Muir Woods National Monument
California

US Department of the Interior
National Park Service

Muir Woods National Monument Sustainable Access Project

DRAFT ENVIRONMENTAL ASSESSMENT

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CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

The National Park Service (NPS) is proposing to improve visitor access and arrival facilities at Muir Woods National Monument (monument), improve visitor experience and safety, and enhance preservation of natural and cultural resources. These improvements include parking areas, bus or shuttle areas, stormwater management infrastructure, restrooms, trails, and interpretive media. This environmental assessment analyzes the impacts that could result from taking no-action and the impacts that could result from two action alternatives.

This environmental assessment has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and implementing regulations, 40 Code of Federal Regulations (CFR) Parts 1500–1508: *Protection of Environment*, 43 CFR Part 46: *Implementation of the National Environmental Policy Act of 1969*, Director's Order 12: *Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2011a) and its accompanying handbook (NPS 2001, 2015a), section 106 of the National Historic Preservation Act of 1966, and section 7, *Interagency Cooperation,* of the Endangered Species Act.

This chapter describes the reasons the National Park Service is taking action. Specifically, this chapter includes the following:

- purpose of, and need, for taking action
- objectives in taking action
- purpose and significance of the monument
- project area evaluated for impacts
- relationship to other plans or agreements
- discussion of issues and impact topics retained for further analysis
- discussion of issues considered but dismissed from further analysis

The monument consists of approximately 554 acres of land located on the Marin Peninsula, a large and mountainous stretch of land north of San Francisco, in Marin County, California. This area is included in the nine-county region generally referred to as the Bay Area and has a population of more than 7 million. Development is largely restricted to the eastern half of the Marin Peninsula along San Francisco Bay, a region traversed by highways leading north from San Francisco over the Golden Gate Bridge. The monument is approximately 2 miles inland of the Pacific Ocean, 10 miles northwest of the Golden Gate Bridge, and near other protected public lands, such as Point Reyes National Seashore, Mount Tamalpais State Park, and the Marin Municipal Water District.

Visitors traveling to the monument in vehicles use Muir Woods Road, a winding two-lane county road that connects on the east with Panoramic Highway and Mill Valley and on the southwest with State Highway 1. The main entrance to the monument is located roughly in the middle of Muir Woods Road, at the southern end of Redwood Canyon. Adjoining the entrance are parking lots, restrooms, and a small visitor center. The monument receives very heavy visitation during the peak season (April through September) and in the off season on holidays and during periods of good weather. Demand for parking often exceeds the capacity of the monument's lots during peak visitation, and informal overflow parking occurs on the shoulders of Muir Woods Road (see figures 1 and 2).

SOURCE: NPS

FIGURE 1. NO AVAILABLE PARKING SPACES

SOURCE: NPS

FIGURE 2. SHOULDER PARKING ALONG MUIR WOODS ROAD

Approximately 1,100,000 people visited the monument in 2015. In response to heavy visitation over several years, the National Park Service has taken steps to manage visitation levels to ensure a high level of protection of natural and cultural resources and provide a positive and safe visitor experience. These steps included expanding the Muir Woods Shuttle service to promote public transportation, installing and operating changeable message signs on US Route 101 to inform visitors that parking may be unavailable, more actively managing parking areas, and increasing interagency enforcement actions to reduce illegal parking. The National Park Service is in the process of implementing a reservation system to manage motorized vehicle access to the monument. This system will be implemented in 2017, with operations beginning in fall 2017. The National Park Service completed an environmental assessment in October 2015 and a finding of no significant impact for the reservation system in December 2015 (NPS 2015b, c). These compliance documents identified the short-, mid-, and long-term visitation and transportation levels for the monument, which are expected to be reduced to approximately 924,400 visitors in 2017. This environmental assessment uses the assumptions for visitation, visitor flow, and transportation capacity from that project.

PURPOSE OF THE ACTION

The purpose of this action is to improve visitor experience and safety by providing appropriate infrastructure, promote the restoration of natural resources and processes, and preserve cultural resources.

NEED FOR THE ACTION

The project is needed to address deferred maintenance and improve the design and placement of parking areas and visitor amenities and to resolve long-standing problems with traffic congestion that detracts from visitor experience, creates the potential for safety concerns, and negatively affects stormwater management and water quality in the Redwood Creek Watershed. The transportation system dates to the 1960s when standards for environmental protection differed from current standards. Currently, some visitors encounter a lack of pedestrian walkways in areas frequented by tour buses, shuttles, and privately owned vehicles. Additionally, the National Park Service needs to update existing stormwater management infrastructure in the project area to implement best management practices and comply with federal law, policy, and regulation.

OBJECTIVES IN TAKING ACTION

All of the action alternatives selected for detailed analysis must meet specific project objectives, supporting the purpose of, and need for, action. The following objectives are grounded in the purpose of and need for action, as well as the monument's enabling legislation and vision described in the *Golden Gate National Recreation Area and Muir Woods National Monument General Management Plan/Environmental Impact Statement* (NPS 2014a, 2015d).

- Visitor Experience and Safety
  - Provide safe and accessible pedestrian routes from all parking areas to the Entry Plaza and connecting trails, incorporating opportunities for education and interpretation.
  - Meet accessibility standards required under the Architectural Barriers Act (ABA) of 1968.

- Transportation
  - Reconfigure parking areas to improve operational efficiency and provide sufficient parking capacity for privately owned vehicles (no more than 232 spaces) as approved in the *Muir Woods National Monument Reservation System Finding of No Significant Impact* (NPS 2015c).
  - Provide sufficient capacity for buses, shuttles, and authorized commercial use vehicles to drop-off and pick-up passengers, as approved in the *Muir Woods National Monument Reservation System Finding of No Significant Impact* (NPS 2015c).
  - Reduce vehicle and pedestrian conflicts in all parking and transit areas.

- Natural Resources
  - Protect water quality in the Redwood Creek Watershed by improving stormwater management infrastructure in the project area.
  - Design infrastructure improvements in a manner that anticipates and encourages future restoration or enhancement projects for plant and animal communities in the watershed.

- Cultural Resources
  - Protect the fundamental resources that contribute to the national significance of the monument.
  - Design infrastructure improvements to be compatible with the Muir Woods cultural landscape and minimize impacts on the property listed in the National Register of Historic Places (national register).
  - Preserve and protect cultural resources to highlight the interpretive and educational values and provide, wherever possible, access to these resources.

PROJECT AREA

The area of analysis is the entry area of Muir Woods National Monument, as shown in figure 3. This area consists of approximately 17 acres of land and water. The majority of proposed actions would occur in the Entry Plaza, parking lots or other developed areas, trails, and at the Dipsea Trail crossing over Redwood Creek.

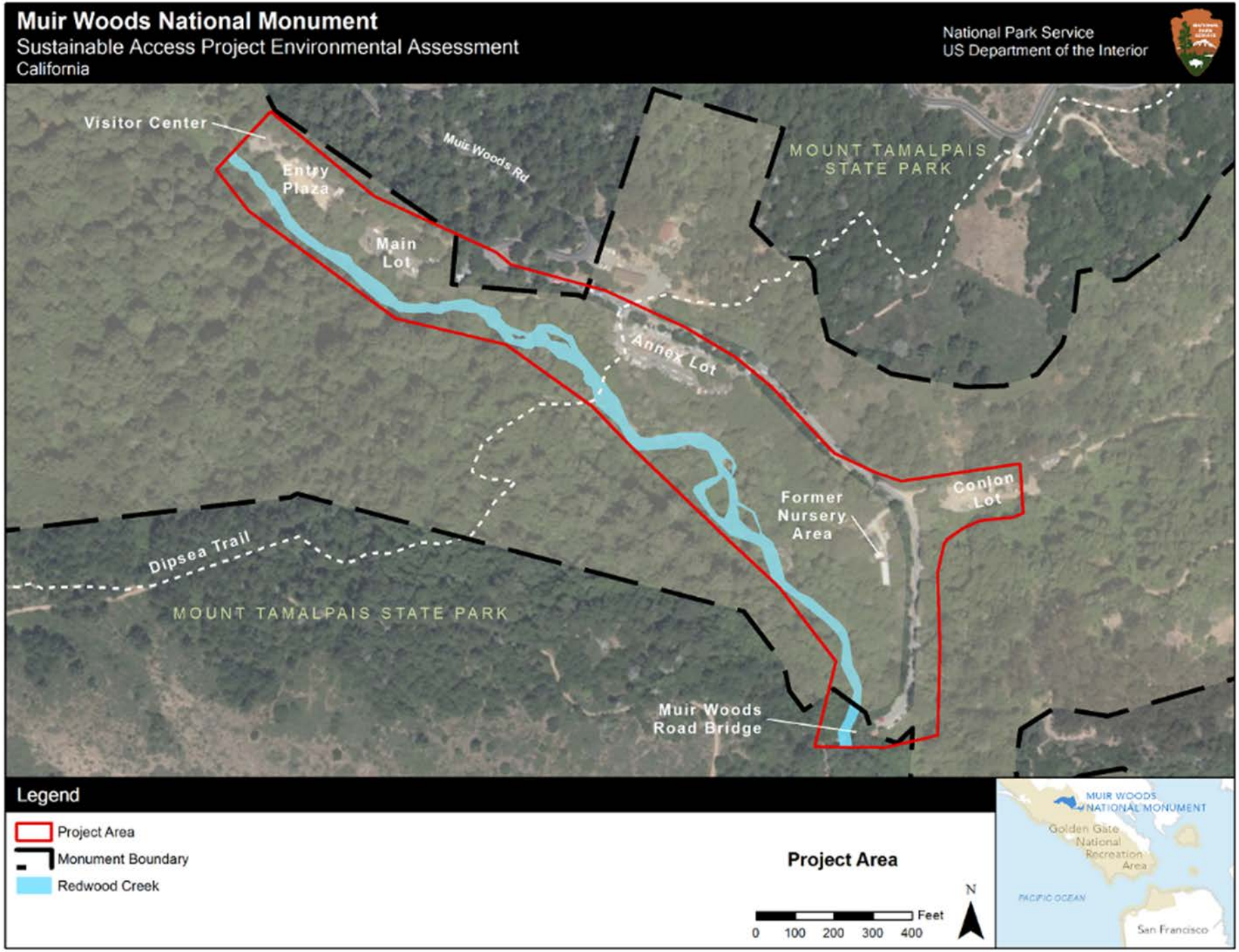


FIGURE 3. MUIR WOODS SUSTAINABLE ACCESS PROJECT AREA

BACKGROUND

Purpose and Significance of Muir Woods National Monument

The purpose of the monument is to preserve the primeval character and ecological integrity of the old-growth redwood forest for its scientific value and inspiration (NPS 2015b). The monument preserves the last remnant old-growth redwood forest near metropolitan San Francisco. The establishment of the monument is also an important demonstration of early 20th century conservation history and continues to inspire stewardship actions today (NPS 2015b).

Relationship to Other Plans or Agreements

Two NPS documents relate to this environmental assessment. The *Record of Decision* for the *Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan / Environmental Impact Statement* provides comprehensive direction for resource preservation and visitor use and a basic foundation for decision making for Golden Gate National Recreation Area and Muir Woods National Monument for the next 20 years. The plan prescribes the resource conditions and visitor experiences to be achieved and maintained over time. A review of the purpose, significance, and special mandates for the park and monument clarifies relevant law and policy requirements (NPS 2014a).

The *Muir Woods National Monument Reservation System*, approved December 2015, focuses on improving the visitor experience at the monument. The reservation system will reduce peak visitation levels at the monument by managing motorized vehicle access and allowing the NPS staff to control parking both within the monument's lots and on Muir Woods Road (owned and managed by Marin County). In accordance with a memorandum of understanding between the National Park Service and Marin County, the approved reservation system will also ensure that parking on Muir Woods Road will support a phased elimination of parking south of the Muir Woods Road Bridge, located south of the monument (NPS 2015e). Both the reservation system and the memorandum of understanding were informed through public involvement.

ISSUES AND IMPACT TOPICS

NEPA regulations require an "early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" (40 CFR Part 1501.7). An issue describes the relationship between actions and environmental resources (natural, cultural, and socioeconomic). Issues are usually problems that either the no-action alternative or current situation has caused or that any of the proposed action alternatives might cause. They also may be questions, concerns, problems, or other relationships, including beneficial ones.

Impact topics are resources or values analyzed for each of the alternatives and are discussed because issues have been identified. During internal scoping, NPS staff identified potential issues that could result from implementation of the action alternatives. Resources or values that could be affected include: visitor use and experience; transportation; geology and soils; vegetation; water quality; threatened and endangered species; cultural resources; and climate change. The impact topics identified during scoping are discussed in greater detail in "Chapter 3: Affected Environment" and are analyzed in "Chapter 4: Environmental Consequences."

IMPACT TOPICS RETAINED FOR FURTHER ANALYSIS

Visitor Experience and Safety

According to Title 54 of the United States Code (USC), providing for visitor enjoyment is one of the basic purposes of the National Park Service (54 USC 100101(a)). Reconfiguring parking within the monument would reduce vehicular congestion and improve visitor safety, thereby enhancing the visitor experience. Pedestrian paths are poorly located and in poor condition, and the parking and arrival experience is disjointed and confusing. Because each alternative could affect visitor experience and safety by changing wayfinding, arrival sequencing, pedestrian and traffic management, and through construction activities, this impact topic is carried forward for detailed analysis.

Transportation

NPS *Management Policies 2006* state: "depending on a park unit's size, location, resources, and level of use, the Service will, where appropriate, emphasize and encourage alternative transportation systems [and] park roads will be well constructed, sensitive to natural and cultural resources, reflect the highest principles of park design, and enhance the visitor experience" (NPS 2006). The reservation system is expected to reduce daily vehicle trips throughout the year (most notably in July and August), reduce peak-hour vehicle trips by more than one-third throughout the year (more than one-half in July and August), and reduce shoulder parking on Muir Woods Road. Both action alternatives could affect transportation at the monument by changing arrival sequencing and traffic management. Additionally, construction activities could affect local transportation for a short period of time. Therefore, this impact topic is carried forward for detailed analysis.

Geology and Soils

NPS *Management Policies 2006* state: the "Service will actively seek to understand and preserve the soil resources of parks, and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil or its contamination of other resources" (NPS 2006). Reduced shoulder parking would minimize areas contributing to surface runoff and erosion along Muir Woods Road. However, the potential for surface runoff and soil compaction from new impervious surfaces and the short-term use of construction equipment would still be present. Therefore, this impact topic is carried forward for detailed analysis.

Vegetation

NPS *Management Policies 2006* states that the agency will strive to maintain all components and processes of naturally evolving monument ecosystems, including the natural abundance, diversity, and ecological integrity of plants (NPS 2006). Reducing shoulder parking along Muir Woods Road would allow regrowth of native vegetation along the shoulder. However, vegetation in the new or expanded parking lots would be permanently removed, and adjacent riparian vegetation would be temporarily affected. Also, the establishment of invasive, nonnative plants, changes in the shade regime, and future hazard tree removal could indirectly affect additional acreage in the vicinity of the project area. Therefore, this impact topic is carried forward for detailed analysis.

Water Resources and Hydrologic Processes

The Clean Water Act was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC 1251 et seq.). Consideration of impacts on wetlands is also

required under Executive Order 11990, "Protection of Wetlands," and NPS Director's Order 77-1: *Wetland Protection* (NPS 2002). Executive Order 11988, "Floodplain Management," requires an examination of impacts on floodplains and potential risk involved in placing facilities in floodplains. NPS *Management Policies 2006* and Director's Order 77-2: *Floodplain Management* (NPS 2003) provide guidelines for proposals in floodplains. Reduced shoulder parking would lower the degree of surface runoff along Muir Woods Road. However, the construction of parking areas and trails could affect hydrology near waters of the United States, requiring proper mitigation measures. Furthermore, construction activities could have a short-term impact on sedimentation. A statement of findings separate from this environmental assessment would not be required for wetlands because of exceptions under sections 4.2.1a and 4.2.1d of Director's Order 77-1. The alternatives would not affect floodplain processes and values; therefore, the project is exempt under section 5b of Director's Order 77-2. This impact topic is carried forward for detailed analysis.

Threatened and Endangered Species

Section 7 of the Endangered Species Act requires all federal agencies to consult with the US Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service to ensure that any action authorized, funded, or carried out by the agency does not jeopardize the continued existence of listed species or critical habitats (16 USC 1531 et seq.). The construction of new parking lots would permanently remove vegetation and could contribute to surface runoff into Redwood Creek, possibly affecting some sensitive species. The National Park Service retrieved a list of species present at the monument from the USFWS Information for Planning and Conservation webpage. The list allowed the National Park Service to determine that coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), and the California red-legged frog (*Rana draytonii*) may be affected as a result of this project. In addition, the project area contains critical habitat for coho salmon and steelhead trout. A separate biological assessment has been prepared to analyze impacts on these species and to fulfill section 7 requirements under the Endangered Species Act. This impact topic is carried forward for detailed analysis because of the potential presence of these species and the presence of critical habitat in the project area.

Cultural Resources

Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470 et seq.), and its implementing regulations under 36 CFR Part 800 require all federal agencies to consider effects of federal actions on historic properties, including historic structures eligible for or listed in the national register. The project area, which is outside of the Muir Woods Historic District, has been surveyed for archeological resources (Gavette 2016). Although the National Park Service would avoid impacts on known archeological sites, it would design new structures to follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995), and National Park Service staff would monitor areas of archeological sensitivity. If archeological resources are identified during construction, the National Park Service would consult with the State Historic Preservation Office in accordance with federal legislation and regulations and NPS policy. Therefore, this impact topic is carried forward for detailed analysis.

Climate Change

The 2012 NPS *Climate Change Action Plan 2012–2014* (NPS 2012a)and 2016 Council on Environmental Quality's (CEQ) *Final Guidance for Federal Departments and Agencies on the Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews* (CEQ 2016) both recommend that federal agencies consider the

extent to which a proposed action and its reasonable alternatives contribute to climate change through greenhouse gas emissions and take into account the ways in which a changing climate over the life of the project may alter the overall environmental implications of such actions. The effects of climate change can result in increased stress to natural systems. Within California, anticipated climate change impacts to note with regard to this environmental assessment include the increase of drought, wildfires, flooding, tree-related disease and loss of native fish, wildlife, and vegetation. Potential changes to monument resources associated with climate change are discussed in "Chapter 3: Affected Environment" on a case-by-case basis as appropriate within each retained impact topic.

IMPACT TOPICS CONSIDERED BUT DISMISSED FROM FURTHER ANALYSIS

In accordance with CEQ regulations 1500.1(b) and the *NEPA Handbook* (NPS 2015a), the National Park Service determines whether impact topics are evaluated in detail or dismissed from further evaluation to concentrate on the issues of concern. This section provides an evaluation and explanation as to why the National Park Service dismissed the following impact topics from further consideration. Impact topics are dismissed from further evaluation if they:

- do not exist in the project area
- would not be affected by the alternatives or the likelihood of impacts are not reasonably expected
- would result in impacts that, through the application of mitigation measures, would be minimal, and
- there is little controversy on the subject or few reasons to otherwise include the topic

Air Quality

Section 118 of the Clean Air Act requires the National Park Service to meet all federal, state, and local air pollution standards (42 USC 7401 et seq.). The project would not increase vehicle trips to the monument, and all alternatives include the same number of available parking spaces. Implementation of either action alternative would result in localized emissions and fugitive dust at the monument during construction activities; however, emissions and fugitive dust would occur only during the construction period and would dissipate quickly. No long-term impacts on air quality are expected. Furthermore, air quality data recorded between 2004 and 2013 has shown improved conditions at the monument. Therefore, the topic was dismissed from further analysis in this document.

Environmental Justice

Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-income Populations", requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the US Environmental Protection Agency's *Environmental Justice Guidance* (1998) would not occur from the construction activities under the action alternatives. Therefore, this topic was dismissed from further analysis in this document.

Dark Night Skies

In accordance with NPS *Management Policies 2006*, the National Park Service strives to preserve dark night skies and will "minimize light that emanates from park facilities, and also seek the

cooperation of park visitors, neighbors, and local government agencies to prevent or minimize the intrusion of artificial light into the night scene of the ecosystems of parks" (NPS 2006). No construction activities would occur at night and no permanent area lighting or lamp posts of any kind would be installed. Therefore, the topic was dismissed from further analysis in this document.

Indian Trust Resources

In accordance with the Environmental Compliance Memorandum 97-2 by the US Department of the Interior, the National Park Service must ensure that it explicitly addresses any anticipated effects on Indian trust resources in an environmental compliance document. If any effects are identified, the National Park Service must consult with the affected tribe(s) on a government-to-government basis with respect to the impact from the proposed project or action. However, if the project or action is expected to have either an insignificant impact or no impact on any Indian trust resources, the environmental compliance document must state the reason for dismissal. Since no Indian trust resources exist in the project area, the topic was dismissed from further analysis in this document (NPS, Terzis, pers. comm. 2016a).

Indian Sacred Sites

In accordance with Executive Order 13007, the National Park Service must accommodate access to, and ceremonial us of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites. Continued access to, and use of, these sites is often essential to the survival of family, community, or regional cultural systems, including patterns of belief and sociocultural and religious life. However, no Indian sacred sites are found in the project area (NPS, Terzis, pers. comm. 2016a). Therefore, the topic was dismissed from further analysis in this document.

Socioeconomics

Construction activities associated with the action alternatives would not adversely affect local businesses or other agencies. However, a decision to make sustainable access improvements would provide beneficial impacts on the local economy as a result of minimal increases in employment for the construction workforce and revenues for the businesses engaged in the construction process. Any increase in workforce and revenue, however, would be temporary, lasting only as long as construction. Because the impact on the socioeconomic environment would be minimal, this topic was dismissed from further analysis in this document.

Soundscapes

In accordance with the NPS *Management Policies 2006* and Director's Order 47: *Sound Preservation and Noise Management* (NPS 2000), an important component of the NPS mission is the preservation of the natural soundscape associated with national monument units. The development of parking lots would occur along the existing road system of the monument where sounds from vehicular traffic and other human activities are common. During construction, anthropogenic noise would likely increase because of construction activities, equipment, vehicular traffic, and crews. Any sounds generated from construction would be temporary, lasting only as long as the construction activity is generating the sounds, and would have no long-term, measureable effect on visitors, employees, or natural soundscape conditions; therefore, the topic was dismissed from further analysis in this document.

Visual Resources

The NPS *Management Policies 2006* state that the monument's scenery and scenic features are included among the resources and values to be protected and conserved unimpaired for enjoyment by current and future generations. Visual impacts from construction activities would be short term and localized. Expanded or new parking lots would become permanent features on the landscape, potentially detracting from the scenic resources of the monument, and affecting visual quality. However, the parking lots would concentrate vehicles within existing lots and limit them to specific areas where they would be screened by incorporating native vegetation, effectively reducing visual impacts. Therefore, this topic was dismissed from further analysis in this document.

Wildlife and Wildlife Habitat

According to the NPS *Management Policies 2006,* the National Park Service strives to maintain all components and processes of naturally evolving park unit ecosystems, including the natural abundance, diversity, and ecological integrity of native animal populations. Parking areas are known to have numerous direct and indirect impacts on wildlife, including direct injury and mortality from vehicle collisions, altered behavior and patterns of habitat use, and increased human use and disturbance of wildlife (Forman and Alexander 1998; Trombulak and Frissell 2000; Gerow et al. 2010). Increased noise levels during the construction phase of this project could also result in temporary increases in localized disturbances to wildlife. While the action alternatives could result in minimal, temporary impacts, they would not affect the viability or population dynamics of wildlife at the monument. Therefore, the topic was dismissed from further analysis in this document.

CHAPTER 2: ALTERNATIVES

INTRODUCTION

This chapter describes alternatives for improving the entry area of the monument, consistent with the purpose of, and need for, action. The planning team at the monument and Golden Gate National Recreation Area developed alternatives that address issues with sustainable infrastructure, operations, and management of both visitor facilities and vehicular traffic. The planning team consulted representatives from Marin County, the California Department of Parks and Recreation, California State Historic Preservation Office, National Marine Fisheries Service, and the US Fish and Wildlife Service and considered the feedback received during the public scoping process. Please see "Chapter 5: Consultation and Coordination" for more information.

The environmental assessment includes three alternatives: the no-action alternative and two action alternatives. The action alternatives present a range of reasonable and feasible approaches that meet the purpose of, and need for, action. This chapter also discusses alternatives that were initially considered but not carried forward for detailed analysis; identifies the NPS preferred alternative; and lists mitigation measures for the alternatives. These elements are represented graphically in the figures for each alternative (i.e., figure 4 for alternative 1, figure 5 for alternative 2, and figure 6 for alternative 3).

ALTERNATIVE 1: NO ACTION

The no-action alternative describes continuing the present management and condition of the entry area. The no-action alternative provides a basis for comparing the management direction and environmental consequences of the action alternatives.

Under the no-action alternative, the monument would maintain the existing 232 parking spaces for privately owned vehicles and 16 parking spaces for buses, shuttles, and commercial use vehicles, and make no sustainable access improvements to infrastructure at the monument. The Entry Plaza currently contains nine parking spaces for visitors with disabilities (ABA-compliant) and two spaces for privately owned vehicles. The Main Lot contains 27 parking spaces for privately owned vehicles and 16 parking spaces for buses, shuttles, and commercial use vehicles and provides passenger drop-off. The Annex Lot contains 114 parking spaces, and the Conlon Lot contains 49 parking spaces for privately owned vehicles. Existing roadside parking for 31 privately owned vehicles would remain on the east side of Muir Woods Road between Conlon Avenue and the Muir Woods Road Bridge.

The monument would maintain the restroom located along Redwood Creek between the Entry Plaza and the Main Lot in its existing location. Visitors who park in the Annex Lot, Conlon Lot, or beside Muir Woods Road would continue to use the pedestrian trail adjacent to the road to reach the Entry Plaza. The wooden plank over Redwood Creek along the Dipsea Trail would remain in place seasonally and continue to serve as a dry season crossing over the creek. Existing culverts would also remain in place. No other engineered stormwater management infrastructure exists in the project area.

Visitors would continue to have access to interpretive and educational opportunities through brochures and exhibits available at the visitor center; taking self-guided walks; and attending talks, tours, and programs led by monument staff or in collaboration with local organizations. Figure 4 shows the existing parking and site infrastructure at the monument.

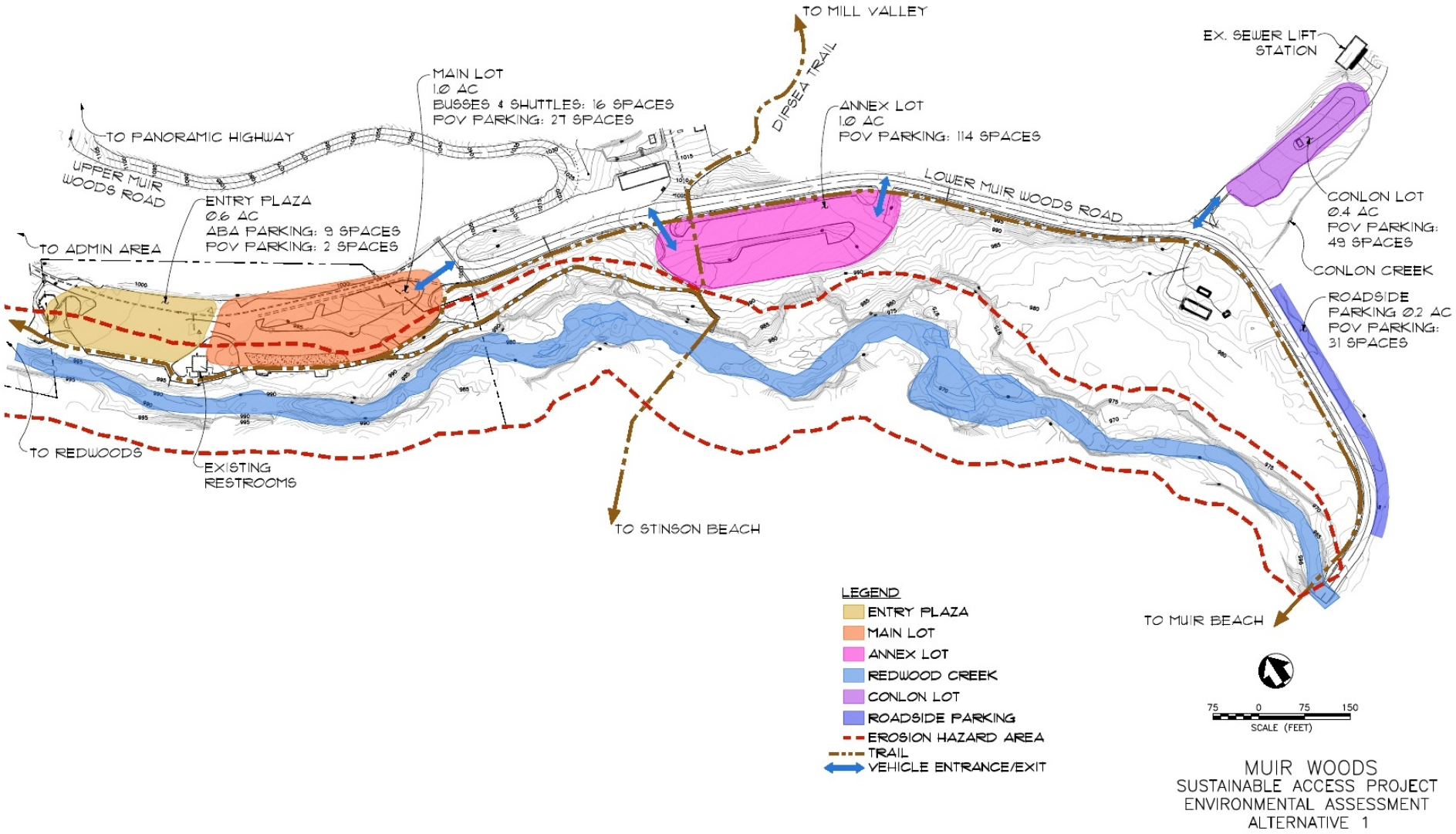


Figure 4. Alternative 1: No Action

ALTERNATIVE 2: ROADSIDE PARKING, ANNEX LOT EXPANSION, AND SUSTAINABLE ACCESS IMPROVEMENTS

Under alternative 2, the National Park Service would modify the configuration of the Entry Plaza, Main Lot, Annex Lot, and Conlon Lot, but would maintain the same number of parking spaces for privately owned vehicles as the no-action alternative (232). The National Park Service would remove all parking from the Entry Plaza, although administrative vehicular access would remain, and would rehabilitate approximately 0.4 acre of the plaza with native riparian vegetation.

