water Act, 33 USC 1341; required if the project needs a USACE Section 404 Permit)	Discharge into Waters of the US, including wetlands
State Historic Preservation Office	Section 106 (National Historic Preservation Act, PL 89-665, 16 U.S.C. 470 et seq.)	Projects that may impact a historic property within the area of potential effect.

Specific measures to avoid potential adverse effects on the CRLF and the SFGS during enhancement activities would be developed in consultation with the USFWS and CDFG. The following general measures provide guidelines for implementation of the conceptual restoration enhancement plan:

- Prior to any ground-disturbing activity, a qualified biologist should provide environmental awareness training for all workers who will be on site. The training should include a brief overview of the ESA, a description of the CRLF and SFGS, what steps should be taken to avoid impacts to their habitats, and what to do if an individual frog or snake is found.
- A temporary exclusion fence should be installed to prevent listed species from entering the work area. The placement of the fence would be directed by a qualified biologist in consultation with the USFWS and CDFG.
- Following installation of the exclusion fence and at least 6 weeks prior to construction, a trapping program will be conducted to remove all listed species from the area to be impacted.
- A qualified biologist should monitor all work activities on site. The monitor would verify that exclusion fence, erosion control measures and any other environmental protection measures are properly installed.
- Work should be confined to the smallest area possible to safely complete the project. Workers should be instructed to stay within the work corridor and limits should be clearly marked.
- Vehicle refueling and maintenance should be conducted a minimum of 150 feet from aquatic habitats and other sensitive areas identified by a qualified biologist.
- Construction activities should be done during the dry season (June 1 through October 15).
- If a CRLF or SFGS is found inside a work area a USFWS and CDFG-authorized biologist should relocate it out of harms way.

5. CONCLUSIONS

With no action, the future of SFGS at Sharp Park is, at best, uncertain. Although historically SFGS have existed at Sharp Park while it functioned as a golf course, conditions of the wetlands and adjacent uplands are far less favorable than in the past. During the past several decades sedimentation of the lagoon and flooding of the surrounding uplands has reduced available habitat. Saline overwash from Pacific storms in the early 1980s probably caused a sharp reduction in both the SFGS population and its prey base. The current population is more a reflection of these historic events than of direct impacts from the golf course, although substantial conflicts do exist, particularly with regard to upland habitat. Mori Point provides nearly all suitable upland habitat used by snakes at Sharp Park, and snakes traveling from these areas to the relatively poor foraging habitat at Laguna Salada face significant hazards. Although these hazards are being addressed and reduced through measures described in the compliance plan, some potential for harm to SFGS from golf operations will always exist. At a minimum the SFGS requires more upland habitat between Horse Stable Pond and Laguna Salada, and would also benefit from having more high quality CRLF breeding habitat in the lagoon.

Though beneficial, due to the limited availability of upland habitat in Sharp Park, increasing the distribution and carrying capacity of the SFGS will not be accomplished by increasing CRLF breeding habitat alone. Increasing SFGS use of the area north of Horse Stable Pond, the areas adjacent to Laguna Salada, and the connecting channel will require maintaining undisturbed upland habitat in these areas. These enhancements can be accomplished without significant changes to the golf course design or to the movement of golfers on the course.

All four conceptual alternatives would accomplish the main goals of restoring, increasing, and diversifying SFGS and CRLF habitat, and meeting the recommendations of the SFGS recovery plan. Under all alternatives, this would be accomplished by:

- Dredging and recontouring the wetlands complex to remove overgrown wetland vegetation, create a mix of shallow water habitat and open water areas, and increase water flow through the wetlands;
- Closing Hole 12 and shortening or narrowing other holes to allow for an SFGS dispersal corridor and upland retreat/basking areas on the east edge of the lagoon, on a peninsula in the center of the lagoon, between the lagoon and the pond, and around the pond;
- Removing non-native Monterey cypress trees to reduce shading in SFGS and CRLF habitat and to reduce perching and spotting locations for predatory birds;
- Installing fencing to restrict intrusions into sensitive habitat and interpretive signs to educate visitors about sensitive wildlife; and
- Developing a water control plan that will alleviate the potential for egg mass and tadpole stranding.

The main differences between the various alternatives are the degree of upland habitat that would be created east of the wetlands complex, the costs to implement the respective alternatives, and the tradeoff between the amount of habitat and the degree to which golf opportunities are lost. Implementing Alternative A18 (with excavation re-use) would be the least costly alternative, would result in the least impact to golf, and would restore the least amount of restored upland habitat for the SFGS. Implementing the No Golf Alternative (with excavation re-use) would have higher costs, would result in the greatest impact to golf, and would restore the greatest amount of upland habitat. Alternative A9 would fall in the middle of the No Golf Alternative and Alternative A18 in terms of cost and amount of restored upland habitat. However, because the best upland habitat for the SFGS is that which is found near water bodies, much of the upland habitat restored east of the wetlands complex under the No Golf Alternative would be of lower value than that located immediately adjacent to the wetlands complex. Therefore, from a habitat restoration standpoint, converting uplands immediately adjacent to the wetland areas would result in the greatest net benefit to the SFGS per acre of enhanced habitat. Focusing restoration efforts on these areas also would result in the least amount of lost golf opportunities since more distant habitat would remain available for golf. While the No Golf Alternative would result in a greater total amount of upland SFGS habitat, the value of the habitat gained through this alternative would diminish with increasing distance from the wetland complex. Furthermore, because of the close proximity of major urban centers including housing, freeways, major roads, and businesses and the intrinsic threats posed by them to the snake, restoring uplands and locating additional wetlands further to the east would potentially increase the chance of take of this species by drawing the SFGS away from the relatively protected existing wetlands complex into areas that would likely be extensively used by hikers, mountain bikers, and dog walkers.

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