2.5 Environmentally Preferred Alternative

The CEQ Regulations implementing NEPA and the NPS NEPA guidelines require that "the alternative or alternatives which were considered to be environmentally preferable" be identified (Council on Environmental Quality Regulations, Section 1505.2). Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative that best protects, preserves, and enhances historic, cultural, and natural resources. The Council on Environmental Quality defines the environmentally preferred alternative as "…the alternative that will promote the national environmental policy as expressed in the National Environmental Policy Act's §101." Section 101 of the National Environmental Policy Act states that "… it is the continuing responsibility of the Federal Government to … (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; (2) assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings; (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences; (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice; (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and (6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The National Park Service has determined that Alternative 1 is the environmentally preferred alternative for this project. Alternative 1, compared to No Action, will bring major benefits in natural creek and floodplain function and in both winter and summer habitat for the resident federally listed salmonid species, thereby preserving and enhancing important natural aspects of our national heritage, as described in NEPA Section 101. Actions will reduce sediment delivery to the creek and provide new areas for sediment deposition, which will contribute to the long-term function of the creek downstream, where separate actions are proposed by NPS and Marin County in the Wetland and Creek Restoration at Big Lagoon, Muir Beach. New floodplain storage on the Old Ballfield will contribute to improved flood conditions for downstream structures, and the higher setback levee will reduce flooding on Highway 1 during large events. Actions will be hydrologically sustainable, requiring little to no future maintenance.

2.6 Mitigations and Best Management Practices

Appendix D contains Best Management Practices that will guide project implementation and a Mitigation Table that summarizes mitigations in the EA.

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

The National Environmental Policy Act (NEPA) requires that environmental documents disclose the environmental impacts of a proposed federal action, reasonable alternatives to that action, and any adverse environmental effects that cannot be avoided should the proposed action be implemented. NEPA requires consideration of context, intensity, and duration of impacts, indirect impacts, cumulative impacts, and measures to mitigate impacts. NPS policy also requires that "impairment" of resources be evaluated in all environmental documents.

Under the Endangered Species Act of 1973, the likelihood of a project to "adversely affect" federally protected species must be evaluated.

3.2 General Methodology

One of the reasons environmental assessments are prepared is to determine whether the potential for significant impact exists. Significance is analyzed by considering the context, duration, and intensity of impacts.

As such, each resource type (Watershed Processes, Geology and Soils, Biological Resources, Cultural Resources, Land Use, Visual Resources, Visitor Use and Recreation, Noise, Human Health, and Traffic) is described under "affected environment". Adverse, beneficial, and cumulative impacts are then analyzed for each alternative. Potential impacts are described in terms of context, duration, intensity, type, and impairment as described below. Finally, a conclusion is drawn for the impact analysis that each alternative is expected to have on each resource type and whether the proposed project is expected to result in impairment to park resources.

Duration

The duration of the impact considers whether the impact would occur in the short-term or the long-term. ***Short-term*** impacts are temporary, transitional, or construction-related impacts associated with project activities. ***Long-term*** impacts are typically those effects that would last several years or more or would be permanent.

Context

The context of the impact considers whether the impact would be ***local*** or ***regional***. For the purposes of this analysis, local impacts would generally be those that occur within the immediate vicinity of the proposed project areas. Regional impacts would occur on surrounding lands and/or in adjacent communities.

Intensity

The intensity of the impact considers whether the effect would be ***negligible, minor, moderate***, or ***major***. Negligible impacts would not be detectable and would have no discernible effect. Minor impacts would be slightly detectable, but would not be expected to have an overall effect.

Moderate impacts would be clearly detectable and could have an appreciable effect. Major impacts would have a substantial, highly noticeable effect.

Type of Impact
Impacts were evaluated in terms of whether they would be ***beneficial*** or ***adverse***. Beneficial impacts would improve resource conditions. Adverse impacts would deplete or negatively alter resources.

Impacts were also evaluated in terms of whether they would be ***direct*** or ***indirect***. Direct impacts would be caused by an action and occurs at the same time and place. Indirect impacts are effects that are later in time or rather removed in distance, but still reasonable foreseeable.

Federally Listed Species
The Endangered Species Act (ESA) defines the terminology used to assess impacts to listed species. Because this EA also doubles as a Biological Assessment (BA) to initiate formal consultation with NOAA Fisheries Service under section 7 of ESA, the following ESA terminology will be used to describe impacts to the federally endangered coho salmon and the federally threatened steelhead.

- ***No effect:*** When a proposed action would not affect a listed species or designated critical habitat.
- ***May affect/is not likely to adversely affect:*** Effects on special status species are discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or are completely beneficial.
- ***May affect /is likely to adversely affect:*** When an adverse effect to a listed species may occur as a direct or indirect result of proposed actions and the effect either is not discountable or is completely beneficial.

Cultural Resources Analyses
The assessment of impacts on cultural resources and historic properties was made in accordance with regulations of the Advisory Council on Historic Preservation (36 CFR 800) implementing Section 106 of the National Historic Preservation Act. Following a determination of the area of potential effect, cultural resources were identified within these areas that are either listed in, or eligible for listing in, the National Register of Historic Places.

An assessment was made of the nature and extent of effects on cultural resources anticipated from implementing proposed undertakings. Cultural resources can be affected by actions that alter in any way the attributes that qualify the resources for inclusion in the National Register. Adverse effects can result when the integrity of a resource's significant characteristics is diminished. Consideration was given both to the effects anticipated at the same time and place of the undertaking, and to those potentially occurring indirectly at a later time and distance.

To provide consistency with requirements of the NEPA, the effects on cultural resources are also described in terminology intended to convey the duration, intensity, and beneficial or adverse nature of potential impacts. Impacts could be of short term, long term, or permanent duration. (Analysis of the duration of impacts is required under the NEPA; however, duration is not

required and is not usually considered in assessing effects in terms of the National Historic Preservation Act.) The intensity of impacts is defined as follows:

Negligible, when the impact is barely perceptible and not measurable. The undertaking does not appreciably diminish significant character-defining attributes of historic properties (including the informational potential of archaeological resources).

Minor, when the impact is perceptible and measurable. The effects remain localized and confined to a single element contributing to the significance of a larger National Register property/district, or archaeological site(s) with low to moderate data potential;

Moderate, when the impact is sufficient to alter the character-defining features of historic properties, generally involving a single or small group of contributing elements, or archaeological site(s) with moderate to high data potential; or

Major, when the impact results in a substantial and highly noticeable change in character-defining features of historic properties, generally involving a large group of contributing elements and/or individually significant property, or archaeological site(s) with high to exceptional data potential.

Cumulative Impacts

The Council on Environmental Quality (CEQ) regulations for implementing NEPA requires the assessment of cumulative impacts in the decision-making process for federal actions. A cumulative impact is described in the Council on Environmental Quality, Regulation 1508.7, as follows:

> *A "cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

Cumulative impacts are considered for both the Action Alternative and the No Action Alternative. Cumulative impacts were determined by combining the effects of the alternative with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other past, ongoing, or reasonably foreseeable future actions within the vicinity of the project site, which includes downstream reaches of Redwood Creek at Muir Beach, the adjacent watershed lands owned by California State Parks, a small parcel owned by the Muir Beach Community Services District, and upstream reaches of Redwood Creek under the management of both the National Park Service and Mount Tamalpais State Park. Cumulative impacts are then evaluated by resource for each impact topic addressed in this chapter. Projects identified for consideration in evaluation of cumulative impacts are listed below. Figure 5 contains a map with locations of projects included in the cumulative analysis.

<u>Wetland and Creek Restoration at Big Lagoon, Muir Beach</u>

NPS and the Marin County Community Development Agency are proposing actions for restoration and public access on 38 acres of coastal wetlands at the mouth of Redwood Creek at Muir Beach. The goal of this project is to restore a functional, self-sustaining ecosystem,

including wetland, riparian and aquatic components. A Draft EIS/EIR, released for public review in December 2006, proposes actions to realign 2,500 linear feet of channel to a natural topographic location, remove a levee confining the channel, reconfigure the visitor parking lot to reduce hydraulic impacts while retaining the same parking capacity, and build a new 150-foot-long Pacific Way bridge that will span both the creek and the floodplain. The project will recreate habitat for sustainable populations of special status species, including federally listed salmonids and the California red-legged frog, reduce flooding on Pacific Way, and provide a compatible visitor experience. This project also proposes to place vegetative material removed during construction on the Upper Field of the Banducci Site for composting.

Muir Beach Community Services District Well Water Treatment Shed

The Muir Beach Community Services District (MBCSD), which owns a small parcel adjacent to the project site, currently conducts water treatment in a small shed on the left bank of Redwood Creek (when facing downstream) and proposes to relocate the storage shed about 200 feet away from the creek onto NPS land. MBCSD has proposed this action to protect the water quality of Redwood Creek from potential spills of water treatment chemicals. The MBCSD operates a groundwater well about 80 feet from Redwood Creek to provide potable water to residents of Muir Beach. The MBCSD operates its well under a California state water right that limits water production during the dry season and has specific conditions to avoid drying out the surface water in the creek.

Creation of Pond for California Red-Legged Frogs at the Banducci Site

As part of a separate project, NPS will construct a 1.2-acre pond on the lower field at the Banducci Site. The pond will be sustained by groundwater and will provide the essential emergent vegetation habitat that is necessary for California red-legged frog breeding. The pond will be constructed in 2007. About 3,853 cubic yards of soil will be excavated for the pond. This material will be reused for the beneficial uses identified in this EA, including reconstruction of the alluvial fan in the Upper Field and construction of a 1.5-foot-high berm around the edge of the pond to reduce sedimentation from overbank flows. Those actions are discussed in Section 3.6.1.

Dias Ridge and Lower Coast View Trails Rehabilitation and Access Improvement Project

The California Department of Parks and Recreation and NPS are proposing a trail realignment of both the Dias Ridge Trail, south of the project area, and the Lower Coast View Trail. This project has been through public scoping, and an Environmental Assessment/Initial Study is being prepared for public review in 2007. The Coast View Trail on Mount Tamalpais, just north of the project vicinity for this project, was realigned by California State Parks in 2004 along the ridge west of and uphill from the project area, thereby erasing a scar from a pre-existing ranch road that had not been constructed according to the contours of the land. However, the Coast View Trail does not have a connection to Muir Beach and terminates on Highway 1 north of Muir Beach. Three alternatives for new trail connections are being evaluated for the Lower Coast View Trail to route visitors from the ridge to the lower watershed and ultimately to Muir Beach, entailing construction of approximately 5,300 to 6,300 lineal feet of new trail that would be constructed in the vicinity of this restoration project. Two alternatives would route a new trail from the Coast View Trail on the ridge of Mount Tamalpais, down the slopes on the southern end of NPS lands on the Banducci Site and then connecting to Muir Woods Road. These trail

alternatives cross the access road at the Banducci Site and Redwood Creek near Highway 1. The new trail alignment would then occupy the top of the new setback levee proposed as part of this project to connect to the Redwood Creek Trail on the east side of Muir Woods Road. This alignment would allow hikers and bikers to avoid the stretch of Highway 1 north of Muir Woods Road. It would also create a trail alignment extending from the coastal ridges to Muir Beach, linking with a separate connection from Muir Beach up Dias Ridge to Panoramic Highway.

GGNRA Southern Marin Equestrian Plan

As part of a planning process on the future equestrian operations on GGNRA lands in southern Marin County, GGNRA is considering the Upper Field of the Banducci site as a possible future location for equestrian facilities either in addition to or in place of existing equestrian operations currently located at the Golden Gate Dairy, an NPS facility on Highway 1 across the road from the Pelican Inn. If equestrian facilities were located at the Banducci site, they could include horse stalls, riding arenas, and paddocks as well as facilities for users such as offices, parking areas, trails and other typical equestrian facilities. This project has been through public scoping in 2006, and an Environmental Analysis for alternatives will be prepared separately by NPS as part of the Southern Marin Equestrian Plan.

Floodplain and Salmonid Habitat Restoration on Lower Redwood Creek at the Banducci Site, 2003

Similar actions to those proposed in this EA were implemented at the project site in 2003 (Figures 2 and 3). NPS, working with the Golden Gate National Parks Conservancy, removed berms along approximately 1,800 linear feet of the middle reach of Redwood Creek through the site to reconnect the creek with about 6 to 10 acres of its historic floodplain. That floodplain, also referred to as the Lower Field, is the subject of additional actions proposed in this EA. NPS also installed 6 Engineered Log Jams to increase complexity in the highly channelized middle reach to enhance summer and winter rearing conditions for the federally listed salmonids. The width of a narrow riparian corridor was expanded from a single row of trees to a minimum width of 80 feet. Finally, a vertical, eroding 300-foot-long stretch of creek bank at a sharp bend at the upstream end of the middle reach was graded to a 3:1 slope, planted with a dense willow mattress, and reinforced with Engineered Log Jams that would also provide habitat structure. This bend is the downstream end of the Upper Alley, where actions in this EA are proposed. All of the actions conducted in 2003 were designed by PWA (2002), based on the feasibility analysis that is also the foundation for actions proposed in this EA (PWA 2000). The 2003 project actions have functioned successfully to meet project goals in the short run and have provided a basis for considering additional actions in this project. Geomorphologist Tim Abbe, of Herrara Associates in Seattle, designed the log jams for both the 2003 project and for this project.

Ongoing Use and Management of Adjacent Lands

Mount Tamalpais State Park land borders the project area to the north. A row of Monterey cypress trees marks the approximate boundary, but the trees are entirely on NPS lands. An open field known as Santos Meadows on State Park land lies to the north; it is typically mowed during summer months and is periodically used for special recreational events under permit from State Parks. A riding ring for horse use occurs on the State Park land, and the nearby Heather Horse Camp, also on State Park land, provides facilities for overnight camping by equestrians and other visitors.

The MBCSD parcel includes picnic tables and cooking grills as well as a stage on adjacent property owned by Mount Tamalpais State Park. This area is the site of parking and a barbecue for a well-attended annual Memorial Day event to raise funds for the Muir Beach Volunteer Fire Department.

Residents occupy three households on NPS lands at the Banducci site under a volunteer agreement with the NPS. Residential use is limited to the immediate areas around the homes and the access road.

Impairment Analysis

In addition to determining the environmental consequences of the alternatives, NPS Management Policies 2006 requires the analysis of potential effects to determine if actions would impair park resources. Under the NPS Organic Act and the General Authorities Act, as amended, the NPS may not allow the impairment of park resources and values except as authorized specifically by Congress.

Impairment is an impact that would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. An impact would be more likely to constitute an impairment to the extent that it 1) affects a resource or value whose conservation is necessary to fulfill specific purposes identified in the enabling legislation or proclamation of the park; 2) is key to the cultural or natural integrity of the park or to opportunities for enjoyment of the park; 3) or as identified as a goal in the park's general management plan or other relevant NPS planning document. An impact would be less likely to constitute an impairment to the extent that it is an unavoidable result, which cannot be reasonably further mitigated, of an action necessary to preserve or restore the integrity of park resources or values.

Impairment of park resources and values was evaluated on the basis of duration and intensity of impacts. In this document, impairment is addressed for each impact topic under each alternative.

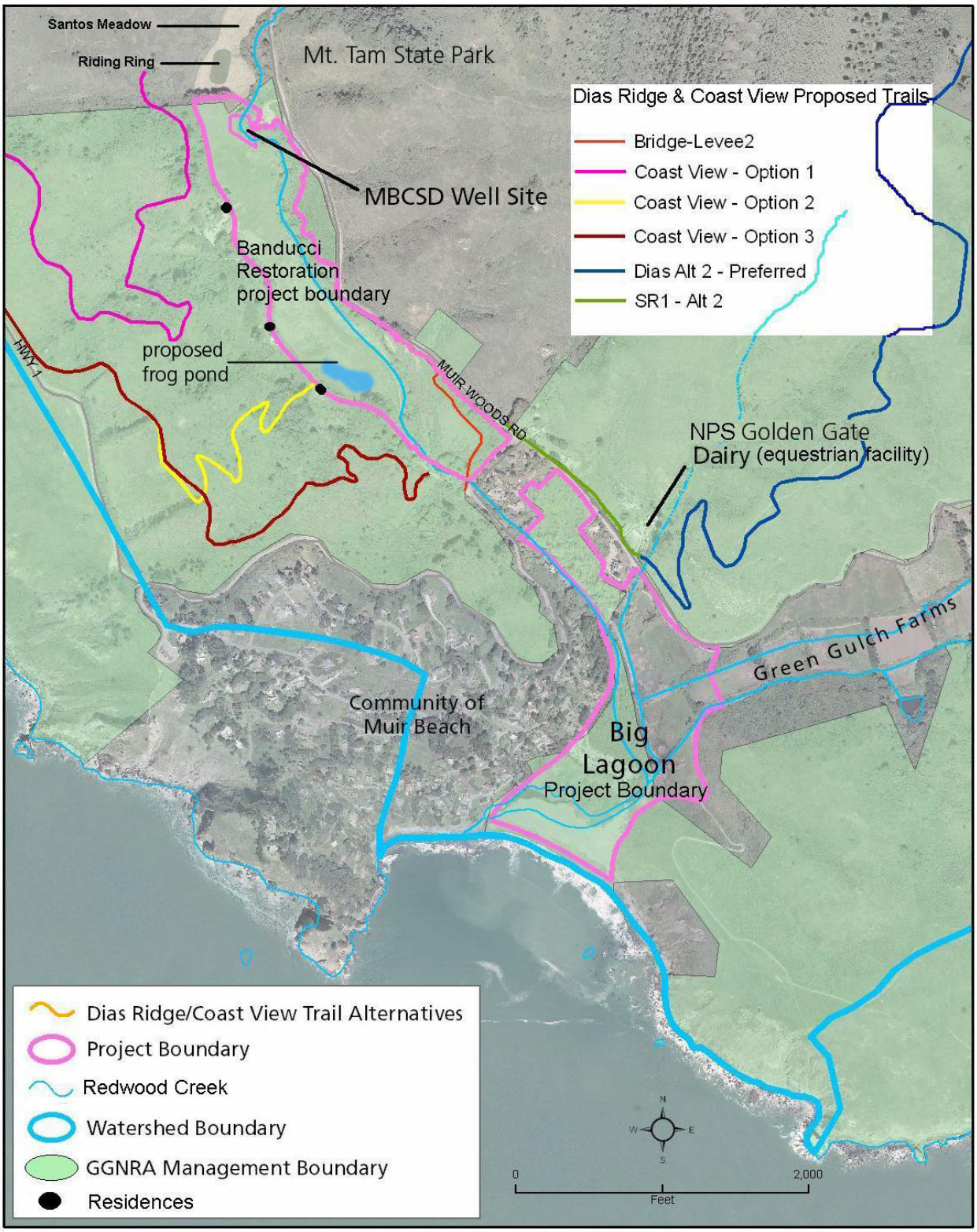
NPS does not make impairment determinations for topics such as transportation, visitor experience, or park operations and facilities unless the impact is resource-based. Impairment relates to park values and purpose. Pursuant to the 1916 Organic Act, one cannot impair visitor enjoyment or park operations in the same way park resources or values could be impaired.

3.3 Regulatory Background

Soils and Geology

NPS Management Policies 2006 *state, "The Park Service will preserve and protect geologic resources as integral components of park natural systems. As used here, the term "geologic resources" includes both geologic features and geologic processes. The Service will (1) assess the impacts of natural processes and human- related events on geologic resources; (2) maintain and restore the integrity of existing geologic resources; (3) integrate geologic resource management into Service operations and planning; and (4) interpret geologic resources for park visitors."*

FIGURE 5. LOCATION OF PROJECTS CONSIDERED IN CUMULATIVE IMPACT ANALYSIS



Hydrology, Water Quality, Wetlands, and Streams

Section 404 of the Clean Water Act prohibits the discharge of dredged or fill material into "waters of the United States" without a permit from the U.S. Army Corps of Engineers (USACE). Waters of the United States are broadly defined in USACE regulations (33 CFR 328) to include navigable waterways, their tributaries, and adjacent wetlands. The definition of waters of the United States includes wetland areas "that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3 7b).

The California Regional Water Quality Board (RWQCB) and the U.S. Environmental Protection Agency (EPA) set water quality standards that are ecologically protective of aquatic systems (RWQCB, 1995; EPA, 2000) and regulate *Section 401 of the Clean Water Act.* Water Quality Certification or a waiver from the RWQCB is required before a Section 404 permit becomes valid. The RWQCB also reviews projects for consistency with Waste Discharge Requirements under the state land disposal regulations.

Executive Order No. 11990, Protection of Wetlands and *Director's Order 77-1, Wetland Protection,* mandates the NPS to avoid to the extent possible the long and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. The Executive Order, Section 1(a), established a policy of "no net loss" of wetlands.

Executive Order 11988, "Floodplain Management" (May 28, 1980) and Director's Order 77-2, Floodplain Management, mandate NPS to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative." The order requires Federal agencies to reduce the risk of flood loss, minimize the impacts of floods on human safety, and restore and preserve the natural and beneficial values served by floodplains. Director's Order 77-2 states that NPS will "restore, when practicable, natural floodplain values affected by land use activities within floodplains."

Vegetation, Wildlife, and Special Status Species

Executive Order 13112, Invasive Species prevents the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. Section 2.a.2 states that federal agencies shall "(i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them."

The Coastal Zone Management Act states that (a) environmentally sensitive habitat areas shall be protected against any substantial disruption of habitat values, and only uses dependent on those

resources shall be allowed within those areas, and (b) development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would substantially degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.

The Act states that all public agencies and all federal agencies, to the extent possible under federal law or regulations or the United States Constitution, shall comply with the provisions of this Act. The California Coastal Commission regulates land uses within the Coastal Zone and issues permits for proposed changes in land use and/or development activities.

The *Federal Endangered Species Act of 1973* and Title 16 (implementing regulations) of the United States Code of Regulations (CFR) 17.1 et seq., designate and provide for protection of threatened and endangered plants and animals and their critical habitat. A Section 7 Consultation (Interagency Consultation) involves projects with a federal connection or requirement; typically these are projects where a federal lead agency (i.e. NPS) is sponsoring or permitting the Proposed Project. In these instances, the federal lead agency initiates and coordinates the following steps: 1) Informal consultation with USFWS and NOAA Fisheries Service to establish a list of target species; 2) Preparation of a biological assessment assessing potential for the project to adversely affect listed species' 3) Coordination and possible formal consultation between Federal biological resource agencies to assess impacts/proposed mitigation; and 4) Development of appropriate mitigation for all substantial impacts on federally listed species.

The USFWS and NOAA Fisheries Service ultimately issue a final Biological Opinion on whether the project would affect the federally listed species. A Section 10(a) Endangered Species Incidental Take Permit may be necessary when the "taking" or harming of a species is incidental to the lawful operation of a project.

The *Federal Migratory Bird Treaty Act* (MBTA) (16 U.S.C., Sec. 703, Supp. I, 1989) prohibits killing, possessing, or trading in migratory birds, except in accordance with regulations prescribed by the Secretary of the Interior. This act encompasses whole birds, parts of birds, and bird nests and eggs. Migratory birds include geese, ducks, shorebirds, raptors, songbirds and many others. The Migratory Bird Executive Order of January 11, 2001 directs executive departments and agencies to take certain actions to further implement the MBTA, and defines their responsibilities of each federal agency taking actions that have, or are likely to make, a measurable affect on migratory bird populations. All project actions must comply with this act; therefore, they cannot result in unauthorized take of migratory birds.

Cultural Resources

The *National Historic Preservation Act of 1966* (PL89-665, 80 Stat. 915, 16 USC Section 470 et seq. and 36 CFR 18, 60, 61, 63, 68, 79, 800) requires agencies to take into account the effects of their actions on properties listed in or eligible for listing in the National Register of Historic Places. The Advisory Council on Historic Preservation has developed implementing regulations (36 CFR 800), which allow agencies to develop agreements for consideration of these historic properties. In June 1992, the NPS, State Historic Preservation Officer, and the Advisory Council on Historic Preservation entered into a programmatic agreement regarding operation and maintenance activities within the GGNRA.

The *Archeological Resources Protection Act of 1979* (PL 96-95, 93 Stat. 712, 16 USC Section 470aa et seq. and 43 CFR 7, subparts A and B, 36 CFR) secures the protection of archeological resources on public or Indian lands and fosters increased cooperation and exchange of information between private, government, and the professional community in order to facilitate the enforcement and education of present and future generations. It regulates excavation and collection on public and Indian lands. It requires notification of Indian tribes who may consider a site of religious or cultural importance prior to issuing a permit.