Parking for visitors with disabilities would be relocated to the Main Lot, with 11 available spaces. The Main Lot would maintain its existing footprint, but would be restriped to meet ABA-parking requirements and provide 18 parking spaces for buses, shuttles, and commercial use vehicles.

The Annex Lot would be reconfigured to contain 143 parking spaces for privately owned vehicles. To accommodate 29 new spaces, the National Park Service would expand the lot to the southeast, requiring 0.2 acre of development and restriping. Fill material would be required to level the expansion area, which slopes downhill. Two new culverts would be installed during expansion to accommodate existing drainages on site. Impervious asphalt would be used to surface the Annex Lot, and the lot would be designed with one-way aisles and a single entry and exit at the southern end of the lot to promote efficient vehicular circulation.

The Conlon Lot would be widened 6 to 8 feet to accommodate a two-way driveway and 48 parking spaces for privately owned vehicles. Visitors parking in the Conlon Lot would access Muir Woods Road by a newly developed pedestrian trail located on the perimeter of the lot beside Conlon Creek. Some utility poles and electrical lines in the lot would be relocated as a result of expansion.

Existing roadside parking would remain on the east side of Muir Woods Road between Conlon Avenue and the Muir Woods Road Bridge and would contain 30 parking spaces for privately owned vehicles. Roadside parking would continue to be parallel to Muir Woods Road and would be paved and striped.

Engineered stormwater management infrastructure would be used to treat the runoff from the Entry Plaza and all parking lots. Shallow excavated ditches lined with filter strip sand and topped with stone to form a subsurface basin, where water is stored until it infiltrates into the soil, would be used to treat stormwater. This system is commonly known as an infiltration trench. These trenches greatly reduce the volume of runoff and are particularly good for groundwater recharge because they allow a significant amount of rainwater to infiltrate (USEPA 2008). This technique is considered very effective when used in conjunction with a pre-treatment technique such as a vegetated buffer strip to capture large sediment particles. Discharge from this infrastructure would meet the applicable water quality standards, such as those found in the *Bay Area Stormwater Management Agencies Association Post-Construction Manual*, and would not require additional treatment (BASMAA 2014).

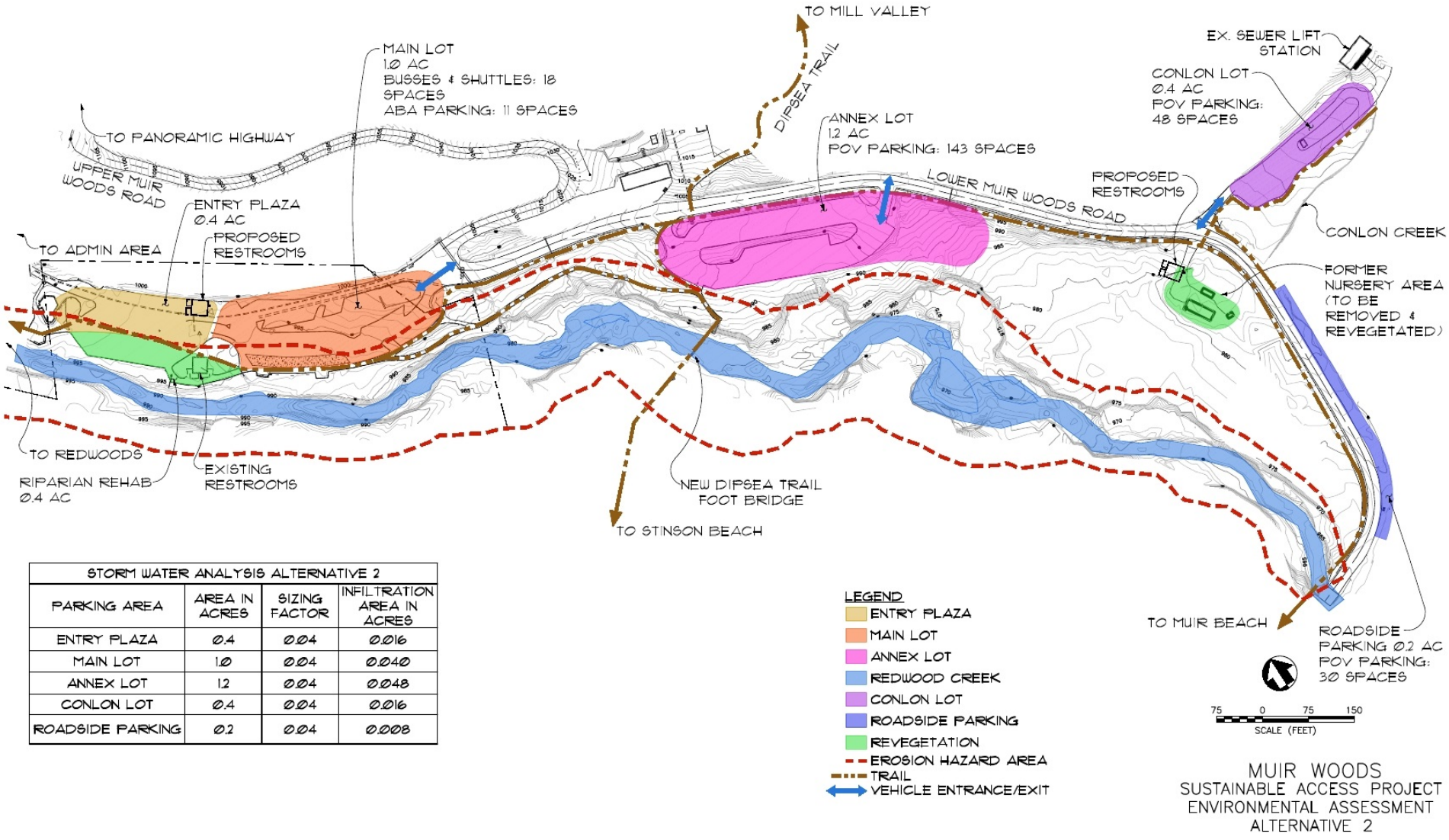
Visitors parking in the Conlon Lot or along the designated roadside area would cross Muir Woods Road at the Conlon Avenue intersection by way of a delineated crosswalk. The existing Muir Woods Road pedestrian trail would remain the primary route to the Dipsea Trail and the Entry Plaza (similar to the no-action alternative).

The portion of the Dipsea Trail passing through the Annex Lot would be realigned to the northwest perimeter of the lot. Additional signs directing visitors to the Entry Plaza and local trails would be installed as a means to improve wayfinding at the monument. A new pedestrian footbridge would be

installed at the Redwood Creek crossing in the location of the existing wooden plank, but placed roughly 14 feet above the creekbed so that the north end of the bridge would match the grade of the Annex Lot.

Under alternative 2, the existing restroom near Redwood Creek in the Entry Plaza would be relocated outside of the erosion hazard area and would be sized to accommodate peak season visitation levels, as approved in the *Muir Woods National Monument Reservation System Environmental Assessment* (NPS 2015b). The relocated restroom would not impede administrative vehicular access to the Entry Plaza. A second restroom would be constructed near the former Nursery Area to accommodate visitors parking at the southern end of the project area. This restroom would also be sized to meet peak season visitation levels and would be visible from the Conlon Lot. Final placement of both restrooms would be determined during the design phase of the project. The existing structures in the former Nursery Area would be removed, and portions of the area would be revegetated with plants native to the monument.

The Entry Plaza would be furnished with new interpretive media telling the story of natural, historic, and cultural resource stewardship at the monument. The segment of trail between the Main Lot and Annex Lot would also be furnished with interpretive media. Figure 5 shows the changes that would occur under alternative 2.



STORM WATER ANALYSIS ALTERNATIVE 2			
PARKING AREA	AREA IN ACRES	SIZING FACTOR	INFILTRATION AREA IN ACRES
ENTRY PLAZA	0.4	0.04	0.016
MAIN LOT	1.0	0.04	0.040
ANNEX LOT	1.2	0.04	0.048
CONLON LOT	0.4	0.04	0.016
ROADSIDE PARKING	0.2	0.04	0.008

Figure 5. Alternative 2

ALTERNATIVE 3: NURSERY PARKING AND SUSTAINABLE ACCESS IMPROVEMENTS (PREFERRED ALTERNATIVE)

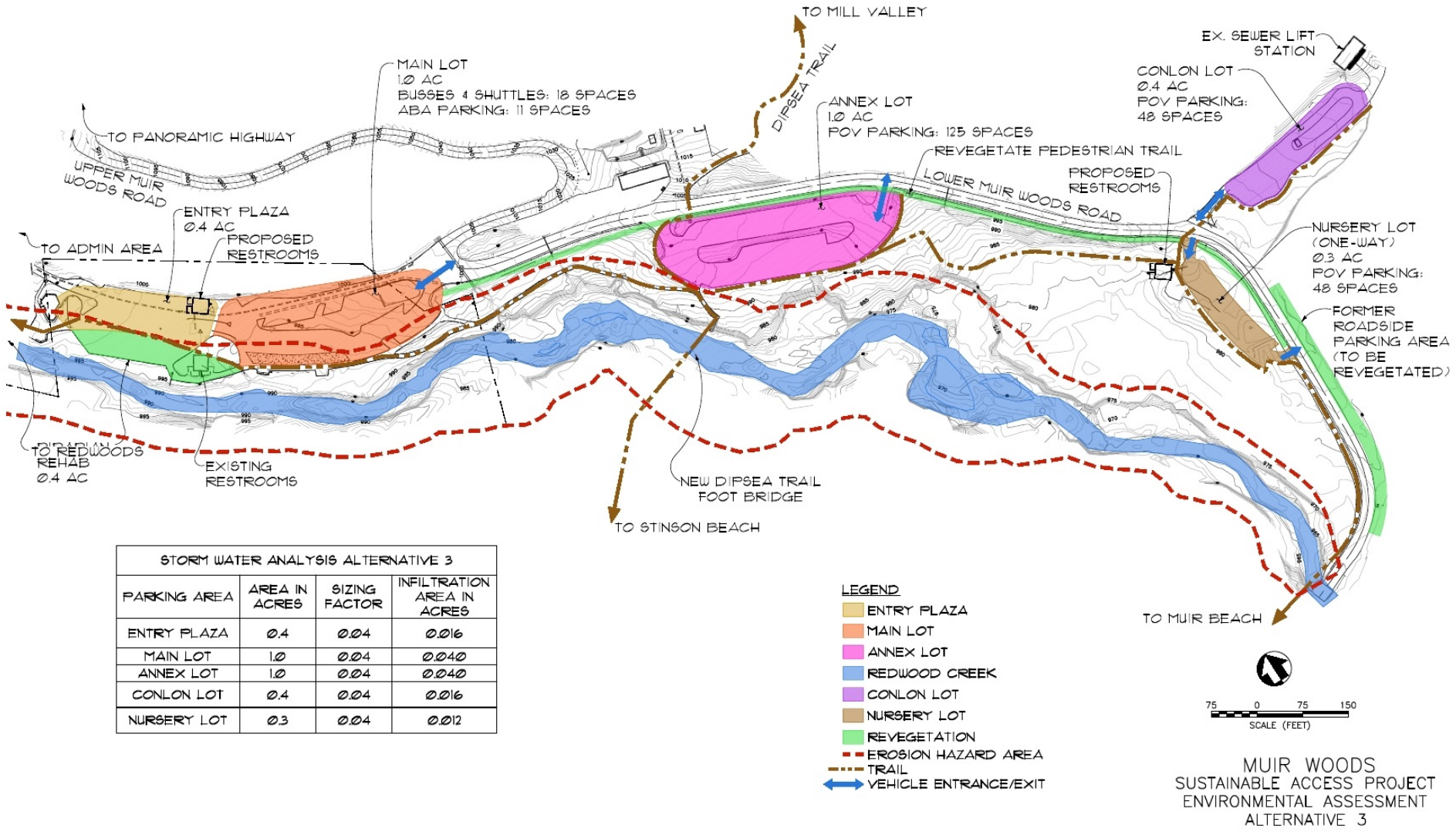
Alternative 3 is the NPS proposed action and has been identified as the preferred alternative. Alternative 3 would modify the Entry Plaza, Main Lot, Annex Lot, Conlon Lot, and the former Nursery Area, but would maintain the same number of parking spaces for privately owned vehicles as the no-action alternative (232). Improvements made in the Entry Plaza, Main Lot, Conlon Lot, to restrooms, and along the Dipsea Trail would be the same as those described under alternative 2. However, existing roadside parking would be eliminated on the east side of Muir Woods Road between Conlon Avenue and the Muir Woods Road Bridge, and the area would be revegetated with plants native to the monument.

The Annex Lot would be re-graded, reconfigured, and restriped to accommodate 11 new spaces, for a total of 125 parking spaces for privately owned vehicles. The Annex Lot would be designed with one-way aisles and a single entry and exit at the southern end of the lot to promote efficient vehicular circulation.

The former Nursery Area would be developed into a parking lot and contain 48 parking spaces for privately owned vehicles. The structures in the former Nursery Area would be removed, and the area would require less than 0.3 acre of development. Minimal filling and grading would be necessary to construct the Nursery Lot because the area is already disturbed. One culvert would be installed during construction to accommodate an existing drainage on site. Impervious asphalt would be used to surface the Nursery Lot, and the lot would be designed with one entrance, one exit, and a single driveway.

The segment of existing pedestrian trail along Muir Woods Road between the Main and Nursery Lots would be decommissioned and revegetated with plants native to the monument. A new woodland pedestrian trail between the Annex Lot and Nursery Lot would be developed. Approximately 1,200 linear feet of disturbance would be required to construct the trail at a width of 6 to 8 feet. The trail would pass along the southern edge of the Annex and Nursery Lots, would tie into the Dipsea Trail and Entry Plaza, and would contain new interpretive media. The trail may need to be built on fill along the perimeter of the Annex and Nursery Lots if it cannot be developed within their respective footprints. To minimize disturbance, low retaining walls may be constructed and small footbridges built over intermittent drainages along the trail route. The trail would meet all applicable accessibility standards. The final segment of this trail between the Main and Annex Lots would be widened to a maximum of 10 to 12 feet with boardwalks over existing drainages.

Figure 6 shows the changes that would occur under alternative 3. Table 1 contains a summary of alternative elements.



STORM WATER ANALYSIS ALTERNATIVE 3			
PARKING AREA	AREA IN ACRES	SIZING FACTOR	INFILTRATION AREA IN ACRES
ENTRY PLAZA	0.4	0.04	0.016
MAIN LOT	1.0	0.04	0.040
ANNEX LOT	1.0	0.04	0.040
CONLON LOT	0.4	0.04	0.016
NURSERY LOT	0.3	0.04	0.012

Figure 6. Alternative 3

TABLE 1. SUMMARY OF ALTERNATIVE ELEMENTS

Element	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Parking lots and locations	No changes to number, location, or design of parking lots for privately owned vehicles (POV) (232 spaces): Entry Plaza – 9 Architectural Barriers Act (ABA) compliant, 2 POV Main Lot – 27 POV Annex Lot – 114 POV Conlon Lot – 49 POV Roadside Parking – 31 POV	Redistribute and design POV parking, to be located as follows (232 spaces): Entry Plaza – 0 Main Lot – 11 ABA compliant Annex Lot– 143 POV Conlon Lot – 48 POV Roadside Parking – 30 POV	Redistribute and design POV parking, to be located as follows (232 spaces): Entry Plaza – 0 Main Lot – 11 ABA compliant Annex Lot – 125 POV Conlon Lot – 48 POV Nursery Lot – 48 POV Roadside Parking – 0 POV
Accommodate buses, shuttles, and commercial use vehicles	No changes to bus, shuttle, and commercial use vehicle accommodation. The Main Lot would continue to accommodate spaces for 16 buses, shuttles, and commercial use vehicles, and 27 POV spaces.	Eighteen parking spaces available for buses, shuttles, and commercial use vehicles in the Main Lot. Remove general POV spaces from the Main Lot.	Same as alternative 2.
Accommodate Architectural Barriers Act (ABA)-compliant parking	No changes to ABA-compliant parking. The Entry Plaza would continue to accommodate nine ABA parking spaces.	Move ABA-compliant parking to the Main Lot, with 11 available ABA parking spaces.	Same as alternative 2.
Develop trail access between parking lots and Entry Plaza	No changes to existing trail access.	Same as alternative 1.	Develop a new woodland pedestrian trail between the Nursery Lot and Annex Lot. Establish small footbridges over intermittent drainages along the trail route. Widen the final portion of this trail between the Main and Annex Lots to a maximum of10 to 12 feet and include a boardwalk over existing drainages. Decommission the Muir Woods Road pedestrian trail between the Nursery and Main Lots.

TABLE 1. SUMMARY OF ALTERNATIVE ELEMENTS – CONTINUED

Element	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Realign Dipsea Trail and construct footbridge over Redwood Creek	No changes to Dipsea Trail. No changes to existing access over Redwood Creek.	Realign the Dipsea Trail alignment near the Annex Lot. Construct a new footbridge over Redwood Creek.	Same as alternative 2.
Relocate restroom in the Entry Plaza	No changes to existing restroom in the Entry Plaza.	Remove the restroom from the Redwood Creek erosion hazard area in the Entry Plaza. Relocate the restroom within the Entry Plaza.	Same as alternative 2.
Construct a new restroom near the former Nursery Area	No new restroom would be constructed near the former Nursery Area.	Construct a new restroom near the former Nursery Area.	Same as alternative 2.
Rehabilitate the Redwood Creek erosion hazard area of the Entry Plaza	No rehabilitation would occur in the Entry Plaza.	Rehabilitate the area of the Entry Plaza in the erosion hazard area with native riparian vegetation.	Same as alternative 2.
Revegetate disturbed areas	No improvements would be made under this alternative; therefore, revegetation in disturbed areas would not be necessary.	Revegetate portions of the former Nursery Area with native plant species.	Revegetate roadside parking areas and the Muir Woods Road pedestrian trail with native plant species.
Upgrade stormwater management infrastructure	No improvements would be made under this alternative; therefore, no major upgrades to stormwater management infrastructure would be made.	Install two new culverts during the Annex Lot expansion to accommodate existing drainages on-site. Construct stormwater management infrastructure to treat runoff from all parking lots.	Install one culvert in the former Nursery Area to accommodate an existing drainage on site. Construct stormwater management infrastructure to treat runoff from all parking lots.
Provide additional wayfinding signs and interpretive media	No additional wayfinding or interpretive media would be provided.	Provide additional signs directing visitors to the Entry Plaza and trails. Add new interpretive media in the Entry Plaza and along trails.	Same as alternative 2, plus add interpretive media along new woodland pedestrian trail between the Annex and Nursery Lots.

MITIGATION MEASURES

The National Park Service places strong emphasis on avoiding, minimizing, and mitigating potentially adverse environmental impacts. To help ensure the protection of natural and cultural resources and the quality of the visitor experience, the National Park Service would implement the following measures and best management practices as part of the action alternatives.

General

- Clearly state all resource protection measures in the construction specifications, and instruct workers to avoid conducting activities outside the project area. Limit disturbances to roadsides, culvert areas, and other areas inside the project area.
- Hold a preconstruction meeting to inform contractors about sensitive areas, including natural and cultural resources.
- Delineate construction zones outside of existing disturbed areas with flagging, and confine all surface disturbance to the construction zone.
- Site staging and storage areas for construction vehicles, equipment, materials, and soils in previously disturbed or paved areas approved by the National Park Service. These areas would be outside of high visitor use areas and clearly identify them in advance of construction.
- Require contractors to properly maintain construction equipment to minimize noise, and do not allow construction vehicle engines to idle for extended periods.
- Remove all tools, equipment, barricades, signs, and surplus materials from the project area upon completion of the project.

Visitor Experience, Safety, and Transportation

- Inform visitors in advance of construction activities via a number of outlets, including the monument's website, various signs, the visitor center, and by bus and shuttle drivers.
- Review the tour bus permit system to develop a process that requires a permit for all tour buses wishing to service the monument.
- To the extent practical, schedule work to avoid construction activity and construction-related delays during peak visitation times.
- Limit construction-related traffic delays resulting from work at pull-offs, within parking lots, and along Muir Woods Road to a maximum of 15 minutes in each direction.
- Develop provisions for emergency vehicle access through construction zones.
- Prune low branches along trees lining the southbound side of Muir Woods Road south of the Conlon Lot to improve the sight distance for vehicles attempting to either make a left out of the parking lot driveway or make a left into the driveway from Muir Woods Road.
- Post signs on Muir Woods Road warning traffic of the pedestrian crossing at the Conlon Lot both before the intersection and at the intersection (following the latest standards published in the Manual on Uniform Traffic Control Devices).

Geology and Soils

- Avoid or minimize disturbance to soils as much as possible.
- Evaluate existing topsoil for invasive, nonnative plant infestations.
- Remove topsoil heavily infested with invasive, nonnative plants. Salvage non-infested topsoil, store according to soil conservation guidelines, and replace once construction is complete.

- Implement erosion control measures that provide for soil stability and prevent movement of soils during rain events (i.e., silt fences and tarps).
- Aerate any ground surface temporarily disturbed during construction and replant with native vegetation to reduce compaction and prevent erosion.
- Use the stormwater pollution prevention plan and project specifications for dust control measures within construction areas, including active haul roads and staging areas, and engage a qualified stormwater practitioner to ensure compliance.

Vegetation

- Develop a detailed revegetation and rehabilitation plan for enhancing areas disturbed by the project. The primary objective of the plan would be to reestablish a self-sustaining native plant community and ensure soil stability. Grade disturbed areas to natural contours; replace stockpiled topsoil; and mulch, replant, or reseed with native vegetation. Regularly monitor planted areas to determine whether remedial actions such as erosion control; invasive, nonnative plant species control; or replacement plantings are necessary.
- Avoid disturbance to particular species such as coast redwood *(Sequioa sempervirens),* California bottlebrush grass *(Elymus californicus*), leopard lily (*Lilium pardalinum*), and California buckeye (*Aesculus californica*) to the greatest extent possible.
- Prior to construction, survey for rare plants in areas where they may occur in vegetated construction zones. Conduct surveys for state (California Native Plant Society [CNPS]) and locally listed plants that may occur in the project area. If state or locally listed plants are found and cannot be avoided, transplant or collect and propagate seeds before revegetating disturbed areas. Monitor revegetated areas with rare plants for up to three years, and take remedial actions to ensure that rare plants are reestablished.
- Prevent or minimize establishment and spread of nonnative vegetation, noxious weeds, and spread of diseases by
  - having all heavy equipment inspected by NPS biologists for proper level of cleanliness (invasive plant seed) upon entry at the work site
  - minimizing soil disturbance
  - pressure washing vehicles
  - covering haul vehicles
  - limiting vehicle and equipment parking in the project area
  - obtaining all fill, rock, or additional topsoil from the project area or obtaining weed-free material from approved sources outside the monument
- Minimize the spread of sudden oak death (*Phytophthora ramorum*) by selected removal of infected trees, stream baiting, conducting ground surveys, reducing the amount of standing water on high use trails, and advising visitors to remove mud from their boots before embarking on established trails.
- Monitor reclaimed areas annually after construction to determine if reclamation and revegetation efforts were successful.

Water Resources and Hydrologic Processes

- Comply with and meet all relevant requirements under the Clean Water Act, including management of stormwater-related non-point source pollutants under the National Pollutant Discharge Elimination System.
- Implement best management practices for drainage and sediment control to prevent or reduce nonpoint source pollution and minimize soil loss and sedimentation in drainage areas. These practices may include, but are not limited to, silt fencing, filter fabric, temporary

sediment ponds, check dams of pea gravel-filled burlap bags or other material, and/or immediate mulching of exposed areas to minimize sedimentation and turbidity impacts as a result of construction activities. Use no plastic materials. Leave erosion control measures in place at the completion of construction to avoid adverse impacts on water resources, after which time NPS staff would be responsible for maintenance and removal.

- Use qualified NPS staff or certified wetland scientists to identify and clearly mark wetlands before construction work. Perform construction activities with caution to prevent damage caused by equipment, erosion, siltation, or pollutant discharges.

Threatened and Endangered Species

- Prior to any construction-related activities, require a training session for all contractors, partners, and NPS staff participating in project-related activities in the project area. Have a qualified biologist conduct the training to familiarize personnel about sensitive resources in the project area. Provide personnel with a brief life-history and physical description of coho salmon, steelhead trout, northern spotted owl, marbled murrelet, California red-legged frog, and other sensitive wildlife in the area. Include staff resource contact information; identification of sensitive resources; the limits of the project area; general best management practices; and appropriate actions to take upon encountering species status species or other wildlife in the training. Have all attendees sign an attendance sheet along with their printed name, company or agency, email address, and telephone number.
- Do not conduct construction activities at night or during dawn or dusk to minimize impacts on wildlife that are most active during these times, such as the northern spotted owl.
- Keep all waste and contaminants contained and remove them daily from the work site.
- Limit access and/or construction below ordinary high water to June 15 to October 31 to minimize potential adverse effects on salmonid spawning and movement. The actual work window may be a subset of that time, and would depend on the current water year, creek conditions, and timing of salmonid migrations.
- Implement the following measures to minimize potential adverse effects on northern spotted owls.
  - If construction commences between February 1 and July 31, the National Park Service would conduct pre-construction surveys for northern spotted owls in suitable nesting habitat.
  - If northern spotted owl nests are detected during pre-construction surveys, conduct no work that raises noise levels above ambient background levels within 0.25-mile of an active nest.
  - From August 6 to September 30, limit construction activities that raise noise levels above ambient background levels to daytime hours beginning two hours after sunrise and ceasing two hours before sunset.
  - Within northern spotted owl habitat, avoid disturbance to native trees greater than 10 inches in diameter at breast height where feasible.
- Implement the following measures to minimize potential adverse effects on marbled murrelet:
  - If construction commences between March 15 and September 15, the National Park Service would conduct 1 year of inland pre-construction surveys within 0.25 mile of potential marbled murrelet nesting habitat. Conduct surveys in accordance with *Methods for Surveying Marbled Murrelets in Forests: A Revised Protocol for Land Management and Research* (Evans Mack et al. 2003).

  - If marbled murrelet breeding activity or nests are detected during pre-construction surveys, conduct no work that raises noise levels above ambient background levels within 0.25 mile of an active nest.
- From August 6 to September 30, limit construction activities that raise noise levels above ambient background levels to daytime hours beginning two hours after sunrise and ceasing two hours before sunset.
- Implement the following measures to minimize potential adverse effects on California red-legged frogs:
  - A qualified biologist would conduct a reconnaissance-level survey for California red-legged frogs within 48 hours prior to starting work in areas that provide potentially suitable habitat.
  - If no California red-legged frogs are found within the project area during the survey, proceed with work. If California red-legged frogs are observed, the National Park Service would re-initiate consultation with the US Fish and Wildlife Service to determine appropriate avoidance and minimization measures. Report any sightings and/or injuries of California red-legged frogs to the US Fish and Wildlife Service within 24 hours.
  - Store pipes, conduits, and other materials that could provide shelter for California red-legged frogs above ground level to reduce the potential for animals to climb into the conduits and other materials.
- Have a qualified biologist conduct pre-construction surveys for dusky-footed woodrat (*Neotoma fuscipes*) prior to project-related activities. Avoid identified woodrat houses to the maximum extent practicable. If houses are unavoidable, the National Park Service would contact the US Fish and Wildlife Service with proposed measures for review and approval prior to construction.

Cultural Resources

- Identify and delineate archeological resources in the vicinity of the project area prior to project work. An archeologist who meets the Secretary of the Interior's professional qualification standards would monitor all new ground disturbance.
- Continue to coordinate with the California State Historic Preservation Office throughout the course of the project if unknown cultural resources are discovered as a result of the actions associated with the alternatives.
- In the event that human remains are discovered during construction activities, stop all work on the project and contact the monument's archeologist contacted immediately. As required by law, notify the coroner. Follow all provisions outlined in the Native American Graves Protection and Repatriation Act (1990).

ALTERNATIVES CONSIDERED AND NOT CARRIED FORWARD

A number of alternatives were identified during internal and public scoping. During scoping, these options did not meet the purpose of, and need for, action, were not feasible, or had several disadvantages and were not carried forward for detailed analysis in this environmental assessment. They are described below.

Expanded Annex Lot Only

This alternative would retain the existing footprint of the Entry Plaza and Main Lot and expand the Annex Lot by an additional acre to the southeast to contain parking for 182 privately owned vehicles. The expansion would address the proposed elimination of roadside parking within the monument

and revegetate previously disturbed areas, such as the former Nursery Area. The alternative would include significant grading and fill. The National Park Service would remove large stands of coast live oak (*Quercus agrifolia*), Arroyo willow (*Salix lasiolepis*), and California buckeye to implement this alternative. Runoff into Redwood Creek would increase as a result of an additional acre of impervious surface in the Annex Lot. This alternative was considered and not carried forward because it would have considerable adverse impacts on natural resources as a result of its large development footprint and proximity to critical habitat for coho salmon and steelhead trout.

Expanded Annex Lot and Nursery Parking

Under this alternative, the Entry Plaza and Main Lot would be reconfigured to serve as a pedestrian space and drop-off location. The Annex Lot would be expanded by more than an acre to the southeast to contain parking for 107 privately owned vehicles and 18 buses, shuttles, and commercial use vehicles. Roadside parking would be eliminated within the monument entirely. A new lot, approximately 1 acre in size, would be developed in the former Nursery Area to contain parking for 70 privately owned vehicles, and driveway access would be added between the Annex Lot and Nursey Area. This alternative would locate all parking for visitors with disabilities in these lots instead of at the Entry Plaza or in the Main Lot, resulting in longer travel distances for these visitors. This alternative was considered and not carried forward because of its adverse impacts on large stands of coast live oak, Arroyo willow, and California buckeye. In addition, runoff into Redwood Creek would increase as a result of additional impervious surfaces.

Construct a Parking Lot on Panoramic Highway

This alternative would develop a parking lot on Panoramic Highway. The proposed parking lot could be visually intrusive from the highway, resulting in viewshed impacts, and it created the potential for adverse impacts from poor traffic circulation because additional traffic would need to access the busy intersection. Furthermore, large buses and shuttles in this area would pose a risk to pedestrians, cyclists, and other automobiles because the alternative would lack the appropriate design to accommodate vehicles of this size. Lastly, adverse effects would likely occur from the increased use of local trails and further analysis of operations identified additional disadvantages. It was considered and not carried forward because public scoping indicated a lack of public support.