Land Use

The *Farmland Protection Policy Act* (FPPA) directs federal agencies to identify and take into account the adverse effects of their programs on the preservation of farmland, (b) to consider alternative actions, as appropriate, that could lessen adverse effects, and (c) to ensure that their programs, to the extent practicable, are compatible with State and units of local government and private programs and policies to protect farmland.

Other Resources

NPS Management Policies 2006 state that NPS will provide for public safety, protection of air quality, noise minimization, and protection of night skies and aesthetic values. NPS Natural Resource Management Guidelines (NPS-77) state: "It may be argued that aesthetics is the over-arching principle that unites the various management strategies discussed in this Guideline. Our current visitors and the future generations for which we are managing parks "unimpaired" should be able to perceive the same objects (or the same types of objects)--whether animate or inanimate--and processes in the same contexts that existed when the park was established."

3.4 Watershed Processes

This section includes separate discussions on hydrological process and channel stability/sediment dynamics.

3.4.1 Hydrological Processes

Affected Environment

Climate in the Redwood Creek watershed is characterized by mild, wet winters and cool, foggy summers. Since 1941, annual rainfall in the watershed has averaged 37.5 inches, with 90% of rainfall occurring from November through April.

Redwood Creek's typical flow patterns vary highly by season, with low flows in the summer and fall, low-to-moderate winter baseflows, and sharp, short-duration winter storm peaks. During summer, baseflows in lower Redwood Creek range from 0 cfs to 2 cfs (cubic feet per second). Winter flows at the Highway 1 Bridge are estimated based on a combination of measured flows and extrapolated data. The 2-year, 5-year, 10-year and 50-year floods are estimated to be 805 cfs, 1,600 cfs, 2,270 cfs, and 4,140 cfs, respectively (PWA 2000, PWA et al, 2003).

The 3,800 linear feet of creek channel through the project site has three distinct subreaches: the upper third, referred to as the "Upper Alley;" the middle portion, referred to as the "Bowling

Alley," and the Lower Reach, extending to the downstream boundary of the site at the Highway 1 Bridge (Figure 2). Design for this project will focus on two subreaches – the Upper Alley and the Lower Reach, totaling about 2,000 linear feet, but some actions are also proposed in the floodplain of the Lower Field.

Upper Alley: Approximately 6.9-square miles of watershed drain to the upstream end of the project site, where the Upper Alley occurs. The Upper Alley is a straightened reach that is highly disconnected from its floodplain and has poor channel complexity. A geomorphic feasibility analysis showed the creekbed of this reach is substantially disconnected from its floodplain by about 6 feet (PWA 2000). A more recent evaluation shows this reach is unstable and subject to an erosional process in which its banks would be widened and large quantities of sediment would be washed downstream as the creek regains stability (KHE 2006). This reach has virtually no woody debris, very few exposed root structures, and discontinuous canopy cover. One portion of the right bank is reinforced by three old cars placed in about the 1950's to prevent the creek from meandering into farm fields. Maps from the 19th Century show this reach once meandered much further west, through what later became the Upper Field. Aerial photos from the 1940's show remnants of this channel alignment, and residents recall a large depression in that area before the fields were leveled. Erosion of the right bank occurred during the Dec. 31, 2005 storm event and appears to be highly likely to progress further upstream.

The Upper Alley funnels high-velocity flows toward a single meander bend which, until 2003, had steep vertical banks subject to significant erosion during winter events. Channel cross-sections show as much as 10 feet of the right bank width at the meander bend eroded along 150 linear feet between 1999 and 2002. Bank erosion at this bend has been halted through actions implemented in fall 2003 to grade the bank to a gentle 3:1 slope, install a dense willow mattress, and reinforce the toe with Engineered Log Jams. A large gravel bar in the center of this bend was graded to temporarily relieve pressure of high flows on the right bank while willows became established. Restoration for the Upper Alley is designed to integrate flow patterns with restoration measures already in place at this bend and further relieve pressure on the formerly eroded bank by directing flows away from the bank by reconfiguring one existing ELJ.

Lower Field: Overbank flows occur on the Lower Field under a 1.5- to 2-year event as the result of NPS' removal of a berm in the Middle Reach of the creek in 2003. About 10 acres of the Lower Field is inundated during a 5-year event, with flows washing across the flat surface in sheet flows. This field is flat from prior grading during the agricultural area and dominated by non-native grasses such as wild oats (*Avena barbata*) and velvet grass (*Holcus lanatus*).

Five similar sized tributary canyons (20 to 50-acres) drain the western valley slopes onto the Lower Field via ephemeral channels that flow in the winter rainy season. The three central tributaries discharge through culverts under the access road into a constructed drainage ditch that parallels the western edge of the field and drains to Redwood Creek at the south end of the Lower Field. The drainage ditch along the road and edge of the field was constructed by farmers in the mid-20th Century to reduce inundation of the agricultural fields. Currently, the inlets of each of the three 12-inch diameter culverts under the road are buried in debris and cannot accommodate flow from the hills. As a result, flows are backed up, with high flows overtopping the access road. Based on groundwater measurements collected at three piezometers in the Lower Field, shallow groundwater conditions occur there, with depths ranging from about 3.5 to

4.5 feet below ground surface (bgs) throughout the year.

The Lower Reach has the most complexity of all three reaches, with more woody debris, the highest rate of pools per linear unit, a more sinuous morphology, and well-formed gravel bars. This reach is not incised, but it is disconnected from its left bank floodplain, the "Old Ballfield," by a historic berm. This floodplain could provide substantial flood storage capacity if it were reconnected to the channel. The endpoint of the project area and the Lower Reach is the State Highway 1 Bridge over Redwood Creek.

Old Ballfield: The historic floodplain at the Old Ballfield currently does not flood in less than a 10-year event due to levee about 1,100 feet long and ranging from about 3 to 5eet high. It was built along the banks earlier in the century to protect farm fields.

The intersection of Highway 1 and Muir Woods Road, at the southeast boundary of the Old Ballfield, has been inundated under recent large storm events, such as the December 31, 2005 flood. The low point of Highway 1 is located approximately 90 feet west of the intersection with Muir Woods Road and can be inundated during an approximately 30-year flood, threatening residential structures south of the road. However, the lowest topographical point of Muir Woods Road, immediately north of the intersection, can be inundated more frequently, requiring about a 15-year flood event (KHE 2006). Five small tributary canyons direct runoff from the eastern valley slopes to this area via small ephemeral channels. The southern-most tributary, closest to the intersection of Highway 1 and Muir Woods Road, does not drain onto the Old Ballfield, but is directed into a large concrete catch-basin at the intersection of Muir Woods Road and Highway 1 that is then directed through a storm drain bordering the south side of Highway 1 to an outfall to Redwood Creek immediately downstream of the Highway 1 crossing. Other runoff is collected in a drainage ditch on the east side of Muir Woods Road, and then directed through a culvert under the road to a drainage ditch parallel to Highway 1 on the south edge of the Old Ballfield. This ditch drains through a 24-inch-diameter corrugated metal culvert about 30 feet upstream of the Highway 1 Bridge. It is equipped with a one-way flap gate to prevent high creek flows from backing up into the pipe and ditch when the outfall is submerged. As a result, the culvert and upslope Old Ballfield area does not drain until creek flows subside, exposing the culvert outlet.

Environmental Consequences (Hydrological Processes)

Alternative 1 (Preferred)

Proposed actions will modify high flow patterns by expanding floodplains in the Upper Alley and the Old Ballfield and by creating topographic diversity in the Lower Field. Actions will also modify low flow patterns in the Upper Alley by using Engineered Log Jams to create a narrower low flow channel that will remain deeper during the dry season and provide better summer rearing habitat for salmonids. Actions and their effects are discussed below in each area of the project site.

Upper Alley: Project actions will expand the current width of the Upper Alley floodplain from about an average of 33 feet to a minimum width of 80 feet. This will be achieved by excavating the high banks and will yield a net creation of 0.43 acres of new floodplain. The proposed Upper

Alley cross-sections are shown in Appendix B. Hydraulic modeling conducted using a Mike11 depth-averaged, one-dimensional unsteady flow model shows that cutting out a new floodplain terrace in the incised bank walls would allow overbank flow on the new terrace in a 2-year flow event in the medium to long-term (KHE 2006). Inundation of the new cut terraces at a 2-year interval will rely on the interaction of the ELJ's and the formation of new gravel bars functioning as intended. Modeled results incorporate an assumption that about one to three years after construction, about 1.5 feet of sediment would accumulate in the form of gravel bars bordering the low flow channel, thereby allowing overbank flow in a 2-year flow event. The material would accumulate faster if large floods occur in the short-term. The two-year floodplain would extend over a minimum width of 80 feet. This will expand floodplain function for aquatic habitat and increase flood storage.

Hydraulic model results also show that project actions in the Upper Alley would reduce velocities in the Upper Alley. The transfer of water out of the main channel onto adjoining floodplains reduces both mainstem channel flow rates and velocities by distributing the flow across a wider cross-sectional area. The greater roughness elements and features of the riparian corridor and floodplain further reduce flow velocities. In the Upper Alley, the creation of inset floodplain terraces leads to reduced peak and average channel velocity under all simulated floods. Peak channel average flow velocity for the 2-year flood was reduced from 5.3- to 4.8-feet per second (ft/s) though the Upper Alley reach, based on the model. Similarly, average peak flow velocities for the flood with a 10-year recurrence interval decreased from 7.3- to 6.8-ft/s and from 8.1- to 7.9-ft/s for the 50-year flood (KHE 2006).

Low flow patterns in the Upper Alley would be altered by installing ELJ's designed specifically to reduce the width of the low flow channel from its current average of 20 feet to a more natural 7.5-foot width. With low flows currently spanning the whole width of the existing channel, the water is too shallow during summer and fall to provide suitable summer habitat for resident salmonids. The ELJ's (discussed in Section 3.6.1) will cause high flows to deposit new gravel bars, thereby defining the path for low flows and enhancing the sinuosity of the low flow channel. About a 10% increase in the sinuosity of the low flow channel is projected, from about 1.01 to about 1.11 (KHE 2006). With the narrower, more sinuous path for the low flow channel, it is projected to deepen by about 1.5 to 2 feet (KHE 2006). These gains are projected to occur within one to three years after project construction, depending on the winter events which occur.

The ELJ's will not span the channel to avoid functioning as grade control which could cause rapid aggradation of the bed and disrupt low flow depths very close to the MBCSD well. The ELJ's will not cause shallower or drier conditions during the low flow period.

Lower Field: Project actions in the Lower Field will not change the frequency or magnitude of overbank flow there. Due to actions taken in 2003 to remove levees there, about 2.05 acres are inundated during a 2-year event, and about 9.86 acres are inundated in a 5-year event. Two remnant levees on the right bank in the Lower Field will be removed. This action this will not increase the frequency of overbank flow, but it will add about 0.12 acres of floodplain. More importantly, the removal of these remnant levees will provide more adequate area for high flows on the Lower Field to return to the creek and an optimum location for a new high flow pathway. New high flow pathways will be created throughout the Lower Field as broad (up to 40 feet wide), shallow (one to two feet deeper than the existing grade), subtle features, not drainage

ditches. They will provide "suggested" pathways for high flows to wash over the site and into the creek. The enhanced connection of drainages from the western hillslopes onto the field will also be connected to the high flow pathways to integrate more drainage into the broader floodplain and will help recharge the groundwater there.

With much of the drainage from the hillslopes more fully directed to the Lower Field due to replaced culverts and new high flow paths connected to them, the southern end of the drainage ditch will be fed directly by only the southern-most canyon drainage. This follows the historic condition shown on 19th Century maps, prior to construction of the ditch in the mid-20th Century. The drainage ditch is already somewhat filled with sediment and does not direct flows efficiently to the lower confluence with Redwood Creek. However it is possible that as much as 80% of the drainage area that could be directed via the ditch will be redirected onto the floodplain. This has the potential to reduce flow velocities in the lower end of the tributary, improving backwater conditions for use as high flow refugia by salmonids (see Section 3.6.1).

Old Ballfield: The removal of the levee on the left creek bank adjacent to the Old Ballfield will allow 2-year flows to wash onto the floodplain for the first time in at least about 50 years. About 4.36 acres of new floodplain will be created through this action. About 1.32 new acres of floodplain will be inundated in a 2-year event with levee removal. A 3-year flow will extend across 4.36 acres of the restored floodplain to the edge of the new setback levee (Figure 6) (KHE 2006). This new floodplain will provide habitat for salmonids (discussed in Section 3.6.1), and increase floodplain storage of flows that would otherwise wash downstream, where residential structures are vulnerable to flooding. Hydraulic modeling results indicate the peak flow rate of a 2-year event would be reduced by about 2% when leaving the project area and the peak flow rate of a 50-year event would be reduced by up to 10% (KHE 2006). This reduction would provide flood reduction benefits to residential structures downstream of Highway 1.

The new setback levee, to be constructed adjacent to the existing riparian vegetation parallel to Highway 1 and Muir Woods Road, will provide a higher level of flood protection than exists under current conditions. Its design is based on hydraulic analyses which demonstrate it is necessary in order to avoid increasing flooding on the road when the creek berm is removed. It will tie in point to about the 27 ft. NGVD elevation on Muir Woods Road and taper to about the 25 ft. NGVD elevation at Highway 1. It is important to note that a remnant 40-foot-long portion of the levee adjacent to Highway 1 and within the Caltrans right-of-way is currently only at a height of 23.5 ft, and full flood reduction benefits of the new setback levee require that portion of levee to also be raised to 25 ft. NGVD. Without increasing the height of the levee in the Caltrans right-of-way, the recurrence of flood conditions would not change compared to existing conditions. Under proposed designs, the frequency of overtopping on Highway 1 will be reduced, requiring a flood magnitude of a 40-year event rather than a 30-year event to be overtopped. The frequency of overtopping on Muir Woods Road would also be reduced, requiring a 35-year event rather than the current 15-year event. These results indicate that the frequency of flooding from overtopping Highway 1 is reduced for residences lying immediately south of Highway 1, although they would still be at risk of flooding from overbank flows downstream of Highway 1. Potential downstream flooding related to run-off near the Winkleman property is not addressed or impacted through these project actions.

New high flow paths and structural diversity on the Old Ballfield would have the same benefits

as those to be constructed on the Lower Field.

In addition to the reduced flooding frequency of Muir Woods Road, Highway 1 and the residences immediately south (downstream) of Highway 1, the proposed project will reduce the peak flow rates propagated to downstream areas between Highway 1 and the Pacific Ocean. The reduced or attenuated peak flow rates occur due to the increased floodplain storage associated with the newly introduced overbank flooding that will result from the project improvements described above. Hydraulic modeling results indicate reductions in peak flow rate leaving the project site of 2 percent for the 2-year flood and up to a 10-percent reduction during a 50-year flood.

Cumulative Impacts

There is a potential cumulative beneficial impact of this project in combination with the 2003 restoration project at this site and the proposed Wetland and Creek Restoration at Big Lagoon, Muir Beach. These three projects together will restore natural hydrological patterns to about a linear mile of the creek, from the Upper Alley to the ocean. The Big Lagoon project will connect the full 38 acres in the coastal area with its floodplain, and the two projects at the Banducci site will have expanded floodplain to virtually all the area that is potentially functional under current creek conditions. The benefits of natural floodplain function improve both sediment dynamics and fish habitat, both discussed in other impact topics. With increased floodplain storage and more channel capacity due to the Big Lagoon project actions, downstream homes will experience a cumulative benefit from all projects together, although their risk of flooding during very large events will remain at about the same level as the existing condition.

Conclusion

Project actions will result in short-term and long-term, direct and indirect, local and regional major beneficial impacts on hydrological processes. The project actions will restore natural overbank flows and more natural flow patterns on the floodplains. Project actions will create a more natural low flow channel in the Upper Alley, with enhanced sinuosity and greater depth. Enhanced floodplain storage will have measurable benefits on downstream flooding by reducing the peak flow rates propagated to areas downstream of Highway 1. The new setback levee will also reduce flooding over Highway 1 to downstream homes. Alternative 1 would not result in impairment to hydrologic processes or resources.

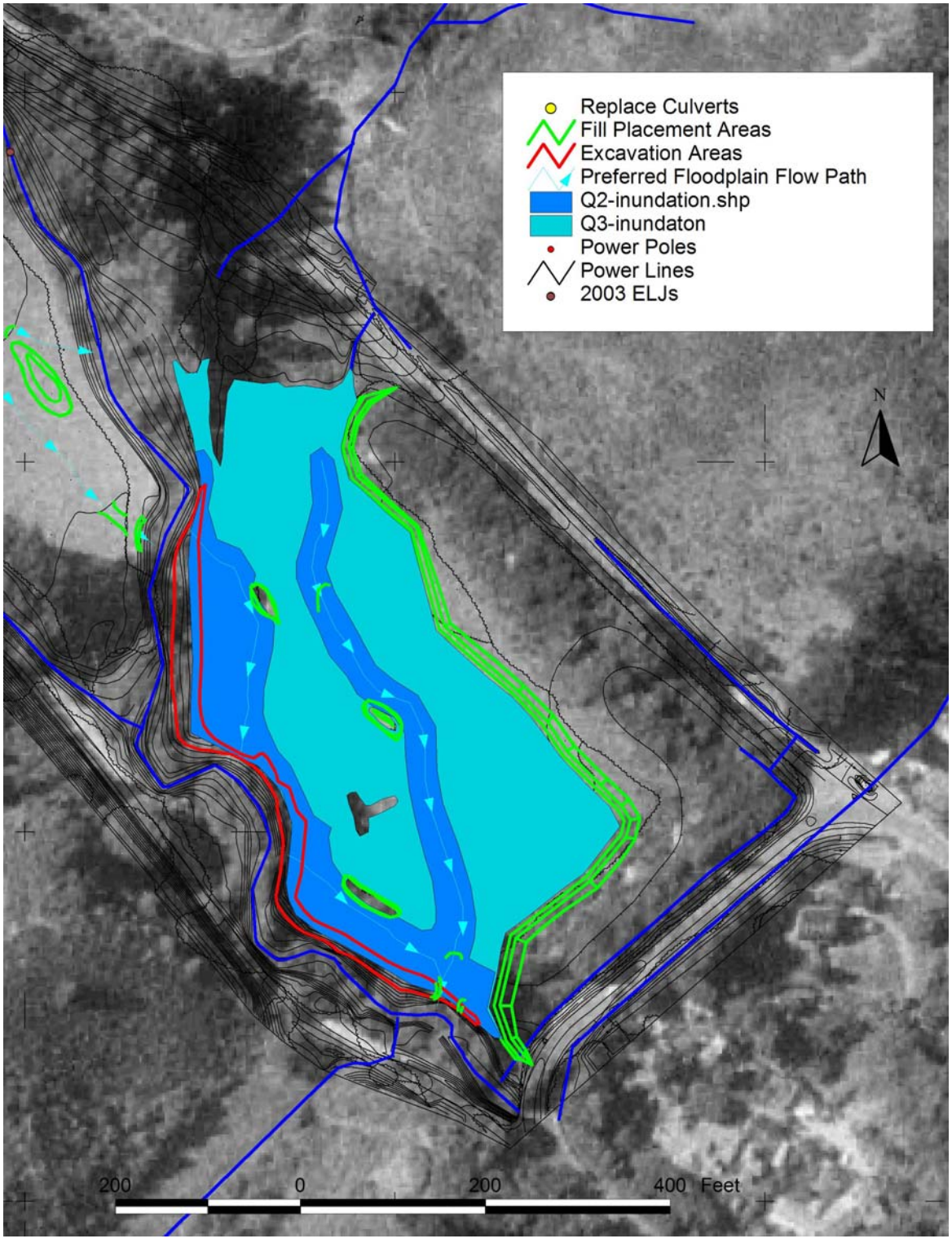
Alternative 2 (No Action)

Under the No Action Alternative the proposed project would not be implemented. There would be no restoration of additional floodplain area at either the Upper Alley or the Old Ballfield and no actions taken on the Lower Field. Natural floodplain functions would remain obstructed until natural processes finally erode the Ballfield berms and the narrow, steep walls of the Upper Alley. Flooding on Highway 1 could occur under more frequent flow events if the levee adjacent to the Old Ballfield is eroded.

Cumulative Impacts

The No Action Alternative would not alter hydrological processes and would not result in any direct or indirect cumulative impacts to hydrological processes or resources.

FIGURE 6. INUNDATION AREAS ON THE OLD BALLFIELD FOR A 2 AND 3-YEAR FLOOD EVENT UNDER PROJECT CONDITIONS



Conclusion
The No Action Alternative would result in local and regional, short and long-term, minor direct and indirect adverse impacts to floodplain function and flood storage. The No Action alternative would not result in beneficial impacts hydrological resources or processes. Although Alternative 2 would result in adverse impacts, these impacts would not result in impairment to hydrologic resources.

3.4.2 Channel Stability and Sediment Dynamics

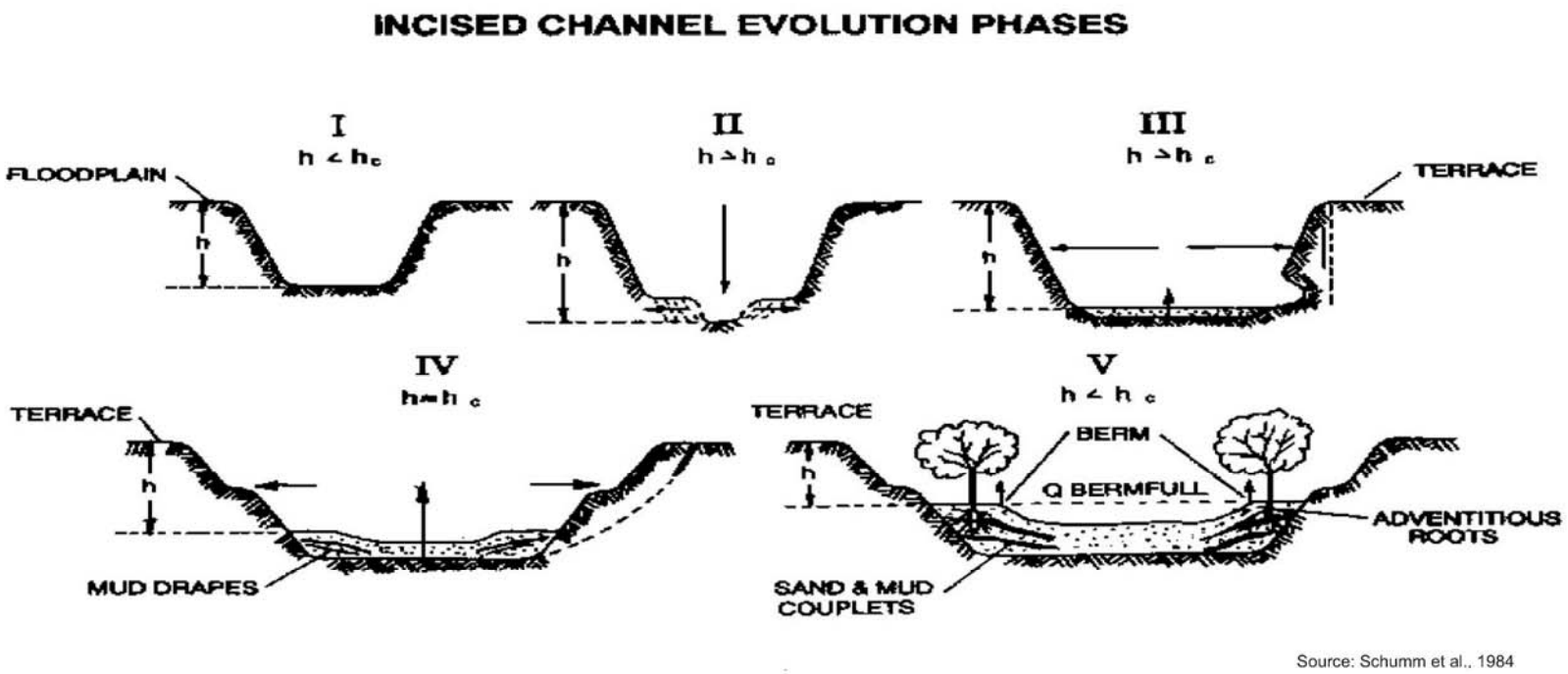
Affected Environment

Upper Alley: The current instability of the channel through the Upper Alley is illustrated by a comparison of the Upper Alley channel dimensions and slope to those of an upstream reference reach, which appears to have regained natural configurations that are desirable in the project reach. The reference reach is a 1,200-foot long reach of Redwood Creek through California State Parks land, centered on the Muir Woods Road Bridge and about 650 linear feet upstream of the Upper Alley. The reference reach was also historically incised in the mid-20th Century when creek flow patterns responded to a rapidly altered hydrograph and sediment inputs from extensive grazing, agricultural operations road construction and other actions in the watershed. However, the reference reach came under California State Parks ownership in the 1960's, some 30 years before farming ended next to the Upper Alley, and the reference reach has already undergone a natural process of recovering from historic incision. Today it displays desirable channel complexity and fish habitat attributes.