All Visitors Arrive By Shuttle

The National Park Service considered this alternative in the 2014 *Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan/Environmental Impact Statement*. It was not carried forward because of its unsustainable cost, large displacement of visitors, and the inability of the National Park Service to maintain privately owned vehicle access while protecting monument resources.

Convert Muir Woods Road to One-Way Travel

This alternative was considered and not carried forward because the National Park Service does not own the road. Furthermore, the alternative raised concerns regarding vehicular access for emergency vehicles, the public, and county. By creating only one-way access, public commenters noted that getting into and out of the valley could be difficult for a variety of users.

SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Table 2 provides a summary of environmental consequences for each resource area analyzed in "Chapter 4: Environmental Consequences." Alternatives are determined to have beneficial or adverse impacts for each area of analysis.

TABLE 2. SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Resource Area	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Visitor Experience and Safety	The no-action alternative would maintain limited wayfinding and interpretive media. The restroom in the Entry Plaza would continue to be undersized and unable to meet current visitation levels. Safety issues would continue to exist between pedestrians and vehicles along Muir Woods Road and within parking lots. There would also be adverse impacts related to pedestrian and vehicle conflicts as a result of trails crossing parking lot driveways, vehicles approaching or exiting the Annex and Conlon Lots, and visitors crossing Muir Woods Road from the Conlon Lot. Shoulder parking would continue to impede emergency vehicle access to the monument.	Beneficial impacts would occur from improved wayfinding, additional interpretive media, and a relocated restroom in the Entry Plaza to accommodate visitation levels. A second restroom located near the former Nursery Area would also result in beneficial impacts. Adverse impacts would continue to occur from conflicts between pedestrians and vehicles along Muir Woods Road and within parking lots. While impacts would be beneficial from additional ABA-compliant parking spaces, minor, adverse impacts could occur from moving the ABA-compliant parking farther from the Entry Plaza. There should be short-term, adverse impacts during the construction period from reduced parking availability and noise from construction equipment.	Beneficial impacts would occur from improved wayfinding, additional interpretive media, and a relocated restroom in the Entry Plaza to accommodate visitation levels. A second restroom would be located near the former Nursery Area, also resulting in beneficial impacts. A new pedestrian woodland trail between the Nursery Lot and Annex Lot would result in beneficial impacts by reducing conflicts between pedestrians and vehicles along Muir Woods Road. The removal of all shoulder parking would result in beneficial impacts to visitor safety from improved emergency access and provide a wide and clear right-of-way for navigation along Muir Woods Road. While impacts from additional ABA-compliant parking spaces and reduced vehicular congestion near those spaces would be beneficial, minor, adverse impacts could occur from moving the ABA-compliant parking farther from the Entry Plaza. There should be short-term, adverse impacts during the construction period from reduced parking availability and noise from construction equipment.

TABLE 2. SUMMARY OF ENVIRONMENTAL CONSEQUENCES – CONTINUED

Resource Area	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Transportation	The no-action alternative would continue adverse impacts from roadside parking for 31 vehicles between the Conlon Lot and Muir Woods Road Bridge. The existing parking lot configuration would be maintained, resulting in adverse impacts from congestion and queuing delays related to vehicles competing for available parking spaces and conflicts between buses and privately owned vehicles searching for or backing out of parking spaces. There would also be pedestrian and vehicle safety issues from trails crossing parking lot driveways and sight distance issues for vehicles approaching or exiting from the Conlon Lot.	Alternative 2 would retain roadside parking for 30 vehicles south of Conlon Lot along Muir Woods Road; therefore, several adverse pedestrian and vehicle safety issues would continue to exist. The Dipsea Trail would be routed around the western edge of the Annex Lot, improving vehicle-pedestrian conflicts, and both revisions to the Annex Lot entrance and mitigation measures would improve vehicle safety. The four existing parking lots would be expanded or reconfigured, resulting in beneficial impacts. Privately owned vehicles parking spaces would be removed from the Main Lot, reducing conflicts with buses, shuttles, and commercial use vehicles and improving overall shuttle/bus safety and circulation.	Alternative 3 would eliminate all shoulder parking along Muir Woods Road between Conlon Avenue and the Muir Woods Road Bridge and would include a Nursery Lot, eliminating adverse impacts from vehicles competing for roadside parking and improving pedestrian-vehicle safety issues. A new woodland trail would replace the existing Muir Woods Road pedestrian trail and travel along the backside of the parking lots, thus avoiding any trails crossing the driveways serving the parking lots improving vehicle/pedestrian conflict locations. Similar to alternative 2, the Dipsea Trail would be routed around the western edge of the Annex Lot, improving vehicle-pedestrian conflicts, and both revisions to the Annex Lot entrance and mitigation measures would improve vehicle safety. The four existing parking lots would be expanded or reconfigured, resulting in beneficial impacts. Privately owned vehicles parking spaces would be removed from the Main Lot, reducing conflicts with buses, shuttles, and commercial use vehicles and improving overall shuttle/bus safety and circulation.
Geology and Soils	Impacts on soils would be adverse from continued vehicular and pedestrian trampling, as well as surface runoff and sedimentation from existing damaged or undersized culverts. Indirect, adverse impacts on the health of vegetation from soil compaction would also occur.	Adverse impacts on soils would occur from removal, compaction, soil structure modification, and increased runoff on approximately 0.2 acre. Beneficial impacts from alternative 2 would include decreased turbidity and sedimentation in Redwood Creek, riparian rehabilitation in the Entry Plaza, and revegetation of the former Nursery Area.	Adverse impacts on soils would occur from removal, compaction, soil structure modification, and increased runoff on approximately 0.2 acre. Beneficial impacts from alternative 3 would include decreased turbidity and sedimentation in Redwood Creek, riparian rehabilitation in the Entry Plaza, and revegetation of the former roadside parking area.

TABLE 2. SUMMARY OF ENVIRONMENTAL CONSEQUENCES – CONTINUED

Resource Area	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Vegetation	Adverse impacts would occur from ongoing ground disturbance. Plant cover and biomass would remain low in a variety of areas because soil compaction could inhibit seed germination and restrict the root growth of plants. No adverse impacts on rare plants are anticipated because existing infrastructure does not currently affect these species.	Adverse impacts would occur from removing approximately 0.2 acre of vegetation from the Annex and Conlon Lots, the roadside parking area, and from the riparian area of Redwood Creek. Direct mortality of plants would also occur in the footprint of the new restrooms and infiltration trenches. Riparian rehabilitation in the Entry Plaza and revegetation of portions of the former Nursery Area would result in beneficial impacts. No impacts on rare plants are anticipated because they would be transplanted or propagated from seed prior to any construction activities.	Adverse impacts would occur from removing approximately 0.3 acre of vegetation in the former Nursery Area, Conlon Lot, and along the new pedestrian woodland trail; by pruning low-hanging branches along Muir Woods Road; and disturbing the riparian area of Redwood Creek. Direct mortality of plants would also occur in the footprint of the new restrooms and infiltration trenches. Revegetation of the existing pedestrian trail along Muir Woods Road, riparian rehabilitation in the Entry Plaza, and revegetation of former roadside parking area would result in long-term, beneficial impacts. No impacts on rare plants are anticipated because they would be transplanted or propagated prior to any construction activities.
Water Resources and Hydrologic Processes	The no-action alternative would not upgrade stormwater management infrastructure, resulting in adverse impacts on water resources and hydrologic processes from continued erosion and runoff from parking lots, shoulder parking, instream disturbance and erosion.	Expansion of the Annex and Conlon Lots, construction of the Dipsea Trail footbridge, and development of the new restrooms could temporarily result in erosion and sedimentation of surface waters. Two drainages in the Annex Lot would be temporarily and adversely affected during installation of two culverts and construction of stormwater management infrastructure. In the long term, beneficial impacts on water resources and hydrologic processes would occur from updating stormwater management infrastructure, revegetation and rehabilitation of disturbed areas, and removal of potential flood hazards.	Expansion of the Conlon Lot, construction of the Nursery Lot, new woodland pedestrian trail, and the Dipsea Trail footbridge, and the development of new restrooms could temporarily result in erosion and sedimentation of surface waters. One drainage in the former Nursery Area would be temporarily and adversely affected during installation of a culvert and construction of stormwater management infrastructure. In the long term, beneficial impacts on water resources and hydrologic processes would occur from updating stormwater management infrastructure, revegetation and rehabilitation of disturbed areas, and removal of ground disturbance and potential flood hazards.

TABLE 2. SUMMARY OF ENVIRONMENTAL CONSEQUENCES – CONTINUED

Resource Area	Alternative 1: No-Action	Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements	Alternative 3: Nursery Parking and Sustainable Access Improvements
Threatened and Endangered Species	The no-action alternative would not upgrade stormwater management infrastructure, resulting in continued impacts on coho salmon and steelhead trout habitat in Redwood Creek, commensurate with water quality impacts from erosion and runoff. In addition, the no-action alternative would not construct a Dipsea Trail footbridge over Redwood Creek, resulting in continued habitat disturbances if visitors walk through the creek bed rather than crossing the wooden plank.	Alternative 2 would establish formal roadside parking, upgrade stormwater infrastructure, develop riparian habitat, and construct a Dipsea Trail footbridge, resulting in potential temporary impacts on coho salmon and steelhead trout habitat in Redwood Creek as a result of erosion and sedimentation, followed by long-term, beneficial impacts. Parking lot expansion would result in loss of northern spotted owl foraging habitat. However, rehabilitating and revegetating the erosion hazard area of the Entry Plaza would increase habitat for the northern spotted owl, resulting in beneficial impacts. Impacts on the marbled murrelet and California red-legged frog are not anticipated because these species are not known to occur within the project area. Overall, alternative 2 may affect but is not likely to adversely affect threatened and endangered species.	Alternative 3 would eliminate shoulder parking, upgrade stormwater infrastructure, and construct a Dipsea Trail footbridge. Potential temporary impacts on coho salmon and steelhead trout habitat in Redwood Creek could occur during construction activities as a result of erosion and sedimentation. These would be followed by long-term, beneficial impacts. Parking lot expansion would result in loss of northern spotted owl foraging habitat. However, rehabilitating and revegetating the erosion hazard area of the Entry Plaza would increase habitat for the northern spotted owl, resulting in beneficial impacts. Impacts on the marbled murrelet and California red-legged frog are not anticipated because these species are not known to occur within the project area. Overall, alternative 3 may affect but is not likely to adversely affect threatened and endangered species.
Cultural Resources	The no-action alternative would not disturb existing cultural resources.	Alternative 2 would avoid one archeological site. The proposed new bridge and trail reroute would not adversely affect the Dipsea Trail. Archeologically sensitive areas at the Nursery Site and the Conlon Lot would be disturbed due to demolition at the Nursery and enlarging the Conlon Lot.	Alternative 3 would disturb one archeological site. The Dipsea Trail would not be adversely affected by the proposed new bridge and trail reroute. Archeologically sensitive areas at the Nursery Site and the Conlon Lot would be disturbed, but could be avoided through proper mitigation measures. Removing the existing Muir Woods Road pedestrian trail and replacing it with a new woodland pedestrian trail would have a beneficial impact on the monument, providing that the eastern end of the trail avoids sensitive areas and archeological monitoring occurs.

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CHAPTER 3: AFFECTED ENVIRONMENT

INTRODUCTION

This chapter presents information about the existing environment at the monument to understand the potential impacts from the alternatives. Issues and impact topics discussed in this chapter include visitor experience and safety, transportation, geology and soils, vegetation, water resources and hydrologic processes, threatened and endangered species, cultural resources, and climate change (where applicable within the impact topics).

VISITOR EXPERIENCE AND SAFETY

Current visitor experience and visitor safety conditions at the monument have played a key role in the purpose of, and need for, action, and are a result of visitation levels and arrival rates that exceed the monument's user capacity.

Visitor Experience

Within the project area, several overlapping components contribute to the visitor experience at the monument, including user capacity; the arrival, entry, and departure experience; the ability to navigate within the monument; the availability of amenities; the accessibility of parking; and the availability of interpretive and educational opportunities.

User Capacity. The National Park Service defines user capacity as the types and levels of visitor and other public use that can be accommodated, while sustaining the desired resource conditions, social conditions, and visitor experiences that complement the purpose of the NPS unit (NPS 2009). This definition acknowledges that desired conditions and visitor experiences are often related to a variety of factors, not merely to the number of people. User capacity considers how people get to a park unit, what they do while there, where they do it, how long they stay, and what impact their activities has on resources and the experience of other visitors (NPS 2015b).

Managing visitation to levels that meet user capacity rates described in the Record of Decision for the *Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan / Environmental Impact Statement* is among the key goals of the monument (NPS 2014a). As a step toward meeting this goal, the monument completed the 2015 *Muir Woods National Monument Reservation System Environmental Assessment* and *Finding of No Significant Impact* for a reservation system, which will begin phased implementation in 2016 and 2017 to help address the number of days that exceed user capacity at the monument (NPS 2015b, d). Both of these documents provide definitions and detail for identifying desired conditions, indicators, and standards that fulfill statutory requirements; align with the monument's purpose and significance; and allow present and future opportunities for public enjoyment of the monument.

Arrival, Entry, and Departure Experience. Visitors arrive at the monument in privately owned vehicles, shuttle buses, tour buses, bicycles, and on foot, but the majority arrive in privately owned vehicles. During peak visitation times, existing parking lots fill to maximum capacity and visitors find informal parking areas, such as along the roadside. Traffic congestion during this time increases substantially as drivers circle around parking lots looking for a parking space and drop passengers off in the Main Lot before continuing to search for parking. Parking areas are spread for approximately a half mile between the visitor center and Muir Woods Road Bridge. Visitors parking informally along Muir Woods Road may have to walk more than a mile to the monument entrance, sharing the

road with vehicular traffic. This experience can create feelings of stress and anxiety as part of the visitors' arrival and departure experience (NPS 2012b).

The entry experience encompasses the visitors' activities from the time they arrive via their transportation mode until they pass through the admission gate at the Entry Plaza. During this time, visitors prepare themselves for their upcoming experience. Activities in this area include using the restroom, resting, sightseeing, viewing interpretive media, decompressing after a long trip, planning their itinerary within the monument, visiting the visitor center and bookstore, and paying the entrance fee before experiencing the forest. The Entry Plaza was originally a parking lot and was modified to provisionally meet the needs of visitors. This area can, however, become very crowded with visitors who have been dropped off and are waiting for their driver to park and rejoin their party, arrival surges from tour and shuttle buses, and occasional backups at the ticket booth (NPS 2012b). Furthermore, noise associated with a lack of separation from the tour and shuttle bus drop-off area and the presence of a restroom in the Entry Plaza disrupts the natural soundscape along Redwood Creek (NPS 2012c).

Wayfinding Opportunities. Multiple trails are located within the project area that provide access to the Entry Plaza and the monument. The Redwood Creek Trail, Dipsea Trail, and Deer Park Fire Road all provide pedestrian access from shoulder parking along Muir Woods Road into the monument. Redwood Creek Trail also extends between the Main Lot and the Annex Lot. Nearby public lands, including Mount Tamalpais State Park, provide trail access directly into the monument. However, because few visitors are aware of these alternate and historic access opportunities and because wayfinding signage is currently inadequate, most visitors walk directly through parking lots or along the side of Muir Woods Road before arriving at the Entry Plaza (NPS 2012c, 2014a). Dipsea Trail, which traverses the project area, drops steeply down a stairway to Muir Woods Road across from the Annex Lot. Trail users must cross Muir Woods Road and the Annex Lot to continue along the trail to cross the wooden plank at Redwood Creek, which is often removed in the winter and spring because it washes away during high flows. For more details on the trails within the project area, see the "Pedestrians" subsection under "Transportation."

Visitor Amenities. One restroom, built in the 1960s, is located along Redwood Creek between the Entry Plaza and the Main Lot. This facility is in moderate condition and is located in the erosion hazard area of the monument. Currently, the restroom is undersized and does not accommodate current visitor use levels. Visitors arriving at the monument and parking in overflow parking may need to walk more than a mile to reach the restroom, and have been found relieving themselves in inappropriate areas (NPS, Aviles, pers. comm. 2016b). The location of the restroom building conflicts with interpretive objectives for Redwood Creek because this location offers a good opportunity to view the stream channel and surrounding riparian forest (NPS 2012c).

Visitor Accessibility Parking for Architectural Barrier Act Standards. The existing vehicle drop-off and pick-up zone near the monument entrance serves visitors with disabilities. Nine ABA-compliant parking spaces are available in the Entry Plaza, exceeding accessibility standards required under the Architectural Barriers Act of 1968 by three spaces (DoD et al. 2015). The ABA-compliant parking spaces currently bring visitors in close contact with administrative vehicles accessing operational areas in the Entry Plaza.

Interpretive and Educational Opportunities. Visitors can experience the interpretive and educational opportunities available at the monument in various ways, including viewing brochures and exhibits available at the visitor center; taking self-guided walks; and attending talks, tours, and programs led by monument staff or in collaboration with local organizations.

While some interpretive opportunities are currently available in the project area—such as at the Dipsea Trailhead near the Annex Lot—the existing interpretive media do not prepare visitors for their experience at the monument and do not mitigate the tendency for visitors to rush directly to the admission gate at the Entry Plaza (NPS 2012b). As a result, the Entry Plaza is less a part of the visitor experience.

Visitor Safety

Muir Woods Road is narrow, winding, and steep in areas. Large vehicles do not always stay in their lanes around curves, presenting danger to oncoming traffic, including other vehicles and bicyclists. Additionally, shoulder parking results in potential safety issues for pedestrians crossing the road to access the monument entrance (NPS 2014b).

When formal parking lots are full, visitors typically park in areas along Muir Woods Road, causing road congestion and potentially unsafe conditions for drivers, bicyclists, and pedestrians, as discussed below. A memorandum of understanding between the National Park Service and Marin County recognizes a desire to cooperatively implement a parking reservation, public transit, and enforcement system to substantially improve these conditions. A primary goal expressed in the memorandum of understanding is to improve traffic and pedestrian safety issues that arise from parking along Muir Woods Road (NPS 2015d).

Within the project area, several areas contribute to visitor safety concerns, including potential conflicts between pedestrians and vehicles, potential conflicts between vehicles and bicycles, potential conflicts between vehicles, and accessibility for emergency vehicles.

Conflicts between Pedestrians and Vehicles. In areas of high pedestrian and vehicle congestion, the potential for pedestrian-vehicle conflict can arise as pedestrians and vehicles attempt to navigate roadways and busy parking areas and as privately owned vehicles, tour buses, and shuttle buses drop-off passengers in areas with high pedestrian traffic. Conflicts may occur in parking areas, in passenger drop-off areas, and along Muir Woods Road. Specific areas of potential conflict occur where (1) pedestrians traveling along Dipsea Trail must cross Muir Woods Road to continue on the trail; (2) pedestrians must cross the vehicle entry/exit point at the Annex Lot along Muir Woods Road; and (3) pedestrians crossing from the Conlon Lot to the trail destined for the Entry Plaza must cross Muir Woods Road along a curve and under tree canopy, a location in which approaching vehicles have limited visibility. Visitors also walk along Muir Woods Road, creating increased potential for pedestrian and vehicle conflicts as privately owned vehicles pull in and out of roadside shoulders and make U-turns.

Conflicts between Bicyclists and Vehicles. Although the volume of bicyclists is lower than pedestrians and vehicles, visitors biking to the monument share the road lanes on Muir Woods Road with vehicular traffic and must contend with crowded traffic conditions on busy days (NPS 2012b). Conflicts arise between bicyclists and vehicles along the narrow and winding roads, particularly between coach buses and bicyclists. Conflicts also arise when vehicles park along the shoulder of Muir Woods Road because drivers may not be accustomed to looking for cyclists as they pull in or out or parking spaces. As passengers in vehicles parking along the shoulder of Muir Woods Road, they may not look for bicyclists before opening the vehicle door.

Conflicts between Vehicles. In areas of high congestion where drivers navigate busy parking lots and narrow roadways, the potential for conflict between vehicles increases. Privately owned vehicles and tour and shuttle buses dropping off passengers occur in the same area within the Main Lot, creating the potential for vehicle conflicts. Use of shoulder parking increases the potential for

conflicts between multiple privately owned vehicles as drivers attempt to navigate the area in search of available parking, as they turn their vehicles in the middle of the road into oncoming traffic, park in informal spaces, and back up into oncoming traffic from roadside spaces.

Emergency Access and Circulation. Muir Woods Road is narrow, particularly during peak visitation times when visitors park along roadway shoulders and the road is crowded with pedestrians making their way to and from the Entry Plaza. Congestion at the Entry Plaza associated with privately owned vehicles and buses dropping off and picking up passengers results in limited space to maneuver. These factors result in a highly restricted traffic circulation that limits the ability of emergency vehicles to quickly access the area.

TRANSPORTATION

Muir Woods Road provides the primary access to the monument. The road is between 24 and 30 feet wide and has a striped centerline to indicate no passing is allowed. The posted speed limit has a county-designated speed varying between 25 and 35 miles per hour (25 miles per hour within the entire monument area). The National Park Service works cooperatively with the County Sheriff and California Department of Parks and Recreation with enforcement on Muir Woods Road. Marin County owns and maintains the roadway (NPS 2012d).

Travel modes evaluated include pedestrian, bicycle, transit, and privately owned vehicle. Existing parking areas were also evaluated for visitor access to the monument. Pedestrians can access the monument via trails outside of the monument's boundaries. However, bicycles, transit, and privately owned vehicles provide the majority of transportation into and out of the monument.

Parking

Parking is provided in four off-street lots and informally permitted along Muir Woods Road. The off-street lots are the Entry Plaza (with 9 spaces for visitors with disabilities and 2 spaces for privately owned vehicles), the Main Lot (43 spaces), the Annex Lot (114 spaces), and the Conlon Lot (49 spaces). Shoulder parking is allowed along the westbound side of Muir Woods Road beginning east of the Conlon Lot. Up to 31 shoulder parking spaces exist between the Conlon Lot and Muir Woods Road Bridge. On the Mount Tamalpais State Park side of Redwood Creek, informal shoulder parking occurs on both sides of Muir Woods Road. However, the implementation of the reservation system will phase out shoulder parking on Muir Woods Road south of the bridge.

Figure 7 shows the existing shoulder parking near the Conlon Lot along Muir Woods Road. Table 3 contains the existing parking areas and space counts within the monument boundaries.

SOURCE: NPS 2011b

FIGURE 7. SHOULDER PARKING NEAR CONLON LOT

TABLE 3. PARKING WITHIN MONUMENT BOUNDARIES

Lot Name	ABA-Compliant Parking	Privately Owned Vehicles	Total (Privately Owned Vehicles)	Transit (Buses and Shuttles)	Total (All Vehicles)
Entry Plaza	9	2	11	0	11
Main Lot	0	27	27	16	43
Annex Lot	0	114	114	0	114
Conlon Lot	0	49	49	0	49
Roadside Parking	0	31	31	0	31
Total	9	223	232	16	248

Pedestrians

A network of walking trails connects the on- and off-street parking areas to the monument's entrance. Beginning from the monument's entrance and heading east, Redwood Creek Trail runs along the creek side of the Entry Plaza and Main Lot. The trail splits along the eastern side of the Main Lot with the southern leg connecting to the southwestern corner of the Annex Lot. The northern leg follows Muir Woods Road, crosses both driveways serving the Annex Lot, and continues along Muir Woods Road until the far side of Redwood Creek, where the trail merges with

the roadway on its way to Muir Beach. The pedestrian network varies in width but maintains an approximate width of 5 feet. Between the Muir Woods Road Bridge and monument entrance, the trail maintains its own right-of-way and has a wooden fence that separates it from Muir Woods Road. Tree stumps, utility poles, and No Parking signs also are situated on the trail, sometimes creating small areas with narrow widths.

Visitors parking in the Conlon Lot must cross Muir Woods Road to access the main pedestrian trail to the monument entrance. Drivers have a limited sight distance to see pedestrians crossing at the Conlon Lot when driving westbound from the Muir Woods Road Bridge toward the Conlon Lot. This issue is also discussed in the "Privately Owned Vehicles" subsection below.

Bicycles

Bicycles are permitted to use Muir Woods Road to access the monument; however, bicycles are not allowed within the monument (NPS 2016c). Bicycle racks are located near the monument entrance approximately 80 feet west of the ABA-compliant parking in the Entry Plaza (NPS n.d.). Bicyclists can access the monument from either Muir Woods Road or Panoramic Highway. Bicycles can create congestion on the roadways because of their lower speed and bicycle-vehicle conflicts on the narrow travel ways and winding roadways that connect the monument to the rest of Marin County (NPS 2012b).

Privately Owned Vehicles

Visitors arriving in privately owned vehicles access the monument by driving on Muir Woods Road either from Panoramic Highway or Highway 1 from Muir Beach. Based on the estimated number of vehicles per hour during peak visitation (i.e., Saturday in July at 11:00 a.m.), potentially more than 200 vehicles per hour access the monument (NPS, Brown, pers. comm. 2016d). Parking demand regularly exceeds supply because only 232 privately owned vehicle spaces are available between the Muir Woods Road Bridge and the monument entrance, resulting in congestion (NPS 2015b).

Drivers looking for parking can cause unsafe conditions for vehicles and pedestrians walking from their vehicles to the monument entrance and for vehicle queuing. Visitors who park along the roadway and walk in active travel lanes along Muir Woods Road or across parking lots with a continuous flow of vehicles can cause pedestrian-vehicle conflicts. Driver frustration can also be an issue as drivers attempt to find a place to park after committing to drive to the monument (NPS 2015b).

The driveway serving the Conlon Lot exits onto Muir Woods Road in the middle of a roadway curve. According to the sight distance tables provided in the American Association of State Highway and Transportation Officials (AASHTO) 2011 *Policy on Geometric Design of Highways and Streets*, a minimum of 280 feet of unobstructed view is required for a left turn from a STOP sign onto a road with a speed limit of 25 miles per hour; the value for a right turn is 240 feet (AASHTO 2011). Because the road is located in a heavily forested area with trees lining the roadway, a driver can only see vehicles approaching up to an estimated maximum of 100 feet to the left and approximately 300 feet to the right. Based on the AASHTO values, the sight distance for a left turn is approximately 200 feet less than what needs to be provided for a safe sight distance. A similar problem exists for vehicles driving southbound away from the Main Lot on Muir Woods Road and attempting to make a left into the Conlon Lot. According to the American Association of State Highway and Transportation Officials, 290 feet of sight distance is required; however, only 100 feet are available, resulting in an unsafe sight distance for vehicles attempting to enter by making a left turn (AASHTO 2011).

Public Transportation

Access to the monument is available through a seasonal 37-seat shuttle bus operated between two park and ride facilities in Sausalito, California, between April and October. The Route 66 shuttle from the Pohono Street Park & Ride offers weekend and holiday service at 10-minute headways from Memorial Day to Labor Day, and 20-minute headways in April, May, September, and October. The Route 66F shuttle from the Sausalito Ferry offers daily 30-minute headways from Memorial Day to Labor Day. The same route offers weekend 1-hour headways in April, May, September, and October. The roundtrip cost is $5.00 for either shuttle and is paid at the monument entrance, where riders obtain a receipt to present to the bus driver to board for the return trip from the monument (Marin Transit 2016).

In 2015, the shuttle carried more than 110,700 passengers—25% of this total volume occurred in July and 44.5% occurred in July and August. Because of the limited seating capacity, uneven passenger arrivals, and the requirement for no standees because of the winding travel route, some individuals are not able to board the first available bus. These individuals are called pass-ups. About 25% of pass-ups had to wait more than 30 minutes before being able to board the shuttle (Marin Transit 2015).

Private tour operators provide bus service to the monument in both large 35-passenger buses and smaller vans and town cars. These services operate from San Francisco or Sausalito to the monument and vie for the 16 designated parking spaces located in the Main Lot. The vans and buses use Panoramic Highway to access Muir Woods via upper Muir Woods Road and exit via lower Muir Woods Road. The Main Lot can accommodate up to 35-foot tour buses. Although not permitted to enter the monument, 40-foot to 45-foot buses sometimes arrive and require extra help by parking ambassadors to guide them through the lot. In addition to the oversized buses, the small vans and town cars take up valuable spaces, requiring the 35-foot buses to park farther away from the monument entrance (NPS 2012d).

The monument requires private tour companies to purchase an annual permit, better known as a Commercial Use Authorization (CUA), to access Muir Woods more than one time per month. The companies that have the CUA permits are not allowed to have more than two commercial carriers at Muir Woods at any one time (NPS 2016c, e). The Main Lot has also recently been reconfigured to maximize space with areas identified for both larger and smaller vehicles and reserved lanes for shuttles. As of 2012, more than 50 companies had purchased CUA permits (NPS 2012d).

GEOLOGY AND SOILS

Past road construction and other developments have disturbed soils within the monument and led to a decrease in soil stability and an increase in erosion. In recent years, some effort has been made to restore soil to naturally occurring conditions through removal of paved trails in favor of raised boardwalks, especially in the monument beyond the entry arch. Some areas of the monument have been fenced to protect soil from compaction cause by foot traffic. However, many areas of the monument are still subject to erosion processes because a few trails are paved. Surface disturbances, such as cuts for trails and roads, vegetation clearing, and alteration of surface water drainages, can trigger or lead to slope failures (NPS 2014a). A natural resources assessment completed in 2011 ranked the soil conditions at the monument as fair because of historic logging, grazing, farming, residential development, and compaction from pedestrians (NPCA 2011).

The project area comprises the Centissima-Barnabe complex, Blucher-Cole complex, Dipsea-Barnabe very gravelly loams, and Bonnydoon gravelly loam (figure 8). Within the project area, the

Centissima-Barnabe complex covers the northern portion, and the Blucher-Cole complex covers most of the southern portion. Dipsea-Barnabe very gravelly loams cover a little more than 2 acres at the southern portion of the project area, while Bonnydoon gravelly loam covers approximately a sixth of an acre (USDA, NRCS 2016). K factors, which describe the soil susceptibility to erosion and the rate of runoff, have been identified for each soil type. Soils with a low K value are susceptible to easy detachment, but have a low runoff rate. Soils with a moderate K value are moderately susceptible to detachment and have a moderate runoff rate. Soils with a high K value are the most erodible and have a high rate of runoff.

The Centissima-Barnabe complex is primarily derived from weathered soft sandstone and shale, and the unit is described as poorly suited for recreational development. This unit has a low to moderate K value and a moderate susceptibility to runoff and erosion. Vegetated cover on this unit can help to prevent erosion, and plant cover can be maintained by limited traffic over the area (USDA, SCS 1985). The Centissima-Barnabe complex is the most commonly encountered soil type within the monument and supports all of the slope redwood stands (McBride and Jacobs 1978).