The channel and floodplain corridor of the reference reach resemble Schumm's Type V channel, or the final evolutionary phase when a channel recovers from incision (Figure 7). This channel type indicates restabilization, with a dynamic balance between sediment supply and sediment transport capacity (Schumm 1984, as cited in KHE 2006). The reference reach is characterized by a well-defined inset floodplain terrace, as well as highly sinuous active and low flow channels. Gravel bars are well formed, and the low flow channel does not extend across the entire bed – it is deeper and narrower than the active channel width. By contrast, the Upper Alley resembles Schumm's Type II channel in the evolution of an incised channel. It has only reached about the second of five stages of recovery from incision; its bank height is significantly higher than the height of a bankfull flow by some six to eight feet. With this configuration of the Upper Alley, the sediment transport capacity of the channel exceeds the sediment supply. A channel in this stage of recovery has yet to cut through its steep banks to develop a natural active channel width and a natural floodplain width. The recovery process would wash significant quantities of sediment downstream, as would have occurred when the reference reach recovered from its historic incision. Natural evolution of the incised channel in the Upper Alley was precluded in part by prior management activities during the agricultural era, when farmers worked to prevent bank erosion through bank stabilization activities such as the placement of old cars on the bank, all of which are still in place (Banducci, pers. com, as cited in KHE 2006).

Kamman Hydrology and Engineering collected a series of channel dimension measurements to characterize the difference between the reference reach and the Upper Alley, shown in Table 3-1 and Figure 8. The active channel, extending from the base of one bank to the other, in the

FIGURE 7. CONCEPTUAL INCISED CHANNEL EVOLUTION MODEL



Where:
h = bank height; hc = critical bank height

Stage I: STABLE (sediment transport capacity equals sediment supply)
Stage II: INCISION (sediment transport capacity exceeds sediment supply)
Stage III: WIDENING (highly variable sediment transport capacity)
Stage IV: DEPOSITION (sediment supply exceeds transport capacity)
Stage V: RESTABILIZATION (dynamic balance between sediment supply and transport capacity)

reference reach is uniformly about 10 feet wider than that of the Upper Alley and more sinuous, weaving amongst gravel bars. By contrast, the low flow channel in the reference reach is uniformly about 12 feet narrower than that in the Upper Alley. Measurements in the reference reach have very little variation, suggesting these widths are at about an equilibrium stage for a recovered incised channel. By comparison, the active channel width of the Upper Alley also acts as the low flow channel, creating broad, shallow flow conditions which do not make good fish habitat. This very straight channel has persisted from winter to winter thus far with very little complexity developing, and its straight alignment has contributed to significant erosion at a downstream bend that was the subject of project actions in 2003. However, in recent winter events since 2003, bank erosion appears to be progressing upstream since the downstream meander bend was protected, signaling that the Upper Alley is likely to begin a more active evolutionary process of channel and floodplain widening.

TABLE 3-1. CHANNEL MORPHOLOGY DIMENSIONS IN PROJECT VICINITY

	Channel Dimensions				
	Reference Reach (n=7)	**Transition Reach (n=3)**	**Upper Alley (n=16)**	**Restored Middle Reach (n=5)**	**Lower Reach (n=1)**
Floodplain (Inset) Width (ft)					
Range	58-128	37-47	25-52	64-100	n/m
Average	**99**	**41**	**33**	**83**	
Stnd. Deviation	20	4	7	15	
Active Channel Width (ft)					
Range	27-39	26-30	15-27	19-52	
Average	**31**	**28**	**21**	**29**	**19.5**
Stnd. Deviation	4	2	3	12	
Low Flow Channel Width (ft)					
Range	6-9	8-20	10-22	8-17	
Average	**7.4**	**12**	**17**	**12**	**9**
Stnd. Deviation	1	5	4	4	

Source: KHE, 2006, based on field measurements in fall 2006.

The reach up to about 250 ft. upstream of the Upper Alley is referred to as a "transitional reach." This is the reach downstream of the Muir Woods Road bridge, flowing through State Parks property and then adjacent to the MBCSD parcel. The transitional reach has progressed somewhat further than the Upper Alley in the evolutionary process of recovery from incision, but it has not progresses as far as the reference reach. It is characterized as Schumm's Type III or Type IV channel that has undergone an erosional process of widening channel banks, with either highly variable sediment transport capacity or a depositional process underway. It has not yet reached a new stage of stabilization, but is actively widening and creating an inset floodplain while also developing more pronounced gravel bars (KHE 2006).

An analysis of channel slopes for selected reaches shows the Upper Alley has a slightly steeper

than average grade (0.46%) than that of the reference reach upstream of Muir Woods Road (0.37%), the transition reach (0.38%) the middle reach (0.39%), and the lower reach adjacent to the Old Ballfield (0.40%). (Only one reach had a steeper grade, the reference reach downstream of Muir Woods Road, 0.68%, and this relatively high slope is believed to be associated with a disturbed channel bed condition associated with riprap grade control structures under the bridge.) The slightly higher than average slope of the Upper Alley is attributable to its straight and channelized morphological state.

Environmental Consequences (Channel Stability and Sediment Dynamics)

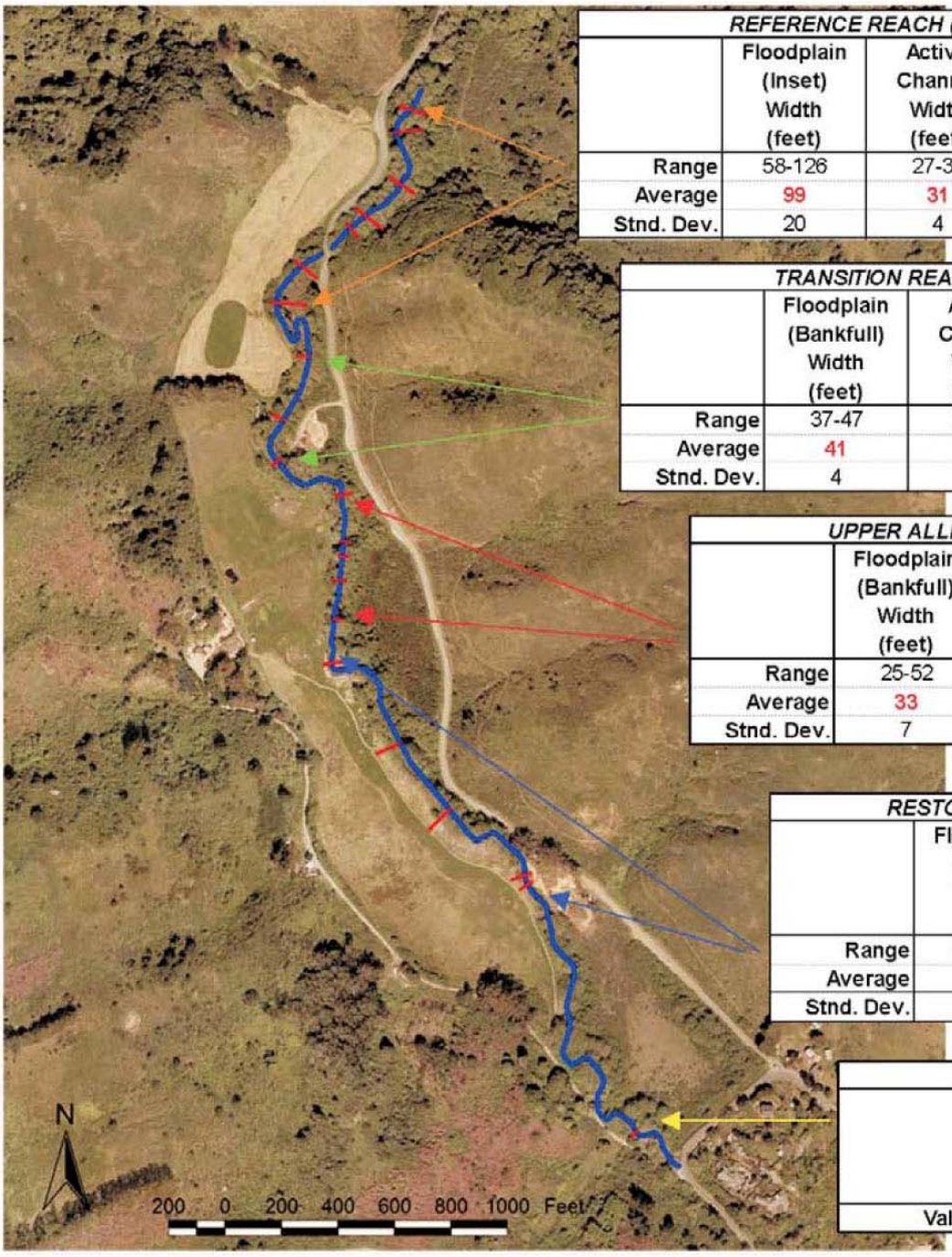
Alternative 1 (Preferred)

Project actions in the Upper Alley will create widths of the floodplain and low flow channel that are similar to those of the reference reach, where recovery from historic incision appears to have already occurred. Widths of the active channel will generally not be created in most of the Upper Alley, except in two short 75-foot-long reaches where no trees occur. Instead, to avoid removal of trees and allow a more natural development of channel widening, actions will encourage the development of undercut banks where trees occur, thereby creating habitat often used in both summer and winter by salmonids. The reference reach widths provide a template for stable channel and floodplain dimensions in which there is a dynamic equilibrium between sediment supply and transport capacity.

The width of the Upper Alley floodplain would be expanded from an average of 33 feet to a minimum width of 80 feet by cutting a terrace, or an inset floodplain, into the banks. The elevation of the new floodplain terrace would receive overbank flows from a bankfull, or 2-year flood event. The 80-foot width is considered to be a reasonable intermediate dimension compared to the range of widths for the reference reach. A total of about 2,185 cubic yards of material will be excavated from banks on both sides of the creek to achieve the desired floodplain width. The specific bank and terrace areas that will be excavated were selected to minimize the total excavation needed. For instance, excavating the left bank at a particular location requires only one foot of excavation to achieve the minimum width, whereas if the right bank were terraced at that location, the cut would have to be up to 4 feet deep. When the floodplain is widened, two 75-foot-long reaches of the active channel would also be widened by about 10 feet, from about 20 feet under the existing condition to about 30 feet. Elsewhere, the active channel will not be widened and will instead allow banks to become undermined adjacent to existing trees. Proposed excavation areas are shown on Figure 4 and in the Upper Alley Profiles in Appendix B. Activities related to the ELJ deflection jams to create a more natural low flow channel width are described in Section 3.6.1, under Fisheries.

The long-term channel stability of the design dimensions for the Upper Alley is supported by a comparison to the reference reach, regional hydraulic geometry relationships, a comparison of channel gradient in selected reaches, and analytical modeling conducted for the creek downstream of Highway 1 as part of the Wetland and Creek Restoration at Big Lagoon, Muir Beach.

FIGURE 8. CHANNEL MORPHOLOGY DIMENSIONS AT THE PROJECT SITE.



REFERENCE REACH (n=7)	Floodplain (Inset) Width (feet)	Active Channel Width (feet)	Low Flow Channel Width (feet)
Range	58-126	27-39	6-9
Average	99	31	7.4
Stnd. Dev.	20	4	1

TRANSITION REACH (n=3)	Floodplain (Bankfull) Width (feet)	Active Channel Width (feet)	Low Flow Channel Width (feet)
Range	37-47	26-30	8-20
Average	41	28	12
Stnd. Dev.	4	2	5

UPPER ALLEY REACH (n=16)	Floodplain (Bankfull) Width (feet)	Active Channel Width (feet)	Low Flow Channel Width (feet)
Range	25-52	15-27	22-Oct
Average	33	21	17
Stnd. Dev.	7	3	4

RESTORED REACH REACH (n=5)	Floodplain (Inset) Width (feet)	Active Channel Width (feet)	Low Flow Channel Width (feet)
Range	64-100	19-52	8-17
Average	83	29	12
Stnd. Dev.	15	12	4

LOWER REACH (n=1)	Floodplain (Inset) Width (feet)	Active Channel Width (feet)	Low Flow Channel Width (feet)
Value	n/a	19.5	9

FIGURE 9. COMPARISON OF UPPER ALLEY TO REFERENCE REACH

Upper Alley Low Flow Channel

Reference Reach Low Flow Channel

As reported by KHE:

> Hydraulic geometry theory assumes that a river/creek corridor system tends to develop in a predictable way as long at the channel is unimpaired to develop in equilibrium with inflowing water and sediment (Copeland et al. 2001). The theory typically relates a dependent variable, such as channel width or depth, to an independent variable such as watershed area or bankfull flow. Hydraulic relationships are based on field measurements at stable, undisturbed alluvial cross sections. Dunne and Leopold (1978) provide average values of bankfull channel dimensions as functions of drainage area for San Francisco Bay region creeks that experience 30-inches of mean annual precipitation (the mean annual precipitation to the Banducci project site is estimated at 34 inches). Using a drainage area of 6.9-square miles to the Banducci Restoration Project site, the Dunne and Leopold hydraulic geometry relations yield a bankfull channel width of 32-feet; a bankfull depth of 2.4-feet; and bankfull cross-sectional area of 33.3-square feet. This bankfull width value of 32-feet agrees well with the Reference Reach active channel width of 31-feet, as the Reference Reach active channel width is probably 3- to 4-feet narrower than the Reference Reach bankfull width (KHE 2006).

Project actions in the Upper Alley will increase sinuosity, thereby reducing the channel slope to a value more similar to, of not equal to, the stable reference reach. The added active channel width will also give the reach more ability to adjust (e.g., meander, aggrade, erode, etc.) to variations in flow and sediment supply, maintaining a relatively stable state by adjusting its slope as necessary. The stable slope in the Upper Alley will be achieved by increasing low flow channel sinuosity and flow length. Lower gradient channels such as the project and project vicinity reach are also more prone to respond to changes in gradient through morphological response/adjustments. In the case of the Upper Alley, reductions in slope will lead to sediment deposition until the reach equilibrates - a desired trend during the first few years after construction. Adjacent reaches will not suffer any adverse impacts from slope adjustments in the Upper Alley, as it will be attaining a grade more similar to upstream and downstream reaches (KHE 2006).

The evaluation of channel slope and width ties in well with stable channel analytical modeling completed by PWA (2004) for the Redwood Creek reach immediately downstream of the Highway 1 Bridge as part of planning for the Wetland and Creek Restoration at Big Lagoon. Using estimates of bankfull discharge and associated sediment concentration at the Highway 1 Bridge, PWA determined the equilibrium slope for a 35-foot wide channel ranges from about 0.36% to 0.41%. The similarity of the PWA equilibrium slope values to that of the reference reach supports the observation that the upper reference reach is in a state of equilibrium. According to PWA's predictions, channels steeper than this range would be more prone to erosion while channels less steep would be prone to deposition. These predictions support the observations that the existing Upper Alley reach is over steep and prone to incision and that increasing channel sinuosity will lower the channel slope into the predicted range of equilibrium.

The project design and resulting conditions would reduce sediment loads to downstream areas for the following reasons.

- Several years after restoration construction in the Upper Alley reach, the ELJs will be

encouraging the in-channel deposition and aggradation of gravel and sand, effectively trapping and storing sediment until the Upper Alley reach equilibrates to its new morphology. After the reach equilibrates, sediment inflow and outflow rates will be balanced.

- Sediment deposition on the floodplain will be enhanced by reconnecting the channel and adjacent floodplains. The reconnected floodplains will act as long-term sediment sinks and storage areas, effectively reducing the long-term sediment delivery rates to downstream reaches.

- Riparian corridor expansion, especially the establishment of large wood, will further enhance the sediment trapping and storage capabilities by vegetation on project floodplains and serve as a source of large woody debris (LWD) recruitment in the active creek channel.

- The proposed channel improvements in the Upper Alley will eliminate a large source of sediment that, over the long-term, would likely be mobilized downstream as the reach naturally widens its active flow channel and incised floodplain terrace to reach a geometry similar to that of the reference reach. As part of the restoration project, this material will be removed by mechanical means and eliminated from entering the creek corridor.

- Future sediment supply from levees along the Old Ballfield and Lower Field that would eventually fail will be eliminated by removing the levees. Along several sections of the left Ballfield channel bank, the levee has been undercut and is currently eroding into the creek. Levee removal will provide both short and long-term reductions in sediment loads to the channel and downstream reaches.

- Redirecting the western drainage channels out of the access road drainage ditch and back onto the floodplain should also reduce sediment loads to the creek by eliminating the delivery of material to the ditch (a relatively efficient hydraulic conduit) that expresses material to Redwood Creek in contrast to allowing the natural settling and accumulation of material in alluvial fans at the drainage mouths.

- Although the project intends to restore and encourage dynamic processes such as erosion and meander migration, these processes are being integrated with the competing processes of sediment trapping and storage. The intent is to help establish/restore the natural balance of dynamic geomorphic processes and accelerating the return to a creek corridor equilibrium between sediment supply and transport. Static conditions do not translate to stable conditions in alluvial systems. Dynamic geomorphic conditions are necessary to recruit and maintain desired ecological function and diversity (KHE, 2006).

Cumulative Impacts

Project actions would yield a cumulative beneficial impact in combination with the previous restoration project at this site (2003) and the proposed Wetland and Creek Restoration at Big Lagoon, Muir Beach. As with hydrological processes, these three projects together will restore more stable and natural channel conditions along about one mile of channel, from the Upper

Alley to the ocean. The cumulative effect will be a more natural, dynamic balance of sediment supply and transport capacity. This is a long-term, direct and indirect, local and regional major benefit.

Conclusion
Project actions will create a more stable channel, with appropriate channel dimensions; and recovery of natural processes following 20th Century channel disturbances will be expedited. Sediment delivery to areas downstream of the project area will be reduced in the short-term due to improved trapping efficiency in the Upper Alley and in the long-term due to greater balance between sediment inputs and outputs, as well as to reduced bank erosion at a vulnerable location under Muir Woods Road. These beneficial impacts are short and long-term, direct and indirect, local, regional and major. These project actions will not result in impairment to channel stability or sediment dynamics.

Alternative 2 (No Action)

Under the No Action Alternative the proposed project would not be implemented. The Upper Alley would not be terraced, nor would the active channel be widened. The incised reach would be left to undergo an eventual natural process by which widening of the active channel and the floodplain would occur. This process would entail the erosion of several thousand cubic yards of sediment that would be washed into the stream. It is unclear how long it would take for this process would occur.

Cumulative Impacts
The No Action Alternative would not result in direct or indirect cumulative impacts.

Conclusion
The No Action Alternative would result in local and regional, long-term, direct and indirect moderate adverse impacts to channel stability and sediment dynamics. Alternative 2 would not result in impairment to channel stability or sediment dynamics.

3.5 Soils and Geology

Affected Environment

The project site is located in an alluvial valley of the Coast Range Geomorphic Province. Known locally as Frank Valley, the valley extends about six miles from Muir Woods National Monument to the coastal lowlands near Muir Beach. Soils in the alluvial valley range from at least 37 ft (11.3 m) deep to possibly as deep as 90 ft (27.4 m) (Laudon 1988, as cited in PWA 2000; Martin 2000), and are dominated by fine loam. A geotechnical investigation conducted at the project site in September 2006 collected soil samples in nine test borings and found soils consisted mostly of soft to medium stiff sandy clays embedded with some clayey sand, gravelly sand and silty sand (Miller Pacific, 2006).

Soils at the site are mapped as a Blucher-Cole complex with 2 to 5 percent slopes (Soil Conservation Service 1979). This complex is characterized by deep, fine loams in the thermic

Fluvaquentic Haploxerolls and thermic Pachic Argixerolls families. The Blucher-Cole complex is described as poorly drained with a high water capacity. While Blucher soils, but not the Blucher-Cole complex, are included on the Natural Resource Conservation Service list of the Marin County hydric soils, both the soils and the hydrology of the study area have been subject to extensive changes throughout the past 50 years, making it possible that localized areas do not completely match mapped criteria.

The Franciscan assemblage underlies most of the Redwood Creek Watershed. It is a mixture of sedimentary, metamorphic and igneous rocks, with shale and sandstone that tend to be highly susceptible to landsliding and debris flows (Stillwater 2006).

The site occurs in the seismically active San Francisco Bay Area and will experience earthquakes in the future. The San Andreas Fault lies offshore, about 2.5 miles from the project site. It forms the strike-slip boundary between the Pacific and North America tectonic plates, running along a roughly North-by-Northwest trend.

The site was leveled in the mid-20th century to create farmland. Depressions were filled and other areas were cut to create a level field. Fill from the northwestern corner of the site, adjacent to the existing row of Monterey cypress trees, was removed (Banducci, personal communication with C. Shoulders, Nov. 20, 2006). The cut created a grade difference of as much as five feet compared to the property to the north, occupied today by the cypress trees on NPS land and Mount Tamalpais State Park property slightly further north. Some excavated material was used to fill a remnant portion of the historic channel alignment that once occurred in what is now about the center of the Upper Field. Channel banks were subject to erosion, but were reinforced with the steel frames of cars, with additional fill placed around the reinforcement (Banducci, pers. communication, with Shoulders, August 2006). Berms were built along the middle and lower reaches of the field; berms in the middle reach were removed by NPS in 2003.

Environmental Consequences

Alternative 1 (Preferred)

Construction activities will entail excavation of site soils, transport of soil to other onsite locations, potential compaction from the use of heavy equipment, and potential for erosion. Quantities and locations of material to be excavated and placed are shown in Table 3-2. The quantity of material excavated will be balanced with quantities needed for beneficial uses, including the creation of the alluvial fan, a berm around the edge of the new frog pond, and the new setback levee on the Old Ballfield.

Soil to be excavated under a separate project to dig a pond for California red-legged frog habitat will be hauled to the Upper Field. Under actions by this project, the soil, consisting primarily of clays, with some silty loam and some gravel, will be used to reconstruct the natural contour of the northern boundary of the site. It will be graded as a new, gently sloping "fan," extending over about 1.3 acres (Figure 4 and Appendix A). Material excavated for the floodplain terrace on the Upper Alley will be used to make up the difference in the quantity of fill needed. The texture of the excavated material is compatible with that of the Upper Field, which is considered

to have a similar soil profile to that of the source area in the Lower Field (KHE 2006). The gentle slope of the newly placed material will be stable, but subject to some surface erosion until it is fully vegetated. It will be revegetated with native coastal scrub species similar to those on the adjacent hillside to the west.

TABLE 3-2. ESTIMATED CUT AND FILL VOLUMES

Design Component	Net Cut (cubic yards)	Net Fill (cubic yards)
Ballfield Levee Removal	776	
Set-Back Levee		1310
Lower Field Levee Removal	124	
Frog Pond Creation*	3212	
Upper Alley Channel Work	2185**	
N. Tributary Alluvial Fan Reconstruction		4937**
Plug Drainage Ditch		50
TOTAL CUT & FILL	**6297**	**6297**

*The frog pond will be excavated through a separate project, but it is shown here because its fill material will be used for this project. An additional 640 CY of material excavated for the frog pond will be used to build a berm around the edge of the pond in this project.

** Approximately 1/3rd of the material generated from the Upper Alley Channel Work will be generated from the left (east) bank excavation work.

Material excavated from the Upper Alley, along with material excavated from the berm at the edge of the Old Ballfield, will be used to build the new set-back levee near the southern and eastern boundaries of the Old Ballfield. Based on a geotechnical analysis, the soil is suitable for the use as a levee to both withstand seismic shaking and flooding (Miller Pacific, 2006). The levee will be constructed following specific geotechnical specifications for subsurface compaction under the new levee, compaction of placed fill at multiple horizontal layers, and slope construction with a maximum inclination of 3:1 side slopes.

Surface soils on the ballfield and the Lower Field will be disturbed during excavation of the shallow high-flow channels, and the material will be placed as small mounds on the field. A new berm will be constructed along the edge of the newly excavated pond in the Lower Field, placing approximately 640 cubic yards of material along the outer edge of the pond.

The floodplain terrace on the left (easterly) bank of the Upper Alley will be constructed by an excavator working from the left bank. An access route from Muir Woods Road will be established. It will follow an alignment of an old ranch road that is currently vegetated but can function for temporary access. Newly excavated banks for the active channel and the floodplain of the Upper Alley will have gentle slopes that will be less susceptible to erosion than the existing undersized channel walls. However, excavated banks on the Upper Alley as well as the Old Ballfield will have newly exposed surfaces that will be subject to erosion and run-off of fine material.