The Blucher-Cole complex is formed in alluvium from various kinds of rocks. Because of the slow permeability of this soil type and risk of flooding, this complex is poorly suited for recreational development. The unit has a moderate to high K value with a moderately high susceptibility to erosion and high rate of runoff. Erosion on this unit can be controlled through maintaining adequate plant cover (USDA, SCS 1985). Proper drainage measures must be installed to make it suitable for road development, and septic tank absorption fields do not function properly during rainy periods. The largest redwood and hardwood trees within the monument occur on this soil type (McBride and Jacobs 1978).

The Dipsea-Barnabe soil type is derived from sandstone and shale, and the unit is poorly suited for recreational development because it is found on steep slopes. This unit has a coarse texture with a low K value and a high susceptibility to erosion and a low rate of runoff. Proper drainage systems and waste material placement can help prevent and control erosion. Native vegetation on this soil type consists of mixed hardwoods and conifers (USDA, SCS 1985).

The Bonnydoon soil type is derived from fractured sandstone and is found on uplands. The unit has a high K value because runoff is very rapid, and the hazard of erosion is very high. Because of the steepness of slope, the soil type is poorly suited for recreational or site development. Intensive runoff control measures are required. Native vegetation on this soil type consists mainly of grasses and forbs (USDA, SCS 1985).

As climate change impacts become more apparent, soil conditions will likely change over time. Higher intensity and more frequent rainfall may lead to more erosion in susceptible soils and an increase in runoff when soils reach saturation levels. With rainfall amounts increasing, erosion and runoff levels may increase at a greater rate—on the order of a 1.7 ratio (Nearing et al. 2004).

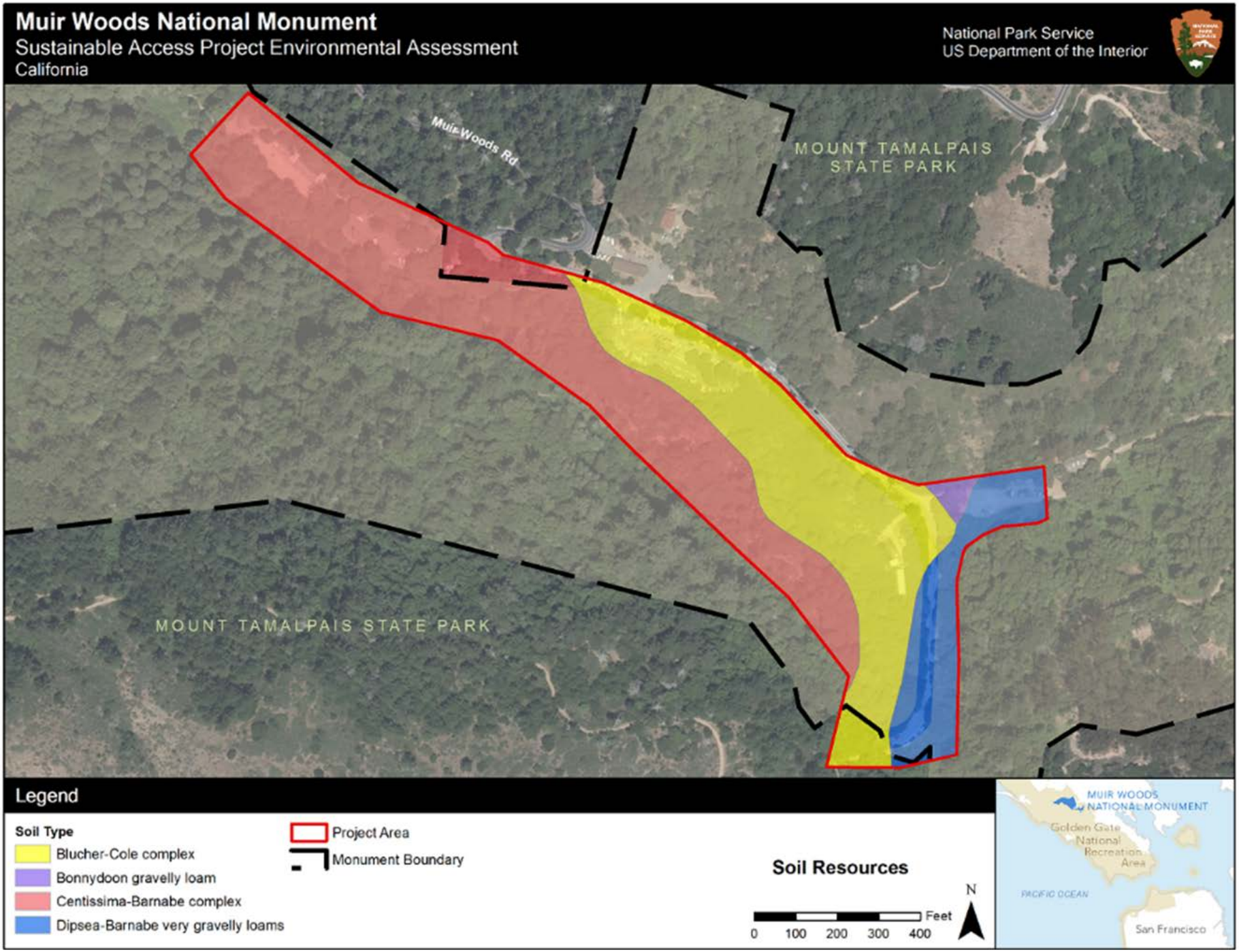

Figure 8. Soil Types in the Project Area

VEGETATION

The project area is outside the redwood forest, and comprises 47 distinct stands of vegetation. Based on the Holland and Keil classification scheme, 17 different types of vegetation were classified (figure 9). Red alder (*Alnus rubra*) and bay laurel-swordfern (*Umbellularia californica*; *Polystichum munitum*) had the highest coverage, while California buckeye had the least (NPS 2013a).

"NPSpecies," a National Park Service database, has 318 vascular plant species documented—13 of which are under review to confirm their presence—within the monument. Approximately 27 other species are probably present, but have not been verified, and 17 species are unconfirmed. Of the 318 species, 44 are listed as historic, meaning they were previously present but are believed to be extirpated, and 74 vascular plants present at the monument are nonnative (NPS 2016f). A survey of vegetation within the project area found 180 species; 97 were native plants and 83 were nonnative. Of the 180 species, 43 had no prior record of occurring at the monument (NPS 2013a).

Few native plant species of concern are found within the monument. The Oakland star tulip, or mariposa lily (*Calochortus umbellatus*), is described in the fire management plan as a CNPS-listed species, which has been found "in the vicinity of Muir Woods" in grasslands (NPS 2005). Nine different vegetation alliances were listed as having either a global or state conservation ranking of 3, making them sensitive to disturbance (NPS 2013a). However, only two rare plant species were found in the project area: California bottlebrush grass and leopard lily.

California bottlebrush grass has a CNPS ranking of 4.3 for being uncommon in California, although it is not threatened or endangered. The only active management for rare plant species in the monument has been some fencing along the valley floor to protect California bottlebrush grass, which appears to have been effective (NPCA 2009). Leopard lily has no federal, state, or CNPS listing, but the species is of local concern to the monument's natural resource management staff because they believe it was once more widespread within the monument (NPS 2013a). California buckeye is also of particular importance to the monument. Though the species is not listed as threatened or endangered by the state or federal government, buckeye-dominated vegetation is rare in California. Furthermore, buckeye-dominated woodlands are especially uncommon in coastal regions and likely have the most unique associated taxa of any buckeye stands elsewhere (NPS, Steers, pers. comm. 2013b).

Other native vegetation types—coastal scrub/chaparral and grassland—have been highly altered because of a combination of fire suppression; land use practices; and invasive, nonnative species (NPS 2005, 2011c). The coastal scrub/chaparral occurs at upper elevations and seems to be invading grasslands as a result of fire suppression (NPS 2005). Coniferous forests are invading the lower elevations of the scrublands. Within the Redwood Creek Watershed, nonnative, Mediterranean annual grasses dominate most native grasslands that occupy ridgetops and slopes (NPS 2011c).

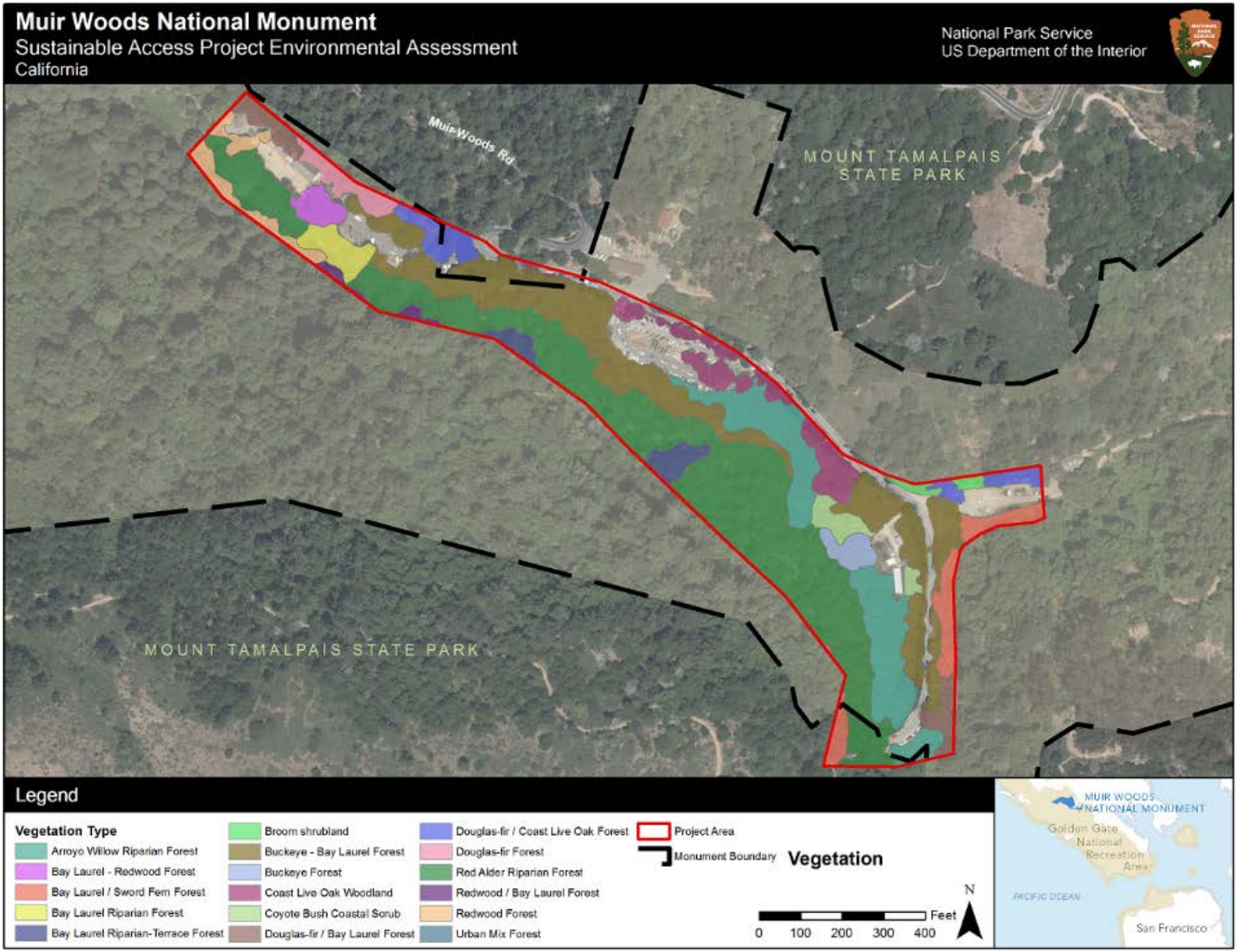

Figure 9. Vegetation Types in the Project Area

Invasive, nonnative plants are a considerable problem within all other vegetation types. The isolated patches of nonnative aquatic plants appear to be limited in extent. Today, three main nonnative species of concern occur at the monument: the forget-me-not (*Myosotis sylvatica*; *Myosotis latifolia*), panic veldtgrass (*Ehrharta erecta*), and traveler's joy (*Clematis vitalba*). Originally introduced to improve the aesthetics of the forest, forget-me-nots quickly spread throughout the monument. Fortunately, the monument has kept this species under control along the canyon floor, although the ability to eliminate it from steep, inaccessible slopes is a staff concern. Along Redwood Creek, removal of this species led to an increase in native plant cover. Control methods for panic veldtgrass and traveler's joy are still being developed and tested. Outside the riparian forests, monument staff have worked to eliminate other invasive species, including cape ivy (*Delairea odorata*), brooms (*Genista monspessulana*; *Cytisus scoparius*; *Spartium junceum*), acacia (*Acacia melanoxylon*; *Acacia decurrens*), and other species (NPCA 2009).

Sudden oak death, a nonnative plant disease caused by the microscopic pathogen *Phytophthora ramorum* is present at the monument, and efforts have been made to reduce its spread by selectively removing infected trees, stream baiting, conducting ground surveys, reducing the amount of standing water on high use trails, and advising visitors to remove mud from their boots before embarking on established trails.

The monument includes the most intact old-growth coast redwood forest in the Bay Area. It is estimated that nearly 2 million acres of forest similar to those at the monument once covered a narrow strip along the coasts of California and Oregon. Today, 97% of this forest area has been displaced or degraded, and most coast redwoods now grow in protected second- and third-growth forests or managed timber plantations. At the monument, the redwood forest "extends along the canyon floor north beyond the monument, across most of the northeastern-facing canyon wall up to the Dipsea Trail, and along portions of the lower southwest-facing wall and adjoining side canyons extending to Canopy View Trail. In these areas, the redwoods thrive in a cool microclimate with loamy soils and ample moisture from fog, rain, and groundwater" (NPCA 2009).

Although this forest is largely isolated within the larger landscape because of natural conditions (i.e., physiography and the restricted environmental requirements of redwoods), the tracts of forest within the monument have had a history of protection that has preserved many of the structural and functional ecological features. However, small areas within the monument's redwood forest show evidence of logging in the late nineteenth century (McBride and Jacobs 1978). Though recreation and tourism (e.g., trampling, campfires, and collecting plants) and park management (e.g., stream alteration and removal of woody debris) have historically degraded vegetation, some areas have been able to recover within a period of years or decades. Studies have shown that areas formerly devoid of vegetation along Redwood Creek have recovered to the point that it is not possible to discern restoration plantings from natural vegetation (NPS 2014a). NPS staff and other resource protection organizations monitor the health of the redwood forest on a regular basis, and have determined the health of the forest to be good. Public ownership of surrounding lands helps maintain certain ecosystem functions within the monument's redwood forests (NPS 2014a).

The effects of climate change on the monument's vegetation are potentially threatening. Fog plays a large role in the coast redwood and Douglas-fir ecosystem. Fog frequency has decreased by 33%—or three fewer hours of fog each day—along California's coast since the early 20th century (NPCA 2011). Precipitation and storm intensity could likely increase in the Bay Area, which would likely increase erosion and floods (NPS 2014a). Because of the coast redwood trees' resistance to adverse effects from flooding, this could help coast redwood seedlings establish, though other species could be negatively affected (NPCA 2011).

WATER RESOURCES AND HYDROLOGIC PROCESSES

Groundwater

In general, groundwater resources are important for the recharge of surface waters and wetlands, to support wildlife habitat, and as a source for municipal and agricultural water supplies. Marin County is underlain by impermeable Franciscan bedrock, resulting in a perched water table. No wells operate in the monument; however, springs located upstream of the monument supply water for use by the Marin Municipal Water District (NPS 2014a).

Surface Water

The primary water resource in the monument is Redwood Creek (figure 10), a perennial stream that flows from its headwaters on Mount Tamalpais through the monument and to the Pacific Ocean (NPS 2014a). Several intermittent or ephemeral tributaries discharge into Redwood Creek from the northeast or east in the boundaries of the project area, including Camino del Canyon and Conlon Creek (Cooprider 2004; Ryan 2016). Redwood Creek and its tributaries flow down steep slopes and through canyons upstream of the monument. As Redwood Creek enters the monument, it is characterized by a slope of less than 2% and a gravel and cobble bed (NPS 2011c, 2014a). Conlon Creek currently flows parallel along the east side of Muir Woods Road; however, historically it flowed along a more direct southwesterly route to Redwood Creek with a confluence that would have been located on western side of Muir Woods Road (Anderson et al. 2015).

Within the monument, Redwood Creek is constrained by a narrow valley (NPS 2011c). Redwood Creek was channelized in the 1930s, and check dams and rock revetments were installed along approximately 57% of the stream within the monument (NPS 2014a). Natural hydrologic processes, including bank erosion, meandering, and flooding were altered because of the revetments on portions of Redwood Creek (NPS 2014a). The channelization resulted in channel widening (NPS 2011c). The revetments remain on portions of the creek; however, some check dams have been removed (NPS 2014a). Although some natural processes have returned, the creek has more riffle habitat and less deep water pool habitat than would naturally occur within a similarly sloped stream, and less large woody debris (Fong 2002, as cited by NPS 2014a; NPCA 2009; NPS 2011c).

Streamflow in Redwood Creek can vary from very low during spring and summer to high and flashy during the winter (Cooprider 2004; NPS 2011c). Measurements taken in 2003–2004 at the Muir Woods Road Bridge, at the downstream end of the project area, showed peak winter flows of approximately 30 to 170 cubic feet per second (cfs) (NPS 2011c). More recent measurements from a monitoring station on Redwood Creek approximately 1.5 miles downstream from the project area showed the daily discharge ranged from periods of no flow to a maximum of 431 cfs (USGS 2016). Using a method that scaled peak flood flows at Redwood Creek near Tamalpais, streamflow was calculated for Redwood Creek at a location approximately 330 feet upstream from the upstream project boundary. Streamflow from this method varied from 426 cfs to 1,864 cfs over a flood frequency range of 50% to 0.2% chance exceedance (Anderson et al. 2016). Peak flow estimates for Conlon Creek range from approximately 22 cfs for the two-year flood event to 175 cfs for the 500-year flood event (Anderson et al. 2015). Climate change models predict changes in the increases in the intensity and frequency of precipitation events and more frequent scouring floods, which could result in increased stormwater runoff and alterations to peak stream flows (NPS 2011c, 2014a).

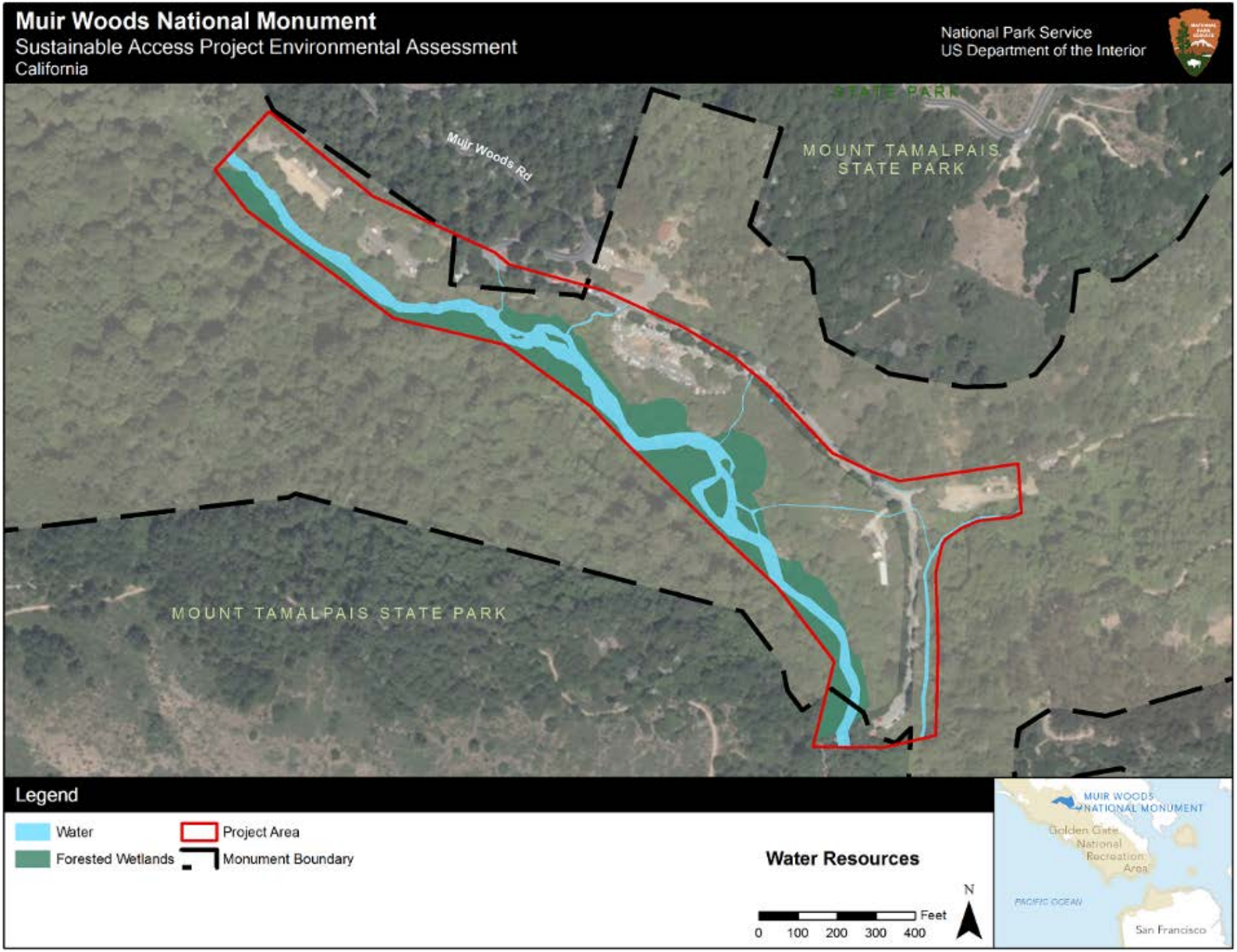

FIGURE 10. SURFACE WATER AND FORESTED WETLANDS

Wetlands

The US Army Corps of Engineers (USACE) is charged with regulating the discharge of dredged or fill materials in wetlands or other "waters of the United States" under section 404 of the Clean Water Act. The US Army Corps of Engineers considers areas that are dominated by hydrophytic vegetation, contain hydric soils, and display indicators of hydrology to be a wetland. The NPS definition of wetlands is similar to that of the US Environmental Protection Agency and the US Army Corps of Engineers; however, the NPS definition is broader in scope and affords a greater jurisdiction than that of the US Army Corps of Engineers. The National Park Service classifies wetlands based on the USFWS Classification of Wetlands and Deepwater Habitats of the United States, also known as the Cowardin classification system (Cowardin et al. 1979). Based on the Cowardin classification system, a wetland must have one or more of the following attributes.

- The habitat at least periodically supports predominantly hydrophytic (wetland) vegetation.
- The substrate is predominantly undrained hydric soil.
- The substrate is nonsoil and saturated with water or is covered by shallow water at some time during the growing season (Cowardin et al. 1979).

Site-specific wetland delineations were conducted in the project area in January to March 2013 and in December 2015 (Ryan 2016). The surveys determined that Redwood Creek is a perennial stream that is permanently flooded and interspersed with intermittently flooded in-channel vegetated islands (Ryan 2016). Ryan determined that the tributaries were seasonally flooded and/or well-drained habitat (Ryan 2016). According to the Cowardin classification, five types of wetlands occur within the project area. Redwood Creek is classified as palustrine, forested, permanently flooded (PFOH), and its tributaries are palustrine, forested, seasonally flooded/well-drained (PFOD) or palustrine, forested, temporarily flooded (PFOA). Palustrine, forested, intermittently flooded (PFOJ) wetlands are adjacent to Redwood Creek between the Main Lot and the Annex Lot and much of the lower reaches of the creek. Palustrine, forested seasonally flooded/seasonally saturated wetlands (PFOE) are located adjacent to Muir Woods Road, approximately 75 feet southeast of the Annex Lot (figure 10) (Ryan 2016). This area is considered part of the historic floodplain. All other land was determined to be upland. The tributaries draining to Redwood Creek are classified as intermittent riverine habitats that are temporarily flooded (USFWS 2009).

Water Quality

The *San Francisco Bay Basin (Region 2) Water Quality Control Plan* describes water quality standards for regional waterbodies. The standards include beneficial uses of waterbodies and the water quality objectives that protect these beneficial uses (San Francisco Bay RWQCB 2013). Redwood Creek has multiple possible beneficial uses including, but not limited to, agricultural, municipal, and domestic supply; freshwater replenishment; coldwater and warmwater habitat, fish migration and spawning, wildlife habitat, and preservation of rare and endangered species; shellfish harvesting; and contact or noncontact water recreation (San Francisco Bay RWQCB 2013; Wallitner 2016). These uses are for the entire length of the creek, not just the reach in the project area.

The San Francisco Bay Area Network Inventory and Monitoring Program monitors two sites close to the project area. One site is on the intermittent tributary, Camino del Canyon and the other is on Redwood Creek at the bridge (Wallitner 2016). During the October 2013 to September 2014 monitoring cycle, Redwood Creek met water quality objectives most of the time (Wallitner 2016). The program measured water temperature, dissolved oxygen, pH, specific conductance, turbidity, nitrogen, and bacteria.

The core water quality parameters are temperature, dissolved oxygen, and pH. Water temperature in Redwood Creek was generally within the optimal temperature range (10 degrees Celsius [°C] to 15.6°C) for juvenile coho salmon with just a few short-term exceedances (Armour 1991; NPS 2011c; Wallitner 2016). Water temperature in Redwood Creek ranged from 8.5°C to 15.7°C; Camino del Canyon temperature samples were similar, ranging from 8.9°C to 13.7°C (Wallitner 2016). The lower limit was exceeded at least once during sampling of both streams, and the upper limit was exceeded at least once in Redwood Creek (Wallitner 2016). Climate change is expected to result in increased regional air temperatures of approximately 3°C to 6°C and droughts longer in duration (The Nature Conservancy 2009; NPS 2011c). Higher air temperature and drought conditions can result in lower streamflow and degrade water quality parameters, including surface water temperature (Georgakakos et al. 2014). The San Francisco Bay Region Water Quality Control Board established a dissolved oxygen minimum of 7 milligrams per liter (mg/L) (San Francisco Bay Region Water Quality Control Board 2013). All dissolved oxygen measurements for 2013–2014 sampling were above this minimum. Redwood Creek had a wider range of dissolved oxygen measurements (7.53mg/L to 11.43 mg/L) than those in Camino del Canyon (10.15 mg/L to 11.43 mg/L) (Wallitner 2016). The mean dissolved oxygen value for Camino del Canyon was the second highest for the 2013–2014 sampling program (Wallitner 2016), and pH measurements for both streams were well within the standard of 6.5 to 8.5, and ranged from 7.22 to 8.08 (Wallitner 2016).

The San Francisco Bay Region Water Quality Control Board does not specify criteria for specific conductance; however, to support diverse aquatic communities in freshwater streams, specific conductance should be below 500 microsiemens per centimeter (µS/cm) (Behar 1997, as cited by Wallitner 2016). Specific conductance values ranged from 121.3 µS/cm to 264.9 µS/cm in Redwood Creek and 156.8 µS/cm to 219.8 µS/cm in Camino del Canyon.

Turbidity levels of up to 41.1 nephelometric turbidity units (NTU) and 134 NTU were recorded in Redwood Creek and Camino del Canyon, respectively, and exceeded the 25 NTU ecological objective (NPS 2016g; Wallitner 2016). The mean turbidity level of 39.8 NTU for Camino del Canyon was one of the highest for the 2013–2014 program year (Wallitner 2016). However, the median values were much lower at 0.46 NTU and 9.61 for Redwood Creek and Camino del Canyon, respectively, providing evidence that the high turbidity levels do not persist over long periods. Erosion of upstream roads and culverts results in sedimentation in the reach of Redwood Creek in the monument (NPS 2014a). Channel incision in the monument results in sediment loading in the downstream portions of Redwood Creek (NPS 2014a). Changes in the intensity and frequency of precipitation events and more frequent flooding associated with climate change could result in increased stormwater runoff and therefore increased levels of pollutants and soil erosion (NPS 2011c).

Water quality criteria for nitrate does not exist; however, an ecological threshold of 0.30 mg/L is frequently used as the threshold to limit eutrophication in streams (Roche et al. 2013, as cited by Wallitner 2016). Nitrate as nitrogen was low in Redwood Creek, ranging from less than 0.15 mg/L to 0.33 mg/L with 17 of 21 samples reporting levels below the detection limit (Wallitner 2016). All samples for nitrate as nitrogen in Camino del Canyon were above the 0.30 mg/L ecological threshold; the samples ranged from 0.35 mg/L to 2.7 mg/L with a mean of 1.09 mg/L, the highest mean recorded during the 2013–2014 sampling (Wallitner 2016). The regional reference value of 0.36 mg/L for total Kjeldahl nitrogen was exceeded in many of the samples especially in Camino del Canyon (USEPA 2000; Wallitner 2016). Redwood Creek samples ranged from less than 0.25 mg/L to 0.63 mg/L and had the lowest mean of 0.33 mg/L. Similar to nitrate as nitrogen, Camino del Canyon had higher levels of total Kjeldahl nitrogen with a mean of 0.51 mg/L and a range 0.29 mg/L to 1.0 mg/L (Wallitner 2016).

Floodplains

Federal Emergency Management Agency flood maps do not identify any floodplains within the monument (FEMA 2009). However, some areas are designated as "areas in which flood hazards are undetermined, but possible" (FEMA 2009). Areas along Redwood Creek are part of an erosion hazard or channel migration area that encompasses portions of two parking lots, a trail, and two small buildings, although records do not indicate that any monument structures have been flooded (ESA 2014; NPS 2014a). The estimated channel migration area ranges from approximately 25 feet wide at the upstream end of the project area to 206 to 225 feet in the middle reaches and to 128 feet at the downstream end (ESA 2014).

The project area historically contained floodplains located on abandoned terraces of Redwood Creek (ESA 2014; Ryan 2016). These floodplains of Redwood Creek within the monument have been altered through streambank stabilization structures, dams, and fill placement (NPS 2014a). Much of Redwood Creek within the monument is held within more rigid banks by these structures and not allowed to meander and flood historic floodplain areas, except for the reaches adjacent to the Nursery and Annex Lots (ESA 2014; NPS 2014a). Streambed incision has also contributed to the creek being hydrologically disconnected from its historic floodplains, which are now located on terraces above the stream channel (Ryan 2016). Preliminary analysis has shown that the current channel is likely to contain a 100-year flood event (ESA 2014). Two-year peak flows were estimated at 180 to 260 cfs and 100-year peak flows were estimated at 880 to 1,500 cfs (Kimball and Kondolf 2002). Occasional flash floods occur in winter when stormwater runoff is more intense (NPS 2014a). Various climate models project either increases or decreases in regional precipitation by 2080; however, there is a consensus that flood events are expected to increase, including scouring events (NPS 2011c, 2014a; Walsh et al. 2014). Based on available climate change information, the expected future state of hydrology would change such that storm intensity and frequency would increase (NPS 2011c, 2014; Walsh et al. 2014). These alterations to storms and heavy precipitation events would change the inundation areas for a 100-year flood event (NPS 2014a).