The installation of seven Engineered Log Jams in the Upper Alley will entail an excavator working in the channel bed. Log tips will be inserted into the bed several feet deep, requiring an initial excavation of a pit in the channel bed, which is refilled after insertion of a log. The

insertion of the log into the channel bed stabilizes the log jam and helps create the long-term effect of the design. Additional logs will be inserted vertically to provide stabilization. Use of heavy equipment in the saturated creek bed can compact the subsurface and cause gravels to become more embedded.

About 28 of the 48 Monterey cypress trees at the northern boundary of the site would be toppled. The toppling would cause the ground surface adjacent to the trees to be unearthed, opening a small pit where the rootball had occurred. Areas where trees were toppled would be refilled with the native soils to be used to recontour the adjacent area. The ground surface elevation of the former trees would be graded to tie into the new contours to be reconstructed at the northern boundary of the Upper Field. Removal of only a portion of the trees would still allow the new contours to be tied into the elevation of the property to the north.

To reduce impacts of potential erosion to the creek during construction, the GGNRA will implement Best Management Practices such as the following actions:

- Areas where heavy equipment may operate in the channel bed will be strictly limited to only the most essential areas.
- Surface gravels in the bed will be segregated during log installation for replacement on the top of the bed after installation is complete.
- Newly graded fill for the alluvial fan in the Upper Field will be covered with a layer of rice straw and revegetated with native coastal species. Erosion control materials such as straw waddles will be placed at the base of the newly placed material to prevent the spread of any eroded surface soils during winter rains.
- Newly graded banks of the Upper Alley and the Old Ballfield will be revegetated with native riparian species to help stabilize and establish cover on these areas quickly.

Cumulative Impacts

Project actions are not likely to result in long-term cumulative impacts adverse impacts to site soils. Potential cumulative soil erosion impacts from this project and in combination with construction of the frog pond or other offsite projects such as the restoration at Big Lagoon would be offset by implementation of Best Management Practices (see Appendix D). There is not likely to be a potential cumulative effect due to combined impacts from the 2003 project actions since previously cleared areas have been sufficiently revegetated. Construction of a possible new trail alignment in the adjacent hillsides as part of the Lower Coast View Trail project could contribute new sediment to the hillside drainages, depending on its specific location and design specifications. Design elements to trap sediment or reduce runoff from trails, in addition to BMP implementation during construction, would reduce potential cumulative impacts from these projects to a less than significant level.

Conclusion

Potential impacts to soil and the creekbed from construction activities and erosion would be local, short-term, direct and indirect, and minor adverse, and reduced to less-than significant levels through the use of BMP's. However, the proposed project would result in local, short and long term, direct and indirect, and moderate beneficial impacts to soil resources and erosion

processes through the rebuilding of natural contours in the Upper Field, along the Upper Alley, and in the Old Ballfield. Alternative 1 would not result in impairment to site soil resources.

Alternative 2 (No Action)

Under this alternative, no actions would be taken to excavate or haul soils. However, because soils from excavation of the frog pond would have been placed at the Upper Field, the alluvial fan would be constructed.

Cumulative Impacts
Alternative 2 would not result in cumulative impacts to soil resources.

Conclusion
There would be no local, short-term, or direct adverse impacts; however, there would be a minor, local, long-term, direct beneficial impact from creation of the alluvial fan. There would be no impairment to site soil resources.

3.6 Biological Resources

Potential impacts to biological resources are discussed and analyzed separately below under the following topics: special status species (salmonids, frogs and owls), other wildlife, wetlands, and vegetation. Based on surveys at the site (Faden, 2002, Taylor 2003), no special status plants are known to occur at the site and are therefore not discussed as a separate topic.

3.6.1 Special Status Species

Fisheries

Affected Environment

Two fish species protected under the federal Endangered Species Acts occur in the watershed. These are coho salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*). Coho salmon in Redwood Creek are part of the Central California Coast Evolutionarily Significant Unit (ESU). Redwood Creek is included in the critical habitat designated for this coho ESU, which was announced on September 2, 2005 and became effective January 2, 2006 (70 FR 52488). The federal listing status of the coho salmon in Redwood Creek was upgraded from threatened to endangered in June 2005 (70 FR 37160). Steelhead in Redwood Creek are part of the Central California Coast Distinct Population Segment (DPS) and were listed as threatened by the NMFS under the federal Endangered Species Act on August 18, 1997 (62 FR 43937–43954).

Since the winter of 1994–95, the NPS has conducted comprehensive monitoring of coho throughout the watershed, including documenting adult abundance, spawning distribution (redd surveys), and juvenile abundance and distribution. The Park conducted a basin-wide habitat survey in 1995, basin-wide fish and habitat surveys in 1998, redd/coho spawner surveys from Winter 1994 to present, and estimates of juvenile fish densities using multiple pass electrofishing at index sites since 1998. Since monitoring began, estimated adult abundance has ranged from a

low of 10 adults in 1999–2000 to 171 adults in 2004–2005 (Reichmuth et al., 2006, Stillwater 2005a).

In monitoring of juvenile coho salmon at five reference sites in Redwood Creek, Dr. Jerry Smith, of San Jose State University, reported abundance of juvenile coho salmon ranging from a low of 1.1 per 100 feet in October 2000 to a high of 42 per 100 feet in August 1995 (Smith 1995, 1996, 1997, 1998, 2000, and 2001). Based on his surveys, Smith identified two factors that potentially limit coho salmon production in the watershed—lack of sufficient pool habitat to support oversummering (especially during dry years) and poor overwinter survival during wet years (e.g., Smith 2001). Smith (2001) concludes that lack of summer habitat provided by deep pools (i.e., > 0.5 m) with complex cover combined with low late-summer and fall flows in the lower creek is the primary factor limiting coho salmon production in the watershed during dry years. In the lower watershed, and particularly downstream of the Muir Beach CSD well, low flows cause pools to become disconnected during late summer and early fall. During dry years, very low coho densities have been observed in the lower reaches of the creek. During wet years, however, floods may be a more critical limiting factor. Smith (2000) hypothesizes that high mortality caused by high flows during wet years may have severely reduced the abundance of the 1997 year class, suggesting that redd scour and/or a lack of floodplain connectivity and access to refugia from high flows may limit production during wet years (Stillwater 2005a).

When assessing the suitability of existing conditions for coho and steelhead, NPS looked at the NOAA Fisheries Service definition of essential habitat features (NOAA 1999, 2000). The features considered to be essential for the various life stages of steelhead and coho include the following: (1) juvenile rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas (NOAA 1999, 2000). Within these areas, essential features of critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (NOAA 1999, 2000). These habitat features in Redwood Creek in general and, where data is available, in the project reach, are discussed below. The project areas with fish habitat that will be affected by project actions include the Upper Reach, the Lower Field, and the Old Ballfield.

Juvenile Summer Rearing Habitat

During the summer, juvenile coho prefer pools featuring adequate cover such as large woody materials, undercut banks, and overhanging vegetation. Young of the year steelhead typically rear in the faster parts of pools, although they can be abundant in flatwater and riffle habitats. Older steelhead typically are found in deep pools with adequate cover.

Summer rearing habitat, especially for coho, in the Upper Alley is limited due to its flat, planar bed morphology in which the low flow channel extends across virtually the entire width of the active channel. Low flows are consequently uniformly shallow throughout this reach and provide very poor summer rearing habitat. There is little sinuosity and very limited woody debris to form pools in this reach.

Habitat conditions specific to the project reach are provided in Table 3-3 (from PWA, 2000). The project reach (referred to as the "Upper Alley") has a distinctly lower rate of pools and woody debris than the lower reach of the Banducci Site used as a reference reach, all factors that

contribute to poor quality juvenile summer rearing habitat.
There is limited fish data. However, electrofishing data from 2002 Jerry Smith sampling activities shows distinct differences between areas with limited pool habitat and sites with greater pool habitat (Table 3-4). The shallow Bowling Alley reach had lower densities of coho salmon who typically prefer pool habitats. In 2001, NPS mapped the locations of dry reaches within the project area. It shows that during dry water years such as 2001, areas such as the Upper Reach and Bowling Alley that have a low percentage of pools will go dry with loss of fish.

TABLE 3-3. HABITAT CHARACTERISTICS OF SUBREACHES OF THE BANDUCCI SITE REDWOOD CREEK, SUMMER 2000*

Banducci Site Subreaches	Creek Station (m)	Pools (no. per km)	Riffles (no. per km)	Exposed Tree Roots (no. per km)	Woody Debris (no. per km)
Lower Reach	694-838	62.5	48.6	48.6	27.8
Upper Reach **	158-287	23.3	46.5	38.8	0
Bowling Alley	370-532	12.3	37.0	18.5	12.3

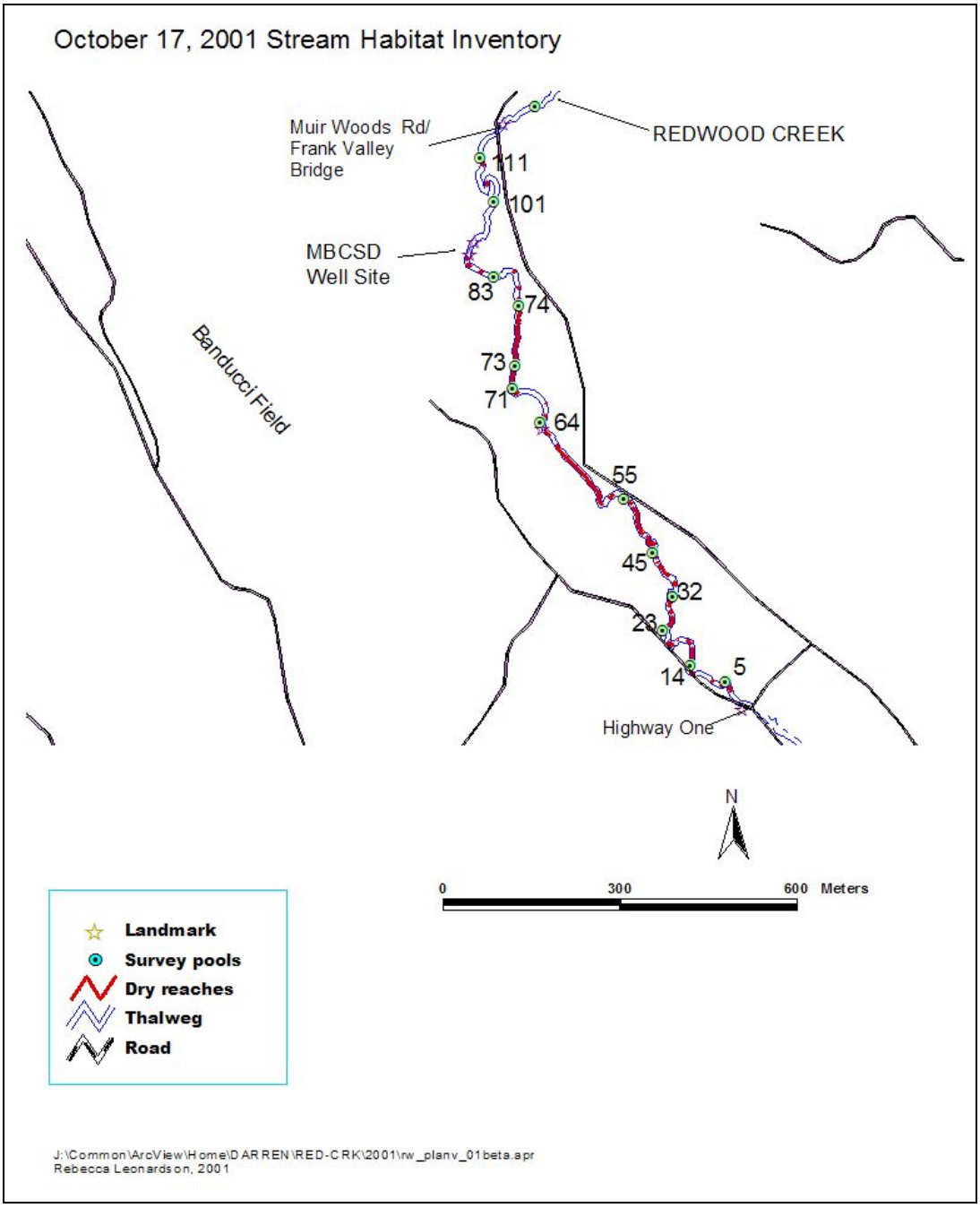
*Table from PWA, 2000.
**The Upper Alley is the project reach.
The Bowling Alley was the focus of project actions in 2003 to remove a berm, install ELJ's, and reconnect the creek with its floodplain.

TABLE 3-4. FISH ABUNDANCE REDWOOD CREEK, OCTOBER 2002

	Tag	Survey Distance (m)	Coho (#/30 m)	SH (#/30 m)
Above Muir Woods Rd Bridge*	RW-01-18 to -20	85	65	2
Below Bowling Alley (J Smith Index 6)	RW-01-08 to -09	98	23	3

*No abundance data is available for Lower and Upper Reaches. Fish info for site above Muir Woods Road Bridge from Smith (2002); this area was also used as a geomorphic reference reach (KHE 2006).

FIGURE 10. PLAN VIEW MAP SHOWING LOCATIONS OF ISOLATED REDWOOD CREEK HABITAT UNITS BETWEEN HIGHWAY ONE AND MUIR WOODS ROAD BRIDGES DURING OCTOBER 17, 2001



Juvenile Salmonid Winter Rearing Habitat
Juvenile coho prefer to overwinter in large mainstem pools, backwater areas and secondary pools with large woody debris, and undercut bank areas (Heifetz et al. 1986, Hassler 1987).

Winter rearing habitat in the Upper Alley is limited by the lack of secondary channels and a low rate of backwater areas, woody debris, undercut banks or other features that can provide refugia from high velocity events. Its channelized morphology, with an undersized floodplain, probably contributes to high flow velocities.

The Lower Field has functioned successfully as a floodplain since NPS took actions in 2003 to remove a berm. Young riparian vegetation is growing along a band about 80-feet wide along the creek, but further inland the floodplain is flat and occupied by non-native grasses, creating a sheet flow pattern for large overbank flows. There is virtually no complexity on the extended floodplain and no identifiable flow paths across the floodplain. One berm in the lower field was removed in 2003 to create a route for flows to reenter the creek, but a much larger area would be available for flow –and fish – to reenter the creek with additional berm removal in the Lower Field.

The channel adjacent to the Old Ballfield is sinuous, with the highest rate of in-stream woody debris in the project site. It has the highest rate of pools, gravel bars and other features representative of channel complexity. However, its historic floodplain on the left bank is obstructed by a berm constructed during the agricultural period. The berm ranges from about 2 to 4 feet high.

Juvenile Migration Corridor
Current conditions are likely adequate for movement of juvenile fish both upstream and downstream under most flow conditions.

Adult Migration Corridor
Adult coho and steelhead upstream migration typically occurs during the late winter through spring, with run-back steelhead seen as late as late-April and early May. Because upstream movements are associated with storm events, there are no barriers within the project area that could impede upstream adult fish passage. Areas within the project area with long lengths of riffle and flatwater may lack sufficient resting pools; however, coho and steelhead adults are able to reach major spawning areas in Mt. Tamalpais State Park and Muir Woods National Monument.

Spawning Areas
In coho spawner surveys conducted from the winter season of 1997-98 through 2005-2006, three redds (two coho and 1 steelhead) have been reported by observers in the Upper Alley Reach. Most redds are observed upstream of the project area.

Substrate quality in the project area would be suitable for spawning and incubation. Based on pebble count surveys conducted in 1995, this reach had a highest percentage of gravel and a low percentage of fine sediment.

Environmental Consequences (Fisheries)

Alternative 1 (Preferred)

To determine the effects of the proposed actions on listed species and designated critical habitat, NPS staff assessed habitat potential in absence of the particular actions against the habitat conditions with the proposed actions and mitigation measures. As guidance, we used essential habitat features for the comparison. The essential features of critical habitat include: substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage (NOAA 1997).

Substrate
Unnatural levels of surface erosion and mass wasting events can contribute large amounts of sediment to the stream environment. Deposition of silts and sands on spawning beds can impair egg development by filling interstitial spaces and reducing water exchange, resulting in decreased oxygen levels and waste removal (Chapman 1988, Bjornn and Reiser 1991). Excessive sediment loading may result in filling of pools, increased streambed heights and incidence of subsurface flows. Decreased substrate size can also reduce refugia for juvenile fish.

To install the log jams and widen the active channel, an excavator will enter the creek. The excavator will fit through existing trees at the bank edge, requiring only spot limbing in order to gain access to the creek. Once the excavator enters the creekbed, impacts will be minimized by reducing its movements and the number of times it moves in or out of the creek to a bare minimum. The tips of the logs will be embedded into the stream and adjacent banks to minimize potential future movement, and designs include two logs to be installed vertically on either side of the structure to provide sufficient stability during large flood events. To embed a log, trenches would be excavated in the bed, then backfilled around the buried log. Vertical logs would have point tips cut at one end and would be installed by driving them directly into the bed from the impact of an excavator bucket.

For installation of partially-buried log elements, surface gravel would be segregated from other trenched material. After log placement, soil will be recompacted around the log and gravel will be replaced on the bed surface.

Log installation, channel widening, floodplain terracing and berm removal would occur during the late summer and early fall. During the construction period, flow is expected to range from 0.1 to 0.01 cfs (based on previous records). Depending upon flow conditions, portions of the project reach may be dry during construction.

If instream flow is present, instream construction activities will result in localized turbidity, a short-term, direct and indirect, moderate to major adverse impact. In addition, any exposed bank materials after construction may have increased susceptibility to surface erosion in the short-term. Project actions will, therefore, include the following mitigation measures.

Mitigation Measures:

- (BIO-1) If flowing water is present, localized areas within the channel will be dewatered and downstream flows will be maintained.
- (BIO-2) Measures would be employed to minimize turbidity from discharging waters by directing discharge into a diffuser.
- (BIO-3) All materials placed for creation of coffer dams would be removed upon completion of activities.
- (BIO-4) During construction, erosion control materials, such as silt fences with straw waddles at the base, will be placed below any banks where berms are to be removed or graded
- (BIO-5) Erosion control materials will be placed on any newly exposed riparian banks.

These measures will reduce any short-term, direct and indirect moderate to adverse impacts to a minor level. In the long-term, the new dimensions of the active channel, low flow channel and floodplain will function partially for a more stable dynamic between sediment deposition and transport, a desired effect. The overall added benefit of the installed log structures will be to provide aquatic cover and create scour pools to add habitat for juvenile salmonids.

Water Quality/Water Temperature

NPS staff conducted a literature review to identify critical water quality parameters that would affect fish. This information was used to identify appropriate "red flags" or parameters to monitor. Based on the information obtained, the NPS used sublethal dissolved oxygen threshold of 5 mg/l and water temperature of 20^{o}C as "red flags".

The project reach is located in an area which has been identified as a critical location for water quality. Multiple years of intensive water quality data (1998, 1999, 2001, 2004-2005) by NPS have identified the channel downstream of the Muir Beach Community Service District's pedestrian bridge as having poor water quality under low flow conditions (PWA 2003; Stillwater 2005c). When stream habitat units are interconnected, measured dissolved oxygen conditions did not go below 5 mg/l during the Summer/Fall of 1998 and 1999 (Fong, unpublished data, 1998 and 1999). Under drought conditions, surface flows diminished to a point where only isolated pools were present. Under these conditions, measured dissolved oxygen levels dipped below 1 mg/l for many pools (Fong, unpublished data, 2001). Concurrent temperature measurements for all years did not exceed the 20^{o}C "red flag."

Project actions may have a local, long term, direct and major beneficial impact on water quality and water temperature because the narrower, deeper dimensions of the low flow channel that will be created by log structures will improve the connectedness of the low flow channel, thereby improving water quality conditions. Project actions are not expected to adversely affect dissolved oxygen or temperature conditions that would affect fish. Construction activities would be conducted either in a dry channel or in isolated pools where fish had been previously removed. Localized removal of adjacent vegetation is expected to have a negligible effect on water quality. Slight increase in water temperature would be expected, but based on past data, water temperatures would not be expected to exceed 20^{o}C. In addition, localized increases in sunlight penetration would result in increased dissolved oxygen levels during daylight hours and slight decreases at night. Short-term impacts to water quality from elevated turbidity should be minimized using the BMPs identified for protecting substrate quality.

Water Quantity
Expected changes in surface flow patterns will be local, direct and major beneficial impacts because installed log structures will result in a narrower, deeper low flow channel, as occurs in the upstream reference reach. The more natural low flow channel dimensions will improve the interconnectedness of the low flow channel, though it cannot prevent some drying that already occurs in dry years. The expanded floodplain in the Upper Alley and the removal of the 970-foot-long berm adjacent to the Old Ballfield floodplain will also allow increased lateral usage of the creek during storm events by aquatic organisms. An increase in both winter and summer rearing habitat is expected. The proposed project would not adversely affect surface flows within the project reach. Short-term construction impacts may be expected should in-stream construction activities occur in a normal to wet-year where instream habitats would be dewatered prior to installation of ELJs. This would result in temporary loss of summer-fall rearing habitat by juvenile salmonids within the dewatered area. To minimize this short term impact, the minimum channel length practical would be dewatered for construction implementation.

Water Velocity
Proposed project actions will reduce flow velocities in the Upper Alley during flood events by widening the floodplain and through increased channel roughness (KHE 2006). This will increase areas suitable for refugia in high winter flows. Currently, channel-forming features, such as meanders and gravel point bars, are often washed out in the channelized reach during high flows. Actions related to the tributary at the southern end of the site will increase its function as a slow-velocity backwater, since three drainages on the site will be restored to their natural route onto the floodplain field and since about 150 linear feet of the lower end of the tributary will be widened to expand its function as low-velocity winter refugia.

Cover/Shelter
Proposed project actions will increase cover/shelter resources for salmonids. Deflection jams, constructed of trees with rootwads, will add substantial cover in a reach where there is currently very little.

Food
Instream construction activities could adversely affect downstream benthic invertebrate communities, and indirectly, juvenile growth. Prolonged release of fine sediments from instream construction activities into downstream areas could reduce the number of invertebrate species and their densities (Wiederholm 1984). Proposed instream construction activities, without mitigation, could also result in short-term increases in instream turbidity which would affect the ability of juvenile fish to feed successfully (Everest et al. 1987). This potential impact will be minimized or avoided through the use of velocity dissipators from the dewatering discharge pipe to slow the rate of discharge and reduce localized erosion and transport of fine sediments. Silt fences placed at the base of the creek bank and below grading areas will minimize impacts to downstream areas. The increased channel complexity due to the installation of the log structures is likely to have a long-term beneficial impact on benthic invertebrate communities.

Riparian Vegetation
Healthy riparian vegetation may be the keystone for a healthy stream. Loss of riparian vegetation can result in increased water temperature fluctuations, reduced inputs of terrestrial plant and invertebrate foods into creek, decreased water storage capacity, reduced filtration

capacity, and increased erosion potential.

In the Upper Alley, most existing tree cover will not be affected by the proposed actions, but up to 6 trees with a diameter greater than 1.5 feet at breast height (DBH) may need to be removed to terrace the new floodplain. On the right bank, the total disturbed area would be 0.58 acres, which includes 0.34 acres where trees occur and 0.24 acres of the flat former agricultural field which is virtually treeless. On the left bank, a total area of 0.29 acres will be disturbed to create the terraced floodplain. Floodplain excavation will be conducted around most existing trees, allowing them to remain on slightly higher mounds, while still achieving the desired floodplain elevation adjacent to the trees. Active channel designs optimize the use of existing trees by leaving them in place and encouraging a flow pattern that will be likely to undercut banks at tree roots, thereby creating desirable conditions for salmonids. Most trees to be removed are red alders (*Alnus rubra*), however, some arroyo willows (*Salix lasiolepis*) may also be removed. The actions will result in a net increase of 0.43 acres of new riparian habitat. The excavated areas will be actively revegetated by NPS to reestablish riparian understory and canopy quickly. Willow brush mattresses will be installed on some edges of the new active channel which are on the outside of a likely meander bend or otherwise appear to be vulnerable to erosion after construction.

In the Lower Field, two short remnant lengths of levees (150 ft. and 85 linear feet) on the right bank of Redwood Creek will be removed, affecting a total area of about 0.12 acres of riparian vegetation. No mature trees will be removed for this excavation. Where high flow paths are excavated about one foot deeper than the existing grade on the Lower Field, NPS will establish willows along the edges, adding riparian cover that will enhance the function of the floodplain as winter refugia for salmonids. In the area where the existing tributary will be widened, willows along about a 75-foot length of this area will be removed and new willows will be established at the new edge of the widened tributary.