THREATENED AND ENDANGERED SPECIES

The monument provides habitat for four federally listed threatened and endangered species. Threatened and endangered species known to occur or which may occur within the boundaries of the monument include coho salmon, steelhead trout, northern spotted owl, marbled murrelet, and California red-legged frog. Information about each of these species including federal and state status, its occurrence at the monument, and primary threats is provided below.

Coho Salmon

Coho salmon is listed as endangered at both the federal and California state levels. Coho salmon is an anadromous fish species, meaning that they begin their life cycle in freshwater environments and migrate to marine environments in their adult stage. Redwood Creek, which flows through the monument before eventually discharging into the Pacific Ocean at Muir Beach, has been designated as critical habitat for coho salmon. Redwood Creek has also been identified as "a high priority restoration area for coho salmon" under the California Department of Fish and Game's 2004 Recovery Strategy (CDFG 2004). Redwood Creek is one of the last streams in California with remaining native stocks of coho salmon. Coho salmon require silt-free gravel substrate, a consistent water temperature, and deep pools for spawning (NPS 2014a).
Coho salmon found in Redwood Creek are part of the Central California Evolutionarily Significant Unit, found in three watersheds in the NPS San Francisco Bay Area Network (NPS 1999). However, genetic analysis shows that the coho salmon in Redwood Creek is a genetically distinct subgroup

than other populations within the same evolutionarily significant unit (NPS and Marin County 2007). Spawning typically occurs between December and February, and juveniles emerge in March and April. Juveniles remain in fresh water for approximately 15 months before migrating to the Pacific Ocean (NPS and Marin County 2007).

The section of Redwood Creek within the project area provides habitat for spawning salmon, but the habitat for juvenile salmon is limited because of the loss of pools that resulted from previous creek alterations. Coho salmon populations can be greatly affected by floods, droughts, and other unpredictable events, which can jeopardize the survival of an entire year's spawning population. Coho salmon are also very sensitive to changes in temperature and therefore may be significantly affected by climate change (NPCA 2011). Over the last century, the maximum, mean, and minimum air temperatures in the central California coastal region have increased by 1°C. Stream temperature is directly correlated with air temperature. Thus, many central California streams that support or have historically supported coho salmon populations, including Redwood Creek, have been affected by rising water temperature. Concurrently, average precipitation and streamflow have decreased (Madej 2010). In 2006, researchers counted lower numbers of juvenile coho per pool than average in Redwood Creek. During 2007–2008, no returning adult coho were observed in Redwood Creek (NPCA 2011). Only remnant coho salmon populations remain in Redwood Creek and are at or near extirpation (CDFW 2015).

Throughout its range, the coho salmon population has declined because of overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices (NMFS 2016). However, observed data trends suggest that climate change will increasingly threaten the viability of coho salmon populations and habitats in the future (Madej 2010).

Steelhead Trout

Steelhead trout is listed as a threatened species at the federal level. Like coho salmon, steelhead trout is an anadromous species. Within the boundaries of the monument, steelhead trout are present in Redwood Creek, which has been designated as critical habitat for this species. Steelhead trout has similar habitat requirements to coho salmon (NPS 2005). Habitat preferences for juvenile steelhead trout are deep pools created by rootwads and boulders in heavily shaded stream sections, although steelhead trout less than one year of age are often forced into shallow-water habitats. Although Redwood Creek has historically provided good spawning habitat for steelhead trout, loss of pools because of previous creek alterations has reduced the availability of preferred habitat for this species (NPCA 2011). Spawning typically occurs in late winter or spring. The amount of time steelhead trout rear in freshwater and marine/estuarine habitats is variable, ranging between one to three years (NPS 2014a). Unlike other species of salmon, steelhead trout do not necessarily die after spawning and are able to spawn more than once (USFWS 2016).

Causes of decline for steelhead trout are the same as those listed for coho salmon—overfishing, habitat loss and degradation, and climate change (NPCA 2011). Increased air and stream temperatures, as well as reduced precipitation and stream flows, are stressors affecting this species. These data trends suggest that climate change is an increasing threat to steelhead trout populations (Madej 2010).

Northern Spotted Owl

The northern spotted owl is listed as a threatened species at the federal level. Marin County supports the highest known density of northern spotted owls throughout its range, estimated to be around 75 pairs. This population is geographically isolated from northern spotted owl populations to the

north, and gene flow between populations is limited (NPS 2005). This species is known to reside and breed within the boundaries of the monument, which is located at the southernmost extreme of the species' range. Although the monument was home to two pairs of northern spotted owl when monitoring began in 1999, northern spotted owls have not established an activity center within the boundaries of the monument since 2010 (Ellis 2016). However, they may still use sites within the monument for feeding, nesting, or roosting. This species most commonly nests in old coast redwood trees and Douglas fir (*Pseudotsuga menziesii*) trees (NPCA 2011).

Although loss of habitat because of development is a concern throughout much of its range, the US Fish and Wildlife Service has identified competition with the barred owl (*Strix varia*) as the primary threat to the northern spotted owl (USFWS 2011). Barred owls have been shown to display aggressive behavior toward northern spotted owls, sometimes leading to displacement of individuals or nests. This has become an increasing threat to northern spotted owls because barred owl range and population size have expanded in recent decades (Kelly et al. 2003). Barred owls are known to nest at the monument and are suspected to be the main driver of decline in the northern spotted owl population both inside and outside the boundaries of the monument.

Marbled Murrelet

The marbled murrelet is listed as threatened at the federal level and endangered at the California state level. This Pacific seabird nests in old-growth forests, but spends most of its life in marine environments (USFWS 1997). While suitable marbled murrelet habitat has been identified in the monument, this species has not been documented at the monument (NPCA 2011). Loss of nesting habitat, primarily because of timber harvest and wildfires, has been identified as the primary threat to this species (USFWS 1997). Shifts in marine food webs from climate change are also expected to affect marbled murrelet populations in the future (USFWS 2012).

California Red-Legged Frog

The California red-legged frog is listed as threatened at the federal level. This aquatic frog breeds in ponds and slow-moving streams and is associated with emergent vegetation. This species has not been identified at the monument, but has been documented in small, human-made ponds adjacent to Redwood Creek, approximately 1.6 miles downstream of the project area. Throughout its range, habitat loss, degradation, and modification are the primary threats to this species (NPS 2016h).

CULTURAL RESOURCES

Area of Potential Effects

As required under section 106 of the National Historic Preservation Act of 1966 (36 CFR 800.16(d)), an area of potential effects must be established to determine and define the "geographic area or areas within which an undertaking may directly or indirectly cause alterations to the character or use of historic properties, if such properties exist and is influenced by the scale and nature of an undertaking. It encompasses both those areas where proposed actions might occur that would directly impact cultural resources, as well as adjacent areas that contain resources that might be indirectly affected" (36 CFR 800.16(d)).

To assess the effects of this undertaking on all historic resources that might be affected, the area of potential effects includes the entire Muir Woods Historic District. The areas that the project would directly affect are the monument entrance area, existing parking areas, and any proposed new parking areas. A detailed map of the area that is directly affected by the area of potential effects, including known resources and areas of indirect impact, is shown in figure 11.

Properties Listed in the National Register

Muir Woods National Monument. The monument is one of the great examples of the early development of the conservation movement in the late 19th and early 20th centuries to preserve an old-growth forest of coast redwoods. Theodore Roosevelt declared it a national monument in 1908 under the provisions of the Antiquity Act of 1906. The portion of the monument as it existed at the end of the period of significance (1907–1947) was entered into the national register in 2008 as a historic district. For a property to be eligible for the national register, it must meet at least one of four main criteria.

- **Criterion A.** The property is associated with events that have made a significant contribution to the broad patterns of our history; or
- **Criterion B.** The property is associated with the lives of persons significant in our past; or
- **Criterion C.** The property embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; or
- **Criterion D.** The property has yielded or may be likely to yield, information important in prehistory or history.

The monument was found to be nationally significant under criterion A and criterion C for the contributions of William Kent and the conservation movement, its use of rustic park architecture, and as an example of Emergency Conservation Work / Civilian Conservation Corps programs in the 1930s, as well as its association with the signing of the United Nations Charter in 1945. Five buildings and 22 structures (dating 1922–1940) are significant under Criterion C as representative examples of pre-World War II-era rustic design characteristic of NPS buildings built during that era. The project would not affect contributing structures in the monument.

Dipsea Trail. Dipsea Trail extends from the town of Mill Valley, over Mount Tamalpais, to Stinson Beach, and is the course for the Dipsea Race, the oldest cross-country trail race in the country. In 2010, the trail was listed in the national register for the Dipsea Race's influence on the development of other foot races and as a manifestation of America's concern for physical fitness (criterion A). Significant built features include the trail bed, 19th century roadbeds, wooden bridges and steps, and stone steps.

Properties with a Formal Determination of Eligibility for the National Register

Camino Del Canyon. The Camino Del Canyon tract was added to the monument as a buffer zone to protect the Redwood groves and the visitor experience in the monument. This area is not within the Muir Woods Historic District. It includes the Conlon Lot, which is within the area of potential effects. In 2007, the monument submitted a determination of eligibility for the area. One property within the tract was found to be eligible for listing in the national register—the Hillwood Camp. This property is outside the zone where visual or auditory impacts are expected and was excluded from the area of potential effects.

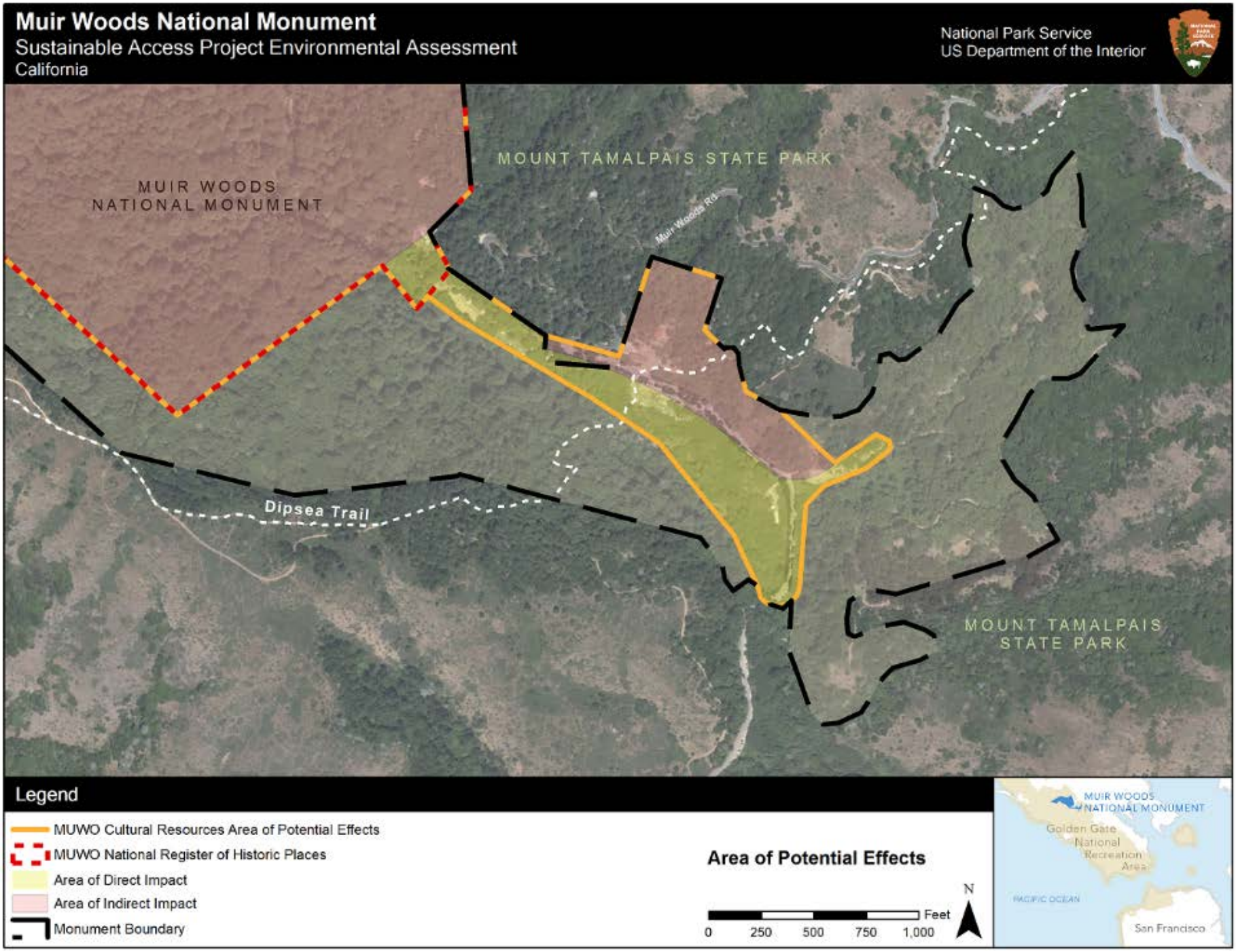

FIGURE 11. AREA OF POTENTIAL EFFECTS

Parking Lot Tract. Just outside the monument entrance, the Parking Lot Tract was excluded from the Muir Woods Historic District because it was not a part of the monument during the period of significance and because of a loss of historic integrity resulting from modern alterations and additions from the construction of parking lots.

Properties with Pending Determinations of Eligibility

Muir Woods Inn. The Muir Woods Inn site was initially surveyed by Faith Duncan in 1988 and recorded as part of site form CA-MRN-568H. It was further evaluated in 2015 and submitted to the California State Historic Preservation Office in early 2016. The site consists of the former Muir Woods Inn and various outbuildings, including a restroom facility, two small cabins, and an architecturally undistinguished house built in 1965 after the period of significance, by the Schlette family, the last owners of the Inn.

The Muir Woods Inn and outbuildings are located on the north side of Muir Woods Road, directly across from the Annex Lot. Joe Landgraff originally built the inn around 1930 as a refreshment shop, which he named Coffee Joe's. In 1945, Coffee Joe's was sold to the Schlette family, who renamed it the "Muir Woods Inn." The National Park Service acquired the property in 1972 and the inn was subsequently remodeled on the interior and exterior. It now serves as an office, storage space, a small machine shop, and a conference room for the monument. The National Park Service determined that the building was not eligible for the national register because it is highly altered and lacks the necessary physical elements required under the national register.

Archeology

An archeological survey was conducted within the project area, along the northeastern side of Redwood Creek between the creek and Muir Woods Road. The 10-acre survey began near the Annex Lot, continued southeast along Muir Woods Road to the bridge crossing and then back up to the Annex Lot along Redwood Creek. The survey documented two new historic sites and one historic isolated find. One of the newly recorded historic sites, CA-MRN-723H, is outside the project area.

The other historic site, CA-MRN-722H (the Annex Lot) is within the project area. Several factors suggest that the site is eligible under criterion D, because it has yielded, and may be likely to further yield, information important to early 20th-century public recreation and tourism at Muir Woods. Two other areas within the direct area of potential effects have a high potential for as yet unknown subsurface deposits: the former Nursery Area and the Conlon Lot, which are the former locations of the Second Lodge of Camp Kent (1910–1924), and the original Camp Kent campgrounds (1898–1923), respectively.

Tribal Consultation

To date, the Federated Indians of Graton Rancheria have not indicated that properties of traditional cultural value associated with this project or within the area of potential effects exist.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

GENERAL METHODOLOGY FOR ESTABLISHING IMPACTS

In accordance with CEQ regulations, direct, indirect, and cumulative impacts are described (40 CFR 1502.16) and the impacts are assessed in terms of context and intensity (40 CFR 1508.27). Where appropriate, mitigating measures for adverse impacts are also described and incorporated into the evaluation of impacts. A full list of mitigation measures can be found in "Chapter 2: Alternatives."

CUMULATIVE IMPACTS ANALYSIS METHODOLOGY

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7/8). The temporal scale for the cumulative impacts analysis includes past actions from the reservation system through reasonably foreseeable future actions.

Cumulative impacts are determined for each impact topic by combining the impacts of the alternative being analyzed and other past, present, and reasonably foreseeable actions that would also result in beneficial or adverse impacts. Because some of these actions are in the early planning stages, the evaluation of cumulative impacts is based on a general description of the projects. Other past, present, and reasonably foreseeable actions located in the vicinity of the monument to be included in the cumulative impacts analysis were identified through the internal and external project scoping processes and are summarized below.

Muir Woods Reservation System

Phase 1 of the reservation system established a parking barrier system along Muir Woods Road. This system involved placing posts and cables along the narrow Muir Woods Road shoulder to improve traffic safety and prevent parking along the shoulder. Approximately a mile of the post system with reflective markers was installed both north of the monument entrance and south towards Kent Canyon. White edge striping was added to the roadway to better define the edge of pavement. Additional No Parking Zone signage and erosion and sediment control measures were also installed. The construction of this project was completed at the end of February 2016. Figure 12 shows the installed posts and erosion control measures in place.

Phase 2 of the reservation system will reduce peak visitation levels at the monument by managing motorized vehicle access and allowing monument staff to control parking both within the monument's lots and on Muir Woods Road (which is owned and managed by Marin County). The reservation system includes two separate, but coordinated systems. Reservations for privately owned vehicles and for the Muir Woods Shuttle will be made directly through a reservation system operated by a third-party operator. Commercial carriers will be required to obtain a reservation for one of the parking spaces designated for commercial carrier use through another, separately managed system. The reservation system will also ensure that parking on the Muir Woods Road shoulder will not initially exceed 80 vehicles south of the Muir Woods Road Bridge (NPS 2015d). By 2021, no vehicles will be allowed to park on the shoulder downstream of the bridge.

SOURCE: NPS

FIGURE 12. POST INSTALLATION AND EROSION CONTROL MEASURES

Muir Woods Road Bridge Replacement Project

Marin County received federal funding to replace local bridges that were identified as structurally deficient and functionally obsolete. Muir Woods Road Bridge over Redwood Creek is one of the bridges identified for replacement, and a project was recently initiated to conduct environmental studies and begin design work. Protecting the riparian habitat and maintaining traffic are expected to be high priorities for the project.

Muir Woods Road Bridge is located just south of the monument boundary. Muir Woods Road is a two-lane roadway that connects Muir Beach, Mill Valley, and the monument. The existing bridge was built in 1946 and is a single-span, reinforced concrete T-beam structure. The bridge needs to be replaced for the following reasons:

- The structure has deficiencies in the structural concrete and structural steel.
- The existing bridge alignment does not meet current road geometry standards.
- Bridge railings do not meet current safety standards.
- Scour from the creek has caused undermining of the structure.

The project improvements are anticipated to extend from 400 feet west of the bridge to 600 feet east of the bridge along Muir Woods Road, which would involve realigning the roadway to correct the current "S" curve. Access to the monument would be maintained at all times. The design stage for this project is expected to begin in 2017 with construction anticipated in 2019.

Muir Woods Road Rehabilitation Project

Through a Federal Land Access Program Grant, this project will repair road slides at various locations, and approximately 36 culverts, 2 of which are located in the project area, will be repaired or replaced to decrease sediment loading into Redwood Creek. As part of this project, 2.48 miles of new asphalt will be resurfaced along Muir Woods Road. The planning stage for the project is expected to be completed in 2017 with construction beginning in 2019 (NPS 2015f).

Muir Woods Lift Station Rehabilitation Project

The monument is planning to rehabilitate water and wastewater lines, as well as critical components of its potable water system and wastewater collection systems. The purpose of this project is to rehabilitate two lift stations located in the former Nursery Area and northeast of the Conlon Lot. The project is anticipated to begin in 2017 and completed in 2018.

Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would restore habitat in Redwood Creek for aquatic life, including the federally threatened coho salmon, and replace aging pedestrian bridges in the monument. As part of this project, selected large boulders (i.e., riprap) that were placed on the banks of Redwood Creek more than 80 years ago to stabilize the stream bank would be removed. Following the riprap removal, large woody debris would be installed in the creek. These two actions would significantly improve the conditions needed to help young fish survive. Four aging pedestrian bridges on Redwood Creek that are reaching the end of their lifespan would also be replaced. The new bridges would provide accessible creek crossings and be designed with a longer span and more durable materials to improve both public safety and enhance the way water flows in the creek to support ongoing habitat restoration efforts. The project is anticipated to begin in 2017 and be completed in 2019.

VISITOR EXPERIENCE AND SAFETY

Methodology and Assumptions

The analysis of visitor experience and safety was based on reviewing the visitation demand forecast to determine future visitation to the monument and the resulting potential increase in traffic that would need to be accommodated. The analysis considered the following elements:

- implementing measures to ensure visitors do not experience crowded conditions by managing user capacity
- evaluating the visitor arrival, entrance, and departure experience at the monument
- addressing wayfinding to assist visitors in finding parking lots and navigating the trail system
- evaluating amenities available to visitors
- evaluating the availability and location of ABA-compliant parking spaces
- assessing the availability of interpretive and educational opportunities that prepare visitors for their experience at the monument
- evaluating emergency access and circulation to ensure emergency personnel can quickly access facilities at the monument

Each of these elements are evaluated under the three alternatives. Visitor safety covering vehicle to vehicle and vehicle to pedestrian conflicts are covered in the “Transportation” section.

Impacts of Alternative 1: No-Action

Analysis. Under alternative 1, the reservation system will alter the arrival, entry, and departure experience; therefore, impacts on visitor experience under the no-action alternative are most accurately described under "Cumulative Impacts." The remaining impacts on visitor amenities and visitor experience with respect to wayfinding, interpretive and educational opportunities, and emergency circulation and access are discussed under alternative 1 in this section.

Under alternative 1, the existing undersized restroom situated within the viewshed of Redwood Creek between the Entry Plaza and Main Lot would remain in place. The restroom would continue to not accommodate peak visitor periods and would remain a long walk from some of the parking locations, resulting in continued direct, long-term, adverse impacts on visitor amenities.

Under alternative 1, pedestrians would also continue to use the Muir Woods Road pedestrian trail to access the Entry Plaza from the Annex and Conlon Lots and from roadside parking. These pedestrians would continue to cross a maximum of three driveways, which would maintain existing vehicle-pedestrian conflicts and safety concerns.

Interpretive and educational opportunities preparing visitors for their experience would continue to only be available at the Dipsea Trailhead. Therefore, impacts on the visitor experience (i.e., wayfinding and interpretive and educational opportunities) would be direct, long term, and adverse—reflecting the status quo for these visitor experience components.

Emergency access and circulation would continue to conflict with pedestrians in the Entry Plaza, and could potentially encounter delays from privately owned vehicles and buses parking in the Main Lot and navigating narrowed roadways caused by shoulder parking along Muir Woods Road. Therefore, impacts on visitor safety from emergency access and circulation would be direct, long term, and adverse, reflecting the mix of buses, privately owned vehicles, and pedestrians in the Main Lot and Entry Plaza and shoulder parking along Muir Woods Road.

Cumulative Impacts. Phase 1 of the reservation system reduced shoulder parking along Muir Woods Road south of the Muir Woods Road Bridge to 80 designated spots, which limited the number of visitors who can arrive by privately owned vehicle and improved safety for both pedestrians and vehicles traveling along sections of Muir Woods Road that had previously accommodated shoulder parking. Until the reservation system is implemented in 2017, the reduced parking availability will cause indirect, short-term, adverse impacts for those visitors who are unable to find parking. Phase 2 of the reservation system will also limit the total number of visitors to the monument by implementing a parking reservation system for privately owned vehicles and for commercial buses and shuttles. The reservation system will reduce the peak historical number of visitors entering and exiting the monument and the number of pedestrians walking the trails to the Entry Plaza at any given time. The visitor arrival, entry, and departure experience will improve as a result of assigning specific timeframes for each vehicle to park at the monument, especially during peak times, which will reduce visitor congestion when finding parking and manage visitation levels to be within the user capacity. The reduction in the number of visitors will result in less strain on the aging and undersized visitor support facilities; the reduction in shoulder parking along Muir Woods Road will improve emergency vehicle access. Therefore, this action will result in direct and indirect, long-term, beneficial impacts on visitor experience and safety.

The Muir Woods Road Bridge Replacement Project would replace an existing structure and may require the pedestrian crossing to be temporarily closed. The project would result in direct, short-term, adverse impacts on visitor experience and safety because pedestrians would need to walk in the

travel-way to cross the bridge during the construction period and emergency vehicles may be delayed when attempting to cross the bridge.

The Muir Woods Road Rehabilitation Project would resurface portions of Muir Woods Road and could cause an inconvenience if visitors have to drive along an unpaved roadway or cross the street at a temporary striped crosswalk. Therefore, the project would result in direct, short-term, adverse impacts on visitor experience and safety during the construction period.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would replace existing pedestrian bridges that are in poor condition, providing visitors an opportunity to use new safer bridges; therefore, the project would result in direct, long-term, beneficial impacts on visitor experience and safety. During the construction phase, this project would result in direct, short-term, adverse impacts on visitor experience and safety because the trail could be closed, requiring visitors to follow an alternative route.

The Muir Woods Lift Station Rehabilitation Project would install pipe connecting the two lift stations in the Nursery and Conlon Lots. This connection would cross Muir Woods Road; however, the project would be coordinated with Marin County and the Muir Woods Road Rehabilitation Project. During the construction, impacts on visitor experience and safety would be direct, short term, and adverse and could potentially affect the arrival and departure experience and emergency vehicle access. These impacts would represent a minimal increase in adverse impacts on visitor experience and safety because the project would be scheduled to coincide with the Muir Woods Road Rehabilitation Project.

Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would result in direct, short-term, adverse and direct, long-term, beneficial impacts on visitor experience and safety. When the continued adverse impacts of alternative 1 are combined with the effects of cumulative actions, an overall long-term, beneficial cumulative impact on visitor experience and safety is expected.

Conclusion. Under alternative 1, the condition of amenities, the lack of wayfinding and interpretive and educational opportunities, and emergency access and circulation patterns would not be improved and would continue to have long-term, adverse impacts on visitor experience and safety.

There would be limited, short-term, adverse cumulative impacts on visitor experience and safety during the construction period of the reasonably foreseeable future actions and long-term, beneficial impacts from reduced congestion in parking lots, along Muir Woods Road, and the trail system. While parking congestion would be alleviated by the full implementation of the reservation system, poor wayfinding on the existing trail network to the Entry Plaza, undersized restroom facilities, and limited interpretive and educational opportunities would continue to detract from the visitor experience. Vehicle-pedestrian safety conflicts would continue; however, the reduction and eventual elimination of all but 30 roadside parking spaces and implementation of the reservation system will reduce the number of both cars and pedestrians entering the monument and improve safety. The impacts of the cumulative actions would be beneficial; however, impacts from alternative 1 would be adverse. The contribution of alternative 1 to cumulative impacts would be minimal; therefore impacts on the arrival, entry, and departure experience; visitor amenities; wayfinding; and interpretive media would result in an overall beneficial cumulative impact.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, the arrival, entry, and departure experience would be modified from current conditions to include (1) a second restroom facility located near the former Nursery Area, (2) relocation of the restroom facility in the Entry Plaza away from Redwood Creek to enhance the arrival experience and remove it from the Redwood Creek viewshed, (3) a noticeable separation between the parking area and Entry Plaza, (4) fewer vehicles attempting to navigate the Main Lot while visitors walk between buses and the monument entry, and (5) a new footbridge crossing the Redwood Creek along the Dipsea Trail. Privately owned vehicles with handicap placards would no longer park in the Entry Plaza, which would provide a quieter experience for visitors as they approach the forest and a more scenic transition from the parking area to the forest. Visitors arriving by bus or shuttle would continue to arrive and depart from the Main Lot; however, privately owned vehicles without a handicap placard would no longer be allowed to park in this lot. Similar to alternative 1, safety would continue to be inadequate for visitors on their way to the Entry Plaza. Pedestrians would continue to use the Muir Woods Road pedestrian trail to access the Entry Plaza from the Annex and Conlon Lots, as well as from roadside parking locations. These pedestrians would cross a maximum of two driveways, which would maintain existing vehicle-pedestrian conflicts.

A new footbridge constructed on the Dipsea Trail would provide a safe river crossing year-round and an additional wayside area for visitors on their walk toward the monument. As a result, impacts on the arrival, entry, and departure experience would be direct, long term, and beneficial from fewer vehicle conflicts in the Main Lot and Entry Plaza, but pedestrian-vehicle conflicts from roadside parking and Conlon and Annex Lots would also continue long-term, adverse impacts.

Two restroom facilities would be available for visitors. The existing restroom in the Entry Plaza would be relocated within the plaza, away from Redwood Creek, to provide visitors with an enriched experience by opening up a new view of Redwood Creek. A second restroom would be added near the former Nursery Area to provide a restroom option closer to all parking locations and would also be available to Dipsea Trail users. Providing a second restroom would reduce the number of visitors who choose the facility situated at the Entry Plaza and reduce the distance between the parking areas and nearest restroom facility. Therefore, impacts on visitor amenities would be direct, long term, and beneficial.

Wayfinding and interpretive media would be installed to help visitors find trails leading to the forest and communicate the history of the monument. Additional signage would direct visitors from the parking areas to the Entry Plaza and other trails. Interpretive media would be provided along the trail connecting the Annex and Main Lots for educational purposes based on the needs of visitors. The additional signage would improve wayfinding, reduce visitor confusion, and provide visitors with a greater understanding of the history and context of the monument they are about to experience. Additional signage would guide visitors in the right direction to assure them they are on the right path and keep them out of the roadway, reducing pedestrian-vehicle conflicts. New interpretive and educational opportunities would also be provided in the Entry Plaza to prepare visitors for their experience of the monument. Together, these changes in wayfinding, interpretive media, and educational opportunities would have direct, long-term, beneficial impacts on visitor experience.