For removal of the 970-foot-long levee adjacent to the Old Ballfield, up to about 0.45 acres of riparian vegetation on the levee footprint will be disturbed. Almost all mature trees will remain in place. Removal of mature trees will be avoided if at all possible, and this is likely to result in about five to six small portions of the levee that are retained in place. Willows are likely to be limbed to create access paths for heavy equipment, and some understory may be crushed under heavy equipment. Access areas will be limited to reduce this impact. Areas disturbed by levee removal will be revegetated as necessary. Additional actions to remove non-native species are discussed in Section 3.6.4

The tree removal and cape ivy removal will have short-term, local, direct minor adverse impacts. Revegetation will be conducted immediately following actions by heavy equipment, and substantial cover is expected within about 5 years. There will be a net gain of 0.43 acres of new riparian habitat in the Upper Alley, 0.12 acres of new floodplain on the Lower Field connected to the larger floodplain, and 4.37 acres newly connected acres of riparian habitat on the Old Ballfield.

Space

Proposed actions will have a beneficial effect on habitat space during summer and winter conditions. The water depth in the low flow channel of the Upper Alley will be increased due to

the installed log jams, and new pools will be created in a reach where few pools occur. Scour in the channel at the ELJ's is projected to be about 2.5 times the height of the exposed rootwad compared to the channel bed (NRCS, 2001, as cited in KHE 2006). The principal author of the NRCS report is the designer of these log jams and will use these observations to balance maximum scour depth of the log jams with minimum risk to the stability of the ELJ's. In the long-term, the added connection of the stream with its floodplain will provide woody debris input to help maintain the channel complexity and available habitat space. The expanded width of the tributary will increase side-channel habitat area for winter refugia. Project actions will allow usage of the floodplain by aquatic organisms.

Safe Passage

Unnatural impediments to fish passage include: velocity barriers, vertical jumps, high temperature zones, dry reaches, and extremely shallow water. Actions that reduce riparian and instream cover may also increase predation by birds (e.g., kingfisher and egrets) over natural levels. Project actions will not result in any velocity barriers, vertical jumps, high temperatures zones, dry reaches, or extremely shallow water. Project actions are expected to increase available pools through the Upper Alley. They will also provide high-flow channels networked across the Lower Field and the Old Ballfield to increase connectivity of the floodplain with the channel for fish. Project actions will increase available cover and available low-flow refugia, facilitating downstream passage to the ocean of adults. Increased complexity will likely reduce risk of predation by birds.

Behavior

The proposed construction work would occur during a critical portion of the summer/fall where dissolved oxygen levels and amount of rearing habitat are at their lowest. Because of extreme low flow conditions in Redwood Creek, fish have limited ability to leave areas of in-water construction. Hence, it is possible that unintended injury or mortality could occur to fish in the construction area. Also, any work in the spring or early summer may impair normal outmigration of smolts (Fong 1997). Project actions will include the following mitigation measures:

Mitigation Measures:

- (BIO-6) No in-water construction activities or creek dewatering will occur prior to July.
- (BIO-7) Prior to any in-stream activities, fish will be removed from project site. Fish will be netted or chased from each individual area where in-channel work will occur. Electrofishing will be used to capture any remaining individuals. Captured fish will be placed in aerated holding containers and transferred to pool habitats outside of the project area.
- (BIO-8) If flowing water is present, nets and silt fences will be placed at the upstream and downstream limits of the project area to prevent entry of fish into the project area and to prevent dispersal of sediments downstream.

Incidental Take

Incidental take of juvenile steelhead trout and coho salmon will likely occur if the project is implemented as described. The numbers of individuals likely to be taken will depend on

instream flow conditions at the time of construction and the reproductive success of steelhead and coho adults of the given year.

To estimate potential numbers for incidental take, we have used the highest juvenile salmonid densities estimates from 1992 to present come from Index Station 6 sampled by our NPS inventory and monitoring program and Dr. Jerry Smith (San Jose State University). It is located downstream and adjacent to the proposed restoration. The high salmonid estimates were done to ensure that we have sufficient "take" allowance for a scenario with wet-year streamflow and high reproductive success of salmonids. The maximum juvenile young-of-the-year steelhead densities of 132 per 100 ft occurred in 1995 (Smith 2003) and 8 per 100 ft for 1+ and older steelhead in 1999 (D.Fong, unpublished data, 1999). In 2005, there was a maximum of 81 coho per 100 ft (M. Reichmuth, unpublished data, 2005).

The maximum expected "take" of juvenile steelhead would be 858 young-of-the-year and 52 1+ and older fish. The total expected "take" of juvenile coho would be 527 young-of-the-year. These estimates are based on densities of juvenile steelhead and coho multiplied by the linear distance of instream construction activities. The maximum distance of instream construction requiring movement of fish is about 650 feet.

Juvenile salmonids will be captured, transported and released from the footprint of the construction site. An unknown percentage of these individuals will be adversely affected in the short-term by capture and handling activities or in the long-term by increased competition with other juvenile salmonids at their relocation sites.

Cumulative Impacts

A pond is proposed for construction in the Lower Field as a separate action to compensate for adverse impacts to threatened California red-legged frogs related to past flood control activities in Redwood Creek at Muir Beach. The new pond will be located within the 5-year floodplain and would likely result in stranding of fish when this frequency event occurs. This potential effect will be reduced by constructing a berm around the pond as part of this project. The berm will prevent flood inundation under a 10-year recurrence interval, thereby reducing potential stranding to an infrequent event.

When combined with preferred alternatives, the construction of the new pond could result in adverse cumulative impacts that are long-term, indirect, local to regional, and minor to moderate. However, long-term, local to regional, moderate to major beneficial cumulative impacts will occur due to the combined benefits of this project, the 2003 floodplain and instream restoration actions, and the proposed Wetland and Creek Restoration at Big Lagoon, Muir Beach. These projects together will have restored some 6,300 linear feet of connected, functioning floodplain habitat. There will be cumulative benefits in the quantity, quality and connectivity of both summer rearing and winter rearing habitat in the Lower Redwood Creek Watershed. The proposed relocation of the MBCSD shed where water treatment chemicals are stored would add a long-term, indirect, minor beneficial impact to water quality protection.

Conclusion

Alternative 1 would result in short-term, direct and indirect, local, and minor to moderate adverse impacts to the federally listed coho and steelhead. With the implementation of the

mitigation measures, which would reduce and/or minimize potential adverse impacts to salmonids, the proposed actions will result in less-than-significant impacts to the species.

Overall, the proposed project "may affect/ is likely to adversely affect" the coho salmon and steelhead, according to the ESA. This is due to the fact that although the implementation of the mitigation measures would reduce and minimize impacts to the species, adverse effects such as harassment, harm, or mortality of individuals may still occur during fish removal prior to construction, dewatering, instream log installation, bank excavation, erosion, turbidity, and tree removal. Impacts considered potentially moderate and actions that would potentially result in a "may affect/likely to adversely affect" determination are short-term and construction-related, and offset by the long-term benefits to the species from improved habitat features.

The proposed project would result in long-term, local to regional, direct and indirect, moderate to major beneficial impacts to the coho salmon and steelhead population in Redwood Creek. With deeper low flow conditions along 580 linear feet of the Upper Alley, a floodplain expanded from an average of 33 feet to 80 feet along the Upper Alley, 0.43 acres of new floodplain in the Upper Alley, installation of 7 ELJ's, new high flow connections on the Lower Field with structural complexity and new routes back to the creek due to additional remnant levee removal, an expanded tributary width for winter refugia, and up to 4.37 acres of newly connected floodplain through removal of the 900-foot-long levee along the Old Ballfield, the project actions will enhance both summer rearing and winter rearing habitat for the coho and steelhead. Overall, the proposed project is expected to result in net increases to the quantity, quality, and connectivity of instream and floodplain habitats. Alternative 1 would not result in impairment to fisheries.

Alternative 2 (No Action)

Under the No Action Alternative the proposed project would not be implemented. The Upper Alley would not be terraced and log structures would not be installed, therefore the low flow channel would not be narrowed or deepened. The incised reach would be left to undergo an eventual natural process by which widening of the active channel and the floodplain would eventually occur, which would then eventually develop instream complexity representative of good summer rearing and winter rearing habitat. Levees adjacent to the Old Ballfield would not be removed, and new functional floodplain acreage would not be made available for winter refugia. The existing floodplain on the Lower Field would remain as is, with no new high flow channels, complexity, or new connections back to the creek.

Cumulative Impacts

No other reasonably foreseeable projects would contribute to cumulative adverse impacts in combination with Alternative 2.

Conclusion

The No Action Alternative would result in local and regional, short and long-term, moderate to major, direct and indirect adverse impacts to in-stream and floodplain habitat for coho salmon and steelhead because their summer and winter rearing habitat in the project area would continue to be limiting to their productivity. Alternative 2 would not result in impairment to fisheries.

California red-legged frog

Affected Environment

The California red-legged frog (*Rana aurora draytonii*) was federally listed as threatened on May 23, 1996, (61 FR 25813), effective June 24, 1996. Surveys have been conducted in 1999 and 2002-2003 along the roadside ditch and mainstem Redwood Creek at the project site to assess breeding activity and rearing habitat quality (Fong 1999 and 2000, Fellers and Guscio 2004). No breeding activity has been documented. Fellers and Guscio (2004) also noted that breeding habitat was poor, but non-breeding rearing habitat in mainstem Redwood Creek was rated as 'medium' based on streamflow condition and cover. However, both breeding and non-breeding habitat for the frog occur about one-half mile downstream of the southernmost end of the project site, at Muir Beach. Breeding activities have been documented at Muir Beach by NPS staff, USGS researchers, and contractors since 1997 (Fong 2000, Fellers and Guscio 2004). A 1.2-acre pond will be constructed under a separate project in the Lower Field to support breeding habitat of the California red-legged frog. This construction is expected to occur in 2007, but it is not expected to support the desired emergent vegetation for about another year. Due to critically low numbers of the California red-legged frogs at Muir Beach, it is unlikely they will colonize the new pond at the project site.

As part of the pond construction project, GGNRA will conduct long-term monitoring of the ability of the site to provide potential red-legged frog breeding habitat by monitoring of emergent plant establishment and duration of ponding. Should no use of the breeding habitat be documented within the first year, the Park will consider the introduction of red-legged frog egg masses from nearby areas within west Marin County.

The project area does not fall within designated critical habitat for the California red-legged frog under the most recent designation by USFWS of critical habitat (Nov. 3, 2005). However, it was designated as critical habitat within the North San Francisco Bay/North Coast recovery unit (Unit 12) in a previous final rule of March 13, 2001 (66 FR 14626) before that designation was vacated by the U.S. District Court for the District of Columbia in November 2002.

The California red-legged frog is found primarily in wetlands and streams in coastal drainages of central California (USFWS 2002). The frog requires specific aquatic and riparian features. Adults require a dense, shrubby or emergent riparian vegetation closely associated with deep (>0.7 meters) still or slow-moving water (USFWS 2002). The highest densities of California red-legged frogs have been associated with deep-water pools with dense stands of overhanging willows and an intermixed fringe of cattails (USFWS 2002). Aestivation sites are located up to 26 meters from water in dense riparian vegetation (USFWS 2002).

California red-legged frogs breed from November through March with earlier breeding records occurring in southern localities (Storer 1925, as cited in USFWS 2002). Egg masses are typically attached to vertical emergent vegetation, such as bulrushes or cattails (Jennings *et al.* 1992), but can be attached to the substrate of ponds. California red-legged frogs are often prolific breeders, laying their eggs during or shortly after large rainfall events in late winter and early spring (Hayes and Miyamoto 1984, as cited in USFWS 2002). Eggs hatch in six to 14 days (Jennings 1988, as cited in USFWS 2002). Breeding sites include streams, creeks, ponds,

marshes, sag ponds, deep pools and backwaters within streams and creeks, dune ponds, lagoons, estuaries, and artificial impoundments, such as stock ponds. California red-legged frogs often successfully breed in artificial ponds with little or no emergent vegetation, as well as ponds with emergent vegetation, and have been observed to successfully breed and inhabit stream reaches that are not cloaked in riparian vegetation, as well as closed-canopy creeks and streams; therefore, factors other than cover are more likely to influence the suitability of aquatic breeding sites, such as the general lack of introduced aquatic predators.

California red-legged frogs often disperse from their breeding habitat to utilize various aquatic, riparian, and upland habitats as summer habitat. This could include ponds, streams, marshes, boulders or rocks and organic debris such as downed trees or logs; industrial debris; and agricultural features, such as drains, watering troughs, or spring boxes. California red-legged frogs can also use small mammal burrows and moist leaf litter (Jennings and Hayes 1994, as cited in USFWS 2002), and ravines that have at least some surface flow during most of the year (USFWS 2002). The historic range of the California red-legged frog extended coastally from the vicinity of Point Reyes National Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward to northwestern Baja California, Mexico (Jennings and Hayes 1985, as cited in USFWS 2002).

Environmental Consequences (California red-legged frog)

Alternative 1

Project actions will complement the to-be-constructed pond in the Lower Field by building a 1.5-foot-high berm around the pond to segregate the pond from sediment deposition in floods having up to a 10-year recurrence interval. About 640 CY of material previously excavated to construct the pond will be used to build the berm over about 0.26 acres. The berm will have a low and wide profile and is expected to support riparian vegetation, including woody vegetation. Heavy sedimentation in pools where California red-legged frogs breed can cause suffocation of egg masses. It could also reduce the depth of the pool, which will rely on groundwater for ponding. The berm also reduces the likelihood of predatory fish entering the frog breeding habitat and consuming tadpoles. Other actions on the Lower Field, Upper Field and Old Ballfield to expand floodplain function, riparian habitat, high flow paths, and enhanced structural diversity on the floodplain will expand available non-breeding habitat for the California red-legged frog over approximately 10 acres in the Lower Field, 4.37 acres in the Old Ballfield, and the entire riparian area along the 3,800 linear feet of Redwood Creek in the project area. Activities that will take place on the site following construction implementation include stewardship work to plant native species, install erosion control, remove non-native species, mow non-native grasses to reduce seed production, and conduct monitoring and educational activities.

Because no red-legged frogs are expected at the Banducci Site (no habitat currently exists) until after completion of the proposed actions, no avoidance or minimization measures are proposed for this site until after breeding habitat has been established. No re-establishment activities would occur until after fall 2007.

To avoid and minimize potential impacts following construction implementation, the following mitigation measures will be followed.

Mitigation Measures

- (BIO-9) Following construction of breeding habitat at the Banducci Site, access roads will be posted with speed limit signs (10 or 15 mph) to minimize vehicle-related injury or mortality to red-legged frogs.

- (BIO-10) Prior to and during construction activities, a biological monitor will search all work localities for the presence of red-legged frogs. The search area will encompass a 50-foot radius around the work sites.

- (BIO-11) Should any frogs be observed, activities will cease until the animal is removed and relocated by a Service-approved biologist. Captured frogs shall be relocated to suitable habitat outside of the construction zone, either upstream or downstream of the construction zone.

- (BIO-12) If erosion control materials are used, only tightly woven fiber netting or non-binded materials (e.g., rice straw) shall be used for erosion control or other purposes at the project site to ensure that the red-legged frog does not get trapped. No plastic mono-filament matting shall be used for erosion control. Revegetation of native species from locally collected propagules will be planted to speed the establishment vegetation which will enhance the habitat.

Cumulative Impacts

Project actions will have a cumulative beneficial impact to habitat for the California red-legged frog in combination with a previous project to create a new pond with suitable breeding habitat. This project will further enhance the long-term viability of the new pond by creating a small berm on the outer edge of the pond to reduce sediment deposition in the pond. This project will also have a cumulative beneficial impact by enhancing the quality of the adjacent non-breeding habitat through actions to restore hydrological function and structural diversity at the project site.

This project will also result in cumulative beneficial impacts in combination with actions proposed by NPS in the Wetland and Creek Restoration at Big Lagoon, Muir Beach, where new, hydrologically sustainable breeding habitat will be created to replace the existing habitat at that location, which is not considered to be sustainable. These cumulative impacts are direct and indirect, local and regional, moderate beneficial impacts.

Conclusion

Alternative 1 would have a direct and indirect, local and regional, moderate beneficial impact on habitat for the California red-legged frog once it is introduced to the site. The project activities will reduce sedimentation to the ponds and enhance the quality and connectivity of available non-breeding habitat. There would be no impairment to the California red-legged frog or its habitat.

Alternative 2 (No Action)

Under Alternative 2, no project actions would take place to construct a berm adjacent to the frog pond or enhance the quality of floodplain and creek habitat.

Cumulative Impacts
In combination with the previous project to construct the pond, the No Action alternative would result in cumulative impacts to the new breeding habitat by resulting in greater sediment deposition in the pond due to lack of a berm and pose a greater risk of predation to California red-legged frog tadpoles. This could impact breeding success or shorten the longevity of the pond by filling during storm events. This would be a long-term, direct and indirect, local and regional moderate adverse impact.

Conclusion
No action would result in a long-term, direct and indirect, local and regional moderate adverse impact due to the lack of construction of a berm around the eastern edge of the pond, thereby allowing greater quantities of sediment to be deposited in the pond. Also, while the pond would become functional for breeding habitat, the habitat quality of adjacent areas would not be enhanced. There would be no impairment to the California red-legged frog or its habitat.

Northern spotted owl

Affected Environment

The Northern Spotted Owl (*Strix occidentalis caurina*) is listed as threatened under the federal Endangered Species Act. Based on annual surveys conducted by NPS, Northern Spotted Owls are known to breed approximately 1.4 kilometers from the Banducci site, in a canyon where Douglas fir and redwood trees occur. Other spotted owls nest at locations further upstream in Muir Woods National Monument. Spotted owls are not known to nest near the Banducci site. Spotted owls are known to nest and roost only in coniferous and mixed evergreen forests in Marin County.

Environmental Consequences (Northern spotted owl)

Alternative 1 (Preferred)

Since project actions will be conducted at a distance of about 1.4 kilometers from the closest known breeding location for spotted owls and will also be conducted outside of the seasonal window for breeding (Jan. 1 through July 31), the actions are not likely to adversely affect the northern spotted owl. In a USFWS Biological Opinion, USFWS concurred that project actions may affect, but are not likely to adversely affect the threatened owl (USWFS 2006).

Cumulative Impacts
Project actions are not projected to result in cumulative impacts in combination with other projects.

Conclusion
Alternative 1 actions could result in short-term, indirect, regional and minor impacts to the northern spotted owl. Alternative 1 would not result in impairment to the northern spotted owl or its habitat.

Alternative 2

Under the No Action alternative, there would be no short-term disturbances to foraging habitat and no expansion of available habitat for prey.

Cumulative Impacts
There would be no cumulative impacts to the northern spotted owl under Alternative 2.

Conclusion
No Action would result in negligible impacts to the Northern Spotted Owl. Alternative 2 would not result in impairment to the California red-legged frog or its habitat.

3.5.2 Other Wildlife

Affected Environment

The songbird use of the Redwood Creek Watershed is summarized in a draft Watershed Assessment (Stillwater 2005a), as follows:

> Riparian woodland habitat comprises less than five percent of the Redwood Creek watershed, but provides breeding and foraging resources for 85 bird species and 16 mammal species. This habitat supports above-average to high bird species diversity and abundance in the San Francisco Bay area compared to other habitat types in the watershed (Flannery et al. 2001). Common species documented include the song sparrow, Swainson's thrush, and Wilson's warbler. Brown-headed cowbirds, black-headed grosbeaks, black phoebes, orange-crowned warblers, song sparrows, warbling vireos, western wood-pewees, Wilson's warblers, ash-throated flycatchers, yellow warblers, northern orioles and common yellowthroats are more abundant in this habitat compared to other vegetation types in the watershed. The shrew-mole and broad-footed mole were only detected in this habitat type (Howell et al. 1998, 1999).
>
> Twenty Species of Concern were detected in the riparian woodlands of the Redwood Creek watershed, including 19 bird species and one mammal species (a bat). In the mid-1990s, researchers determined that nearly one-third of the riparian shrub and herb species in the Redwood Creek riparian corridor was non-native (PWA et al. 1994). Since understory plant volume and diversity are important for nesting riparian birds in the Redwood Creek watershed (Gardali et al. 1999), recent efforts have been made to remove a non-native plant species, Cape-ivy (*Delairea odorata)* from almost 6.2 acres (3.5 ha) of streamside habitat. Following cape ivy removal, bird diversity, richness, and abundance increased significantly in the breeding season (Scoggin et al. 2000).

In addition, numerous species of birds migrate through the area and overwinter in this area, making use of riparian habitats.

Riparian habitats also support high densities of nests for the dusky-footed woodrat (*Neotoma fuscipes*), which tends to inhabit forest habitats of moderate canopy and moderate to dense

understory. Its nests also occur in scrub and chaparral habitats. It constructs nests of shredded grass, leaves, sticks and other materials. Woodrats are nocturnal mammals who tend to occupy previously built nests if available. Both nests and woodrats have been observed in the riparian area along Redwood Creek. No nests are observed in areas proposed for construction, but they may be discovered once work is underway in densely vegetated areas along the creek.

Other species which may be found on the site include black-tailed deer, coyotes, grey foxes, gopher snakes, newts, alligator lizards, bobcats, gophers, and mice.

Environmental Consequences (Wildlife)

Alternative 1

Alternative 1 actions in the Upper Alley will disturb a total of 0.58 acres, including about 0.34 acres of existing riparian habitat and about 0.24 acres of the upper terrace on the field. About 0.29 acres of this area is on the left bank of the creek, all of which is woody riparian habitat. A total of 6 willow and alder trees with a diameter of greater than 1.5 feet DBH may be removed for the Upper Alley excavation. Some trees may have cavities which provide nesting habitat for songbirds. Of the six trees proposed for removal, four trees may be retained if it is determined during construction implementation that they can be avoided. Pre-construction surveys will be conducted to search for potential cavities used for nesting; if trees proposed for removal have such cavities, their proposed removal will be further evaluated for other excavation options to achieve the desired floodplain effects. Other clearing and grubbing will be conducted in this area to excavate banks. The excavation will result in a net creation of 0.43 acres of floodplain in the Upper Alley, with significantly improved riparian corridor habitat conditions and will expand the area available for dense riparian habitat.

The levee to be removed in the Old Ballfield occupies about 0.45 acres of riparian habitat which will be disturbed during construction. Additional adjacent areas may be disturbed by construction equipment for access, but access points will be minimized. Clearing and grubbing will be necessary for levee removal, and some mature trees may be removed, although as many as possible will be retained, including some which may be retained on remnant portions of the levee. Non-native species to be removed, as described in 3.6.4 will extend the area of vegetation disturbance over about 2.8 acres during the initial clearing. Where cape ivy is removed, roots of native species will remain and above-ground growth will become quickly re-established. Where tall fescue is removed, berry-producing shrubs such as those favored by songbirds will be replanted.

About 0.08 acres of willow habitat will be removed to widen the tributary in the Lower Field for winter salmonid habitat. Other actions in the Lower Field to reconnect the hillside drainages with the alluvial plain and create new structural diversity will expand habitat for songbirds and will support the vegetative patchiness often favored by songbirds (Gardali, pers. com, Nov. 2, 2006). Outplanting will not be conducted to establish a dense cover as soon as possible in the Old Ballfield or the Lower Field in order to sustain this patchiness. Instead, a variety of native shrubs yielding berries will be established in the Old Ballfield, and other cover will be allowed to become established naturally. Similarly, in the Lower Field, willow stakes will be established

intermittently along the new high flow paths, but other cover will be allowed to become established naturally.

All construction actions and vegetation removal will be conducted outside of the bird nesting season of March 1 to July 31 to avoid disturbing nesting birds. Trees and other vegetation will not be removed during this breeding season window to avoid impacts to nests.

During excavation on creek banks, it is possible that some woodrat nests will be encountered in dense vegetation where they are currently not detectable. The following avoidance and minimization measure will be followed to reduce impacts to woodrats and their nests:

***Mitigation Measure*:**

- (BIO-13) If woodrat nests are encountered during construction activities, the nests will be avoided, if possible, by establishing a minimum protection buffer of 50 feet around each nest. If nests are identified in areas where heavy equipment operation or excavation is integral to the project design, then the nests would be dismantled prior to grading or vegetation removal activities in a careful, gradual process that would allow any woodrats in the nest to escape into adjacent undisturbed habitat. Surveys will be conducted to determine the likelihood that nests are inhabited, such as a cleared entrance, for example, or recently placed twigs on the nest. A clearly unoccupied nest in an area integral for construction would be dismantled during the routine construction period; however, if the nest appears to be occupied, it would not be dismantled until the non-breeding season of October-November. If young are encountered during nest dismantling, the dismantling activity should be stopped and the material replaced back on the nest and the nest should be left alone and rechecked in 2-3 weeks to see if the young are out of the nest or capable of being out on their own (as determined by a qualified biologist); once the young can fend for themselves, the nest dismantling can continue. Due to the possibility of exposure to hanta virus known to be carried by woodrats, any dismantling or observations of the woodrat nests would be conducted only in a manner that fully protects the health of crews, equipment operators, or surveyors.

Cumulative Impacts

Project actions under Alternative 1 will have direct and indirect, local and regional, long-term beneficial impacts on riparian songbirds in combination with the prior project at the site to restore floodplain connectivity and the downstream actions proposed by NPS in the Wetland and Creek Restoration at Big Lagoon, Muir Beach. Since prior actions established the floodplain connectivity in the Lower Field, these project actions will enhance the structural diversity that will increase its habitat value for songbirds. Similarly, the actions in the Upper Alley, together with prior actions to expand the width of the riparian corridor along 1,300 linear feet of the Middle Reach of the creek, the riparian habitat will have enhanced connectivity along the entire 3,800 linear feet of the Banducci site.

With the project at Big Lagoon proposing to expand riparian habitat in the long term, riparian songbirds will have significantly expanded habitat. These cumulative impacts are long-term,

direct and indirect, local and regional, and major beneficial impacts.

Conclusion
Construction activities to clear and grub in riparian areas, including removal of some trees, will have a short-term, local, minor adverse impact to riparian songbirds and woodrats. This impact is less-than-significant due to the long-term, direct and indirect, local and regional, major beneficial impacts that will occur due to the project actions and the cumulative actions. Riparian habitat will have an adequate width to support nesting of both songbirds and woodrats and will be connected along the entire 3,800 linear feet of the Banducci site. Alternative 1 would not result in impairment to other wildlife species.

Alternative 2 (No Action)

Under the No Action alternative, no actions would be conducted that would have either short-term disturbances or long-term gains in riparian habitat.

Cumulative Impacts
Under the No Action alternative, there would be no cumulative impacts with other projects.

Conclusion
The No Action habitat would have negligible impacts on songbirds or other wildlife. Alternative 2 would not result in impairment to other wildlife species.

3.6.3 Wetlands

Affected Environment

Wetlands are defined by the CWA as "areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that normally do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Under this definition, three criteria must be attained for classification as a jurisdictional wetland: dominance of wetland vegetation, presence of wetland hydrology (inundation or saturation for a specific period of time), and the occurrence of hydric (wetland) soils.

A second wetland definition, one reflecting the broader habitat values associated with wetlands, is used by the USFWS for their National Wetlands Inventory. The USFWS Cowardin system classifies wetlands based on vegetative life form, flooding regime, and substrate material (Cowardin et al., 1979). For the purposes of this definition, wetland features must meet one or more of three criteria. Not all wetlands classified under this system are considered jurisdictional under the USACE definition and CWA.

Jurisdictional Waters and Wetlands
Potential jurisdictional wetlands and other waters of the United States in the Lower and Upper Fields were mapped by NPS and certified by the ACOE in 2003 as part of the permit issued for previous restoration actions (ACOE File No. 27071N). Jurisdictional areas include 4.52 acres of

seasonal wetlands on the field, 0.04 acres of open water in the drainage channel on the western edge of the field, and 2.17 acres of the open water of Redwood Creek on the eastern edge of the field, for a total of 6.73 acres of jurisdictional waters and wetlands. The seasonal wetlands are dominated by native rushes (*Juncus effusis*) and two non-native species, teasel (*Dipsacus fullonum*) and bristly ox-tongue (*Picris echiodes*). This ditch and seasonal wetlands are fed by groundwater, underground springs, and surface flow from the adjacent coastal hills to the west. The riparian corridor along the mainstem of Redwood Creek is not considered jurisdictional wetland.

Additional areas of the project site not included in the 2003 jurisdictional delineation, the Old Ballfield, the lower reach of Redwood Creek, and the Monterey cypress grove, were surveyed between December 2005 and May 2006 for potential jurisdictional waters and wetlands (Castellini and Shoulders, 2006). A potential jurisdictional map of the added area was submitted to ACOE in December 2006. ACOE staff conducted a field review of the site on Jan. 23, 2007 and concurred verbally with the potential jurisdictional areas mapped by NPS. Written certification of the jurisdictional map by ACOE is pending.

Areas of potential jurisdictional wetlands on the Old Ballfield are shown on Table 3-5. They include a 670-foot-long drainage ditch and associated riparian habitat adjacent to Muir Woods Road, a 460-foot long drainage ditch adjacent to Highway 1, and a 0.006-acre portion of two small ditches extending from culverts under Muir Woods Road into the Old Ballfield. These areas are fed by a high groundwater table at the topographically low edges of the Old Ballfield and surface flow and seepage from the hillside drainages to the east (KHE 2006). Most of the drainage from the eastern slopes is routed through a single ephemeral drainage that splits into two drainage courses before crossing through culverts under Muir Woods Road. One drainage course flows along the eastern edge of Muir Woods Road, through a culvert at the intersection with Highway 1 and then through the ditch adjacent to Highway 1 to Redwood Creek, where there is a culvert with a one-way flap gate to prevent the back-up of to the high creek flows into the drainage ditch. During large events, flows in this ditch do not drain until the creek flows subside below the elevation of the culvert at Redwood Creek. The other drainage course from the eastern slopes extends under a culvert north of the riparian corridor next to Muir Woods Road and directs flow out into the Old Ballfield.

Potential jurisdictional waters of the U.S. occur in the 500-foot-long lower reach of Redwood Creek adjacent to the Old Ballfield and terminating at the Highway 1 Bridge. The project area totaling 0.36 acres under the Monterey cypress trees at the north boundary of the site has an ephemeral drainage route under the trees, with sparse understory dominated by blackberry (*Rubus ursinus*), poison oak (*Rhus toxicodendron*), and toyon (*Heteromeles arbutifolia*). Due to lack of wetland indicators, this area is not considered potentially jurisdictional.

TABLE 3-5. CERTIFIED AND POTENTIAL JURISDICTIONAL USACE WETLANDS AND WATERS AT THE BANDUCCI SITE

Site	Jurisdictional Wetland (Acres)*	Jurisdictional Waters (Acres)*
Redwood Creek-Upper and Middle Reach		2.17
Drainage Channel on West Edge of Field		0.04
Seasonal Wetland on West Edge of Field	4.52	
Redwood Creek – Lower Reach		0.44*
Drainage Ditch adjacent to Muir Woods Road	0.68*	
Drainage Ditch adjacent to Hwy 1	0.11*	
Drainage from Culvert under Muir Woods Road in Upper Old Ballfield	0.006*	
Total Wetlands and Waters	**5.32**	**2.65**

* = Potentially jurisdictional wetlands and waters. Other areas were previously certified by the USACOE.

USFWS Wetlands (According to Cowardin Classification)

Surveys for wetlands as defined by the USFWS Cowardin classification system were conducted onsite by NPS in 2002 and supplemented by field surveys in 2006. The types and areas of Cowardin wetlands found within the project area are presented in Table 3-6.

TABLE 3-6. COWARDIN CLASSIFICATION WETLANDS MAPPED AT THE BANDUCCI SITE.

Site Location	Cowardin Classification Wetland	Total Area (Acres)
Redwood Creek Riparian Corridor	Forested wetland (palustrine, permanently flooded)	10.38
Seasonal Wetlands on Western Edge of Field	Scrub-Shrub Emergent Wetland (Palustrine, seasonally flooded, partially drained or ditched)	3.01
Wetlands on Eastern Edge of Seasonal Wetlands	Emergent Wetlands (Palustrine, seasonally saturated)	3.0
Drainage Ditch on Western Edge of Field	Scrub-Shrub Emergent Wetland (Palustrine, seasonally flooded, partially drained or ditched)	1.74
Portion of Upper Field	Emergent Wetland (Palustrine, seasonally saturated, farmed)	4.09
Drainage Ditches at Eastern and Southern Edge of Old Ballfield	Scrub-Shrub Emergent Wetland (Palustrine, seasonally flooded, partially drained or ditched)	2.03

The Cowardin classification system identified two areas as wetlands that were not idenfied in the USACOE jurisdictional wetland delineations. These are: the outer edge of the seasonal wetland, which is dominated by velvet grass (*Holcus lanatus*), and a portion of the Upper Field, which is dominated by teasel (*Disacus fullonum)* and harding grass (*Phalaris aquatica*). Both of these areas are classified as seasonally saturated, rather than seasonally flooded.

FIGURE 11. POTENTIAL JURISDICTIONAL WETLANDS ON THE "OLD BALLFIELD" BANDUCCI SITE.

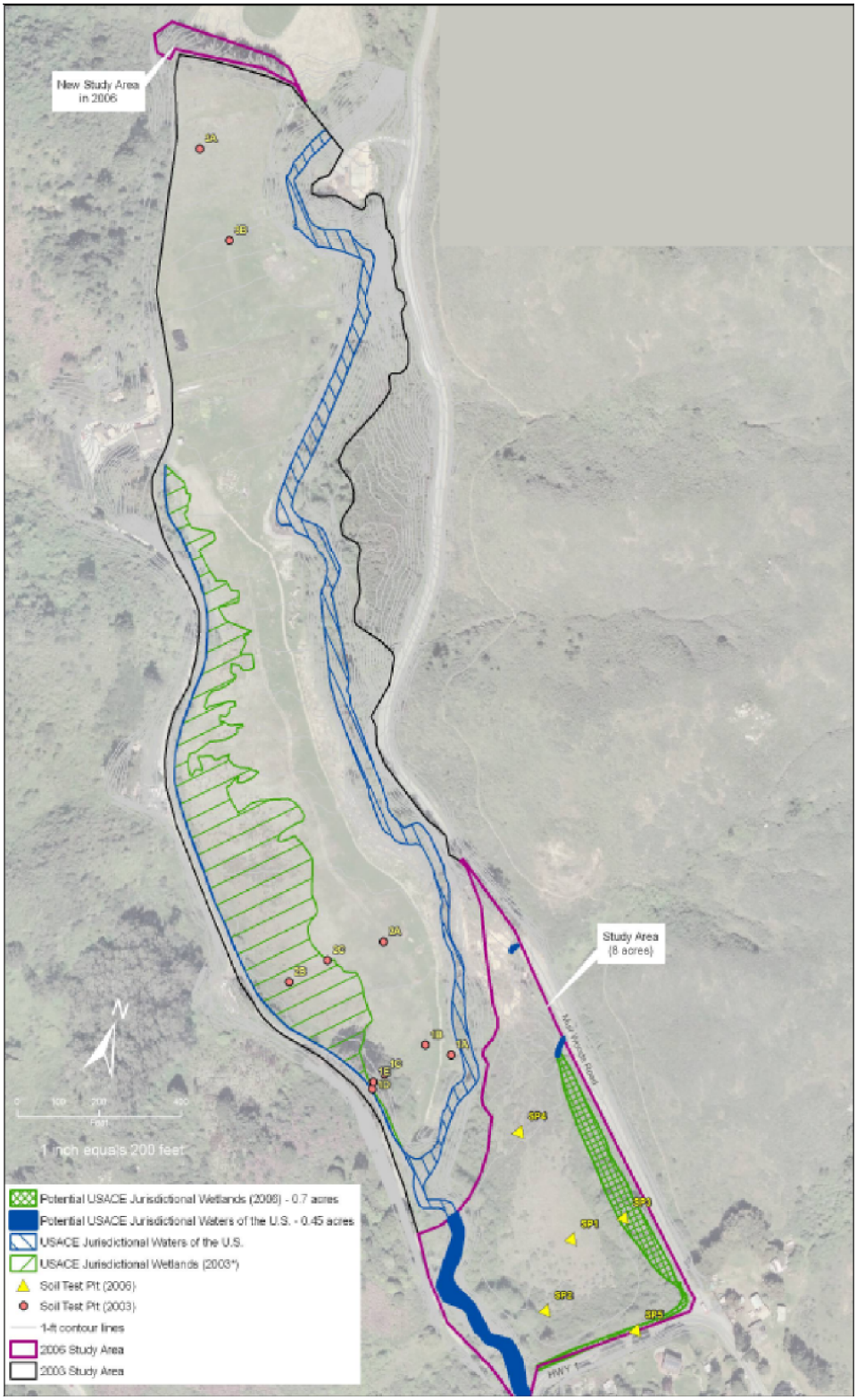
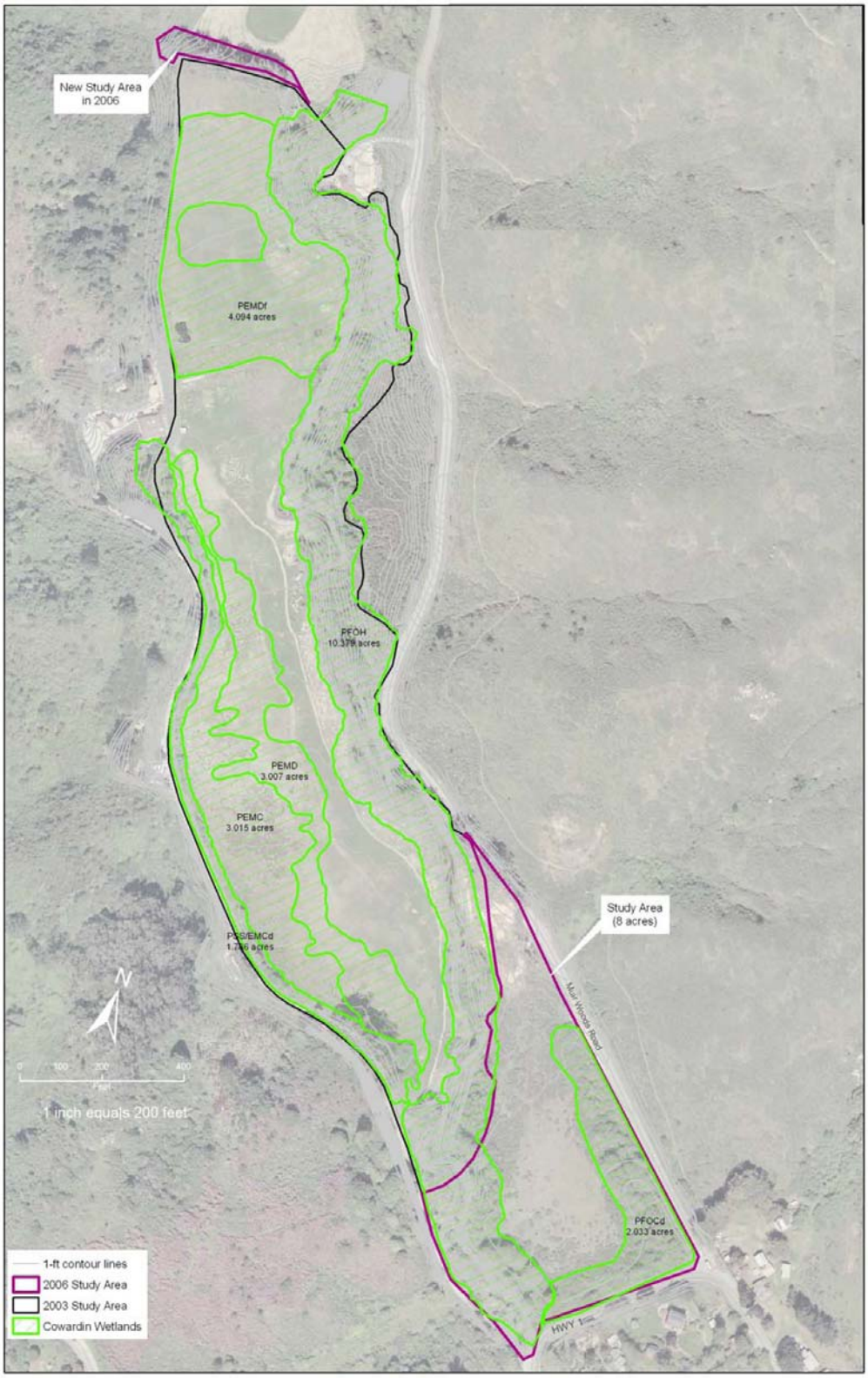


FIGURE 12. COWARDIN WETLANDS AT THE PROJECT SITE



Environmental Consequences (Wetlands)

Alternative 1

Upper Alley: New riparian areas in the newly excavated inset floodplain terrace are not expected to be jurisdictional, but they would expand Cowardin-mapped forested wetlands by about 0.43 acres. Approximately 150 linear feet of the active channel will be widened by about 10 feet to create a more stable channel geometry. This will increase the acreage of potentially jurisdictional open water by 1,500 sq. ft. Six ELJ's to be installed in the channel, often considered fill, would total an area of about 0.014 acres in waters of the U.S. This is based on the total area of the logs in the ELJ design, each a maximum of 30 feet by a maximum diameter of 3 ft. The seventh ELJ is already in place in the creek, but will be reconfigured. Temporary dewatering to be conducted during construction implementation in the Upper Alley would involve the use of coffer dams. While it is likely that only two coffer dams will be needed, one at the upstream and downstream end of the project area, to allow leeway during construction, it is assumed that two separate dewatering areas may be needed, for a total of four coffer dams, each spanning about 30 ft. long by 1 foot wide, for a total area of 0.003 acres of temporary fill in waters of the U.S.

Upper Field: The creation of the new alluvial fan in the Upper Field will not affect jurisdictional wetlands, but a portion of the fan will be constructed over about 0.35 acres of a 4.09-acre Cowardin classified emergent wetland that is seasonally saturated and supports a virtual mono-culture of non-native teasel. The fill is being placed at the northern edge of this wetland where it was once removed for agricultural purposes; thus, this fill placement represents an overall gain in natural features of the site. The intermittent drainage adjacent to the cypress trees is not classified as either a Cowardin or potential jurisdictional wetland. The drainage pattern is not expected to be altered by placement of the fill, but it is possible that run-off may be more likely to flow toward the north, or Santos Meadows on the State Parks property, due to new grade of the alluvial fan. Santos Meadows is dominated by non-native perennial grasses, particularly the noxious harding grass, and if added drainage to that area occurs, it is not likely to alter the vegetative composition or use of the area.

Lower Field and Drainage Ditch: Two tributaries from the hills west of the lower field that currently drain into the roadside ditch will be redirected onto the floodplain of the Lower Field to provide improved hydrological connection between the drainages and the floodplain. Two new, larger culverts or drainage grates to be placed across the road will improve this connection, as will the new high flow paths to be constructed on the Lower Field. Therefore, a large section (990-feet) of drainage ditch adjacent to the road will no longer need to convey the flow from these drainages to the mainstem. Three short stretches of the ditch will be filled (plugged) in order to accommodate redirecting the tributaries through/across the ditch and onto the floodplain of the Lower Field. Ditch fill or plugged sections are each approximately 9-feet wide by 20-feet long, for a total area of 540 sq. ft. The "plugging" approach will minimize potential loss of emergent marsh vegetation and will allow the majority of existing ditch's jurisdictional wetlands to persist. A total of 53-cubic yards of material will be needed to plug the ditches.

The rerouting of the drainages to the floodplain will not reduce the area of the existing jurisdictional seasonal wetland because it is sustained by shallow groundwater which will not be

affected by project actions (KHE 2006).

The widening of about 150 linear feet of the tributary at the southern end of the field from about 4 feet to about 20 feet would expand potentially jurisdictional open water habitat by about 0.05 acres, but this area is already considered a Cowardin-mapped wetland so this type of wetland would not be increased. The tributary will be filled temporarily during construction to create a route for trucks to access the site. This is necessary because an alternate route to the field entails driving down a portion of the access road which is supported by a retaining wall that is susceptible to damage from heavy truck loads. About 40 sq. ft. of the tributary will be filled temporarily and covered with a trench plate. All fill will be removed following construction and before the onset of rains when the tributary might have seasonal flow, and then the tributary will be widened. Flow will not be obstructed by this temporary fill in the tributary.

The creation of high flow paths in the Lower Field is not expected to increase the area of jurisdictional wetlands, but it is likely to expand the Cowardin mapped wetlands by about 0.62 acres because they will be slightly wetter and closer to groundwater elevations. New mounds on the Lower Field will not be placed on jurisdictional wetlands, but two mounds may be created on Cowardin-mapped wetlands. However, they are expected to support riparian scrub vegetation and are not expected to represent a loss of Cowardin-mapped wetlands. These actions will enhance the connectivity of the Lower Field as an alluvial plain receiving drainage from adjacent slopes and will enhance the ability of the site to support a diversity of vegetation.

Berm construction around the new pond will result in the net filling of 0.16-acres of potential jurisdictional wetland. An additional 0.10-acre of the Lower Field outside of the zone of jurisdictional wetland will be covered by the berm. The berm is not likely to be jurisdictional wetland, but it is expected to support willows. However, the pond construction, discussed under Cumulative Impacts, increases the total jurisdictional wetland acreage, more than compensating for any losses of wetland acreage.

Old Ballfield: The new 930-foot-long setback levee was designed to avoid placement on jurisdictional wetlands to the greatest extent possible, while maximizing new area of functional floodplain. However, in order to achieve the flood protection necessary from the setback levee, it must tie into the elevation of Muir Woods Road and it will displace about 0.07 acres of potentially jurisdictional wetland at the junction with Muir Woods Road. The entire footprint of the setback levee is 0.43 acres. It will be constructed at the inner edge of existing scrub-riparian vegetation, outside of the boundaries of the jurisdictional wetland, but within the boundaries of a Cowardin-mapped wetland. Therefore, 0.43 acres of Cowardin-mapped wetland will be displaced by the footprint of the setback levee. The location of the levee is designed to leave adequate space on the road-side of the levee for drainage flows from the hillsides. If the setback levee were to be built too close to the roads, it could reduce conveyance capacity of these drainages.

Drainage from one culvert under Muir Woods Road will be directed to the floodplain side of the new setback levee, leaving only local roadway runoff collecting between the levee and the road. The design will not alter the shallow groundwater conditions that sustain the riparian areas along the road and that likely serve as the primary water supply for the riparian habitat there. No wetland area will be lost as result of this action.

The removal of the levee adjacent to the creek and the creation of new high flow channels on the floodplain at the Old Ballfield are not expected to create new jurisdictional wetlands. The levee removal is not expected to expand Cowardin-mapped wetlands since the riparian area is already classified as a Cowardin wetland; however, the creation of high flow paths may expand areas mapped as Cowardin wetlands by about 0.29 acres since they will be wetter, closer to groundwater elevations, and more likely to support emergent or riparian scrub vegetation.

Summary

Temporary and permanent impacts and gains for jurisdictional wetlands from site-wide restoration actions are summarized in Table 3-7. Permanent impacts and gains to Cowardin-mapped wetlands are shown in Table 3-8.

Construction implementation may result in short-term direct and indirect adverse impacts to wetlands from excavation of high flow channels, inadvertent removal and/or degradation (i.e. from dust, crew trampling, erosion/sedimentation) during levee removal, bank terracing, log installation and creation of the berm at the edge of the pond. However, these impacts are expected to be temporary and minor, especially considering the net benefits to wetlands from project actions. Stewardship actions such as invasive non-native plant removal/control, planting, and monitoring may result in indirect negligible adverse impacts to wetlands.

Site-wide restoration actions would result in long-term direct local minor beneficial impacts to wetlands due to the net gain of 0.078 acres of potentially jurisdictional wetlands. The benefits of enhanced wetland function exceed the benefits of added wetland acreage since hydrologic connectivity and natural drainage patterns will be restored. Restoration actions may also result in a net gain of 0.56 acres of Cowardin-mapped wetlands due to the creation of high flow channels which will trend toward wetter conditions. Cowardin wetlands could be expanded even more, depending on the development of floodplain vegetation once the floodplain is functional.

To avoid and reduce potential impacts to wetlands during construction, all Best Management Practices identified in Director's Order DO-77-1 (Wetland Protection) will be implemented during the project. The list of BMPs has been incorporated into the project and is included in Appendix D.

Cumulative Impacts

Cumulative benefits will result from the combination of 2003 floodplain restoration and proposed actions in this project to enhance the connectivity of the Lower Field to hillside drainage and create micro-topographic conditions to support vegetation and functional diversity. This is a long-term direct and indirect moderate beneficial impact to wetland function.