ABA-compliant parking would be shifted from the Entry Plaza to the Main Lot, which is farther from the monument entrance compared to existing conditions. While 11 parking spots are currently available in the Entry Plaza for ABA-parking, only 9 of those spots are ABA-compliant. The Main Lot would not have any parking for privately owned vehicles without a handicap placard, but all 11

parking spots would be ABA-compliant. Therefore, those parking in ABA-compliant spaces would encounter safer conditions with no privately owned vehicles circulating through the Main Lot. Impacts on ABA-compliant parking would be direct, long term, and beneficial, reflecting safer conditions in the Main Lot and entry experience for those who park in ABA-compliant spaces. However, impacts on ABA-compliant parking could also be direct, long term, and adverse, considering the added distance to walk to the monument entrance.

Alternative 2 would provide more room for emergency vehicles access to the Entry Plaza because privately owned vehicles would no longer be permitted. Therefore, impacts on visitor safety from emergency vehicles access in the Entry Plaza would be direct, long term, and beneficial. Changes to Annex and Conlon Lot circulation patterns would be improved, providing a loop pattern served by one driveway for the Annex Lot and wider travel aisle for the Conlon Lot. Impacts on visitor safety from these circulation changes would be direct, short and long term, and beneficial because of wider travel-ways and counter-clockwise loop designs, which provide for safer driving conditions and improved access for emergency vehicles.

During the construction period for alternative 2, the staging of construction equipment would affect the visual character of the monument grounds; construction noise would affect the soundscape; and the displacement of existing parking when the parking lots are reconfigured would disturb typical arrival and departure patterns. Therefore, implementation of alternative 2 would also result in direct, short-term, adverse impacts on the visitor arrival, entry, and departure experience. Mitigation measures provided in chapter 2 would minimize the adverse impacts to the extent possible during the construction period.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in direct, short-term, adverse and direct, long-term, beneficial impacts on visitor experience and safety and continued long-term, adverse impacts on visitor safety. When the beneficial and adverse impacts of alternative 2 are combined with the beneficial effects of cumulative actions in the project area, an overall long-term, beneficial cumulative impact on visitor experience and safety is expected.

Conclusion. Under alternative 2, the existing visitor experience would be improved by removing privately owned vehicles from the Entry Plaza, reducing the Annex Lot driveways from two to one, improving wayfinding, adding new interpretive media at the Entry Plaza and along the Redwood Creek trail, increasing the number of ABA-compliant parking spaces, adding a new restroom facility, relocating the existing Entry Plaza restroom facility, and removing privately owned vehicle parking spaces from the Main Lot. These improvements would ensure that visitors have access to key amenities, such as restrooms closer to their parking location and can easily locate and utilize the correct trail to safely walk to the Entry Plaza. Visitors would also benefit from experiencing the forest environment beginning as early as the Dipsea Trail footbridge rather than past the Entry Plaza as a result of the improved wayfinding. The placement of ABA-compliant parking farther from the monument entrance would result in a slightly longer distance to travel for those visitors, but the number ABA-compliant parking spaces would increase by two and would still be the closest parking spaces to the entrance of the monument. The overall arrival and amenity improvements, paired with the reduced vehicle and pedestrian congestion from the implementation of the reservation system, would provide a safer and more enjoyable experience for all visitors.

There would be limited, short-term, adverse cumulative impacts on visitor experience and safety during the construction period of the cumulative projects and long-term, beneficial impacts from reduced congestion in parking lots, along Muir Woods Road, and the trail system. Impacts

associated with the cumulative projects would be beneficial, and impacts from alternative 2 would be both beneficial and adverse. The overall contribution of impacts from alternative 2 to the cumulative impacts would be beneficial because of the improved arrival, entry, and departure experience; visitor amenities; wayfinding; interpretive media; and emergency access and circulation.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. The visitor arrival, entry, and departure experience would be similar to that described under alternative 2, resulting in beneficial impacts. Under alternative 3, a new parking lot would be constructed next to the proposed new restroom and a new woodland pedestrian trail connecting the Annex and the new Nursery Lots to allow visitors to begin to experience the forest upon departure from the Nursery Lot. The new woodland pedestrian trail would circulate around the Annex Lot and avoid crossing the driveway serving the Annex Lot, providing a safer and more enjoyable pedestrian experience from the Nursery and Conlon Lots because it would position visitors off of the road and provide a clearer safe path to the monument. Visitors would still need to cross Muir Woods Road from the Conlon Lot; however, wayfinding would clearly direct visitors to the woodland pedestrian trail. This path would also allow visitors to experience the forest enroute toward the Dipsea Trail and Entry Plaza. Therefore, the visitors would experience direct, long-term, beneficial impacts on the arrival, entry, and departure experience.

Visitor amenities, wayfinding, and interpretive and educational opportunities would be improved as described under alternative 2 but would also include interpretive media placed on the new woodland trail connecting the Nursery and Annex Lots. The additional interpretive media would provide visitors with additional information on the monument's history. These changes in the visitor amenities, wayfinding, and interpretive and educational opportunities would provide a direct, long-term, beneficial impact on the visitor experience.

ABA-compliant parking and removal of two spaces for privately owned vehicles in the Entry Plaza would be the same as described under alternative 2. The removal of all shoulder parking under this alternative would benefit emergency access vehicles by providing a wide and clear right of way for navigation along Muir Woods Road. Therefore, impacts on visitor safety would be beneficial as a result of the improved emergency access vehicles. The circulation for the Main, Annex, and Conlon Lots would be the same as described under alternative 2. The addition of the Nursery Lot would improve vehicular circulation patterns and provide an unobstructed path back to Muir Woods Road, also known as a travel-way aisle. With the incorporation of wider travel-ways and counter-clockwise loop designs for the parking lots, there would be a direct, long-term, beneficial impact on visitor safety from improved circulation patterns and emergency vehicles access.

Construction of alternative 3 would also result in the same direct, short-term, adverse impacts on the visitor arrival, entry, and departure experience as described under alternative 2.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in direct, short-term, adverse and direct, long-term, beneficial impacts on visitor experience. When the impacts of alternative 3 are combined with the effects of cumulative actions in the project area, an overall long-term, beneficial cumulative impact on visitor experience and safety is expected.

Conclusion. Under alternative 3, the Nursery Lot would be constructed, all shoulder parking between the Conlon Lot and the Muir Woods Road Bridge would be removed. The alternative would also include all the elements described under alternative 2, including removing vehicles from

the Entry Plaza, reducing the Annex Lot driveways from two to one, adding new wayfinding signs, adding new interpretive media at the Entry Plaza and along the Redwood Creek trail, increasing the number of ABA-compliant parking spaces, adding a new restroom facility, relocating the existing restroom facility, and removing privately owned vehicle parking spaces from the Main Lot. Together, these improvements would have beneficial impacts on all aspects of visitor experience and safety by providing wayfinding to guide visitors, placing interpretive media in multiple locations, providing multiple restrooms, ensuring better emergency access, and prohibiting shoulder parking. Impacts from the relocation of ABA-compliant parking spaces to the Main Lot would be long term and adverse.

There would be limited, short-term, adverse cumulative impacts on visitor experience and safety during the construction period of the cumulative projects and long-term, beneficial impacts from reduced congestion in parking lots, along Muir Woods Road, and the trail system. The impacts from cumulative projects combined with impacts from alternative 3 would be beneficial. The contribution of alternative 3 to the cumulative impacts would be beneficial because the arrival, entry, and departure experience; visitor amenities; wayfinding; interpretive media; and emergency access would be improved.

TRANSPORTATION

Methodology and Assumptions

The analysis of transportation is based on the location of the parking lots, access between the lots, circulation of vehicles through the lots, and visitor safety during the walk between a parking area or the bus and shuttle drop-off area to the Entry Plaza.

For the purposes of this analysis, it is assumed that limiting parking to 232 spaces for privately owned vehicles, implementing the reservation system, and continuing to operate the shuttle will reduce daily visitation to levels that meet the goals and performance standards in the *Golden Gate National Recreation Area and Muir Woods National Monument Final General Management Plan / Environmental Impact Statement* (2014b).

Impacts of Alternative 1: No Action

Analysis. The driveway serving the Conlon Lot would continue to operate with the sight distance issues described in chapter 3, which could affect the safety of vehicles entering and exiting the lot from Muir Woods Road. The density of trees and curve of the road obstruct a driver's view from the Conlon Lot driveway and leave a short distance to react to a vehicle entering or exiting the parking lot. Shoulder parking would still be permitted between the Conlon Lot and the Muir Woods Road Bridge and could result in vehicles making U-turns to access spaces if they arrive on the opposite side of the designated roadside parking area. Therefore, impacts on vehicle safety would be direct, long term, and adverse.

Vehicle-pedestrian conflicts would continue to occur because the existing trail system between the Entry Plaza and parking lots crosses the parking lot driveways and requires visitors to cross Muir Woods Road. The Annex Lot would continue to have two driveways crossing the trail system. The pedestrian crossing between the Conlon Lot and the existing trail system would continue to pose a safety risk because the limited sight distance for vehicles traveling toward the Entry Plaza does not provide enough reaction time to stop for a pedestrian in the crosswalk. Shoulder parking between the Conlon Lot and Muir Woods Road Bridge would continue to require pedestrians to cross Muir Woods Road at random locations to access the trail on the opposite side of the road. Pedestrians

would also continue to access vehicles parking on the shoulder south of Muir Woods Road Bridge along Muir Woods Road, where no off-road trail exists and visitors walk unprotected in the roadway; however, this would be remedied by 2021 once all shoulder parking is eliminated south of Muir Woods Road Bridge, as discussed under cumulative impacts. Therefore, impacts on pedestrian safety would be direct, long term, and adverse as a result of the driveway crossings, the Conlon Lot pedestrian crossing, and shoulder parking north of the Muir Woods Road Bridge.

No change would occur to the number of privately owned vehicles entering the Main Lot, which would continue to cause conflicts between the buses and privately owned vehicles searching for parking spaces or backing out of parking spaces. Therefore, impacts would be direct, long term, and adverse.

Cumulative Impacts. Phase 1 of the reservation system removed some shoulder parking from Muir Woods Road, thus limiting the number of visitors who can arrive by privately owned vehicle. The reservation system will also limit the number of vehicles parking at the monument and reduce the number of vehicles entering and exiting the monument at one time. As a result, fewer vehicles will be driving to the monument and fewer drivers will be searching for parking, especially during peak times, resulting in reduced traffic congestion and improved safety along Muir Woods Road where shoulder parking is removed. The reduction of available privately owned vehicle parking is also forecasted to result in increased bus and shuttle use as the modal split shifts to alternative transportation modes. Therefore, implementation of the reservation system will have long-term, beneficial impacts on transportation.

The Muir Woods Road Bridge Replacement Project would replace an existing structure and improve the roadway alignment by removing an "S" curve or reverse curve where drivers must transition from a right roadway curve directly into a left roadway curve without the road straightening out to provide a safe transition between the curves. This geometric improvement would improve vehicle safety; therefore, the project would result in short-term, adverse impacts on transportation during the construction period and long-term, beneficial impacts on transportation once it is complete.

The Muir Woods Road Rehabilitation Project would resurface portions of Muir Woods Road and address the poor condition of the road where the pavement contains cracks, the shoulder has disappeared, and lane striping has faded or disappeared. A newly resurfaced pavement would improve vehicle safety; therefore, the project would result in short-term, adverse impacts on transportation during the construction period and long-term, beneficial impacts on transportation once the project is complete.

The Muir Woods Lift Station Rehabilitation Project would install pipe connecting the two lift stations in the Nursery and Conlon Lots. During construction, impacts on transportation would be short term and adverse, potentially causing traffic congestion and safety issues, but these issues would be minimized because the project would be coordinated with Marin County and the Muir Woods Road Rehabilitation Project.

Impacts from cumulative projects would result in short-term, adverse and long-term, beneficial impacts. When the adverse impacts of alternative 1 are combined with the beneficial effects of cumulative actions to transportation, an overall long-term, adverse cumulative impact on transportation is expected from the remaining pedestrian and parking safety issues.

Conclusion. Under alternative 1, pedestrian and parking safety issues would remain because parking lot circulation, shoulder parking between Muir Woods Road Bridge and Conlon Lot, shoulder

parking south of Muir Woods Road Bridge, and parking lot driveway access to Muir Woods Road would remain unchanged, resulting in long-term adverse impacts.

Cumulative impacts on transportation would be limited, short term, and adverse during the construction period for the cumulative projects as well as long term and beneficial from resurfacing the pavement, replacing an old bridge, prohibiting shoulder parking, and implementing the reservation system. The impacts of the cumulative actions are beneficial; however, alternative 1 would contribute adverse impacts and would not address vehicle and pedestrian safety concerns. The contribution of alternative 1 to the cumulative impacts would be substantial because the vehicle and pedestrian safety in the parking lots would not be improved, resulting in an overall adverse cumulative impact.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, the number of driveways in the Annex Lot would be reduced from two to one bi-directional driveway, and the Dipsea Trail would be rerouted to circle around the west side of the lot, thereby reducing the number of places for potential vehicle to pedestrian conflicts. These changes would also improve the internal lot circulation by creating a loop pattern and reducing the potential for vehicle to vehicle conflicts. The Main Lot would only serve shuttles, tour buses, and privately owned vehicles with handicap placards, reducing bus conflicts with most privately owned vehicles. Widening the Conlon Lot would provide more maneuvering space for vehicles to travel through the lot and access parking spaces, and the new woodlands pedestrian trail would provide a safe path for pedestrians to enter and exit the monument without walking along the main vehicular travel-way. Potential impacts from pedestrians crossing Muir Woods Road would be mitigated through appropriate signage posted to alert drivers of the Conlon Lot pedestrian crossing, and pedestrian signs posted on both sides of the pedestrian crossing would improve vehicle and pedestrian safety when accessing the Conlon Lot. Vehicles traveling along Muir Woods Road would be warned of the upcoming intersection serving the Conlon Lot and directed to slow down to yield to potential vehicle and pedestrian movements. Mitigation measures would also include pruning branches along the southbound side of Muir Woods Road south of the Conlon Lot to improve the sight distance for left-turning vehicle movements into and out of the Conlon Lot driveway. Therefore, impacts on transportation from vehicle safety would be direct, long term, and beneficial, as a result of reduced vehicle conflict areas and improved signage and sight distances.

Several pedestrian and vehicle safety issues would continue to exist under alternative 2. Shoulder parking issues between the Conlon Lot and Muir Woods Road Bridge would remain the same as described under alternative 1. Shoulder parking in this location would continue to require visitors to cross Muir Woods Road at random locations to access the trail system serving the monument, which is located on the opposite side of the road, and would also require vehicles to potentially make U-turns to access the designated roadside parking area. Therefore, impacts on transportation from vehicle safety would be direct, long term, and adverse as a result of continued shoulder parking.

A reconfigured Main Lot would provide more space for buses to maneuver and more bus parking spaces to allow buses to park while waiting for their passengers to return from visiting the monument. Vehicle to vehicle conflicts would be reduced with all privately owned vehicle parking relocated to the Annex Lot. Activity from privately owned vehicles in the Main Lot would be minimal based on the proposed mitigation to restrict privately owned vehicle drops-offs in the Main Lot to only vehicles with disabled visitors. Therefore, impacts on shuttle/bus safety and circulation would be direct, short and long term, and beneficial.

Alternative 2 would also result in direct, short-term, adverse impacts on transportation during the construction period from the displacement of existing parking when the parking lots are reconfigured.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in short-term, adverse and long-term, beneficial impacts on transportation. Implementation of mitigation and safety measures in potentially problematic locations as noted in chapter 2 would further minimize most of the impacts to provide overall long-term benefits. When the impacts of alternative 2 are combined with the effects of cumulative actions, an overall long-term, beneficial cumulative impact on transportation is expected.

Conclusion. Under alternative 2, many of the safety issues would be addressed through reducing the number of driveways crossing pedestrian trails and posting signs to warn drivers of approaching pedestrian crossings. Shoulder parking north of the Muir Woods Road Bridge would remain in place and continue to create unsafe vehicle conditions from potential U-turns to access the parking spaces and unsafe pedestrian conditions for visitors to walk between their vehicles to the opposite side of the roadway to access the trail to the monument.

There would be limited, short-term, adverse cumulative impacts on transportation during the construction period of the cumulative projects as well as greater long-term beneficial impacts from resurfacing the pavement, replacing an old bridge, prohibiting shoulder parking, and implementing the reservation system. The impacts of the cumulative actions would be beneficial and, combined with the impacts from alternative 2, would continue to be beneficial, especially addressing vehicle and pedestrian safety in the parking lots. A few safety issues would remain, specifically shoulder parking; however, the contribution of alternative 2 to the cumulative impacts would result in an overall beneficial cumulative impact.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. In addition to the improvements described under alternative 2, alternative 3 would eliminate shoulder parking and construct a Nursery Lot to accommodate vehicle parking needs. The new pedestrian trail would connect the Conlon and Nursery Lots to the Entry Plaza and would be located along the creek side of the Annex Lot, avoiding the driveway crossings. Therefore, impacts on vehicle safety would be direct, long term, and beneficial as a result of reduced vehicle conflict areas and improved signage and sight distance from trimming low hanging branches. Impacts on pedestrian safety would be direct, long term, and beneficial, reflecting reduced parking lot trail crossings and removal of shoulder parking.

Shuttle and tour buses would operate in the same manner as described under alternative 2, resulting in direct, long term, and beneficial impacts on shuttle/bus safety and circulation.

Similar to alternative 2, alternative 3 would also result in direct, short-term, adverse impacts on transportation as a result of construction and the displacement of existing parking when the parking lots are reconfigured.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in short-term, adverse and long-term, beneficial impacts on transportation. When the impacts of alternative 3 are combined with the effects of cumulative actions, an overall long-term, beneficial cumulative impact on transportation is expected.

Conclusion. Alternative 3 would result in the benefits described under alternative 2, including improved safety issues from removing most of the driveways crossing pedestrian trails and posting signs to warn drivers of approaching pedestrian crossings. Alternative 3 would contribute additional beneficial impacts from the elimination of shoulder parking between the Conlon Lot and Muir Woods Road Bridge and relocation of parking to the Nursery Lot, thereby improving vehicle and pedestrian safety. The development of the woodland pedestrian trail would further improve pedestrian safety and contribute beneficial impacts on transportation.

There would be limited, short-term, adverse cumulative impacts on transportation during the construction period of the cumulative projects as well as greater, long-term, beneficial impacts from resurfacing the pavement, replacing an old bridge, prohibiting shoulder parking, and implementing the reservation system. The impacts of the cumulative actions would be beneficial and, combined with the impacts from alternative 3, would continue to be beneficial, addressing many of the vehicle and pedestrian safety issues in the parking lots and on Muir Woods Road. The contribution of alternative 3 to the cumulative impacts would result in an overall beneficial cumulative impact.

GEOLOGY AND SOILS

Methodology and Assumptions

Impacts on soils are considered in this analysis through four measures: soil removal, soil compaction, soil erosion, and disturbance relative to the project area. Activities that may result in impacts on soils include ongoing shoulder parking, parking lot construction, trail construction, bridge construction, restroom construction, and rehabilitation or revegetation. The development of engineered stormwater management infrastructure and placement of wayfinding signs or interpretive media would also affect soils. These impacts were assessed by examining soil information and mapping for the monument (see chapter 3).

Impacts of Alternative 1: No Action

Analysis. Under the no-action alternative, vehicular and pedestrian traffic would continue to directly compact soils in areas where barriers do not yet exist along Muir Woods Road and on existing trails. Compaction reduces the amount of space occupied by air within soil aggregates that allows water to drain freely. As a result, soil compaction would remain high, adversely affecting the rate of infiltration of rainwater, leading to surface runoff, sheet erosion, and gully formation. Since soil aeration depends largely on the presence of large pores, compaction would continue to cause ethylene production. High concentrations of ethylene, a natural gas produced by soil microbes in the absence of oxygen, would indirectly damage the roots of plants and impede their ability to exchange vital gases. Existing damaged or inadequately sized culverts would continue to contribute to a high volume of surface runoff and sedimentation into Redwood Creek during rain events, leading to increased soil erosion. Overall, impacts on soils would continue to be directly and adversely affected over the long term.

Cumulative Impacts. Implementation of the reservation system will limit the number of vehicles parking at the monument. This project will reduce ground disturbance and the potential for soil erosion because fewer vehicles will be able to park along the road. Furthermore, erosion and sediment control measures established in phase 1 of the project should aid in soil recovery in the project area. Over time, vegetation should grow where barriers have been established and improve the water-holding capacity of the soil. When soils are stabilized with vegetation, they are less likely to erode and more likely to allow infiltration of rainfall, thereby reducing sediment loads and runoff

into Redwood Creek. Therefore, this project will result in indirect, long-term, beneficial impacts on soil resources.

The Muir Woods Road Bridge Replacement Project would affect the soils along Muir Woods Road and on the banks of Redwood Creek. The replacement of the bridge and the realignment of Muir Woods Road would disturb soils and increase the potential for soil erosion over the long term. Although the project would adhere to applicable erosion and sediment control regulations and implement best management practices (i.e., sediment barriers) to control runoff, the project would result in indirect and direct, short-term, adverse impacts on soil resources.

Portions of Muir Woods Road would be resurfaced and a number of culverts would be repaired or replaced as part of the Muir Woods Road Rehabilitation Project. These actions would permanently disturb soils and temporarily affect the flow of the associated drainages, increasing the potential for sediment to enter Redwood Creek. Implementation of best management practices and erosion and sediment control measures would capture sediment runoff during construction and minimize sediment transport. After construction is complete, the culverts would help to decrease the amount of runoff and gully formation, resulting in indirect, long-term, beneficial impacts on soils.

The Muir Woods Lift Station Rehabilitation Project would likely require ground disturbance and excavation. Removal and compaction would expose and disturb soils, leading to increased potential for soil erosion and sedimentation. Therefore, the project would result in direct, short-term, adverse impacts on soils because monument staff would likely revegetate disturbed areas after rehabilitation.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would remove riprap from the banks of Redwood Creek, which would require excavation of large boulders and the placement of large woody debris in the creek. These activities would result in short-term, adverse impacts from the removal of soil in the erosion hazard area of the monument, soil compaction from workers and construction equipment, and increased turbidity and sedimentation in the creek. However, in the long term, beneficial impacts on soils would occur once native vegetation has stabilized the creek banks.

Cumulative adverse impacts from these projects would include soil removal, soil erosion, and continued sedimentation into Redwood Creek. Some projects would result in beneficial impacts once they are completed, such as reduced erosion, reduced runoff and sedimentation, and increased creek bank stability.

Conclusion. Under alternative 1, there would be direct, adverse impacts on soils from continued vehicular and pedestrian traffic, as well as surface runoff and sedimentation from existing damaged or undersized culverts. Indirect adverse impacts on the health of vegetation from soil compaction would also occur. Alternative 1 would contribute a substantial, adverse increment to cumulative impacts that are otherwise expected to be largely beneficial, resulting in an overall adverse cumulative impact.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, construction activities related to the Annex Lot expansion would be in an area where lithified rock is buried by unconsolidated sediments; therefore, construction activities would not disturb geologic formations. However, approximately 0.2 acre of topsoil and subsoil would be adversely affected by cutting, filling, grading, and paving activities and from the installation of two culverts. Because the primary soil complex in the Annex Lot is Blucher-Cole, a

poorly suited soil for development, the soil would likely require modification with a suitable soil type. Soil mixing from the use of fill materials would disrupt the soil structure, adversely affecting native soils and plants over the long term within and adjacent to the Annex Lot.

Where the topography is relatively flat and grading occurs, impacts would be limited to the upper subsurface soil horizons. Once asphalt has been laid to surface the Annex Lot, a minimal increase in runoff is expected from the increase in impervious surfaces. Similar impacts are anticipated from the expansion of the Conlon Lot and the paving of the designated roadside parking area because these areas consist of Dipsea-Barnabe very gravelly loam, another soil poorly suited for development. Constructing new restrooms in the Entry Plaza and near the former Nursery Area would also permanently disturb soils within their respective footprints, resulting in direct, long-term, adverse impacts. Minimization and mitigation measures, such as those described in chapter 2, would be used to prevent further disturbance to soils in the project area.

Staging and stockpiling of construction equipment and fill material would result in direct, short-term, adverse impacts on soils. Because ground pressure would increase, the adverse effects would likely include an increased soil resistance to penetration and reduced conductivity of soil to water and gas flow through a reduction in the size of pores. Indirect, adverse effects from these actions would include an increase in exposed mineral soil, displaced soil particles, and slower rainfall infiltration.

The installation of interpretive media and wayfinding signs along trails and traffic signage along Muir Woods Road would minimally affect soils in the long term because soils in these areas would be removed to install posts. During realignment of the Dipsea Trail and construction of a footbridge over Redwood Creek, soil disturbance, including potential creek bank disturbance, would increase the potential for soil erosion. It is also anticipated that the construction of infiltration trenches near each parking lot would temporarily affect soils from direct removal within the footprint of the trench. These actions would result in direct, short and long-term, adverse impacts on soils. However, long-term, beneficial impacts on soils are expected because visitors would no longer walk through the creek, thereby reducing turbidity and sedimentation.

Approximately 0.4 acre of the Entry Plaza and 0.2 acre of the former Nursery Area would be revegetated with plants native to the monument. This action would keep the soil and seed bank stabilized in the erosion hazard area and reduce the movement of silt, resulting in direct, long-term, beneficial impacts.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in short and long-term, adverse impacts in localized areas affected by management actions; however, these impacts would be minimized through mitigation. Beneficial impacts on soils would occur from rehabilitation and revegetation activities. When the impacts of alternative 2 are combined with the effects of cumulative actions in the project area, an overall long-term, beneficial cumulative impact on soils is expected.

Conclusion. Under alternative 2, impacts on soils would be direct, short and long term, and adverse from removal, compaction, soil structure modification, and increased runoff. Direct, long-term, beneficial impacts from the alternative include decreased turbidity and sedimentation in Redwood Creek, riparian rehabilitation in the Entry Plaza, and revegetation of portions of the former Nursery Area. The contribution of alternative 2 to the cumulative impacts would result in an overall adverse impact in the short term, but beneficial impacts over the long term.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. Under alternative 3, construction activities related to the establishment of a new Nursery Lot would be in an area where lithified rock is buried by unconsolidated sediments; therefore, construction activities would not disturb geologic formations. Approximately 0.3 acre of topsoil could be adversely affected by cutting, filling, grading, and paving activities and from the installation of a single culvert. Because the primary soil complex in the former Nursery Area is Blucher-Cole, a poorly suited soil for development, the soil would likely require modification with a suitable soil type. Soil mixing from the use of fill material would disrupt the soil structure, adversely affecting native soils and plants over the long term within and adjacent to the Nursery Lot.

Once asphalt has been laid to surface the Nursery Lot, a minimal increase in runoff is expected. Similar impacts are expected from the expansion of the Conlon Lot because this area consists of Dipsea-Barnabe very gravelly loam, another soil poorly suited for development. Constructing new restrooms in the Entry Plaza and near the Nursery Lot would also permanently disturb soils within their respective footprints, resulting in direct, long-term, adverse impacts. Minimization and mitigation measures, such as those described in chapter 2, would be used to prevent further disturbance to soils in the project area.

Approximately 1,200 linear feet of vegetation would be removed to construct a new woodland pedestrian trail between the Annex and Nursery Lots, resulting in long-term, adverse impacts on soils from increased compaction and runoff potential. The new trail would affect the Blucher-Cole soil complex through cutting, filling, and grading activities. However, approximately 1,500 feet of the existing pedestrian trail along Muir Woods Road between the Main and Nursery Lots would be decommissioned and revegetated with plants native to the monument, resulting in long-term, beneficial impacts on soils as a result of soil stabilization, increased permeability, nutrient cycling, and reduced runoff.

Similar to alternative 2, staging and stockpiling of construction equipment and fill material would result in direct, short-term, adverse impacts on soils; the installation of interpretive media and wayfinding signs along trails and traffic signage along Muir Woods Road would directly and adversely affect soils in the long term; the Dipsea Trail realignment and construction of a footbridge over Redwood Creek would adversely and beneficially affect soils over the short and long terms; and the construction of infiltration trenches near each parking lot would temporarily affect soils from direct removal.

Similar to alternative 2, approximately 0.4 acre of the Entry Plaza and 0.2 acre of the former roadside parking area would be revegetated with plants native to the monument. This action would keep the soil and seed bank stabilized in the erosion hazard area and reduce the movement of silt, resulting in indirect, long-term, beneficial impacts. Additionally, approximately 0.2 acre of the former roadside parking area designated in alternatives 1 and 2 would be revegetated with plants native to the monument, resulting in beneficial impacts on soils from stabilization, increased permeability, nutrient cycling, and reduced runoff.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in limited, short and long-term, adverse impacts in localized areas affected by management actions; these impacts would be minimized through mitigation. Beneficial impacts on soils would occur from rehabilitation and revegetation activities. When the impacts of alternative 3 are combined with the beneficial effects of cumulative actions in the project area, the overall cumulative impact on soils is expected to be long term and beneficial.

Conclusion. Under alternative 3, impacts on soils would be direct and adverse as a result of removal, compaction, soil structure modification, and increased runoff over the short and long terms. Direct, long-term, beneficial impacts from the alternative include decreased turbidity and sedimentation in Redwood Creek, riparian rehabilitation in the Entry Plaza, and revegetation of portions of the former Nursery Area. The contribution of alternative 3 to the cumulative impacts would result in an overall adverse impact in the short term, but some beneficial impacts over the long term.

VEGETATION

Methodology and Assumptions

Impacts on vegetation considered in this analysis include permanently removed or degraded plants as a result of construction activities, the potential for invasive, nonnative plant dispersal and associated control, and rehabilitation or revegetation of disturbed areas. In addition, impacts on rare plant species are addressed in this section. Information gathered on park vegetation types and distribution is described in chapter 3, including the type of vegetative cover found near parking areas and along Muir Woods Road that could be disturbed under any of the alternatives.

Impacts of Alternative 1: No Action

Analysis. Under alternative 1, vehicular and pedestrian trampling would continue to directly and adversely affect vegetation in areas where barriers do not yet exist along Muir Woods Road, along existing trails, and in riparian areas, resulting in breakage, loss of productivity, and mortality of plants in the long term. Additionally, plant cover and biomass would remain low because soil compaction could inhibit seed germination. Soil compaction would also cause indirect effects on vegetation because individual plants would grow fewer lateral roots and root hairs, effectively reducing their ability to use available nutrients. However, no adverse impacts on rare plants such as California bottlebrush grass or leopard lily are anticipated because existing infrastructure does not currently affect these species. Therefore, this alternative would result in long-term, adverse impacts on vegetation, mainly in areas that have already been disturbed.

Cumulative Impacts. Phase 1 of the reservation system temporarily disturbed sparse vegetation when barrier posts were installed. However, the barrier posts prevent parking along the shoulder of Muir Woods Road and therefore eliminate vehicular ground disturbance, allowing vegetation to reestablish in these areas. Furthermore, the project implemented erosion and sediment control measures that should aid in vegetative growth. Over time, vegetation will increase organic matter content and improve the water-holding capacity of the soil and aid subsequent plant growth, resulting in indirect, long-term, beneficial impacts on vegetation.

The Muir Woods Road Bridge Replacement Project would adversely affect vegetation in the short term along Muir Woods Road and on the banks of Redwood Creek. Depending on the amount of vegetation affected, the project could temporarily alter creek flow as a result of trampling, breakage, and removal of riparian plant species, resulting in direct, short-term, adverse impacts on vegetation from degradation of plants near the bridge.

The Muir Woods Road Rehabilitation Project would resurface portions of Muir Woods Road and repair or replace culverts in the project area. Excavation and trampling by workers has a high potential to remove or damage vegetation; however, impacts would be minimized through the implementation of best management practices. After construction is complete, vegetation would reestablish or be replanted, resulting in direct, long-term, beneficial impacts on this resource.

Construction associated with the Muir Woods Lift Station Rehabilitation Project would require ground disturbance and excavation. Construction would remove or damage vegetation and lead to increased potential for soil erosion and sedimentation, resulting in direct, short-term, adverse impacts on vegetation.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would remove riprap from the banks of Redwood Creek, which would require excavation of large boulders and the placement of large woody debris in the creek. These activities would result in short-term, adverse impacts from the removal of vegetation in the erosion hazard area of the monument. However, direct, beneficial impacts on vegetation would occur in the long term because native vegetation would be planted to stabilize the creek banks.

Cumulative adverse impacts from these projects would remove and degrade vegetation. Some projects, such as those that include revegetation, increased organic matter, increased water-holding capacity of soil, and stabilization of the Redwood Creek bank, would result in beneficial impacts in the long term once they are completed.

Conclusion. Under alternative 1, impacts on vegetation would continue to be adverse from ongoing ground disturbance in the long term. Plant cover and biomass would remain low in a variety of areas because soil compaction could inhibit seed germination and restrict the root growth of plants. No adverse impacts on rare plants are anticipated because existing infrastructure does not currently affect these species. The contribution of alternative 1 to cumulative impacts would result in an overall adverse impact in the short term, but some beneficial impacts over the long term.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, vegetation would be permanently removed from approximately 0.2 acre of land southeast of the Annex Lot to expand the lot, resulting in direct, long-term, adverse impacts. Trees and shrubs such as arroyo willow and coast live oak would be cleared and grubbed, which would result in direct mortality and a slight decrease in nutrient cycling. Native understory shrubs, ferns, forbs, and grasses would also be removed. Low-hanging branches along Muir Woods Road would be pruned and the Conlon Lot entrance realigned to improve the sight distance for vehicles attempting to enter and exit the lot or pull-in and out of roadside parking.

Species adversely affected by direct mortality in the Conlon Lot from expansion and laying down pavement in the roadside parking area would largely include bay laurel and sword fern. California buckeye could also be adversely affected; however, buckeye trees over 20-inches in diameter at breast height would not be removed unless approved by monument staff. Adverse impacts are not anticipated on California bottlebrush grass or leopard lily because a rare plant survey would be conducted prior to any construction activities. However, if state or locally listed plants are found and cannot be avoided, these plants would be transplanted or seeds would be collected, propagated, and replanted in another location. Constructing new restrooms in the Entry Plaza and near the former Nursery Area would likely remove vegetation within their footprints, resulting in direct, long-term, adverse impacts.

Staging and stockpiling of construction equipment and fill material would result in trampling, potential vegetation loss, and the increased potential for the spread of invasive, nonnative plants (e.g., forget-me-not, panic veldtgrass, cape ivy, brooms, acacia) and diseases (e.g., sudden oak death). The spread of these invasive, nonnative plants and diseases would mostly occur from equipment that

harbor seed in the tire tread or from transporting host plant material. However, equipment would be washed and inspected to remove seed and host plant material to mitigate these potential impacts.

Installation of interpretive media and wayfinding signs along trails and traffic signage along Muir Woods Road would directly and adversely affect vegetation in the long term because vegetation in these areas would be uprooted or maintained at a specific height to enhance visitor experience and improve safety. During realignment of the Dipsea Trail and construction of a footbridge over Redwood Creek, ground disturbance, including potential creek bank disturbance, would increase the potential for loss of riparian vegetation. In addition, the construction of infiltration trenches near the parking lots is anticipated to affect vegetation by directly removing various plant species within the footprint of the trench. These actions would result in direct, long-term, adverse impacts on vegetation.

Approximately 0.4 acre of the Entry Plaza and 0.2 acre of the former Nursery Area would be revegetated with plants native to the monument. This action would keep the soil and seed bank stabilized in the erosion hazard area, reduce the movement of silt, keep the water temperature of Redwood Creek cooler, and increase the availability of food and nesting habitat for a variety of wildlife species. Furthermore, an increase in vegetation would stabilize soils, resulting in a reduction in nutrient and chemical pollution by trapping and filtering these substances before they enter Redwood Creek.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in short and long-term, adverse impacts in localized areas affected by management actions; however, these impacts would be minimized through mitigation. Overall long-term benefits would result from rehabilitation and revegetation of disturbed areas. Therefore, when the primarily beneficial impacts as a result of alternative 2 are combined with the beneficial effects of other cumulative actions in the project area, an overall long-term, beneficial cumulative impact on vegetation is expected.

Conclusion. Under alternative 2, direct, adverse impacts would occur from removing vegetation from the Annex and Conlon Lots, the roadside parking area, and from the riparian area of Redwood Creek. Direct mortality of plants would also occur in the footprints of the new restrooms and infiltration trenches. However, beneficial impacts from riparian rehabilitation in the Entry Plaza and revegetation of portions of the former Nursery Area would result in long-term, beneficial impacts. No impacts on rare plants are anticipated because a survey would be conducted prior to any construction activities. Alternative 2 would primarily contribute a beneficial increment to cumulative impacts, resulting in an overall beneficial cumulative impact on vegetation.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. Under alternative 3, vegetation would be permanently removed from less than 0.3 acre of land in the former Nursery Area when the Nursery Lot is established, which would result in direct, long-term, adverse impacts. Trees and shrubs such as arroyo willow and coyote bush (*Baccharis pilularis*) would be cleared and grubbed, which would result in direct mortality and a slight decrease in nutrient cycling. Native understory shrubs, ferns, forbs, and grasses would also be removed. California buckeye could also be adversely affected because up to three trees could be removed to construct the Nursery Lot. However, buckeye trees over 20-inches in diameter at breast height would not be removed unless approved by monument staff. Low-hanging branches along Muir Woods Road would be pruned and the Conlon Lot entrance realigned to improve the sight distance for vehicles attempting to enter and exit the lot.

Species adversely affected in the Conlon Lot from expansion would include bay laurel and sword fern. Adverse impacts on California bottlebrush grass or leopard lily are not anticipated because a rare plant survey would be conducted prior to any construction activities. However, if state or locally listed plants are found and cannot be avoided, these plants would be transplanted or seeds would be collected, propagated, and replanted in another location. Constructing new restrooms in the Entry Plaza and adjacent to the Nursery Lot would likely remove vegetation within their respective footprints, resulting in direct, long-term, adverse impacts.

Approximately 1,200 linear feet of vegetation would be removed to develop a new woodland pedestrian trail between the Annex and Nursery Lots, resulting in long-term, adverse impacts on arroyo willow, bay laurel, and coast live oak. Similar to the impacts in the former Nursery Area, the new trail could potentially affect California buckeye, but removal would be avoided where possible. Approximately 1,500 feet of the existing pedestrian trail along Muir Woods Road between the Main and Nursery Lots would be decommissioned and revegetated with plants native to the monument, resulting in long-term, beneficial impacts on vegetation.

Similar to alternative 2, the staging and stockpiling of construction equipment and fill material would result in trampling, vegetation loss, and the increased potential for the spread of invasive, nonnative plants and diseases; the installation of interpretive media and wayfinding signs along trails and traffic signage along Muir Woods Road would uproot or maintain the height of vegetation; the Dipsea Trail realignment and construction of a footbridge over Redwood Creek would increase the potential for loss of riparian vegetation; and the construction of infiltration trenches near each parking lot would remove vegetation. These actions would result in direct, long-term, adverse impacts on vegetation.

Similar to alternative 2, approximately 0.4 acre of the Entry Plaza would be rehabilitated with plants native to the monument. This action would keep the soil and seed bank stabilized in the erosion hazard area, reduce the movement of silt, keep the water temperature of Redwood Creek cooler, and increase the availability of food and nesting habitat for a variety of wildlife species. Additionally, an increase in vegetation would stabilize soils, resulting in a reduction in nutrient and chemical pollution by trapping and filtering these substances before they enter Redwood Creek. Approximately 0.2 acre of the former roadside parking area designated in alternatives 1 and 2 would be revegetated with plants native to the monument.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in limited short and long-term, adverse impacts in localized areas affected by management actions; these impacts would be minimized through mitigation. Overall long-term benefits would result from rehabilitation and revegetation of disturbed areas. Therefore, when the primarily beneficial impacts as a result of alternative 3 are combined with the beneficial effects of other cumulative actions in the project area, an overall long-term, beneficial cumulative impact on vegetation is expected.

Conclusion. Under alternative 3, direct, adverse impacts would occur from removing vegetation in the former Nursery Area, Conlon Lot, and along the new pedestrian woodland trail and pruning low-hanging branches along Muir Woods Road and from disturbance to the riparian area of Redwood Creek. Direct mortality of plants would also occur in the footprints of the new restrooms and infiltration trenches. However, beneficial impacts from the revegetation of the existing pedestrian trail along Muir Woods Road, riparian rehabilitation in the Entry Plaza, and revegetation of former roadside parking area would result in long-term, beneficial impacts. No impacts on rare plants are anticipated because a survey would be conducted prior to any construction activities.

Alternative 3 would primarily contribute a beneficial increment to cumulative impacts, resulting in an overall beneficial cumulative impact on vegetation.

WATER RESOURCES AND HYDROLOGIC PROCESSES

Methodology and Assumptions

This analysis of potential impacts on water resources and hydrologic processes focuses on impacts on groundwater, surface water, wetlands, water quality, and floodplains within the monument and water resources that are hydrologically connected, including the downstream reaches of Redwood Creek. Potential impacts on these resources could result from alterations or disturbance to each resource, including changes to quality, quantity, or associated functions and values. Analysis of potential impacts was based on a review of existing literature, data, maps, and professional judgment.

Impacts of Alternative 1: No Action

Analysis. Under alternative 1, current management actions would continue, and existing uses, developments, and facilities would remain the same. Roadside parking would continue along Muir Woods Road, and stormwater management infrastructure, including damaged or inadequately sized culverts, would not be improved, thereby continuing to contribute a higher volume of water, sediment, and other pollutants to the creek during rain events. Ground disturbance in the former Nursery Area, shoulder parking along portions of Muir Woods Road, and the location of the Muir Woods Road pedestrian trail would remain, allowing for potential sedimentation of local water resources. The wooden plank over Redwood Creek along the Dipsea Trail would remain as a pedestrian crossing, as would the frequent inadvertent foot traffic through the creek instead of over the wooden plank, resulting in creek bed disturbance, increased erosion and sedimentation, and hydrologic disturbance during high flows. Therefore, alternative 1 would result in direct and indirect, long-term, adverse impacts on surface water, water quality, and hydrologic processes as a result of continued sediment erosion and runoff from road shoulders and parking lots and instream disturbance. The existing management actions do not pollute the groundwater or impede groundwater recharge, therefore, there would be no impacts on these resources.

Cumulative Impacts. The reservation system will restrict the number of vehicles parking along Muir Wood Road, which will reduce ground disturbance and the potential for erosion and sediment loading to local waters. The installation of road parking barriers along Muir Woods Road used fiber roll or wattle matting next to culverts to prevent the transport of sediment or other construction-related pollutants into the drainages and to stabilize disturbed ground. The barrier system avoided all culverts that crossed the road by leaving a 10-foot opening on either side of the culvert. The barrier system prevents parking along the shoulder of Muir Woods Road. Installation of erosion and sediment control measures and culvert avoidance minimize and prevent sediment and other pollutants from entering local streams, resulting in short-term, beneficial impacts on water resources. Therefore, this action will continue to result in short- and long-term, beneficial impacts on water resources by eliminating ground disturbance and potential sediment loading.

The Muir Woods Road Bridge Replacement Project would affect the surface water and hydrologic processes of Redwood Creek. The replacement of the bridge, improvements to Muir Woods Road adjacent to the bridge, and realignment of the road would disturb soils and increase the potential for soil erosion and associated sedimentation of Redwood Creek. Initial actions to remove and replace the existing bridge would temporarily alter creek flow; however, protection of the riparian habitat along the creek would be a project priority. The project would adhere to applicable erosion and sediment control regulations and implement best management practices and other sediment barriers

to control runoff into the creek. Therefore, the project would result in short-term, adverse impacts on water resources from degradation of water quality from increased sediment and loads and alteration of hydrologic processes. After construction of the Muir Woods Road Bridge, the added impervious surface would increase the volume of stormwater entering Redwood Creek and road-related sediment and pollutant loading, resulting in long-term, adverse impacts on water resources.

The Muir Woods Road Rehabilitation Project would resurface portions of Muir Woods Road and repair or replace a number of culverts. The application of road resurfacing materials and use of associated equipment has the potential to accidentally release hazardous materials to the ephemeral drainages; however, impacts would be minimized through the implementation of best management practices and appropriate hazardous material use and storage. The repair or replacement of culverts would temporarily disturb the flow of the associated drainages and increase the potential for sediment to enter the drainages and Redwood Creek. During construction, impacts on water resources and hydrologic processes would be short term and adverse as a result of flow alteration and sediment and pollutant loading; however, the use of best management practices and erosion and sediment control measures would capture sediment runoff, and implementation of a stormwater pollution prevention plan during construction would minimize sediment transport. After construction is complete, the culverts would help to decrease the amount of sediment entering Redwood Creek and improve water quality, resulting in long-term, beneficial impacts on water resources.

Construction associated with the Muir Woods Lift Station Rehabilitation Project would require ground disturbance and excavation. Construction would disturb and expose soils, which could increase the potential for soil erosion, sedimentation of surrounding water resources, and accidental release of hazardous materials. Ground disturbance during construction could also temporarily alter localized surface water drainage. If ground disturbance exceeds 1 acre, the project must obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity and would be required to comply with associated regulations, including the development of a stormwater pollution prevention plan and implementation of best management practices related to stormwater, sediment and erosion control, and waste management. Dewatering would be necessary if high groundwater levels were encountered. The project would have to comply with discharge and treatment requirements if any fecal coliform contamination is found in the groundwater. Therefore, the project could result in short-term, adverse impacts on water resources and hydrologic processes from potential water quality and drainage issues. Compliance with any necessary stormwater permits and stormwater pollution prevention plans would minimize potential short-term, adverse impacts and prevent long-term impacts.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Projects would replace pedestrian bridges over Redwood Creek, remove riprap from the creek banks, and install large woody debris. Dismantling and replacing the pedestrian bridges, removing existing riprap, and installing large woody debris would disturb the ground and the creek bed and banks and increase the potential for soil erosion and sediment transport into Redwood Creek, resulting in short-term, adverse impacts on water resources. Although there would be temporary, adverse impacts associated with added sediment during construction and installation, the project would result in overall long-term, beneficial impacts from the placement of large woody debris that would stabilize the creek banks and prevent erosion.

The cumulative actions would have adverse effects on water quality and hydrology; however, these effects would be relatively limited and localized compared to the more widespread benefits from the elimination of ground disturbance and the installation of stormwater management and erosion and sediment control measures. The overall impacts from these cumulative actions would be beneficial.

Alternative 1 would contribute adverse effects to the cumulative actions because of sedimentation from continuing ground and instream disturbance and erosion and altered hydrology from high runoff volumes. These water quality and hydrologic impacts would be widespread within the monument and downstream. Therefore, when the primarily widespread adverse impacts from alternative 1 are combined with the effects of other cumulative actions in the project area, an overall adverse cumulative impact is expected.

Conclusion. Under alternative 1, impacts on water resources and hydrologic processes would continue to be direct and indirect, long term, and adverse from ongoing sediment erosion and runoff from disturbed road shoulders and parking lots and inadequate stormwater management infrastructure that contribute sediment, water volume, and pollutants to local waterways. Instream disturbances would also contribute to sediment and alter local hydrology. The contribution of alternative 1 to the cumulative impacts would be appreciable because of the potential alteration of water quality and hydrology in the monument and downstream of Redwood Creek, resulting in an overall adverse cumulative impact.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, the addition of wayfinding signs and interpretive media and accommodation of buses, shuttles, commercial use vehicles, and ABA-compliant parking in the Main Lot would have no impacts on water resources and hydrologic processes. Additionally, because no changes to existing trail access between parking areas and the Entry Plaza would occur, impacts would be the same as those described under alternative 1.

Realignment of the Dipsea Trail; construction of a footbridge over Redwood Creek; and ground disturbance, including potential bank disturbance, would increase the potential for soil erosion and sediment transport into Redwood Creek. Best management practices to control stormwater and erosion and sediment would be implemented to minimize adverse impacts. After construction, the placement of the footbridge would not disturb the creek bed, although some structural parts of the bridge may be located close to the creek banks and in the adjacent erosion hazard area. There would be no impacts on the floodplain because the bridge would be constructed approximately 14 feet above the creekbed, at the same grade as the Annex Lot, to avoid flooding and to account for the potential future migration of the creek channel, resulting in no adverse impacts on hydrologic processes. Construction of the new footbridge would result in direct, short-term, adverse impacts from potential sedimentation but would eliminate the existing instream foot traffic and associated erosion and water quality issues, resulting in direct, long-term, beneficial impacts on water resources and hydrologic processes.

The existing restroom in the Entry Plaza would be relocated from within the erosion hazard area close to Redwood Creek to a position outside of the erosion hazard area. During the removal and relocation process, soils would be exposed, which could increase the potential for soil erosion, sedimentation of surrounding water resources, and accidental release of hazardous materials. During relocation, impacts could be indirect, short term, and adverse; however, best management practices would be implemented to control stormwater, erosion and sediment, and accidental releases of construction-related pollutants to minimize impacts. After the restroom is relocated, impacts would be direct, long term, and beneficial from the removal of potential flooding hazards and allowing the erosion hazard area to slow potential high flows that overtop the banks of Redwood Creek.

The construction of a new restroom near the former Nursery Area would expose soils and lead to increased potential for soil erosion, sedimentation of surrounding water resources, and accidental

release of hazardous materials. The project would result in indirect, short-term, adverse impacts; however, best management practices would be implemented to control stormwater, erosion and sediment, and accidental releases of construction-related pollutants to minimize impacts on water quality.

The part of the Entry Plaza within the erosion hazard area would be rehabilitated through revegetation with native riparian plant species. The revegetated area would reduce the volume of stormwater runoff into Redwood Creek and improve hydrology by helping to reduce peak streamflow. The rehabilitated erosion area would also help slow and store high flood flows that overtop the creek banks. Therefore, this action would result in direct, long-term, beneficial impacts on water resources and hydrologic processes.

Revegetation of portions of the former Nursery Area with native plant species would stabilize the exposed soils and prevent erosion and transport of soils into local waterways. This would improve the water quality of the creek. Additionally, the reestablishment of vegetation would help to slow and capture any overbank flows from Redwood Creek or overland stormwater runoff before entering Redwood Creek. Reducing runoff into the creek would attenuate peak storm flows and minimize streambed and bank erosion. Revegetation of disturbed areas would result in indirect, long-term, beneficial impacts on water resources and hydrologic processes.

Expansion of the Annex and Conlon Lots would require clearing and ground disturbance of less than 0.3 acre. Soil exposure and the use of construction equipment would increase the potential for erosion, sediment loading into Redwood Creek, and the accidental release of hazardous materials. Best management practices would be implemented during construction to minimize impacts from stormwater, erosion and sediment, and hazardous materials. Stormwater management infrastructure would be upgraded to improve water quality, quantity, and drainage. Two culverts would be constructed at the Annex Lot to convey the flow of existing ephemeral drainages, which would result in temporary direct, adverse impacts from altered drainage during construction with overall long-term benefits. Stormwater management measures, including infiltration trenches and buffer strips, would be designed and constructed to meet applicable water quality standards. Although impervious surface would increase under this alternative, the implementation of these facilities would have benefits from reducing the volume of and treating the stormwater runoff to at least pre-project levels, or better, from all the parking lots and eliminating long-term, adverse impacts. The location, size, spacing, capacity, and other details concerning the stormwater management infrastructure would be determined during the design phase. Therefore, the project would result in direct, short-term, adverse impacts on water resources and hydrologic processes during construction and direct, long-term, beneficial impacts after construction is completed.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in limited, short-term, adverse impacts in localized areas affected by management actions; however, the effects of these impacts would be minimized through mitigation measures described in chapter 2. Overall long-term beneficial impacts would result from revegetation and rehabilitation of disturbed areas and updated stormwater management. Therefore, when the beneficial impacts as a result of alternative 2 are combined with the beneficial effects of other cumulative actions in the project area, an overall long-term, beneficial cumulative impact is expected.

Conclusion. Under alternative 2, the management actions are expected to contribute minimal, temporary, adverse impacts during construction from alterations to water quality and localized drainage impacts. Over time, these actions would contribute beneficial impacts from revegetation

and rehabilitation of disturbed areas and updated stormwater management and would result in an overall long-term, beneficial cumulative impact within the monument and downstream. Compared to alternative 1, alternative 2 would improve water resources and hydrologic processes, including water quality conditions, over time by reducing adverse impacts from continuing ground disturbance and inadequate stormwater management infrastructure and adding improvements.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. Under alternative 3, impacts from realigning the Dipsea Trail and constructing the footbridge, relocating or constructing restrooms, and rehabilitating the Redwood Creek erosion hazard area in the Entry Plaza would be the same as those described under alternative 2. Establishing additional wayfinding signs and interpretive media and accommodating buses, shuttles, commercial use vehicles, and ABA-compliant parking in the Main Lot would have no impacts on water resources and hydrologic processes.

Installing a new woodland pedestrian trail between the Annex and Nursery Lots would require approximately 1,200 linear feet of clearing and grubbing, as well as the construction of small footbridges over the existing intermittent drainages located along the trail route. Ground disturbance, including potential bank disturbance associated with the intermittent drainages, would increase the potential for soil erosion and sediment transport into surrounding surface waters. Therefore, construction of the new trail and footbridges over drainages would result in direct, short-term, adverse impacts from potential sedimentation; however, best management practices for stormwater and erosion and sediment control would be implemented to minimize impacts from water quality degradation.

Decommissioning the Muir Woods Road pedestrian trail would eliminate ground disturbance by foot traffic along the trail and associated potential sediment loading, resulting in long-term, indirect, beneficial impacts.

Revegetating the disturbed area of the existing roadside parking area and the Muir Woods Road pedestrian trail with native plant species would stabilize the exposed soils and prevent erosion and transport of soils into local waterways. This would improve the water quality of surrounding surface waters. Additionally, reestablishing vegetation would help to slow and capture any overland stormwater runoff before entering Redwood Creek or ephemeral drainages. Reducing runoff into the waterways would attenuate peak storm flows and minimize streambed and bank erosion. Therefore, revegetation of disturbed areas would result in direct, long-term, beneficial impacts on water resources and hydrologic processes.

Parking lot expansion and the development of engineered stormwater management infrastructure would be similar to those described under alternative 2. Under this alternative, the Conlon Lot expansion would be the same as under alternative 2, resulting in similar indirect, short-term, adverse impacts from potential increased sediment and pollutant loading to surface waters during construction. Infiltration trenches and buffer strips would be constructed to reduce the volume of, and treat the stormwater runoff from, all parking lots, which would result in beneficial impacts. Although impervious surface would be increased, the implementation of infiltration trenches and buffer strips would allow the areas to retain runoff volume, velocity, and water quality at pre-project levels, if not better. One culvert would be constructed in the Nursery Lot to convey the flow of an existing ephemeral drainage. The location, size, spacing, capacity, and other details concerning the stormwater management infrastructure would be determined during the design phase. Short-term, direct, adverse impacts from alteration of the drainage would result during construction but in the long term, impacts would be direct and beneficial from improved stormwater flow. Therefore, the

stormwater improvements under alternative 3 would result in direct, short-term, adverse impacts on water resources and hydrologic processes during construction and direct, long-term, beneficial impacts after completion.

The development of the former Nursery Area into a parking lot would require removing existing structures, clearing vegetation, and installing impervious surfaces. During construction, ground disturbance would result in indirect, short-term, adverse impacts from increased potential for erosion, sediment loading, and accidental releases of hazardous materials. Temporary, direct, adverse impacts on water resources and hydrology would result before the culvert to convey flow from an existing on-site drainage is completed. Approximately 0.3 acre of previously disturbed compacted ground would be paved; however, stormwater management infrastructure discussed above would prevent long-term, adverse impacts on hydrology and water quality from the added impervious surface.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in limited, short-term, adverse impacts in localized areas affected by management actions; these impacts would be minimized through mitigation. Overall long-term benefits would result from the removal of areas of continued disturbance, revegetation and rehabilitation of disturbed areas, and updated stormwater management. Therefore, when the beneficial impacts associated with alternative 3 are combined with the beneficial effects of other cumulative actions in project area, an overall long-term, beneficial cumulative impact is expected.

Conclusion. Under alternative 3, management actions are expected to contribute minimal, temporary, adverse impacts during construction from alterations to water quality and localized drainage impacts. Over time, these actions would contribute substantial, beneficial impacts from the removal of large areas of continued disturbance, revegetation and rehabilitation of disturbed areas, and updated stormwater management and would result in an overall long-term, beneficial cumulative impact experienced within the monument and downstream. Compared to alternative 1, alternative 3 would greatly improve water resources and hydrologic processes, including water quality conditions by reducing adverse impacts from continuing ground disturbance and inadequate stormwater management infrastructure and adding improvements.

THREATENED AND ENDANGERED SPECIES

Methodology and Assumptions

This analysis examines the potential for actions associated with each of the alternatives to affect threatened or endangered species or their habitats at the monument. Threatened and endangered species known to occur or potentially occurring at the monument are identified in chapter 3. The area of analysis includes all habitats within the boundary of the monument. However, any impacts on coho salmon or steelhead trout associated with impacts on water quality may extend outside the boundaries of the monument to downstream reaches of Redwood Creek.

Impacts of Alternative 1: No Action

Analysis.

Coho Salmon — Under alternative 1, coho salmon and their critical habitat would be indirectly affected commensurate with impacts on water quality as described under "Water Resources and Hydrologic Processes." Water quality and habitat conditions in Redwood Creek would continue to

be affected by sedimentation, pollution, and instream erosion associated with high volumes of stormwater runoff that enter the creek following rainfall events. Under alternative 1, these impacts would persist over time because roadside parking would continue, and stormwater management infrastructure (including damaged or undersized culverts) would not be upgraded. The wooden plank over Redwood Creek along the Dipsea Trail would remain in place and continue to serve as a crossing over the creek, potentially resulting in direct disturbances to coho salmon habitat if visitors walk through the creek instead of on the plank. Overall, alternative 1 may affect but is not likely to adversely affect coho salmon. Potential effects could be direct or indirect over the long term but would not represent a substantial change from existing conditions.

Steelhead Trout — Impacts on steelhead trout under alternative 1 would be the same as those described for coho salmon because of the habitat overlap between the two species.

Northern Spotted Owl — Alternative 1 would not disturb northern spotted owls or their habitats because no construction activities would occur. Therefore, no impacts on northern spotted owls are anticipated.

Marbled Murrelet — The marbled murrelet has not been documented at the monument, despite the presence of suitable nesting habitat. Therefore, alternative 1 would have no impact on this species.

California Red-Legged Frog — The California red-legged frog has not been documented at the monument and is not likely to be present because of a lack of suitable breeding habitat. Therefore, alternative 1 would have no impact on this species.

Cumulative Impacts. Phase 1 of the reservation system indirectly benefited coho salmon and steelhead trout by preventing or reducing the amount of parking along the shoulder of Muir Woods Road. Erosion as a result of roadside parking had previously contributed to sediment loading and degradation of water quality in Redwood Creek. Erosion and sediment control measures were also installed as part of the project, and these measures have further reduced the potential for water quality and habitat degradation in Redwood Creek. Indirect, beneficial impacts on coho salmon and steelhead trout associated with this project are expected to continue over the long term. This project did not likely affect northern spotted owls or marbled murrelet. Furthermore, the reservation system will reduce the amount of parking along Muir Woods Road, completely eliminating parking south of the Muir Woods Road Bridge. This will potentially improve water quality and habitat conditions for coho salmon and steelhead trout in Redwood Creek by reducing or preventing erosion and sedimentation associated with roadside parking. The agencies will consult under the Endangered Species Act on any potential impact to listed species as warranted.

The Muir Woods Road Bridge Replacement Project would have indirect, short-term impacts on coho salmon and steelhead trout commensurate with impacts on water quality in Redwood Creek. Replacement of the bridge would result in short-term increases in sediment loading from ground disturbances and would temporarily alter the flow of Redwood Creek. These impacts would be minimized by implementing sediment barriers and other best management practices; protection of riparian habitat along Redwood Creek would be a priority. This project would result in indirect, short-term impacts on northern spotted owls because of increased noise disturbances during construction. The project would not affect marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat are expected to occur. The project would not affect the California red-legged frog because this species is not likely to occur in the project area.

Road resurfacing and culvert replacement for the Muir Woods Road Rehabilitation Project would have indirect, short-term impacts on coho salmon and steelhead trout because of the increased potential for runoff and sedimentation associated with ground disturbances. These impacts would be minimized by implementing sediment barriers and other best management practices. The project would have indirect, long-term, beneficial impacts on coho salmon and steelhead trout because road slides would be repaired and two culverts would be replaced (within the project area), resulting in decreased erosion and sedimentation in Redwood Creek. This project could result in indirect, short-term impacts on northern spotted owls because of increased noise disturbances during construction. The project would not affect marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat are expected to occur. The project would not affect the California red-legged frog because this species is not likely to occur in the project area.