There will also be a cumulative benefit in wetland acreage from the construction of the new frog pond in the Lower Field, with a maximum ponded water surface of 1.13 acres. A portion of the new frog pond will be constructed within seasonal wetlands previously certified by the ACOE in 2003 as jurisdictional, but about 0.25 acre of the new pond will be constructed in area that is currently not jurisdictional. Even with placement of the berm around the new pond, there will be

an additional 0.09-acres of potential jurisdictional wetland created. These actions with the pond and its berm will not increase the acreage of Cowardin wetlands. Construction impacts from past and future projects, which could include vegetation removal, altered hydrology patterns, erosion or sedimentation, will not result in cumulative adverse impacts to wetlands because each project's individual implementation of practices to avoid and minimize impacts, as well as the overall expansion of wetland function, reduces potential cumulative effects to less than significant levels.

TABLE 3-7. TEMPORARY AND PERMANENT IMPACTS AND GAINS TO POTENTIAL USACE JURISDICTIONAL WETLANDS AND WATERS

Site	Temporary Wetland/Waters Impact (Acres)	Permanent Wetland/Waters Impact (Acres)	Permanent Wetland/Waters Gain (Acres)
Upper Alley:			
ELJ Installation		0.01	
Widen Active Channel			0.03
Coffer Dams	0.003		
Lower Field:			
New pond**			0.25
Berm at edge of pond		0.16	
Plugs in Drainage Ditch		0.012	
Widened End of Drainage Ditch			0.05
Temporary Crossing	0.0009		
Old Ballfield:			
Edge of Setback Levee		0.07	
Total Wetlands and Waters	**0.0039**	**0.252**	**0.33**
Net Change in Permanent Waters and Wetlands: +0.078 acres			

**The pond represents new wetland acreage since the prior certification of jurisdictional wetlands.

TABLE 3-8. IMPACTS AND GAINS TO COWARDIN-MAPPED WETLANDS

	Cowardin Wetland Class		
Site	Forested Wetland (Acres)	Scrub-Shrub Emergent Wetland (Acres)	Emergent Wetland (seasonally saturated) (Acres)
Upper Alley :			
New Floodplain Terrace	+0.43		
Upper Field:			
Alluvial Fan Reconstruction			-0.35
Lower Field:			
High Flow Channels		+0.62	
Old Ballfield:			
High Flow Channels		+0.29	
Alignment of Setback Levee		-0.43	
Total Change	**+0.43**	**+0.48**	**-0.35**
Net Change in Cowardin-mapped wetland acreage: +0.56			

Conclusion
Alternative 1 would result in short-term, direct and indirect, local and minor impacts to wetlands during construction activities. With implementation of BMPs, these adverse impacts to wetlands would be reduced to less-than significant levels. The 0.25 acres of jurisdictional wetlands removed would be offset by 0.33 acres created, and the 0.78 acres of Cowardin-mapped wetlands removed would be offset by 1.34 acres created. The net result of project actions is the direct and indirect, long-term, local moderate beneficial impacts on wetlands due to enhanced hydrological connectivity and enhanced functional diversity of the wetlands. There would be no impairment to wetlands.

Alternative 2

Under this alternative, no actions would be taken to expand wetland acreage or enhance wetland function. However, because soils from excavation of the frog pond would have been placed at the Upper Field, the alluvial fan would be constructed, resulting in the loss of 0.35 acres of Cowardin wetlands.

Cumulative Impacts
There would be no identifiable cumulative impacts to wetlands due to the No Action alternative.

Conclusion
Alternative 2 may result in long-term, direct, adverse, local, and minor impacts to Cowardin wetlands, which are anticipated to be less-than-significant. There would be no impairment to wetlands.

3.6.4 Vegetation and Native Plant Communities

Affected Environment

Historic maps of the project site show today's Lower Field occupied by what is most likely woody riparian species, and the Ballfield was shown with scattered riparian species (U.S. Coast Survey, circa 1870). During its agricultural period from the late 1900's until 1995, riparian trees were removed and the area was under cultivation, mostly of flowers and hay. In the mid-20th Century, historic aerial photographs show very little riparian vegetation occurred adjacent to the creek. After farming ended, a mix of non-native and native species became established at the site.

Most of the Lower Field, as well as the Upper Field, is dominated by non-native grasses, including perennials such as velvet grass (*Holcus lanatus*) and harding grass (*Phalaris aquatica*) as well as annuals such as wild oats (*Avena barbata*). A grove of red alders (*Alnus rubra*) volunteered at the southern end of the Lower Field after farming ended, and within 10 years the trees have grown to more than 20 feet high, with an understory of blackberry (*Rubus ursinus*) and rushes (*Juncus effusis*). A seasonal wetland dominated by rushes and teasel (*Dipsacus sp.)* occurs along the western edge of the Lower Field. The affected environment of wetlands is discussed in Section 3.6.3.

Farming ended on the Old Ballfield before it did on the Lower Field, and this area has developed a strip of riparian vegetation along its eastern and southern edges, adjacent to Muir Woods Road and Highway 1. Arroyo willows (*Salix lasiolepis*) and dogwood (*Cornus stolonifera*) dominate this riparian strip. The northern portion of the field is vegetated by a mix of abundant coyote brush (*Baccharis pilularis*), blackberry (*Rubus ursinus*), and non-native grasses. A virtual monoculture of mature tall fescue (*Festuca arundinaceae*) extends over about 1.5 acres of the southern portion of the Old Ballfield. Tall fescue is a noxious, non-native perennial grass that is often used for residential lawns, but can easily invade natural areas and obstruct the recruitment of native species. Both the Old Ballfield and the Lower Field have been occupied by numerous Jubata grass individuals in the past, but they have largely been removed by NPS and volunteers.

Riparian vegetation along the mainstem creek has recovered significantly since the period of its greatest disturbance in the mid-20th Century. It is dominated by red alder (*Alnus rubra*), which generally grows very close to bankfull elevations, and arroyo willow (*Salix lasiolepis*). Other tree species that occur more infrequently in the riparian corridor include buckeye (*Aesculus californica*), bay laurel (*Umbellularia californica,*), and coast live oaks (*Quercus agrifolia*). Common shrubs occurring in the riparian corridor include red elderberry (*Sambucus racemosa*), dogwood (*Cornus sericea*), and twinbery (*Lonicera involucrata*). The native California blackberry (*Rubus ursinus*) is probably the single-most common understory species. Other understory species include thimbleberry (*Rubus parviflorus*), nettle (*Urtica dioica*), wild cucumber (*Marah fabaceous*), gooseberry (*Ribes divaricatum* and *Ribes sanguineum*), sword fern (*Polystichum munitum*), lady fern (*Athyrium filix-femina*), and false solomon's seal (*Smilacina racemosa*). Two locations of the relatively uncommon bleeding heart (*Dicentra formosa*) are known – one on the east bank of the mainstem near Heather Horse Camp and one on the west bank of the mainstem at the Banducci Site, which was salvaged during 2003 project actions.

Extensive cover by the noxious, invasive vine cape ivy (*Delaria odorata*) became established in the riparian corridor even before farming ended at the site. Data collected in 1998 by NPS showed cape ivy cover was about 45% of all species cover, with cover by many other native species suppressed. Between 1998 and 2006, NPS has removed cape ivy from most areas along Redwood Creek at the Banducci site, except for in two remaining areas. A significant cover by cape ivy remains in the riparian area on the left (easterly) bank of Redwood Creek adjacent to the Old Ballfield, extending over about 1.3 acres. Cape ivy also still occurs on the left bank of Redwood Creek upstream of this area, but NPS removed about 1.8 acres of Cape ivy on the left bank of the Upper Alley in 2005 and 2006. Some of the area along the Upper Alley where cape ivy was removed will be within the banks to be excavated to widen the floodplain. The riparian area on the right (westerly) bank of the lower reach of the project site has shown a significant increase in cover by native species since cape ivy was removed in 1998 (Shoulders 2001).

NPS staff have observed that over about the past five years, the noxious, invasive non-native grass, panic veldt grass (*Erhata erecta*) has rapidly spread along the riparian corridor through the project site and elsewhere along Redwood Creek. The grass grows well in shade and appears to outcompete other native species.

The small drainage at the northern edge of the site that flows through the Monterey cypress

windrow is largely unvegetated, but there is some cover by blackberry and poison oak. A patch of cape ivy occurs at the eastern edge of the windrow. Native coastal scrub species, along with about four slender Eucalyptus trees, occur on the hill adjacent to the windrow.

Environmental Consequences (Vegetation and Native Plant Communities)

Alternative (Preferred)

Project actions affecting riparian habitat are discussed in Section 3.6.1 under Fisheries. Project actions affecting jurisdictional wetlands are discussed in Section 3.6.3 under Wetlands. No special status plant species are known to occur on the site, based on surveys conducted in 2002 and 2003 (Faden, 2002; Taylor, 2003). Revegetation goals and strategies for subareas of the site, vegetation types, and native plant palettes for nursery grow-out and planting are show in Appendix C.

Old Ballfield: Project actions will remove the 1.5 acres of tall fescue by scraping it out with heavy equipment. The mature grasses will be scraped out just below rooting depth, or about 4 inches. The excavated plants will be placed in a pile at the southern edge of the site, covered with a tarp, and allowed to compost for more than a year. Some riparian woody species, particularly understory shrubs, will be planted in this area following construction activities, but it will mostly be allowed to revegetate through natural recruitment. However, the new set-back levee will be actively revegetated with native scrub species such as coyote brush, since it would be prone to establishment by non-native species. Revegetation management will focus on follow-up removal of noxious species, such as tall fescue.

Project actions will also entail the removal of cape ivy in the riparian area in the northern and western edges of the Old Ballfield. Since berm removal will restore frequent overbank flows to the field, and since a 3-year event will extend over the entire newly restored floodplain, cape ivy would be expected to spread throughout the site if it is not removed. Removal of cape ivy on the levee footprint will be conducted with heavy equipment used for levee excavation. Surface material contaminated with cape ivy roots or above-ground growth will be segregated from subsurface material to be re-used for the set-back levee. Material with cape ivy will be removed from the site to prevent its re-establishment. Cape ivy elsewhere in the riparian zone next to the levee will be removed through a combination of cutting and raking. All above-ground herbaceous growth will be cut and raked and hauled from the site. The newly exposed ground surface will be grubbed repeatedly for cape ivy roots and new sprouts that appear throughout the following growing season. Roots of native perennials are not disturbed by this method and quickly become re-established. Replanting will only be conducted in the area where the levee is removed.

Lower Field: Newly created high flow channels will be revegetated with intermittent willow stakes inserted deep into the floodplain (Appendix C). The willows will help maintain the high flow channels by promoting scour against their trunks, and they will provide additional cover for fish using the floodplain as winter refugia. The newly excavated areas are likely to become naturally revegetated with a mix of native and non-native species occurring at the site, such as velvet grass and juncus. The Lower Field may retain a long-term patchiness of vegetation types,

which is considered beneficial for bird habitat. Due to the extensive stands of velvet grass at the site, it is not considered feasible or within the scope of this project to remove it. Newly placed logs on the Lower Field are expected to invite establishment of species such as blackberry, hedge nettle and colts foot. The logs provide perches for birds, which drop seeds, and the logs also create pockets of moisture and shade which supports establishment of such species. Newly created mounds will be managed to prevent the establishment of noxious species and will be replanted with appropriate upland species, particularly shrubs.

Upper Field: The newly created alluvial fan will tie into the adjacent hillside currently dominated by coastal scrub species. The newly placed fill will be revegetated with nursery-grown stock of coastal scrub species, such as coffeeberry (*Rhamnus californica*), gooseberry (*Ribes sanguineum*), snowberry (*Symphoricarpus albus*), and mugwort (*Artemisia douglasiana).* This will extend a native vegetation community into a portion of the site that is currently inhabitated mostly by non-native grasses.

Upper Alley: Portions of the newly excavated active channel which appear to be vulnerable in the short run to bank erosion will be protected with a willow brush mattress or similar biotechnical erosion control. These areas are likely to be limited to outside meander bends or similar vulnerable reaches of the creek bank. Willows and understory riparian species will be planted on the newly cut floodplain, and the area will be managed to prevent weed establishment, but most of the area will be allowed to become naturally vegetated with riparian plants.

On the east side of the Upper Alley, a temporary haul road will be cut through the brush between Muir Woods Road and the creek. This area is dominated by coyote brush. Trucks carrying excavated fill from the east bank of the Upper Alley will drive down this temporary road to carry fill to the Old Ballfield for the new setback levee. Following construction, brush debris will be placed atop the temporary haul road to reduce visual impacts, possible temporary erosion, and possible use by other vehicles. The area will be naturally revegetated through encroaching scrub species.

Short-term direct minor adverse impacts to vegetation and native plant communities may occur due to construction activities, such as temporary removal or degradation due to heavy equipment and the temporary haul road. Long-term indirect adverse impacts may result from future weed encroachment in project areas after soil disturbance. This impact would be minor to moderate, and would be largely off-set by the long-term, direct and indirect, moderate beneficial impact of removing significant stands of the noxious species, cape ivy and tall fescue, and the establishment of new native riparian habitat in the Upper Alley, the Lower Field and the Old Ballfield.

To reduce weed encroachment and impacts to native vegetation communities, the following mitigation will be implemented.

Mitigation Measures:

- (BIO-14) All vehicles will be brought in cleaned and free of weeds to prevent the spread and/or introduction of invasive plant species.

- (BIO-15) Soils and vegetation contaminated with weed seeds would be segregated and disposed of or treated as appropriate.
- (BIO-16) At the discretion of the project Biological Monitor, restrictions will be placed on the movement or deposition of fill, rock, or other materials containing weed seed or viable plant cuttings to areas relatively free of weeds.

Project actions would result in local, long-term direct and indirect moderate to major beneficial impacts due to the restoration of the riparian corridor along 580 linear feet of the Upper Alley, the 10-acre Lower Field, and the 4.37-acre Old Ballfield; the removal of cape ivy from 1.3 acres, and the removal of tall fescue from 1.5 acres in the Old Ballfield. Due to the recreation of natural contours at the northern end of the Upper Field, a coastal scrub community can become established in this area.

Cumulative Impacts

Cumulative long-term, direct and indirect, moderate to major beneficial impacts will occur due to this project in combination with actions conducted previously in 2003. The newly restored floodplain connection with the middle reach in 2003 allows this project to refine the topography and therefore the vegetation that will occur on the Lower Field. In addition, the previously widened floodplain corridor along the middle reach will combine with current project actions to create a functional riparian corridor width along the entire 3800 linear feet of channel in the project area. Vegetation in the 2003 restoration area is established, but still immature as of late 2006. However, its survival through multiple years and its apparent high recruitment rate after overbank flows indicates that with ample time, the area will clearly become a functional riparian habitat.

Conclusion

Alternative 1 would result in short and long-term, direct and indirect, local, and minor to moderate adverse impacts to vegetation and native plant communities. With the implementation of the mitigations, adverse impacts would be reduced to less-than-significant levels. However, the proposed project would result in long-term, direct and indirect, local, and moderate to major beneficial impacts. New native riparian habitat will be established over 0.43 acres in the Upper Alley, 4.37 acres in the Old Ballfield, and scattered over 10 acres in the Lower Field. Additionally, noxious non-native species would be removed from 2.8 acres in the Old Ballfield. Overall, the proposed project would result in a net increase to the quantity and quality of vegetation and native plant communities as well as cumulative long-term, direct and indirect, moderate to major beneficial impacts 3. There would be no impairment to vegetation.

Alternative 2 (No Action)

Under the "No Action" Alternative (Alternative 2), none of the proposed actions would be implemented within the Project Area. Therefore, non-native species removal would occur, and landscape modifications that allowed the expansion of riparian habitat would not be conducted. As a result, no adverse impacts would occur to biological resources from equipment, vehicle or crewmember disturbances, habitat removal, harm, or mortality. However, the prior, long-term disturbances to vegetation from previous land uses would persist.

Cumulative Impacts
Cumulative impacts of no action would be the same as project-specific impacts of no action.

Conclusion
Alternative 2 may result in long-term, indirect, adverse, local, and minor to moderate impacts to Vegetation and Native Plant Communities that may be considered significant if noxious non-native plant species continue to encroach on native riparian communities. There would be no impairment to vegetation.

3.6 Cultural Resources

Affected Environment

For the purposes of Section 106 of the National Historic Preservation Act, the requirement that Federal agencies take into account the impact of their actions on properties listed in or eligible for listing in the National Register of Historic Places, the project boundary is considered the Area of Potential Effect (APE) for assessing impacts (Figure 1).

This APE incorporates the relatively flat areas adjacent to Redwood Creek which were part of Ranch S, a 170-acre subdivision created by the Tamalpais Land and Water Co. and sold to Antonio A. Silva in 1898. Silva developed a dairy ranch, with cattle grazing on the hills west of the valley. The ranch was representative of the Portuguese dairy ranching community that extended through southern Marin at the turn of the century. The Portuguese dairy community is significant in the history of Marin County since these ranchers worked collectively through family and financial connections to eventually own nearly all the southern Marin ranches until about the 1950's. The Portuguese also represented a significant percentage of about 23% of the total population of Sausalito in the late 1800's (Weeks and McKee, 2006).

Silva's dairy ranch ceased to operate by the 1930s. The only remaining remnant from the 30 year period of dairy ranching is the main house, which has undergone major alterations. The ranch was converted to a cut flower farming operation when Silva rented the land to Amadeo Banducci Sr. Since farming requires more intense utilization of the land than that based on animal husbandry and milk production, the landscape of the dairy-era was highly altered. Dairy barns and other structures were demolished.

Due to its role in the history of the Portuguese Dairy Ranching period in southern Marin, the Banducci site was evaluated in 2005-07 in a Determination for Eligibility (DOE) for listing in the National Register of Historic Places. However, based on the lack of identifiable features from the dairy ranching period, the DOE found the site is not eligible for listing for this historic association (Weeks and McKee, 2006).

When Banducci began to farm the land on Ranch S in the 1930s, he planted delphiniums, gladiolas, daffodils and stock which he irrigated with creek water. He also helped establish the San Francisco Flower Mart in association with other Italian growers. During the period of World War II, he focused on growing vegetables, including peas, artichokes, zucchini and Italian beans. Banducci eventually acquired the land in 1948 and then refocused on the flower business and

grew crops of heather cultivated on the hillsides. An extensive irrigation pipe system was installed on the floodplain fields and hillsides to irrigate flower crops, and the system was fed by water from 5 wells installed adjacent to Redwood Creek (Weeks and McKee, 2006). During this period, landscape modifications were made to the agricultural field to protect crops. Levees were constructed, the drainage ditch adjacent to the road was constructed, and fields were leveled, with drainage sloping away from the creek to reduce loss of top soil by erosion. A remnant ox-bow in the northern field was filled in at that time. The Monterey cypress windbreak at the northern edge of the site was planted in the 1950's.

The farm was eventually sold to the National Park Service in 1980, and the Banducci's leased the site for farming until 1995. Farming ended in 1995 due to lack of state water rights for diversions. A hydrological analysis found the wells used for irrigation dried the creek during low-flow periods which were critical for salmonids about to be listed in the federal Endangered Species List (PWA, 1995). Since that time, the fields have remained fallow and both native and non-native plant species have invaded the former agricultural fields.

The DOE evaluation found that while the Banducci Flower Farm was once a prominent feature of the Muir Beach/Frank Valley landscape, it also does not meet the criteria for listing in the National Register of Historic Places since it does not retain defining features and was one of many similar properties in the Bay Area (Weeks and McKee, 2006). As of January of 2007, the NPS was awaiting concurrence with its National Register findings from the California State Historic Preservation Office.

Archeological Resources

The indigenous people of Marin County, known as the Coast Miwok, may have lived in Marin County for as long as 8 to 10,000 years (Meyer, 2005). Today, the Coast Miwok are represented by the Federated Indians of Graton Rancheria (FIGR), a federally recognized American Indian tribe.

Coast Miwok settlements were probably clustered around estuaries and low-lying areas, but the cliffs along western Marin were probably unsuitable for residence (Meyer 2005). The earliest archaeological record for Marin County is from a site near Richardsons Bay, where sites dating to as early as 5600 BP (Before Present) were found (Moratto 1984, as cited in Barker, 2005). The Frank Valley/Muir Beach area probably attracted native peoples due to its access to abundant food, water, fertile bottomlands and other resources (Barker 2005).

Three known prehistoric archeological sites occur in the Muir Beach area. One site (CA-MRN-333) is already listed in the National Register of Historic Places (NRHP) and the cluster may comprise an archeological district associated with the mouth of Redwood Creek since all sites appear to be eligible for listing individually. The valley upstream of Muir Beach extending through and beyond the project site also has a high potential for additional prehistoric sites. With the valley's history of repeated flooding that resulted in alluvial deposition as well as channel migration, it is possible that archaeological sites were buried and have yet to be identified (Weeks and McKee, 2006). An historic archeological site has also been found in association with the Golden Gate Dairy (Ranch M) nearby, and historic period archeological

sites related to 19th century dairy farming are expected on Ranch S.

The soil type in the project area (Blucher-Cole complex) is the same as the surface soil type at two other Marin County locations where archeological sites have been found, along the banks of Chileno Creek and at Olompali State Historic Park (Meyer 2005). Meyer has suggested that if these areas have a depositional history similar to that of Frank Valley, then it is likely that similar aged (Late Holocene) "buried soils" and archaeological deposits are also present in the alluvial landforms of lower Redwood Creek (Meyer 2005).

In September 2006, NPS conducted a subsurface investigation for potential archaeological sites in the former agricultural field at the base of three alluvial fans on the western edge of the site in consultation with the Federated Indians of Graton Rancheria. Five mechanical test trenches were excavated in the vicinity of planned frog habitat ponds, and one adjacent to the current Banducci residence based on past discoveries of obsidian and groundstone artifacts . This last and northern-most trench was excavated up to 17 feet deep in the field near the vicinity of the main house. Other trenches were excavated to about six to eight feet deep at the base of the next two drainages to the south. No buried soils or archaeological features or artifacts were found (pers. comm., Leo Barker, Sept. 26, 2006). In 2002, the FIGR participated in a surface archaeological survey along the creek, but no indigenous sites were located (Barker 2005).

While no archaeological sites have been located at the site, Amadeo Banducci reports that his family often found arrowheads and other fragments of obsidian artifacts on the hillsides and fields during farming operations, and a large collection of obsidian bifaces, mortar fragments, and other indigenous artifacts was recorded in 2006 (Banducci, pers. comm. with Leo Barker Sept. 26, 2006).

Environmental Consequences

Alternative 1 (Preferred)

While no known archaeological resources have been identified at the site, there is the potential that archaeological resources could be discovered during restoration actions that disturb site soils. Most restoration actions affect soils that have been previously altered for farm management, such as the construction of levees, the drainage ditch adjacent to the access road, and bank stabilization along the Upper Alley. High flow channels to be constructed on the Lower Field and Old Ballfield will generally be about 1 foot deep, or possibly a maximum of 2 feet deep, well within the range that would have been disturbed by cultivation. The new setback levee on the Old Ballfield will require some subsurface compaction prior to its construction; however, the Old Ballfield has not been considered a likely "hot spot" due to its historic function as the lowland drainage. The Monterey cypress trees at the northern boundary of the site occur at the base of an alluvial fan, which is a potential hot spot. Construction actions will be monitored for possible discoveries.

Because there are no National Register properties within the APE and this project aims to have negligible effects on historic resources, Section 106 review on this project will be carried out by NPS under its 1992 Programmatic Agreement with the State Historic Preservation Office. If

buried archaeological resources are discovered during construction, the following mitigation measure would be enacted as appropriate:

Mitigation Measures:

- (ARCH-1) If buried cultural resources such as chipped stone or groundstone or human bone are inadvertently discovered during ground-disturbing activities, work should stop in that area and within a 100-foot radius of the find until a qualified archaeologist can assess the significance of the find.

- (ARCH-2) Inadvertent discoveries will be treated in accordance with 36 CFR 800.13 (Protection of Historic Properties: Post-review discoveries). The archaeological resource will be assessed for its eligibility for listing on the NRHP in consultation with the SHPO and the Federated Indians of Graton Rancheria (if it is an indigenous archaeological site) and a determination of the project effects on the property will be made. If the site will be adversely affected, a treatment plan will also be prepared as needed during the assessment of the site's significance. Assessment of inadvertent discoveries may require archaeological excavations or archival research to determine resource significance. Treatment plans will fully evaluate avoidance, project redesign, and data recovery alternatives before outlining actions proposed to resolve adverse effects.

- (ARCH-3) If human skeletal remains are encountered, protocols under federal law will apply. All work shall stop in the vicinity of the discovery, and the find will be secured and protected in place. The Marin County coroner and Park Archaeologist will both be immediately notified. If a determination finds that the remains are Native American, and that no further coroner investigation of the cause of death is required, they will be treated in accordance with the Native American Graves Protection and Repatriation Regulations at 43 CFR 10.4 (Inadvertent discoveries).