The Muir Woods Lift Station Rehabilitation Project could result in indirect, short-term impacts on coho salmon and steelhead trout because of the potential runoff and sedimentation associated with ground disturbances during construction. Conditions are expected to return to baseline once the project is completed. This project could result in indirect, short-term impacts on northern spotted owls because of increased noise disturbances during construction. The project would not affect marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat are expected to occur. The project would not affect the California red-legged frog because this species is not likely to occur in the project area.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would replace four pedestrian bridges and restore aquatic habit in Redwood Creek. This project would result in direct, short-term impacts on coho salmon and steelhead trout, followed by direct, long-term, beneficial impacts. Short-term impacts would consist of habitat disturbance and temporary increases in turbidity during bridge replacement and riprap removal. These impacts would be localized and conditions would quickly return to baseline. Restoration activities, including the placement of woody debris to create habitat for juvenile coho salmon, would benefit both coho salmon and steelhead trout. Increased noise during bridge replacement and riprap removal could temporarily disturb northern spotted owls but is not likely to result in an adverse impact. The project would not impact marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat are expected to occur. The project would not affect the California red-legged frog because this species is not likely to occur in the project area.

Cumulative actions would have direct and indirect, short- and long-term impacts on threatened and endangered species. Most impacts on coho salmon and steelhead trout would be indirect and temporary, commensurate with impacts on water quality in Redwood Creek. These impacts would be followed by long-term, beneficial impacts associated with reduced erosion and sedimentation and restoration of aquatic habitat in Redwood Creek. Impacts on northern spotted owl would be indirect and short term, potentially resulting from noise disturbances during construction activities. Conditions would quickly return to baseline once construction is completed. The cumulative actions would not affect marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat are expected to occur. The cumulative actions would not affect the California red-legged frog because this species is not likely to occur in the project area. When the impacts from alternative 1 are combined with the effects of other cumulative actions in the study area, threatened and endangered species would not be likely to be adversely impacted. Alternative 1 would contribute an increment to the overall cumulative impact because of continued water quality and habitat degradation in Redwood Creek associated with inadequate parking and stormwater management infrastructure.

Conclusion. Under alternative 1, coho salmon and steelhead trout critical habitat would continue to be affected by erosion, sedimentation, and water quality degradation associated with inadequate parking and stormwater management infrastructure and the continued use of the wooden plank crossing Redwood Creek on the Dipsea Trail. Direct and indirect impacts would persist over the long term, but would not represent a substantial change from existing conditions. Northern spotted owl, marbled murrelet, and California red-legged frog would not be affected under alternative 1. Overall, alternative 1 is not likely to adversely affect threatened or endangered species. Cumulative impacts would be beneficial, and alternative 1 would contribute an increment to the overall cumulative impact.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis.

Coho salmon — Under alternative 2, realignment of the Dipsea Trail and construction of a footbridge over Redwood Creek may result in indirect, temporary impacts on coho salmon habitat as a result of increased sedimentation associated with ground disturbance during construction. However, implementation of best management practices would minimize these impacts. Construction of a footbridge over Redwood Creek would have long-term, beneficial impacts on coho salmon and their critical habitat because Dipsea Trail users would have a formal bridge to use and would not disturb habitat in Redwood Creek by using the existing wooden plank crossing or walking through the creek.

Relocation of the restroom in the Entry Plaza and construction of a new restroom in the former Nursery Area would have indirect, temporary impacts on coho salmon and their critical habitat, commensurate with water quality impacts in Redwood Creek. Ground disturbance during construction would temporarily increase sedimentation. Best management practices would minimize these impacts and disturbed areas would be revegetated following construction, resulting in long-term, beneficial impacts. Similarly, rehabilitation of riparian habitat in the Redwood Creek erosion hazard area of the Entry Plaza may result in temporary impacts on coho salmon and their critical habitat associated with ground disturbance. However, rehabilitation of riparian habitat would improve water quality over the long term by reducing erosion, resulting in indirect, beneficial impacts on coho salmon and their critical habitat.

Expansion of the Annex and Conlon Lots could result in indirect, temporary impacts on coho salmon and their critical habitat from increased sedimentation as a result of ground disturbance during construction. However, stormwater management infrastructure, including the installation of two new culverts, infiltration trenches, and buffer strips would have indirect, long-term, beneficial impacts on coho salmon and their habitat, commensurate with improved water quality in Redwood Creek.

Overall, alternative 2 may affect but is not likely to adversely affect coho salmon. Potential impacts would be indirect and temporary, resulting from increased sedimentation associated with ground disturbance during construction. However, these impacts would be minimized through the implementation of mitigation measures and best management practices, and therefore would not be significant. Reduced erosion and sedimentation and improved water quality in Redwood Creek as a result of improved stormwater management infrastructure, construction of a footbridge over Redwood Creek, revegetation of disturbed areas such as the former Nursery Area, and rehabilitation of riparian habitat in the Entry Plaza would result in direct and indirect, long-term, beneficial impacts on coho salmon and their habitat.

Steelhead Trout — Impacts on steelhead trout under alternative 2 would be the same as those described for coho salmon because of the habitat overlap between the species.

Northern Spotted Owl — Under alternative 2, noise and the presence of equipment and crews during construction activities could result in direct, temporary impacts on northern spotted owls. These impacts could occur during parking lot expansion, installation of stormwater management infrastructure, restroom construction and relocation in the former Nursery Area and Entry Plaza, and construction of the Dipsea Trail footbridge over Redwood Creek. If owls are present in the vicinity of construction activities, noise or visual disturbances could cause individuals to flush the area, potentially resulting in disruptions to feeding, nesting, or breeding behavior. However, temporarily displaced individuals would likely return to their habitat once construction activities are complete. Parking lot expansion would result in the loss of approximately 0.2 acre of potential northern spotted owl foraging habitat, resulting in a long-term impact. This would not represent a substantial loss in overall potential foraging habitat at the monument, given the small amount of loss. If present in the project area, northern spotted owls would likely forage in adjacent habitats.

Most impacts would be avoided by seasonal and hourly restrictions on construction activities and other best management practices designed to avoid, minimize, or mitigate impacts on threatened and endangered species. No construction activities would occur at night or during dawn or dusk to avoid times when northern spotted owls are most active.

Rehabilitation of approximately 0.4 acre of riparian habitat in the Redwood Creek erosion hazard area of the Entry Plaza would have direct, long-term, beneficial impacts on the northern spotted owl, which is associated with this habitat type. Therefore, alternative 2 may affect but is not likely to adversely affect northern spotted owls.

Marbled Murrelet — The marbled murrelet has never been documented at the monument, although old-growth forest habitat, which is suitable for nesting, does exist at the monument. Alternative 2 would not result in the destruction or degradation of marbled murrelet habitat. Therefore, alternative 2 would have no impact on this species.

California Red-Legged Frog — The California red-legged frog has not been documented at the monument, and is not likely to be present because of a lack of suitable breeding habitat. However, ground disturbance associated with installation of the Dipsea Trail footbridge and culvert replacements would occur in areas that provide potentially suitable dispersal, foraging, and sheltering habitats. These activities could result in temporary impacts on the California red-legged frog in the unlikely event that this species is present during construction activities. Reduction of untreated stormwater runoff into Redwood Creek, stabilization of erosion hazard areas, and revegetation of portions of the Entry Plaza would result in long-term, beneficial impacts on California red-legged frog non-breeding habitat. Therefore, alternative 2 may affect but is not likely to adversely affect the California red-legged frog.

Cumulative Impacts. Cumulative Impacts from past, present, and reasonably foreseeable future actions would be the same as those described for alternative 1. When the impacts from alternative 2 are combined with the effects of other cumulative actions in the study area, an overall beneficial cumulative impact is expected. Alternative 2 would contribute a beneficial increment to the overall cumulative impact as a result of stormwater infrastructure improvements, which would improve habitat and water quality in Redwood Creek, and rehabilitation of riparian habitat in the Entry Area.

Conclusion. Alternative 2 would result in indirect, temporary impacts on coho salmon and steelhead trout from increased sedimentation and water quality degradation associated with ground disturbance during construction activities. Construction of the Dipsea Trail footbridge over Redwood Creek, revegetation of disturbed areas, and improvements to stormwater management infrastructure would have direct and indirect, long-term, beneficial impacts on coho salmon and steelhead trout because of improved water quality and reduced habitat disturbances associated with foot traffic on the Dipsea Trail at the Redwood Creek crossing. Northern spotted owls could potentially be directly and temporarily affected by noise and other disturbances associated with construction activities, although most impacts would be avoided by seasonal and hourly restrictions. Rehabilitation of riparian habitat in the Entry Area would have long-term, beneficial impacts on the northern spotted owl. Alternative 2 would have no effect on marbled murrelet because this species has not been documented at the monument, and no disturbances to old-growth forest habitat would occur. Alternative 2 may affect but is not likely to adversely affect the California red-legged frog because this species has not been documented at the monument, and is not likely to be present due to a lack of suitable breeding habitat. Overall, alternative 2 may affect but is not likely to adversely affect threatened or endangered species. Under alternative 2, all potential impacts would be avoided, minimized, or mitigated by the implementation of best management practices. Cumulative impacts would beneficial. Alternative 2 would contribute a beneficial increment to the overall cumulative impact.

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis.

Coho Salmon — Under alternative 3, impacts on coho salmon and their critical habitat associated with realigning the Dipsea Trail and constructing a footbridge over Redwood Creek, relocating restroom facilities in the Entry Plaza and constructing a new restroom in the Nursery Area, and rehabilitating riparian habitat in the Entry Plaza would be the same as those described under alternative 2. These impacts would be direct and indirect and would be both temporary and long term. Impacts commensurate with changes to water quality in Redwood Creek and reduced habitat disturbance from foot traffic at the Dipsea Trail crossing.

Under alternative 3, activities associated with the expansion of the Conlon Lot would be the same as those described under alternative 2, potentially resulting in similar indirect, short-term impacts commensurate with changes in water quality in Redwood Creek. Unlike, alternative 2, the Annex Lot would not be expanded under alternative 3. The former Nursery Area would be developed into a parking lot, resulting in indirect, short-term impacts on coho salmon and their critical habitat from sedimentation and degradation of water quality as a result of ground disturbances during construction. Implementation of best management practices would minimize these impacts, and upgrades to stormwater management infrastructure, including the installation of one new culvert in the former Nursery Area, infiltration trenches, and buffer strips would have indirect, long-term, beneficial impacts on coho salmon and their habitat, commensurate with improved water quality in Redwood Creek.

Installing a new woodland pedestrian trail between the Annex and Nursery Lots would result in indirect, temporary impacts on coho salmon and their critical habitat, from increased sedimentation and reduced water quality in Redwood Creek as a result of ground disturbance during construction. However, decommissioning the Muir Woods Road pedestrian trail would have indirect, long-term, beneficial impacts on coho salmon and their habitat because of decreased erosion from foot traffic, resulting in improved water quality in Redwood Creek.

Revegetation of the Muir Woods Road pedestrian trail and roadside parking areas would have indirect, long-term, beneficial impacts on coho salmon and their critical habitat commensurate with improved water quality and reduced erosion and sedimentation.

Overall, alternative 3 may affect but is not likely to adversely affect coho salmon. Potential impacts would be indirect and temporary, commensurate with impacts on water quality in Redwood Creek. However, these impacts would be minimized with the implementation of avoidance, minimization, and mitigation measures, and therefore would not be significant. Reduced erosion and sedimentation and improved water quality in Redwood Creek as a result of improved stormwater management infrastructure, construction of a footbridge over Redwood Creek, revegetation of disturbed areas, and rehabilitation of riparian habitat in the Entry Plaza would result in direct and indirect, long-term, beneficial impacts on coho salmon and their habitat.

Steelhead Trout — Impacts on steelhead trout under alternative 3 would be the same as those described for coho salmon because of the habitat overlap between the species.

Northern Spotted Owl — Under alternative 3, impacts on the northern spotted owl would be similar to those described under alternative 2. Potential impacts on northern spotted owls would consist of temporary disturbances to individuals as a result of noise and the presence of equipment and crews during construction activities and minimal loss of foraging habitat as a result of parking lot expansion.

Temporary impacts associated with expansion of the Conlon Lot, restroom relocation in the Entry Plaza, and construction of a footbridge over Redwood Creek would be the same as those described under alternative 2, and impacts from the installation of stormwater management infrastructure would be very similar. Noise and visual disturbances associated with development of a parking lot in the Nursery Area may affect northern spotted owls, but is not likely to adversely affect the owls. Impacts could occur wherever owls are present in the vicinity of construction activities.

Most impacts would be avoided by seasonal and hourly restrictions on construction activities and other best management practices designed to avoid, minimize, or mitigate impacts on threatened and endangered species. No construction activities would occur at night or during dawn or dusk to avoid times when northern spotted owls are most active. Temporarily displaced individuals would likely return to their habitat once construction activities are completed.

Rehabilitation of approximately 0.4 acre of riparian habitat in the Redwood Creek erosion hazard area of the Entry Plaza would have direct, long-term, beneficial impacts on the northern spotted owl, similar to alternative 2. Therefore, alternative 3 may affect but is not likely to adversely affect northern spotted owls.

Marbled Murrelet — The marbled murrelet has never been documented at the monument, although old-growth forest habitat, which is suitable for nesting, does exist at the monument. Alternative 3 would not result in the destruction or degradation of marbled murrelet habitat. Therefore, alternative 3 would have no impact on this species.

California Red-Legged Frog — Potential impacts on the California red-legged frog would be similar to those described under alternative 2. This species has not been documented at the monument and is not likely to be present due to a lack of suitable breeding habitat. However, ground disturbance associated with installation of the Dipsea Trail footbridge and culvert replacements could result in temporary impacts on the California red-legged frog in the unlikely event that this species is present in non-breeding habitats during construction activities. Reduction of untreated stormwater runoff

into Redwood Creek, stabilization of erosion hazard areas, and revegetation of portions of the Entry Plaza would result in long-term beneficial impacts on California red-legged frog non-breeding habitat. Therefore, alternative 3 may affect but is not likely to adversely affect the California red-legged frog.

Cumulative Impacts. Cumulative Impacts from past, present, and reasonably foreseeable future actions would be the same as those described for alternative 1. When the impacts from alternative 3 are combined with the effects of other cumulative actions in the study area, an overall beneficial cumulative impact is expected. Alternative 3 would contribute a beneficial increment to the overall cumulative impact as a result of stormwater infrastructure improvements, which would improve habitat and water quality in Redwood Creek, and rehabilitation of riparian habitat in the Entry Area.

Conclusion. Alternative 3 would result in indirect, temporary impacts on coho salmon and steelhead trout from sedimentation and water quality degradation during construction. Construction of the Dipsea Trail footbridge over Redwood Creek, revegetation of disturbed areas, and improvements to stormwater management infrastructure would have direct and indirect, long-term, beneficial impacts on coho salmon and steelhead trout as a result of improved water quality and reduced habitat disturbances associated with foot traffic on the Dipsea Trail at the Redwood Creek crossing. Northern spotted owls could potentially be affected by noise and other disturbances associated with construction activities. Rehabilitation of riparian habitat in the Entry Area would have long-term, beneficial impacts on the northern spotted owl. Alternative 3 would have no impacts on marbled murrelet because no disturbances to old-growth forest habitat would occur. Alternative 3 may affect, but is not likely to adversely affect, the California red-legged frog because this species is not likely to be present in the project area. Overall, alternative 3 may affect but is not likely to adversely affect threatened or endangered species. Under alternative 3, all potential impacts would be avoided, minimized, or mitigated by the implementation of best management practices. Cumulative impacts would be beneficial. Alternative 3 would contribute a beneficial increment to the overall cumulative impact.

CULTURAL RESOURCES

Methodology and Assumptions

As noted in chapter 3, resources that are listed in the national register or resources that are considered eligible for the national register or that NPS staff consider archeologically sensitive are located within the area of potential effects. Cultural resources that could be affected are the national register-listed Muir Woods Historic District, the national register-listed Dipsea Trail, two national register-eligible archeological sites, and areas of archeological sensitivity east of the Annex Lot and around the Conlon Lot.

The analysis of impacts is based on a review of existing literature, data, maps, information provided by NPS staff, and professional judgment. Impacts are defined as activities that affect any character-defining features of the historic and archeological resources within the area of potential effects. Impacts could come from removing historic materials and activities that change the nature of the resource, adding new trails, excavating in areas of archeological sensitivity, and visual impacts that detract from the natural setting of the Dipsea Trail and the Muir Woods Historic District.

Impacts of Alternative 1: No Action

Analysis. Under alternative 1, existing management would continue, and no additional construction or ground disturbance would be required. Privately owned vehicles would continue to park along

the shoulder of Muir Woods Road, but there would be no new adverse or beneficial impacts on cultural resources in these areas. The road is not part of the Muir Woods Historic District and has been identified as not a national register-eligible resource, either archeologically or above ground. Because of the location of shoulder parking, it would have no physical or visual impacts on the Muir Woods Historic District.

Cumulative Impacts. The implementation of the reservation system will limit the number of vehicles parking at the monument, reducing the number of vehicles that would be able to park along the shoulder of Muir Woods Road and limiting the number of visitors at the monument at any given time. A reduction in visitation would have a beneficial effect on the Muir Woods Historic District by reducing or eliminating its overuse.

The Muir Woods Road Bridge Replacement Project is located in the southern portion of the monument along Muir Woods Road. Out of visual range from the Muir Woods Historic District, the replacement of the bridge and the realignment of Muir Woods Road would have no effect on the historic district. An archeological survey of the area conducted in 2015–2016 yielded no resources on NPS land in the vicinity of the bridge, and the area was not identified as being archeologically sensitive (Gavette 2016). Work on the bridge is expected to be conducted in the-right-of way, and coordination among the National Park Service, the California Department of Transportation, and the California State Historic Preservation Office throughout the course of construction activities would avoid or minimize any impact on cultural resources, if discovered during construction.

As part of the Muir Woods Road Rehabilitation Project, portions of Muir Woods Road would be resurfaced, and a number of culverts would be repaired or replaced. No resources in these areas were identified in the 2015–2016 archeological survey of the area; however, monitoring during construction was recommended (Gavette 2016). The study also recommended that if any resources were discovered, construction would be stopped, and the National Park Service would follow procedures as outlined in 36CFR 800.13 (post review discoveries) (Gavette 2016). If no resources are discovered and if the procedures outlined in 36CFR 800.13 are followed, this project would result in no adverse impacts on cultural resources.

The Muir Woods Lift Station Rehabilitation Project would likely require ground disturbance and excavation. Removal and compaction would expose and disturb soils that have already been identified as potentially archeologically sensitive for subsurface resources in the recent archeological survey (Gavette 2016). The survey recommended monitoring earth disturbing activities and following 36 CFR 800.13 if resources are discovered during construction. Similar to the Muir Woods Road Rehabilitation Project, this project would have no adverse impact on cultural resources if the procedures outlined in 36 CFR 800.13 are followed. It is also quite possible that the soils around the existing lift station are already disturbed and are no longer archeologically sensitive. Consequently, the project would result in no adverse impact.

The Muir Woods Salmon Habitat Enhancement and Bridge Replacement Project would remove riprap from the banks of Redwood Creek, which would require excavation of large boulders and the placement of large woody debris in the creek. This activity would have an adverse impact on the rip-rap as a historic feature, but have no adverse impacts on known archeological resources (Gavette 2016). However the project may require ground disturbance along Redwood Creek in an area outside the area of potential effects and would not affect the historic district as a whole. Since creek banks are often considered archeologically sensitive, an adverse impact on subsurface archeological resources could occur from ground disturbance during removal of the riprap. However, the earth-disturbing activities would also be monitored to minimize any impacts on archeological resources. The project would also replace four bridges within the Muir Woods Historic District. The

replacement bridge designs would follow the guidance of the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995). Consequently the removal and subsequent replacement of the four bridges would not result in adverse impacts.

Cumulative impacts on cultural resources from these projects would include ground disturbance in the vicinity of areas identified as archeologically sensitive at the lift station and along Redwood Creek. However, these activities would be monitored to avoid impact to the extent possible. Replacement of the bridges inside the Muir Woods Historic District would follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties* and thus have no adverse impact on the historic district (NPS 1995). Consequently, the bridge replacements would have no adverse impacts.

Conclusion. Under alternative 1, the potential for minimal, adverse impacts on landscape features, archeologically sensitive areas, and bridge replacement would be minimized by monitoring and documenting proposed earth-moving activities in the area of Redwood Creek and the lift station and following the Secretary of the Interior's *Standards for the Treatment of Historic Properties* for the design of the bridges (NPS 1995). Consequently alternative 1 would contribute minimal, adverse impacts to cumulative impacts that are otherwise expected to be largely beneficial.

Impacts of Alternative 2: Roadside Parking, Annex Lot Expansion, and Sustainable Access Improvements

Analysis. Under alternative 2, construction activities related to the Annex Lot expansion would occur in an area that avoids archeological site CA-MRN-722H, resulting in no adverse impact on the archeological site. This expansion would not alter the visual aesthetics of the Muir Woods Historic District because the affected area would be in the same location as the existing lot. Monitoring for archeological resources would occur during the construction of infiltration trenches around each lot because the 2015–2016 archeological survey of the area indicated the potential archeological sensitivity of the soil and the need for monitoring during construction. The Annex Lot would expand by 0.02 acre, but the expansion site would be located in an area that has not been identified as archeologically sensitive. The design of the expansion of the Annex Lot would avoid site CA-MRN-722H. Soil compaction and disturbance caused by staging and stockpiling of construction equipment and materials would be avoided in areas of archeological sensitivity.

The former Nursery Area is the site of the Second Lodge of Camp Kent (about 1910–1924), while the Conlon Lot is the site of the original Camp Kent campgrounds (1898–1923) (Gavette 2016). The sensitive areas around the Conlon Lot could be adversely affected, but planned monitoring would minimize and mitigate this impact. Demolition and revegetation activities in the former Nursery Area would be monitored in the same way as the Conlon Lot to minimize or mitigate any impacts.

Although the national register-listed Dipsea Trail would be rerouted and a new bridge would be built, this change would have no adverse impact on the trail as a whole. The national register nomination indicated that the route of the trail and its individual features have changed over its lifetime, making these proposed modifications part of the ever-changing nature of the trail. The section planned for reroute is very small, and the proposed bridge would be designed to meet the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995). Consequently, there would be no adverse impact on the Dipsea Trail or the Muir Woods Historic District.

The new wayfinding signs and interpretive media proposed under this alternative would follow NPS signage guidelines and would have no adverse impacts on the integrity of the Muir Woods Historic

District because they would not be placed within the historic district. The new restrooms in the Entry Plaza and near the former Nursery Area would be designed in a style that is in keeping with the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995). Consequently, the addition of the restrooms would have no adverse impact on the Muir Woods Historic District or the monument. The necessary sewer and water lines would avoid the known archeological sites and be subject to archeological monitoring during construction, resulting in no adverse impacts on any potential resources. The creation of a new trail between the Conlon Lot and the Annex Lot would have no adverse impact because it would be constructed on fill and located in previously surveyed areas where no archeologically sensitive sites or soils were identified. The trail would not affect the Muir Woods Historic District because it would not be visible from the historic district.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 2 would result in short- and long-term, adverse impacts in areas that would be affected by management actions. Although greater than those caused by alternative 1, the adverse impacts would be minimal. Any potential impacts would be mitigated through monitoring, site avoidance, and appropriate design. When the impacts of alternative 2 are combined with the effects of cumulative actions in the project area, additional adverse impacts are expected. The overall adverse impact would be minimal.

Conclusion. Under alternative 2, impacts on cultural resources would be direct, short- and long-term, and minimal because known archeological sites would be avoided, new structures would be designed to follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995), and areas of archeological sensitivity would be monitored. Although the impacts would be within the area of potential effects, most would occur outside the Muir Woods Historic District. There would be no adverse impacts from expansion of the Annex Lot, while work at the Conlon Lot would require monitoring to avoid or minimize impacts. The introduction of new restroom facilities in the Entry Plaza and the former Nursery Area would have minimal impact because the design would follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995).

Impacts of Alternative 3: Nursery Parking and Sustainable Access Improvements

Analysis. Under alternative 3, construction activities related to the creation of a new parking lot in the former Nursery Area would avoid the identified archeological site and have no effect on the Muir Woods Historic District because of the new parking lot's distance from the historic district; alternative 3 would eliminate any visual impacts on the historic district.

Similar to alternative 2, construction of infiltration trenches around each lot would avoid archeologically sensitive area and be subject to archeological monitoring. Soil compaction and disturbance caused by staging and stockpiling of construction equipment and materials would be avoided in areas of archeological sensitivity. The impacts associated with the expansion of the Conlon Lot, alterations to the Dipsea Trail, installation of additional wayfinding signs and interpretive media, and construction of a restroom in the Entry Plaza would be the same as those described under alternative 2.

Decommissioning the Muir Woods Road pedestrian trail would beneficially change the appearance of the monument by establishing vegetation along the roadside and improving the visual approach to the Muir Woods Historic District. The proposed eastern end of the new woodland pedestrian trail connecting the Annex Lot to the Nursery Lot and the new restroom would be built in

archeologically sensitive areas. However, impacts would be minimized or avoided by constructing the trail on fill and monitoring the project during construction. If avoidance measures are undertaken, the overall activities proposed in alternative 3 would result in no direct, long- or short-term, adverse impacts on cultural resources.

Cumulative Impacts. Impacts from past, present, and reasonably foreseeable future actions considered in the cumulative impacts analysis would be the same as those described for alternative 1. Alternative 3 would result in minimal, direct, short- and long-term, impacts in some archeologically sensitive areas. However, it is expected that most of these impacts would be mitigated through avoidance, monitoring, and compliance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995). When the impacts of alternative 3 are combined with the effects of cumulative actions in the project area, an overall minimal, direct impact is expected.

Conclusion. Under alternative 3, impacts on cultural resources would be minimal, direct, short- and long-term because known archeological sites would be avoided, structure design would follow the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (NPS 1995), and areas of archeological sensitivity would be monitored. Most of the activities proposed under alternative 3, while in the area of potential effects, would occur in locations outside the Muir Woods Historic District. There would be no adverse impacts from the construction of the Nursery Lot, while work at the Conlon Lot would require monitoring to avoid or minimize impacts. The relocation or construction of new restroom facilities in the Entry Plaza and the former Nursery Area would have no impact because they would follow the Secretary of the Interior's s *Standards for the Treatment of Historic Properties* (NPS 1995). Similar to alternative 2, the overall impact of alternative 3 would be minimal.

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CHAPTER 5: CONSULTATION AND COORDINATION

This chapter describes the public involvement and agency consultation during the preparation of the Muir Woods National Monument Sustainable Access Project Environmental Assessment. A combination of activities, including internal scoping, has helped to guide the National Park Service in developing this environmental assessment. This chapter provides a detailed list of the various consultations initiated during the development of the document.

PLANNING AND PUBLIC INVOLVEMENT

NEPA regulations require an "early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). The internal scoping process for the Muir Woods National Monument Sustainable Access Project Environmental Assessment began on October 5, 2011. Internal and external scoping associated with this environmental assessment has been extensive and has included dozens of internal interdisciplinary team meetings and reviews.

Public Involvement

Public scoping for this environmental assessment began with a public notice issued on September 4, 2013. The document contained information on the project and was posted on the NPS Planning, Environment, and Public Comment (PEPC) website. The public comment period closed on January 11, 2014.

The National Park Service also held agency and public scoping meetings to gather input on the environmental assessment on September 18, 2013, in Mill Valley, California. The public meeting was held at the Tam Valley Elementary School from 6:30 pm to 8:30 pm. The meeting began with a presentation and was followed by an open house, allowing the public to view display boards and other informational materials describing the project background and project area, the purpose and need for improved access, and possible issues and impact topics to be analyzed in the environmental assessment. The public also had the opportunity to speak to personnel from Golden Gate National Recreation Area and from the monument to raise concerns and have their questions answered.

During the comment period, the National Park Service received 177 correspondences. The majority of these comments concerned potential alternatives and alternative elements. These alternatives and elements include, but are not limited to, constructing a parking lot on Panoramic Highway; implementing a reservation system to reduce congestion; enforcing restrictions on roadside parking; and making improvements to existing parking infrastructure. Commenters also provided input on issues concerning visitor experience and safety, including suggestions on how to alleviate these issues. The National Park Service continued to gather information to guide the project in several public meetings and during a gathering of community leaders convened by Congressman Jared Huffman in 2014.

A final public scoping meeting was held on June 27, 2016, at the Tamalpais High School Student Center. At the meeting, NPS staff presented the planning background, an updated analysis of project area resources, and a range of action alternatives. The National Park Service also introduced alternative 3 as the likely preferred alternative.

The environmental assessment will be open to formal public and agency review for 30 days. Interested individuals, agencies, and organizations will be notified of its availability. The document

will be available for public review on the NPS Planning, Environment, and Public Comment website at https://parkplanning.nps.gov/projectHome.cfm?projectID=48923, and hard copies will be available at both the monument and local public libraries.

AGENCY CONSULTATION

The National Park Service has initiated consultation with relevant agencies during the preparation of this environmental assessment. This consultation is discussed in more detail below. Copies of correspondence between the National Park Service and other agencies, and responses from the agencies, if applicable, will be provided in the decision document.

Section 7 of the Endangered Species Act

Section 7 of the Endangered Species Act requires federal agencies to consult with the US Fish and Wildlife Service regarding the potential for proposed actions to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. As described in the "Threatened or Endangered Species" section of chapter 3, federally listed species and designated critical habitat occur in the vicinity of the project area. As a result, the National Park Service has sought concurrence from both the US Fish and Wildlife Service and the National Marine Fisheries Service on the determination that the project may affect, but is not likely to adversely affect, federally listed species.

Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the impacts of their undertakings on historic properties. This environmental assessment evaluates impacts on cultural resources according to NPS *Management Policies 2006*. Compliance with section 106 of the National Historic Preservation Act is being carried out separately but concurrently with the planning process. The National Park Service sent a letter to the California State Historic Preservation Office in September 2013 initiating consultation on the project (NPS, 2016i). In a letter dated May 5, 2016, the National Park Service wrote to the California State Historic Preservation Office describing the area of potential effect and provided an archeological survey of the project area, identifying two sites and recommending monitoring for those locations as well as other areas with archeological sensitivity (Gavette 2016). The California State Historic Preservation Office replied on July 6, 2016, acknowledging the continuation of consultation and approving the area of potential effect.

ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
°C	degrees Celsius
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CFR	Code of Federal Regulations
CNPS	California Native Plant Society
CUA	Commercial Use Authorization
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
monument	Muir Woods National Monument
national register	National Register of Historic Places
NEPA	National Environmental Policy Act
NPS	National Park Service
NTU	nephelometric turbidity units
PEPC	Planning, Environment, and Public Comment
USACE	US Army Corps of Engineers
USC	United States Code
USFWS	US Fish and Wildlife Service

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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