Cumulative Impacts

The proposed project would not have impacts to historic resources and would avoid impacts to archaeological resources; therefore the proposed project would not contribute cumulatively to impacts that have occurred to cultural resources from other regional projects.

Conclusion

With mitigations to protect potential archaeological discoveries, the project would have long-term, direct and indirect, local and regional negligible impacts to historic or archaeological resources. If a site is discovered, this would be regional, long term, direct benefit to the understanding of prehistoric uses in the region. There would be no impairment to historic or cultural resources.

Alternative 2 (No Action)

The No Action Alternative would mean that no proposed project actions would occur onsite; therefore, this alternative would not result in any impacts to archaeological resources.

Conclusion
Under the No Action Alternative, no adverse impacts to historic or cultural resources are anticipated. Similarly, no cumulative or beneficial impacts are anticipated. There would be no impairment to historic or cultural resources.

3.7 Visitor Use and Recreation

Affected Environment

While the project site in within the same watershed as Muir Woods National Monument and Muir Beach, both highly visited sites, the project site does not have any areas designated for public use or recreation. The only public trail on the Banducci site is the Mount Tamalpais State Park Coast View trail on the hills at the western edge of the property, but that is not within the project area, and its southern edge does not connect to other trails. The Heather Cut-off Trail, on California State Parks property near the northern boundary of the project area, routes hikers and equestrians north of the Banducci site through Santos Meadows. The Redwood Creek trail is east of the project site, on the eastern side of Muir Woods Road. Its trailhead begins at the intersection of Highway 1 and Muir Woods Road, directly across from the southeast corner of the Old Ballfield. Bikers frequently use Muir Woods Road as an access to other locations.

The Muir Beach Volunteer Fire Department hosts an annual Memorial Day fundraising event at the assemblage of picnic facilities and grills on the MBCSD and State Parks properties immediately north of the project area. Santos Meadows is used for parking during that event.

Environmental Consequences

Alternative 1 (Preferred)

Since the project area does not have visitor or recreational facilities, there will be no impacts to such resources from project actions. Residential use of the site or adjacent areas will not be impacted by completed project actions. Community events on properties adjacent to the site will not be impacted.

Cumulative Impacts
While this project does not impact existing recreational uses, the new setback levee to be constructed in the Old Ballfield is proposed as a trail connector in two out of three alternatives for new trail alignments of the Lower Coast View Trail. The Dias Ridge and Lower Coast View Trails Rehabilitation project, jointly proposed by NPS and Mount Tamalpais State Park, has proposed two possible trail alignments to extend the Coast View Trail through the southern coastal hills on the Banducci property. The new alignments would route visitors to a new crossing over Redwood Creek adjacent to the existing Highway 1 Bridge. The new crossing would tie into the setback levee for a connection to the Redwood Creek trail on the east side of Muir Woods Road. The trail connection would provide the first southern trail route to Muir Beach and expand available opportunities for bikers who want to avoid Highway 1. The added function of the setback levee as a trail connection would be a long-term, direct, major beneficial impact to visitor and recreational uses.

Conclusion
The project actions would not impact recreational use. There is the potential for long-term, direct, major beneficial cumulative impacts if the setback levee functions as a trail connector between a new alignment of the Coast View trail and the Redwood Creek Trail.

Alternative 2 (No Action)

Under the No Action Alternative, no project actions would be taken and there would be no impacts to visitor, residential or recreational uses.

Cumulative Impacts
Under the No Action Alternative, the setback levee would not be constructed. The Dias Ridge and Lower Coast View Trail Improvements project could still elect to route a trail through the Old Ballfield, but its impacts would not be offset by ecological gains proposed as part of this project. This would be a long-term, direct and minor adverse impact.

Conclusion
Alternative 2 would not result in impacts to visitor, residential or recreational use, but long-term, direct, and minor adverse impacts could occur due to cumulative impacts.

3.8 Land Use

Affected Environment

Projects are subject to Farmland Protection Policy Act (FPPA) requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency. The FPPA is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. For the purposes of the FPPA, the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) has classified farmland as prime farmland, unique farmland, and land of statewide or local importance.

The NRCS' Farmland Mapping and Monitoring Program lists the soil type at the site, the Blucher-Cole complex, as Farmland of Statewide Importance, but not as prime farmland (California Dept. of Conservation, 2004). Farmland of Statewide Importance has a good combination of physical and chemical characteristics for the production of crops. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use. Farmland of Statewide Importance must meet all the following criteria: water, soil temperature, acidity-alkalinity, water table, soil sodium content, flooding, erodability, and rock content. The soils at the Banducci site are likely to meet these criteria.

The site has a long history of agricultural use due to both its dairy ranching and flower farm operations through the 20th Century. Agricultural operations continued on the site through a lease arrangement after NPS purchased the property in 1980, but farming ended in 1995 due to financial feasibility associated with the lack of state water rights for diversions and hydrological

data indicating the agricultural water diversions dried out Redwood Creek at a time when resident coho salmon were about to be added to the federal Endangered Species List (PWA, 1995). The lack of a legal water source effectively ended the farming operation. Due to the presence of good farmland, local interest in farming at the site has persisted despite the lack of a water source that meets state water rights laws.

The site is included in the GGNRA General Management Plan of 1980 as part of the Pastoral Landscape Management Zone due to its former agricultural operations. The 1980 GMP recognized that additional resource management studies might change the configuration of this pastoral zone. The creek through the site is recognized in the GMP as part of a biotic sensitivity subzone where use and development should be either discouraged or mitigated. GGNRA is currently preparing a new GMP, slated for completion in about 2011. GGNRA is also currently preparing a management plan for three Marin County equestrian operations, including the Golden Gate Dairy, at Muir Beach, which has included discussions of possibly relocating equestrian operations to the Upper Field of the Banducci site.

Today the site is managed by GGNRA as a natural area. Residential use on the site continues, but is generally restricted to the area around the dwellings and the access road. The fields have begun to develop more natural features, such as the seasonal wetlands on the western edge of the field. Prior actions to reconnect Redwood Creek with the floodplain on the Lower Field have led to the natural recruitment of alders over an extensive area, reminiscent of tree cover shown on historic maps.

Environmental Consequences

Alternative 1 (Preferred)

The FPPA instructs federal agencies to consider alternative actions that could lessen adverse effects to farmland. However, there is only one alternative analyzed because there is not another reasonable alternative that will restore natural creek processes in the project area. However, project actions in the Upper Alley, Lower Field and the Old Ballfield will allow enhancement of natural processes at the site while not precluding other potential future uses in the Upper Field that could be determined through other planning processes, including farming or equestrian uses.

If the site were ever farmed again, the most desirable land would be the Upper Field, which has deep loam soil but is less susceptible to flooding (Banducci, pers. comm. C. Shoulders, Nov. 2006). Even before removal of the berm in the Middle Reach in 2003, the Lower Field and the Old Ballfield were susceptible to wet conditions that made them less desirable for farming. Currently, there is no source for irrigation of the agricultural fields. FPPA does not require regulation, permitting or permission from National Resources Conservation Science (NRCS) to proceed with conversion of Important Farmlands but the NRCS requests notification of the project. The required forms have been filed with the NRCS.

Project actions will not increase flooding on Upper Field or make it less productive or desirable as farmland. About 0.24 acres on the eastern edge of the Upper Field will be excavated along the creek bank to expand the available floodplain and riparian area, but this will not cause more

frequent flooding on the rest of the Upper Field. This bank has been stabilized by artificial features for many years, and the banks of the creek are likely to erode to about this width over time eventually (KHE 2006). The Upper Field will also be reduced by the placement of fill over about 1.3 acres next to the Monterey cypress trees to recreate an alluvial fan. This is an approximate area of fill formerly removed for agricultural operations. The rest of the Upper Field – extending over about 8 to 10 acres – will remain effectively unaltered by project actions. The bank excavation and the placement of the fill represent a minor reduction in the total area available for other uses, and since the area is currently not used for agriculture, this effect is minor.

Actions in the Lower Field will not increase flooding there, since the Lower Field was already reconnected to its historic, natural floodplain by previous actions in 2003. However, the creation of high flow actions, placement of logs, and revegetation actions to invite vegetative and structural diversity in this area would create a natural habitat that is not compatible with other uses, especially uses which would entail vegetation removal, earth moving, or grading. This area is recognized by the former farmer of the site as less desirable for farming due to its shallow groundwater and tendency to remain wet. Also, the floodplain provides added flood storage area that benefits downstream residents.

Project actions to remove the levee adjacent to the Old Ballfield would increase flooding there and remove it from suitability for future farming. With shallow groundwater, the site is already less desirable for farming than the Upper Field. The added floodplain storage area of the Old Ballfield also provides direct flood reduction benefits to downstream residents. It is possible that some uses of this area that would not entail extensive or routine vegetation removal, grading, filling or similar activities could be compatible with the long-term function of this site as a floodplain.

The proposed actions would not represent a conflict with existing GMP objectives or management zones, which anticipated that additional resource management studies could significantly alter the configuration of the Pastoral Landscape Management Zone.

Cumulative Impacts

Prior actions in 2003 established the long-term natural function of the Lower Field by reconnecting it as a floodplain with the Middle Reach of the creek. Proposed actions do not alter that function, but further enhance that area's natural function. The cumulative impact of these two projects in the lower field is a long-term, direct, minor adverse impact on land use as farming.

Conclusion

Project actions would have a long-term, direct and minor adverse impact on land use as farmland. While the most desirable land for farming in the Upper Field would not be precluded from that use by proposed project actions, there would be minor reductions of 0.24 and 1.3 acres in available area in the Upper Field (compared to 8 to 10 acres remaining). The impact is further considered minor due to the lack of farming and questions about the long-term viability of farming at the site due to the lack of state water rights for irrigation sources. Other project actions in the Lower Field and Old Ballfield would affect areas that are not considered desirable

for farming due to their shallow groundwater, wet conditions, and the overall gains in flood reduction that occur due to allowing the areas to function for floodplain storage.

Alternative 2 (No Action)

Under the No Action alternative, no excavation would occur along the Upper Alley, the alluvial fan would not be reconstructed in the Upper Field, and actions to enhance floodplain function on the Lower Field and Old Ballfield would not be conducted. There would be no impacts to land use as farmland.

Cumulative impacts
Under the No Action, there would be no cumulative impacts to land use as farmland.

Conclusion
The No Action alternative would have no impacts to potential land use as farmland.

3.9 Noise

Affected Environment

The noise environment of the site is influenced by human activity from adjacent residential and traffic on adjacent Muir Woods Road and Highway 1. However, the predominantly unoccupied landscape of the site makes the area relatively quiet with a natural soundscape influenced by sounds of the creek and songbird use.

Environmental Consequences

Alternative 1 (Preferred)

Proposed actions would result in negligible to minor adverse impacts to the soundscape of the site during construction. Construction activities would involve the use of excavators, dump trucks and a water pump that could temporarily result in short-term, direct, and minor to moderate adverse impacts to noise levels at adjacent residences. The pump to be used for dewatering during installation of the ELJ's in the Upper Alley would be powered by a generator that would run continuously, including overnight, until in-channel work was completed. This is anticipated to be about one to two weeks, but the generator is not expected to be operated over weekends. Noise from the generator would be muffled by constructing a wall of straw bales around the generator. Construction noise levels would vary depending on the specific actions underway. Typical noise levels from construction equipment are shown in Table 3.9. Long-term impacts to ambient noise levels are not anticipated.

As riparian habitat expands over the Lower Field and the Old Ballfield, if songbird use of these areas also expands, then there may be a long-term, indirect, minor beneficial impact to the natural soundscape.

TABLE 3-9. TYPICAL NOISE LEVELS

Typical Noise Sources at a Given Distance from Noise Source (at a distance a person would typically be from the source)		Typical Construction Equipment Noise Levels at 50 feet	
Noise	**dBA**	**Noise**	**dBA**
Rock Music Day	110-150	Jack hammers	130
Leaf blower, lawnmower	90-105	Chain saw	100
Ambulance siren	100	Front Loaders/excavators	80-90
Air Compressor	90	Scrapers/Pavers	89
Hair Dryer	80-95	Bulldozers	85
Vacuum cleaner	84-89	Generators	81
Light Traffic	50	Backhoes	80-85
Threshold of Hearing	10	Pumps	76

Acoustical Engineers and U.S. Environmental Protection Agency, *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, December 1971, Noise Pollution Clearinghouse (www.nonoise.org)

Cumulative Impacts

There will be no cumulative impacts to noise or natural soundscapes due to project actions. If other projects were to occur at the same time, there would be short-term, direct and indirect , minor adverse cumulative adverse impacts resulting from increased noise in the area.

Conclusion

Potential impacts to noise levels and the natural soundscape would be short-term, direct, and minor to moderate, but less-than-significant due to its short-term nature during the construction period only. A long-term, direct, minor beneficial impact may occur due to expansion of riparian habitat that will enhance the natural soundscape through added songbird use. There would be no impairment to the natural soundscape.

Alternative 2 (No Action)

Under the no action alternative, there would be no impacts to noise levels or the natural soundscape.

Cumulative Impacts

There would be no cumulative impacts as a result of the No Action Alternative.

Conclusion

Alternative 2 would result in no impacts to noise levels or the natural soundscape. There would be no impairment to the natural soundscape.

3.10 Visual Resources

Affected Environment

The project site is visible from Muir Woods Road as well as adjacent ridges both to the east and west. From a distance, it retains the image of an elongated, flat field, framed by Muir Woods Road on one side and the access road on the other. Its extensive stand of non-native grasses

gives the appearance of a former agricultural field more than that of a natural area. However, the growth of the riparian area since farming ended, as well as the natural establishment of a seasonal wetland on the western edge of the site, have begun to suggest a more natural appearance to the site. The Monterey cypress windrow at the northern boundary of the site creates a visual buffer or obstruction, depending on one's viewpoint, from the adjacent State Parks lands to the north. Most people in vehicles passing by the Old Ballfield would only see the dense willow riparian habitat adjacent to Muir Woods Road and Highway 1, but a small clearing at the northern end of the Old Ballfield allows a view over much of the field.

Environmental Consequences

Alternative 1 (Preferred)

Project actions in the Upper Alley, Upper Field, and Lower Field will enhance the natural appearance of the site, just as they will enhance the natural function. Visual changes over the long term will be most apparent in the Lower Field, where the likely increase in patchy riparian habitat will be supported by the high flow paths and the added connection of flows from the western drainages. The placement of some large trunks with rootwads on the Lower Field may draw visual attention in the early phase after construction, but the trunks will blend with the long-term growth of riparian species and overall habitat complexity of the site due to project actions. The reconstructed alluvial fan in the northern portion of the site will be revegetated with native coastal scrub species such as those on the adjacent hillside, and this new feature will create a contour that appears natural to the eye and well-integrated with the adjacent area. The removal of about 28 out of 48 existing Monterey cypress trees in the windrow will create gaps through the row of trees that will be noticeable, but it is not likely to appear visually unappealing. The levee removal adjacent to Redwood Creek in the Old Ballfield will not be visible from a distance. The new setback levee will be almost entirely obstructed from view by passing vehicles due to the roadside riparian habitats, but it will be visible briefly from the opening adjacent to Muir Woods Road. There will be a short-term, local, direct, moderate visual impact from the new setback levee that will be visible from one viewpoint, but this will be reduced in the long run by the expansion of riparian habitat in the Old Ballfield that will largely obstruct its view and the establishment of scrub species such as coyote brush on the walls of the new setback levee that will allow it to blend into the landscape.

Cumulative Impacts

The possible construction of a new Coast View trail alignment in the hills to the west of the project area may alter the visual image of the area by creating non-natural features that are visible from a distance. These impacts are those of the trail project and are not cumulative impacts in combination with this project since this project will not have long term adverse visual impacts.

Conclusion

Alternative 1 will result in a short-term, local, direct moderate adverse impact to visual resources from the construction of the setback levee, but this impact would be less than significant. This impact will be reduced to a negligible impact in the long run as vegetation because naturally established. Other actions in Alternative 1 will result in a long-term, indirect, minor beneficial

visual impact by expanding natural features. There would be no impairment to visual resources.

Alternative 2 (No Action)

The No Action alternative would result in no visual impacts.

Cumulative Impacts
Cumulative impacts would be the same as those under Alternative 1.

Conclusion
The No Action alternative would result in no visual impacts. There would be no impairment to visual resources.

3.11 Human Health

Affected Environment

The drainage ditch parallel to the gravel access road on the site maintains ponded water during some periods of the year, and two of the ponded areas are directly across the road from two of the residential homes on the site. The mainstem of Redwood Creek may also have very slow moving water or stagnant water in summer or fall months of very dry years. Stagnant water provides opportunities for mosquito production, which poses a concern about human health due to vector-borne diseases known to be transported by mosquitoes, such as viral encephalitis (including West Nile virus), malaria, lyme disease, ehrliciosis, babesiosis, plague and American typanosomiasis.

Vector-borne disease control is administered by NPS in cooperation with U.S. Public Health Service; Centers for Disease Control; California Department of Health Services, Vector-Borne Disease Section; and Marin County Department of Health Services. The Marin-Sonoma Mosquito Abatement District (MSMAD) works under the direct supervision of the GGNRA to assist in addressing vector-borne disease issues following guidelines stated in NPS Director's Order 77 (Natural Resource Management, including integrated pest management) and 2001 Management policies. MSMAD maintains a small unit responsible for the prevention, elimination, or control of mosquitoes and other arthropods known to be potential carriers of infectious diseases, or that present a public nuisance (Marin-Sonoma Mosquito Abatement District 2005). Together with the California Department of Health Services, local mosquito abatement districts monitor the presence and spread of these diseases through use of sentinel chicken flocks, water samples, and traps.

Seasonal, semi-permanent, and permanent wetlands that remain flooded for periods of 2–3 weeks or longer during late summer and early fall provide optimal conditions for mosquito production. In optimal conditions, mosquitoes can rapidly reproduce within 1 to 2 weeks and many species can produce multiple generations during a season. Mosquitoes commonly found in wetland areas generally prefer to breed in warm stagnant water that is rich in organic matter, or within soil and at the base of vegetation along the edges of drying pools of water. The larvae of some species hide among aquatic vegetation for protection against predators.

NPS uses integrated pest management methods are used to control mosquito and anthropod populations where populations appear to pose a threat to human health. It is far less costly and more effective to control mosquito populations as larvae, before they mature and disperse into the environment. The MSMAD's primary emphasis is on cataloging, reducing and abating larval sources. Adult mosquito control, in the form of ultra-low-volume spray, is used only as a temporary measure in non-sensitive natural areas, or when other methods are not feasible. Any application of adulticides only occurs after GGNRA, U.S. Public Health Service, and the NPS Washington office agree that there is a need for such application. All pesticide application must be approved by the NPS IPM program. MSMAD works closely with NPS to provide any needed information to assist in decision-making. Abatement methods employed by the MSMAD are habitat modification, microbial or bacterial insecticides, growth-regulating hormones, and chemical larvicides. Habitat modification, the preferred control method, involves reducing areas of stagnant of water by modifying channel networks to allow flow exchange (e.g., daily tidal flows) into potential breeding areas (Marin-Sonoma Mosquito Abatement District 2005); however, since the goals of this project are to maintain ponding, this action is not likely to be suitable at this site.

Environmental Consequences

Alternative 1 (Preferred)

Actions proposed in this EA to alter the flow patterns from the drainage ditch into the field are likely to reduce areas of stagnant water that could support mosquito breeding. Flows currently back up behind sediment-filled culverts, creating ponded water on the west side of the road, and this back-up will be addressed through the placement of two new larger culverts or drainage grates across the road. Water flowing through the culverts will be encouraged to flow out onto the field through the creation of the new flow paths that will be about 1 foot deeper than the existing grade. Water currently does not flow effectively through the drainage ditch due to extensive vegetative growth and an accumulation of sediment and can pond in the drainage ditch. With implementation of the proposed project actions, water is likely to flow more effectively out to the field and remain ponded for less time in some portions of the ditch. This will contribute to a minor reduction in standing water. However, since actions are planned to avoid losing existing emergent wetland species along the road, some water will remain in the ditch as occurs under the existing condition. The actions proposed for the Lower Field are not expected to create new pockets of standing water and high flows are expected to dissipate more quickly than would be needed for mosquito breeding.

Actions proposed in the Upper Field, along the Upper Alley, and in the Old Ballfield will not create new areas where mosquito breeding would occur. New areas of floodplain would be temporarily inundated, but would not provide suitable mosquito breeding habitat. There would be no increase in standing water due to actions in these areas.

Cumulative Impacts

Actions by a separate project to dig out a new 1.2-acre pond for red-legged frog breeding in the Lower Field could provide new opportunities for mosquito production, but its impacts are related solely to those of that project and there is no likely cumulative effect in combination with actions proposed in this EA. However, it is conceivable that if new mosquito populations breed in the frog pond, they could also seek out other standing water for breeding. To minimize mosquito production, the Park has proposed an adaptive management approach identical to actions taken for the creation of foraging habitat for San Francisco garter snake in Pacifica, San Mateo County (USFWS Biological Opinion 1-1-05-F-0063). These actions include monitoring for larval mosquitoes when water is present in the pond. Should numbers be present at levels sufficient to pose public health risks, the Park's Integrated Pest Management (IPM) coordinator will treat the ponded areas with a biological control agent (*Bacillus thuringensis*). In the long term, colonization of the created wetland habitat by predatory insects should also assist with reducing the risk posed by mosquitoes.

Conclusion
Project actions will result in a negligible impact to human health and safety related to mosquito breeding habitat. While some flows from the drainage ditch will be more likely to flow into the field, rather than stagnating in the drainage ditch, this effect is very localized and some ponding will still occur in the drainage ditch.

Actions by a separate project to construct a new pond for the red-legged frog would provide new potential mosquito breeding habitat, which would be a long-term, indirect, local moderate cumulative impact to residents of the site. This impact can be reduced through monitoring of larval mosquitoes. If numbers appear to be present at levels that would pose public health risks, larvae may be treated by NPS with bacteria that kill larvae.

Alternative 2 (No Action)

Under the No Action alternative, there would be no actions to either enhance or reduce breeding habitat for mosquitoes or to affect human health.

Cumulative Impacts
Cumulative impacts under the No Action alternative would be the same as those under Alternative 1.

Conclusion
There would be negligible adverse impacts to human health under the no action, since there wouldn't be any actions that would reduce the amount of water in the ditches. Cumulative impacts would be the same as those under Alternative 1.

3.12 Traffic

Affected Environment

Muir Woods Road, a county road adjacent to the project site, provides one of two primary routes from Muir Woods National Monument to Mill Valley and San Francisco. During the summer months, this route is busy and receives approximately one-third to one-half of the traffic traveling down upper Muir Woods Road to Muir Woods National Monument (NPS, unpublished traffic count data, 2005).

The entrance to the Banducci site is a dirt and gravel access road with an entrance at the southern end of the property on Highway 1. The entrance to the access road is adjacent to the Highway 1 Bridge. The access road travels north along the base of the hillside, and provides access for several residents. The Banducci family still resides on the site, adjacent to the Banducci site project area.

Environmental Consequences

Alternative 1 (Preferred)

Some trucks hauling excavated fill will access Muir Woods Road at two temporary access points established for construction. One access point to the road will be established from the Old Ballfield, and the other will be established from a scrub-dominated field on the east side of the creek near the Upper Alley. When material is excavated from the left (east) bank of the Upper Alley, trucks will access the east bank by a temporary haul road to be cut through brush adjacent to Muir Woods Road. Up to about 70 truck trips will be generated to haul material from the east side of the creek, down Muir Woods Road, and to the Old Ballfield for construction of the setback levee or back to the access road via Highway 1 to deliver the material to the Upper Field. The access point to the Old Ballfield would be established at a sufficient distance from the intersection with Highway 1 to avoid impacting traffic flow at the intersection.

Appropriate temporary traffic control will be established, and any necessary temporary traffic control permits will be obtained from Marin County. However, traffic traveling south on Muir Woods Road may be temporarily slowed as trucks enter or depart the east bank of the creek. Most construction would be implemented after Labor Day weekend, when visitation rates – and therefore traffic volumes - are reduced. No hauling on this route would be conducted on weekends. Other traffic generated for construction implementation would consist of the delivery of a large excavator and other trucks and vehicles to be used on site. Most construction actions would be implemented without generating traffic on public roads.

Residents at the project site may experience short-term, temporary impacts when construction vehicles access the site via the access road, although almost all hauling of excavated material will not take place on the access road, but will be trucked down the field instead. The installation of two new culverts or drainage grates across the access road may impede traffic temporarily, and this action will be coordinated in advance with site residents to minimize inconvenience.